REGION 9

SAN FRANCISCO, CA 94105

October 1, 2025

MEMORANDUM

SUBJECT: Final Interim Feasibility Study

FROM: Amanda Cruz, Remedial Project Manager

EPA has finalized the Feasibility Report for the Interim Remedy, dated August 2025. This Interim Remedy Feasibility Study (FS) was prepared for the United States Environmental Protection Agency (EPA) to support the development of the interim remedy for the Orange County North Basin (North Basin) to address groundwater contaminated with volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) originating from known or suspected sources in the North Basin. The Interim FS was developed by OCWD and finalized by EPA. The Interim Remedy containment area, also referred to as the Target Area, covered approximately 47 percent of the overall North Basin VOC plume, at the time of the Remedial Investigation (RI). The Target Area has the highest concentrations in the North Basin. The alternatives screened against the 9 criteria in the FS include options to prevent vertical and horizontal migration of the highest contamination in the North Basin from spreading and further impacting drinking water wells. The North Basin is in the northern portion of the Orange County groundwater basin, which has beneficial uses of groundwater, including municipal supply. This groundwater supply provides approximately 85 percent of the potable water for 2.5 million people in central, western, and northern Orange County.

The EPA will utilize this FS and develop a Proposed Plan to address the spreading contamination. The Proposed Plan is anticipated to go for public comment in the Second Quarter of Fiscal Year 2026. During the public comment period the EPA will hold a series of public meetings to inform the public on the Proposed Plan and to gather feedback from the community. Following the public comment period EPA will take the public feedback and issue a remedy document known as the Record of Decision.

Attachments: Orange County North Basin Superfund Site, Interim Remedy Feasibility Study Report, Final August 2025

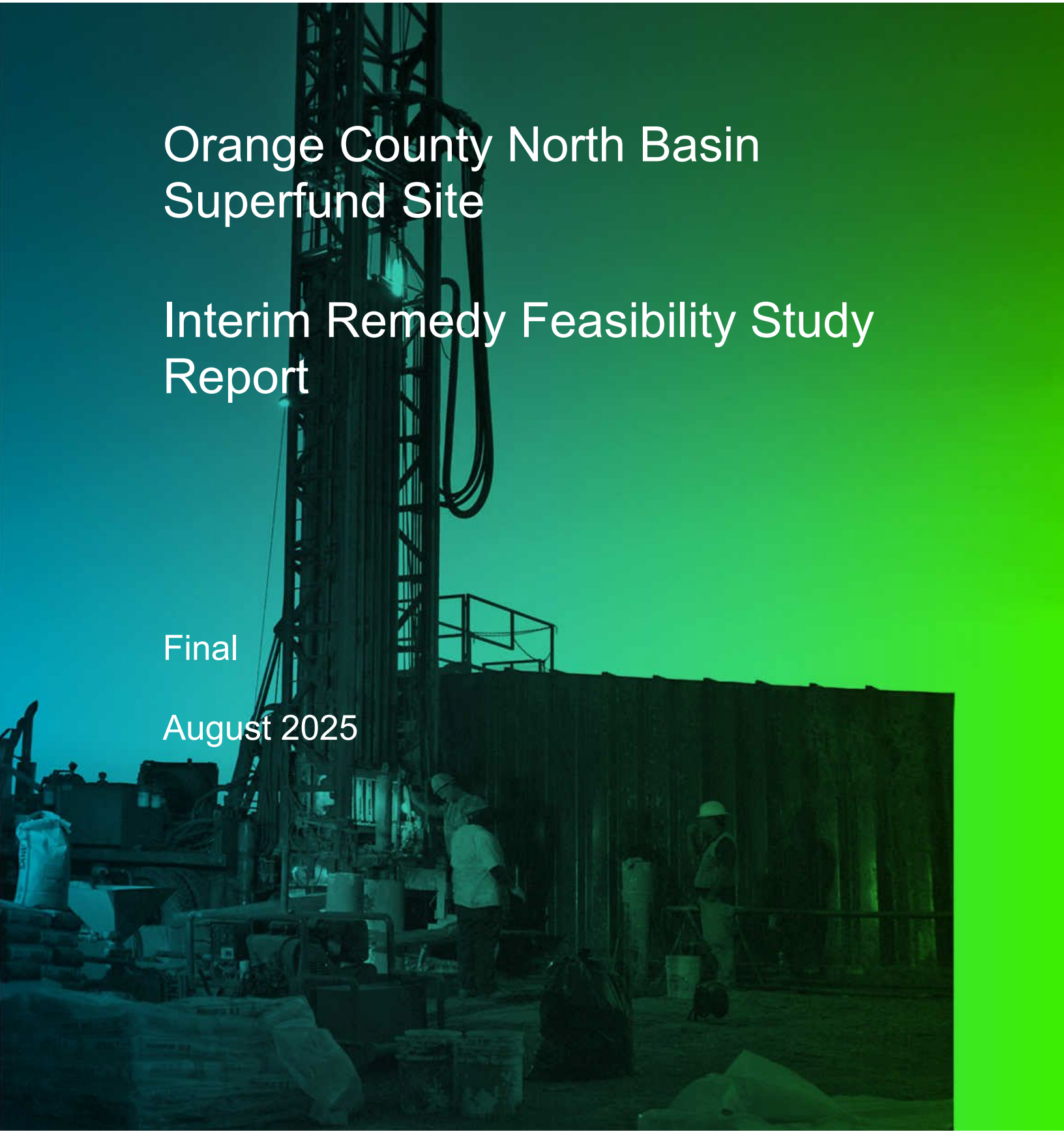
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U.S. Environmental Protection Agency

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Orange County North Basin Superfund Site

Interim Remedy Feasibility Study Report

Final

August 2025

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Orange County North Basin Superfund Site

Interim Remedy Feasibility Study Report

Final
August 2025

Prepared for:

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Preface

This Interim Remedy Feasibility Study (FS) was prepared for the United States Environmental Protection Agency (EPA) to support the development of the interim remedy for the Orange County North Basin (North Basin) to address groundwater contaminated with volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) originating from known or suspected sources in the North Basin, and to further characterize the nature and extent of VOCs and SVOCs in groundwater in the North Basin. The Interim FS was developed by OCWD and finalized by EPA. This document was prepared pursuant to the Administrative Settlement Agreement, EPA Docket Number 2016-03.

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Acronyms and Abbreviations

µg/L	micrograms per liter
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
1,2,3-TCP	1,2,3-trichloropropane
Acceptable exposure levels	COC concentrations protective of human health and the environment, based on ARARs or risk-based levels
AECOM	AECOM Technical Services, Inc.
AFY	acre-feet per year
AOP	advanced oxidation process
ARAR	applicable or relevant and appropriate requirement
AS	air stripping
ASA	Administrative Settlement Agreement
BEA	Basin Equity Assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
ClO_4	perchlorate
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
DDW	Division of Drinking Water
DTSC	California Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EW-1	extraction well OCWD-EW1
FBR	fluidized bed reactor
FS	Feasibility Study
GAC	granular-activated carbon
gpm	gallons per minute
GRA	general response action
GWRS	Groundwater Replenishment System
H_2O_2 AOP	hydrogen peroxide in the advanced oxidation process
HERO	Office of Human and Ecological Risk
HRA	health risk assessment
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IC	institutional control
IX	ion exchange
LGAC	liquid-phase granular-activated carbon
MCL	maximum contaminant level
mg/L	milligrams per liter
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution and Contingency Plan
ng/L	nanograms per liter
NL	notification level
North Basis	Orange County North Basin
NPL	National Priorities List
OC San	Orange County Sanitation District
OCWD	Orange County Water District
OEHHA	Office of Environmental Health Hazard Assessment
O&M	operation and maintenance

PCE	tetrachloroethene
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutane sulfonic acid
PFHxS	perfluoro hexane sulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonic acid
POTW	publicly owned treatment works
PP	Proposed Plan
ppt	parts per trillion
project	Orange County North Basin Superfund Site
RA	Remedial Action
RAO	remedial action objective
RD	Remedial Design
RI	remedial investigation
RI report	Remedial Investigation and Feasibility Study, Orange County North Basin Remedial Investigation Report
RO	reverse osmosis
ROD	Record of Decision
RpA	Replenishment Assessment
RSL	regional screening level
RWQCB	Regional Water Quality Control Board
site	Orange County North Basin Superfund Site
State Water Board	State Water Resources Control Board
SVOC	Semi-volatile organic compound
Target Area	Interim Remedy containment area
TBC	To Be Considered
TCE	trichloroethene
TDS	total dissolved solids
TOP	Total Organic Precursors
UV	ultraviolet
VGAC	vapor-phase granular-activated carbon
VOC	volatile organic compound
VI	vapor intrusion
Work Plan	Feasibility Study Orange County North Basin Work Plan
Work Plan Addendum	Remedial Investigation and Feasibility Study Orange County North Basin Work Plan Addendum

Executive Summary

The U.S. Environmental Protection Agency (EPA) and Orange County Water District are completing a Feasibility Study (FS) to support development of an interim remedy to address groundwater with high levels of volatile organic compounds (VOCs) and the semi-volatile organic compound (SVOC) 1,4-dioxane originating from known or suspected sources in the Orange County North Basin (North Basin), and to characterize further the nature and extent of VOCs and 1,4-dioxane contamination in groundwater. The Interim Remedy containment area, also referred to as the Target Area, covered approximately 47 percent of the overall North Basin VOC plume, at the time of the Remedial Investigation (RI) and Feasibility Study, Orange County North Basin RI Report (AECOM 2022) and shown on Figure 2-3.

This FS Report presents the development and evaluation of remedial alternatives to support selection of the Interim Remedy. The Interim Remedy will address potential risks to human health and the environment because of the high VOCs and 1,4-dioxane in the impacted groundwater within the Interim Remedy containment area. Although potential risks related to the impacted groundwater have been identified, all the water being served to the public in the North Basin service area meets State and federal drinking water standards. The FS complies with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Pollution and Contingency Plan in Part 300 under Title 40 of the Code of Federal Regulations.

The analyses of the remedial alternatives that are presented in this FS Report are intended to provide adequate information concerning remedial action (RA) options to decision-makers to enable them to address the VOC and 1,4-dioxane-impacted groundwater. The results of these analyses will be used as the basis for selection of an appropriate Interim Remedy during development of the Proposed Plan and Record of Decision.

Selection of Contaminants of Concern

All RAs at CERCLA sites must be protective of human health and the environment and comply with applicable or relevant and appropriate requirements (ARARs) unless a waiver is justified. Therefore, the selection of contaminants of concern (COCs) for the North Basin groundwater Interim Remedy was based on human health risk considerations and ARARs as described below. The North Basin is in the northern portion of the Orange County groundwater basin, which has beneficial uses of groundwater, including municipal supply. This groundwater supply provides approximately 85 percent of the potable water for 2.5 million people in central, western, and northern Orange County. This drinking water

supply must meet federal maximum contaminant levels (MCLs), and more stringent California MCLs.

Based on the groundwater sampling and analytical data that was collected during the RI and previous investigations, it was found that the following analytes consistently exceeded their respective federal and/or State MCLs in groundwater:

- Tetrachloroethene (PCE) (MCL is 5 micrograms per liter [µg/L])
- Trichloroethene (TCE) (MCL is 5 µg/L)
- 1,1-Dichloroethene (1,1-DCE) (MCL is 6 µg/L)
- 1,2,3-Trichloropropane (1,2,3-TCP) (MCL is 0.005 µg/L)
- 1,2-Dichloroethane (1,2-DCA) (MCL is 0.5 µg/L)

In addition to the above contaminants, 1,4-dioxane was selected as a COC based on its widespread distribution in the North Basin area and its contribution to the cumulative excess lifetime cancer risk exceeding 1×10^{-4}. Because there is no federal or State MCL for 1,4-dioxane, the acceptable exposure level is the State Notification Level (NL) of 1 µg/L. Therefore, PCE, TCE, 1,1-DCE, 1,2,3-TCP, 1,2-DCA, and 1,4-dioxane were selected as the COCs for the North Basin groundwater Interim Remedy based on the ARARs and human health risk considerations (AECOM 2022). The VOCs 1,2,3-TCP and 1,2-DCA were detected at concentrations exceeding the MCLs at fewer locations and within the footprint of the other COCs. Therefore, the distribution of COCs discussed in this document focuses on the "primary" COCs PCE, TCE, 1,1-DCE, and 1,4-dioxane.

Nitrate-nitrogen (MCL is 10 milligrams per liter), perchlorate (MCL is 6 µg/L), perfluorooctanoic acid (MCL is 4 nanograms per liter [ng/L]), perfluorooctanesulfonic acid (PFOS; MCL is 4 ng/L), and other non-VOC constituents also have been detected at concentrations that exceed MCLs or NLs (AECOM 2022). Although not considered COCs, these constituents will be considered during Interim Remedy selection and design to ensure that groundwater treatment technologies comply with all applicable ARARs.

Development of Remedial Action Objectives

Remedial action objectives (RAOs) establish acceptable exposure levels that are protective of human health and the environment and consider several factors, including ARARs, cancer risk/non-cancer hazards, technical limitations such as detection limits, uncertainty, and other pertinent information. Acceptable exposure levels for COCs in the North Basin are based on ARARs (e.g., MCLs) or risk-based levels within the risk range of 1×10^{-6} and 1×10^{-4} in accordance with the National Oil and Hazardous Substances Pollution and Contingency Plan (NCP). The RAOs for the North Basin Interim Remedy are as follows, based on the RI/FS guidance:

- **RAO #1**: Prevent exposure via direct contact (e.g., ingestion, dermal contact, and inhalation of vapors coming from water while showering) with contaminated groundwater with concentrations of trichloroethene, tetrachloroethene, 1,1-dichloroethene, 1,4-dioxane, 1,2-dichloroethane, and 1,2,3-trichloropropane that exceed acceptable exposure levels.
- **RAO #2**: Prevent further lateral migration outside of the containment area of the COCs trichloroethene, tetrachloroethene, 1,1-dichloroethene, and 1,4-dioxane in the Shallow zone. Prevent further vertical migration of COCs from the containment area in the Shallow zone to protect the beneficial use as drinking water in the Principal zone.

The RAOs for this interim action will function to support the final Site objective which is anticipated to be to restore the Shallow and Principal aquifers as a drinking water source (i.e., meet drinking water standards throughout the entire plume). A preliminary remediation goal was not established for this interim action; a final remediation goal will be determined when the final remedy is selected for the overall Site action. During Interim Remedy implementation a water quality assessment of the Site will establish the pre-remediation concentrations and spatial distribution of COCs within the Shallow and Principal Aquifers.

Development of Remedial Alternatives

The remedial alternatives were developed by:

- Identification of potential treatment and disposal technologies as general response options
- Screening of potential treatment and disposal technologies based on technical impracticability
- Evaluation of process options based on effectiveness, implementability, and relative cost
- A combination of media-specific technologies as alternatives
- Screening of alternatives

After the screening of alternatives was completed, selected technologies were evaluated using the NCP criteria for a detailed analysis of the various alternatives. A numerical groundwater flow model was used to support evaluation of remedial alternatives for the FS. The Orange County North Basin Groundwater Modeling Report (Intera 2017), North Basin Model Refinements Technical Memorandum (Intera 2021), and Groundwater Modeling of North Basin Interim Remedy Containment Scenarios Technical Memorandum (Intera 2024) document the groundwater model development, refinements, and use of that model to develop and evaluate plume containment scenarios, respectively.

The remedial alternatives that were considered for detailed evaluation included:

- Alternative 1: no action

- Alternative 2: groundwater extraction; discharge to publicly owned treatment works/ groundwater replenishment system, monitoring, and institutional controls (ICs)
- Alternative 3: groundwater extraction; discharge to a central treatment plant; discharge for direct use (potable water), monitoring, and ICs
- Alternative 4: groundwater extraction; discharge to a central treatment plant; discharge to injection wells, monitoring, and ICs
- Alternative 5: groundwater extraction; discharge to a central treatment plant; discharge to an infiltration basin, monitoring, and ICs
- Alternative 6: groundwater extraction from two groups of extraction wells (Groups 1 and 2) and discharges to two treatment plants (Group 1 discharges to injection wells and Group 2 discharges to an infiltration basin), monitoring, and ICs

EPA notes that an additional approach (monitored natural attenuation [MNA] and ICs) was thoroughly considered but is not presented as an alternative because it would not be protective of human health and the environment. However, in the interest of transparency and to demonstrate to the public the extent to which EPA has attempted to identify alternatives, information readily available to EPA regarding MNA and ICs approach is presented. EPA also notes that while two of the alternatives analyzed would not be implementable at the full volumes assessed due to current infrastructure limitations, they are presented for public consideration so that EPA can take into account public input and potentially issue modifying documentation in the future.

Finally, EPA emphasizes that the Interim Remedy alternatives address the most contaminated part of the Orange County North Basin regional plume while the Regional Aquifer Plume RI/FS is underway by EPA to ensure that the entire plume will be addressed. The basis for development of these Interim Remedy alternatives is discussed in Sections 5 and 6 of this FS. Additional investigations and analysis may be conducted during Remedial Design (RD) to optimize remedy performance.

A total of 17 extraction wells are proposed for the containment remedy in Alternatives 2 through 6. Alternatives 3 through 6 use the preferred treatment technology of primary treatment with liquid-phase granular-activated carbon (LGAC) to remove VOCs and secondary treatment with an ultraviolet (UV) advanced oxidation process (AOP) to treat 1,4-dioxane. Based on current estimated influent concentration at the treatment plant, PFOS concentrations will slightly exceed the MCL of 4 ng/L; however, based on the ability of LGAC to treat low concentrations of per- and polyfluoroalkyl substances (PFAS), the assumed treatment sequence (LGAC and UV AOP) is considered appropriate to address potential PFAS concentrations. Although not considered COCs, nitrate, perchlorate, and PFAS are considered during Interim Remedy selection and design to ensure that groundwater

treatment technologies comply with all applicable ARARs. Future changes to current regulatory and/or risk-based contaminant thresholds for emergent contaminants may drive changes to the treatment technologies evaluated in this report, or expansion of the RD to address new requirements.

Table 7-1 summarizes the detailed evaluation of remedial alternatives that are presented in this FS. Alternative 1 did not satisfy all NCP evaluation criteria and is therefore not eligible for selection. Alternatives 2 through 6 satisfy the evaluation criteria, with Alternative 4 having the lowest present-worth cost of the active remedial alternatives that were rated fair or better for implementability, at $248.9 million and a capital cost of $118 million. Although Alternative 3 would have a lower present worth cost, it would have a significantly lower implementability (rated poor to fair) because the City of Fullerton is not currently able to commit to receiving this treated groundwater.

1. Introduction

The U.S. Environmental Protection Agency (EPA) is completing a Feasibility Study (FS) to support development of an Interim Remedy to address groundwater impacted by volatile organic compounds (VOCs) and the semi-volatile organic compound (SVOC) 1,4-dioxane, originating from known or suspected sources in the Orange County North Basin (North Basin) Superfund Site (Site), and to characterize the nature and extent of VOC and 1,4-dioxane contamination in groundwater. The Site encompasses an approximately 7-square-mile portion of the groundwater aquifer under Fullerton, Anaheim, and Buena Park in Orange County, California. The Interim Remedy containment area (Target Area) covers approximately 47 percent of the overall North Basin VOC plume, as shown in the North Basin Remedial Investigation report (RI report; AECOM 2022) later discussed in this section.

The FS complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Pollution and Contingency Plan in Part 300 under Title 40 of the Code of Federal Regulations (40 CFR Part 300).

The RI and initial preparation of the FS were conducted pursuant to EPA's Administrative Settlement Agreement (ASA) Docket Number 2016-03 (Appendix A) with the Orange County Water District (OCWD). Funding for that portion of the project was provided in full or in part under Proposition 1 the Water Quality, Supply, and Infrastructure Improvement Act of 2014, through an agreement with the State Water Resources Control Board (State Water Board). The contents of this document do not necessarily reflect the views and policies of the foregoing, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

1.1 Purpose and Approach for the Feasibility Study

The purpose of this FS Report is to develop and evaluate appropriate interim remedial action alternatives to support the selection of the Interim Remedy. The Interim Remedy is intended to be implemented to address potential risks to human health and the environment due to the impacted groundwater within and downgradient from the Interim Remedy containment area. The analyses of the remedial alternatives presented in this FS Report are intended to provide adequate information concerning remedial action options to decision-makers to address the VOC and 1,4-dioxane-impacted groundwater in the Interim Remedy containment area. The results of these analyses will be used as the basis for the selection of the appropriate Interim Remedy in the Interim Remedy containment area during the Proposed Plan (PP) and Record of Decision (ROD) project phases. Additionally, EPA is also presenting information on

approaches not considered alternatives, but for which EPA's analysis may be informative for the public.

The following guidance documents were used extensively for the preparation of this FS Report:

- Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988)
- National Oil and Hazardous Substances Pollution and Contingency Plan (NCP) (EPA 1994)

This FS presents relevant information concerning the site and analyses of potential remedial action alternatives. The following general steps were completed during this FS:

Refinement of the Conceptual Site Model (CSM): The CSM is an engineering management tool that summarizes the nature and extent of the release, environmental media impacted, fate and transport of the contaminants of potential concern (COPCs), potential receptors and exposure pathways, and assessments of risk to human health and the environment. The CSM for the North Basin was initially developed/refined during the RI process and is further refined in this FS. The COPCs were further refined during the human health risk assessment process to define the contaminants of concern (COCs), which are the subset of COPCs that pose an unacceptable health risk or exceed concentrations defined in applicable or relevant and appropriate requirements (ARARs).

Development of the Remedial Action Objectives (RAOs): The RAOs are the site-specific goals for protection of human health and the environment. They were developed to address the groundwater COCs.

Development of General Response Actions (GRAs): GRAs (e.g., physical containment, in situ treatment, ex situ treatment, and monitored natural attenuation [MNA]) that may be taken to satisfy the RAOs were selected for the groundwater COCs.

Identification and Screening of Appropriate Remediation Technologies and Process Options: Remediation technologies and process options applicable to each GRA were identified and evaluated based on their effectiveness to achieve the RAOs, technical and administrative implementability, and cost.

Development of Remedial Alternatives: Representative technologies and process options corresponding to different GRAs were assembled to develop a range of remedial alternatives for the groundwater COCs.

Individual Analysis of Remedial Alternatives: Individual analyses of the remedial alternatives were performed using the following nine evaluation criteria identified in the NCP (40 C.F.R. § 300.430 [e][9][iii]):

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Implementability
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Cost
- State acceptance
- Community acceptance

In accordance with CERCLA guidance, the final two criteria, State and community acceptance, are not formally evaluated in the FS. They will be considered following public comment on a PP. State and community acceptance, response to public comments, and the final remedy selection will be documented in a ROD.

Comparative Analysis of Remedial Alternatives: Comparative analyses of remedial alternatives were conducted for each of the nine NCP evaluation criteria to identify the relative advantages and disadvantages of each alternative.

1.2 Organization of the Feasibility Study Report

This report has been organized into the following sections:

- **Section 1, Introduction**: The purpose and approach for the FS, which includes guidance documents used for the preparation and organization of the report
- **Section 2, Background Information**: The Site location and history, previous investigations and actions, the ASA between OCWD and EPA for the Interim Remedy RI/FS, and a summary of previous investigations
- **Section 3, Conceptual Site Model**: A summary of the information presented in AECOM's 2022 RI report (AECOM 2022), including the physical characteristics, nature, and extent of the COCs; fate and transport of the COCs; and the human health risk assessment
- **Section 4, Potential Applicable or Relevant and Appropriate Requirements and Remedial Action Objectives**: The potential ARARs and RAOs for the North Basin, based on the COCs and exposure pathways identified through the risk assessment process
- **Section 5, Identification and Screening of Technologies**: A discussion that screens the GRAs and includes the identification and screening of technology types and process options

- **Section 6, The Interim Remedial Alternatives**: Descriptions of the remedial action alternatives for impacted groundwater that were developed by combining different technologies and process options, corresponding to the different GRAs as developed in Section 5
- **Section 7, Detailed Analysis of Alternatives**: A detailed evaluation of alternatives with respect to the nine evaluation criteria, specified in the NCP to address statutory requirements and preferences of CERCLA, and a comparative evaluation of the interim remedial alternatives. Additional information on approaches not considered alternatives is also presented here
- **Section 8: References**: The references cited in this report that were consulted in the development of the FS
- **Appendix A, Administrative Settlement Agreement between the OCWD and EPA**
- **Appendix B, Applicable or Relevant and Appropriate Requirements**: A detailed review of the ARARs for the remedial alternatives for the North Basin
- **Appendix C, Groundwater Modeling of Plume Containment**: The results of groundwater flow modeling using particle tracking to evaluate the interim remedial alternatives for the COC-impacted groundwater
- **Appendix D, Cost Estimates for Remedial Alternatives–North Basin**: The detailed assumptions and cost estimates for each remedial alternative that was considered for the North Basin
- **Appendix E, Liquid-Phase Granular Activated Carbon (LGAC) Adsorption Isotherms**: The LGAC adsorption model calculations for relevant treatment alternatives
- **Appendix F, PFAS TOP Analysis**: A summary of the per- and polyfluoroalkyl substances (PFAS) Total Organic Precursors (TOP) data

2. Background Information

This section presents background information on the North Basin area, including the location and a description, historical use, and a listing of important previous investigations and actions that have been conducted as a part of the CERCLA process.

2.1 Location

Figure 2-1 shows the Interim Remedy containment area within the North Basin. The North Basin is in the northern portion of the Orange County Groundwater Basin and is within the administrative boundaries of Fullerton and Anaheim as well as along the southwestern border of Placentia, California (Figure 2-2). The ASA (refer to Figure 1, Appendix A) contained the initial Interim Remedy containment area; however, this area was later redefined during development of the 2022 RI report and expanded to the north, following installation and sampling of monitoring well FM-33A, which showed that the plume extent was slightly farther to the north in that area than previously believed.

The North Basin generally encompasses VOC and 1,4-dioxane contamination from approximately a half-mile east of State Route 57 and westward, north of Lincoln Avenue, east of Magnolia Avenue, and south of Chapman and Commonwealth Avenues (Figure 2-3). Trichloroethene (TCE), tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE), 1,2,3-trichloropropane (1,2,3-TCP), 1,2-dichloroethane (1,2-DCA), and 1,4-dioxane are present in groundwater in this area at concentrations that exceed maximum contaminant levels (MCLs) and/or State notification levels (NLs) for drinking water (OCWD 2012).

2.2 Site Area History

The North Basin was used primarily for agriculture until the early 1950s. Industrial activity has increased since then, and multiple industrial facilities (refer to the RI report, (AECOM 2022)) have operated in this area. The diverse array of industrial activities has included electronics manufacturing, metals processing and plating, aerospace manufacturing, musical instrument manufacturing, rubber and plastics manufacturing, and dry cleaning. Source cleanups are being conducted under State oversight at multiple existing and former industrial facilities. Few of these cleanups have been completed, and additional source identification and remediation at others is still required. These industrial facilities are known or suspected to have contributed to the VOC and SVOC contamination of groundwater in the North Basin and are referred to as the “Release Sites” in this report.

VOCs and 1,4-dioxane have been reported in potable supply wells at concentrations approaching or exceeding federal and State MCLs and/or NLs for drinking water. To date, four municipal drinking water production wells (three in Fullerton, and one in Anaheim), Page

Mutual Water Company's only potable water supply well (in Fullerton), and one private production well (in Fullerton) that was used to produce soda and bottled water have been taken out of service because of VOC and 1,4-dioxane contamination. The City of Fullerton wells F-FS13, F-KIM1, and F-7; and private well BAST-F in Fullerton were destroyed (sealed/grouted) in conformance with all applicable California Well Standards and all applicable County requirements (OCWD 2012). The City of Anaheim well A-23 was destroyed (sealed/grouted) in conformance with all applicable California Well Standards and all applicable County and City of Anaheim requirements (OCWD 2012). Page Mutual Water Company's inactive well PAGE-F has not been destroyed.

OCWD previously performed investigations and other supporting actions in the North Basin to address the impacts of the VOC and SVOC contamination on the production wells and groundwater resources. These activities included installing and sampling groundwater monitoring wells, groundwater grab sampling, production wells sampling, groundwater modeling, installing extraction wells, and operating an extraction well.

On October 14, 2016, OCWD entered into the ASA with EPA to conduct an RI/FS to support development of an Interim Remedy to address VOC and 1,4-dioxane contaminated groundwater in the Interim Remedy containment area, in accordance with the NCP. The Interim Remedy containment area is shown on Figure 2-2. The North Basin was proposed by EPA to be included on the National Priorities List (NPL) on January 18, 2018. On September 3, 2020, EPA added the North Basin site to the NPL.

2.2.1 Previous Investigations

Since 1990, OCWD has performed installations, monitoring, investigations, and other studies to evaluate the hydrogeology and nature/extent of the regional groundwater contamination in the North Basin, including the following (OCWD 2012):

- Installation of approximately 100 groundwater monitoring wells
- Regular monitoring of OCWD monitoring and production wells
- Collection of approximately 30 groundwater grab samples (one-time samples)
- Development of a numerical groundwater flow model
- Installation, testing, and sampling of six extraction wells

The findings of these investigations identified widespread VOC and 1,4-dioxane contamination in the North Basin and increasing concentration trends in monitoring and production wells, indicating further migration and expansion of the VOC and 1,4-dioxane plumes (OCWD 2012).

The Santa Ana Regional Water Quality Control Board (RWQCB) and the California Department of Toxic Substances Control (DTSC) have provided or are providing oversight of investigation and/or cleanup at the Release Sites in the North Basin, shown on Figure 2-2. Releases of VOCs and SVOCs from these sites, and possibly from others, have combined to form the regional, commingled VOC and 1,4-dioxane plume in the North Basin. Summary descriptions of the Release Sites, including groundwater data, are presented in the RI report (AECOM 2022). Remedial activities to address the sources contributing to the regional VOC and SVOC contamination are expected to be performed by the responsible parties, with the oversight of the RWQCB and/or DTSC. The scope of the RI excluded site-specific data collection at the Release Sites.

2.2.2 OCWD Remedial Actions

In 2016, OCWD implemented a project to equip extraction well OCWD-EW1 (EW-1) for extraction and interim plume containment (OCWD 2019). EW-1 is one of the six extraction wells previously installed by OCWD. It is in the northeastern portion of the North Basin, downgradient from the Howmet (formerly known as Arconic and Alcoa) and Aerojet VOC Release Sites (Figure 2-2). Because of increasing VOC concentrations observed downgradient from EW-1 in a deep monitoring well and a City of Fullerton production well, OCWD determined the need to operate this interim containment well as an independent remedial action outside the scope of the ASA. Consequently, under its statutory authority, OCWD proceeded with the EW-1 project without EPA oversight and concurrence. EW-1 has been in operation since September 2017. It operated at extraction rates between approximately 800 to 1,000 gallons per minute (gpm), with a cumulative groundwater extraction of approximately 3,057 million gallons of contaminated groundwater and removal of approximately 204 pounds of PCE and TCE from the aquifer through December 2024 (OCWD 2025). The discharge from EW-1 was treated by OC San's Wastewater Treatment Plant 1 and OCWD's Groundwater Replenishment System (GWRS) and was used to recharge groundwater in the basin. GWRS is a regional advanced treatment facility that treats tertiary-treated wastewater to drinking water standards for managed aquifer recharge.

2.2.3 Administrative Settlement Agreement Remedial Investigation

As specified in the ASA, an RI was conducted from September 2017 to August 2019. The objectives of the RI were to characterize the nature and extent of the commingled regional VOC and 1,4-dioxane contamination in groundwater, and to support the development of an FS for the Interim Remedy to address regional VOC and 1,4-dioxane contamination. The specific objectives stated in the RI report:

- Address data gaps and further refine estimates of the lateral and vertical extent of the regional VOC and 1,4-dioxane contamination, with a focus on the Interim Remedy containment area (Figure 2-2)
- Collect additional lithologic and hydrogeologic data to support the evaluation of the fate and transport of the VOC and 1,4-dioxane contamination, and revise/update the CSM and numerical groundwater flow model of the North Basin
- Collect data to prepare a baseline health risk assessment (HRA)
- Refine the Interim Remedy containment area for hydraulic containment of contaminated groundwater
- Support the FS for the development of the Interim Remedy for regional groundwater VOC and 1,4-dioxane contamination

The technical approach and scope to address these objectives included the following key elements, as stated in the RI report:

- Installing additional monitoring wells, including geophysical and lithologic logging of well boreholes
- Sampling and gauging the new and existing monitoring wells
- Identifying the COCs
- Developing a representative dataset for characterizing the nature and extent of the VOC and 1,4-dioxane contamination in the North Basin
- Refining the CSM and the numerical groundwater model based on the results of the RI investigations as well as on previous water level and contaminant concentration data, geophysical and lithologic logs, and hydrogeologic information
- Developing the HRA and ecological risk screening, based on the refined CSM

The RI for the Interim Remedy containment area was performed in accordance with the Remedial Investigation and Feasibility Study Orange County North Basin Work Plan (Work Plan; AECOM 2017) and the Remedial Investigation and Feasibility Study Orange County North Basin Work Plan Addendum (Work Plan Addendum; AECOM 2018). The investigation findings were documented in the RI report (AECOM 2022).

3. Conceptual Site Model

A CSM is an engineering management tool that summarizes the physical characteristics of the site, nature and mechanisms of release, environmental media (groundwater) affected by a release, the nature and distribution of COCs, fate and transport of COCs, potential receptors and exposure pathways, and potential risks to human health and the environment. Developing an accurate CSM is key to developing and evaluating appropriate remedial alternatives for a site. The CSM for the North Basin is discussed in the following sections.

3.1 Conceptual Site Model Overview

The Orange County Groundwater Basin has three main aquifer systems – Shallow, Principal, and Deep zones – composed of Holocene to upper Pleistocene sands, gravels, and conglomerates interbedded with silt and clay (AECOM 2022). The Interim Remedy RI/FS is focused on the Shallow and Principal zones because of the presence of dissolved VOC and 1,4-dioxane contamination in these units. The overview includes the following:

- The portion of the comingled VOC and 1,4-dioxane groundwater plume within the Interim Remedy containment area occupies 5 square miles.
- The extent of the combined VOC and 1,4-dioxane contamination in the Shallow zone is approximately 5.5 miles long and 1.25 miles wide (Figure 2-3); and the extent of the VOC and 1,4-dioxane contamination in the Principal zone is approximately 5.25 miles long and 0.75 miles wide (Figure 2-3). The extent of the combined plumes encompasses approximately 6.4 square miles in portions of Fullerton, Anaheim, and Buena Park in Orange County, California.
- The commingled VOC and SVOC contamination (including the COCs PCE, TCE, 1,1-DCE, 1,2,3-TCP, 1,2-DCA, and 1,4-dioxane) is present in both the Shallow zone (at depths of approximately 80 to 200 feet below ground surface [bgs]) and Principal zone (at depths of approximately 200 to greater than 500 feet bgs).
- Based on the COC concentrations detected downgradient from the known Release Sites, the COC contamination appears to have originated from multiple industrial sites in the North Basin (Figure 2-2). Over time, lateral migration of COC plumes from these individual sites has combined into a regional, commingled plume in the Shallow zone.
- The downward vertical hydraulic gradient between the Shallow and Principal zones has caused vertical migration of dissolved VOCs and 1,4-dioxane in the areas where the fine-grained unit separating these zones is discontinuous or absent, allowing the plume to migrate into the Principal zone. Also, over the many decades since the releases first occurred, contaminated groundwater has migrated from the Shallow to the Principal zone even where an aquitard (a geological layer that restricts the flow of groundwater because of its low permeability, acting as a barrier between aquifers) is present.

- Dissolved VOCs and 1,4-dioxane have migrated laterally and vertically along preferential flow paths within the Shallow and Principal zones. Advection (the usually horizontal movement of a mass of fluid) is the dominant process for migration of dissolved COC plumes.
- Analyses of groundwater samples that were collected between August 2018 and July 2019 found concentrations in the Shallow zone as high as 120 times the MCL (e.g., TCE in the northwestern portion of the North Basin, shown on Figure 2-3), while in the Principal zone, concentrations were generally lower (i.e., up to 9.6 times the MCL for PCE in the central northeastern portion of the North Basin, shown on Figure 2-3). The VOC and 1,4-dioxane contamination has impacted production wells in the Shallow and Principal zones.
- The pattern of increasing concentrations in wells at the leading edge of the regional contaminant distributions indicates that migration of dissolved VOCs and 1,4-dioxane continues to occur in the North Basin (AECOM 2022). Therefore, the distribution and concentrations of VOCs and 1,4-dioxane will continue to increase and/or remain above the MCLs or NLs in both the Shallow and Principal zones in the absence of remedial actions to contain and remove these constituents from groundwater.

Land use in the Interim Remedy containment area is variable and includes commercial/light industrial, residential, park, and open space uses (Figure 3-1). The receptors with the greatest potential for exposure to the COC-impacted groundwater include residents, landscaper workers, and car wash workers. The North Basin HRA is attached to the RI report (AECOM 2022). For residents and landscapers, the *de minimis* or insignificant cancer risk of 1 in 1 million (1×10^{-6}) and the Proposition 65 threshold level of 10 in 1 million (1×10^{-5}) are exceeded in wells screened in both the Shallow and Principal zones. The CERCLA Basis of Action threshold level of 100 in 1 million (1×10^{-4}) and/or select drinking water MCLs are exceeded in wells screened in both the Shallow and Principal zones. The cancer risk in the Principal zone is driven primarily by the presence of PCE and arsenic. The cancer risk in the Shallow zone is driven primarily by the presence of TCE and PCE, and to a lesser extent by perfluorooctanoic acid (PFOA). The noncancer hazard index (HI) threshold of 1 is exceeded for all receptors. Arsenic and PFOA are not considered COCs for the Site (Section 3.3) because arsenic concentrations are within the naturally occurring background concentration range, and a point source for PFOA in the North Basin has not been identified. Figure 3-2 shows the overall CSM for the North Basin in cross-section.

3.2 Physical Characteristics

3.2.1 Land and Groundwater Use

3.2.1.1 Proposed Future Land Use

The North Basin is within the northern portion of the Orange County Groundwater Basin. The current population within the broader basin is approximately 2.5 million people

(OCWD 2015). Current land uses in the North Basin include commercial/light industrial, residential, park, and open space uses (Figure 3-1). Future land uses within the North Basin are not expected to change substantively from current uses.

3.2.1.2 Groundwater Use

The aquifer underlying the North Basin is a Class II aquifer, pursuant to EPA's groundwater policy for classification of groundwater systems. Class II consists of groundwater that currently is being used or that may be used as a source of drinking water in the future. The beneficial uses of groundwater from the Orange County Groundwater Basin include municipal supply, industrial, and agricultural supply. Locally, potable water supply is the primary beneficial groundwater use, with approximately 34 production wells within or approximately 1,500 feet southwest (wells A-DMGC and A-48) of the North Basin, including wells owned by the Cities of Anaheim and Fullerton, Golden State Water Company, and Page Avenue Mutual Water Company (taken out of service in August 2024 because of VOC and 1,4-dioxane contamination). Groundwater constitutes 85 percent of the potable water supply for central, northern and western Orange County.

3.2.2 Geology and Hydrogeology

The North Basin is within the Central Block subdivision of the Los Angeles Basin, a sedimentary basin deposited within a broad synclinal, northwest-trending trough, extending north into Los Angeles County (Intera 2017). Subsidence and deposition of predominantly marine sediments occurred from the Oligocene through the Miocene to the early Pliocene. This was followed by a period of accumulation, during which rates of deposition, initially of sandstone, siltstone, and gravel, then, from the late Pleistocene to present, of clastic debris from the San Gabriel and Santa Ana mountains, exceeded rates of subsidence (Intera 2017). Within the North Basin, the Shallow and Principal zones that are the focus of the RI report (AECOM 2022) are likely to consist primarily of Pleistocene or more recent terrestrial, alluvial fan, fluvial, and possibly fluvial deltaic deposits, underlain by the upper Pliocene Pico and Upper Fernando formations and transitioning into marine deposits south and southwest of the North Basin (Intera 2017). Pleistocene unconsolidated sands and gravels of the San Pedro, Lakewood and La Habra formations are the primary production aquifers in the basin and in turn are overlain by Recent alluvial sediments, including channel deposits of the Santa Ana River (Intera 2017). The Pleistocene and younger units, consisting of interconnected sand and gravel deposits, are variably separated by aquitards of lower permeability fine-grained clay and silt deposits that become thinner and more discontinuous in inland areas, allowing groundwater to move from shallow to deeper aquifers (Intera 2017). Table 1 in Appendix C summarizes the hydraulic parameters for the Shallow and Principal zones.

3.3 Contaminants of Concern

VOCs and SVOCs have been detected in groundwater in the North Basin at concentrations that exceed MCLs and are considered COCs. The VOCs that were detected most frequently at concentrations exceeding regulatory limits are PCE, TCE, and 1,1-DCE. The SVOC 1,4-dioxane contributes to the cumulative excess lifetime cancer risk exceeding 1 x 10^{-4}. These constituents are considered the primary COCs for the Interim Remedy. Other VOCs, including 1,2,3-TCP and 1,2-DCA, have been detected at concentrations exceeding the MCLs and are also COCs. However, their exceedances occur at fewer locations and within the footprint of the other COC distributions. Therefore, the distribution of COCs discussed in this document focuses on the "primary" COCs PCE, TCE, 1,1-DCE, and 1,4-dioxane, but the remedial alternatives will address the full list of COCs.

Nitrate, perchlorate, PFOA/perfluorooctane sulfonic acid (PFOS), and other non-VOC constituents also have been detected at concentrations that exceed the MCLs or NLs (Table 3-2). Although arsenic is present in the groundwater and was considered in the overall HRA risk assessment calculations, its concentrations are within the range expected for natural occurring background and is not considered a site COC.

Nitrate in groundwater typically is present because of agricultural use of fertilizers. Perchlorate (ClO_4) is both naturally occurring and a human-made contaminant that is found increasingly in groundwater, surface water, and soil. Most perchlorate that is manufactured in the U.S. is used as an oxidizer in solid fuel for rockets and missiles. In addition, perchlorate-based chemicals are also used for the construction of highway safety flares, fireworks, matches, pyrotechnics, explosives, common batteries, and automobile air bags. Perchlorate was also a constituent of fertilizer that was used in citrus farming from the early to mid-1900s. As discussed above, prior to urban development, the North Basin area was used heavily for citrus farming.

PFOS and PFOA are fluorinated organic chemicals, part of a larger family of compounds that are referred to as PFAS. These human-made chemicals once were used to manufacture a diverse collection of consumer goods, ranging from pizza boxes to stain-resistant carpets to Teflon-coated pans. PFOS and PFOA were historically released into the soil and water. They are persistent chemicals and remain in the environment for long periods.

The elevated concentrations for these constituents (i.e., nitrate, perchlorate, and PFAS) appear to be associated with activities occurring outside and upgradient from the North Basin and/or are from activities not directly related to the known Release Sites in the North Basin and from regional non-point source groundwater contamination. Such non-point source and regional activities include historical agricultural use (nitrate and perchlorate), recharge of

Santa Ana River water containing wastewater treatment plant effluent and associated PFOS/PFOA, other potential source releases, and/or ambient geochemical conditions.

Industrial activities with potential association to PFAS release include primary and secondary manufacturing facilities, such as chemical processing plants, metal plating and finishing, electronics, textile, apparel, carpet, paper, and packaging plants. Other potential sources include areas where fire-fighting foams may have been used or stored (i.e., firefighting training facilities, airports, and military bases). A point source for PFOS/PFOA in the North Basin has not been identified. Perchlorate also represents a chemical that may not have a point source in the North Basin. However, metal plating, which could be a source of perchlorate and PFOS/PFOA contamination, is known to have occurred in the North Basin.

These constituents were considered “background” constituents in the RI. The background constituents were characterized because they contribute to the overall health risks associated with groundwater exposures in the North Basin (refer to Appendix E in the RI report) and are important factors to be considered when evaluating treatment alternatives to ensure that groundwater treatment technologies comply with all applicable ARARs.

3.4 Sources and Distribution of Contaminants of Concern

Releases of VOCs and SVOCs from multiple sources areas are believed to have combined and resulted in the regional commingled COC plumes in groundwater in the North Basin. Section 2.2.1 discusses the known suspected sources. Figure 2-3 shows the locations of the known suspected sources present in the North Basin, as well as the extent of the composite VOC and 1,4-dioxane plume in the Shallow and Principal zones. A detailed summary and descriptions of the Release Sites, including groundwater data, are presented in the RI report. The Shallow and Principal zones are merged locally, where the fine-grained unit that separates them is thin or absent, and preferential vertical migration of COCs from the Shallow to Principal zone has occurred in these areas. As demonstrated in the RI report (AECOM 2022), recent concentration trends suggest further expansion of the COC plumes into the Principal zone.

The locations of the production and monitoring wells from which data were used to define and prepare the plume maps are shown on Figure 2-3. Figure 2-3 also shows the approximate extent of the composite COC plume in the Shallow and Principal zones, in areas where PCE, TCE, and/or 1,1-DCE concentrations have exceeded their respective MCLs and/or where 1,4-dioxane has exceeded its NL, based on water quality data that was collected between August 1, 2018 and July 31, 2019 (AECOM 2022). VOC- and zone-specific plume maps are included in the RI Report, along with cross-sections that show the hydrogeology and vertical extent of COC contamination.

The extent of the regional COC contamination in the Shallow zone is approximately 5.5 miles long and 1.25 miles wide (Figure 2-3). The extent of the combined VOC and 1,4-dioxane contamination in the Principal zone is approximately 5.25 miles long and 0.75 miles wide (Figure 2-3). The contaminant distribution in the Shallow zone extends from the upgradient eastern part of the North Basin, westward across much of the area, and generally is wider and distributed across a larger area than in the Principal zone (Figure 2-3). The Principal zone plume appears narrower and extends from the northeastern portion of the North Basin toward the southwest, impacting production wells in the southern portion of the area outside and downgradient from the southwestern Interim Remedy containment area. COC concentrations in the Shallow zone generally are higher than in the Principal zone, with the highest concentration of up to 120 times the MCL for TCE detected in the northwestern portion of the North Basin (Figure 2-3). COC concentrations in the Principal zone are up to 9.6 times the MCL for PCE in the central northeastern portion of the North Basin.

The evaluation of the vertical distribution of the regional commingled plume in groundwater indicated that COCs migrated laterally and vertically from depths of about 150 feet bgs in the eastern portion of the North Basin to depths of approximately 500 feet bgs in the southwestern portion. Increasing COC concentration trends have been observed in several wells that were completed in the Shallow and Principal zones (AECOM 2022).

The increasing concentrations observed in COC-impacted North Basin wells indicate further migration of COCs from the Shallow zone to the Principal zone, and expansion of the COC plumes into the Principal zone (OCWD 2012). Figure 2-3 shows the current estimate of the Interim Remedy containment area.

Data gaps remain regarding the lateral and vertical extent of COCs in the Shallow and Principal zones, and additional monitoring wells will be necessary to: 1) refine the size of the Interim Remedy containment area 2) provide the data needed to refine the remedial alternatives, and 3) monitor the performance of the Interim Remedy. These additional monitoring wells may be installed: 1) as part of the Remedial Design (RD) if a significant data gap is identified at that time; and 2) as part of the Remedial Action (RA) for performance monitoring.

3.5 Contaminant Migration Pathways

Data from previous investigations demonstrate that COCs have migrated from the suspected source areas, commingled, and eventually migrated from the Shallow zone to the Principal zone, impacting the production wells. A general overview of suspected migration pathways for COC contamination in the North Basin is as follows:

- Spills and other releases of COCs have occurred at multiple industrial facility sites in the North Basin. Releases of COCs at these locations have migrated to groundwater, impacting the Shallow zone in the vicinity of these sites and creating local COC plumes.
- Over time, lateral migration of COC plumes from these individual sites have combined into a regional, commingled plume in the Shallow zone.
- The vertical hydraulic gradient is downward between the Shallow and Principal zones, and preferential vertical migration has occurred where the fine-grained unit separating these zones is discontinuous or absent, allowing the COC plume to migrate into the Principal zone.
- COC plumes in the Principal zone have migrated toward and have impacted drinking water supply wells in the North Basin.

3.6 Potential Receptors

3.6.1 Human Receptors

This FS considers only the direct exposure pathways for groundwater (EPA 2016). Potential receptors include residents and commercial/industrial workers in Anaheim and Fullerton. Potential exposure routes include ingestion, dermal contact, and inhalation of vapors in groundwater (while showering) pathways. Figure 3-3 shows a conceptual model diagram for human health exposures.

Ecological Receptors

Contaminants in groundwater are a concern only for biota if the contaminants migrate to seawater or daylight into surface water (discharge to surface water). Groundwater in the North Basin does not discharge to the ocean, which is more than 10 miles to the southwest at the shortest distance. Groundwater levels closer to the coast are below sea level, and OCWD actively manages seawater intrusion with an active freshwater barrier that is recharged through hundreds of injection wells (OCWD 2019).

The surface water bodies that cross the North Basin are Fullerton Creek and its tributary, and Carbon Creek. Depth-to-groundwater in the North Basin (80 to 120 feet bgs) is more than 60 feet below the bottom of the surface channels, and therefore contaminated groundwater does not discharge to these creeks.

Because no complete or likely pathways exist for exposure to ecological receptors (i.e., the COC-impacted groundwater is unlikely to discharge into the ocean or to the creeks in that area), the potential for ecological receptors to be adversely affected by groundwater COCs is considered negligible; therefore, a further ecological risk evaluation was not performed.

3.7 Risk Assessment

A baseline HRA was completed for the Site and the details are provided in Appendix E of the RI report (AECOM 2022). The baseline HRA presents an evaluation of the potential threat to human health and the environment in the absence of any remedial action. The HRA process included the identification of COCs, an exposure assessment, a toxicity assessment, and risk characterization. The results and conclusions from the baseline HRA are summarized in this section.

3.7.1 Proposed Future Use of North Basin and HRA Purpose / Scope

The North Basin is assumed to be available for residential, commercial, or recreational use. The HRA quantitatively addresses complete exposure pathways of COCs in groundwater and production wells to the most sensitive receptors (residents) and landscapers. In addition, because of inadequate information regarding their exposure, car wash workers are qualitatively addressed in the uncertainty section of the RI report (AECOM 2022).

The results of the HRA and ecological risk evaluation are intended to support future remedial decisions for the North Basin. The purpose of the HRA is to assess human health risks associated with potential exposure to existing North Basin-related chemical impacts from exposures to groundwater in the Shallow and Principal zones and to address whether the potential exists for COCs in groundwater to pose an ecological hazard. The HRA evaluates potential risks related to exposure to impacted groundwater. This is separate from the delivery of potable water to domestic, commercial, and industrial users in the basin service area. The North Basin is a managed basin, and all the water being served to the public in the North Basin service area meets State and federal requirements. The proposed exposure and pathway scenarios that were evaluated in the HRA are shown in Table 3-1, along with the scenario evaluated for ecological receptors. No completed exposure pathways were identified for ecological receptors.

Table 3-1: Proposed Scenarios Evaluated in the HRA

Potentially Exposed Populations	Potential Exposure Pathways
Residents	Ingestion of groundwater Dermal contact with groundwater while showering Inhalation of vapors while showering
Landscaper	Incidental ingestion of groundwater Dermal contact with groundwater Inhalation of vapors via sprinklers
Car Wash Worker (addressed qualitatively in the Uncertainty Section of the RI report (AECOM 2022)	Incidental ingestion of groundwater Dermal contact with groundwater Inhalation of vapors from water used at car wash

Potentially Exposed Populations	Potential Exposure Pathways
Ecological Receptors	Incomplete pathways of exposure – no discharge to surface water

3.7.2 Contaminants of Concern

The selection of COPCs was based on a review of the groundwater sampling data from OCWD Shallow and Principal wells in the Interim Remedy containment area that were collected between August 1, 2018, and July 31, 2019. All detected chemicals initially were considered for evaluation in the HRA; however, only those with toxicity values listed in DTSC Office of Human and Ecological Risk (HERO) HHRA Note 10 (Toxicity Criteria) (DTSC 2019), EPA regional screening levels (RSLs), and/or a MCL and/or NL were retained for evaluation.

The COCs retained for evaluation were PCE, TCE, 1,1-DCE, 1,2,3-TCP, 1,2-DCA, and 1,4-dioxane. Section 3.3 discusses the COCs and other constituents that were detected in groundwater. Some chemicals, including PFOS/PFOA, perchlorate, and nitrate, may be present because of regional non-point source groundwater contamination. A point source for PFOS/PFOA in the North Basin has not been identified. Perchlorate also represents a chemical that may not have a point source in the North Basin. However, metal plating, which could be a source of perchlorate and PFOS/PFOA contamination, is known to have occurred in the North Basin. Health risks from chemicals that are not known to be related to a point source release in the North Basin are included in the HRA and are discussed further in the Uncertainty Section in Appendix E of the RI report (AECOM 2022).

3.7.3 Exposure Assessment

The objective of the exposure assessment is to estimate the magnitude, frequency, duration, and routes of reasonably anticipated human exposure to COPCs associated with groundwater in the North Basin. The exposure assessment is based on identification of relevant potential receptors and the associated pathways of potential exposure. Human health risks are calculated for significant complete or potentially complete exposure pathways. The elements listed below must be present for an exposure pathway to be considered as potentially complete. If any of the element(s) is (are) absent, the exposure pathway is considered incomplete (i.e., no exposure will occur) and will have no associated health risk.

Four elements are necessary for a complete exposure pathway:

- A contaminant source
- A retention medium and transport mechanism
- A point of potential human contact with the contaminated medium (e.g., soil, water, air)

- An exposure route at the exposure point (e.g., inhalation, ingestion, dermal contact)

After the potentially complete exposure pathways are identified, quantification of chemical intake doses for each receptor requires that an estimate be calculated for the following:

- Each North Basin-related chemical concentration in groundwater in the Shallow and Principal wells to which the receptor may be exposed (also referred to as the exposure point concentration [EPC])
- The dose of each North Basin-related chemical to receptors after they are exposed to a contaminant (e.g., milligrams of chemical per kilogram of body weight per day or cubic meters of air per day)
- The time (hours per day), frequency (days per year), and duration (years) of contact for the receptors that are exposed to contaminants
- The physical characteristics of the receptors (e.g., body weight, skin surface area)

3.7.4 Toxicity Assessment

The toxicity assessment characterizes the relationship between the magnitude of exposure to a COPC and the nature and magnitude of adverse health effects that may result from each exposure. For the HRA, adverse health effects were classified in two categories – noncarcinogens and carcinogens. Toxicity values were generally developed based on the threshold approach for noncarcinogenic effects and the non-threshold approach for carcinogenic effects. They may be based on epidemiological studies, short-term human studies, or sub-chronic or chronic animal data. Toxicity values that are used to estimate adverse noncarcinogenic health effects as hazard quotients (HQs) are called reference doses or reference concentrations, and toxicity values used to estimate incremental lifetime cancer risks (also referred to as excess lifetime cancer risks) are called cancer slope factors or inhalation unit risk factors.

Toxicity values were selected as the most conservative of the values listed in the DTSC HERO, HERO HHRA Note Number 10, Toxicity Criteria (DTSC 2019) and the current EPA Integrated Risk Information System database. The DTSC Toxicity Criteria for Human Health Risk Assessments, Screening Levels, and Remediation Goals rule regarding the hierarchy for toxicity criteria in the absence of these two primary sources was followed, using “other sources” as provided in Appendix E of the RI report (AECOM 2022). The resulting toxicity criteria used in the HRA also are provided in Appendix E of the RI report.

3.7.5 Risk Characterization

Risk characterization includes the integration of the toxicity and exposure assessments to provide quantitative and qualitative expressions of risk. The methods used to assess noncarcinogenic hazards and excess cancer risks and the associated risk estimates for

residents using the North Basin groundwater for domestic use and groundwater exposure for landscapers are addressed in this section.

The HRA specifically calculated noncancer and cancer risk for the ingestion, dermal contact, and vapor inhalation pathways (including the mutagenic mode of action calculations) for:

- Residential exposure to Principal zone groundwater
- Residential exposure to Shallow zone groundwater
- Landscaper exposure to Principal zone groundwater
- Landscaper exposure to Shallow zone groundwater

3.7.6 Identification of Contaminants of Concern

The COCs for residents based on exposure to groundwater were identified, based on the following criteria:

- When the potential cumulative cancer risk exceeded 1 x 10^{-6}, then individual COPCs with exceedances of the cancer risk level of 1 x 10^{-6} were identified for further evaluation.
- When the potential noncancer HI exceeded 1, then individual COPCs that exceed a noncancer threshold of 1 were identified for further evaluation.
- Individual COPCs were used that were detected at a concentration greater than their respective federal or State MCL and/or State NLs.

The risk results exceed the CERCLA Basis of Action threshold level of 100 in 1 million (1 x 10^{-4}) in both the Shallow and Principal zones. Results showed that *de minimis* or insignificant cancer risk of 1 x 10^{-6} is exceeded and the noncancer HI threshold of 1 is exceeded in both the Shallow and Principal zone monitoring wells for the hypothetical residential exposure. Table 3-2 lists the preliminary and final COCs for the sites that meet the criteria, as discussed above. The rationale for the final COC determination is also shown.

3.7.7 Conceptual Site Model Exposure Pathways

A CSM describes the sources of contaminants at a site, their potential release and transfer through environmental media, and the points and means by which human populations may come into contact with the contaminants. The focused CSM for the North Basin comingled groundwater plume is shown in cross-section in Figure 3-2, and the exposure routes are shown in Figure 3-3 and are described in the following paragraphs.

The receptors with the greatest potential exposures to groundwater impacts associated with the North Basin include residents, landscapers, and car wash workers, with the latter qualitatively evaluated in the uncertainty section of the RI report (AECOM 2022). The

potentially complete exposure pathways for these receptors include one or both of the following means of contact: ingestion of and/or dermal contact with groundwater; and/or Inhalation of vapors from household use of water or a sprinkler that uses groundwater.

Groundwater is not used for agricultural purposes in the North Basin, thereby eliminating the ingestion of produce/food products as a potentially complete exposure pathway for human receptors.

Vapor intrusion (VI) could potentially pose human health concerns at individual buildings at the North Basin Superfund site. The State, through the RWQCB and DTSC, is currently evaluating VI associated with several Release Sites within the current site footprint. VI is not evaluated as part of the Interim Remedy. EPA expects to evaluate the VI pathway in the Final Comprehensive Remedy for the North Basin.

Ecological receptors potentially could be exposed to COCs if groundwater discharges to surface water (e.g., creeks or the ocean). Discharge to seawater is considered incomplete because groundwater in the North Basin does not discharge to the ocean. Groundwater levels near the coast are below sea level, and two seawater intrusion barriers are operated near the coast to prevent seawater intrusion. Discharge to creeks does not occur because the depth of the groundwater (approximately 100 feet bgs) is well below the bottom of the creek channels in the North Basin. Although inhalation of vapors from a sprinkler that uses groundwater is considered a potentially complete exposure pathway for landscapers, this pathway is not quantitatively evaluated for ecological receptors. A discussion of this pathway is presented in the uncertainty section of the RI report (AECOM 2022). In summary, this pathway is not considered a complete and significant pathway for ecological receptors because birds and other mammals do not tend to remain in areas where sprinklers are in use, and any released volatile chemicals post-irrigation are expected to attenuate rapidly in outdoor air.

The interconnection of seawater and freshwater is managed actively. Therefore, no complete exposure pathways were identified for ecological receptors. The receptors and assessment of potentially complete exposure pathways are presented in the CSM (Figure 3-3). The general exposure characteristics of each receptor are shown in Table 3-3. Additional receptor-specific exposure parameters are provided in Attachments A, B, C, and D of the HRA, attached to the RI report (AECOM 2022).

Table 3-3: Exposure Parameters and Values

Exposure Parameters	Resident	Landscaper
Body weight (BW) (kilograms)	80 kg (adult); 15 kg (child)	80 kg
Averaging time (AT) (days)	25,550 carcinogens; ED x 365, noncarcinogens	25,550 carcinogens; ED x 365, noncarcinogens
Exposure duration (ED) (year)	6 years (child); 20 years (adult)	25 years
Exposure frequency (EF) (days/year)	350 days/year	250 days/year (assumes 5 days per week for 50 weeks/year)
Exposure Time (ED) (hours/day)	24 hours/day	8 hours/day (assumes landscaper works throughout the study area)
Ingestion Rate (IR) (liters/day)	2.5 liters/day (adult); 0.78 liters/day (child)	2.5 liters/day
Skin surface area for groundwater contact (square centimeters)	19,652 cm^2 (adult) 6,365 cm^2 (child)	6,032 cm^2
Soil Dermal absorption fraction (unitless)	chemical specific	chemical specific
Water permeability coefficient (Kp)	chemical specific	chemical specific

3.7.8 Uncertainty Analysis for HRA

Uncertainty is inherent in the risk assessment process. The quantitative estimates of risk presented in the HRA report generally may be one or several orders of magnitude different from the actual risk associated with a given exposure. Uncertainties and limitations occur in the risk assessment process because of the use of estimates and conservative assumptions with varying degrees of uncertainty. To minimize the consequences of uncertainty, regulatory guidance typically relies on the use of conservative estimates of adverse health effects in the absence of precise scientific data. Because multiple conservative assumptions are used, the overall risk characterization results that are presented in the HRA report may overestimate the potential risk and therefore should be protective of public health. The uncertainties considered in the HRA include uncertainty in data collection and analysis, exposure estimation, toxicological data, and risk characterization.

3.7.9 Conclusions

The purpose of the HRA was to assess the potential for adverse health effects from exposure to groundwater from Shallow and Principal zones in the Interim Remedy containment area. Exposures were evaluated using data from the Shallow and Principal zone monitoring wells for residential, landscaper, and ecological receptors. The HRA is intended to be a conservative evaluation and does not include standard water treatment procedures that would reduce COC exposure. Water quality measurements are in place to evaluate the potential for unacceptable exposure to chemicals in municipal water served to the public.

Exposure pathways for ecological receptors were evaluated, and no complete or likely pathways occurred for exposure to ecological receptors, and the potential for ecological receptors to be adversely affected by groundwater COCs is considered negligible. Therefore, a further ecological risk evaluation was not performed. Although inhalation of vapors from a sprinkler that uses groundwater was considered as a potentially complete exposure pathway for landscapers, this pathway was not evaluated quantitatively for ecological receptors, and it is unlikely because supplied potable water is from a managed basin and meets State and federal standards for drinking water. Even if sprinkler water was from a direct groundwater supply, this pathway is not considered a complete and significant pathway for ecological receptors because birds and other mammals do not tend to remain in areas where sprinklers are in use, and any released volatile chemicals post-irrigation are expected to attenuate rapidly in outdoor air.

The results of the HRA are summarized as follows. For residents and landscapers, the *de minimis* or insignificant cancer risk of 1 in 1 million (1×10^{-6}), the Proposition 65 threshold level of 10 in 1 million (1×10^{-5}), and the CERCLA Basis of Action threshold level of 100 in 1 million (1×10^{-4}) are exceeded in wells screened in both the Shallow and Principal zones. The noncancer HI threshold of 1 is exceeded for all receptors and all wells. Table 3-4 summarizes the risk assessment results based on groundwater data that was collected between August 1, 2018 and July 31, 2019.

Table 3-4: Summary of Risk Assessment Results

Receptor/Cancer or Noncancer	Shallow Wells	Principal Wells
Resident/cancer risk	4×10^{-4}	3×10^{-4}
Resident/noncancer hazard index	18	23
Landscaper/cancer risk	2×10^{-4}	2×10^{-4}
Landscaper/noncancer hazard index	6	10

Shallow Zone – Resident

For the Shallow Zone resident (refer to the HRA, Attachment B-9), the cancer risk was 4E-04 (also expressed as 4 in 10,000 or 4×10^{-4}), and the noncancer HI was 18 (refer to the HRA, Attachment B-5). The cancer risk is driven by the presence of TCE (18% of total cancer risk) and PCE (65% of total cancer risk) and to a lesser extent PFOA (6%) (refer to the HRA, Attachment B-9). The noncancer HI is driven by the presence of TCE (67% of HI), uranium (10% of HI) and PFOA (8% of HI) (refer to the HRA, Attachment B-5).

Shallow Zone – Landscaper

For the Shallow Zone landscaper (refer to the HRA, Attachment D), the cancer risk was 2E-04 (also expressed as 2 x 10^{-4} or 2 in 10,000) (refer to the HRA, Attachment D-9), and the noncancer HI was 6 (refer to the HRA, Attachment D-5). The cancer risk is driven by the presence of TCE (10% of the total cancer risk) and PCE (76% of the total cancer risk). The noncancer HI is driven by the presence of TCE (61% of the HI), uranium (13% of the HI) and PFOA (11% of the HI).

Principal Zone – Resident

For the Principal Zone resident, the cancer risk was 3E-04 (also expressed as 3 in 10,000 or 3 x 10^{-4}) (refer to the HRA, Attachment A-9), and the noncancer HI was 23 (refer to the HRA, Attachment A-5). The cancer risk is driven by the presence of PCE (37% of the total cancer risk) and arsenic (42% of the total cancer risk). The noncancer HI is driven by the presence of arsenic (72% of the HI) and PFOA (8.7% of the HI).

Principal Zone – Landscaper

For the Principal Zone landscaper (refer to the HRA, Attachment C), the cancer risk was 2E-04 (also expressed as 2 x 10^{-4} or 2 in 10,000) (refer to the HRA, Attachment C-9), and the noncancer HI was 10 (refer to the HRA, Attachment C-5). The cancer risk is driven by the presence of arsenic (42% of the total cancer risk) and PCE (42% of the total cancer risk). The noncancer HI is driven by the presence of arsenic (74% of the HI) and PFOA (9% of the HI).

Non-Point Source Contribution

COPCs that are indicative of non-point source chemicals include PFOS, PFOA, perchlorate, uranium, and nitrate. The HRA evaluated the contribution of the non-point source chemicals with respect to cancer risk and noncancer hazard for each receptor. The HRA determined that concentrations of non-point source chemicals do not contribute to cancer risk for any well or receptor. However, non-point source chemicals contribute a significant portion of the noncancer hazard for residents and landscapers using water from wells screened in the Principal zone. A majority of this contribution is from uranium, nitrate, and perchlorate.

Car Wash Worker

No risk assessment guidance is available that provides exposure parameters for car wash workers. Therefore, a large degree of uncertainty is involved in evaluating health risks quantitatively to this receptor. However, this receptor can be evaluated quantitatively using conservative assumptions. Study area car wash workers can be assumed to work as full-time

employees who work at facilities that provide car washing services using water from the study area. An on-site car wash employee can be assumed to work for 8 hours per day, 5 days per week, for 250 days per year, for 25 years. The exposure pathways identified for the study area car wash worker include:

- Incidental ingestion of water from the Shallow and Principal zones
- Dermal contact with water from the Shallow and Principal zones (via sprinklers in the car wash)
- Inhalation of vapors from sprinkler water from the Shallow and Principal zones

This exposure scenario is similar to a landscaper (assumed to be exposed to water from sprinklers for 8 hours per day, 5 days per week, 250 days per year, for 25 years). To render a conservative assessment, the ingestion rate may increase because of incidental ingestion and skin surface available for exposure may double the exposure, compared to a landscaper. Therefore, the cancer risk and noncancer hazard for a car wash worker would be two times that calculated for a landscaper. For water from the Shallow and Principal zones, the cancer risks would be 4E-04 (also expressed at 4×10^{-4} or 4 in 10,000) and 4E-04 (also expressed as 4×10^{-4} or 4 in 10,000, respectively). For water from the Shallow and Principal zones, the noncancer HIs would be 12 and 19, respectively, suggesting that use of groundwater in car wash facilities may pose an unacceptable heath risk.

PFOS/PFOA

PFOS/PFOA contribute less than 11% of the total HI for the Principal zone and less than 12% of the total HI for the Shallow zone. PFOS/PFOA contribute less than 13% of the total cancer risk for the Principal zone and less than 11% of the total cancer risk for the Shallow zone. In August 2019, the Office of Environmental Health Hazard Assessment (OEHHA) recommended NLs for PFOA and for PFOS be set at the lowest levels at which they can be reliably detected in drinking water, using currently available and appropriate technologies. This recommendation is based on OEHHA's development of reference levels intended to protect against cancer and noncancer effects, including effects on the liver and immune system. After independent review of the available information on the risks, the Division of Drinking Water (DDW) established NLs at 6.5 parts per trillion (ppt) for PFOS and 5.1 ppt for PFOA. These levels are consistent with OEHHA's recommendations. On April 10, 2024, EPA announced the final National Primary Drinking Water Regulation for six PFAS compounds (i.e., PFOA, PFOS, perfluoro hexane sulfonic acid [PFHxS], perfluorononanoic acid [PFNA], and HFPO-DA) as contaminants with individual MCLs, and PFAS mixtures containing at least two or more PFHxS, PFNA, HFPO-DA, and perfluorobutane sulfonic acid (PFBS) using an HI MCL to account for the combined and co-occurring levels of these PFAS in drinking water. The established MCLs are 4 ppt for PFOS and 4 ppt for PFOA.

4. Applicable or Relevant and Appropriate Requirements and Remedial Action Objectives

This section discusses the ARARs and RAOs for the North Basin based on the location, proposed interim remedial alternatives, COCs, and exposure pathways identified through the risk assessment process.

4.1 Potential Applicable or Relevant and Appropriate Requirements

CERCLA requires that remedial actions selected for sites with hazardous substances meet two threshold criteria: 1) protectiveness of human health and the environment; and 2) compliance with applicable or relevant and appropriate requirements — ARARs. ARARs are those statutory provisions and promulgated regulations that must be met by remedial actions at a site. Section 121(d) of CERCLA requires that on-site remedial actions attain or waive federal environmental ARARs or, where more stringent, state environmental and facility-siting ARARs. The FS identifies the ARARs for the North Basin alternatives and the selected remedy must meet the ARARs or provide a justification for a waiver.

4.1.1 Criteria for Evaluation of ARARs

Under Section 121(d)(2) of CERCLA, ARARs are derived from both federal and state laws and regulations. Federal ARARs for a remedial action may include promulgated requirements under any of the federal environmental laws (e.g., the Clean Air Act, the Clean Water Act, the Safe Drinking Water Act). State ARARs may include only those promulgated requirements under a state's environmental or facility siting laws that are "more stringent" than federal laws. State regulations under federally authorized programs are considered federal requirements, and where a state ARAR for a chemical, location, or action has no federal equivalent or is broader in scope than the federal ARAR, the state ARAR is considered more stringent.

As explained in Part 300.400(g) under Title 40 of the CFR, ARARs are regulations of general applicability that are legally enforceable and are categorized as either "applicable" or "relevant and appropriate." "Applicable" requirements must be both promulgated and substantive. These requirements include federal or more stringent state substantive cleanup standards, standards of control, or requirements promulgated under federal environmental laws or state environmental or facility siting laws that meet all jurisdictional prerequisites of a requirement and directly address the circumstances at the site or the proposed remedial activity.

A requirement is applicable if the specific terms, or "jurisdictional prerequisites" directly address site circumstances. Each requirement selected for a site or the particular remedial activity must meet the pertinent jurisdictional prerequisites:

- The entity, as specified by the statute or regulation, is subject to its authority.
- The statute or regulation requires, directs, or prohibits the specific type of activities.
- The types of substances or activities fall directly under the authority of the requirement.
- The period for which the statute or regulation is in effect.

If a requirement is not directly applicable, it may be selected nevertheless as an ARAR as "relevant and appropriate." Relevant and appropriate requirements are evaluated on a site-specific basis by assessing the jurisdictional prerequisites and comparing them to circumstances at the site. If sufficient similarity exists between the requirement and the site circumstances, then the requirement can be selected as a relevant and appropriate ARAR.

Evaluating whether a requirement is relevant and appropriate is done in two separate steps. First, to assess relevance, a comparison is made between the remedial action, location, or chemicals covered by the requirement and the conditions at the site, release, or potential remedy. A requirement is relevant if the requirement generally pertains to these conditions. Second, to evaluate whether the requirement is appropriate, an analysis is done of the nature of the substances, site characteristics, circumstances of the release, or the proposed remedial activities, and the requirement is considered appropriate if it is well-suited to these substances, characteristics, or activities. As with applicable ARARs, only the *substantive portions* of requirements can be determined to be relevant and appropriate.

The evaluation of whether a requirement is relevant and appropriate is subject to discretion. Pertinent factors to consider include the type of remedial actions, the hazardous substances present, waste characteristics, and physical characteristics of the site. The possibility exists for only part of a requirement to be considered relevant and appropriate. After a requirement is determined to be relevant and appropriate, it must be applied in the same way as if it were applicable. However, only those remedial response activities conducted on site must comply with the relevant and appropriate requirements.

In addition to ARARs, non-promulgated advisories, guidance, or criteria (referred to as To Be Considered [TBC] criteria) may be used in conjunction with ARARs, to determine acceptable risks to human health and the environment at a site. TBCs may be used to calculate cleanup levels when no ARARs exist, or when ARARs alone are not sufficiently protective of human health and the environment.

To be selected, a remedy must be protective of human health and the environment, but certain circumstances exist under which ARARs may be waived. Section 121(d) of CERCLA allows for the selection of a remedial alternative that will not attain ARARs, where any of the following conditions for a waiver exists:

- The remedial action is an interim measure, and the final remedy will attain the ARAR on completion.
- Compliance with the ARAR will result in a greater risk to human health and the environment than alternative options.
- Compliance with the ARAR is technically impracticable from an engineering perspective.
- Alternative remedial actions will attain the equivalent of the ARAR.
- The State has not consistently applied the standard, requirement, criterion, or limitation in similar circumstances at other remedial actions.
- A balance between protecting human health and the environment at the facility cannot be achieved with available funds for responses at other facilities.

ARARs include only the substantive portions of applicable or relevant and appropriate requirements, and Section 121(e) of CERCLA exempts CERCLA response actions that are conducted entirely on site from all federal, state, and local administrative requirements (e.g., permitting, record-keeping, consultation, notification, reporting). Accordingly, the distinction between what part of a remedial activity is occurring on site versus what part is off-site is critical for ARARs analysis. For this evaluation, the NCP defines the "on-site response action" as activity that takes place within "the areal extent of contamination and any area in very close proximity to the contamination necessary for implementation of the response action" (40 CFR 300.5). If the point of discharge for a remedy is “on site,” the discharge is subject to the substantive requirements that have been selected as ARARs that may have been required in a permit, such as discharge limits, but a permit itself would not be required because obtaining the permit itself is considered an administrative – or non-substantive – requirement. However, if the point of discharge is considered “off-site,” a permit may be required, along with any other administrative requirements.

ARARs must be substantive and also specific. Section 121(d)(2)(A) of CERCLA, EPA’s 2023 OLEM Directive 9234.0-07, Documenting Applicable, or Relevant and Appropriate Requirements in CERCLA Response Action Decisions (March 1, 2023), requires ARARs documentation to be sufficiently specific and include exact citations to the specific statutory or regulatory requirements, as required by Part 300.400(g)(5) under Title 40 of the CFR. This level of specificity is intended both to provide transparency during the ARARs selection

process and, importantly, to facilitate compliance with substantive requirements during implementation of the response action.

4.1.2 Types of ARARs

ARARs fall into three broad categories, based on the chemical contaminants present, site characteristics, and remedial alternatives proposed for cleanup:

- **Chemical-specific ARARs** are those environmental laws and regulations that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based values or discharge limits to determine the acceptable amount or concentration of chemicals that may remain in or be discharged to specific media (refer to the Preamble to Proposed NCP, 53 Federal Register 51437). Chemical-specific ARARs are linked to the specific contaminants identified at a site.
- **Location-specific ARARs** govern activities based on the environmental sensitivities of the site area. Examples of location-specific ARARs include protective uses of floodplains, wetlands, endangered species habitats, or historically significant resources. These requirements are triggered by the particular location of, and the proposed activity at the site.
- **Action-specific ARARs** are technology-, equipment-, or activity-based requirements and limitations with respect to hazardous wastes and are requirements to conduct certain actions to address particular site circumstances. Action-specific ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular activities related to management of hazardous substances or pollutants. These requirements define acceptable treatment and disposal procedures for hazardous substances. A common example of action-specific ARARs include the Resource Conservation and Recovery Act regulations for waste treatment, storage, and disposal. Action-specific requirements are triggered by the remedial activities that are selected as part of a remedy.

4.1.3 Potential ARARs/TBCs for the North Basin

ARARs identification for the North Basin involved the two-part ARARs analysis: first, a determination is made as to whether a given requirement is applicable; then, if the requirement is not applicable, a determination is made as to whether it is relevant and appropriate. Furthermore, non-promulgated guidance is considered in conjunction with promulgated ARARs, to assist in evaluating risk at a site. An important consideration for selection of ARARs for the North Basin is that identified ARARs apply to *on-site* actions; any activities that occur *off-site* need to comply with governing regulations and permit conditions. A list of the potential federal and State ARARs and TBCs for the North Basin Interim Remedy is provided in Appendix B. The final determination of ARARs will be documented in the ROD.

Chemical-Specific ARARs

The North Basin is in the northern portion of the Orange County Groundwater Basin, where beneficial uses of groundwater include municipal supply. The North Basin Interim Remedy RI/FS is focused on groundwater, and only direct exposure pathways from groundwater were considered. Potential chemical-specific ARARs for groundwater include federal MCLs and those more stringent State MCLs.

Location-Specific ARARs

Location-specific ARARs include sensitive or hazard-prone locations, such as floodplains or wildlife habitats. The North Basin is a developed area with little, if any, undisturbed habitats, and therefore habitat-related constraints would not be expected for the North Basin. Also, groundwater in the North Basin does not discharge to surface water. Areas of the North Basin are within a 100-year floodplain, and requirements related to floodplain management may be potential ARARs, depending on the infrastructure necessary for the remedial alternatives and their location with respect to floodplains.

Action-Specific ARARs

Action-specific ARARs are those ARARs related to the actual remedial components, and action-specific ARARs also exist for the discharge of extracted groundwater. Each of the alternatives screened under the nine NCP evaluation criteria for the North Basin Interim Remedy incorporate extraction and ex situ treatment of COC-impacted groundwater. Several alternatives include treatment of extracted groundwater and discharge that would be subject to ARARs. Treatment alternatives would be subject to the ARARs that would apply to the activity being conducted. Discharge alternatives for the remedy would include the following:

- **Sanitary Sewer**: discharge of treated or untreated groundwater to the Orange County Sanitation District's (OC San) sanitary sewer system (in OC San's service area, sanitary flows are captured, treated, and recycled by OCWD's GWRS for groundwater replenishment)
- **Reinjection**: re-injection of treated groundwater via injection wells
- **Percolation**: discharge of treated groundwater to recharge basins for percolation to groundwater
- **Drinking Water**: supply of treated water to Fullerton's and/or Anaheim's potable water distribution system

After treated water is discharged, follow-on activities are considered *off-site*, thus, they are beyond the realm of project defined ARARs and simply subject to applicable permit requirements and limits. Therefore, for alternatives involving re-injection and percolation, the Santa Ana RWQCB waste discharge permit provides standards for the treated water (Order No. R8-2002-0033 and Amending Order No. R8-2013-0020). These discharge orders are in

limited use, and the possibility exists that it will not be renewed or amended before implementation of the Interim Remedy. If that is the case, individual permits may be issued instead if recharge or re-injection options are selected for the Interim Remedy. Discharge standards for recharge of treated groundwater include MCLs for TCE, PCE, 1,1-DCE, 1,2,3-TCP, 1,2-DCA, and the NL for 1,4-dioxane. For alternatives involving the use of treated groundwater for potable consumption (i.e., use in the Fullerton and/or Anaheim potable water distribution system), the water served must meet MCLs. The DDW Process Memo 97-005 criteria would apply for the treatment of impaired groundwater for potable uses. For discharge of groundwater into the OC San's system, standards are contained in OC San's wastewater discharge regulations (i.e., Ordinance No. OCSD-53).

4.2 Development of Remedial Action Objectives

RAOs are goals for protecting human health and the environment in each specific environmental medium. In accordance with the NCP (under 40 CFR Section 300.430 [e][2][i]), RAOs are developed by specifying site COCs, and by identifying the medium of concern (groundwater), potential exposure pathways, and acceptable exposure levels. Acceptable exposure levels are based on ARARs or risk-based levels. As 1,4-dioxane has been established as a COC, the acceptable exposure level was calculated to be as close as possible to the EPA point of departure for cancer risk (1×10^{-6}, which corresponds to a concentration of 0.46 micrograms per liter [µg/L]). However, due to analytical sensitivity considerations for 1,4-dioxane, that number is modified to 1 µg/L, which corresponds to the state NL. Acceptable exposure levels for the remaining COCs are based on their respective MCLs.

RAOs for the North Basin Interim Remedy are to protect human health and the environment by preventing exposure to and containing contaminated groundwater in the Interim Remedy containment area. As part of identification, screening, and evaluation of alternatives, RAOs are defined for each medium of interest (e.g., groundwater). Consistent with EPA's RI/FS Guidance (EPA/540/G-89/004):

- RAOs should be as specific as possible but not so specific that the range of remedial alternatives is unduly limited.
- RAOs should specify the medium of concern, COCs, potentially complete exposure pathway(s) and receptor(s), and an acceptable COC level or range of levels for each exposure route. COCs are a refinement of COPCs and are determined after completion of both the human health risk assessment and ARARs analysis.

- Protectiveness may be achieved by reducing exposure, as well as by reducing contaminant levels, and thus RAOs should specify acceptable contaminant exposure levels and exposure route.
- RAOs should incorporate and be based on the current and future use of the site, groundwater and surface water classifications (uses), and the point(s) of exposure.

4.2.1 Media of Concern

Groundwater is the only medium of concern for the North Basin Interim Remedy, and thus the FS considers only the direct exposure pathways for groundwater.

4.2.2 Contaminants of Concern

All remedial actions at CERCLA sites must be protective of human health and the environment and must comply with the ARARs unless a waiver is justified. The selection of COCs was based on human health risk considerations, known releases in the North Basin, and the ARARs, as described below.

The aquifer underlying the North Basin is a Class II aquifer, pursuant to EPA's groundwater policy for classification of groundwater systems. Class II consists of groundwater that currently is being used or that may be used as a source of drinking water in the future. Accordingly, federal or more stringent State MCLs constitute potential chemical -specific ARARs for groundwater and were used for selection of COCs. Based on groundwater sampling and analyses, as summarized in Section 3.3, the following analytes exceeded their respective federal MCL or State MCL, or acceptable exposure levels in groundwater relatively consistently: PCE, TCE, 1,1-DCE, 1,2,3-TCP, 1,2-DCA, and 1,4-dioxane. VOCs were selected as COCs for the North Basin groundwater based on the ARARs. The SVOC 1,4-dioxane was selected as a COC based on its contribution to the cumulative lifetime cancer risk exceeding 1 x 10^{-4}. Because there is no federal or state MCL for 1,4-dioxane, the acceptable exposure level is the State NL of 1 µg/L. Inorganic analytes, in particular nitrate and perchlorate, also have been detected in the aquifer above the primary MCLs but are not considered COCs (Section 3.3). In addition, PFAS compounds have been detected throughout the aquifer. Although not considered COCs, nitrate, perchlorate, and PFAS are considered during Interim Remedy selection and design to ensure that groundwater treatment technologies comply with all applicable ARARs.

4.2.3 Potential Exposure Pathways

This section presents potential exposure pathways specific to the identified COCs for groundwater. These exposure pathways are consistent with those assumed during the

human health risk assessment that was completed as part of the RI (AECOM 2022) and this FS.

Currently, groundwater with COC concentrations greater than MCLs in the North Basin is not used for drinking water. If future domestic groundwater use is assumed, exposure of potential on-site residents and industrial workers to contaminants in groundwater can occur via the following exposure pathways:

- Ingestion of impacted groundwater
- Dermal contact with impacted groundwater
- Inhalation of volatiles from groundwater during household water use

4.2.4 Remedial Action Objectives

Based on the identified COCs, potential exposure pathways and risks to human health and the environment, and ARARs, the following RAOs were developed for the North Basin Interim Remedy:

- RAO #1: Prevent exposure via direct contact (e.g., ingestion, dermal contact, and inhalation of vapors coming from water while showering) with contaminated groundwater with concentrations of trichloroethene, tetrachloroethene, 1,1-dichloroethene, 1,4-dioxane, 1,2-dichloroethane, and 1,2,3-trichloropropane that exceed acceptable exposure levels.
- RAO #2: Prevent further lateral migration outside of the containment area of the COCs trichloroethene, tetrachloroethene, 1,1-dichloroethene, and 1,4-dioxane in the Shallow zone. Prevent further vertical migration of COCs from the containment area in the Shallow zone to protect the beneficial use as drinking water in the Principal zone.

The RAOs for this interim action will function to support the final Site objective which is anticipated to be to restore the Shallow and Principal aquifers as a drinking water source (i.e., meet drinking water standards throughout the entire plume). A preliminary remediation goal was not established for this interim action; a final remediation goal will be determined when the final remedy is selected for the overall Site action. During Interim Remedy implementation a water quality assessment of the site will establish the pre-remediation concentrations and spatial distribution of COCs within the Shallow and Principal Aquifers.

Consistent with the provisions of Section 300.430 (e)(2)(i) under Title 40 of the CFR, the above RAOs specify North Basin COCs, medium of concern (groundwater), and potential exposure pathways (domestic use). The RAOs establish acceptable exposure levels that are protective of human health and the environment and consider several factors, including ARARs, cancer risk/non-cancer hazards, technical limitations such as detection/quantification limits, uncertainty, and other pertinent information. Acceptable

exposure levels for COCs in the North Basin are based on ARARs (e.g., MCLs) or risk-based levels within the risk range of 1×10^{-6} and 1×10^{-4} in accordance with the NCP.

5. Identification and Screening of Technologies

The Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988) stipulates that following identification of RAOs, the next phase of the FS process is the identification, development, and screening of technologies, which typically include the following steps:

- Identifying potential treatment and disposal technologies as GRAs
- Screening potential treatment and disposal technologies based on technical impracticability
- Evaluating process options based on effectiveness, implementability, and relative cost
- Combining media-specific technologies into remedial alternatives
- Screening the alternatives

After the screening of potential treatment and disposal technologies is completed, the selected technologies then are evaluated using the NCP criteria for the detailed analysis of alternatives. This section summarizes the technology identification and screening process that leads to development of interim remedial alternatives, and Section 6 presents a detailed analysis of the interim remedial alternatives.

5.1 General Response Actions

GRAs are broad categories of actions defining containment, treatment, removal, pumping, or other actions, singly or in combination, that may be taken to satisfy the RAOs for the site. The GRAs are medium (e.g., groundwater) specific. GRAs aid development of the alternatives by specifying which remedial technology types are likely to be effective in achieving the RAOs.

Five general response actions (i.e., institutional actions, natural attenuation and monitoring, physical containment, in situ treatment, and ex situ treatment) were identified. In addition, as required by the NCP, the “no action” alternative is to be retained throughout the FS process. The no action alternative is included to provide a baseline for comparison with the other alternatives. Because remedial actions will not be implemented with the no action alternative, long-term human health and environmental risks for the Site essentially will be the same as those identified in the baseline HRA (refer to Section 3.7), which indicate a risk will exist if the groundwater is used for domestic purposes. The GRAs are shown in Table 5-1 and are described further in Section 5.1.1.

5.1.1 No Action

Under this GRA, no further response actions will be conducted for the COC-impacted groundwater. Remedial actions will not be implemented with the no action alternative. Therefore, long-term human health and environmental risks for the North Basin essentially will be the same as those identified in the baseline HRA, which identified significant health risks for the primary receptors (AECOM 2020).

5.1.2 Institutional Controls and Access Restrictions

The institutional controls (ICs) will include non-engineered instruments, such as administrative and/or legal controls that will minimize the potential for human exposure to COC-impacted groundwater by restricting its use. The administrative/legal controls may be in the form of restrictions that prohibit the use of groundwater for purposes that may lead to unacceptable risk from current or potential future groundwater exposure. Voluntary ICs (by means of well closures by groundwater producers) already are in place at the North Basin. Other potential voluntary ICs are subscriptions to services, such as Terradex (available online at https://www.terradex.com/) that provide notifications of any well drilling and well permits with the County or municipal entities. Currently, no ICs preclude construction of production wells in any part of the North Basin. New ICs can be implemented by agencies involved in permitting construction and operation of production wells, to preclude exposure to contaminated groundwater. Also, ICs can be implemented to preclude construction and operation of new production wells in areas that will accelerate the lateral and vertical migration of contaminated groundwater. ICs implemented as part of an interim remedy will not preclude the plume from continuing to expand outside the containment area and consequently will not meet the RAOs. However, ICs can be included with another GRA to address RAO #1. Consequently, the ICs are retained as applicable for this FS.

5.1.3 Monitored Natural Attenuation

The term “monitored natural attenuation,” refers to the reliance on natural attenuation processes to achieve site-specific RAOs in a reasonable timeframe compared with that offered by other more active methods. The “natural attenuation processes” that are at work in an MNA approach may include a variety of physical, chemical, and/or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, and/or concentration of COCs in soil or groundwater. These in situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants. When evaluating natural attenuation processes for site remediation, EPA prefers processes that degrade or destroy contaminants. Additionally, the EPA expects that MNA would generally be most appropriate for sites where the contaminant plumes are no

longer increasing in extent or are shrinking. Natural attenuation processes typically occur at all sites but to varying degrees of effectiveness depending on the types and concentrations of contaminants present and the physical, chemical, and biological characteristics of the soil and groundwater. Even though these mechanisms are present, they may not be sufficient to meet RAOs. MNA should be supported by multiple lines of evidence justifying its appropriateness to be retained as a remedial alternative or combined with other GRAs (e.g., ICs). The "lines of evidence," are:

1. Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. In the case of a groundwater plume, decreasing contaminant concentrations should not be solely the result of plume migration. The primary attenuating mechanism should also be understood for all classes of contaminants (i.e., inorganic, organic, and radionuclide).

2. Hydrogeologic, geochemical, and biological data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.

3. Data from field or microcosm studies (conducted with actual contaminated site media) directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

The data and analysis that are presented in the RI report (AECOM 2022) indicate that the COC plumes are not stable, and that the COCs are not attenuating sufficiently to meet the RAOs. Consequently, MNA will not meet NCP threshold evaluation criteria (overall protection of human health and the environment and compliance with ARARs) and is not presented as an alternative for consideration. However, EPA's analysis of MNA is retained for completeness and transparency in the decision-making process despite it not meeting the effectiveness criterion.

5.1.4 Physical Containment

This GRA includes the containment of COC-impacted groundwater by a vertical physical barrier. The containment will minimize further migration of the impacted groundwater. This alternative will not directly reduce the volume, toxicity, or mobility of COCs in groundwater. Because of the vertical extent of COCs (more than 350 feet bgs) in groundwater in the Interim

Remedy containment area and the area to be contained (2,000 acres), physical containment is not an implementable option and therefore is not retained as applicable for this FS.

5.1.5 In Situ Treatment

In situ treatment includes treatment of COC-impacted groundwater using physical/chemical or biological treatment technologies. Groundwater will not be extracted aboveground and the treatment will occur entirely in the subsurface, directly to zones with currently impacted groundwater, or to zones where contaminated groundwater may migrate in the future. In situ remediation technologies that have been considered include injecting amendments to allow bacteria to flourish that destroy the COCs, injecting oxidizing chemicals that destroy the COCs, constructing a permeable reactive barrier containing material (e.g., zero-valent iron) that will result in the destruction of the COCs as the contaminated groundwater flows through the barrier, air sparging (e.g., injecting air into the aquifer to volatilize dissolved VOCs) combined with soil-vapor extraction to collect the vapor-phase VOCs, and then treating the soil vapor and thermal heating to volatilize the dissolved-phase VOCs, combined with soil-vapor extraction, and then treating the soil vapor. Table 5-1 lists descriptions, an effectiveness evaluation, implementability, and relative costs for in situ technologies that were identified and screened. Additional discussion of in situ technologies and approaches is presented next:

The Interim Remedy containment area in the Shallow zone encompasses approximately 2,000 acres, is saturated from approximately 80 to 200 feet bgs, and has a high degree of lateral and vertical heterogeneity (refer to the RI report for a more detailed description of the Shallow zone hydrogeology, AECOM, 2022). Because of the heterogeneity in the aquifer and the depths requiring treatment, injecting amendments will not be practical because more permeable zones will result in short-circuiting and/or insufficient distribution of injected amendments. Also, numerous sources of COCs are found throughout the Interim Remedy containment area, and because of the heterogeneity in the aquifer, VOCs are migrating into the Principal zone from multiple locations throughout the Interim Remedy containment area. Consequently, multiple lines of injection will be required to meet the RAOs. The required spacing of injection points will be based on pilot testing, conducted to determine the zone of influence and overlap. For the screening evaluation, an injection spacing of no greater than 20 feet was considered appropriate based on professional judgment and previous experience with similar subsurface materials and conditions. Because of the width of the plume in the Interim Remedy containment area of approximately 7,000 feet, and assuming an injection spacing for an amendment or oxidant of no greater than 20 feet with five transect lines of injection intersecting the length of the plume (which is more than 13,000 feet) will require approximately 1,750 borings and injection wells. The North Basin is fully developed. Thus, these borings and wells will have to be constructed in City streets and/or on private property.

The magnitude of the necessary property rights render this response action administratively infeasible, thus it does not pass the implementability criterion.

Constructing a permeable reactive barrier to a depth of 200 feet will require borings that are backfilled with the reactive barrier material. Trenching and backfilling with permeable reactive material to that depth is not feasible. Backfilled borings would be used to construct the reactive barrier curtain. Boring spacing will need to be close enough to minimize the potential for gaps in the reactive barrier curtain. The following estimate assumes a 5-foot spacing; however, system design will require pilot testing to determine the necessary spacing and zone of influence for the reactive barrier material. With five permeable reactive barriers, each 7,000 feet wide, and having a 5-foot boring spacing will require 7,000 borings. The magnitude of the necessary property rights render this response action administratively infeasible, thus it does not pass the implementability criterion. Furthermore, the North Basin COC plume contains PCE, TCE, 1,1-DCE, and 1,4-dioxane. This mixture of contaminants may not be readily destroyed by a singular in situ amendment.

Air sparging, combined with SVE to prevent impacts on surface air concentrations, will not be technically feasible because of the area and depth of the plume and the presence of 1,4-dioxane, which will not volatilize because of its hydrophilic properties. Therefore, this response action did not pass the implementability criterion.

Thermal heating combined with SVE is not technically feasible across a saturated interval of 80 to 200 feet bgs. Furthermore, thermal heating has not been widely tested for treatment of 1,4-dioxane. Therefore, this response action did not pass the implementability criterion.

Because of the area to be contained (2,000 acres), the depth of groundwater contamination (80 to 200 feet bgs), heterogeneity in the aquifer, and high probably of failure because of those conditions, as well as the mix of COCs, the large number of borings and injection wells needed, in situ treatment is not an implementable option, and therefore is not retained for detailed screening.

5.1.6 Ex Situ Treatment

Ex situ treatment will include the extraction of impacted groundwater using groundwater extraction wells and aboveground treatment using physical/chemical or biological processes. The treated groundwater will be discharged using appropriate technologies that are discussed in this section. Ex situ treatment is a mature technology that will address RAO #2 and has been retained as applicable for this FS. Because of the large area and volume of impacted groundwater in the North Basin, even at the high extraction rates considered in the following ex situ treatment options, ex situ treatment will not completely clean up the

groundwater within a foreseeable period but instead will serve as a plume containment measure and prevent further lateral and vertical migration of COCs.

The various aspects of ex situ treatment, including the extraction wellfield options, groundwater discharge or reuse options, ex situ treatment options, and treatment facility options, are discussed next, and more details are presented in Section 6.

5.1.6.1 Wellfield Options

The refined North Basin groundwater flow model was used to develop and evaluate various wellfield options with extraction only from the Shallow zone. That modeling was used to facilitate a comparison of the wellfield options and is described in more detail in Section 6.3.1, and in the modeling technical memorandum that is provided in Appendix C. As shown in Table 5-1, the following extraction wellfield options were evaluated:

- The existing wellfield, consisting of the five extraction wells (refer to Simulation 1 in Section 6.3.1) previously installed by OCWD (refer to Figure C-1 in Appendix C). The existing wells that are screened in both the Shallow and Principal zones will be modified to pump only from the Shallow zone.
- The existing and new wells (also called the augmented wellfield) option, consisting of five existing OCWD extraction wells, augmented with 12 additional extraction wells (refer to Simulation 2 in Section 6.3.1), to achieve containment of the plumes and minimize vertical migration from the Shallow to Principal zones (refer to Figure C-5 in Appendix C).
- The alternative wells option, consisting of alternative locations for extraction wells (refer to Simulation 3 in Section 6.3.1) that can achieve containment of the plumes and minimize vertical migration with minimal use of existing extraction wells, compared to the augmented wellfield option (refer to Figure C-6 in Appendix C).
- The existing and new wells with re-injection, the same extraction well field configuration but adding injection wells on North East Street, south of the Raymond Basin (refer to Figure C-7a in Appendix C).
- The existing and new wells with recharge basin, the same extraction well field configuration but adding infiltration of treated water in the eastern portion of the North Basin and south of OCWD's La Jolla Recharge Basin (refer to Figure C-7a in Appendix C).

As is further described in Section 6.3.1, the augmented wellfield or existing and new wells option (Simulation 2) has been retained as the preferred extraction option based on the simulation results for containment, ease of implementability, and lower cost.

5.1.6.2 Groundwater Discharge Options

The following five discharge options for the extracted groundwater were evaluated during the alternative screening (Table 5-1):

- Discharge of untreated groundwater to the sewer and to a publicly owned treatment works (POTW), and then advanced purification and re-use of the treated water through OCWD's GWRS
- Discharge of treated groundwater to the aquifer system via injection wells
- Discharge of treated groundwater to the aquifer system via infiltration basins
- Direct potable use of treated groundwater
- Discharge of treated groundwater to surface water

The discharge of treated groundwater to surface water is not retained for use in developing the remedial alternatives because this option will not incorporate beneficial uses of the treated groundwater. For this option, the treated groundwater would be discharged to the Santa Ana River and ultimately to the Pacific Ocean. California Water Code (Section 100) requires implementation of discharge options that support the beneficial use of extracted groundwater to the fullest extent possible. The State does not support a wasteful discharge of otherwise useable water. State concurrence as a support agency is required for the project to be administratively feasible; therefore, this alternative was not further evaluated as it was determined to not be implementable.

5.1.6.3 Ex-situ Treatment Options

Six ex situ groundwater treatment options were evaluated during the alternative screening (Table 5-1) as follows:

- **LGAC**: LGAC is an adsorptive technology and appropriate treatment for PCE, TCE, and other VOCs in groundwater. LGAC is cost-effective for the concentrations expected to be present in groundwater extracted for the Interim Remedy; however, the activated carbon is not as efficient at adsorption of 1,1-DCE, which is expected to be present in the groundwater above the MCLs. In addition, LGAC can also treat PFOA and PFOS, although it may require a longer residence time than for VOCs. Based on the anticipated influent PFOA and PFOS concentrations (slightly above the MCLs) and the 1,1-DCE concentrations, the proposed LGAC adsorption system will treat these contaminants adequately. If PFAS concentrations are significantly higher in the future than currently indicated, then modification to the treatment (e.g., addition of ion exchange or novel adsorbers) may need to be considered. Also, LGAC is not effective for 1,4-dioxane, nitrate, and perchlorate treatment. Nitrate and perchlorate are not considered COCs in this FS, as discussed previously. In conclusion, LGAC has been retained as a viable groundwater treatment process option for VOCs and PFAS at the anticipated concentrations.

- **Air stripping/vapor-phase granular activated carbon (AS+VGAC)**: Air stripping is a technology that transfers dissolved VOCs in extracted groundwater to air passed through the groundwater in a packed column or tray configuration. For chlorinated VOCs, the resulting off-gas is typically treated with VGAC (vapor-phase granular-activated carbon). AS+VGAC treatment is effective for PCE, TCE, 1,1-DCE, and other VOCs; however, it is not effective for 1,4-dioxane and inorganic compounds (such as nitrate). At the relatively low VOC concentrations expected to be present in the wellfield discharge, it will be less cost-effective than LGAC treatment; therefore, AS+VGAC has not been retained for further evaluation of treatment options.
- **Advanced oxidation process (AOP)**: This is a treatment process that is designed to remove organic contaminants through reactions with hydroxyl radicals. AOP is a non-selective treatment technology that is more costly to operate than LGAC and therefore will be implemented to remove 1,4-dioxane in a treatment train downstream from LGAC treatment which will also remove VOCs and PFAS. 1,4-Dioxane has a low molecular weight, is highly soluble in water, and is not readily volatile, making treatment techniques other than AOP less effective. Variants of AOP technologies include ultraviolet (UV)-hydrogen peroxide, UV-ozone, and UV-ozone/peroxide-based processes. UV-peroxide AOP is preferred because it is less likely to form bromates, which have a low MCL (10 µg/L). UV-chlorine AOP is also used in potable reuse for 1,4-dioxane and NDMA destruction. However, this technology works better when pH is less than 6.

  UV-peroxide AOP has been retained as a viable groundwater treatment process option. Currently, UV AOP is being considered for placement downstream from the LGAC vessels; however, because UV AOP also can be effective in reduction of chlorinated VOCs, other options such as placement of UV AOP ahead of the LGAC can be evaluated during the RD phase. AOP treatment has the potential to convert some unknown PFAS to other smaller chain and known PFAS. With the possible exception of PFOS, the treatment plant influent concentration of PFAS is anticipated to be below regulatory values/limits. As discussed in Section 2.2.4, a PFAS TOP analysis was conducted as a conservative measure, to determine whether AOP can produce higher concentration of short-chain PFAS. The TOP analysis indicated that an increased PFAS concentration after AOP is not expected to be significant, and additional PFAS treatment is not likely to be required. A discussion of the TOP analysis is provided in Appendix F. Furthermore, since LGAC can treat the low levels of PFAS concentrations that are anticipated, significant PFAS is not expected to enter the UV AOP system.
- **Fluidized bed reactor (FBR)**: This is a treatment technology that typically is considered for perchlorate and nitrate in groundwater, involving anaerobic biodegradation of perchlorate to chloride and nitrate to nitrogen, with the biodegradation occurring on particles in a fluidized bed (typically granular-activated carbon) reactor. Perchlorate and nitrate are not considered COCs in this FS. FBR produces a biological sludge that requires disposal, has a higher capital cost, is more complicated to operate and maintain, and is not economical at the expected perchlorate concentrations. Furthermore, this is a more complex technology with

significantly higher costs than LGAC and ion exchange (IX) and is not well proven for treatment to achieve drinking water standards. Therefore, FBR technology has not been retained for further evaluation of treatment options. As described further in the following discussion, treatment for perchlorate and nitrate may not be required if use of a central treatment plant is implemented.

- **Ion exchange (IX)**: This is an appropriate treatment technology for perchlorate and nitrate in the extracted groundwater. Single-use IX resin is the most commonly used technology for perchlorate treatment and requires less space than biological treatment with an FBR system. Regenerable IX treatment for nitrate treatment generally is more economical and simpler to operate than reverse osmosis (RO) (refer to the next bullet point) and produces a smaller volume of wastewater than RO. In addition, IX recently has been implemented in Orange County to remove PFOA, PFOS, and PFBS in groundwater for potable supply, however this uses a different resin type than is typically selected for treatment of perchlorate and nitrate. IX has been retained as a viable groundwater treatment process option if treatment is required for perchlorate, nitrate, and/or PFAS. As discussed below, treatment for perchlorate, nitrate, and PFAS may not be required if use of a central treatment plant is implemented.
- **Reverse osmosis**: RO uses specialized filters and membranes to remove contaminants from water. Hydraulic pressure is used to force water through a semi-permeable membrane to produce treated water. RO is energy-intensive and relatively high in cost, compared to other technologies (e.g., LGAC, IX), and it produces a concentrated brine requiring disposal as wastewater. RO is effective as part of a treatment train for removal of total dissolved solids (TDS) and other inorganics, to achieve drinking water standards and allow potable use of groundwater. RO will be less effective in removing VOCs and 1,4-dioxane than LGAC and AOP, respectively, but it will be effective in removing PFOA and PFOS. RO will be less cost-effective compared to IX, if treatment is required for nitrate, perchlorate or PFAS. However, because one of the alternatives is to discharge the treated water for potable use, RO is considered good for effectiveness, if needed to reduce TDS concentrations. Consequently, RO has been retained as a viable groundwater treatment process option when used in combination with other treatment technologies to remove VOCs, and 1,4-dioxane. RO would be provided by a water supplier and not as a project cost.

LGAC, AOP, and IX have been retained for use in the remedial alternatives. AS+VGAC has not been retained because it is a viable option only at higher VOC concentrations, while the anticipated influent concentrations to the treatment system are expected to be below the threshold (100 µg/L) that may make AS+VGAC a viable option. Also, FBR has not been retained because the technology primarily is a viable option for nitrate and perchlorate, which are not considered COCs in this FS. RO has not been retained as a primary treatment technology because it is not a viable option for treating COCs. However, it is retained as an optional treatment augmentation for City of Fullerton to use for TDS reduction if needed for potable use distribution. Of the retained technologies, LGAC is the preferred primary

treatment technology for the anticipated VOC concentrations, while other technologies are being retained as needed to address other contaminants. For example, AOP has been retained to address 1,4-dioxane, and IX has been retained if needed to address nitrate, perchlorate, and/or PFAS. For emerging contaminants that currently do not have MCLs, promulgation of standards in the future may require consideration of additional treatment technologies.

PFAS Total Oxidizable Precursor Evaluation

During the review and comment process for the initial Draft FS, EPA and RWQCB expressed concerns over the possibility of increased concentrations of PFAS compounds from PFAS precursors that are exposed to oxidizing conditions of the UV and hydrogen peroxide in the advanced oxidation process (H_2O_2 AOP) treatment, which may be used to remove 1,4-dioxane in the extracted groundwater. To further evaluate this, OCWD collected samples from 10 Shallow zone wells throughout the North Basin containment area for the PFAS TOP analysis. The TOP analysis was a two-step process with an aggressive oxidation step that converted unknown PFAS (called precursors) to commonly analyzed perfluoroalkyl acids (known as terminal PFAS compounds). After the TOP assay oxidation and analytical process, the increase in measurable PFAS relative to pre-oxidation levels gave an estimate of the concentration of PFAS precursors in the sample that oxidized to form shorter-chain PFAS compounds. This can be used to demonstrate the likelihood of the UV AOP treatment, resulting in an increase in PFAS compound concentrations.

The results of this analysis indicated that the proposed treatment alternatives using UV/H_2O_2 AOP are not expected to increase concentrations of PFAS precursor compounds to a level that would result in formation of PFAS compounds above the MCLs or currently identified and accepted exposure levels. This is based on current regulations and risk-based levels. The regulations regarding PFAS are anticipated to change and evolve over time. Therefore, the RD will need to consider possible future discharge limits for PFAS compounds. Additional treatment may be required in the future as additional MCLs for emergent contaminants such as PFAS are promulgated.

The sampling and analysis are summarized as follows:

- 10 Shallow zone wells throughout the North Basin containment area were sampled for the PFAS TOP analysis:
- Wells included in this analysis are shown in Figure 2-3 and include: AM-41A, FM-5, FM-7A, FM-10A, FM-11A, FM-12A, FM-16A, FM-18A, FM-19A, and FM-30A.

Summary of Analysis and Results

- Samples were analyzed for 24 PFAS compounds, using Method 537 (modified), before and after an oxidation procedure. The oxidation procedure involved treating the water with persulfate, hydroxide, and heating to create hydroxyl radical oxidation. This was a more aggressive oxidation process than what would occur with the advanced oxidation process, used to treat groundwater for 1,4-dioxane (UV/H2O2 AOP).
- Two samples exceeded holding times: FM-11A and AM-41A. OCWD sent three sets of samples each from those two wells to the Eurofins laboratory, one of two known labs that conducts PFAS TOP analysis, and holding times were exceeded with all three. However, according to Eurofins, the method holding times are expected to increase in the future, and the holding times did not exceed those expected future limits. Because of schedule concerns in preparing the revised draft FS, OCWD requested the TOP analytical results for the third set of samples for FM-11A and AM-41A. A summary of the TOP results for the detected PFAS compounds in the North Basin samples are provided in Appendix F.
- PFOA, PFOS, PFHxS, and PFBS all exhibited on average a decrease in the TOP testing, implying that the UV oxidation process will not create additional PFAS.
- Based on current groundwater concentrations, only PFOS possibly may exceed the MCL in the influent to the treatment plant, and because LGAC treatment is effective for PFOS at slight exceedances of the MCLs, the PFAS concentrations entering the UV AOP are expected to be minimal.
- Perfluorobutanoic acid (PFBA) is the only PFAS compound that exhibited an increase greater than 1 nanogram per liter (ng/L).

Key points regarding PFBA:

- Only a few states have advisory-type drinking water values for PFBA. The lowest is 7 µg/L (7,000 ng/L) in Minnesota. No MCLs have been adopted and no plans to do so have been announced.
- The EPA tap water RSL for PFBA is 1,800 ng/L (HQ = 0.1), which indicates substantially less noncancer potency than other commonly observed PFAS compounds, targeted for the MCLs.
- The average observed increase in PFBA of approximately 20 ng/L represents less than 1.5% of its tap water RSL, and the final PFBA concentrations in oxidized groundwater are similarly low.
- PFBA is a short-chain PFAS, and currently available granular-activated carbon or ion exchange resins are not considered an effective treatment approach to remove PFBA. Reverse osmosis or nanofiltration systems will be needed for effective treatment, significantly increasing treatment costs.
- Requiring treatment for PFBA is comparable to requiring treatment for TCE if concentrations increase from 1 to 1.01 µg/L.

5.1.6.4 Treatment Facility Options

Two options were evaluated for the types of treatment facilities during the alternative screening:

- **Centralized plant system**: In this option, piping from the extraction wells will convey groundwater to a single, central treatment plant. The location of the plant will depend on the availability and cost of a suitable property. Ideally, the plant will be at or near the point of discharge or use (e.g., near the injection wells, recharge basins, or connection to the potable distribution system), to reduce the overall costs for conveyance. A central plant system has been retained as applicable for the FS.
- **Distributed plant system**: In this option, piping from the extraction wells will convey groundwater to multiple smaller treatment plants near the extraction well clusters. Discharges from each treatment system will be handled independently. Because of the cost of acquiring land, permitting, and constructing the treatment plants at multiple locations, and because discharge of the treated groundwater is likely to occur at one location or proximal locations (e.g., injection wells), a distributed plant system likely will be higher in total cost. To retain this option for evaluation in RD, one example of a distributed plant option with two treatment plants has been included in the detailed evaluation of alternatives.

5.2 TECHNOLOGIES RETAINED FOR REMEDIAL ALTERNATIVE DEVELOPMENT

Table 5-1 shows the preliminary screening of the above-mentioned technologies based on the general objective/remediation area, remedial technology type, remedial technology process option description, effectiveness, implementability, and cost. The grey-shaded cells in Table 5-1 show the technologies/process options that have been selected for alternative development. MNA and ICs do not meet the screening criteria but were retained for evaluation for completeness and transparency in the decision-making process. Physical containment and in situ treatment of groundwater were not retained because they did not pass the screening criteria for implementability and effectiveness. Ex situ treatment and specific discharge options also have been retained for further evaluation, along with the no action alternative. MNA with ICs did not pass the implementability or effectiveness criteria but is considered as an additional approach for transparency.

5.3 REMEDIAL ALTERNATIVES

The following remedial alternatives were developed by combining different retained technologies and process options, corresponding to the different GRAs described previously:

- Alternative 1 – No action
- Alternative 2 – Groundwater extraction; discharge to POTW/GWRS; monitoring; ICs

- Alternative 3 – Groundwater extraction; discharge to centralized treatment plant; discharge for direct use (potable water); monitoring; ICs
- Alternative 4 – Groundwater extraction; discharge to a centralized treatment plant; discharge to injection wells; monitoring; ICs
- Alternative 5 – Groundwater extraction; discharge to central treatment plant; discharge to infiltration basin; monitoring; ICs
- Alternative 6 – Groundwater extraction from two groups of extraction wells (Group 1 and Group 2); treatment in two treatment plants (discharge Group 1 wells to infiltration basin; discharge Group 2 wells to injection wells); monitoring, ICs

Further description of these alternatives and detailed evaluations are provided in Sections 6 and 7. Additionally, an approach EPA considered but is not presenting as an alternative (MNA and ICs) is described in Sections 6 and 7.

6. Interim Remedial Alternatives

This section presents descriptions of the interim remedial alternatives that are evaluated in more detail in Section 7, as well as an additional approach EPA considered but is not presenting as an alternative. Table 6-1 summarizes the remedial alternatives.

6.1 Alternative 1 – No Action

The NCP (40 C. F. R. 300.430[e][6]) requires that a "no action" alternative (Alternative 1) be evaluated to provide a baseline condition if no remedial action is taken. Under Alternative 1, no ICs, containment, or treatment of the COC-impacted groundwater will be provided to reduce potential risks to human health or the environment. For Alternative 1, COCs will continue to migrate in the groundwater. Natural processes will be the only mechanism acting to reduce the concentrations of COCs in groundwater; however, these mechanisms will not be monitored under this alternative.

6.2 Groundwater Extraction, Treatment, Discharge of the Treated Groundwater, Monitoring and ICs

Alternatives 2 through 6 will include groundwater extraction, treatment to remove COCs and other constituents as needed to allow for discharge of the treated groundwater, monitoring, and ICs to achieve the RAOs for the Interim Remedy. This section initially presents 1) a summary of the groundwater modeling that provides the basis for the selection of the augmented wellfield, the number of extraction wells, and individual well flow rates (Section 6.2.1); and 2) a description of the anticipated treatment plant influent concentrations (Section 6.2.2). The descriptions of various extraction options (Alternatives 2 to 6) are presented in Section 6.2.3.

6.2.1 Groundwater Modeling of The Extraction Based Containment Options

Groundwater modeling with particle tracking was conducted to support development of various extraction options, to ensure that the selected extraction option will provide adequate containment of the COC plume in the Shallow zone, and to facilitate evaluation of Alternatives 2 through 6 that will involve groundwater extraction. Groundwater modeling includes a baseline model representing the "no action" alternative, with expected regional pumping/recharge operations but without any pumping from extraction wells to control the COC plume. All modeling simulations included the existing operating production wells as well as domestic, irrigation, industrial wells, and the AC Products remediation well ACP/P-02 (Figure 2-3) within the model domain. As discussed in this section and in more detail in the modeling technical memorandum (provided in Appendix C), the wellfield options that were simulated using the North Basin groundwater flow model evaluation for containment included the following:

- Simulation 1 – Existing wellfield consisting of five extraction wells (Figure C-1 in Appendix C) previously installed by OCWD, pumping at a total flow rate of 2,547 gpm, built on the baseline model but with extraction from those wells only from the Shallow zone.
- Simulation 2 – Existing and new wells consisting of five existing OCWD extraction wells, augmented with 12 additional extraction wells (Figure C-5 in Appendix C) for a total of 17 extraction wells (also referred to as an "augmented" wellfield), operating at 6,351 gpm to achieve containment of the plumes and minimize vertical migration from the Shallow to Principal zones.
- Simulation 3 – Alternative wells consisting of two existing OCWD extraction wells and 13 alternative locations for extraction wells for a total of 15 extraction wells (Figure C-6 in Appendix C), operating at 6,956 gpm, which can achieve containment of the plumes and minimize vertical migration with fewer extraction wells than the augmented wellfield option.
- Simulation 4 – Existing and new wells with injection, the same as Simulation 2 but adding injection wells on North East Street, south of the Raymond Basin (refer to Figure C-7a in Appendix C), and a slightly higher extraction flow rate of 6,546 gpm required to maintain containment compared to Simulation 2.
- Simulation 5 – Existing and new wells with recharge basin, the same as Simulation 2 but adding infiltration of treated water at an infiltration basin approximately 2,200 feet south of OCWD's La Jolla Recharge Basin (refer to Figure C-7a in Appendix C).

Table 6-2 summarizes the simulation results for the above-mentioned simulations (wellfield options); the data have been extracted from the modeling technical memorandum, prepared by Intera (2024) (refer to Table C-6b in Appendix C). Appendix C also provides figures that show the well locations and particle tracking simulation results for the simulations.

Table 6-2. Summary of Model Simulation Results

Modeling Simulation		Number of Existing Wells	Number of New Wells	Total Extraction Rate (gpm)	Total Injection/ Recharge Rate (gpm)	Percentage of Particles Contained
ID	Name					
-	Baseline	-	-	-	-	4%
1	Existing Wells	5	-	2,547	-	56%
2	Existing and New Wells	5	12	6,351	-	95%
3	Alternative Wells	2	13	6,956	-	90%
4	Existing and New Wells with Injection	5	12	6,546	6,546	93%
5	Existing and New Wells with Recharge Basin	5	12	6,351	6,351	94%

[1] Containment area statistics are based on the volume-weighted number of particles

A target of at least 90% particle capture was used as a goal for satisfying RAO #2, based on professional judgement and experience. The particle containment target was approved by EPA and Santa Ana RWQCB.

According to the simulation results, the baseline or no action alternative only shows 4% plume containment resulting from uncaptured particles “trapped” in low conductivity or low hydraulic gradient areas in the Shallow zone and aquitard. Groundwater extraction using the existing wellfield (Simulation 1) leads to 56% plume containment based on particle tracking (refer to Figures C-9a–c in Appendix C for particle tracking). Simulation 1 was not sufficient to achieve the target of 90% plume containment based on particle tracking, and therefore additional extraction wells were necessary to increase plume containment and prevent migration of the particles into the Principal zone. In Simulation 2, new extraction wells were included along the particle flow paths and upgradient from the heterogeneities in the upper aquitard, to maximize capture and containment in the Shallow zone while reducing the downward migration of the particles into the Principal zone. As shown in Table 6-2, the existing and new wells in Simulation 2, pumping at 6,351 gpm (10,245 acre -feet per year [AFY]) are anticipated to capture or contain 95% of the particles in the Interim Remedy containment area (refer to Figures C-10a–c in Appendix C for particle tracking). In Simulation 3, pumping at 6,956 gpm (11,220 AFY) was shown to achieve 90% capture and containment of the particles with two fewer wells than Simulation 2.

The existing and new wells option (Simulation 2) was selected as the preferred extraction option for development of remedial alternatives, as mentioned in Section 5.1.6. The primary basis for this selection is the lower overall extraction rate needed to achieve containment (6,351 gpm, 17 wells) compared to the alternative wellfield (Simulation 3; 6,956 gpm, 15 wells), and the containment performance that was measured as a percentage of particles captured is better (95% versus 90%). Further details regarding all simulations are provided in Appendix C, including the particle tracking results for each simulation, shown in Figures C-9a through C–13c in Appendix C.

The augmented wellfield option uses more of the existing OCWD extraction wells than the alternative wellfield and consequently will be easier to implement. Identifying constructible locations for extraction wells in a highly developed area and securing access can take considerable time and expense, particularly when the wells may need to be on private property.

The locations of the existing and the proposed extraction wells for the augmented wellfield simulation are shown on Figure 6-1, relative to the COC groundwater plume extents. As shown, the augmented wellfield includes 17 extraction wells. Table 6-3 summarizes the

construction details for the extraction wells that were used for the augmented wellfield and the simulated extraction rates that will be needed to achieve containment. The extraction wells are screened in the Shallow zone. Three existing extraction wells (OCWD-EW1, OCWD-EW3, and OCWD-EW4) are screened in both the Shallow and Principal zones, but extraction was assumed from the Shallow zone only. OCWD-EW1 and OCWD-EW3 will need to be modified to seal off the Principal zone screened intervals. A temporary means of sealing off the Principal zone screened intervals (e.g., inflatable packer or removable fill material) is recommended if the Principal zone extraction at those locations is determined to be needed in the future. The Principal zone screened intervals in OCWD-EW4 got clogged with grout during well construction. Consequently, approximately 98% of the water extracted by OCWD-EW4 originates from the Shallow zone, and no temporary modification of that well is expected to be needed.

The modeled locations of extraction wells were not evaluated for access or constructability. The final number of extraction wells, their actual locations, and their pumping rates will be determined during the RD phase. The RD also will consider potential impacts that changes in hydraulic gradient have on groundwater remedial actions, which may be ongoing at Source Sites. However, modifications to Source Site groundwater remedial actions may be needed if necessary to meet the Interim Remedy primary objective of protecting potable water supplies. The conveyance pipeline locations that are shown in the figures and used in the evaluation and cost analysis are conceptual and based on simple assumptions regarding potential right-of-way issues and property access. These assumed routes for conveyance piping are likely to be adjusted in the RD phase, based on factors including property ownership, access agreements, existing infrastructure, and constructability.

In addition to the existing monitoring wells, approximately 20 new monitoring wells are expected to be installed to support performance monitoring of the Interim Remedy. The exact number and precise locations of these monitoring wells will be determined after the Interim Remedy is selected during the RD phase. Groundwater monitoring will be conducted regularly and the ICs will be maintained, as described earlier.

6.2.2 Treatment Plant Influent Concentrations

As discussed in Section 5, the central treatment plant and one distributed treatment plant option have been retained to develop remedial alternatives. The central plant is expected to be on commercial/industrial property, acquired near the discharge location or at similar properties centrally located near extraction wells or pipelines. As further described in Section 6.2.3, the conceptual equipment layout will be developed for each alternative (Alternatives 3 to 6), to facilitate the treatment train systems, including LGAC and AOP (UV oxidation) sized for a range of 6,351 to 6,546 gpm. Based on the preliminary layouts (further described below),

approximately 1 acre of land will be required to construct, operate, and maintain the central treatment plant. One distributed treatment plant option, including two treatment plants for two groups of extraction wells, has been included for Alternative 6.

6.2.2.1 One Centralized Treatment Plant

For Alternatives 3 to 5, Table 6-4 lists the anticipated treatment plant influent concentrations for COCs and other constituents and the applicable regulatory criteria (e.g., MCLs, NLs). The influent concentrations for ex-situ treatment were estimated using the extraction rates for the augmented wellfield and concentrations of COCs and other contaminants, reported in the nearby monitoring wells. The constituent concentrations at each extraction well were assumed to be the maximum concentrations that were reported for the nearby monitoring wells that were screened in the same aquifer zone in the last 5 years. The constituent concentrations that were assigned to each extraction well were multiplied by the relative extraction rate (extraction rate divided by total wellfield extraction), and the weighted concentrations for each constituent for each extraction well were summed to estimate the constituent concentrations for the wellfield blend. The COCs whose influent concentrations were estimated to exceed regulatory criteria are PCE, TCE, 1,1-DCE, 1,2,3-TCP, 1,2-DCA, and 1,4-dioxane. Other constituents that may need to be considered during the RD phase to ensure compliance with all applicable ARARs for treated groundwater include perchlorate, nitrate, and PFAS. For emerging contaminants any new standards that are promulgated may influence the selection of treatment technologies and adoption of these compounds as additional COCs, as needed, through future decision documents.

6.2.2.2 Two Distributed Treatment Plants

For Alternative 6, Table 6-4 lists the anticipated treatment plant influent concentrations for COCs and other constituents for each treatment plant (Group 1 and Group 2 wells) and the applicable regulatory criteria (e.g., MCLs, NLs). As described previously, the influent concentrations for the two treatment plants were estimated based on a weighted average of COC concentrations in nearby monitoring wells and the extraction flow rates. The Group 2 wells' influent concentration exhibited higher COC concentrations for all primary COCs (i.e., 1,1-DCE, PCE, and TCE), including PFAS that exceeded the MCLs. The Group 1 wells' influent concentrations were significantly lower for all COCs.

6.2.3 Alternatives 2 through 6 – Groundwater Extraction, Treatment and Discharge Options

As previously described, Alternatives 2 through 6 include various options for treatment and discharge of the extracted groundwater, as further discussed below and summarized in Table 6-1. The actual locations and design parameters for the components of the alternatives will be determined during the RD phase. The RD needs a plan for possible variations and needed

modifications to the Interim Remedy following startup, which may include: 1) using variable-frequency drives for the extraction well pump motors to allow the pumping rates to be modified; 2) oversized pipelines to allow for increased pumping rates or the possible need to add extraction wells, avoiding the need to excavate in the streets to replace the initially installed piping; and 3) a factor of safety in the design of the treatment plant, to allow for increased flows and/or increased COC concentrations.

6.2.3.1 Alternative 2 – Groundwater Extraction; Discharge to POTW/GWRS; monitoring; ICs

In this alternative the extracted groundwater using the existing and new wells (Simulation 2) will be conveyed to the existing sanitary sewer trunk lines, which convey wastewater to an existing POTW that is operated by OC San. The POTW will discharge the treated effluent to OCWD's GWRS for full advanced treatment and eventual use for managed aquifer recharge in the Orange County Groundwater Basin. GWRS treatment includes microfiltration, reverse osmosis, and advanced oxidation using UV light and hydrogen peroxide. The advanced oxidation process destroys 1,4-dioxane. The GWRS is operated by the OCWD, in cooperation with OC San. The advantages of this option will be its sustainability (extracted groundwater will be used for aquifer recharge), and the extracted groundwater may not need to be treated before sewer discharge because it is expected to have constituent concentrations less than the permitted discharge limitations. OC San Ordinance OCSD-53 summarizes the maximum allowable discharge limits for non-domestic discharges. Of the COCs, only 1,4-dioxane has a discharge limitation, and the concentration limit (1,000 µg/L) is higher than the concentrations expected for the wellfield discharge. However, if this alternative is selected the 1,4-dioxane concentration limit will need to be confirmed. Therefore, this option may avoid or reduce the costs associated with constructing and operating a central groundwater treatment system. If determined to be cost-effective, this option may be combined with other on-site treatment and discharge options. The primary disadvantages will be permitting challenges for large-volume discharges and the fees charged by OC San for discharge and treatment. The OCWD Replenishment Assessment (RpA) and Basin Equity Assessment (BEA) for the extracted groundwater are assumed not to be applicable. The OC San administrative and discharge fees/costs will be applied, based on the volume of groundwater discharged to the sewer (based on Ordinances OCSD-50 and OCSD-51). Permitting will be addressed during the RD phase.

This option has been evaluated through modeling as Simulation 2 (refer to Appendix C for details). The results are summarized in Table 6-5, and as shown, this option will lead to 95% plume containment, based on volume-weighted particle tracking.

Table 6-5. Model Simulation 2 Results for Alternative 2

Alternative 3A Modeling Simulation		Unweighted No. of Particles	Weighted No. of Particles	No. of Particles Captured by EW wells[1]	No. of Particles Captured by ACP-02 [1]	No. of Particles Not Captured but Contained	No. of Particles Neither Captured nor Contained	Percentage Captured or Contained
ID	Name							
2	Existing and New Wells	3,591	360	329	12	1	18	95%

[1] Containment area statistics are based on the volume-weighted number of particles

A conceptual layout for Alternative 2, including the augmented wellfield, and a conceptual process flow diagram are shown on Figures 6-2 and 6-3, respectively. As discussed above, for this alternative, groundwater extracted from the augmented wellfield will be conveyed via newly installed discharge piping to an existing OC San sewer trunk line, which will convey the water to an existing POTW. City sewers are not expected to have adequate capacity for all the extracted groundwater. The total length of the new discharge piping will be approximately 29,000 linear feet. Piping diameters will range from 4 to 26 inches. The discharge piping will connect to the sewer trunk lines on Orangethorpe Avenue and State College Boulevard. The quantity of the discharge going to the sewer system will be approximately 4,100 million gallons per year. The POTW will treat the water and discharge the treated effluent to OCWD's GWRS for additional treatment and use for managed aquifer recharge in the basin. Currently, GWRS does not have adequate capacity to accept the full 6,351 gpm of extracted groundwater. Despite this option not currently expected to accommodate disposal of all the extracted groundwater, it has been retained for detailed evaluation because of a possible increase in the available capacity of the GWRS if influent flows to OC San's treatment plants decrease in the future, or as a partial disposal option in concert with other disposal options.

The estimated capital and annual operation and maintenance (O&M) costs are presented in Section 7 as part of the detailed evaluation of alternatives. The capital costs for this alternative include monitoring well installation, extraction well installation, piping network construction, project management, design and construction management, and implementation of ICs. Annual O&M costs include direct costs, such as electricity costs for the extraction pump operations, pump maintenance costs, O&M labor costs, OC San discharge fees, and reporting costs. Indirect costs, such as project management and technical support, are included as well. In addition, periodic costs, such as extraction well redevelopment and extraction pump replacement, are included.

This alternative will include performance monitoring involving the installation of an estimated 20 additional groundwater monitoring wells, 10 in the Shallow zone and 10 in the Principal zone. Well installation costs are included under the capital costs in the cost estimate. In

addition, annual O&M costs are included for annual groundwater monitoring/reporting for 96 existing and 20 new monitoring wells, to better evaluate performance. This alternative also will include ICs, such as permitting requirements for construction and operation of production wells that can prevent exposure to contaminated groundwater, to achieve RAO #1.

6.2.3.2 Alternative 3 – Groundwater extraction; centralized treatment plant using LGAC and AOP (RO/IX is Optional for Potable Water Discharge); monitoring; ICs

In this option, the extracted groundwater using existing and new wells (Simulation 2) will be conveyed to a central treatment plant that will provide flexibility for further processing to potable standards for a local water purveyor (e.g., the City of Fullerton) if desired. The primary advantages of this option will include the production of high-quality water suitable for direct beneficial uses, and this option will avoid or reduce the capital and operational costs associated with recharge facilities (injection wells or recharge basins). The primary disadvantage of this approach is that it will require acceptance from the City of Fullerton. The City of Fullerton has concerns regarding their additional costs to upgrade infrastructure to accommodate the additional water and additional treatment may be required to match their existing water conditions. A conceptual layout for the extraction wells, piping, and treatment plant for Alternative 3 are shown on Figures 6-4, 6-5, and 6-6, respectively. For the evaluation of this alternative, the groundwater extracted from the augmented wellfield is assumed to be conveyed via piping to a central treatment plant, and the treated water will be available to the City to tie into its potable water distribution system. This option has been evaluated through modeling as Simulation 2 (refer to Appendix C for details). The results are summarized in Table 6-6, and as shown, this option will lead to 95% plume containment, based on particle tracking.

Table 6-6. Model Simulation 2 Results for Alternative 3

Alternative 3B Modeling Simulation		Unweighted No. of Particles	Weighted No. of Particles	No. of Particles Captured by EW wells[1]	No. of Particles Captured by ACP-02 [1]	No. of Particles Not Captured but Contained	No. of Particles Neither Captured nor Contained	Percentage Captured or Contained
ID	Name							
2	Existing and New Wells	3,591	360	329	12	1	18	95%

[1] Containment area statistics are based on the volume-weighted number of particles

The City of Fullerton indicated that modifications to their distribution system will be required to accommodate the treated groundwater. The required improvements will include a new pump station, pipeline and electrical upgrades, and assessment/replacement of pressure

reducing valves and other appurtenances. These modifications are not included as part of this alternative.

Figure 6-5 shows the process flow diagram for the treatment plant, and Figure 6-6 shows the treatment plant equipment layout for this option. The treatment plant will include a treatment train, starting with a set of particulate filters to remove suspended solids, LGAC to remove VOCs, and an UV AOP unit to remove 1,4-dioxane. The treatment plant will be designed for a total flow rate of 6,351 gpm, to meet the discharge standards for COCs based on the MCLs for TCE, PCE, and 1,1-DCE, and the NL for 1,4-dioxane. Twenty 20,000 -pound (lb) LGAC vessels (10 pairs in lead-lag configuration) will be required to treat the groundwater, followed by the UV AOP treatment unit. The number and volume of LGAC vessels were calculated based on adsorption rates of carbon, concentration assumptions, and extraction rates (refer to Appendix E). Any additional treatment required by the City of Fullerton, such as TDS reduction, is not included as part of this alternative.

PFAS constituents are expected to be present in the plant influent (although below regulatory values/limits, possibly except for PFOS) and UV oxidation treatment potentially can produce other smaller chain PFAS constituents in the reactor. As mentioned in Section 5.1.6.3, the TOP analysis of groundwater samples showed that this is not expected to be a significant concern. However, in instances where influent PFAS concentrations slightly exceed regulatory limits and the treatment relies on GAC for PFAS removal, the concentration of desorbed PFAS in the backwash water must be confirmed before discharge to the sewer. Additional authorization from local agencies (e.g., OC San) may be necessary to ensure that the PFAS levels do not interfere with downstream wastewater treatment systems. This consideration applies to Alternatives 3 through 6, for which the integrated treatment plant process design regarding PFAS will be finalized upon confirmation. Although not expected to be needed based on wellfield blend concentrations, IX will be used if the groundwater needs treatment for perchlorate and/or nitrate. Modifications to the treatment may be required in the future as the MCLs for emerging contaminants are promulgated. Additional regulatory requirements for the treatment of impaired groundwater for potable uses are included in DDW’s Process Memo 97-005.

The estimated capital and annual O&M costs are presented in Section 7 as part of the detailed evaluation of alternatives. The capital costs for this alternative include direct costs of monitoring well installation, extraction well installation, piping network construction, treatment plant construction, LGAC system, and UV AOP system. Indirect costs include project management, design and construction management, 97-005 process memo documentation, and development of the ICs. Annual O&M costs include direct costs, such as electricity for the pumps and UV AOP system, pump maintenance, routine O&M labor, granular-activated

carbon (GAC) media changeouts and disposal, UV AOP lamp replacements, treatment additives, lab analysis, and periodic reporting costs. GAC media changeouts are estimated by the carbon vendor to be once every 3 months (refer to Appendix E). The GAC changeouts are conservatively assumed to be driven by the influent concentration of 1,1-DCE, which is not strongly adsorbed by GAC. Indirect costs, such as project management and technical support, are included as well. In addition, periodic costs, such as extraction well redevelopment and extraction pump replacement, are included, based on experience.

At an average interim remedy extraction rate of 6,351 gpm (10,245 AFY), approximately 42% of the City of Fullerton's current water demand will be satisfied with this new water source. In the case of Fullerton, the City will likely need to reduce pumping from existing production wells significantly if this alternative is implemented. Disinfection will be required before serving water, but that cost is not included in the cost estimate, and it is assumed to be the responsibility of the City. Additional costs related to electricity for the pumping into the City of Fullerton's public water supply network are assumed to be borne by the City, which would normally have to pump the water. The RpA and BEA are not included in the cost estimate. Any potential cost savings to the City of Fullerton by reduced pumping from existing wells are not accounted in this evaluation. If this alternative is selected, during the RD phase, additional simulations are recommended to evaluate the effect of reduced pumping from existing production wells, as the Fullerton wells may affect the model flow field and thus affect the hydraulic containment in the Interim Remedy containment area. Because the City's production wells produce water from the Principal zone and most of the extraction for plume containment will be from the Shallow zone, the effect of reduced pumping from the existing City production wells on plume containment is expected to be minimal.

This alternative includes performance monitoring involving installation of 20 additional groundwater monitoring wells, 10 in the Shallow zone and 10 in the Principal zone. Well installation costs are included under the capital costs in the cost estimate. In addition, annual O&M costs are included for annual groundwater monitoring/reporting for 96 existing and 20 new monitoring wells, to evaluate remedial performance. This alternative also will include the ICs, such as permitting requirements for construction and operation of production wells that can prevent exposure to contaminated groundwater to achieve RAO #1.

6.2.3.3 Alternative 4 – Groundwater extraction wells; centralized treatment plant using LGAC and AOP; discharge to injection wells; monitoring; ICs

In this option, the extracted groundwater will be treated to standards consistent with the general permitting requirements for recharge of treated groundwater and will be returned to the aquifer system via injection wells. Permits will be attained for the re-injection of treated groundwater, associated with groundwater remediation pending required treatment of COCs

to levels equivalent to the MCLs or NLs. The permitting details will be addressed during the RD phase. The primary benefits of this approach include returning treated groundwater to the basin, and background constituents in groundwater may not need to be treated before discharge if their discharge is consistent with the antidegradation policies. The primary disadvantage of this option is that injection wells often are difficult and costly to operate and maintain. They are prone to clogging, and spare capacity is needed to allow for the wells to be off-line for maintenance and redevelopment, and to allow for reduced future capacity. This option has been further evaluated through modeling as Simulation 4 (refer to Appendix C for details). The results are summarized in Table 6-7, and as shown, this option will lead to 93% plume containment, based on particle tracking.

Table 6-7. Model Simulation 4 Results for Alternative 4

Alternative 3C Modeling Simulation		Unweighted No. of Particles	Weighted No. of Particles	No. of Particles Captured by EW wells[1]	No. of Particles Captured by ACP-02 [1]	No. of Particles Not Captured but Contained	No. of Particles Neither Captured nor Contained	Percentage Captured or Contained
ID	Name							
4	Existing and New Wells with Injection	3,591	360	320	12	1	27	93%

[1] Containment area statistics are based on the volume-weighted number of particles

A conceptual layout for Alternative 4 is shown on Figure 6-7, and the process flow diagram is shown on Figure 6-8. For this alternative, groundwater extracted from the augmented wellfield will be conveyed via piping to a central treatment plant, and the treated groundwater will be conveyed to injection wells. The total length of the new discharge piping will be approximately 35,000 linear feet. Piping diameters will range from 6 to 28 inches. For the FS, the treatment plant and injection wells are assumed to be south of the COC plumes, in the area between the 91 Freeway and the Raymond Flood Control Basin (Figure 6-9). The injection wells will be along North East Street south of La Palma Avenue in Anaheim (Figure 6-7). The treatment plant will be designed for an extraction flow rate of 6,546 gpm, to meet the discharge standards for the injection of treated groundwater, in accordance with Santa Ana RWQCB waste discharge permit limits, which are assumed to be based on the MCLs for TCE, PCE and 1,1-DCE, and the NL for 1,4-dioxane. In the event that (a) the Santa Ana RWQCB does not adopt an updated General Order for Discharge of Treated Groundwater (currently Order No. R8-2002-0033 and Amending Order No. R8-2013-0020) before the start of the discharge under this alternative, or (b) the discharge is unable to qualify for authorization under a General Order, an individual waste discharge permit will be necessary for the Interim Remedy.

Although the estimated wellfield blend TDS concentration of approximately 688 milligrams per liter (mg/L) exceeds the TDS water quality objective for the entire basin, it is well within the range of the basin, and TDS concentration management is assumed to not be required. Basin water quality objectives are TBCs for the North Basin Interim Remedy and do not limit the selection of remedial alternatives. TDS concentration management is not included as part of this alternative in the FS because TDS is not a COC, and as discussed below, the water will be injected into the same aquifer zone from which it is extracted, and in this closed system, additional salts will not be introduced into the basin. Also, the TDS in the vicinity of the hypothetical injection wells in both the lower Shallow zone and upper Principal zone is comparable to or higher than in the injected water. OCWD does not have a Shallow zone monitoring well immediately adjacent to the hypothetical injection wells presented herein. However, an OCWD monitoring well that is screened in the upper Principal zone, AM-22A, is immediately adjacent to the hypothetical injection wells (Figures 2-3 and 6-7). The average TDS in AM-22A is 790 mg/L. Also, average TDS concentrations in upper Principal zone monitoring well AM-16A, northwest of the assumed injection wells, and lower Shallow zone monitoring well AM-25A, southeast of the assumed injection wells (Figure 2-3), are 818 and 651 mg/L, respectively. Injection of the treated groundwater into the Shallow zone in the vicinity of the hypothetical injection wells is not expected to adversely degrade TDS concentrations in the Shallow or Principal zones or adversely impact downgradient extraction wells. However, if deemed necessary, further evaluation of TDS impacts associated with injection wells can be conducted during the RD phase. A plan to conduct performance monitoring and reporting, that includes monitoring to meet discharge permit requirements will be developed as part of the RA, and that plan will be submitted to EPA and State regulatory agencies for review and approval. Performance monitoring also may be needed to evaluate injection well mounding, potentially mobilizing contaminants from existing release sites, including closed sites.

Figure 6-8 shows the process flow diagram for the treatment plant, and Figure 6-10 shows a possible treatment plant equipment layout for this option. The treatment plant will include a treatment train, starting with a set of particulate filters to remove suspended solids, LGAC to remove VOCs, and a UV AOP unit to remove 1,4-dioxane. Although not expected to be needed based on the wellfield blend, IX will be used if the groundwater needs treatment for perchlorate, nitrate, or PFAS. The Shallow zone has TDS concentrations that are similar to that of the extracted groundwater, whereas the TDS concentrations in the Principal zone are lower, generally less than 500 mg/L. For this alternative, the injection wells will be completed in the Shallow zone (the typical depth is less than 200 feet bgs), rather than the Principal zone, to avoid the need to treat the extracted groundwater for TDS (by RO), which otherwise will be required to comply with the antidegradation policies. As stated previously, the management of TDS is not included in this alternative or in the cost estimate.

Excess injection capacity generally is required to accommodate hydraulic inefficiencies that are associated with injection, gradual reduction in well performance because of clogging, and frequent rehabilitation for injection wells systems, and therefore, the injection wellfield was assumed to consist of 17 Shallow zone injection wells (500 gpm per well plus 30% more injection wells to address clogging), with a capacity of approximately 500 gpm each, assuming similar construction dimensions and placement for both extraction and injection wells. Based on recent groundwater modeling, re-injection of the treated groundwater via the injection wells at a 100-foot spacing in the Shallow zone in areas not in the current or former industrial areas is not expected to cause adverse plume migration or adverse groundwater mounding (refer to Figure C-7b in Appendix C).

The estimated capital and annual O&M costs are presented in Section 7 as part of the detailed evaluation of alternatives. The capital costs for this alternative include direct costs of monitoring well installation, extraction well installation, injection well installation, piping network construction, treatment plant construction, and LGAC system and UV AOP system procurement. Indirect costs include project management, design and construction management, and development of the ICs. Annual O&M costs include direct costs, such as electricity for the pumps and UV AOP system, pump maintenance, routine O&M labor, GAC media changeouts and disposal, UV AOP lamp replacements, injection well redevelopment, lab analysis, and periodic reporting costs. GAC media changeouts are estimated by the carbon vendor to be once every 3 months (refer to Appendix E) as discussed previously. Indirect costs, such as project management and technical support, are included as well. Periodic costs, such as extraction well development and extraction pump replacement, are included based on experience. OCWD's RpA and BEA are assumed to not be applicable.

The uncertainty in this alternative may cause the cost estimate to move outside the range of +50% to -30% primarily due land acquisition costs in the highly developed OCNB area. According to EPA comments, the assumed area of land between East Street and La Palma Avenue in Anaheim where the injection wells will be installed and the assumed injection well configuration for this option may be smaller than what will be required hydraulically by the aquifer to accommodate the volume of water that is re-injected (e.g., because of mounding). Preliminary hydraulic analysis based on the anticipated injection rates and a 100-foot spacing of injection wells showed that mounding will not be a significant concern. If more land or more infrastructure (piping) is needed, this will affect the cost of this alternative. Additional hydraulic analysis will be needed for this alternative during the RD phase, to optimize the wellfield, determine the proper well spacing, assess the water quality degradation because of concentrated recharge, monitor the effectiveness of the injection, and evaluate groundwater rise at the recharge facilities. The exact configuration of the system will be a part of the RD phase and is not within the scope of this FS.

This alternative includes performance monitoring involving installation of 20 additional groundwater monitoring wells, 10 in the Shallow zone and 10 in the Principal zone. Well installation costs are included under the capital costs in the cost estimate. In addition, annual O&M costs are included for annual groundwater monitoring/reporting for 96 existing and 20 new monitoring wells, to better evaluate the remedial performance. This alternative also will include ICs, such as permitting requirements for construction and operation of production wells that can prevent exposure to contaminated groundwater to achieve RAO #1.

6.2.3.4 Alternative 5 – Groundwater extraction wells; discharge to centralized treatment plant using LGAC and AOP; discharge to infiltration basin; monitoring; ICs

In this option, the extracted groundwater will be treated to standards consistent with general permitting requirements and will be returned to the aquifer system via an infiltration basin. OCWD has indicated that its existing recharge basins in or near the North Basin do not have adequate capacity to accept the treated groundwater. Also, the use of the nearby Raymond and Placentia basins (Figure 6-11) will not be feasible because they operate primarily as flood control basins, cannot be used during rainy months, and will require substantial improvements (pump stations) and administrative agreements to be used as both recharge and flood control facilities. Therefore, this option will require the purchase of geologically suitable land for construction of a new recharge basin to accept the treated groundwater. The primary benefits of this approach will include the following: it will return treated groundwater to the basin; and background constituents may not need to be treated before discharge. The primary disadvantage of this option is that substantial property will need to be acquired to construct a new recharge basin. This option has been evaluated further through modeling as Simulation 5 (refer to Appendix C for details). The results are summarized in the excerpt table from Appendix C, and as shown, this option will lead to 96% plume containment, based on particle tracking.

Table 6-8. Model Simulation 5 Results for Alternative 5

Alternative 3D Modeling Simulation		Unweighted No. of Particles	Weighted No. of Particles	No. of Particles Captured by EW wells[1]	No. of Particles Captured by ACP-02 [1]	No. of Particles Not Captured but Contained	No. of Particles Neither Captured nor Contained	Percentage Captured or Contained
ID	Name							
5	Existing and New Wells with Infiltration Basin	3,591	360	327	12	1	20	94%

[1] Containment area statistics are based on the volume-weighted number of particles

A conceptual layout for Alternative 5, including the augmented wellfield layout, piping, treatment plant, and infiltration basin are shown on Figure 6-11. For this alternative, groundwater extracted from the augmented wellfield will be conveyed via piping to a central

treatment plant and discharged to a new recharge basin. The total length of the new discharge piping will be approximately 42,000 linear feet. Piping diameters will range from 6 to 26 inches. The treatment plant is assumed to be co-located with a new infiltration basin east of State Route 57 and north of State Route 91, where geologic conditions are expected to be favorable for surface recharge, and upgradient from the COC plumes (Figure 6-13).

The assumed infiltration basin location is approximately 2,200 feet south of OCWD's La Jolla Recharge Basin (Figure 6-11), which has an observed average percolation rate of approximately 5 feet per day (2.5 inches per hour). This average percolation rate accounts for long-term clogging and downtime for periodic cleaning. Based on an infiltration capacity like the La Jolla Basin (5 feet per day), the wetted area of the recharge basin will need to be approximately 6 acres. Thus, a total land area of approximately 7 acres will need to be acquired, and existing structures/improvements will need to be demolished for construction of the co-located treatment plant (1 acre) and recharge basin (6 acres). An investigation will be conducted during the RD phase, to verify that the selected infiltration basin location will be suitable for recharge commensurate with the extraction rate, plus a factor of safety in case additional extraction is deemed necessary following the Interim Remedy system startup. Based on recent groundwater modeling, recharge of the treated groundwater using the assumed location of a new recharge basin is not expected to cause adverse plume migration or adverse groundwater mounding in this area (refer to Appendix C).

The treatment plant will be designed to treat an extraction flow rate of 6,351 gpm, plus a factor of safety of 30%, to meet the discharge standards for the recharge of treated groundwater, in accordance with Santa Ana RWQCB waste discharge permit limits, which are assumed to be based on the MCLs for TCE, PCE, and 1,1-DCE, and the NL for 1,4-dioxane. In the event that (a) the Santa Ana RWQCB does not adopt an updated General Order for Discharge of Treated Groundwater (currently Order No. R8-2002-0033 and Amending Order No. R8-2013-0020) before the start of the discharge under this alternative, or (b) the discharge is unable to qualify for authorization under a General Order, an individual waste discharge permit will be necessary for the Interim Remedy. Also, although the estimated wellfield blend TDS concentration of approximately 688 mg/L exceeds the TDS water quality objective for the basin, TDS concentration management is assumed to not be required for the same reasons discussed for Alternative 4. Furthermore, during base flow conditions (i.e., dry conditions), the TDS of Santa Ana River water recharged nearby averages more than 700 mg/L. Similar to Alternative 4, a plan to conduct performance monitoring and reporting that includes monitoring to meet discharge permit requirements will be developed as part of the RA, and that plan will be submitted to EPA and State regulatory agencies for review and approval.

Figure 6-12 shows the process flow diagram for the treatment plant, and Figure 6-10 shows the treatment plant equipment layout for this option, similar to Alternative 4. The treatment train will have a set of particulate filters to remove suspended solids, LGAC to remove VOCs, and a UV AOP unit to remove 1,4-dioxane. Although not expected to be needed based on wellfield blend concentrations, IX will be used if the groundwater needs treatment for perchlorate, nitrate, and PFAS.

The estimated capital and annual O&M costs are presented in Section 7 as part of the detailed evaluation of alternatives. The capital costs for this alternative include direct costs of monitoring well installation, extraction well installation, infiltration basin property acquisition and construction, piping network construction, treatment plant construction, and LGAC system and UV AOP system procurement. Indirect costs include project management, design and construction management, and development of the ICs. Annual O&M costs include direct costs, such as electricity for pumps and the UV AOP system, pump maintenance, routine O&M labor, GAC media changeouts and disposal, UV AOP lamp replacements, infiltration basin maintenance, lab analysis, and periodic reporting costs. GAC media changeouts are estimated by the carbon vendor to be once every 3 months (refer to Appendix E), as discussed previously. Indirect costs, such as project management and technical support, are included as well. Periodic costs, such as extraction well development, extraction pump replacement, and infiltration basin maintenance (e.g., periodic erosion repair and sediment removal), are included. The exact configuration of the system will be a part of the RD phase and is not within the scope of this FS. OCWD's RpA and BEA are assumed to not be applicable.

This alternative includes performance monitoring involving installation of 20 additional groundwater monitoring wells, 10 in the Shallow zone and 10 in the Principal zone. Well installation costs are included under the capital costs in the cost estimate. In addition, annual O&M costs are included for annual groundwater monitoring/reporting for 96 existing and 20 new monitoring wells, to evaluate remedial performance. This alternative also would include the ICs, such as permitting requirements for construction and operation of production wells that can prevent exposure to contaminated groundwater to achieve RAO #1.

6.2.3.5 Alternative 6 – Groundwater Extraction (Group 1 and Group 2 Wells); Dual Treatment Plants with Discharge to Infiltration Basin (Group 1) and Injection Wells (Group 2); monitoring; ICs

This option will integrate features from Alternatives 4 and 5 by dividing the same extraction wellfield into two distinct groups. Groundwater from one group (Group 1) will be processed in a dedicated treatment plant and discharged to an infiltration basin (similar to Alternative 5), while groundwater from the other group (Group 2) will be treated in a second treatment plant

and discharged to injection wells (similar to Alternative 4). Figure 6-14 shows the conceptual layout of the two groups of extraction wells, treatment plant, and discharge locations. Permitting for reinjection/infiltration and land acquisition will follow the procedures described in Alternatives 4 and 5.

No dedicated groundwater modeling simulation was performed for Alternative 6; however, the results are expected to be like Alternatives 4 and 5. The modeling for Alternatives 4 and 5 indicates an estimated 96% plume containment (refer to Appendix C and Tables 6-8 and 6-9 for supporting details). The system will employ approximately 23,000 linear feet of new discharge piping for Group 1 and 24,000 linear feet for Group 2, with diameters ranging from 6 to 22 inches.

This alternative has been included in the FS to keep the option of distributed treatment plants for use during design if needed. The disadvantage of this option will be the need to construct and operate two treatment plants, resulting in higher capital expenditures and increased operating costs compared to a single facility; and the added complexity in managing dual treatment and discharge systems requiring extensive coordination and monitoring.

For Group 1, extracted groundwater will be conveyed to a central treatment plant, co-located with a new infiltration basin. This facility will be east of State Route 57 and north of State Route 91, approximately 2,200 feet south of OCWD's La Jolla Recharge Basin (Figure 6-14), in an area with favorable geologic conditions for surface recharge and upgradient from the COC plumes. Based on an observed percolation rate of 5 feet per day, the recharge basin is estimated to require a wetted area of approximately 3 acres, to accommodate the flow from Group 1, necessitating roughly 4 acres of land (including 1 acre for the treatment plant). The treatment plant for Group 1 will be designed for an extraction flow rate of 2,873 gpm plus a 30% safety factor, to meet the discharge standards as established by the Santa Ana RWQCB (based on the MCLs for TCE, PCE, and 1,1-DCE, and the NL for 1,4-dioxane). Although the estimated wellfield blend TDS concentration is approximately 558 mg/L—exceeding the basin objective—TDS management is not considered necessary, like Alternative 5. Performance monitoring and permitting will be conducted as described in Alternative 5.

For Group 2, the treatment plant will be designed for an extraction flow rate of 3,673 gpm, to meet the discharge standards for injection. The proposed injection wells will be south of the VOC plumes in the area between the 91 Freeway and the Raymond Flood Control Basin, with potential placements along North East Street south of La Palma Avenue in Anaheim, similar to Alternative 4 (Figure 6-14). In this case, the injection wells are planned for completion in the Shallow zone (typically less than 200 feet bgs), to avoid the need for additional TDS treatment, as outlined in Alternative 4. Excess injection capacity is

incorporated to account for hydraulic inefficiencies, anticipated performance reductions because of clogging, and the need for periodic rehabilitation.

Process flow diagrams for the treatment plants are shown on Figures 6-15 and 6-16 for Groups 1 and 2, respectively, while preliminary equipment layouts are shown on Figures 6-17 and 6-18. The treatment train for both groups follow the designs established for Alternatives 4 and 5, beginning with particulate filters to remove suspended solids, followed by LGAC for VOC removal and a UV AOP unit to remove 1,4-dioxane. PFAS constituents are expected to be present in the plant influent, and the UV oxidation process may produce additional smaller-chain PFAS constituents in the reactor. In instances where influent PFAS concentrations exceed regulatory limits and the treatment relies on GAC for PFAS removal, the concentration of any PFAS desorbed into the backwash water should be confirmed before discharge to the sewer. Additional authorization from local agencies (e.g., OC San) may be necessary to ensure that the backwash does not interfere with downstream wastewater treatment systems. Ion exchange will be available if treatment for perchlorate and/or nitrate becomes necessary, although it is not expected to be required, based on the wellfield blend concentrations.

Capital and annual O&M costs for Alternative 6 are detailed in Section 7 and build on the evaluations from Alternatives 4 and 5. The capital costs for both groups include direct expenses, such as monitoring well and extraction well installation, piping network and treatment plant construction, and procurement of LGAC and UV AOP systems, as well as indirect costs for project management, design, and construction management, and development of implementation controls. Group 1 will incur additional direct costs for acquisition and construction of the infiltration basin, while Group 2 will include direct costs for injection well installation.

Annual O&M costs for both groups cover direct expenditures, including electricity for pumps and the UV AOP system, pump maintenance, routine labor, GAC media changeouts and disposal (estimated at one changeout every 3 months; refer to Appendix E), UV AOP lamp replacements, lab analysis, and periodic reporting, as well as indirect costs for project management and technical support. Periodic costs, such as extraction well development, extraction pump replacement, and infiltration basin maintenance (e.g., periodic erosion repair and sediment removal) are included. The exact configuration of the system will be a part of the RD phase and is not within the scope of this FS. Periodic costs also are incorporated; for Group 1 wells, this includes extraction well development, extraction pump replacement, and infiltration basin maintenance (e.g., erosion repair and sediment removal), while for Group 2 wells, periodic expenses include extraction well development, pump replacement, and injection well redevelopment. OCWD's RpA and BEA fees are assumed to not apply. As

stated in Alternative 4, the final injection well network configuration will be established during the RD phase.

Alternative 6 incorporates performance monitoring including installation of 20 additional groundwater monitoring wells (10 in the Shallow zone and 10 in the Principal zone). The capital cost estimates account for these additional installations, and annual O&M expenses include the costs for monitoring and reporting for the 96 existing wells and the 20 new monitoring wells. In addition, this alternative includes the ICs, such as permitting requirements for constructing and operating production wells, to help prevent exposure to contaminated groundwater and support achievement of RAO #1.

6.3 ADDITIONAL APPROACH – MNA AND ICS

This approach, considered by EPA but not presented as an alternative, would rely on natural attenuation processes and monitoring for the remediation of COC-impacted groundwater. The data and analysis that are presented in the RI report (AECOM 2022) indicate that the COC plumes are not stable, and that the COCs are not attenuating sufficiently to meet the RAOs. Consequently, MNA will not meet NCP threshold evaluation criteria (overall protection of human health and the environment and compliance with ARARs) and is not presented as an alternative for consideration. For transparency, EPA is presenting here the details of what an MNA and ICs approach would include.

For an MNA and ICs approach, existing OCWD monitoring wells could be used; however, the installation of additional monitoring wells would be necessary, along with long-term monitoring of groundwater quality. This approach would assume installation of 20 additional groundwater monitoring wells, 10 in the Shallow zone and 10 in the Principal zone, and annual groundwater monitoring/reporting for 96 existing OCWD monitoring wells and 20 new wells (for a total of 116 monitoring wells). These additional wells would be assumed to be required to provide adequate coverage to evaluate the occurrence of natural attenuation processes, as well as to monitor remedial performance (plume containment). However, the number, location, and depth of these monitoring wells is theoretical because developing a more precise estimate is not practical for an approach that could not be selected as an interim remedy.

Monitoring is a component of MNA, and monitoring would be a component of Alternatives 2 through 6 (the containment alternatives), and therefore the associated cost of its implementation has been estimated. Although Alternatives 2 through 6 include the same number of monitoring wells as this approach for cost purposes, the actual number and locations of additional monitoring wells are likely to be different for the MNA approach versus the containment alternatives. The number and locations of monitoring wells will depend, in

part, on the locations of monitoring wells installed by EPA as part of the comprehensive RI, and the actual locations of extraction wells will be determined during the RD.

As previously discussed, MNA refers to the monitoring of naturally occurring physical, chemical, and biological processes in the subsurface that reduce the concentration or mass of dissolved-phase COCs in groundwater. Also as discussed, EPA has no evidence that MNA is occurring or could be considered as a protective alternative. The evaluation of natural attenuation is undertaken through the assessment of the following:

- Extent and/or concentration stability of COC impacts (primary evidence); this includes decreases in concentration and the presence of chlorinated solvent breakdown daughter products (e.g., PCE to TCE to cis- or trans-1,2-DCE to vinyl chloride)
- Changes in the concentration of biogeochemical parameters, such as nitrate, sulfate, ferrous iron, and dissolved methane, as indicative of microbiological activity (secondary evidence)

Certain geochemical parameters can indicate the occurrence of biodegradation, identify specific biodegradation zones, and establish that a stable and consistent supply of terminal electron acceptors exists. A generalized summary of microbial reactions and geochemical indicators involved in MNA is shown in Table 6-9.

Table 6-9. Microbial Degradation Processes (adapted from Beck and Mann 2010)

Process	Terminal Electron Acceptors	Redox Potential, Eh (millivolts)	Indicators
Aerobic respiration	Oxygen (O_2)	+820	Decrease in dissolved oxygen concentration
Nitrate reduction	Nitrate (NO_3^-)	+720	Decrease in dissolved nitrate concentration
Manganese reduction	Manganese (Mn^{4+})	+520	Increase in dissolved manganese (Mn^{2+}) concentration
Iron reduction	Ferric iron (Fe^{3+})	-50	Increase in dissolved ferrous iron (Fe^{2+}) concentration
Sulfate reduction	Sulfate (SO_4^{2-})	-220	Decrease in sulfate concentration
Methanogenesis	Carboxylic acids and Carbon dioxide (CO_2)	<-240	Increase in dissolved methane (CH_4) concentration

Source: adapted from Beck and Mann 2010

As part of EPA's thorough consideration of this approach, EPA determined that annual groundwater monitoring for the 116-well network would include the following analytical testing methods: VOCs including benzene, toluene, ethylbenzene, and xylenes, oxygenates by Method 8260, total petroleum hydrocarbons by Method 8015, 1,4-dioxane by Method 8270

SIM (selective ion monitoring), inorganics by Method 300.0 (i.e., nitrate, sulfate, chloride, TDS), metals by Method 6010 (i.e., iron, manganese, arsenic, chromium), ferrous iron (SM 4500), and methane and carbon dioxide by RSK-175M. A few selected wells would be tested for microbiology periodically, but this is not included in the cost estimate.

This approach would also include ICs to preclude potential exposure to constituents in groundwater. The ICs would include administrative and/or legal controls to restrict the use of contaminated groundwater (e.g., permitting requirements for construction and operation of production wells that will preclude exposure to contaminated groundwater). This would help achieve RAO #1 and prevent potential exposure to constituents in groundwater. However, the ICs by themselves would not prevent the COC plumes from continuing to expand outside the Interim Remedy containment area. Consequently, the MNA and ICs would not meet RAO #2.

The estimated capital and annual costs are presented in Section 7, where information for this approach is presented alongside the detailed evaluation of alternatives. The capital costs estimated include monitoring well installation cost, project management, and implementing the ICs. As stated previously, annual groundwater monitoring and reporting would be included in this approach, with the goal of reporting to provide confirmation that the ICs are in place and operating as intended. However, as emphasized earlier, the approach of MNA and ICs is not considered a viable alternative and EPA is presenting detailed information on this approach for transparency and public information.

7. Detailed Analysis of Alternatives

The NCP requires that a detailed analysis of remedial alternatives be conducted during the FS, based on the nine evaluation criteria identified in Section 300.430 (e)(9)(iii) under Title 40 of the CFR. The results of the detailed analysis provide the basis for identifying a preferred alternative and preparing the PP. Section 7.1 briefly describes each of the nine evaluation criteria. Section 7.2 presents the comparative analysis of the remedial alternatives, to evaluate the relative performance of each alternative with respect to each evaluation criteria.

7.1 Evaluation Criteria

The nine evaluation criteria identified in the NCP are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The threshold criteria must be satisfied by each alternative and relate directly to statutory findings that ultimately must be made in the ROD. The two threshold criteria include:

- Overall protection of human health and the environment
- Compliance with the ARARs

The primary balancing criteria are used to weigh major tradeoffs among alternatives and include:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

The modifying criteria are addressed following comments on the FS Report and PP, and can influence the final remedy decision in the ROD; they include:

- State acceptance
- Community acceptance

Each of the nine evaluation criteria is described in the following subsections.

7.1.1 Overall Protection of Human Health and the Environment

Protection of human health and the environment will be accomplished by eliminating, reducing, or controlling exposure to COCs to levels based on ARARs or risk-based levels. This criterion is an evaluation of how each alternative will protect human health and the environment, in both the short-term and long-term, from unacceptable risks posed by

hazardous substances, pollutants, or contaminants present at the site. In particular, this criterion reflects whether risks will be reduced.

7.1.2 Compliance with the Applicable or Relevant and Appropriate Requirements

Under this criterion, the alternatives are evaluated to determine whether they will attain ARARs under federal environmental laws and State environmental or facility siting laws, or will provide grounds for invoking a waiver.

7.1.3 Long-Term Effectiveness and Permanence

The evaluation of alternatives under this criterion addresses the results of remedial action in terms of risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. Factors to be considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities
- Adequacy and reliability of controls, such as containment systems and the ICs that will be necessary to manage treatment residuals and untreated waste

7.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion evaluates alternatives based on the degree to which they will employ recycling or treatment that reduces toxicity, mobility, or volume. This includes how treatment will be used to address the principal threats posed by the site. Factors to be considered include the following:

- The treatment or recycling processes that the alternatives will employ and materials that they will treat
- The amount of contaminants that will be removed, destroyed, treated, or recycled
- The degree of expected reduction in toxicity, mobility, or volume of the waste because of treatment or recycling and the specification of which reductions will be occurring
- The degree to which the treatment will be irreversible
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate, such hazardous substances and their chemicals
- The degree to which treatment will reduce the inherent hazards posed by principal threats at the site

7.1.5 Short-Term Effectiveness

Under this criterion, the alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The short-term impacts of alternatives are evaluated considering the following:

- Short-term risks that may be posed to the community during implementation of an alternative
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures
- Potential environmental impacts with respect to sustainability metrics (i.e., emission of pollutants and greenhouse gases) of the remedial action and the effectiveness and reliability of mitigative measures during implementation
- Time until protection will be achieved

7.1.6 Implementability

The implementability evaluation of the alternatives was based on the following factors:

- Technical feasibility, including technical difficulties and unknowns associated with construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy
- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits/permit-equivalency from other agencies
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to get any necessary additional resources; the availability of services and materials; and the availability of prospective technologies

7.1.7 Cost

The cost estimates include capital costs, annual O&M costs, and periodic costs (maintenance beyond annual), which are used to estimate present-worth costs for a 30-year period, based on a discount rate of 7% (EPA 2000). The cost estimates are approximate Class III estimates that are +50%/-30% and appropriate for comparison of the alternatives. The cost estimates follow the EPA guidance for FS documents (EPA 2000). Various sources were used for developing the cost estimates, including technology vendors (e.g., Evoqua for LGAC, Trojan UV for UV AOP), previous cost estimates developed by AECOM for similar projects, and cost information provided by OCWD and the City of Fullerton.

The capital costs include direct costs, such as well installation, piping installation, treatment equipment procurement, property acquisition, and development of an IC plan. A capital cost contingency is included in the range of 15 to 35%, based on engineering judgement of complexity and uncertainty. Indirect capital costs include project management, design and permitting, and construction management, estimated at 5%, 6%, and 6% of direct costs, respectively.

The O&M costs include annual costs (such as labor, parts, media, and power) and periodic costs. The annual costs include groundwater monitoring, routine changeout of GAC, routine O&M labor costs, electricity costs, chemical additive costs, permit fees or other assessments, waste disposal costs, well redevelopment cost, recharge basin cleaning, and implementing the ICs. Alternative 2, the O&M costs include OC San discharge fees for the extracted groundwater. OCWD RpA and BEA fees on the extracted groundwater are excluded as a project cost from all alternatives.

The present-worth costs for each alternative are developed based on a discount rate of 7%, and the estimates are compared in Table 7-1. Present worth costs also are also shown for a discount rate of 3.1%, as requested by EPA. A 20% contingency is included with the O&M cost estimates. The potential periodic costs include the recovery well or extraction well redevelopment, infiltration basin repair, and/or membrane replacement costs. The frequency of potential periodic costs is based on engineering judgement and experience.

7.1.8 State Acceptance

The criterion evaluates the State acceptance by considering the following:

- The State's position and key concerns related to the preferred alternative and other alternatives
- State comments on the ARARs or the proposed use of waivers

As noted above, this evaluation is not addressed herein but will be evaluated following State and public review of the PP. However, state agencies (RWQCB and DTSC) have been involved during the Interim Remedy RI/FS.

7.1.9 Community Acceptance

This evaluation includes determining which alternatives or components of the alternatives that interested persons in the community will support, have reservations about, or oppose. This evaluation is not addressed herein but will be completed after public review and public comments are received on the PP.

7.2 COMPARATIVE EVALUATION OF INTERIM REMEDIAL ALTERNATIVES

A comparative evaluation of the remedial alternatives and additional approach that are described in Section 6 are presented in this section, based on the first seven CERCLA FS criteria analysis. As stated previously, the last two criteria typically are evaluated after State and public review of the PP and the State and public comments are received; they will be discussed in the ROD. The rating scheme to comparatively evaluate the alternatives is presented in Section 7.2.1, and the comparative evaluations of the alternatives against each criterion are presented in Section 7.2.2 to Section 7.2.8. A summary of the detailed evaluation of the alternatives for each criterion is shown in Table 7-1. EPA has also included a detailed evaluation of the additional approach presented for transparency and public information.

7.2.1 Evaluation Rating

For the evaluation criteria of Overall Protection of Human Health and the Environment, and Compliance with the ARARs, the alternatives are evaluated with respect to meeting those criteria. For the criteria Long-Term Effectiveness and Permanence, Reduction of Toxicity, Mobility and Volume through Treatment, Short-Term Effectiveness, and Implementability, each alternative is provided a qualitative five-point rating scheme as good, fair to good, fair, poor to fair, and poor, and is based on experience and professional judgment. For the Cost criterion, the rating is modified to low, low to moderate, moderate, moderate to high, and high.

7.2.2 Overall Protection of Human Health and the Environment

With respect to the Overall Protection of Human Health and the Environment criterion, the following were found:

- Alternatives 2 through 6 will meet the criteria requirements and be protective of human health and the environment, through hydraulic containment of COCs in groundwater, physical and chemical processes that treat groundwater, and ICs that preclude exposure to groundwater with COCs above acceptable levels.
- Alternative 1 and the additional approach presented for transparency will not meet the requirement of this criterion and will not be protective of human health and the environment; although the additional approach includes ICs that could prevent exposure to impacted groundwater, the plume will continue to migrate and not meet RAO #2.

7.2.3 Compliance with the Applicable or Relevant and Appropriate Requirements

With respect to the Compliance with ARARs criterion, the following were found:

- Alternatives 2 through 6 are expected to comply with the ARARs. The additional approach described, which would rely solely on MNA, is not expected to comply with the ARARs. This criterion does not apply to Alternative 1, no action.

7.2.4 Long-Term Effectiveness and Permanence

For the criteria of Long-Term Effectiveness and Permanence, the ratings were as follows:

- Alternatives 2 through 6 are rated good, where groundwater will be extracted to contain COCs in groundwater in the Interim Remedy containment area. The extracted groundwater will be treated by a groundwater treatment plant (Alternatives 3, 4, 5, and 6) or by the OC San wastewater treatment plant and OCWD GWRS (Alternative 2). For Alternative 2, the GWRS currently does not have sufficient capacity to treat all the extracted groundwater. Sufficient capacity will be available only if future flows to OC San decrease sufficiently to provide available unused capacity in the GWRS. The GWRS currently is under construction for its third and final expansion, and OC San is expected to provide adequate flow to use all the expanded capacity. If flows from OC San decrease in the future because of water conservation, then the GWRS may have the capacity to accept a portion of the flows under Alternative 2. Adding more capacity to the GWRS is not an available option because no room exists on OCWD's property for a fourth expansion. For Alternative 3, the treated groundwater will be discharged to a pipeline that is connected to the purveyor's potable system, which will require upgrades and modifications to accept these flows. All these systems will need to be maintained until RAOs are attained, which may be an indefinite period into the future. Furthermore, because the treatment system primarily will be designed to contain the contamination, not reduce COC plumes, ICs will need to be maintained indefinitely into the future to preclude exposures to COCs.
- Alternative 1 is rated poor because it is a "no action" alternative that will not contain the plume from further expansion. The additional approach presented should also be considered poor because it does not involve plume containment and data presented in the RI report demonstrate that the plume will continue to migrate and adversely impact potable groundwater resources.

7.2.5 Reduction of Toxicity, Mobility and Volume through Treatment

For the criteria of Reduction of Toxicity, Mobility and Volume through Treatment, the ratings were as follows:

- Alternatives 2 through 6 are rated good because they include groundwater extraction and treatment, which will contain the COC plumes in the Interim Remedy containment area, but they may not reduce the size and concentration of the source COC plumes until the sites that are continuing sources of COCs in groundwater are remediated. Source site remediation is under the purview of the State. The groundwater will be treated to meet ARARs before discharge. The spent carbon will be sent for regeneration at permitted facilities, where the COCs will be destroyed, either thermally or chemically. The AOP treatment process also will destroy 1,4-dioxane. Thus, Alternatives 2 through 6 will result in destruction of the VOCs and 1,4-dioxane.

- Alternative 1 is rated poor because it does not include active groundwater treatment and will not contain the plume from further expansion. Similarly, the additional approach presented should also be considered poor for the same reasons.

7.2.6 Short-Term Effectiveness

For the criteria of Short-Term Effectiveness, the ratings were as follows:

- This criterion does not apply to Alternative 1 (no action) which does not include any field activities or construction.
- Alternative 2 is rated fair to good, because it will have short-term risks to construction workers.
- Alternative 4 is rated like Alternative 2 at fair to good, because it will have short-term risks to workers with installation of wells and construction of pipelines.
- Alternatives 3, 5 and 6 are rated lower, at fair, because they will have additional risks associated with longer discharge pipelines and substantial demolition/construction for the new infiltration basin.
- The additional approach presented for transparency was not rated but could be considered “poor” based on time until protection is achieved, because it is technically infeasible based on multiple lines of evidence demonstrating that MNA is occurring in the North Basin.

7.2.7 Implementability

All remedial technologies are proven, off the shelf and effective in addressing the most contaminated part of the regional plume. The ratings were as follows:

- This criterion does not apply to Alternative 1 (no action) which does not include implementation of any remedial action.
- Alternative 4 is rated the highest of the active remedial alternatives, at fair to good, with the primary challenges being the complexity of construction and treatment operations and the potential for injection well clogging.
- For Alternatives 5 and 6, the fair rating is due to challenges with acquiring a large area of developed land for infiltration, the demolition of existing structures, and construction of the infiltration basin and additional discharge piping.
- Alternative 3 is rated lower, at poor to fair, because the City of Fullerton has communicated that this alternative will present numerous technical, financial, and community-related challenges, with the primary challenge being the need for upgrades to the infrastructure (i.e., new transmission pipeline and pump stations), which are not in the City’s current capital improvement plan.
- Alternative 2 is rated poor because the GWRS currently does not have adequate capacity to handle an additional 6,351 gpm flow rate, and this is considered a bigger

technical challenge than Alternatives 3 and 5. However, because of the declining flow rate into OC San's treatment plants in the recent past, more capacity possibly will be available in the future.

- The additional approach presented for transparency was not rated but could be considered not implementable (technically infeasible) because there are not multiple lines of evidence demonstrating that MNA is occurring in the North Basin.

7.2.8 Cost

Cost estimates include capital costs, annual O&M costs, and periodic costs, which are used to estimate present-worth costs for a 30-year period, based on a discount rate of 7% (EPA 2000). The cost estimates are approximate Class III estimates that are +50%/-30% and appropriate for a comparison of the alternatives. The cost estimates follow the EPA guidance for FS documents (EPA 2000). Cost estimates for a discount rate of 3.1% are included per EPA comments. Various sources were used for developing the cost estimates, including technology vendors (e.g., Evoqua for LGAC, Trojan UV for UV AOP), previous cost estimates developed by AECOM for similar projects, and cost information provided by OCWD and City of Fullerton. The capital costs include direct costs, such as well installation, piping installation, treatment equipment procurement, property acquisition, and development of an IC plan. The cost for installation and equipping 17 extraction wells are included in the cost estimate. The use of five existing OCWD extraction wells will be considered during remedial design. A capital cost contingency is included in the range of 15 to 35%, based on engineering judgement of complexity and uncertainty. Indirect capital costs include project management, design and permitting, and construction management, estimated at 5%, 6% and 6% of direct costs, respectively.

O&M costs include annual costs and periodic costs. Annual costs include groundwater monitoring, routine changeout of GAC, routine O&M labor costs, electricity costs, chemical additive costs, permit fees or other assessments, waste disposal costs, well redevelopment cost, recharge basin cleaning, and implementing the ICs. For Alternative 2, O&M costs include OC San discharge fees. For Alternative 3, the cost for additional discharge pipeline or improvements to connect to the City water network, treatment for TDS using RO, and disinfection or offsets for reduced pumping from other wells or supplemental water, if any, from the City of Fullerton are not included as remedy costs. OCWD RpA and BEA are not included for any of the alternatives. A 20% contingency is included with the O&M cost estimates. Periodic costs include extraction well redevelopment or infiltration basin maintenance, and membrane replacement costs. The frequency of periodic costs is based on professional experience.

Table 7-1 summarizes the estimated capital, annual O&M, periodic and 30-year present-worth costs (Level III +50%/-30% following the AACE International Cost Estimate Classification System I) for the five alternatives that can be incurred. Appendix D provides detailed cost estimate spreadsheets for these five alternatives. The active remedial alternatives (Alternatives 2 through 6) range from $234.1 million (Alternative 3) to $301.4 million (Alternative 2). The capital costs for the active remedial alternatives range from $50.1 million (Alternative 2) to $151.6 million (Alternative 6). Alternative 3 has the lowest present-worth cost of the active remedial alternatives, at $231.3 million, with a capital cost of $110.7 million, but its implementability is rated low at poor to fair because of the uncertainty of the acceptance of the water by the City of Fullerton. Of the active remedial alternatives with fair or higher implementability, Alternative 4 had the lowest present-worth cost at $248.9 million, with a capital cost of $118 million. These costs include a 35% contingency for capital cost and a 20% contingency for O&M for the active remedial alternatives. EPA also estimated the cost of the additional approach, which would have a relatively low 30-year present-worth cost of $4.9 million. Appendix D contains the cost estimate spreadsheets for the remedial alternatives and additional approach, with a summary cost sheet followed by detailed costs with a capital cost sheet and O&M cost sheet for each alternative as well as the additional approach presented for transparency.

7.3 Summary and Comparison of Alternatives

Table 7-1 summarizes the detailed evaluation of the Interim Remedy alternatives and additional approach that are discussed in this section. These alternatives address the most contaminated part of the regional plume, and a Regional Aquifer Plume RI/FS is underway to ensure that the entire plume is addressed. The basis for development of these alternatives are discussed in Sections 5 and 6. Additional investigations and analysis may be conducted during the RD phase to assess the exact pumping rates needed for containment, potential injection rates per well in the Shallow zone, available land for infiltration basins, available capacity in sewer trunk lines, and OC San's willingness to accept the groundwater. A more detailed evaluation of a central treatment plant versus a distributed treatment plant, city distribution system capacity, and costs also is expected as part of the RD phase. A survey of available land for infiltration basins versus injection wells may need additional evaluation, to confirm that the injection well discharge option is the most cost-effective discharge option. Currently, Alternative 4 (groundwater extraction; discharge to a central treatment plant; discharge to injection wells; monitoring; and ICs) has the lowest present-worth cost of the active remedial alternatives that are rated fair or better for implementability. Based on these analyses, additional variations of the above alternatives may be considered during RD phase, including a combination of components of the current alternatives. Any post-ROD change to the Interim Remedy will be properly evaluated and documented in accordance with the NCP.

8. References

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Docket No. 2016-03, Orange County North Basin and OCWD Proceeding under Sections 104 and 122 of the CERCLA (42 U.S. Code Section 9604 and Section 9622.

Tables

Tables

TABLE 3-2: CONTAMINANTS OF CONCERN IN GROUNDWATER

COC	Rationale for Preliminary COC Designation	Final COC Designation	Notes
PCE	Exceeds MCL in Principal and Shallow wells based on EPC or maximum concentration, at relatively high frequency; major cancer risk driver (Section 3.7 and 3.8 of HRA, AECOM 2022).	Yes; considered *primary* COC due to frequency and magnitude of exceedances of MCL	High frequency of exceedance of MCL (38%). Maximum concentration of PCE (133 µg/L) exceeds Federal and CA MCLs of 5 µg/L. For the Resident exposure scenario, PCE contributes 37% of total cancer risk and 1.2% of noncancer hazard in Principal wells and 65% of total cancer risk and 3% of noncancer hazard in Shallow wells.
TCE	Exceeds MCL in Principal and Shallow wells based on maximum concentration or EPC (Shallow), at relatively high frequency; substantial risk driver (Section 3.7 and 3.8 of HRA, AECOM 2022).	Yes; considered *primary* COC due to frequency and magnitude of exceedances of MCL	High frequency of exceedance of MCL (29%). Maximum concentration of TCE (162 µg/L) exceeds Federal and CA MCLs of 5 µg/L. For the Resident exposure scenario, TCE contributes 18% of total cancer risk and 67% of total noncancer hazard in Shallow wells and 3% of total cancer risk and 7% of total noncancer hazard in Principal wells.
1,1-DCE	Detected in Shallow wells at concentrations exceeding the Federal MCL and California MCL	Yes; considered *primary* COC due to frequency and magnitude of exceedances of MCLs	Frequency of exceedance of MCL is 12%. Maximum concentration of 1,1-DCE (126 µg/L) exceeds CA MCL of 6 µg/L. For the Resident exposure scenario 1,1-DCE contributes less than 1% of total noncancer hazard in Principal and Shallow wells. 1,1-DCE does not contribute to cancer risk.
1,4-Dioxane	Exceeds acceptable exposure level in Principal and Shallow wells	Yes; considered *primary* COC due to frequency of exceedances of acceptable exposure level (the NL)	Frequency of exceedance of NL is 31%. Maximum concentration of 1,4-dioxane (15.6 ug/L) exceeds NL of 1 µg/L. For the Resident exposure scenario, 1,4-dioxane contributes less than or equal to 1% of total cancer risk and total noncancer hazard in Principal and Shallow wells.
1,2,3-TCP	Exceeds NL in Principal and Shallow wells	Yes; not considered a *primary* COC due to low frequency of exceedance of NL.	Frequency of exceedance of NL is 4%. For the Resident exposure scenario, 1,2,3-TCP contributes 4% of total cancer risk and less than 1% of total noncancer hazard in Principal and Shallow wells.
1,2-DCA	Detected in the Shallow zone at concentrations exceeding the California MCL	Yes; not considered a *primary* COC due to low frequency of exceedance of CA MCL.	Frequency of exceedance of MCL is 4%. 1,2-DCA is reported as ND in Principal wells. For the Resident exposure scenario, 1,2-DCA contributes less than 1% of total cancer risk and total noncancer hazard in Shallow wells.

TABLE 3-2: CONTAMINANTS OF CONCERN IN GROUNDWATER

COC	Rationale for Preliminary COC Designation	Final COC Designation	Notes
Arsenic	Major cancer and noncancer risk driver in Principal wells (Section 3.7 and 3.8 of HRA, AECOM 2022)	No; Arsenic is reported as nondetect in Shallow wells and detected below Federal and California MCLs in Principal wells. Arsenic is in the range of natural background (see note (a)).	Arsenic is ND in Shallow wells. Maximum concentration of arsenic (1.4 µg/L) is well below Federal and CA MCLs of 10 µg/L. For the Resident exposure scenario, Arsenic contributes 42% of total cancer risk and 72% of total noncancer hazard in Principal wells. (a) Arsenic concentrations in North Basin wells outside VOC plumes range from ND (<1 µg/L) to 30 µg/L in Principal zone. Site concentrations of arsenic in Principal wells range from 1 µg/L to 1.4 µg/L, within the observed range outside of the VOC plume and therefore considered background.
PFOA[a]	Exceeds MCL in Principal and Shallow wells based on EPC or maximum concentration	No; PFOA is not indicative of onsite releases.	
PFOS[a]	Exceeds MCL in Principal and Shallow wells based on EPC or maximum concentration	No; PFOS is not indicative of onsite releases.	
Nitrate (as N)[a,b]	Exceeds MCL in Principal and Shallow wells	No; nitrate (as N) is not indicative of onsite releases but is likely to be from agricultural releases (see notes (a) and (b)).	Concentrations of nitrate (as N) range from 0.34 mg/L to 26.3 mg/L in Shallow wells and 0.35 to 24 mg/L in Principal wells. For the Resident exposure scenario, Nitrate (as N) contributes 2% of total noncancer hazard in Principal and Shallow wells. Nitrate does not contribute to cancer risk. (a) Nitrate (as N) concentrations in North Basin wells adjacent to VOC plumes range from ND (<0.1 mg/L) to 27.7 mg/L in Shallow zone and range from ND (<0.1 mg/L) to 47.4 mg/L in Principal zone. (b) "High concentrations of nitrate in groundwater are often associated with the use of fertilizers or animal/human wastes. Based on SWRCB data from 2007 to 2017, 854 active and standby public water supply wells (of 11,906 wells sampled) had at least one detection of nitrate (as N) above the MCL. Most wells with nitrate detections above the MCL occurred in Los Angeles (128 wells), Tulare (95 wells), and Kern (88 wells) counties." Reference: State Water Resources Control Board, Division of Water Quality: Nitrate Groundwater Information Sheet, Revised November 2017

TABLE 3-2: CONTAMINANTS OF CONCERN IN GROUNDWATER

COC	Rationale for Preliminary COC Designation	Final COC Designation	Notes
Perchlorate[a,b]	Exceeds California MCL in Principal and Shallow wells	No; perchlorate is not indicative of onsite releases (see notes (a) and (b))	Site concentrations of perchlorate range from 1.1 µg/L to 13 µg/L in Shallow wells and range from 0.32 µg/L to 14.9 µg/L in Principal wells. For the Resident exposure scenario, perchlorate contributes 2% of total noncancer hazard in Principal wells and 1% of total noncancer hazard in Shallow wells. Perchlorate does not contribute to cancer risk. (a) Perchlorate concentrations are likely a result of historic use of citrus fertilizer and recharge of Colorado River water. (b) Perchlorate concentrations in North Basin wells outside of the VOC plumes (i.e., off-site) range from ND (<0.1 µg/L) to 17 µg/L in Shallow zone and range from ND (<0.1 µg/L) to 21.2 µg/L in Principal zone. Site concentrations within the VOC plume are therefore considered background.
Uranium[a,b]	HI > 1 in Shallow wells (Resident)	No; Uranium is detected at concentrations below the Federal MCL and is not indicative of onsite releases. Uranium is in the range of natural background.	For the Resident exposure scenario, Uranium contributes 2% of total noncancer hazard in Principal wells and 10% of total noncancer hazard in Shallow wells. Uranium does not contribute to cancer risk. (a) Uranium concentrations in North Basin wells outside of the VOC plumes (i.e., off-site) range from ND (<1 µg/L) to 5.6 µg/L in Principal zone. Site concentrations of uranium in Principal wells range from 1.1 µg/L to 2.4 µg/L. Site concentrations within the VOC plume are therefore considered background. (b) No uranium data is available for North Basin wells adjacent to VOC plumes in the Shallow zone. The concentration of uranium in Shallow wells is 7 µg/L, which is below the MCL of 30 µg/L.

Notes:

[a] A point source for arsenic, PFOA, PFOS, uranium, nitrate and perchlorate has not been identified within the North Basin area.

[b] OCWD database queried for arsenic, nitrate as N, perchlorate, and uranium in North Basin wells that have never exceeded the MCL or NL for TCE, PCE, 1,1-DCE and 1,4-dioxane. Both monitoring and production wells were selected for the area within the composite VOC plume and within a 0.5-mile buffer around that boundary.

COC	chemical of concern	MCL	Maximum Contaminant Level		
DCA	dichloroethane	NL	Notification Level	PFOS	perfluorooctanesulfonic acid
DCE	dichloroethane	PCE	tetrachloroethane	TCE	trichloroethene
EPC	exposure point concentration	PFOA	perfluorooctanoic acid	TCP	trichloropropane
HI	hazard index			USEPA	United States Environmental Protection Agency

TABLE 3-2: CONTAMINANTS OF CONCERN IN GROUNDWATER

Preliminary COC	Rationale for Preliminary COC Designation	Final COC Designation	Notes
Nitrate (as N)[a,b]	Exceeds MCL in Principal and Shallow wells	No; nitrate (as N) is not indicative of onsite releases but is likely to be from agricultural releases (see notes (a) and (b)).	Concentrations of nitrate (as N) range from 0.34 mg/L to 26.3 mg/L in Shallow wells and 0.35 to 24 mg/L in Principal wells. The percent of cancer risk or noncancer hazard is for the Resident exposure scenario. Note that Nitrate (as N) contributes 2% of total noncancer hazard in Principal and Shallow wells. (a) Nitrate (as N) concentrations in North Basin wells adjacent to VOC plumes range from ND (<0.1 mg/L) to 27.7 mg/L in Shallow zone and range from ND (<0.1 mg/L) to 47.4 mg/L in Principal zone. (b) "High concentrations of nitrate in groundwater are often associated with the use of fertilizers or animal/human wastes. Based on SWRCB data from 2007 to 2017, 854 active and standby public water supply wells (of 11,906 wells sampled) had at least one detection of nitrate (as N) above the MCL. Most wells with nitrate detections above the MCL occurred in Los Angeles (128 wells), Tulare (95 wells), and Kern (88 wells) counties." Reference: State Water Resources Control Board, Division of Water Quality: Nitrate Groundwater Information Sheet, Revised November 2017

TABLE 3-2: CONTAMINANTS OF CONCERN IN GROUNDWATER

Preliminary COC	Rationale for Preliminary COC Designation	Final COC Designation	Notes
Perchlorate[a,b]	Exceeds California MCL in Principal and Shallow wells	No; perchlorate is not indicative of onsite releases (see notes (a) and (b))	Site concentrations of perchlorate range from 1.1 µg/L to 13 µg/L in Shallow wells and range from 0.32 µg/L to 14.9 µg/L in Principal wells. The percent of cancer risk or noncancer hazard is for the Resident exposure scenario. Note that perchlorate contributes 2% of total noncancer hazard in Principal wells and 1% of total noncancer hazard in Shallow wells. (a) Perchlorate concentrations are a result of historic use of citrus fertilizer and recharge of Colorado River water. (b) Perchlorate concentrations in North Basin wells adjacent to VOC plumes range from ND (<0.1 µg/L) to 17 µg/L in Shallow zone and range from ND (<0.1 µg/L) to 21.2 µg/L in Principal zone.

TABLE 3-2: CONTAMINANTS OF CONCERN IN GROUNDWATER

Preliminary COC	Rationale for Preliminary COC Designation	Final COC Designation	Notes
Uranium[a,b]	HI > 1 in Shallow wells (Resident)	No; Uranium is detected at concentrations below the Federal MCL and is not indicative of onsite releases. Uranium is in the range of natural background.	Uranium contributes 2% of total noncancer hazard in Principal wells and 10% of total noncancer hazard in Shallow wells. The percent of cancer risk or noncancer hazard is for the Resident exposure scenario. (a) Uranium concentrations in North Basin wells adjacent to VOC plumes range from ND (<1 µg/L) to 5.6 µg/L in Principal zone. Site concentrations of uranium in Principal wells range from 1.1 µg/L to 2.4 µg/L. (b) No uranium data is available for North Basin wells adjacent to VOC plumes in the Shallow zone. The concentration of uranium in Shallow wells is 7 µg/L, which is below the MCL of 30 µg/L.

Notes:

[a] A point source for arsenic, PFOA, PFOS, uranium, nitrate and perchlorate has not been identified within the North Basin area.

[b] OCWD database queried for arsenic, nitrate as N, perchlorate, and uranium in North Basin wells that have never exceeded the MCL or NL for TCE, PCE, 1,1-DCE and 1,4-dioxane. Both monitoring and production wells were selected for the area within the composite VOC plume and within a 0.5-mile buffer around that boundary.

COC	chemical of concern
DCA	dichloroethane
DCE	dichloroethene
EPC	exposure point concentration
HI	hazard index
MCL	Maximum Contaminant Level
NL	Notification Level
PCE	tetrachloroethane
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
TCE	trichloroethene
TCP	trichloropropane

TABLE 5-1. IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS
(Page 1 of 3)

General Response Actions	General Objective/ Remediation Area	Remedial Technology Type	Remedial Technology Process Option	Technology Process Option Description [b]	Effectiveness [c]	Implementability [d]	Cost [e]	Screening/Evaluation Comments [f]
No Action	None	None	None	No Action	No Remedial Action would be implemented to reduce volume, toxicity or mobility of COCs in groundwater.	Easily implementable because no action needs to be taken.	There are no costs associated with this technology.	**Selected** as a comparative alternative.
Institutional Controls (ICs)	Groundwater use restrictions	ICs	ICs	ICs include administrative and/or legal controls that restrict use of contaminated groundwater in a manner that may result in unacceptable risk to human health. For example, permitting requirements for the construction and operation of production wells that would preclude exposure to contaminated groundwater.	ICs do not directly reduce volume, toxicity, or mobility of COCs in groundwater. However, ICs would minimize the potential for exposure to COCs in groundwater by restricting groundwater and site use. No adverse impacts occur during the implementation of ICs because no construction activities are associated with this process option. However, ICs would not prevent the plume from spreading and adversely impacting local resources used for potable water.	ICs are relatively easy to implement; the process to implement ICs is already in place. New ICs could be implemented to preclude construction of new wells that result in exposure to contaminated groundwater or that accelerate the migration of contaminants.	Low	**Selected for alternative development.** To be used in conjunction with other technologies/process options for alternative development
Monitored Natural Attenuation (MNA)	Plume remediation and containment	MNA	MNA	MNA relies on natural attenuation processes such as biodegradation, dispersion, dilution, sorption, volatilization, chemical or biological stabilization, and transformation to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. MNA requires groundwater monitoring to assess the effectiveness of natural attenuation processes.	Ineffective as there are not multiple lines of evidence that it is occurring in the North Basin. Increasing trends in concentrations of COCs observed in several wells and conditions suitable for biodegradation are not present.	Cannot be implemented since suitable conditions are not present in the North Basin.	Low	**Examined as a potential approach; not expected to meet RAOs by itself; not selected** for alternative development because it is not technically feasible.
Physical Containment	Plume containment	Vertical Barriers	Slurry Walls/Sheet Pile Walls/Grout Curtains	Containment using slurry walls, sheet piles, and grout curtains includes installing a physical barrier to reduce contaminant migration due to groundwater movement.	Not expected to be effective due to the depth and size of the COC plume.	Technically impractical due to depth of COC plumes (e.g., impractical for depths >100 feet bgs).	Very High	**Not selected** for alternative development primarily due to implementability and effectiveness considerations.
In-Situ Treatment	Plume Remediation and Containment	In Situ Chemical Oxidation	Direct Injection or Recirculation Loop	This technology would include injection of a chemical reagent/oxidant into the contaminated portion of the aquifer to oxidize COCs into innocuous products such as carbon dioxide and water. The chemical oxidants like permanganate may be used for the treatment of PCE/TCE.	Not expected to be effective due to subsurface heterogeneities and site size.	Technically challenging to implement due to size of site.	Moderately High	**Not selected** for alternative development primarily due to effectiveness and implementability considerations.
		In Situ Bioremediation (ISB)/In Situ Chemical Reduction (using a combination of carbon substrate and zero valent iron [ZVI] or dissolved iron)	Direct Injection or Recirculation Loop	The bioremediation technology would include injection of electron donor (carbon substrate), or a mixture of carbon substrate and ZVI to stimulate microorganisms and/or chemical reduction pathways to degrade COCs. Not expected to be effective for 1,4-dioxane.	Not expected to be effective due to subsurface heterogeneities and site size. Not effective for treatment of 1,4-dioxane.	Technically challenging to implement due to subsurface heterogeneities and expansive vertical and horizontal extents of COCs. Not implementable for 1,4-dioxane.	Very High	**Not selected** for alternative development primarily due to effectiveness and implementability considerations.
		Air Sparging/SVE (Source Control a, Diffuse Plume Remediation, or Containment)	Air Sparging/SVE	Air sparging involves the injection of air or oxygen through the contaminated aquifer. Injected air removes VOCs from groundwater by volatilization. SVE removes the volatilized VOCs, which are treated aboveground. Not effective for 1,4-dioxane.	Not expected to be effective due to the size and depth of the VOC plume. Not effective for 1,4-dioxane.	Significant technical implementability challenges due to above-ground infrastructure. Technically challenging to implement due to subsurface heterogeneities and size and depth of VOC plume. Not implementable for 1,4-dioxane.	High	**Not selected** for alternative development primarily due to implementability considerations.
Ex-Situ Treatment	Plume Remediation and Containment	Groundwater Extraction	Existing Wellfield	Use six existing extraction wells (OCWD-EW1 through EW4)	Would not adequately capture entire plume containment area	Good.	Low	Does not meet RAOs. **Not selected** for alternative development
			Augmented Wellfield	Use a total of 17 extraction wells to augment the existing OCWD wellfield (5 wells) for a total extraction flow rate of approximately 6,500 gpm	Modeling shows that it captures majority of the plume (~97%)	Moderate to Good. Will require access agreements to install 12 new wells and piping	Medium	**Selected for alternative development**
Ex-Situ Treatment	Plume Remediation and Containment	Groundwater Extraction	Centralized Treatment Plant	A single centralized treatment plant collects extracted groundwater from wells, treats and discharges the groundwater. Estimated 6 to 10-acre site required.	This approach can be effective and will require the design and operation of only one complex system.	Good. This approach has been routinely implemented at groundwater treatment systems and would require purchase of a larger property for locating the system.	High	**Selected for alternative development**
			Distributed Treatment Plant	Multiple plants located near extraction well clusters. Local plants will treat COCs exclusive to the connected extraction wells. Up to 3 local plants with multiple discharges will be considered.	This approach can be effective and will require the design and operation of two or three complex systems.	Moderate to Good. This approach has been implemented for groundwater treatment systems when wells are present in clusters and are far apart. Smaller properties will suffice but multiple properties will be required.	High	**Selected for alternative development**

TABLE 5-1. IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS
(Page 2 of 3)

General Response Actions	General Objective/ Remediation Area	Remedial Technology Type	Remedial Technology Process Option	Technology Process Option Description [b]	Effectiveness [c]	Implementability [d]	Cost [e]	Screening/Evaluation Comments [f]
Ex-Situ Treatment	Plume Remediation and Containment	Groundwater Treatment	Liquid Phase Granular Carbon (LGAC)	Extracted groundwater/vapor is treated to remove dissolved VOCs & PFAS by adsorption to LGAC. The carbon is replaced when its adsorption capacity is reached. Used carbon is disposed of or regenerated.	Effectiveness for meeting permit discharge compliance levels for VOC and PFAS concentrations at the Site. Used in conjunction with other treatment technologies.	Implemented as part of a groundwater extraction. Treatment generates spent carbon which would require regeneration or disposal.	Moderately High	**Selected for alternative development**
			Air Stripping/Vapor Phase Granular Carbon (VGAC)	Air is moved through extracted groundwater to volatize VOCs. VOCs are treated by adsorption to VGAC. The carbon is replaced when its adsorption capacity is reached. Used carbon is disposed of or regenerated.	Effectiveness for meeting permit discharge compliance levels for COC concentrations except 1,4-dioxane at the Site	Require additional area for treatment equipment then LGAC. Not a preferred option for low VOC concentrations and high flow rates.	Higher operating costs than LGAC.	**Not selected** for alternative development primarily due to cost.
			Advanced Oxidation Process (AOP)	Extracted groundwater is treated to remove COCs by chemical oxidation using ultraviolet light, hydrogen peroxide, and/or ozone, and involves oxidation by the highly reactive hydroxyl radical.	Effectiveness for meeting permit discharge compliance levels for 1,4-dioxane concentrations at the Site. Used in conjunction with other treatment technologies.	Good. Implemented as part of a groundwater extraction. Hydrogen peroxide and ozone pose a safety risk for handling oxidants on-site. Ozone will create bromates in groundwater at concentrations that could exceed MCLs.	High	**Selected for alternative development.**
			Ion Exchange (IX)	Extracted groundwater is treated to remove nitrate and perchlorate by capturing anions on a positively charged resin and releasing a harmless chloride ion in its place.	Effective for treating perchlorate and nitrate. Proven ability to remove perchlorate to below 4 ppb. It is also a viable option for PFAS. However, different type of resins are used for perchlorate, nitrate, and PFAS removal. Fast reaction and simple operation.	IX is a fully developed technology for perchlorate treatment in water. It is also a viable option for PFAS. Implemented in conjunction with other treatment options. Can be operated at a high flow rate.	Moderately High	**Selected** for alternative development if needed to reduce perchlorate, PFAS or nitrate levels
			Reverse Osmosis (RO)	Extracted groundwater is pumped through membranes while blocking the passage of COCs.	Effective at removing perchlorate, nitrate, and PFAS. Inefficient at low concentrations of perchlorate, nitrate and PFAS.	Highly energy intensive. Produces a brine that requires disposal.	Very High	**Not selected** for alternative development as it is not used for COC removal. It is optional for City of Fullerton to use for TDS reduction if needed for potable use distribution.
			Fluidized Bed Reactor (FBR)	Compounds in water are metabolized by microorganisms as a food source. Includes aerobic, anaerobic processes	Effective for treating perchlorate and nitrate in groundwater but these are not considered COCs in this FS. Not proven for 1,4-dioxane treatment. Also, not reliable or well proven for drinking water treatment.	Produces a biological sludge that requires disposal, more complicated to operate and maintain. Technology has been implemented more widely at lower flow rates and higher concentrations.	High	**Not Selected** because more complex and higher in cost compared to ion exchange and not reliable (well proven) for drinking water applications.
Discharge	Discharge of treated water from the Treatment Plant	Injection Wells	Injection Wells	Install injection wells to inject treated extraction water into the aquifer. Install up to 25 injection wells to inject at 400 gpm per well.	Wells may require frequent redevelopment. Used in conjunction with groundwater extraction and treatment. Excess wells required for maintenance and reduced capacity over time.	Require space for up to 25 injections wells. Installation of injection wells for groundwater reinjection is a mature and well-known technology	High	**Selected for alternative development**
		Infiltration Basins	Infiltration Basin	Extracted and treated water discharged to infiltration basins or trenches.	Requires the purchase of additional property to construct the infiltration basin.	A pilot test may be required to estimate infiltration rates for proper design and implementation of infiltration galleries.	High	**Selected for alternative development**
		Publicly Owned Treatment Works	Orange County Sanitation District Sewage Treatment Facility	Extracted and treated water discharged to Local POTW connections on State College and Orangethorpe with subsequent recycling through OCWD's Groundwater Replenishment System (GWRS).	Groundwater will undergo treatment with other municipal wastewater. Treatment plant capacity is expected to be adequate, but City sewer systems are not expected to have adequate capacity for all the extracted groundwater, and GWRS does not have adequate capacity to accept the full volume of treated groundwater.	Not currently implementable for the full volume of extracted groundwater due to capacity of City sewer systems and the OCWD GWRS. There may be a possible increase in the available capacity of the GWRS in the future, or as a partial disposal option in concert with other disposal options.	Very High	**Selected for alternative development**
		Discharge to Potable Water Distribution System	City of Fullerton Potable Water Distribution Network	Treated water is distributed to local water agencies for uses as a potable water.	Used in conjunction with groundwater extraction and treatment.	Not currently implementable because the City of Fullerton is not currently able to commit to receiving the full volume of treated groundwater. Implementability may change in the future based on City approaches to financial and administrative barriers to accepting treated groundwater.	High Additional costs for supplemental treatment (e.g., TDS reduction) or pipeline infrastructure would be paid by the City of Fullerton	**Selected for alternative development**
		Discharge to Surface Water	Lakes, Streams	Treated water is discharged to surface water in accordance with a National Pollutant Discharge Elimination System permit. Alternative would export groundwater from the basin without beneficial uses.	Effective if used in conjunction with groundwater extraction and treatment.	Not implementable due to administrative infeasibility without State concurrence as the support agency.	High	**Not selected for alternative development** because not implementable.

Notes:
Gray shading = Technologies/Process Options selected for alternative development.

[a] Source control refers to the area of potential ***historical*** sources of the COCs.

TABLE 5-1. IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS
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[b] See text for detailed description of technologies and process options.
[c] Evaluation factors included ability of the process option to handle estimated areas and volumes of groundwater (i.e., to reduce volume, toxicity, and mobility of COCs in groundwater) and attain one or more of the RAOs; potential impacts to human-health and the environment during implementation of the process option; and whether the process is reliable and proven.
[d] Evaluation factors included ability to obtain regulatory approval; availability of equipment and skilled workers; extensiveness of knowledge required to implement the process option; and need for treatment or disposal of process waste.
[e] The relative cost for each option is estimated as to whether it is low, moderate, or high based on the engineering judgment.
[f] Note that there are a few technology types/process options that are not retained for alternative development (FS evaluation) as described in the Screening Comment column but will be considered again during remedial design. E.g. alternate wellfield, distributed treatment plant
[g] Interim remedial goals will be based on potential ARARs or risk-based clean-up values

AOP	Advanced Oxidation Process	MCL	drinking water maximum contaminant level
ARAR	applicable or relevant and appropriate requirements	MNA	monitored natural attenuation
bgs	below ground surface	O&M	operation and maintenance
COC	contaminant of concern	OCWD	Orange County Water District
CRWQCB	California Regional Water Quality Control Board	PCE	tetrachloroethene
FBR	Fluidized Bed Reactor	PFAS	per- and polyfluoroalkyl substances
FS	feasibility study	POTW	publicly owned treatment works
gpm	gallons per minute	RAO	Remedial Action Objective
GWRS	Groundwater Replenishment System	RG	Remedial Goal
IC	institutional control	RO	Reverse Osmosis
ISB	In Situ Bioremediation	SVE	soil vapor extraction
ISCO	In Situ Chemical Oxidation	TCE	trichloroethene
IX	Ion Exchange	TDS	total dissolved solids
LGAC	liquid phase granular carbon	VOC	volatile organic compound

TABLE 6-1. DESCRIPTION OF INTERIM REMEDIAL ALTERNATIVES

Interim Remedial Alternative	Description of Interim Remedial Alternatives
Alternative 1: No Action	The NCP (40 Code of Federal Regulations 300.430[e][6]) requires that a "no action" alternative be evaluated to provide a baseline condition if no remedial action is taken. Under Alternative 1, no ICs, containment, or treatment of the COC-impacted groundwater are provided to reduce potential risks to human health or the environment.
Alternative 2: Groundwater extraction wells; discharge to POTW/GWRS; Monitoring and ICs	Groundwater extracted from the augmented wellfield[1] (6,351 gpm) would be conveyed via piping to an existing OC San sewer trunk line, which would convey the water to an existing POTW. The POTW would discharge the treated effluent to OCWD's GWRS for additional treatment and reuse for managed aquifer recharge in the basin. Monitoring and ICs would be included with 20 additional monitoring wells installed and annual monitoring of 116 monitoring wells and 17 extraction wells.
Alternative 3: Groundwater extraction wells; discharge to centralized treatment plant; discharge to City of Fullerton for direct use (potable water); Monitoring and ICs	Groundwater extracted from the augmented wellfield[1] (6,351 gpm) would be conveyed via piping to a centralized treatment plant, where the water would be treated using a combination of LGAC and AOP to discharge limits meeting potable water standards. Additional treatment (e.g. reverse osmosis to reduce total dissolved solids) and/or blending is not included as part of this alternative but is optional for the City of Fullerton to implement. Monitoring and ICs are the same as in Alternative 2, with 20 additional monitoring wells installed and annual monitoring of 116 monitoring wells and 17 extraction wells.
Alternative 4: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to injection wells; Monitoring and ICs	Groundwater extracted from the augmented wellfield[1] (6,546 gpm) would be conveyed via piping to a centralized treatment plant, where the extracted groundwater would be treated using a combination of LGAC and AOP and discharged to 17 injection wells. The groundwater will be treated to meet the Santa Ana RWQCB discharge standards for Order R8-2013-0012 (expired) and Antidegradation Resolution 68-16. In the event the Santa Ana RWQCB doesn't adopt a general order or if the discharge doesn't qualify, an individual permit may be necessary. Monitoring and ICs are the same as in Alternative 2, with 20 additional monitoring wells installed and annual monitoring of 116 monitoring wells and 17 extraction wells.
Alternative 5: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to infiltration basin; Monitoring and ICs	Groundwater extracted from the augmented wellfield[1] (6,351 gpm) would be conveyed via newly installed piping to a newly constructed centralized treatment plant, where the extracted groundwater would be treated using a combination of LGAC and AOP to limits meeting the Santa Ana RWQCB discharge standards for Order R8-2013-0012 (expired) and discharged to an infiltration basin. In the event the Santa Ana RWQCB doesn't adopt a general order or if the discharge doesn't qualify, an individual permit may be necessary. Monitoring and ICs are the same as in Alternative 2, with 20 additional monitoring wells installed and annual monitoring of 116 monitoring wells and 17 extraction wells.

TABLE 6-1. DESCRIPTION OF INTERIM REMEDIAL ALTERNATIVES

Interim Remedial Alternative	Description of Interim Remedial Alternatives
Alternative 6: Groundwater extraction, Group 1 and Group 2 wells; discharge to two treatment plants; 1) infiltration basin; 2) injection wells; Monitoring and ICs	Groundwater extracted from the Group 1 wellfield[1] (2,873 gpm) would be conveyed via piping to a treatment plant, where the extracted groundwater would be treated using a combination of LGAC and AOP and discharged to an infiltration basin; while groundwater from the Group 2 wellfield (3,673 gpm) would be conveyed to a separate treatment plant and discharged to injection wells. The groundwater will be treated to meet the Santa Ana RWQCB discharge standards for Order R8-2013-0012 (expired) and Antidegradation Resolution 68-16. In the event the Santa Ana RWQCB doesn't adopt a general order or if the discharge doesn't qualify, an individual permit may be necessary. Monitoring and ICs are the same as in Alternative 2, with 20 additional monitoring wells installed and annual monitoring of 116 monitoring wells and 17 extraction wells.
Additional Approach: MNA and ICs	This approach, considered by EPA but not presented as an alternative, would rely on natural attenuation processes and monitoring for remediation of COC-impacted groundwater. MNA refers to the monitoring of naturally occurring physical, chemical, and biological processes in the subsurface that reduce the concentration or mass of dissolved-phase COCs in groundwater. EPA has no evidence that MNA is occurring and is not considered as a protective alternative. However, EPA's analysis is presented for transparency and public information. This approach would assume the installation of 20 additional monitoring wells, 10 in the Shallow zone and 10 in the Principal zone. Annual monitoring of 96 existing and the 20 new monitoring wells would be included to evaluate natural attenuation. ICs would include non-engineered mechanisms (e.g. permit requirements for construction and operation of a production well) established to limit potential human exposure to COC-impacted groundwater that would be maintained indefinitely into the future.

Notes

AOP: Advanced Oxidation – to treat 1,4-dioxane
COCs: contaminants of concern
EPA: U.S. Environmental Protection Agency
gpm: gallons per minute
GWRS: Groundwater Replenishment System
ICs: institutional controls
LGAC: Liquid phase granular activated carbon – to treat primary COCs namely, PCE, TCE and 1,1-DCE
MNA: monitored natural attenuation
OC San: Orange County Sanitation District
POTW: Publicly Owned Treatment Works
RWQCB: Regional Water Quality Control Board
[1]Three wellfield options (existing, augmented, alternative) were evaluated by groundwater modeling (Appendix C) and the "augmented" wellfield using the 5 existing wells and adding 12 new extraction wells was considered the preferred option.

TABLE 6-3. EXISTING AND NEW EXTRACTION WELL CONSTRUCTION AND FLOW RATES

Well ID	Existing or Proposed	Well Diameter	Well Casing Material	Screen Interval (feet bgs)	Screened Aquifer Zone	Alternatives 2, 3 and 5	Alternative 4	Alternative 6[2]	
						Simulations 2 and 5 Flow Rate (gpm)	Simulation 4 Flow Rate (gpm)	Group 1 (gpm)	Group 2 (gpm)
OCWD-EW1	Existing	12"	Stainless Steel	160-295	Shallow and Upper Principal[1]	373	373	373	
OCWD-EW2	Existing	12"	Stainless Steel	130-196	Shallow	650	650		650
OCWD-EW2A	Existing	12"	Stainless Steel	122-188	Shallow	500	500		500
OCWD-EW3	Existing	12"	Stainless Steel	150-259	Shallow and Upper Principal[1]	423	423		423
OCWD-EW3A	Existing	12"	Stainless Steel	235-390	Principal	0	0	0	0
OCWD-EW4	Existing	12"	Stainless Steel	130-255	Shallow and Upper Principal[1]	600	600		600
EW-05	Proposed	12"	Stainless Steel	?	Shallow	200	200	200	
EW-06	Proposed	12"	Stainless Steel	?	Shallow	200	200	200	
EW-07	Proposed	12"	Stainless Steel	?	Shallow	500	500	500	
EW-08	Proposed	12"	Stainless Steel	?	Shallow	500	500	500	
EW-09	Proposed	12"	Stainless Steel	?	Shallow	500	500	500	
EW-10	Proposed	12"	Stainless Steel	?	Shallow	200	200	200	
EW-11	Proposed	12"	Stainless Steel	?	Shallow	200	200	200	
EW-12	Proposed	12"	Stainless Steel	?	Shallow	200	200	200	
EW-13	Proposed	12"	Stainless Steel	?	Shallow	300	300		300
EW-14	Proposed	12"	Stainless Steel	?	Shallow	205	400		400
EW-15	Proposed	12"	Stainless Steel	?	Shallow	400	400		400
EW-16	Proposed	12"	Stainless Steel	?	Shallow	400	400		400
					TOTAL	**6,351**	**6,546**	**2,873**	**3,673**

NOTES

gpm = gallons per minute

[1] These wells will have the section of the screen in the Principal Zone plugged so extraction will be focused in the Shallow Zone

[2]Alternative 6 splits extraction wells into two groups and assumes a total extraction flow rate of 6,546 gpm based on Simulation 4.

TABLE 6-4. ESTIMATED TREATMENT PLANT INFLUENT CONCENTRATIONS AND REGULATORY VALUES/LIMITS

Analyte	Units	Influent Concentration (Alternatives 3 to 5)	Influent Concentration (Alternative 6)		Regulatory Standards	
			Group 1	Group 2		
1,1-Dichloroethane	µg/L	0.2	0.1	0.2	5	MCL
1,1-Dichloroethene	µg/L	**15**	2.1	**25**	6	MCL
1,2,3-Trichloropropane	µg/L	0.001	0.001	0.001	0.005	MCL
1,2-Dichloroethane	µg/L	0.10	0.00	0.15	0.5	MCL
1,4-Dioxane	µg/L	2.3	0.7	3.6	1	NL
Perchlorate	µg/L	3.4	0.9	5.3	6	MCL
Tetrachloroethene	µg/L	**21**	**11**	**28**	5	MCL
Trichloroethene	µg/L	**48**	**14**	**72**	5	MCL
Nitrate (as N)	mg/L	7.6	4.4	9.9	10	MCL
Total Dissolved Solids	mg/L	688	558	790	500/1000	SMCL
Per and Polyfluoro Alkyl Substances (PFAS)						
perfluorooctane sulfonate (PFOS)	ng/L	4	5	6	4	MCL
perfluorooctanoic acid (PFOA)	ng/L	2	2	3	4	MCL
perfluorobutane sulfonate (PFBS)	ng/L	[a]0.3	0.0	1.0	1	HI
perfluorobutane sulfonic acid (PFBSA)	ng/L	0.8	0.6	1.3	500	NL
					5000	RL

NOTES

Influent concentration estimated as a flow weighted average using data from time period 8/1/18 to 7/31/19

Extraction well concentration for each analyte was assumed to be the same as that at the nearest monitoring well

HI= Hazard Index

MCL = Maximum Contaminant Level
NL = California Division of Drinking Water Notification Level
RL = California Division of Drinking Water Response Level
SMCL = California Title 22 Secondary MCL

Highlighted cells indicate the influent concentration exceeds the selected standard.

Bold value exceeds MCL

[a] The HI for PFBS = 0.3/2000 = 0.0002 (well below HI of 1)

TABLE 7-1. SUMMARY OF DETAILED EVALUATION OF INTERIM REMEDIAL ALTERNATIVES
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Criterion	Alternative 1 – No Action	Alternative 2: Groundwater extraction wells; discharge to POTW/GWRS; Monitoring and ICs	Alternative 3: Groundwater extraction wells; discharge to centralized treatment plant; discharge to direct use (potable water); Monitoring and ICs [e]	Alternative 4: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to injection wells; Monitoring and ICs [e]	Alternative 5: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to infiltration basin; Monitoring and ICs [e]	Alternative 6: Groundwater extraction wells; discharge to two treatment plants; Group 1 discharge to infiltration basin; Group 2 discharge to injection wells; Monitoring and ICs	Alternative Approach – MNA and ICs
Overall Protection of Human Health and the Environment	**Does not Meet the Criterion** Under this alternative, no remedial activities would be conducted to contain, treat, or reduce potential risks due to exposure to COCs in groundwater. COCs in groundwater would continue to spread to non-impacted areas of the aquifer.	**Meets the Criterion** This alternative is protective of human health and the environment through hydraulic containment of COCs in groundwater, followed by physical and chemical processes that treat the groundwater. New ICs would be implemented by agencies involved in permitting the construction and operation of production wells to preclude exposure to contaminated groundwater. Also, ICs could be implemented to preclude the construction and operation of new production wells in areas that would accelerate the lateral and vertical migration of contaminated groundwater.	**Meets the Criterion** This alternative is protective of human health and the environment through hydraulic containment of COCs in groundwater, physical and chemical processes that treat groundwater, and ICs that preclude exposure to groundwater with COCs above acceptable exposure levels, as described for Alternative 2	**Meets the Criterion** This alternative is protective of human health and the environment through hydraulic containment of COC in groundwater, physical and chemical processes that treat groundwater, and ICs that preclude exposure to groundwater with COCs above acceptable exposure levels, as described for Alternative 2.	**Meets the Criterion** This alternative is protective of human health and the environment through hydraulic containment of COC in groundwater, physical and chemical processes that treat groundwater, and ICs that preclude exposure to groundwater with COCs above acceptable exposure levels, as described for Alternative 2	**Meets the Criterion** This alternative is protective of human health and the environment through hydraulic containment of COC in groundwater, physical and chemical processes that treat groundwater, and ICs that preclude exposure to groundwater with COCs above acceptable exposure levels, as described for Alternative 2.	**Does not meet the Criterion** This approach is not protective of human health and the environment. Natural processes such as dilution and dispersion would be the only processes acting to reduce concentrations of COCs in groundwater and will not meet RAOs in a reasonable timeframe. COCs in groundwater would continue to spread to non-impacted areas of the aquifer.
Compliance with ARARs	**Criterion does not Apply** Because Alternative 1 entails no Remedial Action, a discussion of compliance with ARARs is not appropriate for this alternative.	**Meets the Criterion** Complies with all identified ARARs.	**Meets the Criterion** Complies with all identified ARARs.	**Meets the Criterion** Complies with all identified ARARs. Applicable discharge standard here is Order R8-2013-0012 (expired). In the event the Santa Ana RWQCB doesn't adopt a general order or if the discharge doesn't qualify, an individual permit may be necessary.	**Meets the Criterion** Complies with all identified ARARs. Applicable discharge standard here is Order R8-2013-0012 (expired). In the event the Santa Ana RWQCB doesn't adopt a general order or if the discharge doesn't qualify, an individual permit may be necessary.	**Meets the Criterion** Complies with all identified ARARs. Applicable discharge standard here is Order R8-2013-0012 (expired). In the event the Santa Ana RWQCB doesn't adopt a general order or if the discharge doesn't quality, an individual permit may be necessary.	**Does not meet the Criterion** Because there are not multiple lines of evidence that natural attenuation is occurring, groundwater will continue to exceed MCLs.
Long-Term Effectiveness and Permanence [a]	**Poor** [b] This alternative would not achieve the RAOs. It is not effective in the long term since it includes no controls for preventing or reducing exposure to COCs in groundwater and is not protective of human health and the environment. All current or potential future risks would remain under this alternative. Natural processes including dilution and dispersion would continue to act to reduce concentrations of COCs in groundwater. However, these processes are not sufficient to control the migration of COCs in groundwater to non-impacted areas.	**Good** Under this alternative, groundwater would be extracted to contain COCs in groundwater within the Interim Remedy containment area, and the extracted groundwater would be conveyed via newly installed discharge piping to an existing sanitary sewer trunk line, which would convey the water to an OC San POTW. The POTW would treat the water and discharge the treated effluent to OCWD's GWRS for further treatment and reuse for managed aquifer recharge in the basin. All these systems would need to be maintained until RAOs are attained. Additionally, because the treatment system would primarily be designed to contain COCs within the Interim Remedy containment area, ICs would need to be maintained into the future to preclude exposures to COCs. At this time, the GWRS does not have sufficient capacity to treat the extracted groundwater, but sufficient capacity may be available sometime in the future if wastewater flows to the OC San decline in the future freeing up available GWRS capacity.	**Good** Under this alternative, groundwater would be extracted to contain COCs in groundwater within the Interim Remedy containment area, and the extracted groundwater would be conveyed via piping to a centralized treatment plant where the water would be treated using a combination of LGAC and AOP to discharge limits meeting potable water standards. The treated groundwater would be discharged to a pipeline connected to the purveyor's potable distribution system, which would require upgrades/modifications to accept these flows. The water purveyor (City) could optionally choose to add RO treatment to reduce total dissolved solids. All these systems would need to be maintained for the alternative to be effective, including the purveyor's potable water system until RAOs are met. Additionally, because the treatment system would primarily be designed to contain COCs within the Interim Remedy containment area, ICs would need to be maintained into the future to preclude exposures to COCs.	**Good** Under this alternative, groundwater would be extracted to contain COCs in groundwater within the Interim Remedy containment area, and the extracted groundwater would be conveyed via piping to a centralized treatment plant where the extracted groundwater would be treated using a combination of LGAC and AOP to meet discharge standards. The treated groundwater would be re-injected into the aquifer, with injection in the Shallow zone. All these systems would need to be maintained for the alternative to be effective, including the injection wells, until RAOs are met. Additionally, because the treatment system would primarily be designed to contain COCs in the Interim Remedy containment area, ICs would need to be maintained into the future to preclude exposures to COCs.	**Good** Under this alternative, groundwater would be extracted to contain COCs in groundwater within the Interim Remedy containment area, and the extracted groundwater would be conveyed via piping to a centralized treatment plant, where the extracted groundwater would be treated using a combination of LGAC and AOP to meet discharge standards. A new infiltration basin would be constructed in the eastern portion of the Study Area where geologic conditions are favorable for surface recharge, upgradient of the COC plumes. All these systems would need to be maintained for the alternative to be effective, including the infiltration basin, until RAOs are met. Additionally, because the treatment system would primarily be designed to contain COCs in the Interim Remedy containment area, ICs would need to be maintained into the future to preclude exposures to COCs.	**Good** Under this alternative, groundwater would be extracted to contain COCs in groundwater within the Interim Remedy containment area, and the extracted groundwater would be conveyed via piping to two treatment plants, where the extracted groundwater would be treated using a combination of LGAC and AOP to meet discharge standards. The treated groundwater would be returned to the aquifer, with injection or infiltration into the Shallow zone. All these systems would need to be maintained for the alternative to be effective, including the injection wells and infiltration basin, until RAOs are met. Additionally, because the treatment system would primarily be designed to contain the COCs in the Interim Remedy containment area, ICs would need to be maintained into the future to preclude exposures to COCs.	**Poor** This approach would not achieve the RAOs and is not effective in the long-term. There are not multiple line of evidence indicating that natural attenuation processes are occurring in the North Basin to control the spread of COCs in groundwater to non-impacted areas. In addition, these processes are not expected to reduce toxicity of groundwater by reducing concentrations of COCs in the near term. ICs would have to be implemented to reduce exposures to COCs and would need to be expanded as the plume migrates, resulting in additional aquifer locations that may need to be restricted for beneficial use.

TABLE 7-1. SUMMARY OF DETAILED EVALUATION OF INTERIM REMEDIAL ALTERNATIVES
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Criterion	Alternative 1 – No Action	Alternative 2: Groundwater extraction wells; discharge to POTW/GWRS; Monitoring and ICs	Alternative 3: Groundwater extraction wells; discharge to centralized treatment plant; discharge to direct use (potable water); Monitoring and ICs [e]	Alternative 4: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to injection wells; Monitoring and ICs [e]	Alternative 5: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to infiltration basin; Monitoring and ICs [e]	Alternative 6: Groundwater extraction wells; discharge to two treatment plants; Group 1 discharge to infiltration basin; Group 2 discharge to injection wells; Monitoring and ICs	Alternative Approach – MNA and ICs
Reduction in Toxicity, Mobility, and Volume through Treatment	**Poor** This alternative would not reduce toxicity, mobility and/or volume of COCs in groundwater through treatment. Natural processes such as dilution and dispersion would be the only processes acting to reduce concentrations of COCs in groundwater.	**Good** This alternative would contain COCs in groundwater in the Interim Remedy containment area, reducing the migration of COCs to non-impacted areas. In addition, this alternative would reduce the mass of COCs in groundwater through treatment. The treatment would occur at the Orange County Sanitation District facility and additional treatment at the GWRS prior to use for managed aquifer recharge.	**Good** This alternative would contain COCs in groundwater in the Interim Remedy containment area, reducing the migration of COCs to non-impacted areas. In addition, this alternative would reduce the mass of COCs in groundwater through treatment using a range of treatment technologies including LGAC and AOP. This treatment would produce water that meets drinking water standards, but it is optional for the water purveyor (City) to add additional RO treatment to reduce total dissolved solids.	**Good** This alternative would contain COCs in groundwater in the Interim Remedy containment area, reducing the migration of COCs to non-impacted areas. In addition, this alternative would reduce the mass of COCs in groundwater through treatment using a range of treatment technologies including LGAC and AOP adequate to meet the state discharge standards for re-injection.	**Good** This alternative would contain COCs in groundwater in the Interim Remedy containment area, reducing the migration of COCs to non-impacted areas. In addition, this alternative would reduce the mass of COCs in groundwater through treatment using a range of treatment technologies including LGAC and AOP adequate to meet the state discharge standards for infiltration.	**Good** This alternative would contain COCs in groundwater in the Interim Remedy containment area, reducing the migration of COCs to non-impacted areas. In addition, this alternative would reduce the mass of COCs in groundwater through treatment using a range of treatment technologies including LGAC and AOP adequate to meet the state discharge standards for re-injection.	**Poor** This alternative would not reduce toxicity, mobility and/or volume of COCs in groundwater through treatment. Natural processes such as dilution and dispersion would be the only processes acting to reduce concentrations of COCs in groundwater.
Short-Term Effectiveness	**Criterion Does Not Apply**	**Fair to Good** Although Alternative 2 relies on existing treatment systems and may have lower short-term risks to construction workers and lower treatment residuals than Alternatives 3 through 6, the GWRS currently does not have capacity to treat the extracted groundwater; therefore, this alternative may require longer to reach remediation goals than Alternatives 3 through 6. Alternative 2 is expected to generate treatment residuals (GHG and pollutant emissions) due to energy consumption operating OC San's POTW and OCWD's GWRS.	**Fair** Because Alternative 3 relies on a newly constructed treatment system and additional pipeline construction, this alternative may have more short-term risks to construction workers than Alternative 2. Alternative 3 is similar with respect to treatment residuals including spent carbon, particulate filters, and GHG and pollutant emissions compared to Alternatives 4, 5, and 6. However, the City of Fullerton has not agreed to accept the treated groundwater at this time, and have financial and administrative obstacles to accepting the water; therefore this alternative may require longer to reach remediation goals.	**Fair to Good** Because Alternative 4 relies on a newly constructed system and injection wells, this alternative may have higher short-term risks to construction workers than Alternative 2, requiring additional mitigation measures. Alternative 4 is expected to generate treatment residuals like spent carbon, particulate filters and GHG similar to Alternatives 3, 5, and 6	**Fair** Because Alternative 5 relies on a newly constructed treatment system, this alternative may have higher short-term risks to construction workers than Alternative 2, and the construction risks are expected to be greater than Alternative 3 and 4 because of the longer pipe routing and substantial demolition/construction required for the new infiltration basin. Alternative 5 is expected to generate treatment residuals like spent carbon, particulate filters and GHG.	**Fair** Because Alternative 6 relies on two newly constructed treatment systems, this alternative may have higher short-term risks to construction workers than Alternatives 2 through 5, and the construction risks are expected to be greater than Alternatives 4 and 5 because of the longer pipe routing and substantial demolition/construction required for the new infiltration basin. Alternative 6 is expected to generate treatment residuals like spent carbon, particulate filters and GHG.	**Poor** This approach is technically infeasible for reaching protectiveness; multiple lines of evidence do not demonstrate that natural attenuation is occurring in the North Basin.

TABLE 7-1. SUMMARY OF DETAILED EVALUATION OF INTERIM REMEDIAL ALTERNATIVES
(Page 3 of 4)

Criterion	Alternative 1 – No Action	Alternative 2: Groundwater extraction wells; discharge to POTW/GWRS; Monitoring and ICs	Alternative 3: Groundwater extraction wells; discharge to centralized treatment plant; discharge to direct use (potable water); Monitoring and ICs [e]	Alternative 4: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to injection wells; Monitoring and ICs [e]	Alternative 5: Groundwater extraction wells; discharge to a centralized treatment plant; discharge to infiltration basin; Monitoring and ICs [e]	Alternative 6: Groundwater extraction wells; discharge to two treatment plants; Group 1 discharge to infiltration basin; Group 2 discharge to injection wells; Monitoring and ICs	Alternative Approach – MNA and ICs
Implementability[c]	**Criterion does not Apply**	**Poor** In addition to groundwater monitoring, Alternative 2 includes the installation of additional extraction wells and conveyance piping to an existing sewer system. The GWRS currently does not have the capacity to treat the extracted groundwater for this alternative; consequently, this alternative is currently not implementable; however, if the wastewater flows decline in the future, capacity may be available and this alternative could be implemented. Implementation of ICs is expected to present few administrative difficulties because the ICs would involve modifications to existing permitting processes.	**Poor to Fair** Alternative 3 is considered more administratively complex and uncertain to implement than alternatives 2 and 4 through 6 because it requires approval from the City of Fullerton to accept this water. The City has communicated that this alternative presents numerous technical, financial and community-related challenges with the primary challenge being the need for upgrading infrastructure such as new transmission pipeline and pump stations to accept the water. These infrastructure components are not included in the City's current capital improvement plan. It also is more administratively difficult than other alternatives because water is discharged to an existing purveyor's potable water system, which requires compliance with SWRCB DDW Policy 97-005. The technical challenges will include the City reducing pumping from existing production wells and stopping use of supplemental water. Alternative 3 is less technically complex than Alternatives 4 through 6 since it involves less additional construction to implement. Implementation of ICs is expected to present few administrative difficulties because the ICs would involve modifications to existing permitting processes.	**Fair to Good** Alternative 4 is considered more complex to implement than Alternative 2 because it proposes construction of a new centralized treatment plant and Alternatives 2 and 3 due to the installation of extraction and injection wells and conveyance piping. However, it is considered more administratively implementable compared to Alternative 3 because it does not involve the uncertainty of the City accepting the entire treated groundwater volume for the long term. Alternative 4 is considered less complex than Alternatives 5 since it does not require the construction of a new infiltration basin and 6 since it does not call for a second treatment plant. Some potential technical challenges are anticipated because injection wells are prone to clogging and will likely require periodic maintenance and regular backflushing to maintain the required injection capacity. Implementation of ICs is expected to present few administrative difficulties because the ICs would involve modifications to existing permitting processes.	**Fair** Alternative 5 is considered more complex to implement than Alternative 2 because it proposes construction of a new centralized treatment plant, and more complex than Alternatives 2 through 4 and 6 due to additional discharge piping, and an infiltration basin, in addition to the installation of extraction wells and wellfield conveyance piping. However, it is considered more implementable compared to Alternative 3 because it does not involve the uncertainty of the City accepting the entire treated groundwater volume for the long term. Construction of an infiltration basin will require the acquisition of relatively large areas of developed land which could create administrative difficulties. Additional piping will need to be constructed and maintained because the areas favorable for surface recharge are located in the far eastern portion of the North Basin area. Some technical challenges can be anticipated with periodic maintenance to ensure adequate infiltration capacity; however, this effort is expected to be less challenging than analogous maintenance for injection wells (Alternative 4) Implementation of ICs is expected to present few administrative difficulties because the ICs would involve modifications to existing permitting processes.	**Fair** Alternative 6 is considered more complex to implement than Alternatives 2, 4 and 5 because it proposes construction of two new treatment plants, additional discharge piping, injection wells and an infiltration basin, in addition to the installation of extraction wells and wellfield conveyance piping. However, it is considered more implementable compared to Alternative 3 because it does not involve the uncertainty of the City accepting the entire treated groundwater volume for the long term. Construction of injection wells and an infiltration basin will require the acquisition of relatively large areas of developed land which could create administrative difficulties. Additional piping will need to be constructed and maintained because the areas favorable for surface recharge are in the far eastern portion of the North Basin area. Some technical challenges can be anticipated with periodic maintenance of the infiltration basin and injection wells. Implementation of ICs is expected to present few administrative difficulties because the ICs would involve modifications to existing permitting processes.	**Poor** This approach is not implementable (technically infeasible). Multiple lines of evidence do not demonstrate that natural attenuation is occurring in the North Basin.
State Acceptance	USEPA will evaluate the two modifying criteria (State Acceptance and Community Acceptance) following regulatory agency review of this FS report and public comment on the Proposed Plan						This approach is not considered a viable alternative and therefore these criteria are not applicable
Community Acceptance	USEPA will evaluate the two modifying criteria (State Acceptance and Community Acceptance) following regulatory agency review of this FS report and public comment on the Proposed Plan						
Cost[d]	No Costs	**High** Capital Cost = $50.1MM Annual O&M Costs = $20.0MM Periodic Costs = $8.5MM **Present Worth (30 year) = $301.4MM** Level III Estimate +50%/-30% Discount rate = 7%	**Moderate** Capital Cost = $113.5MM Annual O&M Costs = $9.4MM Periodic Costs = $11.5MM **Present Worth (30 year) = $234.1MM** Level III Estimate +50%/-30% Discount rate = 7%	**Moderate** Capital Cost = $118.0MM Annual O&M Costs = $10.2MM Periodic Costs = $12.5.MM **Present Worth (30 year) = $248.9MM** Level III Estimate +50%/-30% Discount rate = 7%	**Moderate to High** Capital Cost = $147.7 MM Annual O&M Costs = $9.5MM Periodic Costs = $11.8MM **Present Worth (30 year) = $271.9MM** Level III Estimate +50%/-30% Discount rate = 7%	**High** Capital Cost = $ 151.6MM Annual O&M Costs = $11.7MM Periodic Costs = $12.2MM **Present Worth (30 year) = $300.5MM** Level III Estimate +50%/-30% **Discount rate = 7%**	**Low** Capital Cost = $2.5MM Annual O&M Costs = $0.2MM Periodic Costs = $0 **Present Worth (30 year) = $4.9MM** Level III Estimate +50%/-30% Discount rate = 7%
		Present Worth (30 year) = $442.4MM Discount rate = 3.1%	**Present Worth (30 year) = $302.1MM** Discount rate = 3.1%	**Present Worth (30 year) = $322.7MM** Discount rate = 3.1%	**Present Worth (30 year) = $337.7MM** Discount rate = 3.1%	**Present Worth (30 year) = $384.4MM** Discount rate = 3.1%	**Present Worth (30 year) = $6.2MM** Discount rate = 3.1%

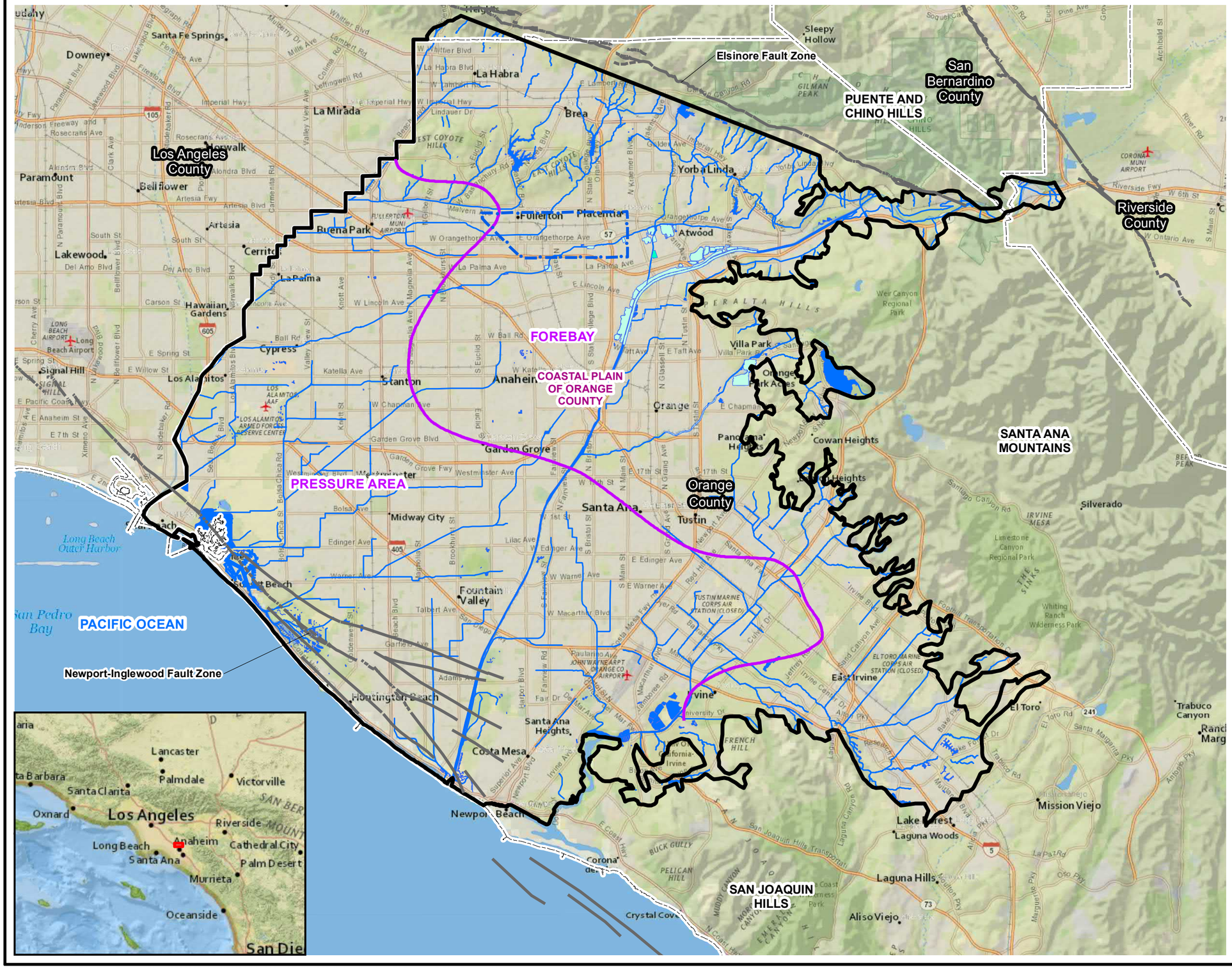
Notes:
[a] The ratings of remedial alternatives with respect to long-term effectiveness reflect the effectiveness of alternatives in treating/reducing exposure to COCs in the long-term as well as magnitude of treatment residuals at the conclusion of remedial activities.
[b] Ratings are provided for remedial alternatives with respect to NCP criteria. The ratings are relative to other alternatives. Five step ratings are provided ranging from poor, poor to fair, fair, fair to good and good. Cost ratings range from low to high.
[c] EPA notes that while two of the alternatives analyzed would not be implementable at the full volumes assessed, due to current infrastructure limitations, they are presented for public consideration so that EPA can take into account public input and potentially issue modifying documentation in the future.
[d] Cost assumptions and the associated conceptual design parameters are presented in Appendix D. Present worth analyses assume a 7% discount rate (EPA 540-R-00-002, OSWER 9355.0-75). However, a discount rate of 3.1% was included in the evaluation per EPA request.
[e] Conceptual design for Alternatives 4 through 6 assume that the LGAC adsorption is the primary treatment followed by UV oxidation while Alternative 3 leaves RO treatment to reduce total dissolved solids as optional to the City of Fullerton to enable serving the water for potable use. RO is not included as part of Alternative 3. Also, benefits and drawbacks of other treatment variations such as placing UV oxidation as the primary treatment step followed by LGAC adsorption will be evaluated in remedial design.

Acronyms on next page

TABLE 7-1. SUMMARY OF DETAILED EVALUATION OF INTERIM REMEDIAL ALTERNATIVES
(Page 4 of 4)

AOP	Advanced Oxidation Process	GWRS	Groundwater Replenishment System	NCP	National Contingency Plan	RAO	Remedial Action Objective
ARAR	Applicable or Relevant and Appropriate Requirement	IC	Institutional Control	O&M	Operation and Maintenance	RO	Reverse Osmosis
COC	Contaminant of Concern	LGAC	Liquid phase Granular Activated Carbon	OC San	Orange County Sanitation District	RWQCB	Regional Water Quality Control Board
DDW	Division of Drinking Water	MCL	Maximum Contaminant Limit	OCWD	Orange County Water District	SWRCB	California State Water Resources Control Board
EPA	United States Environmental Protection Agency	MM	Million	OSWER	Office of Solid Waste and Emergency Response	UV	Ultraviolet
GHG	Greenhouse Gases	MNA	Monitored Natural Attenuation	POTW	Publicly Owned Treatment Works		

Figures



LEGEND

- TARGET AREA FOR INTERIM REMEDY PLUME CONTAINMENT
- COASTAL PLAIN OF ORANGE COUNTY GROUNDWATER BASIN OUTLINE (DWR BULLETIN 118, BASIN NUMBER 8-01)
- FOREBAY/PRESSURE LINE
- MAJOR FAULTS
- RECHARGE FACILITIES AND FLOOD RETENTION BASINS
- SURFACE WATER FEATURES
- COUNTY BOUNDARY

N

0 1.5 3 Miles

1 " = 3 Miles

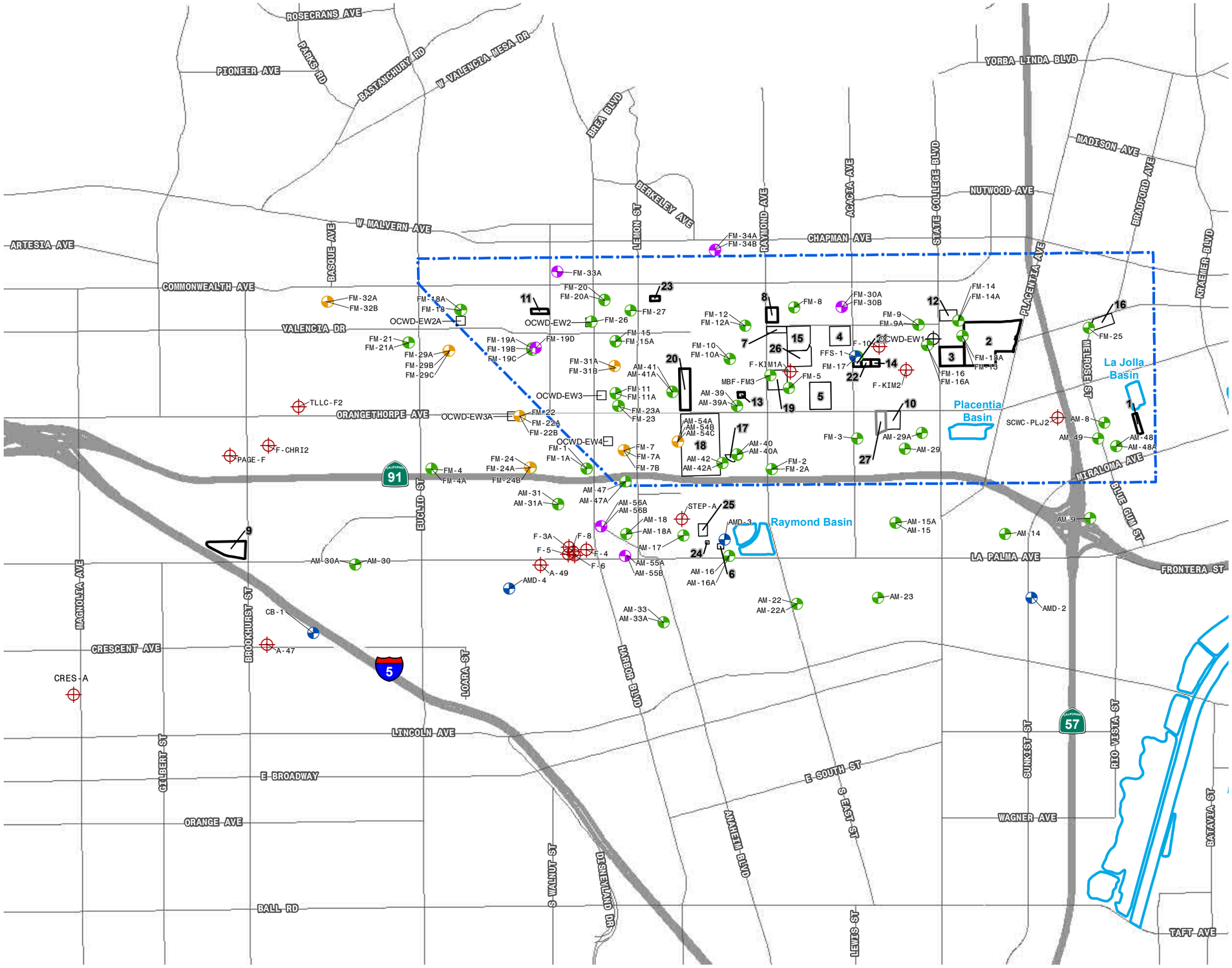
Base Map Source: ArcGIS Online, National Geographic World Map
Surface Water Features: National Hydrography Dataset
Faults: U.S. Geological Survey and California Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed 11/28/2016, from USGS website: http//earthquakes.usgs.gov/hazards/qfaults/

REGIONAL CONTEXT MAP

ORANGE COUNTY NORTH BASIN

Date 4/7/2022	AECOM	Figure 2-1
Project No. 60750913		

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Date: Wednesday, January 19, 2022 7:48:20 PM Created by: Amy Burgess



LEGEND

- OCWD GROUNDWATER MONITORING WELL
- OCWD MULTIPORT MONITORING WELL
- OCWD EXTRACTION WELL
- OCWD EXTRACTION WELL - INACTIVE
- PRODUCTION WELL
- OCWD MONITORING WELL INSTALLED FOR PHASE 1 RI (2017/2018)
- OCWD MONITORING WELL INSTALLED FOR PHASE 2 RI (2018)
- TARGET AREA FOR INTERIM REMEDY PLUME CONTAINMENT
- RECHARGE FACILITIES AND FLOOD RETENTION BASINS
- ACTIVE SITE GROUNDWATER MONITORING - DATA AVAILABLE FOR PERIOD 8/12018 THROUGH 7/31/2019
- INACTIVE SITE GROUNDWATER MONITORING - NO DATA AVAILABLE FOR PERIOD 8/1/2018 THROUGH 7/31/2019
- ACTIVE SITE GROUNDWATER MONITORING - DATA NOT AVAILABLE FOR 2018-2019 PERIOD

RELEASE SITES

1. (ACP/) AC PRODUCTS, INC.
2. (AJ/) AEROJET
3. (AL/) ARCONIC/ALCOA
4. (AE/) AMERICAN ELECTRONICS, INC.
5. (AD/) ARNOLD ENGINEERING
6. (BRH/) BODYCOTE/RODDICK/HINDERLITER
7. (CBSF/) CBS (FENDER)
8. (CMI/) CHICAGO MUSICAL INSTRUMENTS
9. (CSC/) CIRCLE SEALS
10. (CM/) CRUCIBLE MATERIALS
11. (FM/) FULLERTON MANUFACTURING
12. (YRC/) MARK IV/GULTON/EDO
13. (KS/) KESTER SOLDER (NORTHROP)
14. (KF/) KHYBER FOOD, INC.
15. (FMW/) MAG AEROSPACE INDUSTRIES, INC.
16. (MDI/) MICRODOT INSERTS
17. (MP/) MONITOR PLATING
18. (NEMD/) NORTHROP ESD
19. (MWL/) MOORE BUSINESS FORMS
20. (NY12/) NORTHROP Y-12
21. (OCM/) ORANGE COUNTY METAL PROCESSING
22. (PCA/) PCA METALS FINISHING CO
23. (PQ/) PENNZOIL / QUAKER STATE
24. (RE/) RELIANCE ELECTRIC
25. (WCR/) W.C. RICHARDS
26. (WH/) WEYERHAUESER CO
27. VISTA PAINT

N

0 1,500 3,000 Feet

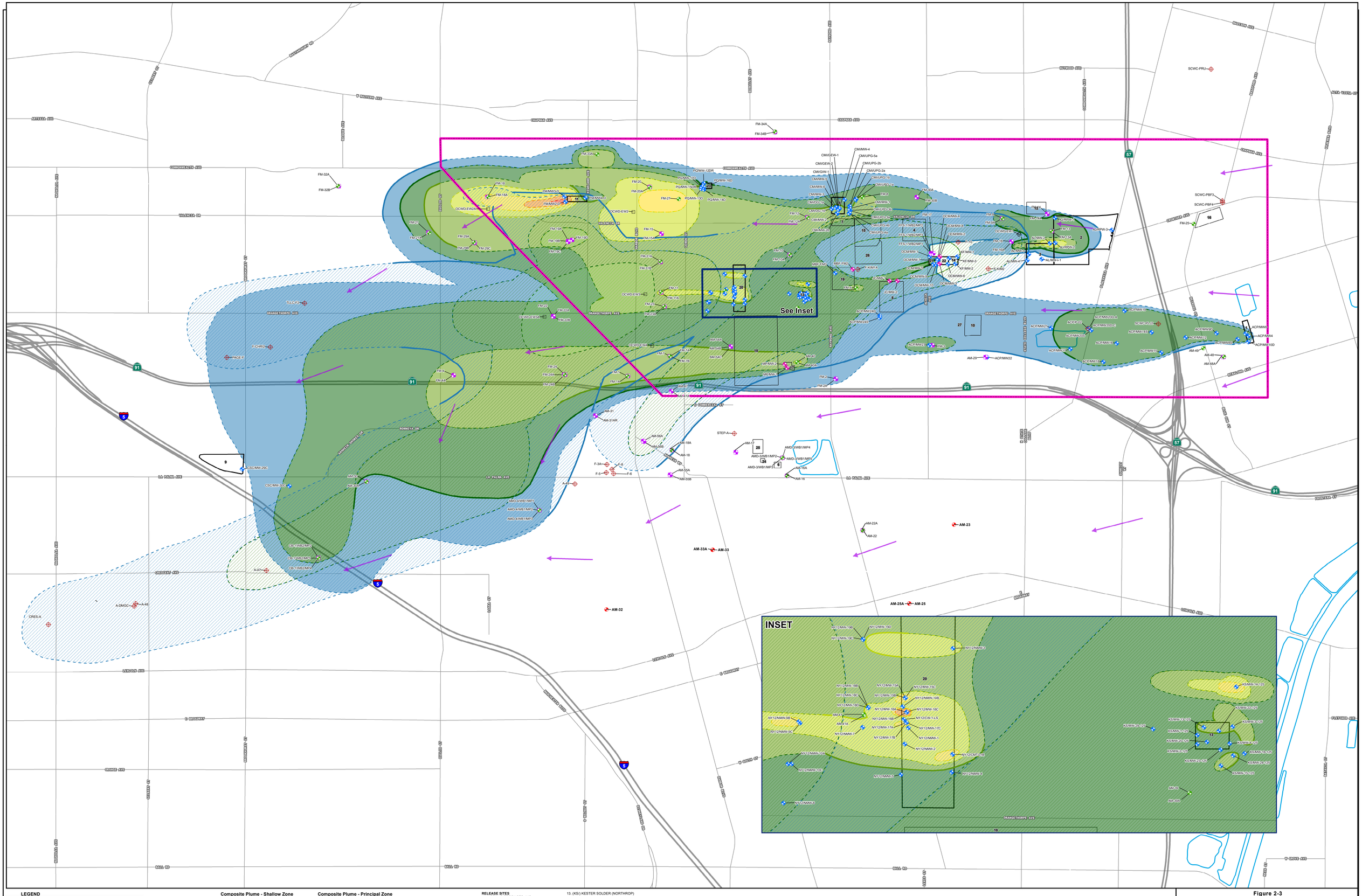
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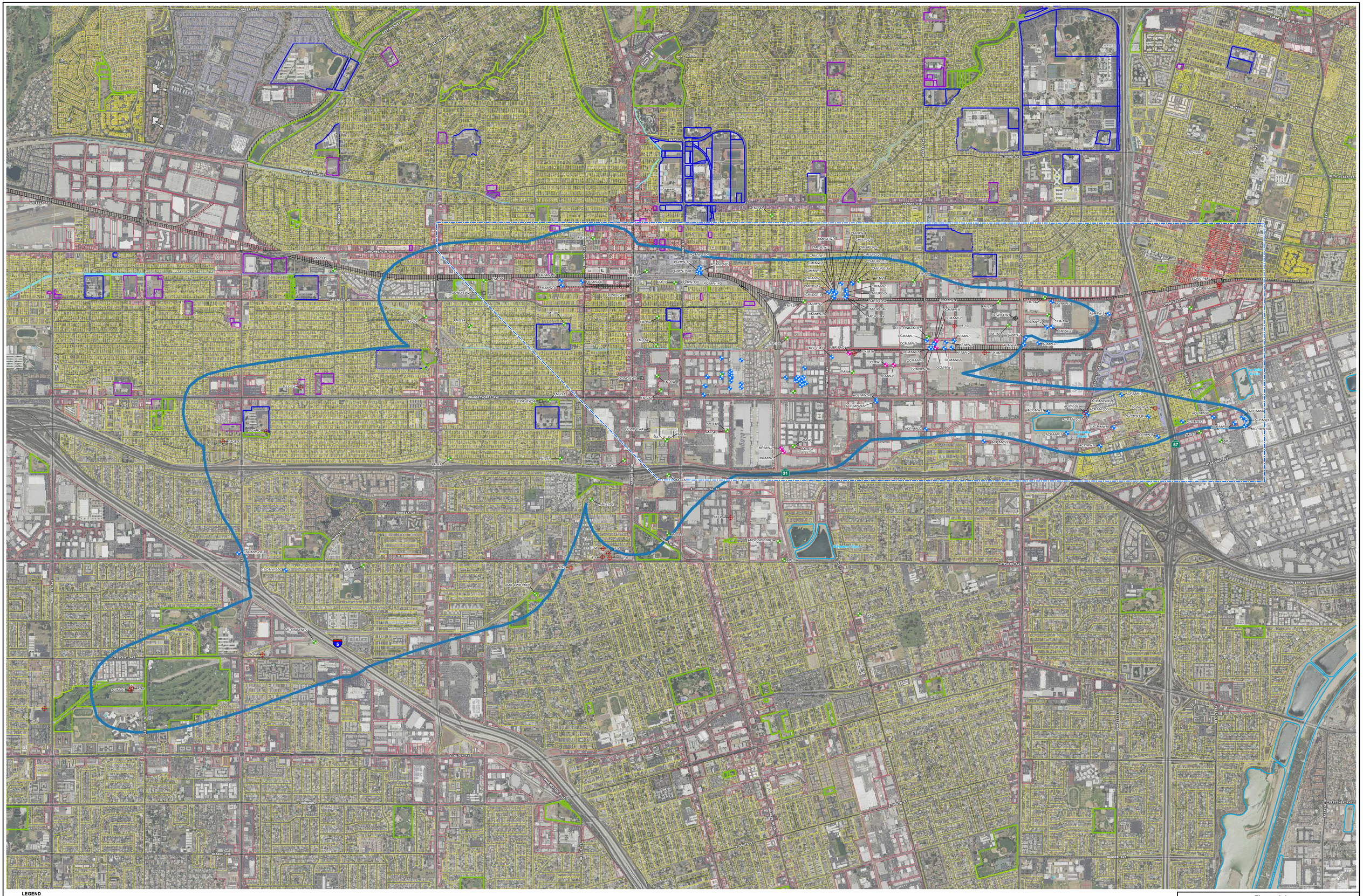
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Data: EA Engineering Science, June 2016 (USEPA Consultant)

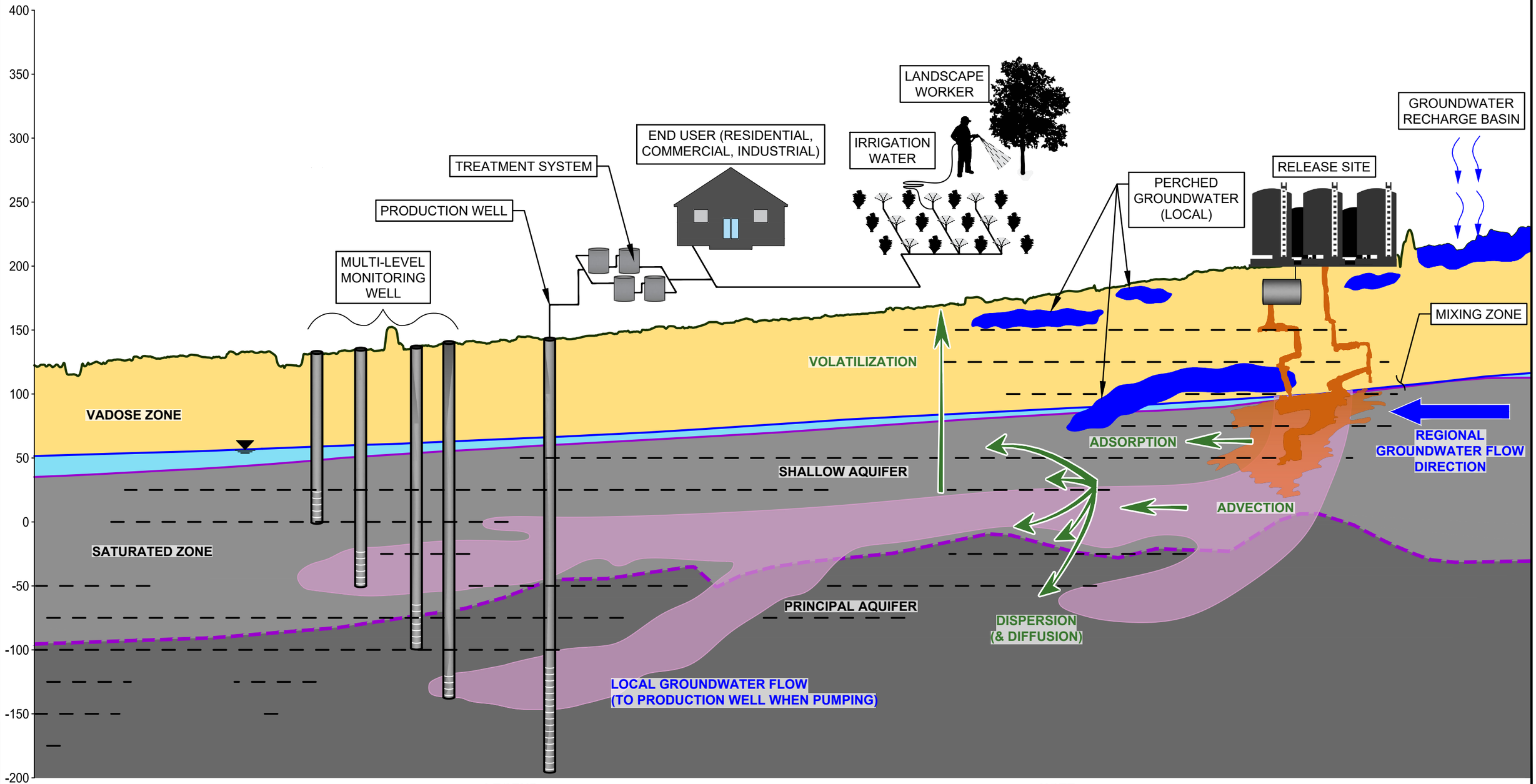
INTERIM REMEDY CONTAINMENT AREA ORANGE COUNTY NORTH BASIN

Date 5/20/2025	AECOM	Figure 2-2
Project No. 60750913		

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Date: Thursday, April 7, 2022 9:54:11 AM Map Created By: Amy Burgess


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INSET
ORANGETHORPE AVE
LA PALMA AVE
CHAPMAN AVE
COMMONWEALTH AVE
VALENCIA DR
MAGNOLIA AVE
HARBOR BLVD
STATE COLLEGE BLVD
ANAHEIM AVE
91
57
5
FM-1A
FM-2A
FM-3A
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PIONEER AVE
RANCHO SANTA FE
RANCHO SANTA FE RD
BERKELEY AVE
BERKELEY AVE
ORANGETHORPE AVE
COMMONWEALTH AVE
VALENCIA DR
ORANGETHORPE AVE
ORANGE AVE
CRESCENT AVE
LINCOLN AVE
E BROADWAY
E COMMERCIAL ST
ROMNEYA DR
CHAPMAN AVE
NORWOOD AVE
LA PALMA AVE
ORANGE AVE
WALKER AVE
FLETCHER AVE
FRONTERA ST
ASTA VESTA DR
ASTERO DR
MAGNOLIA AVE
HARBOR BLVD
STATE COLLEGE BLVD
KRAEMER BLVD
ANAHEIM BLVD
EUCLID ST
MAGNOLIA ST
BROOKHURST ST
HARBOR BLVD
WESTERN AVE
KNOTT AVE
DALE ST
BEACH BLVD
ORANGE-SHAPPELL DETENTION BASIN
Fairmont Basin
Fairmont Park
Dr. John Basin
Dr. John Park
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FM-40A



LEGEND:

- FINE-GRAINED UNIT
- POTENTIOMETRIC SURFACE - SHALLOW AQUIFER ZONE
- POTENTIOMETRIC SURFACE - PRINCIPAL AQUIFER ZONE
- DISSOLVED PHASE CONSTITUENT FATE AND TRANSPORT PROCESS

NOTE:

NOT TO SCALE

[1] A CAR WASH WORKER WAS CONSIDERED IN THE HUMAN HEALTH RISK ASSESSMENT

CONCEPTUAL SITE MODEL DIAGRAM

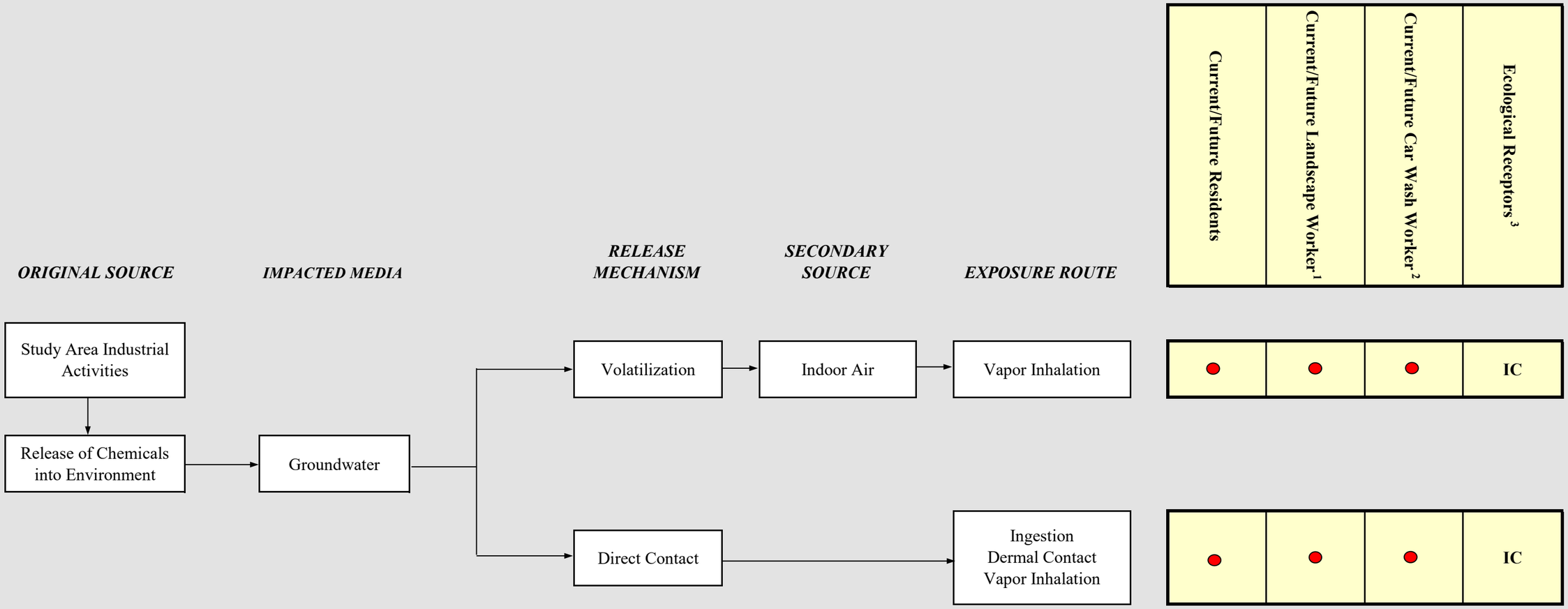
Date: 3-3-2022

Project No. 60750913

AECOM

Figure 3-2

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Legend

- ● **Potentially complete and significant pathway**
- ○ **Potentially complete but insignificant pathway**
- **IC** **Incomplete pathway**
- **NA** **Not applicable**

Notes:

1 - Landscape worker exposure assumes exposure to impacted water via sprinklers.

2 - Car wash worker exposure assumes exposure to impacted water via the water used to wash cars.

3 - Ecological receptors are not a receptor of concern because no complete exposure pathways are identified.

Project No. 60750913	AECOM	CONCEPTUAL SITE MODEL FOR HUMAN HEALTH AND ECOLOGICAL EXPOSURE	Figure 3-3
	Orange County North Basin Study Area		

EUCLID ST
W MALVERN AVE
CHAPMAN AVE
LEMON ST
BERKELEY AVE
RAYMOND AVE
ACACIA AVE
NUTWOOD AVE
COMMONWEALTH AVE
STATE COLLEGE BLVD
PLACENTIA AVE
MADISON AVE
BRADFORD AVE
COMMONWEALTH AVE
HIGHLAND AVE
VALENCIA DR
OCWD-EW2A
OCWD-EW2
EW16
EW10
EW11
EW7
EW5
EW8
EW6
OCWD-EW1
EW15
OCWD-EW3
EW12
EW13
EW9
MELROSE ST
ORANGETHORPE AVE
OCWD-EW4
EW14
ROMNEYA DR
LA PALMA AVE
BLUE GUM ST
57
91

LEGEND

- EXISTING EXTRACTION WELL
- POTENTIAL EXTRACTION WELL
- EXTRACTION WELL - INACTIVE
- HIGHWAY
- MAJOR ROAD
- TARGET AREA FOR CONTAINMENT

COMPOSITE PLUME PRINCIPAL ZONE
- 1X-2X MCL
- 2X-5X MCL
- 5X-10X MCL

COMPOSITE PLUME SHALLOW ZONE
- 1X-2X MCL
- 2X-5X MCL
- 5X-10X MCL

- 10X-20X MCL
- 20X-50X MCL
- 50X-100X MCL
- >100X MCL

N

750 375 0 750 1,500 2,250 Feet

Figure 6-1
Alternative 2
Groundwater Extraction Well Locations

DRAWN BY: PMH	DESIGNED BY:	SCALE: 1 " = 1,500 '
CHECKED BY:	APPROVED BY:	DATE: 9-2024
PROJECT NUMBER: 60525807	MAP SHEET NUMBER: SHEET # OF #	REV NO.: 1

ANSI B 11" x 17"

OCWD-EW2A
FLOW (gpm): 500

OCWD-EW2
FLOW (gpm): 650

EW-10
FLOW (gpm): 200

EW-5
FLOW (gpm): 200

EW-7
FLOW (gpm): 500

EW-11
FLOW (gpm): 200

EXIST 48" RCP OC San
TRUNK SEWER

EXIST 30" VCP OC San
TRUNK SEWER

EW-12
FLOW (gpm): 200

EW-16
FLOW (gpm): 400

OCWD-EW1
FLOW (gpm): 373

EXIST 36" VCP OC San
TRUNK SEWER

**CONNECT TO EXIST 36" VCP
OC San TRUNKLINE**

EW-15
FLOW (gpm): 400

EW-8
FLOW (gpm): 500

EW-6
FLOW (gpm): 200

OCWD-EW3
FLOW (gpm): 423

EW-13
FLOW (gpm): 300

EXIST 36", 18" AND 12" VCP
OC San TRUNK SEWER

EW-9
FLOW (gpm): 500

OCWD-EW4
FLOW (gpm): 600

EW-14
FLOW (gpm): 205

**CONNECT TO EXIST 54" RCP
OC San TRUNKLINE**

EXIST 30" VCP AND 54" RCP
OC San TRUNK SEWER

LEGEND:

- PROPOSED EXTRACTION WELL
- EXISTING EXTRACTION WELL
- POTABLE WATER WELL
- CONVEYANCE PIPING
- OC San TRUNK SEWER MAIN

0 1500' 3000'

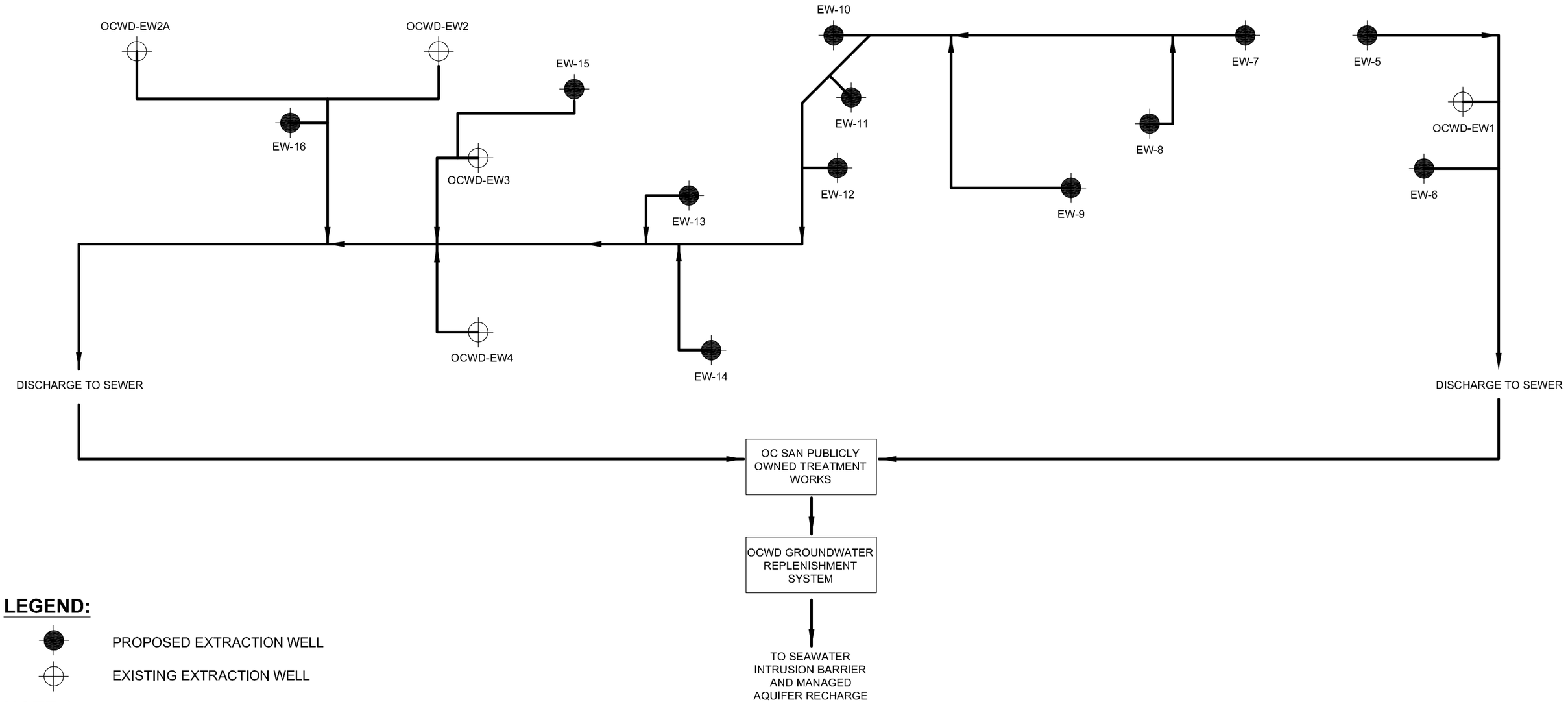
© 2020 Microsoft Corporation © 2020

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-F TE-ALT 3.DWG

**Orange County North Basin
Feasibility Study**
Project No.: 60750913 Date: April 2025

**SITE PLAN - ALTERNATIVE 2
GROUNDWATER EXTRACTION
DISCHARGE TO SEWER**

AECOM
Figure: 6-2



LEGEND:

PROPOSED EXTRACTION WELL

EXISTING EXTRACTION WELL

NOTE 1:

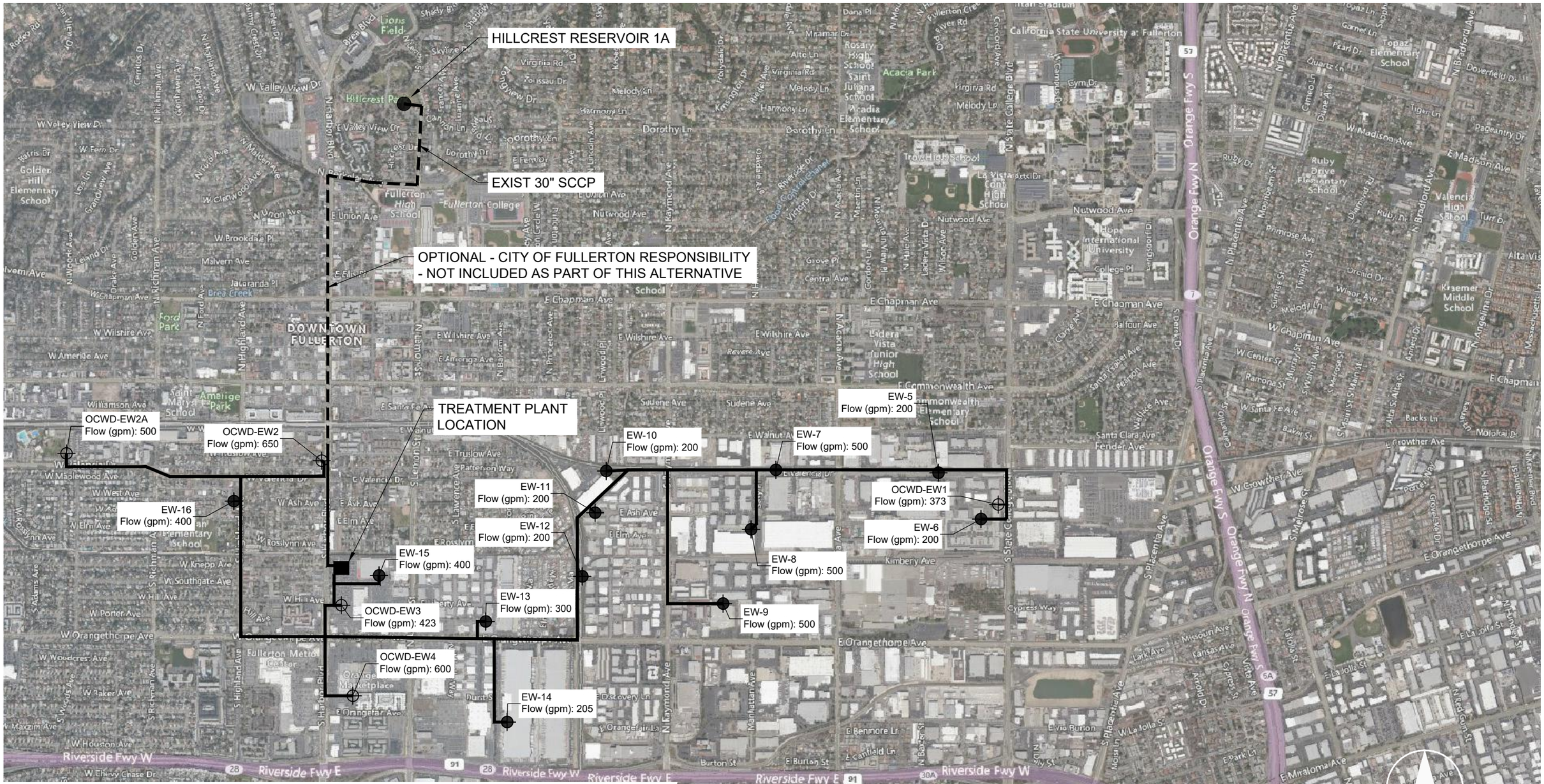
OCWD Groundwater Replenishment System includes microfiltration, reverse osmosis, and advanced oxidation which destroys 1,4-dioxane.

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-3-PFD-ALT 3.DWG

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

PROCESS FLOW DIAGRAM - ALTERNATIVE 2
GROUNDWATER EXTRACTION DISCHARGE TO SEWER

AECOM
Figure: 6-3



LEGEND:

- EXISTING EXTRACTION WELL
- PROPOSED EXTRACTION WELL
- CONVEYANCE PIPING

NOTES:

1- The City of Fullerton may identify a different location to connect to the potable water distribution system.

2- Treatment plant location is assumed and may be moved.

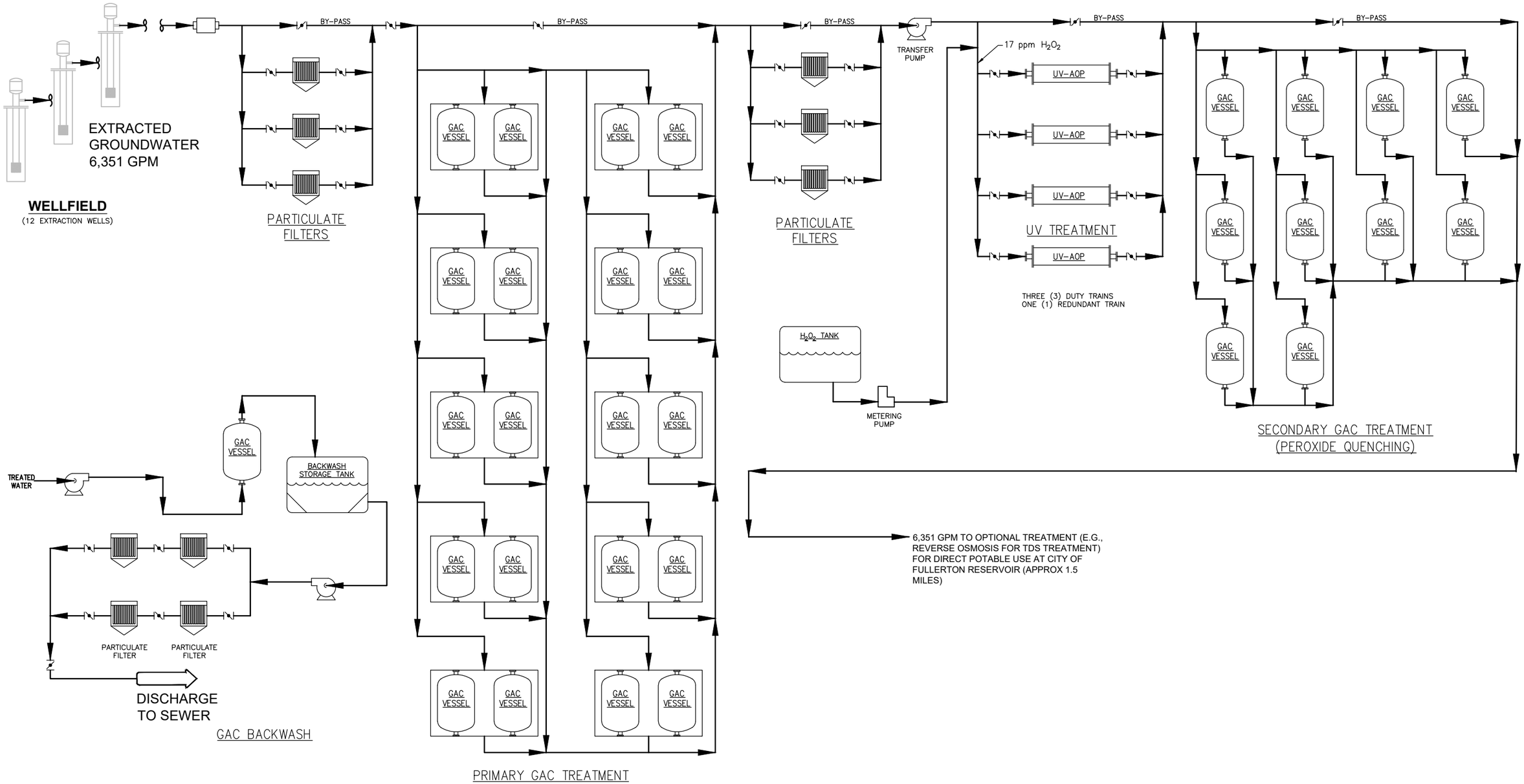
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Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-4-SITE-ALT 4.DWG

Orange County North Basin Feasibility Study
Project No.: 60750913 Date: April 2025

SITE PLAN - ALTERNATIVE 3
GROUNDWATER EXTRACTION AND
TREATMENT DISCHARGE TO DIRECT REUSE
(OPTIONAL POTABLE UPGRADE)

AECOM
Figure: 6-4



LEGEND:

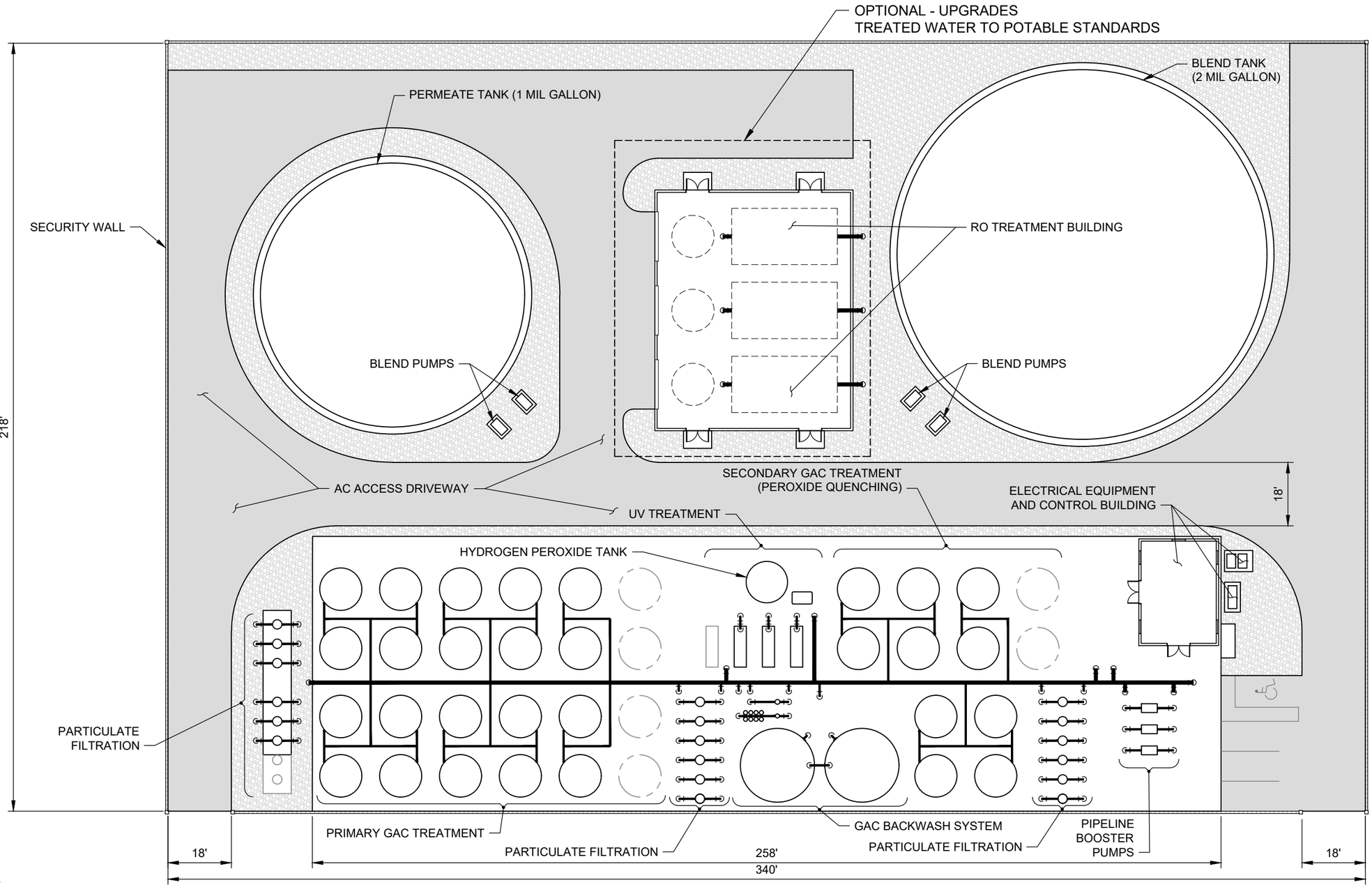
GAC	GRANULAR ACTIVATED CARBON
UV AOP	ULTRAVIOLET ADVANCED OXIDATION PROCESS

Filename: \\NA.AECOMNET.COM\LFSVAMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-5-PFD-ALT 4.DWG

Orange County North Basin
Feasibility Study
Project No.: 60525807 Date: April 2025

PROCESS FLOW DIAGRAM - ALTERNATIVE 3
GROUNDWATER EXTRACTION AND TREATMENT DISCHARGE TO CITY OF FULLERTON

AECOM
Figure: 6-5



NOTES:

1. ALTERNATIVE 4 DOES NOT INCLUDE A REVERSE OSMOSIS SYSTEM TO ALLOW POTABLE USE OF TREATED WATER AT THE CITY OF FULLERTON AND IS PLACED WITHIN A BUILDING.

2. SECONDARY GAC TREATMENT INCLUDED 10 VESSELS IN PARALLEL TO REMOVE RESIDUAL PEROXIDE.

0 30' 60'

1" = 30'

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-6-EQUIP-ALT 4.DWG

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

TREATMENT PLANT EQUIPMENT LAYOUT
ALTERNATIVE 3

AECOM
Figure: 6-6

ANSI B 11" x 17"

OCWD-EW2A
Flow (gpm): 500

OCWD-EW2
Flow (gpm): 650

EW-16
Flow (gpm): 400

EW-15
Flow (gpm): 400

OCWD-EW3
Flow (gpm): 423

OCWD-EW4
Flow (gpm): 600

EW-14
Flow (gpm): 400

EW-13
Flow (gpm): 300

EW-12
Flow (gpm): 200

EW-11
Flow (gpm): 200

EW-10
Flow (gpm): 200

EW-9
Flow (gpm): 500

EW-8
Flow (gpm): 500

EW-7
Flow (gpm): 500

EW-6
Flow (gpm): 200

EW-5
Flow (gpm): 200

OCWD-EW1
Flow (gpm): 373

TREATMENT PLANT LOCATION

17 INJECTION WELLS

LEGEND:

- PROPOSED EXTRACTION WELL
- EXISTING EXTRACTION WELL
- CONVEYANCE PIPING
- INJECTION WELL (17 WELLS)

0 1500' 3000'

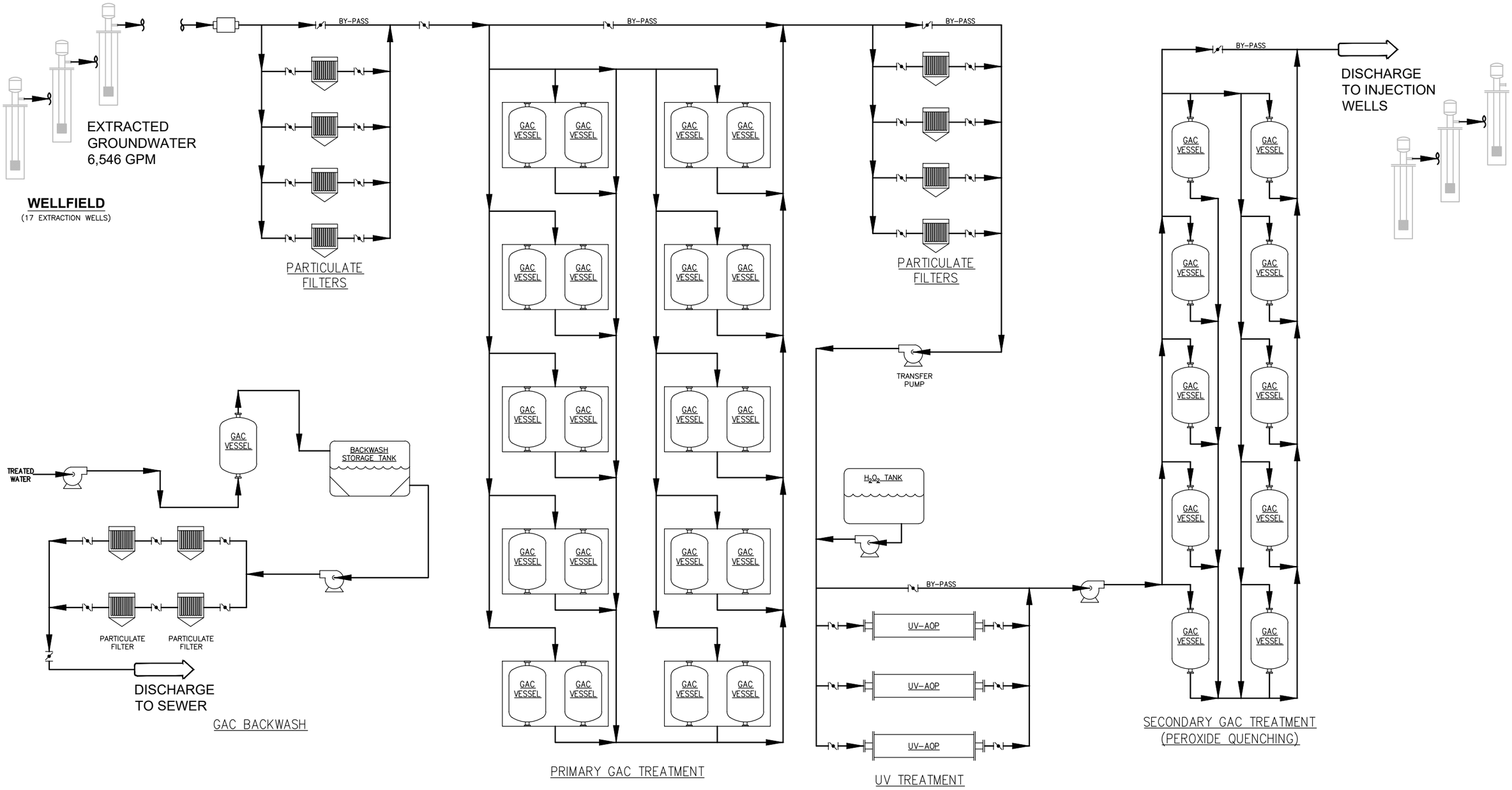
Filename: \\NA.AECOMNET.COM\LFSVAMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CADFIGURES\2025_APRIL\60750913-OCWD FS-FIG6-7-SITE-ALT 5.DWG

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

SITE PLAN - ALTERNATIVE 4
GROUNDWATER EXTRACTION AND TREATMENT DISCHARGE TO INJECTION WELLS

AECOM
Figure: 6-7

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-8-PFD-ALT 5.DWG



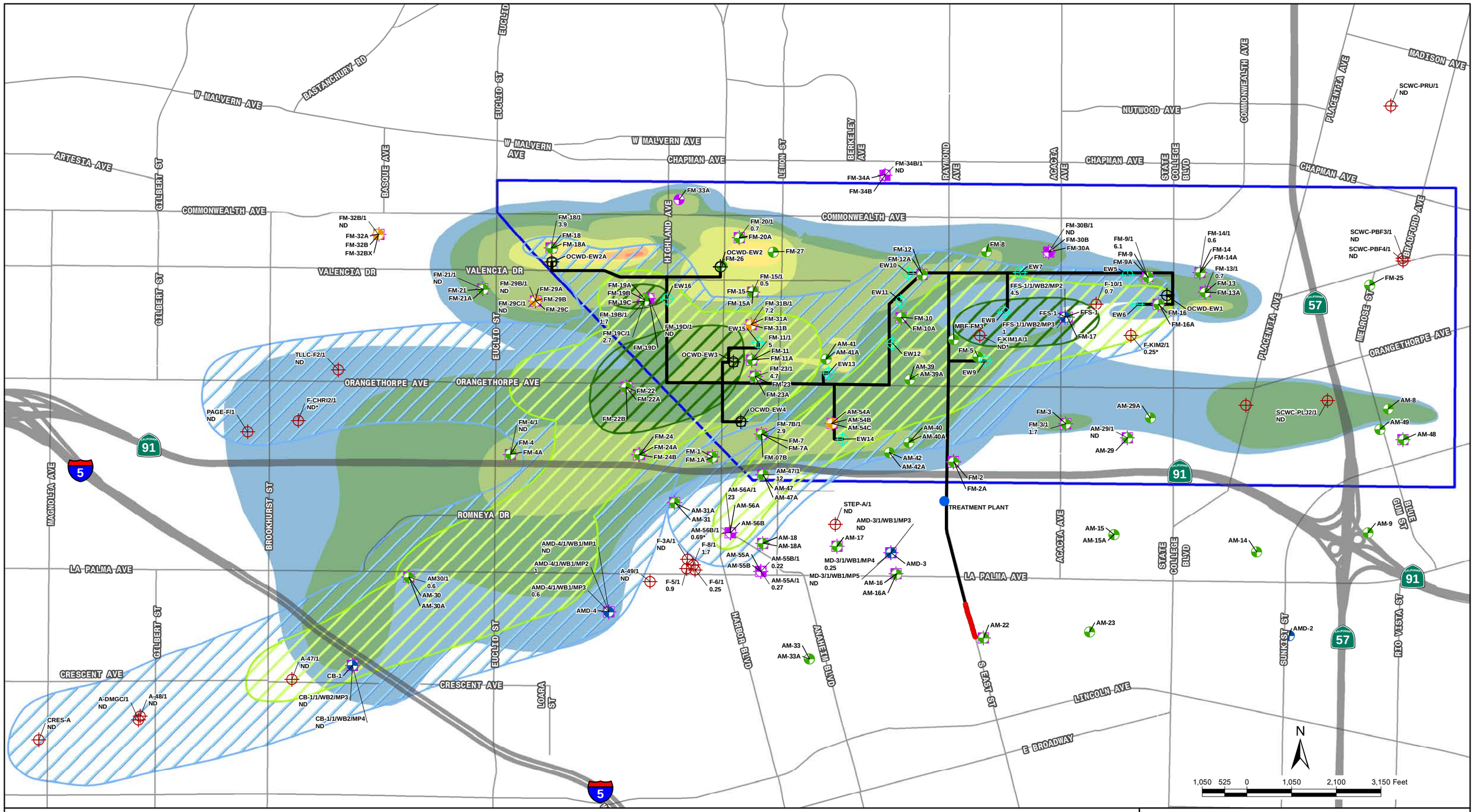
LEGEND:

GAC	GRANULAR ACTIVATED CARBON
UV AOP	ULTRAVIOLET ADVANCED OXIDATION PROCESS

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

PROCESS FLOW DIAGRAM - ALTERNATIVE 4
GROUNDWATER EXTRACTION AND TREATMENT DISCHARGE
TO INJECTION WELLS

AECOM
Figure: 6-8



LEGEND

- INJECTION WELL
- TREATMENT PLANT
- OCWD MULTIPORT MONITORING WELL
- OCWD GROUNDWATER MONITORING WELL
- OCWD MONITORING WELL INSTALLED FOR PHASE 1 RI (2017/2018)
- OCWD MONITORING WELL INSTALLED FOR PHASE 2 RI (2018)
- MONITORING WELL
- EXISTING EXTRACTION WELL
- PROPOSED EXTRACTION WELL
- EXTRACTION WELL - INACTIVE
- PRODUCTION WELL
- CONVEYANCE PIPING
- HIGHWAY
- MAJOR ROAD
- TARGET AREA FOR CONTAINMENT

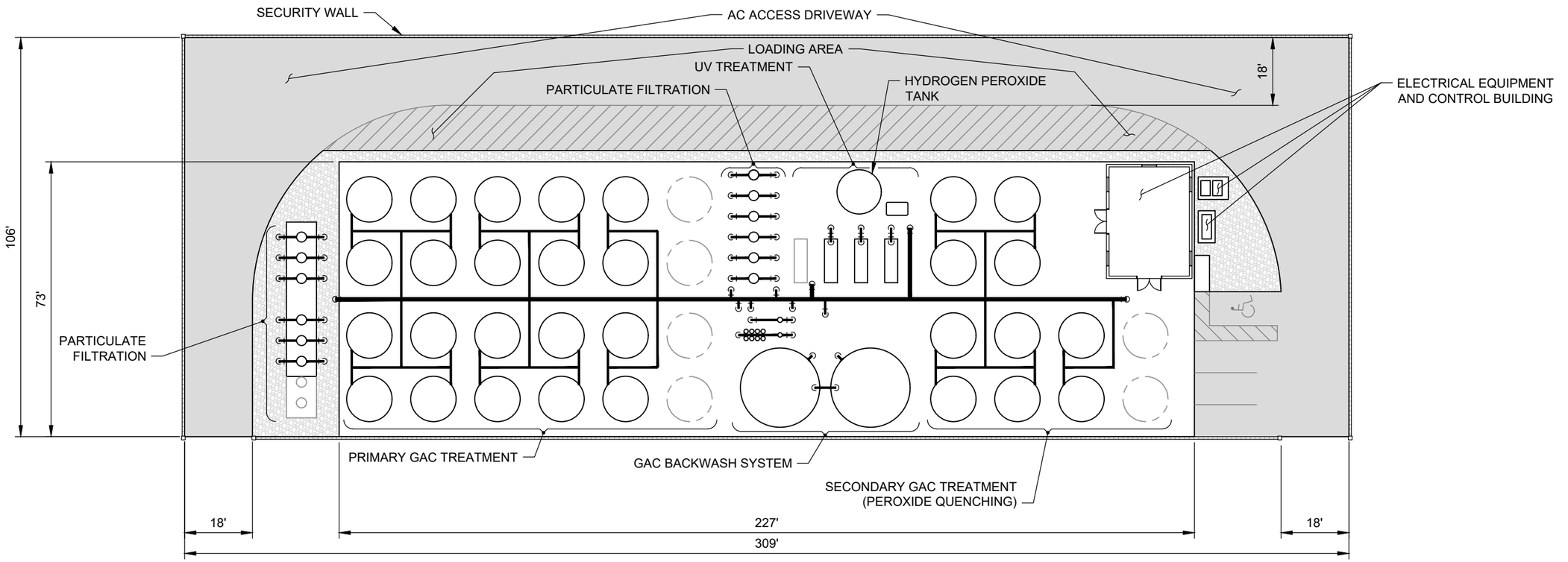
COMPOSITE PLUME PRINCIPAL ZONE
- 1X-2X MCL
- 2X-5X MCL
- 5X-10X MCL

COMPOSITE PLUME SHALLOW ZONE
- 1X-2X MCL
- 2X-5X MCL
- 5X-10X MCL

- 10X-20X MCL
- 20X-50X MCL
- 50X-100X MCL
- >100X MCL

Figure 6-9
Alternative 4 Groundwater Extraction and Treatment Discharge to Injection Wells

DRAWN BY: PMH	DESIGNED BY:	SCALE: 1 " = 2,100 '
CHECKED BY:	APPROVED BY:	DATE: 9-2024
PROJECT NUMBER: 60525807	MAP SHEET NUMBER: SHEET # OF #	REV NO.: 1



NOTE:

1. SECONDARY GAC TREATMENT INCLUDES 10 VESSELS IN PARALLEL TO REMOVE RESIDUAL PEROXIDE.

0 30' 60'

1" = 30'

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

TREATMENT PLANT EQUIPMENT LAYOUT
ALTERNATIVE 4 & 5

AECOM
Figure: 6-10

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-10-EQUIP-ALT 5&6.DWG

ANSI B 11" x 17"

OCWD-EW2A
Flow (gpm): 500

OCWD-EW2
Flow (gpm): 650

EW-16
Flow (gpm): 400

EW-15
Flow (gpm): 400

OCWD-EW3
Flow (gpm): 423

EW-13
Flow (gpm): 300

OCWD-EW4
Flow (gpm): 600

EW-14
Flow (gpm): 205

EW-11
Flow (gpm): 200

EW-12
Flow (gpm): 200

EW-10
Flow (gpm): 200

EW-5
Flow (gpm): 200

EW-7
Flow (gpm): 500

OCWD-EW1
Flow (gpm): 373

EW-6
Flow (gpm): 200

EW-8
Flow (gpm): 500

EW-9
Flow (gpm): 500

INFILTRATION BASIN AND TREATMENT PLANT LOCATION

PLACENTIA FLOOD CONTROL BASIN

RAYMOND FLOOD CONTROL BASIN

INSET

LEGEND:

- PROPOSED EXTRACTION WELL
- EXISTING EXTRACTION WELL
- CONVEYANCE PIPING
- INFILTRATION BASIN AND TREATMENT PLAN

0 1500' 3000'

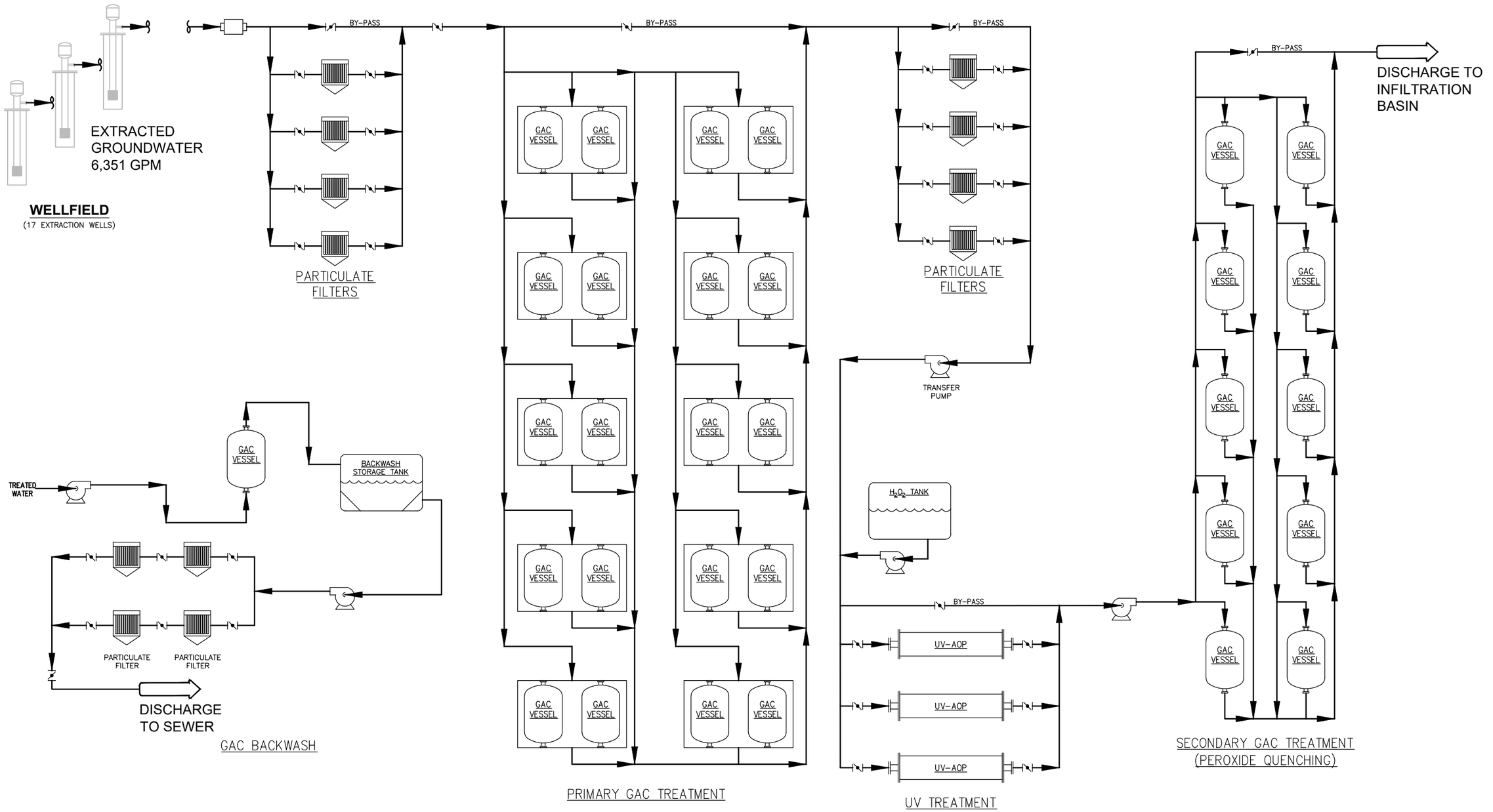
Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\EN\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-11-SITE-ALT 6.DWG

Orange County North Basin Feasibility Study
Project No.: 60750913 Date: April 2025

SITE PLAN - ALTERNATIVE 5 GROUNDWATER EXTRACTION AND TREATMENT DISCHARGE TO INFILTRATION BASIN

AECOM
Figure: 6-11

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA11DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-12-PFD-ALT 6.DWG



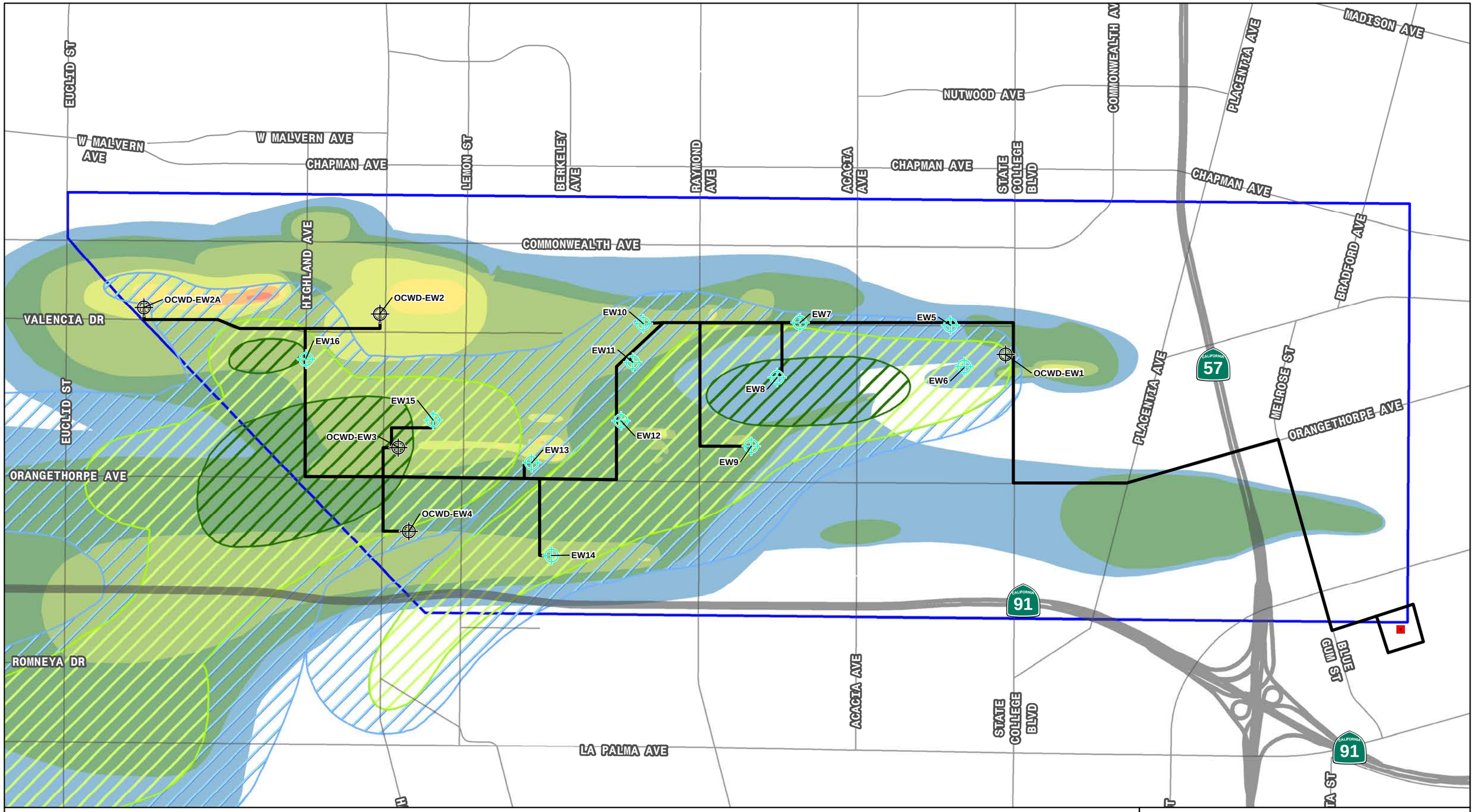
LEGEND:

GAC	GRANULAR ACTIVATED CARBON
UV AOP	ULTRAVIOLET ADVANCED OXIDATION PROCESS

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

PROCESS FLOW DIAGRAM - ALTERNATIVE 5
GROUNDWATER EXTRACTION AND TREATMENT DISCHARGE TO INFILTRATION BASIN

AECOM
Figure: 6-12



LEGEND

- INFILTRATION AND TREATMENT PLANT
- EXISTING EXTRACTION WELL
- POTENTIAL EXTRACTION WELL
- EXTRACTION WELL - INACTIVE
- CONVEYANCE PIPING
- HIGHWAY
- MAJOR ROAD
- TARGET AREA FOR CONTAINMENT

COMPOSITE PLUME PRINCIPAL ZONE
- 1X-2X MCL
- 2X-5X MCL
- 5X-10X MCL

COMPOSITE PLUME SHALLOW ZONE
- 1X-2X MCL
- 2X-5X MCL
- 5X-10X MCL

- 10X-20X MCL
- 20X-50X MCL
- 50X-100X MCL
- >100X MCL

N

750 375 0 750 1,500 2,250 Feet

Figure 6-13
Alternative 5 Groundwater Extraction and Treatment Discharge to Infiltration Basin

DRAWN BY: PMH	DESIGNED BY:	SCALE: 1 " = 1,500 '
CHECKED BY:	APPROVED BY:	DATE: 9-2024
PROJECT NUMBER: 60525807	MAP SHEET NUMBER: SHEET # OF #	REV NO.: 1

ANSI B 11" x 17"

GROUP 2

GROUP 1

OCWD-EW2A
Flow (gpm): 500

OCWD-EW2
Flow (gpm): 650

EW-16
Flow (gpm): 400

EW-15
Flow (gpm): 400

EW-13
Flow (gpm): 300

OCWD-EW3
Flow (gpm): 423

OCWD-EW4
Flow (gpm): 600

EW-14
Flow (gpm): 400

EW-10
Flow (gpm): 200

EW-11
Flow (gpm): 200

EW-12
Flow (gpm): 200

EW-5
Flow (gpm): 200

EW-7
Flow (gpm): 500

OCWD-EW1
Flow (gpm): 373

EW-6
Flow (gpm): 200

EW-8
Flow (gpm): 500

EW-9
Flow (gpm): 500

INFILTRATION BASIN AND TREATMENT PLANT LOCATION

INSET

LA JOLLA RECHARGE BASIN

PLACENTIA FLOOD CONTROL BASIN

TREATMENT PLANT LOCATION

RAYMOND FLOOD CONTROL BASIN

10 INJECTION WELLS

LEGEND:

- PROPOSED EXTRACTION WELL
- EXISTING EXTRACTION WELL
- CONVEYANCE PIPING
- INFILTRATION BASIN AND TREATMENT PLAN
- INJECTION WELL (10 WELLS)

0 1500' 3000'

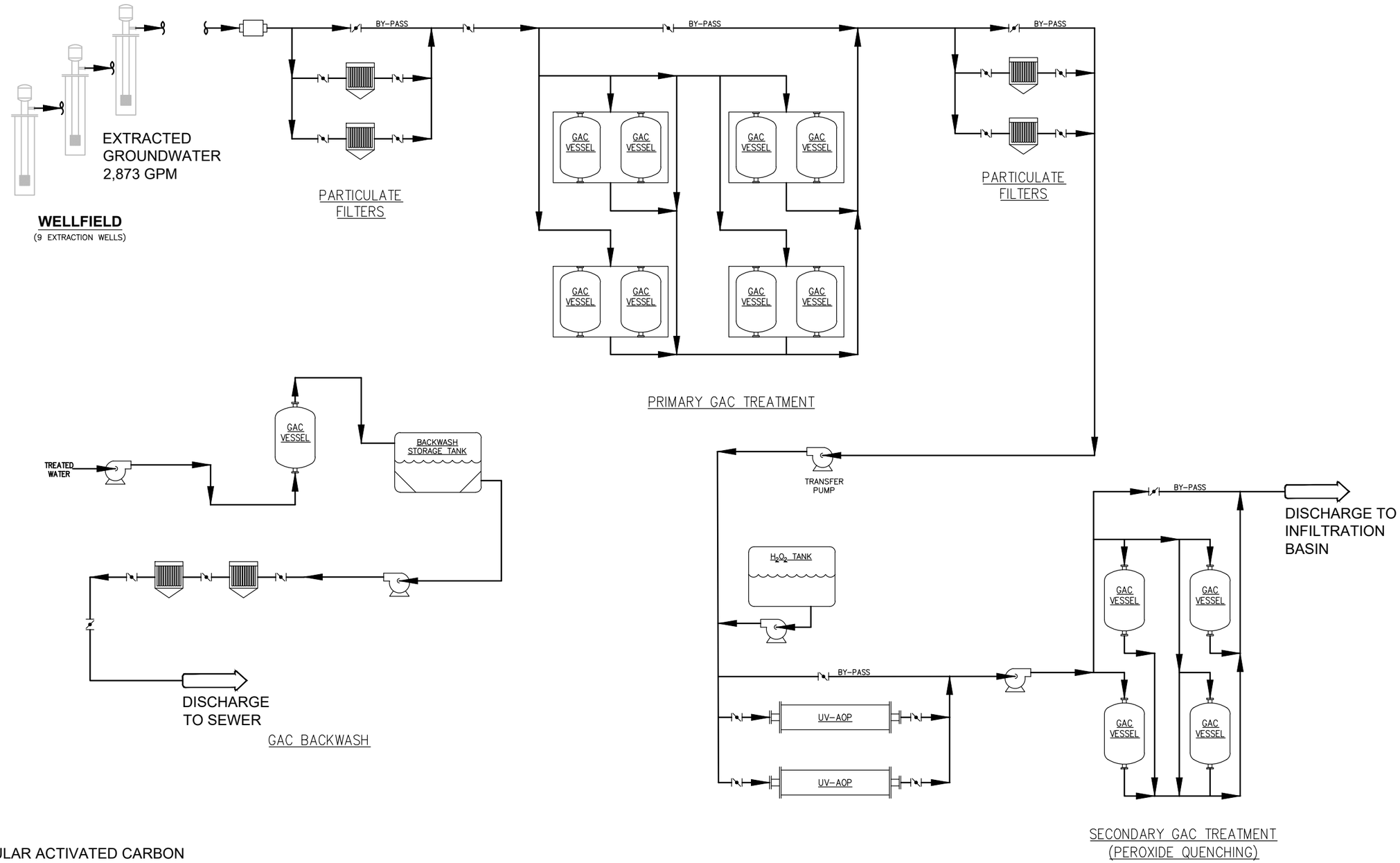
Filename: \\NA.AECOMNET.COM\LFSVAMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-14-SITE-ALT-7.DWG

Orange County North Basin Feasibility Study
Project No.: 60750913 Date: April 2025

**SITE PLAN - ALTERNATIVE 6
GROUNDWATER EXTRACTION AND
TREATEMENT DISCHARGE TO INFILTRATION
BASIN AND INJECTION WELLS**

AECOM

Figure: 6-14



LEGEND:

GAC	GRANULAR ACTIVATED CARBON
UV AOP	ULTRAVIOLET ADVANCED OXIDATION PROCESS

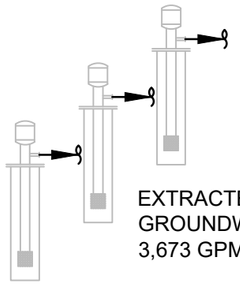
Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-15-PFD-ALT 7_GROUP1.DWG

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

PROCESS FLOW DIAGRAM - ALTERNATIVE 6 GROUP 1 WELLS
GROUNDWATER EXTRACTION AND TREATMENT DISCHARGE
TO INFILTRATION BASIN

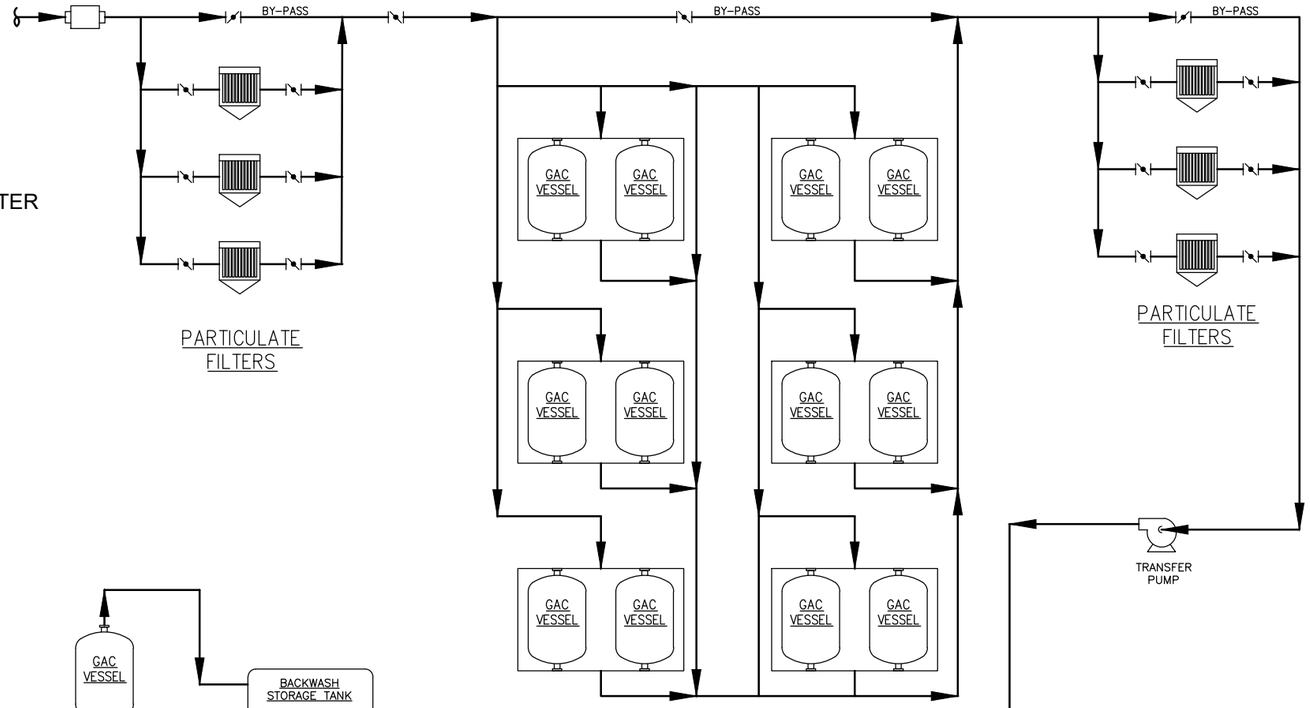
AECOM
Figure: 6-15

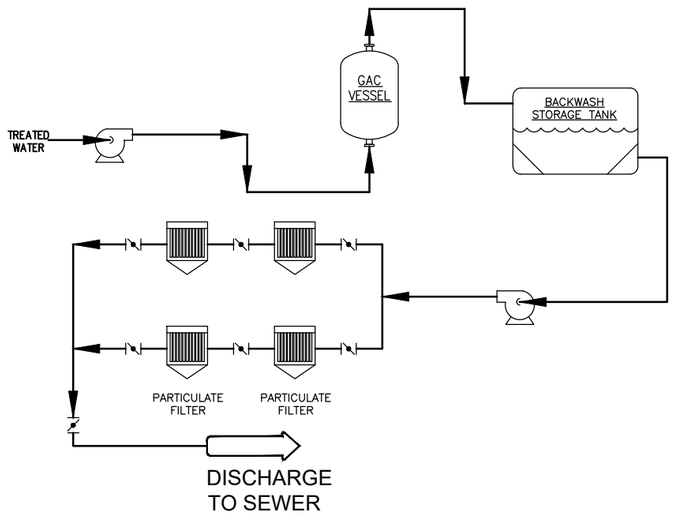
Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-16-PFD-ALT 7_GROUP2.DWG



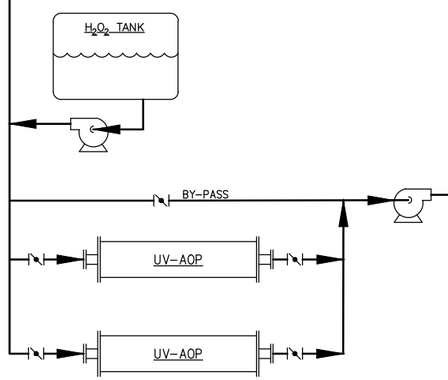
EXTRACTED
GROUNDWATER
3,673 GPM

WELLFIELD
(8 EXTRACTION WELLS)

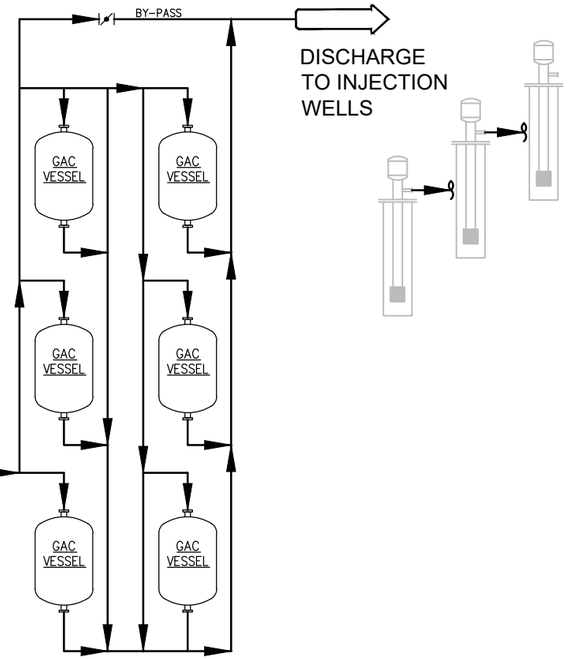




GAC BACKWASH



UV TREATMENT



SECONDARY GAC TREATMENT
(PEROXIDE QUENCHING)

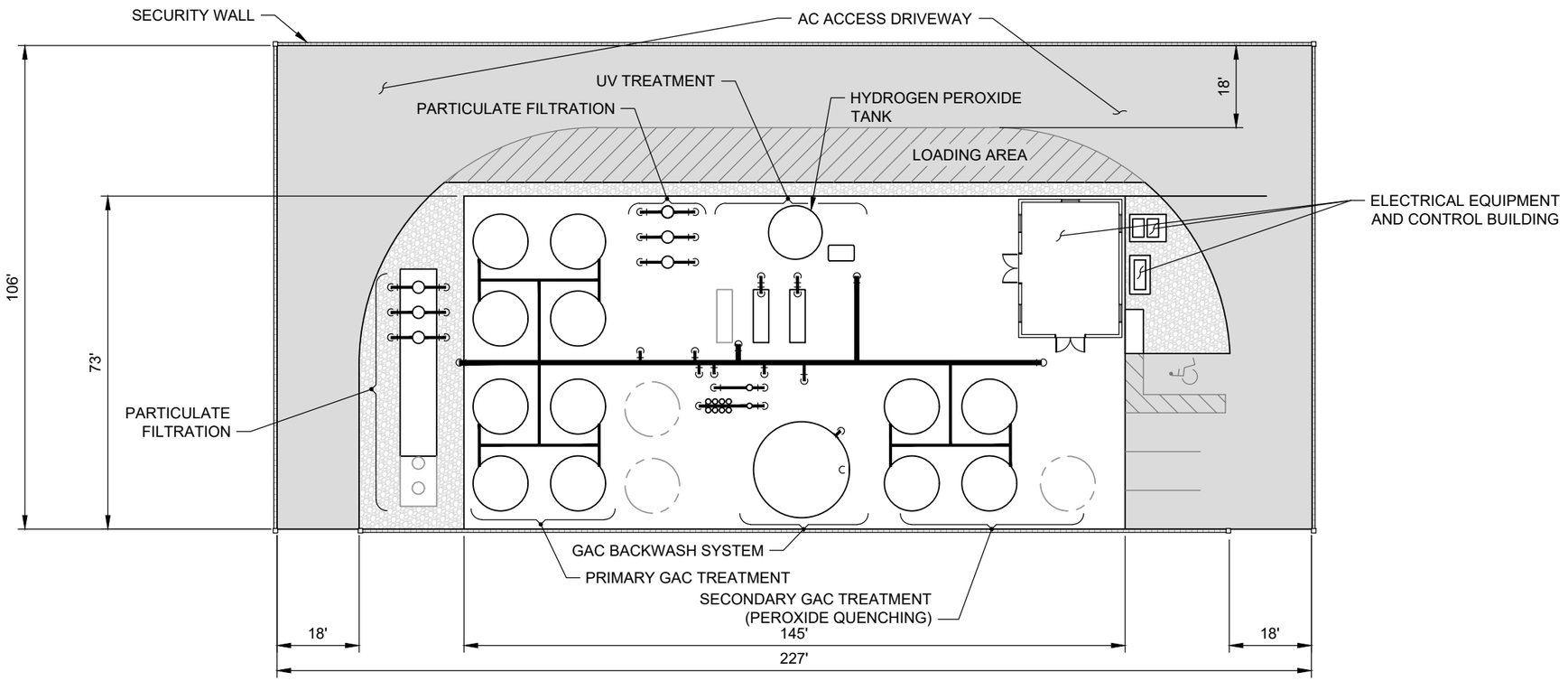
LEGEND:

GAC	GRANULAR ACTIVATED CARBON
UV AOP	ULTRAVIOLET ADVANCED OXIDATION PROCESS

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

PROCESS FLOW DIAGRAM - ALTERNATIVE 6 GROUP 2 WELLS
GROUNDWATER EXTRACTION AND TREATMENT DISCHARGE
TO INJECTION WELLS

AECOM
Figure: 6-16



NOTE:

1. SECONDARY GAC TREATMENT INCLUDES 4 VESSELS IN PARALLEL TO REMOVE RESIDUAL PEROXIDE.

0 30' 60'

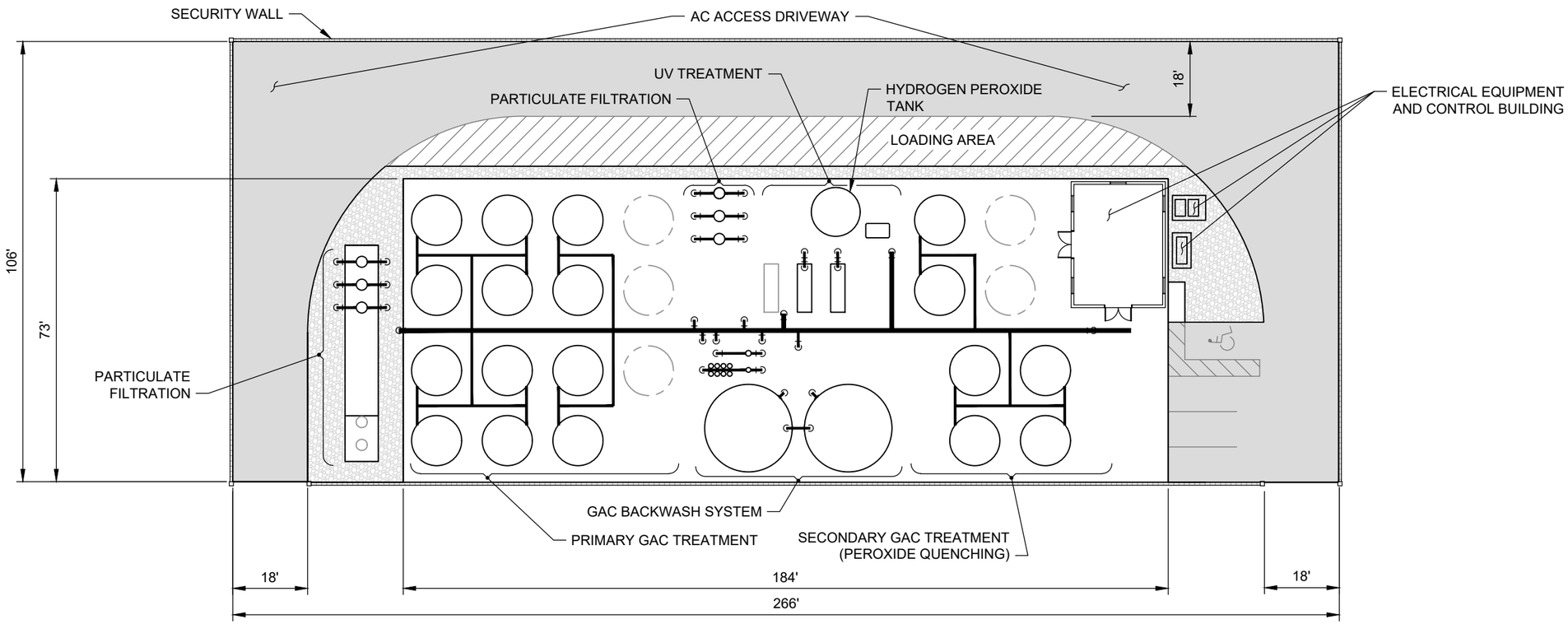
1" = 30'

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

TREATMENT PLANT EQUIPMENT LAYOUT
ALTERNATIVE 6 GROUP 1 WELLS

AECOM
Figure: 6-17

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-17-EQUIP-ALT 7_GROUP1_V2.DWG



NOTE:

1. SECONDARY GAC TREATMENT INCLUDES 6 VESSELS IN PARALLEL TO REMOVE RESIDUAL PEROXIDE.

0 30' 60'

1" = 30'

Filename: \\NA.AECOMNET.COM\LFS\AMER\ORANGE-USORA1\DCS\PROJECTS\ENV\60525807_OCWDNBASIN\900-CAD-GIS\910-CAD\FIGURES\2025_APRIL\60750913-OCWD FS-FIG6-18-EQUIP-ALT 7_GROUP2_V3.DWG

Orange County North Basin
Feasibility Study
Project No.: 60750913 Date: April 2025

TREATMENT PLANT EQUIPMENT LAYOUT
ALTERNATIVE 6 GROUP 2 WELLS

AECOM

Figure: 6-18

Appendices

Appendix A
Administrative Settlement Agreement between the OCWD and EPA

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION IX

IN THE MATTER OF: ORANGE COUNTY NORTH BASIN and ORANGE COUNTY WATER DISTRICT Proceeding Under Sections 104 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9604 and 9622.	)	U.S. EPA Docket No. 2016-03 **ADMINISTRATIVE SETTLEMENT AGREEMENT FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ADMINISTRATIVE SETTLEMENT AGREEMENT
FOR REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

ADMINISTRATIVE SETTLEMENT AGREEMENT FOR REMEDIAL INVESTIGATION AND FEASIBILITY STUDY ORANGE COUNTY NORTH GROUNDWATER BASIN

I. JURISDICTION AND GENERAL PROVISIONS

1. This Administrative Settlement Agreement (Settlement Agreement) is entered into voluntarily by the United States Environmental Protection Agency (EPA) and Orange County Water District (OCWD). The Settlement Agreement concerns the preparation and performance of a remedial investigation and feasibility study (RI/FS) for the northern portion of the Orange County groundwater basin that has been impacted by volatile organic compound contamination located generally within the Cities of Fullerton, Anaheim, and Placentia, and payment of Future Response Costs incurred by EPA in connection with the RI/FS.

2. This Settlement Agreement is issued under the authority vested in the President of the United States by Sections 104 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9604, 9607, and 9622 (CERCLA). This authority was delegated to the Administrator of EPA on January 23, 1987, by Executive Order 12580, 52 Fed. Reg. 2923 (Jan. 29, 1987), and further delegated to Regional Administrators by EPA Delegation Nos. 14-14-C (Administrative Actions Through Consent Orders, Apr. 15, 1994) and 14-14-D (Cost Recovery Non-Judicial Agreements and Administrative Consent Orders, May 11, 1994). These authorities were further redelegated by the Regional Administrator of EPA Region 9 to the Superfund Assistant Directors by Regional Delegation 1290.15 (September 29, 1997).

3. In accordance with Sections 104(b)(2) and 122(j)(1) of CERCLA, 42 U.S.C. §§ 9604(b)(2) and 9622(j)(1), EPA notified the California Department of Toxic Substances Control and the Santa Ana Regional Water Quality Control Board on December 2, 2015 of negotiations with potentially responsible parties regarding the release of hazardous substances that may have resulted in injury to the natural resources under State trusteeship.

4. OCWD is a special water district created in 1933 by the State of California pursuant to the Orange County Water District Act. OCWD is a public entity with the authority to manage and protect the water resources in Orange County, California, including conducting investigations of water quality within the District. As such, OCWD is interested in undertaking the work described in this Settlement Agreement. EPA and OCWD recognize that this Settlement Agreement has been negotiated in good faith and that the actions undertaken by OCWD in accordance with this Settlement Agreement do not constitute an admission or any evidence of liability. OCWD does not admit, and retains the right to controvert in any subsequent proceedings other than proceedings to implement or enforce this Settlement Agreement, the validity of the findings of fact in Section V and the conclusions of law and determinations in Section VI. OCWD agrees to comply with and be bound by the terms of this Settlement Agreement and further agrees that it will not contest the basis or validity of this Settlement Agreement or its terms.

II. PARTIES BOUND

5. This Settlement Agreement applies to and is binding upon EPA and upon OCWD and its successors and assigns. Any change in the form or status of OCWD, including but not limited to, any transfer of assets or real or personal property, shall not alter OCWD's responsibilities under this Settlement Agreement.

6. OCWD shall ensure that its contractors, subcontractors, and representatives receive a copy of this Settlement Agreement and comply with this Settlement Agreement. OCWD shall be responsible for any noncompliance with this Settlement Agreement.

7. Each undersigned representative of OCWD certifies that he or she is fully authorized to enter into the terms and conditions of this Settlement Agreement and to execute and legally bind OCWD to this Settlement Agreement.

III. STATEMENT OF PURPOSE

8. In entering into this Settlement Agreement, the objectives of EPA and OCWD are: (a) to protect human health and the environment by preventing exposure to contaminated groundwater in the North Basin Study Area; (b) to determine the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants at or from the North Basin Study Area to support the development of an interim groundwater remedy to hydraulically contain contaminated groundwater originating from the majority of known or suspected sources in the North Basin Study Area, by conducting an initial Remedial Investigation as more specifically set forth in the Statement of Work (SOW) attached as Appendix A to this Settlement Agreement; (c) to identify and evaluate remedial alternatives for an interim groundwater remedy to hydraulically contain contaminated groundwater originating from the majority of known or suspected sources in the North Basin Study Area to prevent, mitigate, or otherwise respond to or remedy any release or threatened release of hazardous substances, pollutants, or contaminants at or from the Study Area, by conducting an initial Feasibility Study as more specifically set forth in the SOW in Appendix A to this Settlement Agreement; (d) to further characterize the full nature and extent of contamination in the North Basin Study Area downgradient of the interim groundwater remedy area, by conducting certain Remedial Investigation activities as specifically set forth in the SOW attached as Appendix A to this Settlement Agreement; and (e) to recover response and oversight costs incurred by EPA with respect to this Settlement Agreement.

9. The Work conducted under this Settlement Agreement is subject to approval by EPA and shall provide all appropriate and necessary information to assess Study Area conditions and evaluate alternatives to the extent necessary to select a remedy that will be consistent with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Part 300 (NCP). OCWD shall conduct all Work under this Settlement Agreement in compliance with CERCLA, the NCP, and all applicable EPA guidance, policies, and procedures.

IV. DEFINITIONS

Unless otherwise expressly provided in this Settlement Agreement, terms used in this Settlement Agreement that are defined in CERCLA or in regulations promulgated under CERCLA shall have the meaning assigned to them in CERCLA or in such regulations. Whenever terms listed below are used in this Settlement Agreement or its appendices, the following definitions shall apply:

"CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601-9675.

"DOJ" shall mean the United States Department of Justice and its successor departments, agencies, or instrumentalities.

"Day" or "day" shall mean a calendar day. In computing any period of time under this Settlement Agreement, where the last day would fall on a Saturday, Sunday, or federal or state holiday, the period shall run until the close of business of the next working day.

"Effective Date" shall mean the effective date of this Settlement Agreement as provided in Section XXVIII.

"EPA" shall mean the United States Environmental Protection Agency and its successor departments, agencies, or instrumentalities.

"EPA Hazardous Substance Superfund" shall mean the Hazardous Substance Superfund established by the Internal Revenue Code, 26 U.S.C. § 9507.

"RWQCB" shall mean the California Regional Water Quality Control Board, Santa Ana Region, and any successor departments or agencies of the State.

"OCWD" shall mean Orange County Water District.

"DTSC" shall mean the California Department of Toxic Substances Control and any successor departments or agencies of the State.

"Engineering Controls" shall mean constructed containment barriers or systems that control one or more of the following: downward or lateral migration, infiltration, or seepage of surface runoff or rain; or natural leaching migration of contaminants through the subsurface over time. Examples include extraction wells and treatment systems, including conveyance systems needed to transport untreated and treated water, facilities for recharging treated groundwater, caps, engineered bottom barriers, immobilization processes, and vertical barriers.

"Future Response Costs" shall mean all costs, including, but not limited to, direct and indirect costs, that the United States incurs in reviewing or developing plans, reports,

and other deliverables submitted pursuant to this Settlement Agreement, in overseeing implementation of the Work, or otherwise implementing, overseeing, or enforcing this Settlement Agreement, including but not limited to, payroll costs, contractor costs, travel costs, laboratory costs, the costs incurred pursuant to Section XII (Access and Institutional Controls) (including, but not limited to, the cost of attorney time and any monies paid to secure access, including, but not limited to, the amount of just compensation), Paragraph 42 (emergency response), Paragraph 85 (Work takeover), community involvement (including, but not limited to, the costs of any technical assistance grant under Section 117(e) of CERCLA, 42 U.S.C. § 9617(e), and the costs incurred by the United States in enforcing the terms of this Settlement Agreement, including all costs incurred in connection with Section XV (Dispute Resolution), and all litigation costs.

"Institutional controls" shall mean non-engineered instruments, such as administrative and/or legal controls, that help to minimize the potential for human exposure to contamination and/or protect the integrity of a remedy by limiting land and/or resource use. Examples of institutional controls include easements and covenants, zoning restrictions, special building permit requirements, and well drilling prohibitions.

"Interest" shall mean interest at the rate specified for interest on investments of the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, compounded annually on October 1 of each year, in accordance with 42 U.S.C. § 9607(a). The applicable rate of interest shall be the rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year.

"Municipal solid waste" or "MSW" shall mean waste material: (1) generated by a household (including a single or multifamily residence); or (2) generated by a commercial, industrial or institutional entity, to the extent that the waste material (i) is essentially the same as waste normally generated by a household; (ii) is collected and disposed of with other municipal solid waste as part of normal municipal solid waste collection services; and (iii) contains a relative quantity of hazardous substances no greater than the relative quantity of hazardous substances contained in waste material generated by a typical single-family household.

"NCP" shall mean the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, codified at 40 C.F.R. Part 300, and any amendments thereto.

"North Basin" shall mean the northern portion of the Orange County Groundwater Basin, located in Orange County, California, and depicted generally on the map attached as Appendix A.

"North Basin Special Account" shall mean the special account, within the EPA Hazardous Substance Superfund, established for the North Basin Study Area by EPA pursuant to Section 122(b)(3) of CERCLA, 42 U.S.C. § 9622(b)(3).

"North Basin Study Area" or "Study Area" shall mean the area under investigation for the purposes of this Agreement.

"Paragraph" shall mean a portion of this Settlement Agreement identified by an Arabic numeral or an upper or lower case letter. References to paragraphs in the SOW will be so identified, e.g., "SOW Paragraph 15."

"Parties" shall mean EPA and OCWD.

"RCRA" shall mean the Resource Conservation and Recovery Act, also known as the Solid Waste Disposal Act, 42 U.S.C. §§ 6901-6992.

"Sampling and Analysis Plan" or "SAP" shall mean the Sampling and Analysis Plan presented either as a single work plan or two separate plans that that consist of the Quality Assurance and Project Plan (QAPP) and the Field Sampling Plan (FSP).

"Section" shall mean a portion of this Settlement Agreement identified by a Roman numeral. References to sections in the SOW will be so identified, e.g., "SOW Section V."

"Settlement Agreement" shall mean this Administrative Settlement Agreement, the SOW, all appendices attached hereto (listed in Section XXVI) and all documents incorporated by reference into this document including without limitation EPA-approved submissions. EPA-approved submissions (other than progress reports) are incorporated into and become a part of the Settlement Agreement upon approval by EPA. In the event of conflict between this Settlement Agreement and any appendix or other incorporated documents, this Settlement Agreement shall control.

"State" shall mean the State of California.

"Statement of Work" or "SOW" shall mean the Statement of Work for development of a RI/FS for the North Basin, as set forth in Appendix A to this Settlement Agreement. The Statement of Work is incorporated into this Settlement Agreement and is an enforceable part of this Settlement Agreement as are any modifications made thereto in accordance with this Settlement Agreement.

"United States" shall mean the United States of America and each department, agency, and instrumentality of the United States, including EPA.

"Waste Material" shall mean (a) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under Section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27).

"Work" shall mean all activities OCWD is required to perform under this Settlement Agreement, except those required by Section XIV (Retention of Records).

V. FINDINGS OF FACT

10. The North Basin is located in the northern portion of Orange County, in the cities of Fullerton, Anaheim, and Placentia. The larger Orange County groundwater basin, of which the North Basin is a part, is within the 360-square-mile coastal plain of Orange County and supplies water to more than 20 cities and water agencies serving more than 2 million customers. This area includes a range of uses including commercial, industrial, and residential uses.

11. The Orange County Water District has characterized the Orange County Groundwater Basin as consisting of three hydraulically connected aquifer zones: Shallow, Principal, and Deep. In North Basin, the Shallow Aquifer system includes unconsolidated sediments extending to an average depth of approximately 200 feet below ground surface (bgs) and the Principal Aquifer system contains unconsolidated sediments extending to a depth of over 1000 feet. The depth to groundwater in the shallow aquifer ranges from approximately 80 to 120 feet bgs, with isolated areas of shallower, perched groundwater. Contamination with volatile organic compounds (VOCs) has been detected in the Shallow and Principal aquifers, and locally in perched groundwater.

12. In 2014, EPA was approached by state and local agencies - RWQCB, DTSC, and OCWD - to investigate potential risk to the North Basin's domestic water supply in the Shallow and Principal aquifers.

13. There are many source areas in the North Basin where historical industrial activity has contaminated the soil and groundwater with chemicals, including tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), and 1,4-dioxane. The diverse array of industrial activities operating in this area includes electronics manufacturing, metals processing, aerospace manufacturing, musical instrument manufacturing, rubber and plastics manufacturing, and dry cleaning. Source cleanups are being conducted under State oversight at a number of current and former facilities. Some of these cleanups have been completed, and additional source identification and remediation at others may be required. During this RI/FS process, it is expected that State oversight of these cleanups will continue.

14. RWQCB is overseeing work and/or cleanup at six sites oversight of initial investigation and/or remediation work at two other sites. An additional six sites are being addressed under DTSC oversight. Three of the DTSC sites have active, participating parties, and threeare being cleaned up as "orphan sites"

15. Contamination associated with former industrial activity appears to have impacted both the shallow and principal aquifers. Four drinking water production wells impacted by contamination have been destroyed due to contaminant levels: Fullerton well F-FS13 (2002), Fullerton well F-KIM1 (2002), Anaheim well A-23 (2001) and private well BAST-F (2013).

16. Within the North Basin, 1,1-DCE has been detected in groundwater at concentrations up to 1,700 ug/L. PCE has been detected in groundwater at concentrations up to

3,300 ug/L. 1,4-dioxane has been detected in groundwater at concentrations up to 1,500 ug/L. TCE has been detected in groundwater at concentrations up to 23,000 ug/L.

17. OCWD is a special water district created by the State of California pursuant to the Orange County Water District Act. OCWD is a public entity undertaking the work described in this Settlement Agreement pursuant to its authority under said Act and to protect the water resources in Orange County, California; and

18. The North Basin is not listed on EPA's National Priorities List (NPL). In parallel with the RI/FS being conducted with this Agreement, EPA Region 9 is proceeding with its own evaluation of the contamination for potential NPL listing.

VI. CONCLUSIONS OF LAW AND DETERMINATIONS

Based on the Findings of Fact set forth in Section V, EPA has determined that:

19. The North Basin is a "facility" as defined in Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

20. The contamination found at the North Basin, as identified in the Findings of Fact above, includes "hazardous substances" as defined in Section 101(14) of CERCLA, 42 U.S.C. § 9601(14) or constitutes "any pollutant or contaminant" that may present an imminent and substantial danger to public health or welfare under Section 104(a)(1) of CERCLA.

21. The conditions described in the Findings of Fact in Section V above constitute an actual and/or threatened "release" of a hazardous substance from the facility as defined in Section 101(22) of CERCLA, 42 U.S.C. § 9601(22).

22. OCWD is a "person" as defined in Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

23. OCWD has been determined to be capable of conducting the actions set forth in this Agreement properly as provided in Section 122(a) of CERCLA, 42 U.S.C. § 9622(a). The actions required by this Settlement Agreement are necessary to protect the public health, welfare, or the environment, are in the public interest, 42 U.S.C. § 9622(a), are consistent with CERCLA and the NCP, 42 U.S.C. §§ 9604(a)(1), 9622(a), and will expedite effective remedial action and minimize litigation, 42 U.S.C. § 9622(a).

24. EPA has determined that OCWD is qualified to conduct the RI/FS within the meaning of Section 104(a) of CERCLA, 42 U.S.C. § 9604(a), and will carry out the Work properly and promptly, in accordance with Sections 104(a) and 122(a) of CERCLA, 42 U.S.C. §§ 9604(a) and 9622(a), if OCWD complies with the terms of this Settlement Agreement.

VII. SETTLEMENT AGREEMENT AND ORDER

25. Based upon the foregoing Findings of Fact and Conclusions of Law and Determinations, it is hereby Agreed that OCWD shall comply with all provisions of this Settlement Agreement, including, but not limited to, all appendices to this Settlement Agreement and all documents incorporated by reference into this Settlement Agreement.

VIII. DESIGNATION OF CONTRACTORS AND PROJECT COORDINATORS

26. Selection of Contractors, Personnel. All Work performed under this Settlement Agreement shall be under the direction and supervision of qualified personnel. Within 30 days after the Effective Date, and before the Work outlined below begins, OCWD shall notify EPA in writing of the names, titles, and qualifications of the personnel, including contractors, subcontractors, consultants, and laboratories to be used in carrying out such Work. With respect to any proposed contractor, OCWD shall demonstrate that the proposed contractor has a quality system that complies with ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs," (American National Standard, January 5, 1995, or most recent version), by submitting a copy of the proposed contractor's Quality Management Plan (QMP). The QMP should be prepared in accordance with "EPA Requirements for Quality Management Plans (QA/R-2)," (EPA/240/B-01/002, March 2001; Reissued May 2006) or equivalent documentation as determined by EPA. The qualifications of the persons undertaking the Work for OCWD shall be subject to EPA's review, for verification that such persons meet minimum technical background and experience requirements. This Settlement Agreement is contingent on OCWD's demonstration to EPA's satisfaction that OCWD is qualified to perform properly and promptly the actions set forth in this Settlement Agreement. If EPA disapproves in writing of any person's technical qualifications, OCWD shall notify EPA of the identity and qualifications of the replacements within 30 days after the written notice. If EPA subsequently disapproves of the replacement, EPA reserves the right to terminate this Settlement Agreement and to conduct a complete RI/FS, and to seek reimbursement for costs and penalties from OCWD. During the course of the RI/FS, OCWD shall notify EPA in writing of any changes or additions in the personnel used to carry out such Work, providing their names, titles, and qualifications. EPA shall have the same right to disapprove changes and additions to personnel as it has hereunder regarding the initial notification.

27. Within 14 days after the Effective Date, OCWD shall designate a Project Coordinator who shall be responsible for administration of all actions by OCWD required by this Settlement Agreement and shall submit to EPA the designated Project Coordinator's name, address, telephone number, and qualifications. To the greatest extent possible, the Project Coordinator shall be present on site or readily available during Work. EPA retains the right to disapprove of the designated Project Coordinator. If EPA disapproves of the designated Project Coordinator, OCWD shall retain a different Project Coordinator and shall notify EPA of that person's name, address, telephone number, and qualifications within 7 days following EPA's disapproval. OCWD shall have the right to change its Project Coordinator, subject to EPA's

right to disapprove. OCWD shall notify EPA 14 days before such a change is made. The initial notification may be made orally, but shall be promptly followed by a written notification. Receipt by OCWD's Project Coordinator of any notice or communication from EPA relating to this Settlement Agreement shall constitute receipt by OCWD.

28. EPA has designated Wayne Praskins of Region IX's Superfund Division as its Project Coordinator. EPA will notify OCWD of a change of its designated Project Coordinator. Except as otherwise provided in this Settlement Agreement, OCWD shall direct all submissions required by this Settlement Agreement to the Project Coordinator at US EPA Region IX, 75 Hawthorne Street, SFD-7-3, San Francisco, California, 94105, or Praskins.Wayne@epa.gov.

29. EPA's Project Coordinator shall have the authority lawfully vested in a Remedial Project Manager (RPM) and On-Scene Coordinator (OSC) by the NCP. In addition, EPA's Project Coordinator shall have the authority consistent with the NCP, to halt any Work required by this Settlement Agreement, and to take any necessary response action when s/he determines that conditions at the Study Area may present an immediate endangerment to public health or welfare or the environment. The absence of the EPA Project Coordinator from the area under study pursuant to this Settlement Agreement shall not be cause for the stoppage or delay of Work.

30. EPA shall arrange for a qualified person to assist in its oversight and review of the conduct of the RI/FS, as required by Section 104(a) of CERCLA, 42 U.S.C. § 9604(a). Such person shall have the authority to observe Work and make inquiries in the absence of EPA, but not to modify the RI/FS Work Plan.

IX. WORK TO BE PERFORMED

31. OCWD shall conduct the RI/FS in accordance with the provisions of this Settlement Agreement, the SOW, CERCLA, the NCP, and EPA guidance, including, but not limited to the "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (RI/FS Guidance) (OSWER Directive # 9355.3-01, October 1988 or subsequently issued guidance), "Guidance for Data Useability in Risk Assessment" (OSWER Directive #9285.7-09A, April 1992 or subsequently issued guidance), and guidance referenced therein, and guidance referenced in the SOW, as may be amended or modified by EPA. The Remedial Investigation (RI) shall consist of collecting data to characterize North Basin conditions, determining the nature and extent of the contamination at or from the North Basin, assessing risk to human health and the environment, and conducting treatability testing as necessary to evaluate the potential performance and cost of the treatment technologies that are being considered. The Feasibility Study (FS) shall determine and evaluate (based on treatability testing, where appropriate) alternatives for remedial action to prevent, mitigate, or otherwise respond to or remedy the release or threatened release of hazardous substances, pollutants, or contaminants at or from the North Basin. The alternatives evaluated must include, but shall not be limited to, the range of alternatives described in the NCP, and shall include remedial actions that utilize permanent solutions and alternative treatment technologies or resource recovery

technologies to the maximum extent practicable. In evaluating the alternatives, OCWD shall address the factors required to be taken into account by Section 121 of CERCLA, 42 U.S.C. § 9621, and Section 300.430(e) of the NCP, 40 C.F.R. § 300.430(e).

32. OCWD shall submit all deliverables to EPA and the State in electronic form. If any deliverable includes maps, drawings, or other exhibits that are larger than 8.5" by 11", upon request by EPA, OCWD shall also provide EPA with paper copies of such exhibits.

33. Technical Specifications for Deliverables. Sampling and monitoring data should be submitted in standard regional Electronic Data Deliverable (EDD) format. Other delivery methods may be allowed if electronic direct submission presents a significant burden or as technology changes.

34. Spatial data, including spatially-referenced data and geospatial data, should be submitted: (1) in the ESRI File Geodatabase format; and (2) as unprojected geographic coordinates in decimal degree format using North American Datum 1983 (NAD83) or World Geodetic System 1984 (WGS84) as the datum. If applicable, submissions should include the collection method(s). Projected coordinates may optionally be included but must be documented. Spatial data should be accompanied by metadata, and such metadata should be compliant with the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata and its EPA profile, the EPA Geospatial Metadata Technical Specification. An add-on metadata editor for ESRI software, the EPA Metadata Editor (EME), complies with these FGDC and EPA metadata requirements and is available at https://edg.epa.gov/EME/.

35. Each file must include an attribute name for each unit or sub-unit submitted. Consult http://www.epa.gov/geospatial/policies.html for any further available guidance on attribute identification and naming.

36. Spatial data submitted by OCWD does not, and is not intended to, define the boundaries of the North Basin.

37. Upon receipt of the draft FS report, EPA will evaluate, as necessary, the estimates of the risk to the public and environment that are expected to remain after a particular remedial alternative has been completed and will evaluate the durability, reliability, and effectiveness of any proposed Institutional Controls.

38. Modification of the RI/FS Work Plan.

a. If at any time during the RI/FS process, OCWD identifies a need for additional data, OCWD shall submit a memorandum documenting the need for additional data to the EPA Project Coordinator within 14 days after identification. EPA in its discretion will determine whether the additional data will be collected by OCWD and whether it will be incorporated into plans, reports, and other deliverables.

b. In the event of unanticipated or changed circumstances in the Study Area, OCWD shall notify the EPA Project Coordinator by telephone within 24 hours of discovery of the unanticipated or changed circumstances. In the event that EPA determines that the unanticipated or changed circumstances warrant changes in the RI/FS Work Plan, EPA shall modify or amend the RI/FS Work Plan in writing accordingly. OCWD shall perform the RI/FS Work Plan as modified or amended.

c. EPA may determine that in addition to tasks defined in the initially approved RI/FS Work Plan, other additional Work may be necessary to accomplish the objectives of the RI/FS. OCWD agrees to perform these response actions in addition to those required by the initially approved RI/FS Work Plan, including any approved modifications, if EPA determines that such actions are necessary for a complete RI/FS.

d. OCWD shall confirm its willingness to perform the additional Work, in writing to EPA within 30 days after receipt of the EPA request. If OCWD objects to any modification determined by EPA to be necessary pursuant to this Paragraph, OCWD may seek dispute resolution pursuant to Section XV (Dispute Resolution). The SOW and/or RI/FS Work Plan shall be modified in accordance with the final resolution of the dispute.

e. OCWD shall complete the additional Work according to the standards, specifications, and schedule set forth or approved by EPA in a written modification to the RI/FS Work Plan or written RI/FS Work Plan supplement. EPA reserves the right to conduct the Work itself at any point, to seek reimbursement from OCWD, and/or to seek any other appropriate relief.

f. Nothing in this Paragraph shall be construed to limit EPA's authority to require performance of further response actions in the Study Area.

39. Off-Site Shipment.

a. OCWD may ship hazardous substances, pollutants and contaminants from the Study Area to an off-site facility only if they comply with Section 121(d)(3) of CERCLA, 42 U.S.C. § 9621(d)(3), and 40 C.F.R. § 300.440. OCWD will be deemed to be in compliance with CERCLA Section 121(d)(3) and 40 C.F.R. § 300.440 regarding a shipment if OCWD obtains a prior determination from EPA that the proposed receiving facility for such shipment is acceptable under the criteria of 40 C.F.R. § 300.440(b). OCWD may ship Investigation Derived Waste (IDW) from the North Basin to an off-site facility only if OCWD complies with EPA's "Guide to Management of Investigation Derived Waste," OSWER 9345.3-03FS (Jan. 1992).

b. OCWD may ship Waste Material from the North Basin to an out-of-state waste management facility only if, prior to any shipment, it provides written notice to the appropriate state environmental official in the receiving facility's state and to the EPA Project Coordinator. This written notice requirement shall not apply to any off-site shipments when the total quantity of all such shipments will not exceed ten cubic yards. The written notice must

include the following information, if available: (1) the name and location of the receiving facility; (2) the type and quantity of Waste Material to be shipped; (3) the schedule for the shipment; and (4) the method of transportation. OCWD also shall notify the state environmental official referenced above and the EPA Project Coordinator of any major changes in the shipment plan, such as a decision to ship the Waste Material to a different out-of-state facility. OCWD shall provide the written notice after the award of the contract for remedial investigation and feasibility study and before the Waste Material is shipped.

40. Meetings. OCWD shall make presentations at, and participate in, meetings at the request of EPA during the initiation, conduct, and completion of the RI/FS. In addition to discussion of the technical aspects of the RI/FS, topics will include anticipated problems or new issues. Meetings will be scheduled at EPA's discretion.

41. Progress Reports. In addition to the plans, reports, and other deliverables set forth in this Settlement Agreement, OCWD shall provide to EPA monthly progress reports by the 15th day of the following month. At a minimum, with respect to the preceding month, these progress reports shall (a) describe the actions that have been taken to comply with this Settlement Agreement during that month, (b) include all results of sampling and tests and all other data received by OCWD, (c) describe Work planned for the next two months with schedules relating such Work to the overall project schedule for RI/FS completion, and (d) describe all problems encountered and any anticipated problems, any actual or anticipated delays, and solutions developed and implemented to address any actual or anticipated problems or delays.

42. Emergency Response and Notification of Releases.

a. In the event of any action or occurrence during, arising from, or relating to performance of the Work that causes or threatens a release of Waste Material from the Study Area that constitutes an emergency situation or may present an immediate threat to public health or welfare or the environment, OCWD shall immediately take all appropriate action. OCWD shall take these actions in accordance with all applicable provisions of this Settlement Agreement, including, but not limited to, the Health and Safety Plan, in order to prevent, abate or minimize such release or endangerment caused or threatened by the release. OCWD shall also immediately notify the EPA Project Coordinator or, in the event of his/her unavailability, the OSC or the Regional Duty Officer at (415) 947-4400 of the incident or conditions. In the event that OCWD fails to take appropriate response action as required by this Paragraph, and EPA takes such action instead, OCWD shall reimburse EPA all costs of the response action not inconsistent with the NCP pursuant to Section XVIII (Payment of Response Costs).

b. In addition, in the event of any release of a hazardous substance from the Study Area, OCWD shall immediately notify the EPA Project Coordinator, the OSC, or Regional Duty Officer at (415) 947-4400 and the National Response Center at (800) 424-8802. OCWD shall submit a written report to EPA within 7 days after each release, setting forth the events that occurred and the measures taken or to be taken to mitigate any release or endangerment caused or threatened by the release and to prevent the reoccurrence of such a release. This reporting

requirement is in addition to, and not in lieu of, reporting under Section 103(c) of CERCLA, 42 U.S.C. § 9603(c), and Section 304 of the Emergency Planning and Community Right-To-Know Act of 1986, 42 U.S.C. § 11004, *et seq*.

X. EPA APPROVAL OF PLANS AND OTHER SUBMISSIONS

43. After review of any plan, report, or other item that is required to be submitted for approval pursuant to this Settlement Agreement, in a notice to OCWD, EPA shall: (a) approve, in whole or in part, the submission; (b) approve the submission upon specified conditions; (c) modify the submission to cure the deficiencies; (d) disapprove, in whole or in part, the submission, directing that OCWD modify the submission; or (e) any combination of the above. However, EPA shall not modify a submission without first providing OCWD at least one notice of deficiency and an opportunity to cure within 14 days, except where to do so would cause serious disruption to the Work or where previous submission(s) have been disapproved due to material defects.

44. In the event of approval, approval upon conditions, or modification by EPA, pursuant to Paragraph 43.a, 43.b, 43.c, or 43.e, OCWD shall proceed to take any action required by the plan, report, or other deliverable, as approved or modified by EPA subject only to its right to invoke the Dispute Resolution procedures set forth in Section XV (Dispute Resolution) with respect to the modifications or conditions made by EPA. Following EPA approval or modification of a submission or portion thereof, OCWD shall not thereafter alter or amend such submission or portion thereof unless directed by EPA. In the event that EPA modifies the submission to cure the deficiencies pursuant to Paragraph 43.c and the submission had a material defect, EPA retains the right to seek stipulated penalties, as provided in Section XVI (Stipulated Penalties).

45. Resubmission.

a. Upon receipt of a notice of disapproval, OCWD shall, within 30 days or such longer time as specified by EPA in such notice, correct the deficiencies and resubmit the plan, report, or other deliverable for approval. Any stipulated penalties applicable to the submission, as provided in Section XVI, shall accrue during the 14-day period or otherwise specified period but shall not be payable unless the resubmission is disapproved or modified due to a material defect as provided in Paragraphs 46 and 47, respectively. Notwithstanding the receipt of a notice of disapproval, OCWD shall proceed to take any action required by any non-deficient portion of the submission, unless otherwise directed by EPA. Implementation of any non-deficient portion of a submission shall not relieve OCWD of any liability for stipulated penalties under Section XVI (Stipulated Penalties).

b. OCWD shall not proceed with any activities or tasks dependent on the following deliverables until receiving EPA approval, approval on condition, or modification of such deliverables: RI/FS Work Plan and Sampling and Analysis Plan, Groundwater Flow Modeling Plan, Groundwater Flow Monitoring Report, Risk Assessment Technical

Memorandum, ARARs Technical Memorandum, Remedial Investigation Report and Treatability Testing Work Plan, Treatability Testing Sampling and Analysis Plan, Treatability Testing Health and Safety Plan, Remedial Alternatives Identification and Screening Technical Memorandum, Detailed Analysis of Remedial Alternatives Technical Memorandum, and Feasibility Study Report. While awaiting EPA approval, approval on condition, or modification of these deliverables, OCWD shall proceed with all other tasks and activities that may be conducted independently of these deliverables, in accordance with the schedule set forth under this Settlement Agreement.

c. For all remaining deliverables not listed above in Paragraph 45.b, OCWD shall proceed will all subsequent tasks, activities, and deliverables without awaiting EPA approval on the submitted deliverable. EPA reserves the right to stop OCWD from proceeding further, either temporarily or permanently, on any task, activity or deliverable at any point during the RI/FS.

46. If EPA disapproves a resubmitted plan, report, or other deliverable, or portion thereof, EPA may again direct OCWD to correct the deficiencies. EPA shall also retain the right to modify or develop the plan, report, or other deliverable. OCWD shall implement any such plan, report, or deliverable as corrected, modified, or developed by EPA, subject only to OCWD's right to invoke the procedures set forth in Section XV (Dispute Resolution).

47. If upon resubmission, a plan, report, or other deliverable is disapproved or modified by EPA due to a material defect, OCWD shall be deemed to have failed to submit such plan, report, or other deliverable timely and adequately unless OCWD invokes the dispute resolution procedures in accordance with Section XV (Dispute Resolution) and EPA's action is revoked or substantially modified pursuant to a Dispute Resolution decision issued by EPA or superseded by an agreement reached pursuant to that Section. The provisions of Section XV (Dispute Resolution) shall govern the implementation of the Work and accrual and payment of any stipulated penalties during Dispute Resolution.

48. In the event that EPA takes over some of the tasks, but not the preparation of the RI Report or the FS Report, OCWD shall incorporate and integrate information supplied by EPA into the final reports.

49. All plans, reports, and other deliverables submitted to EPA under this Settlement Agreement shall, upon approval or modification by EPA, be incorporated into and enforceable under this Settlement Agreement. In the event EPA approves or modifies a portion of a plan, report, or other deliverable submitted to EPA under this Settlement Agreement, the approved or modified portion shall be incorporated into and enforceable under this Settlement Agreement.

50. Neither failure of EPA to expressly approve or disapprove of OCWD's submissions within a specified time period, nor the absence of comments, shall be construed as approval by EPA. Whether or not EPA gives express approval for OCWD's deliverables, OCWD is responsible for preparing deliverables acceptable to EPA.

XI. QUALITY ASSURANCE, SAMPLING, AND ACCESS TO INFORMATION

51. Quality Assurance. OCWD shall assure that Work performed, samples taken, and analyses conducted conform to the requirements of the SOW, the Sampling and Analysis Plan (SAP), and guidance identified therein. OCWD will assure that field personnel used by OCWD are properly trained in the use of field equipment and in chain of custody procedures. OCWD shall only use laboratories that have a documented quality system that complies with "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01/002, March 2001; Reissued May 2006) or equivalent documentation as determined by EPA.

52. Sampling.

a. All results of sampling, tests, modeling, or other data (including raw data) generated by OCWD, or on OCWD's behalf, during the period that this Settlement Agreement is effective, shall be submitted to EPA in the next monthly progress report as described in Paragraph 41 (unless previously submitted in a separate document). EPA will make available to OCWD validated data generated by EPA unless it is exempt from disclosure by any federal or state law or regulation.

b. OCWD shall orally notify EPA and the State at least 14 days prior to conducting significant field events as described in the SOW, RI/FS Work Plan, or Sampling and Analysis Plan. At EPA's oral or written request, or the request of EPA's oversight assistant, OCWD shall allow split or duplicate samples to be taken by EPA (and its authorized representatives) or the State of any samples collected in implementing this Settlement Agreement. All split samples of OCWD shall be analyzed by the methods identified in the QAPP.

53. Access to Information.

a. OCWD shall make available to EPA and the State, copies of all records, reports, documents, and other information (including records, reports, documents, and other information in electronic form) (hereinafter referred to as Records) within its possession or control or that of its contractors or agents relating to activities at the Study Area or to the implementation of this Settlement Agreement, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence, or other documents or information related to the Work. OCWD shall also make available to EPA and the State, for purposes of investigation, information gathering, or testimony, its employees, agents, or representatives with knowledge of relevant facts concerning the performance of the Work.

b. OCWD may assert business confidentiality claims covering part or all of the Records submitted to EPA and the State under this Settlement Agreement to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. § 9604(e)(7), and 40 C.F.R. § 2.203(b). Records determined to be confidential by EPA will be afforded the

protection specified in 40 C.F.R. Part 2, Subpart B. If no claim of confidentiality accompanies Records when they are submitted to EPA and the State, or if EPA has notified OCWD that the Records are not confidential under the standards of Section 104(e)(7) of CERCLA or 40 C.F.R. Part 2, Subpart B, the public may be given access to such Records without further notice to OCWD. OCWD shall segregate and clearly identify all Records submitted under this Settlement Agreement for which OCWD asserts confidentiality claims.

c. OCWD may assert that certain Records are privileged under the attorney-client privilege or any other privilege recognized by federal law. If OCWD asserts such a privilege in lieu of providing Records, it shall provide EPA and the State with the following: (i) the title of the Record; (ii) the date of the Record; (iii) the name, title, affiliation (e.g., company or firm), and address of the author of the Record; (iv) the name and title of each addressee and recipient; (v) a description of the contents of the Record; and (vi) the privilege asserted by OCWD. However, no Records created or generated pursuant to the requirements of this Settlement Agreement shall be withheld on the grounds that they are privileged or confidential.

d. No claim of confidentiality shall be made with respect to any data, including, but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, or engineering data, or any other Records evidencing conditions at or around the Study Area.

54. In entering into this Settlement Agreement, OCWD waives any objections to any data gathered, generated, or evaluated by EPA, the State or OCWD in the performance or oversight of the Work that has been verified according to the quality assurance/quality control (QA/QC) procedures required by the Settlement Agreement or any EPA-approved RI/FS Work Plans or Sampling and Analysis Plans. If OCWD objects to any other data relating to the RI/FS, OCWD shall submit to EPA a report that specifically identifies and explains its objections, describes the acceptable uses of the data, if any, and identifies any limitations to the use of the data. The report must be submitted to EPA within 15 days after submittal of the document containing the data.

XII. ACCESS AND INSTITUTIONAL CONTROLS

55. If any property where access is needed to implement this Settlement Agreement, is owned or controlled by OCWD, OCWD shall, commencing on the Effective Date, provide EPA, the State, and their representatives, including contractors, with access at all reasonable times to such property for the purpose of conducting any activity related to this Settlement Agreement.

56. Where any action under this Settlement Agreement is to be performed in areas owned by or in possession of someone other than OCWD, OCWD shall use its best efforts to obtain all necessary access agreements within 30 days after the Effective Date, or as otherwise specified in writing by the EPA Project Coordinator. OCWD shall immediately notify EPA if

after using its best efforts they are unable to obtain such agreements. For purposes of this Paragraph, "best efforts" includes the payment of reasonable sums of money in consideration of access. OCWD shall describe in writing its efforts to obtain access. If OCWD cannot obtain access agreements, EPA may either (a) obtain access for OCWD or assist OCWD in gaining access, to the extent necessary to effectuate the response actions described in this Settlement Agreement, using such means as EPA deems appropriate; (b) perform those tasks or activities with EPA contractors; or (c) terminate the Settlement Agreement.

57. Notwithstanding any provision of this Settlement Agreement, EPA retains all of its access authorities and rights as well as all of its rights to require land/water use restrictions, including enforcement authorities related thereto, under CERCLA, RCRA, and any other applicable statutes or regulations.

XIII. COMPLIANCE WITH OTHER LAWS

58. OCWD shall comply with all applicable state and federal laws and regulations when performing the RI/FS. No local, state, or federal permit shall be required for any portion of any action conducted entirely on-site, including studies, if the action is selected and carried out in compliance with Section 121 of CERCLA, 42 U.S.C. § 9621. Where any portion of the Work is to be conducted off-site and requires a federal or state permit or approval, OCWD shall submit timely and complete applications and take all other actions necessary to obtain and to comply with all such permits or approvals. This Settlement Agreement is not, and shall not be construed to be, a permit issued pursuant to any federal or state statute or regulation.

XIV. RETENTION OF RECORDS

59. During the pendency of this Settlement Agreement and for a minimum of 10 years after commencement of construction of any remedial action, OCWD shall preserve and retain all non-identical copies of Records (including Records in electronic form) now in its possession or control or that come into its possession or control that relate in any manner to the performance of the Work or the liability of any person under CERCLA with respect to the North Basin, regardless of any corporate retention policy to the contrary. Until 10 years after commencement of construction of any remedial action, OCWD shall also instruct its contractors and agents to preserve all Records of whatever kind, nature, or description relating to performance of the Work.

60. At the conclusion of this document retention period, OCWD shall notify EPA at least 90 days prior to the destruction of any such Records, and, upon request by EPA, OCWD shall deliver any such Records to EPA. OCWD may assert that certain Records are privileged under the attorney-client privilege or any other privilege recognized by federal law. If OCWD asserts such a privilege, it shall provide EPA with the following: (a) the title of the Record; (b) the date of the Record; (c) the name and title of the author of the Record; (d) the name and title of each addressee and recipient; (d) a description of the subject of the Record; and (f) the privilege asserted by OCWD. However, no Records created or generated pursuant to the

requirements of this Settlement Agreement shall be withheld on the grounds that they are privileged or confidential.

61. OCWD hereby certifies that to the best of its knowledge and belief, after thorough inquiry, it has not altered, mutilated, discarded, destroyed, or otherwise disposed of any Records (other than identical copies) relating to the North Basin since the issuance of the invitation letter by EPA regarding this Settlement Agreement and the SOW for the RI/FS for the North Basin and that it has fully complied with any and all EPA and State requests for information regarding the North Basin pursuant to Sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e), and Section 3007 of RCRA, 42 U.S.C. § 6927, and state law.

XV. DISPUTE RESOLUTION

62. Unless otherwise expressly provided for in this Settlement Agreement, the dispute resolution procedures of this Section shall be the exclusive mechanism for resolving disputes arising under this Settlement Agreement. The Parties shall attempt to resolve any disagreements concerning this Settlement Agreement expeditiously and informally.

63. If OCWD objects to any EPA action taken pursuant to this Settlement Agreement, including billings for Future Response Costs, it shall notify EPA in writing of its objection(s) within 15 days after such action, unless the objection(s) has/have been resolved informally. EPA and OCWD shall have 60 days from EPA's receipt of OCWD's written objection(s) to resolve the dispute (the Negotiation Period). The Negotiation Period may be extended at the sole discretion of EPA. Such extension may be granted orally but must be confirmed in writing.

64. Any agreement reached by the Parties pursuant to this Section shall be in writing and shall, upon signature by the Parties, be incorporated into and become an enforceable part of this Settlement Agreement. If the Parties are unable to reach an agreement within the Negotiation Period, an EPA management official at the Assistant Director level or higher will issue a written decision. EPA's decision shall be incorporated into and become an enforceable part of this Settlement Agreement. OCWD's obligations under this Settlement Agreement shall not be tolled by submission of any objection for dispute resolution under this Section. Following resolution of the dispute, as provided by this Section, OCWD shall fulfill the requirement that was the subject of the dispute in accordance with the agreement reached or with EPA's decision, whichever occurs, and regardless of whether OCWD agrees with the decision.

XVI. STIPULATED PENALTIES

65. OCWD shall be liable to EPA for stipulated penalties in the amounts set forth in Paragraphs 66 and 67 for failure to comply with any of the requirements of this Settlement Agreement specified below unless excused under Section XVI (Force Majeure). "Compliance" by OCWD shall include completion of the Work under this Settlement Agreement or any activities contemplated under any RI/FS Work Plan or other plan approved under this Settlement Agreement identified below, in accordance with all applicable requirements of law, this

Settlement Agreement, the SOW, and any plans or other documents approved by EPA pursuant to this Settlement Agreement and within the specified time schedules established by and approved under this Settlement Agreement.

66. Stipulated Penalty Amounts - Work (Including Payments).

a. The following stipulated penalties shall accrue per day for any noncompliance identified in Paragraph 66.b:

Penalty Per Violation Per Day	Period of Noncompliance
$ 100	1st through 14th day
$ 300	15th through 30th day
$ 750	31st day and beyond

b. Compliance Milestones.

(1) Payment of Future Response Costs

(2) Submittal of Draft and Final RI/FS Work Plan (SOW Section 3.1)

(3) Submittal of Draft and Final Field Sampling and Analysis Plan (SOW Section 3.2.1)

(4) Submittal of Draft and Final Groundwater Flow Modeling Report (SOW Sections 3.4, 3.5, and 3.6)

(5) Submittal of Risk Assessment Technical Memorandum (SOW Section 3.11)

(6) Submittal of Draft and Final RI Report (SOW Section 3.7)

(7) Submittal of Remedial Alternatives Technical Memoranda (SOW Sections 3.8 and 3.9)

(8) Submittal of Draft and Final FS Report (SOW Section 3.12)

67. Stipulated Penalty Amounts - Reports.

The following stipulated penalties shall accrue per violation per day for failure to submit timely or adequate reports or other plans or deliverables, other than those referenced in Paragraph 66.b., pursuant to this Settlement Agreement:

Penalty Per Violation Per Day	Period of Noncompliance
$ 250	1st through 14th day
$ 500	15th through 30th day
$ 1,000	31st day and beyond

68. In the event that EPA assumes performance of a portion or all of the Work pursuant to Paragraph 85 (Work Takeover), Respondents shall be liable for a stipulated penalty in the amount of $50,000.

69. All penalties shall begin to accrue on the day after the complete performance is due or the day a violation occurs and shall continue to accrue through the final day of the correction of the noncompliance or completion of the activity. However, stipulated penalties shall not accrue: (a) with respect to a deficient submission under Section X (EPA Approval of Plans and Other Submissions), during the period, if any, beginning on the 31st day after EPA's receipt of such submission until the date that EPA notifies OCWD of any deficiency; and (b) with respect to a decision by the EPA management official designated in Paragraph 64 of Section XV (Dispute Resolution), during the period, if any, beginning on the 21st day after the Negotiation Period begins until the date that the EPA management official issues a final decision regarding such dispute. Nothing in this Settlement Agreement shall prevent the simultaneous accrual of separate penalties for separate violations of this Settlement Agreement.

70. Following EPA's determination that OCWD has failed to comply with a requirement of this Settlement Agreement, EPA may give OCWD written notification of the same and describe the noncompliance. EPA may send OCWD a written demand for the payment of the penalties. However, penalties shall accrue as provided in the preceding Paragraph regardless of whether EPA has notified OCWD of a violation.

71. All penalties accruing under this Section shall be due and payable to EPA within 30 days after OCWD's receipt from EPA of a demand for payment of the penalties, unless OCWD invokes the dispute resolution procedures under Section XV (Dispute Resolution). OCWD shall make all payments required by this Paragraph to EPA by Fedwire Electronic Funds Transfer to:

Federal Reserve Bank of New York
ABA = 021030004
Account = 68010727
SWIFT address = FRNYUS33
33 Liberty Street
New York NY 10045
Field Tag 4200 of the Fedwire message should read "D 68010727 Environmental Protection Agency"

and shall reference stipulated penalties, Site/Spill ID Number A9AN, and the EPA docket number for this action. At the time of payment, OCWD shall send notice that payment has been made as provided in Paragraph 79.b below.

72. The payment of penalties shall not alter in any way OCWD's obligation to complete performance of the Work required under this Settlement Agreement.

73. Penalties shall continue to accrue as provided in Paragraph 69 during any dispute resolution period, but need not be paid until 15 days after the dispute is resolved by agreement or by receipt of EPA's decision.

74. If OCWD fails to pay stipulated penalties when due, EPA may institute proceedings to collect the penalties, as well as Interest. OCWD shall pay Interest on the unpaid balance, which shall begin to accrue on the date of demand made pursuant to Paragraph 71.

75. Nothing in this Settlement Agreement shall be construed as prohibiting, altering, or in any way limiting the ability of EPA to seek any other remedies or sanctions available by virtue of OCWD's violation of this Settlement Agreement or of the statutes and regulations upon which it is based, including, but not limited to, penalties pursuant to Section 122(*l*) of CERCLA, 42 U.S.C. § 9622(*l*), and punitive damages pursuant to Section 107(c)(3) of CERCLA, 42 U.S.C. § 9607(c)(3). Provided, however, that EPA shall not seek civil penalties pursuant to Section 122(*l*) of CERCLA or punitive damages pursuant to Section 107(c)(3) of CERCLA for any violation for which a stipulated penalty is provided in this Settlement Agreement, except in the case of willful violation of this Settlement Agreement or in the event that EPA assumes performance of a portion or all of the Work pursuant to Section XX (Reservation of Rights by EPA), Paragraph 85. Notwithstanding any other provision of this Section, EPA may, in its unreviewable discretion, waive any portion of stipulated penalties that have accrued pursuant to this Settlement Agreement.

XVII. FORCE MAJEURE

76. OCWD agrees to perform all requirements of this Settlement Agreement within the time limits established under this Settlement Agreement, unless the performance is delayed by a *force majeure*. For purposes of this Settlement Agreement, *force majeure* is defined as any event arising from causes beyond the control of OCWD or of any entity controlled by OCWD, including but not limited to its contractors and subcontractors, which delays or prevents performance of any obligation under this Settlement Agreement despite OCWD's best efforts to fulfill the obligation. *Force majeure* does not include financial inability to complete the Work or increased cost of performance.

77. If any event occurs or has occurred that may delay the performance of any obligation under this Settlement Agreement, whether or not caused by a *force majeure* event, OCWD shall notify EPA orally within five (5) business days of when OCWD first knew that the event might cause a delay. Within seven (7) days thereafter, OCWD shall provide to EPA in

writing an explanation and description of the reasons for the delay; the anticipated duration of the delay; all actions taken or to be taken to prevent or minimize the delay; a schedule for implementation of any measures to be taken to prevent or mitigate the delay or the effect of the delay; OCWD's rationale for attributing such delay to a *force majeure* event if it intends to assert such a claim; and a statement as to whether, in the opinion of OCWD, such event may cause or contribute to an endangerment to public health, welfare, or the environment. Failure to comply with the above requirements shall preclude OCWD from asserting any claim of *force majeure* for that event for the period of time of such failure to comply and for any additional delay caused by such failure.

78. If EPA agrees that the delay or anticipated delay is attributable to a *force majeure* event, the time for performance of the obligations under this Settlement Agreement that are affected by the *force majeure* event will be extended by EPA for such time as is necessary to complete those obligations. An extension of the time for performance of the obligations affected by the *force majeure* event shall not, of itself, extend the time for performance of any other obligation. If EPA does not agree that the delay or anticipated delay has been or will be caused by a *force majeure* event, EPA will notify OCWD in writing of its decision. If EPA agrees that the delay is attributable to a *force majeure* event, EPA will notify OCWD in writing of the length of the extension, if any, for performance of the obligations affected by the *force majeure* event.

XVIII. PAYMENT OF RESPONSE COSTS

79. Payments of Future Response Costs.

a. OCWD shall pay EPA all Future Response Costs not inconsistent with the NCP. On a periodic basis, EPA will send OCWD a bill requiring payment that includes a Regional SCORPIOS cost summary, which includes direct and indirect costs incurred by EPA, its contractors, and DOJ. OCWD shall make all payments within 30 days after receipt of each bill requiring payment, except as otherwise provided in Paragraph 81 of this Settlement Agreement. Payments shall be made to EPA by Fedwire Electronic Funds Transfer ("EFT") to:

Federal Reserve Bank of New York
ABA = 021030004
Account = 68010727
SWIFT address = FRNYUS33
33 Liberty Street
New York NY 10045
Field Tag 4200 of the Fedwire message should read "D 68010727 Environmental Protection Agency"

and shall reference Site/Spill ID Number A9AN and the EPA docket number for this action.

b. At the time of payment, OCWD shall send notice that payment has been made to Wayne Praskins by email at Praskins.Wayne@epa.gov, and to the EPA Cincinnati Finance Center by email at cinwd_acctsreceivable@epa.gov, or by mail to

EPA Cincinnati Finance Office
26 W. Martin Luther King Drive
Cincinnati, Ohio 45268

Such notice shall reference Site/Spill ID Number A9AN and the EPA docket number for this action.

c. The total amount to be paid by OCWD pursuant to Paragraph 79.a shall be deposited by EPA in the North Basin Special Account to be retained and used to conduct or finance response actions at or in connection with the North Basin, or to be transferred by EPA to the EPA Hazardous Substance Superfund, provided, however, that EPA may deposit a Future Response Costs payment directly into the EPA Hazardous Substance Superfund if, at the time the payment is received, EPA estimates that the North Basin Special Account balance is sufficient to address currently anticipated future response actions to be conducted or financed by EPA at or in connection with the North Basin. Any decision by EPA to deposit a Future Response Costs payment directly into the EPA Hazardous Substance Superfund for this reason shall not be subject to challenge by OCWD pursuant to the dispute resolution provisions of this Settlement or in any other forum.

80. Interest. If OCWD does not pay Future Response Costs within 30 days after OCWD's receipt of a bill, OCWD shall pay Interest on the unpaid balance. The Interest unpaid Future Response Costs shall begin to accrue on the date of the bill and shall continue to accrue until the date of payment. If EPA receives a partial payment, Interest shall accrue on any unpaid balance. Payments of Interest made under this Paragraph shall be in addition to such other remedies or sanctions available to the United States by virtue of OCWD's failure to make timely payments under this Section. OCWD shall make all payments required by this Paragraph in the manner described in Paragraph 79.

81. OCWD may contest payment of any costs billed under Paragraph 79 if it determines that EPA has made a mathematical error or included a cost item that is not within the definition of Future Response Costs, or if it believes EPA incurred excess costs as a direct result of an EPA action that was inconsistent with a specific provision or provisions of the NCP. Such objection shall be made in writing within 30 days after receipt of the bill and must be sent to the EPA Project Coordinator. Any such objection shall specifically identify the contested Future Response Costs and the basis for objection. In the event of an objection, OCWD shall within the 30 day period pay all uncontested Future Response Costs to EPA in the manner described in Paragraph 79. Simultaneously, OCWD shall establish, in a duly chartered bank or trust company, an interest-bearing escrow account that is insured by the Federal Deposit Insurance Corporation, and remit to that escrow account funds equivalent to the amount of the contested Future Response Costs. OCWD shall send to the EPA Project Coordinator a copy of the

transmittal letter and check paying the uncontested Future Response Costs, and a copy of the correspondence that establishes and funds the escrow account, including, but not limited to, information containing the identity of the bank and bank account under which the escrow account is established as well as a bank statement showing the initial balance of the escrow account. Simultaneously with establishment of the escrow account, OCWD shall initiate the Dispute Resolution procedures in Section XV (Dispute Resolution). If EPA prevails in the dispute, within 5 days after the resolution of the dispute, OCWD shall pay the sums due (with accrued interest) to EPA in the manner described in Paragraph 79. If OCWD prevails concerning any aspect of the contested costs, OCWD shall pay that portion of the costs (plus associated accrued interest) for which it did not prevail to EPA in the manner described in Paragraph 79. OCWD shall be disbursed any balance of the escrow account. The dispute resolution procedures set forth in this Paragraph in conjunction with the procedures set forth in Section XV (Dispute Resolution) shall be the exclusive mechanisms for resolving disputes regarding OCWD's obligation to reimburse EPA for its Future Response Costs. Nothing herein limits the ability of the State to seek reimbursement of its costs related to ongoing oversight of investigations and cleanups at facilities within the Study Area or to seek reimbursement of costs related to activities performed under this Settlement Agreement.

XIX. COVENANT NOT TO SUE BY EPA

82. In consideration of the actions that will be performed and the payments that will be made by OCWD under the terms of this Settlement Agreement, and except as otherwise specifically provided in this Settlement Agreement, EPA covenants not to sue or to take any administrative action against OCWD pursuant to Sections 106 and 107(a) of CERCLA, 42 U.S.C. §§ 9606 and 9607(a), for the Work, Past Response Costs, and Future Response Costs. This covenant not to sue shall take effect upon the Effective Date. This covenant not to sue is conditioned upon the complete and satisfactory performance by OCWD of its obligations under this Settlement Agreement, including, but not limited to, payment of Future Response Costs pursuant to Paragraph 79 (Payment of Future Response Costs). This covenant not to sue extends only to OCWD and does not extend to any other person.

XX. RESERVATIONS OF RIGHTS BY EPA

83. Except as specifically provided in this Settlement Agreement, nothing in this Settlement Agreement shall limit the power and authority of EPA or the United States to take, direct, or order all actions necessary to protect public health, welfare, or the environment or to prevent, abate, or minimize an actual or threatened release of hazardous substances, pollutants, or contaminants, or hazardous or solid waste on, at, or from the Study Area. Further, nothing in this Settlement Agreement shall prevent EPA from seeking legal or equitable relief to enforce the terms of this Settlement Agreement, from taking other legal or equitable action as it deems appropriate and necessary, or from requiring OCWD or any other person in the future to perform additional activities pursuant to CERCLA or any other applicable law.

84. The covenant not to sue set forth in Section XIX above does not pertain to any matters other than those expressly identified therein. EPA reserves, and this Settlement Agreement is without prejudice to, all rights against OCWD with respect to all other matters, including, but not limited to:

a. liability for failure by OCWD to meet a requirement of this Settlement Agreement;

b. liability for costs not included within the definitions of Past Response Costs or Future Response Costs;

c. liability for performance of response action other than the Work;

d. criminal liability;

e. liability for violations of federal or state law that occur during or after implementation of the Work;

f. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments;

g. liability arising from the past, present, or future disposal, release or threat of release of Waste Materials outside of the North Basin; and

h. liability for costs incurred or to be incurred by the Agency for Toxic Substances and Disease Registry related to the North Basin not paid as Future Response Costs under this Settlement Agreement.

85. Work Takeover. In the event EPA determines that OCWD has ceased implementation of any portion of the Work, are seriously or repeatedly deficient or late in its performance of the Work, or are implementing the Work in a manner that may cause an endangerment to human health or the environment, EPA may assume the performance of all or any portion of the Work as EPA determines necessary. OCWD may invoke the procedures set forth in Section XV (Dispute Resolution) to dispute EPA's determination that takeover of the Work is warranted under this Paragraph. Notwithstanding any other provision of this Settlement Agreement, EPA retains all authority and reserves all rights to take any and all response actions authorized by law.

XXI. COVENANT NOT TO SUE BY OCWD

86. OCWD covenants not to sue and agree not to assert any claims or causes of action against the United States, or its contractors or employees, with respect to the Work, Past Response Costs, Future Response Costs, or this Settlement Agreement, including, but not limited to:

a. any direct or indirect claim for reimbursement from the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, based on Sections 106(b)(2), 107, 111, 112, or 113 of CERCLA, 42 U.S.C. §§ 9606(b)(2), 9607, 9611, 9612, or 9613, or any other provision of law;

b. any claim arising out of the Work or arising out of the response actions for which the Past Response Costs or Future Response Costs have or will be incurred, including any claim under the United States Constitution, the State Constitution, the Tucker Act, 28 U.S.C. § 1491, the Equal Access to Justice Act, 28 U.S.C. § 2412, or at common law; or

c. any claim pursuant to Sections 107 and 113 of CERCLA, 42 U.S.C. §§ 9607 and 9613, Section 7002(a) of RCRA, 42 U.S.C. § 6972(a), or state law relating to the Work or payment of Past Response Costs or Future Response Costs.

87. These covenants not to sue shall not apply in the event the United States brings a cause of action or issues an order pursuant to the reservations set forth in Section XX (Reservations of Rights by EPA), other than in Paragraph 84.a (liability for failure to meet a requirement of the Settlement Agreement) or 84.d (criminal liability), but only to the extent that OCWD's claims arise from the same response action, response costs, or damages that the United States is seeking pursuant to the applicable reservation.

88. OCWD reserves, and this Settlement Agreement is without prejudice to, claims against the United States, subject to the provisions of Chapter 171 of Title 28 of the United States Code, and brought pursuant to any statute other than CERCLA or RCRA and for which the waiver of sovereign immunity is found in a statute other than CERCLA or RCRA, for money damages for injury or loss of property or personal injury or death caused by the negligent or wrongful act or omission of any employee of the United States, as that term is defined in 28 U.S.C. § 2671, while acting within the scope of his or her office or employment under circumstances where the United States, if a private person, would be liable to the claimant in accordance with the law of the place where the act or omission occurred. However, the foregoing shall not include any claim based on EPA's selection of response actions, or the oversight or approval of OCWD's plans, reports, other deliverables, or activities.

89. Nothing in this Agreement shall be deemed to constitute approval or preauthorization of a claim within the meaning of Section 111 of CERCLA, 42 U.S.C. § 9611, or 40 C.F.R. § 300.700(d).

XXII. OTHER CLAIMS

90. By issuance of this Settlement Agreement, the United States and EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of OCWD.

91. Nothing in this Settlement Agreement constitutes a satisfaction of or release from any claim or cause of action against any person not a party to this Settlement Agreement, for any liability such person may have under CERCLA, other statutes, or common law, including but not limited to any claims of the United States for costs, damages, and interest under Sections 106 and 107 of CERCLA, 42 U.S.C. §§ 9606 and 9607.

92. No action or decision by EPA pursuant to this Settlement Agreement shall give rise to any right to judicial review except as set forth in Section 113(h) of CERCLA, 42 U.S.C. § 9613(h).

XXIII. EFFECT OF SETTLEMENT/CONTRIBUTION

93. Nothing in this Settlement Agreement shall be construed to create any rights in, or grant any cause of action to, any person not a Party to this Settlement Agreement. Except as provided in Section XXI (Covenant Not to Sue by OCWD), each of the Parties expressly reserves any and all rights (including, but not limited to, pursuant to Section 113 of CERCLA, 42 U.S.C. § 9613), defenses, claims, demands, and causes of action which each Party may have with respect to any matter, transaction, or occurrence relating in any way to the Study Area against any person not a Party hereto. Nothing in this Settlement Agreement diminishes the right of the United States pursuant to Section 113(f)(2) and (3) of CERCLA, 42 U.S.C. § 9613(f)(2)-(3), to pursue any such persons to obtain additional response costs or response action and to enter into settlements that give rise to contribution protection pursuant to Section 113(f)(2).

94. The Parties agree that this Settlement Agreement constitutes an administrative settlement pursuant to which OCWD has, as of the Effective Date, resolved liability to the United States within the meaning of Sections 113(f)(2) and 122(h)(4) of CERCLA, 42 U.S.C. §§ 9613(f)(2) and 9622(h)(4), and is entitled, as of the Effective Date, to protection from contribution actions or claims as provided by Sections 113(f)(2) and 122(h)(4) of CERCLA, or as may be otherwise provided by law, for the "matters addressed" in this Settlement Agreement. The "matters addressed" in this Settlement Agreement are the Work, Past Response Costs, and Future Response Costs.

95. The Parties further agree that this Settlement Agreement constitutes an administrative settlement pursuant to which OCWD has, as of the Effective Date, resolved liability to the United States within the meaning of Section 113(f)(3)(B) of CERCLA, 42 U.S.C. § 9613(f)(3)(B).

96. OCWD shall, with respect to any suit or claim brought by it for matters related to this Settlement Agreement, notify EPA in writing no later than 60 days prior to the initiation of such suit or claim. OCWD also shall, with respect to any suit or claim brought against it for matters related to this Settlement Agreement, notify EPA in writing within 10 days after service of the complaint or claim upon it. In addition, OCWD shall notify EPA within 10 days after service or receipt of any Motion for Summary Judgment and within 10 days after receipt of any order from a court setting a case for trial, for matters related to this Settlement Agreement.

97. In any subsequent administrative or judicial proceeding initiated by EPA, or by the United States on behalf of EPA, for injunctive relief, recovery of response costs, or other relief relating to the Study Area, OCWD shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, *res judicata*, collateral estoppel, issue preclusion, claim-splitting, or other defenses based upon any contention that the claims raised in the subsequent proceeding were or should have been brought in the instant case; provided, however, that nothing in this Paragraph affects the enforceability of the covenant by EPA set forth in Section XIX.

XXIV. INDEMNIFICATION

98. OCWD shall indemnify, save and hold harmless the United States, its officials, agents, contractors, subcontractors, employees, and representatives from any and all claims or causes of action arising from, or on account of negligent or other wrongful acts or omissions of OCWD, its officers, directors, employees, agents, contractors, subcontractors, and representatives in carrying out actions pursuant to this Settlement Agreement. In addition, OCWD agrees to pay the United States all costs incurred by the United States, including but not limited to attorneys' fees and other expenses of litigation and settlement, arising from or on account of claims made against the United States based on negligent or other wrongful acts or omissions of OCWD, its officers, directors, employees, agents, contractors, subcontractors, and any persons acting on its behalf or under its control, in carrying out activities pursuant to this Settlement Agreement. The United States shall not be held out as a party to any contract entered into by or on behalf of OCWD in carrying out activities pursuant to this Settlement Agreement. Neither OCWD nor any such contractor shall be considered an agent of the United States.

99. The United States shall give OCWD notice of any claim for which the United States plans to seek indemnification pursuant to this Section and shall consult with OCWD prior to settling such claim.

100. OCWD waives all claims against the United States for damages or reimbursement or for set-off of any payments made or to be made to the United States, arising from or on account of any contract, agreement, or arrangement between OCWD and any person for performance of Work on or relating to the Study Area. In addition, OCWD shall indemnify and hold harmless the United States with respect to any and all claims for damages or reimbursement arising from or on account of any contract, agreement, or arrangement between OCWD and any person for performance of Work on or relating to the Study Area.

XXV. INSURANCE

101. At least 30 days prior to commencing any on-site Work under this Settlement Agreement, OCWD shall secure, and shall maintain for the duration of this Settlement Agreement, commercial general liability insurance with limits of $2 million dollars, for any one occurrence, and automobile insurance with limits of $1 million dollars, combined single limit, naming the EPA as an additional insured with respect to all liability arising out of the activities

performed by or on behalf of OCWD pursuant to this Settlement Agreement. Within the same period, OCWD shall provide EPA with certificates of such insurance and a copy of each insurance policy. OCWD shall submit such certificates and copies of policies each year on the anniversary of the Effective Date. In addition, for the duration of the Settlement Agreement, OCWD shall satisfy, or shall ensure that its contractors or subcontractors satisfy, all applicable laws and regulations regarding the provision of worker's compensation insurance for all persons performing the Work on behalf of OCWD in furtherance of this Settlement Agreement. If OCWD demonstrates by evidence satisfactory to EPA that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering some or all of the same risks but in an equal or lesser amount, then OCWD need provide only that portion of the insurance described above which is not maintained by such contractor or subcontractor.

XXVI. INTEGRATION/APPENDICES

102. This Settlement Agreement and its appendices and any deliverables, technical memoranda, specifications, schedules, documents, plans, reports (other than progress reports), etc. that will be developed pursuant to this Settlement Agreement and become incorporated into and enforceable under this Settlement Agreement constitute the final, complete, and exclusive agreement and understanding among the Parties with respect to the settlement embodied in this Settlement Agreement. The Parties acknowledge that there are no representations, agreements, or understandings relating to the settlement other than those expressly contained in this Settlement Agreement. The following appendices are attached to and incorporated into this Settlement Agreement: Appendix A, the SOW, including attachments 1-3, and Appendix B, Map.

XXVII. ADMINISTRATIVE RECORD

103. EPA will determine the contents of the administrative record file for selection of the remedial action. OCWD shall submit to EPA documents developed during the course of the RI/FS upon which selection of the response action may be based. Upon request of EPA, OCWD shall provide copies of plans, task memoranda for further action, quality assurance memoranda and audits, raw data, field notes, laboratory analytical reports, and other reports. Upon request of EPA, OCWD shall additionally submit any previous studies conducted under state, local, or other federal authorities relating to selection of the response action, and all communications between OCWD and state, local, or other federal authorities concerning selection of the response action. At EPA's discretion, OCWD shall establish a community information repository at or near the Study Area, to house one copy of the administrative record.

XXVIII. EFFECTIVE DATE AND SUBSEQUENT MODIFICATION

104. This Settlement Agreement shall be effective 10 days after the Settlement Agreement is signed by the Regional Administrator or his/her delegate.

105. This Settlement Agreement may be amended by mutual agreement of EPA and OCWD. Amendments shall be in writing and shall be effective when signed by EPA. EPA Project Coordinators do not have the authority to sign amendments to the Settlement Agreement.

106. No informal advice, guidance, suggestion, or comment by the EPA Project Coordinator or other EPA representatives regarding reports, plans, specifications, schedules, or any other writing submitted by OCWD shall relieve OCWD of its obligation to obtain any formal approval required by this Settlement Agreement, or to comply with all requirements of this Settlement Agreement, unless it is formally modified.

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XXIX. NOTICE OF COMPLETION OF WORK

107. When EPA determines that all Work has been fully performed in accordance with this Settlement Agreement, with the exception of any continuing obligations required by this Settlement Agreement, including but not limited to payment of Future Response Costs and record retention, EPA will provide written notice to OCWD. If EPA determines that any Work has not been completed in accordance with this Settlement Agreement, EPA will notify OCWD, provide a list of the deficiencies, and require that OCWD modify the RI/FS Work Plan if appropriate in order to correct such deficiencies, in accordance with Paragraph 38 (Modification of the RI/FS Work Plan). Failure by Respondents to implement the approved modified RI/FS Work Plan shall be a violation of this Settlement Agreement.

Agreed this ___ day of July, 2016.

ORANGE COUNTY WATER DISTRICT

By: _____
Cathy Green, President

By: _____
Michael R. Markus, P.E., General Manager

APPROVED AS TO FORM:
RUTAN & TUCKER, LLP.

_____
General Counsel, Orange County Water District

It is so AGREED this ____ day of July, 2016.

BY:_____

John Lyons
Acting Assistant Director
Superfund Division
Region IX
U.S. Environmental Protection Agency

EFFECTIVE DATE: _____

STATEMENT OF WORK
for
Remedial Investigation and Feasibility Study (RI/FS)

ORANGE COUNTY NORTH BASIN

US EPA Region IX
June 2016

Statement of Work for Remedial Investigation/Feasibility Study
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Acronyms

ANSI	American National Standards Institute
ARAR	Applicable or Relevant and Appropriate Requirement
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	Chemical of Concern
CSM	Conceptual Site Model
DCE	Dichloroethene
DQO	Data Quality Objectives
DTSC	California Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
HSP	Health and Safety Plan
IC	Institutional Control
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NELAP	National Environmental Laboratory Accreditation Program
OCWD	Orange County Water District
OSHA	Occupational Safety and Health Administration
OSWER	EPA Office of Solid Waste and Emergency Response
OU	Operable Unit
QA/QC	Quality Assurance/ Quality Control
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
PCE	Perchloroethene (tetrachloroethene)
RAOs	Remedial Action Objectives
RI/FS	Remedial Investigation/ Feasibility Study
RSL	Regional Screening Levels
RWQCB	Regional Water Quality Control Board, Santa Ana Region
SAP	Sampling and Analysis Plan
SOW	Statement of Work
TBC	To be Considered
TCE	Trichloroethene
TM	Technical Memorandum
VOC	Volatile Organic Compound

STATEMENT OF WORK FOR REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

Orange County North Basin

1. Introduction and General Requirements

1.1. Purpose

This Statement of Work (SOW) describes activities to be performed by Orange County Water District (OCWD) at the Orange County North Basin Study Area (North Basin or Study Area) pursuant to the Settlement Agreement, Docket # 2016-03 (Settlement Agreement). Figure 1 in Attachment 1 shows the location of the Study Area. The Settlement Agreement requires OCWD to conduct a Remedial Investigation and Feasibility Study (RI/FS) to support the development of an interim groundwater remedy to hydraulically contain contaminated groundwater originating from the majority of known or suspected sources in the Study Area, and to further characterize the nature and extent of contamination in the Study Area. EPA may use the results of the RI/FS to identify and propose remedial actions needed to address human health risks, and ecological risks if a pathway for exposure is identified.

OCWD shall furnish all necessary and appropriate personnel, materials, and services needed for, or incidental to, performing and completing the work.

1.2. EPA Oversight and State Review

In accordance with the schedules established in the Settlement Agreement or in this SOW, OCWD shall submit to EPA and the State of California (the State) plans, reports and other deliverables required under the Settlement Agreement, this SOW and the Work Plan required by Section 3.1 of this SOW. All plans, reports and other deliverables will be reviewed and approved or disapproved by EPA pursuant to Section X of the Settlement Agreement ("EPA Approval of Plans and Other Submissions"), except for the Health and Safety Plan (HSP), which will be reviewed by EPA but neither approved nor disapproved.

If EPA disapproves a deliverable and requests modifications, OCWD shall revise the deliverable and resubmit it to EPA and the State, as provided in Section X of the Settlement Agreement. After receipt of comments from EPA, if any, on a draft document, OCWD shall submit for EPA and State review a revised document within 14 days of receipt of such comments or within 21 days of receipt of such comments for the RI/FS Work Plan, Sampling & Analysis and Health and Safety Plans for RI fieldwork, RI Report, Groundwater Flow Modeling Plan, Groundwater Flow Modeling Report, Remedial Alternatives Identification and Screening Technical Memorandum (TM), Detailed Analysis of Remedial Alternatives TM, and FS Report, unless specified

otherwise in the Settlement Agreement, in Attachment 2 to this SOW, or in writing by EPA.

EPA will review deliverables to assess the likelihood that the work will achieve the requirements set forth in the Settlement Agreement and this SOW. Notwithstanding any action by EPA or the State, OCWD remain fully responsible for satisfying the provisions and requirements of the Settlement Agreement and this SOW. Nothing in the Settlement Agreement, this SOW, or any other submission shall be deemed to constitute a warranty or representation of any kind by EPA or the State that full performance of the RI and FS will achieve these requirements. OCWD's compliance with submissions approved by EPA does not foreclose EPA from seeking additional work as provided for in the Settlement Agreement.

1.3 Communication between EPA, OCWD, and State Agencies

The primary EPA contact for activities to be conducted pursuant to this SOW is the EPA Project Manager:

Wayne Praskins
Remedial Project Manager
U.S. EPA, Region IX
75 Hawthorne Street, SFD-7-3
San Francisco, CA 94105
(415) 972-3181
praskins.wayne @epa.gov

The alternate contact for EPA is:

Caleb Shaffer
Section Chief, California Site Cleanup Section 1
U.S. EPA, Region IX
75 Hawthorne Street, SFD-7-1
San Francisco, CA 94105
(415) 972-3336
shaffer.caleb@epa.gov

The legal contact for EPA is:

Bethany Dreyfus
U.S. EPA, Region IX
Office of Regional Counsel, ORC-3
75 Hawthorne Street
San Francisco, CA 94105
(415) 972-3886
dreyfus.bethany@epa.gov

The California Department of Toxic Substances Control (DTSC) contact is:

John Scandura
Branch Chief
Brownfields and Environmental Restoration Program
Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630-4732
john.scandura@dtsc.ca.gov
(714) 484-5440

The Santa Ana Regional Water Quality Control Board (RWQCB) contact is:

Ann Sturdivant
Section Chief, Site Cleanup Program
Santa Ana Regional Water Quality Control Board
3737 Main Street, Suite 500
Riverside, CA 92501
ann.sturdivant@waterboards.ca.gov
(951) 782-4904

The OCWD contact is:

Dave Mark
Principal Hydrogeologist
Orange County Water District
18700 Ward Street
Fountain Valley, CA 92708
dmark@ocwd.com
(714) 378-3337

The alternate contact for OCWD is:

William Hunt
Director of Special Projects
Orange County Water District
18700 Ward Street
Fountain Valley, CA 92708
whunt@ocwd.com
(714) 378-8229

1.4 Contractor Personnel and Qualifications

As required by Section VIII of the Settlement Agreement, and in accordance with the schedule included as Attachment 2 to this SOW, OCWD shall notify EPA in writing of the names, titles, and qualifications of the supervising personnel, including contractors to be used in carrying out the Work, and provide a copy of the proposed contractor's Quality Management Plan (QMP). EPA will issue a notice of disapproval or an authorization to proceed regarding hiring of the proposed contractor.

1.5 Reporting to EPA and the State

1.5.1 Monthly Progress Report

OCWD shall prepare and submit written Monthly Progress Reports as required by Section IX of the Settlement Agreement. The progress reports shall, at a minimum: (1) describe the actions that have been taken to comply with the Settlement Agreement during that month, (2) describe Work planned for the next two months with schedules relating such Work to the overall project schedule, (3) describe all problems encountered and any anticipated problems, any actual or anticipated delays, and solutions developed and implemented to address any actual or anticipated problems or delays, (4) describe any modifications that OCWD has proposed to the EPA or that have been approved by the EPA, and (5) describe any community relations activities completed during the previous month or planned for the next two months. Progress reports are due by the fifteenth day of the following month.

1.5.2 Progress Meetings and Documentation of Critical Decisions

Any critical decisions made in meetings or conversations with EPA representatives shall be documented in a written submittal submitted by OCWD to EPA and the State within five (5) days of the decision. The submittal shall document the decision and the rationale for the decision.

1.5.3 Reporting During Field Efforts

OCWD shall communicate more frequently when field work is occurring, in accordance with any requirements in the approved Work Plan or any approved Sampling and Analysis Plans (SAPs) submitted in accordance with this SOW.

1.6 EPA Guidance and Reference Materials

OCWD shall complete the Work in accordance with the provisions of the Settlement Agreement, this SOW, CERCLA, the National Contingency Plan (NCP), and EPA guidance, including, but not limited to, the "Interim Final Guidance for Conducting Remedial Investigations and

Feasibility Studies under CERCLA" (OSWER Directive # 9355.3-01, October 1988 or subsequently issued guidance), "Guidance for Data Usability in Risk Assessment" (OSWER Directive #9285.7-05, October 1990 or subsequently issued guidance), guidance referenced therein, and guidance referenced in Attachment 3 to this SOW.

2. Background

2.1. Orange County North Basin

The Orange County Groundwater Basin is part of the 360-square-mile coastal plain of Orange County. The Santa Ana River, the primary surface water drainage feature in the area, is located east and southeast of the Study Area. The northern portion of the Basin, which includes the cities of Fullerton, Anaheim and Placentia, falls within the region known as the Forebay, the predominant area of basin recharge. In the Study Area, OCWD has identified three aquifers or aquifer systems: Shallow, Principal and Deep. The Principal Aquifer is the primary source of approximately 70 percent of the potable water supply in OCWD's boundary. However, the Shallow Aquifer is also locally used for potable water supply. In portions of the Study Area, the boundary between the Shallow and Principal Aquifers is generally delineated by a fine-grained layer at a depth of approximately 200 to 250 feet; however, this fine-grained layer may be absent or discontinuous, particularly in the eastern part of the Study Area.

OCWD is responsible for managing the Orange County Groundwater Basin, which supplies water to more than 20 cities and other water agencies, serving more than two million customers. OCWD has divided the aquifers into the three aforementioned primary aquifer systems based on the presence of regional aquitards, differences in potentiometric surfaces, and changes in water quality. In the Study Area, the Shallow Aquifer includes sediments extending to an average depth of approximately 200 feet below ground surface (bgs). The Principal Aquifer contains unconsolidated strata extending to an average depth of about 850 feet. The Deep Aquifer contains the unconsolidated aquifers below the Principal Aquifer, extending to an average depth of 1,300 feet bgs. Groundwater in these aquifers generally occurs under unconfined conditions in the North Basin and under semi-confined to confined conditions further west and south. The depth to groundwater in the Shallow Aquifer ranges from approximately 80 to 120 feet bgs. In the Shallow Aquifer, groundwater flow in the area is generally from east to west, but flow may change seasonally and year to year due to changes in groundwater pumping patterns and recharge

Investigations of the North Basin, the area generally under the cities of Anaheim, Fullerton and Placentia, have revealed groundwater contamination from volatile organic compounds (VOCs) and other chemicals. Beginning in the 1950s, VOCs were used for industrial activities in this area. Releases of VOCs into the environment are believed to have resulted in comingled groundwater contamination plumes. To protect public health due to elevated levels of VOCs, four drinking water production wells impacted by contamination have been destroyed: Fullerton well F-FS13 (2002), Fullerton well F-KIM1 (2002), Anaheim well A-23 (2001) and private well BAST-F (2013). High concentrations of perchloroethene (PCE), trichloroethene (TCE), 1,1-

dichloroethene (1,1-DCE) and 1,4-dioxane have been detected in monitoring wells in the Study Area. Other chemicals, including but not limited to 1,2-dichloroethane (1,2-DCA), perchlorate, nitrate, and 1,2,3-trichloropropane, have also been detected.

The North Basin is not on the National Priorities List. DTSC completed a site discovery report in February 2011 and petitioned EPA to conduct an investigation in November 2014 (DTSC 2014). Accordingly, in parallel to the planned RI/FS work, EPA is conducting a Preliminary Assessment and Site Inspection as prescribed by the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) to help evaluate whether the Study Area warrants a proposed listing.

2.2. Source areas

The Study Area was used primarily for agricultural purposes from about 1920 to 1954. Since that time, industrial activity has increased, and multiple industrial facilities in the area are known or suspected to have contributed to the groundwater contamination. The RWQCB and DTSC have identified several sites potentially responsible for groundwater contamination in the North Basin.

The RWQCB is overseeing investigation work and/or cleanup at six sites, namely AC Products (172 East La Jolla St., Placentia); Aerojet (601 South Placentia Ave., Fullerton); Alcoa Plant 1 (800 S. State College Blvd., Fullerton); Monitor Plating (800 East Orangefair Lane, Anaheim); Northrop Kester Solder (1730 North Orangethorpe Park, Anaheim); and Northrop Y-12 (301 E. Orangethorpe Ave., Anaheim). The RWQCB also provided oversight of initial investigative and/or remediation work at the former Fullerton Manufacturing (311 S. Highland Ave, Fullerton) and Northrop ESD/EMD sites (500 E. Orangethorpe Ave, Anaheim).

DTSC is overseeing investigation and/or cleanup work at an additional four sites, namely the former Chicago Musical Instruments (CMI) (350 S. Raymond Ave., Fullerton); Orange County Metal Processing (1711 East Kimberly Ave., Fullerton); PCA Metal Finishing (1726 East Roslyn Ave., Fullerton); and Crucible Materials (2100 Orangethorpe Ave., Fullerton). DTSC considers CMI, Orange County Metal Processing, and PCA Metal Finishing to be "orphan sites," but the status of the CMI site may change. In April 2016, DTSC proposed a settlement with Pitney Bowes Inc. and Novitex Enterprise Solutions, Inc. to perform response actions at the CMI site.

Additionally, the Orange County Health Care Agency (OCHCA) has overseen work at some sites in the Study Area.

As stated in EPA's September 2015 letter to both State agencies, EPA expects that the RWQCB and DTSC will continue investigatory and remedial work at sites they are currently overseeing.

2.3. Regional Plume

Spills, leaks, and other contaminant releases are believed to have resulted in comingled plumes of groundwater contamination in an area several miles long and a mile or more wide. Attachment 1 includes a figure depicting the approximate extent and levels of contamination. The actual extent and levels of contamination may differ from the depiction in the figure, especially in areas with limited data. Data collected as part of the planned RI will be used to improve the understanding of the nature and extent of groundwater contamination in the Study Area.

3. List of Deliverables and Other Tasks

OCWD shall plan and conduct RI and FS work in accordance with this SOW and relevant EPA regulations and guidance, some of which are referenced in Attachment 3. The RI/FS shall, among other things, include field investigation as described in this SOW and, in support of an interim remedy, identify applicable or relevant and appropriate requirements (ARARs); assess potential risks to human health and the environment; and develop, screen, and evaluate remedial action alternatives. Section 3.1.8 describes the preliminary objectives of the interim remedy.

OCWD shall submit plans, reports, and other deliverables for EPA and State review. This SOW requires written submittals describing the results of groundwater modeling, describing the results of the baseline risk assessment, identifying ARARs, describing the development and screening of remedial alternatives, and providing the results of the detailed evaluation of remedial alternatives, as well as a RI Report and a FS Report. Major deliverables are specified in Attachment 2. Pursuant to Section X of the Settlement Agreement, EPA may approve, disapprove, require modifications of, or modify each deliverable.

OCWD shall implement quality control procedures to ensure the quality of all reports and submittals to EPA and the State. These procedures shall include, but are not limited to, internal technical and editorial review; and documentation of all reviews, problems identified, and corrective actions taken.

3.1. Remedial Investigation/Feasibility Study Work Plan

OCWD shall submit a draft RI/FS Work Plan (hereafter "Work Plan") for EPA and State review and approval in accordance with Section IX of the Settlement Agreement and relevant EPA guidance. The Work Plan shall describe the tasks required to complete the RI/FS, the methodologies to be used, information to be produced during and at the conclusion of each task, a description of the work products that will be submitted to EPA, and a schedule for their completion. OCWD may request to meet with EPA and the State prior to submission of the Work Plan to clarify any questions regarding the SOW.

OCWD shall submit a Revised RI/FS Work Plan, if directed by EPA. Upon approval by EPA, OCWD shall implement the Work Plan. Upon its approval by EPA pursuant to Section X of the Settlement Agreement, the Work Plan (and other plans, reports, and deliverables submitted to EPA under the Settlement Agreement) shall be incorporated into and become enforceable under the Settlement Agreement. The Work Plan shall include the elements described in Sections 3.1.1 through 3.1.14 of this SOW.

3.1.1. Study Area Description and Conceptual Site Model (CSM)

The Work Plan shall include a brief description of the Study Area, including the suspected sources, nature, and extent of soil and groundwater contamination; and geographic, hydrogeologic, ecological, cultural, or natural resource features relevant to the RI/FS.

The Work Plan shall also provide an initial conceptual site model (CSM) for the Study Area, along with provisions for updating the CSM when appropriate based on the availability of new information.

3.1.2. Data Management

The Work Plan shall describe how water level, water quality, and other data to be compiled during the RI/FS will be managed. Unless otherwise indicated, data shall be submitted to EPA and the State in electronic format. When necessary due to file size, OCWD shall provide an acceptable file transfer mechanism for the submission of large documents.

3.1.3. RI Activities

The Work Plan shall describe previous findings relevant to the Study Area, and field activities needed to satisfy the requirements of this SOW. The Work Plan shall include provisions for submittal of one or more SAPs that will generate data needed to satisfy the following objectives:

- Refine the CSM and fill data gaps to support the development and evaluation of remedial alternatives for an interim remedy and further characterize the nature and extent of contamination in the Study Area;
- Prepare a baseline risk assessment for human health in support of an interim remedy-
- Evaluate risks to ecological receptors;
- Provide any other data needed to satisfy the requirements of this SOW; and,
- Provide data to address any concerns about the quantity, quality, completeness, or usability of water quality or other data that will be used to satisfy the requirements of this SOW.

The RI investigation shall include, at a minimum:

- Review of existing data developed by EPA, RWQCB, DTSC, OCWD, private companies, and other local entities relevant to the nature and extent of groundwater contamination in the Study Area;
- Creation of a list of potential chemicals of concern (COCs), likely including but not limited to PCE, TCE, 1,1-DCE and 1,4-dioxane;
- Evaluation of the sources of contamination;
- Construction and sampling of new groundwater monitoring wells needed to support development of an interim groundwater remedy and better define groundwater flow directions and the nature and extent of groundwater contamination. A preliminary list of wells is provided in Table 1 in Attachment 1; and,
- Measurements of groundwater elevations and collection and analysis of groundwater samples for possible COCs from new and selected existing groundwater wells throughout the Study Area. The Work Plan shall propose initial sampling frequencies by well and COC, and provide for modifying those frequencies as the investigation progresses. If accessible, sampling existing groundwater monitoring wells associated with the site at 311 South Highland Avenue in Fullerton, California (known as the "Fullerton Manufacturing" site) should be included.

The monitoring well locations shown on Figure 1 in Attachment 1 are subject to change based on constructability and ability to secure access in a timely manner.

As described in more detail in Section 4 of this SOW, the SAP shall describe planning, field, laboratory, data review and interpretation, and reporting efforts needed to satisfy the RI objectives.

3.1.4. Technical Reports

The Work Plan shall include provisions for the preparation and submittal to EPA of one or more technical reports that summarize the results of RI field activities. If appropriate, the reports shall update figures showing water level contours and/or the nature and extent of groundwater contamination in plan view and/or vertical cross section, update the CSM, and make recommendations for any additional RI work needed to satisfy the requirements of this SOW.

3.1.5. Groundwater Flow Modeling

The Work Plan shall include provisions for the use of a numeric groundwater flow model to better understand groundwater movement in the Study Area, support the placement of

groundwater monitoring wells and complete other field activities, and/or evaluate remedial alternatives.

OCWD has developed a groundwater flow model of the Study Area (the "OCWD Model"). The Work Plan shall include provisions for submittal to EPA of a report documenting the development and calibration of the OCWD Model.

The Work Plan shall include provisions for submittal to EPA of a Groundwater Flow Modeling Plan. The Plan shall provide for revisions to the OCWD model if needed to address EPA comments, and provisions for submittal to EPA of preliminary modeling results and a Groundwater Modeling Report at the completion of the modeling effort.

The model shall be calibrated over a wide-range of hydrogeological conditions and have the capability to simulate transient conditions in three dimensions. The model shall be capable of conducting particle tracking simulations to evaluate hydraulic control. The modeling effort shall include a sensitivity analysis. The modeling effort should consider the procedures outlined in EPA's guidance document "A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems, EPA/600/R-08/003, January 2008."

3.1.6. Risk Assessment

The Work Plan shall include provisions for the preparation and submittal of a Technical Memorandum (TM) that presents the results of a Baseline Human Health Risk Assessment to support an interim remedy for the Study Area. The risk assessment shall be conducted in accordance with applicable EPA and State guidance, including but not limited to "Interim Final Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part A)," (RAGS, EPA-540-1-89-002, OSWER Directive 9285.7-01A, December 1989); and "Interim Final Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)," (RAGS, EPA 540-R-97-033, OSWER Directive 9285.7-01D, January 1998).

The risk assessment shall address pathways of exposures to contaminated groundwater that pose an actual or potential risk to human health and the environment (e.g., human consumption, dermal contact, inhalation). The risk assessment shall also consider cumulative exposure where multiple contaminants are present.

This task will also evaluate whether there are potentially complete exposure pathways for site contaminants to ecological receptors. If no potentially complete exposure pathways exist, then the ecological risk assessment will be considered complete with documentation of that finding and no further work will be necessary. The Work Plan will include provisions for preparation of an ecological risk assessment in accordance with applicable EPA guidance if EPA determines that there are complete exposure pathways for site contaminants to ecological receptors

3.1.7. Treatability Studies and Pilot Testing

The Work Plan shall include provisions for treatability studies and pilot testing if necessary to support the development of an interim remedy. OCWD shall submit plans for any proposed testing to EPA and the State and obtain EPA approval prior to conducting the corresponding field work. The results of any treatability studies or pilot tests shall be included in the screening of remedial alternatives described below.

3.1.8. Preliminary Remedial Objectives and Remedial Alternatives Development and Screening

The preliminary objectives of an interim remedy would be: i) protect human health and the environment by preventing exposure to contaminated groundwater in the Study Area; and ii) hydraulically contain contaminated groundwater to protect water supply wells and groundwater resources threatened by the spread of the contamination. The area targeted for hydraulic containment (the "Target Area") shall include contaminated groundwater from the majority of known or suspected sources of groundwater contamination in the Study Area. The preliminary Target Area boundary is shown in Figure 1 in Attachment 1.

The Work Plan shall include provisions for the preparation and submittal to EPA of a TM that: i) refines the remedial action objectives; ii) identifies a range of remedial actions including engineering controls and any institutional controls (ICs) needed to address the risks; and iii) provides the results of an initial screening of alternatives to reduce the number of potential remedies for the final detailed evaluation.

3.1.9. Detailed Evaluation of Remedial Alternatives

The Work Plan shall include provisions for the preparation and submittal to EPA of a TM that presents a detailed evaluation of interim remedial alternatives that pass the initial screening based on the nine evaluation criteria specified in 40 CFR 300.430[e][9]. The submittal shall also evaluate any ICs identified as a component of the remedial alternatives. The evaluation shall: (1) state the objectives of the ICs; (2) determine the specific types of ICs to be used to meet the remedial action objectives; (3) determine when the ICs need to be implemented and for what duration; (4) discuss and document

any prior or necessary agreements and with whom (e.g., state and/or local government entities, local landowners, conservation organizations, OCWD) for securing, maintaining and enforcing the ICs.

3.1.10. Applicable or Relevant and Appropriate Requirements

The Work Plan shall include provisions for the preparation and submittal to EPA of a ARARs TM that describes potentially applicable or relevant and appropriate requirements (ARARs) under federal or state law and any proposed ARARs waivers, as required in CERCLA section 121(d). ARARs are environmental regulations, standards, criteria, or limitations, promulgated under federal or more-stringent state laws, for consideration for each remedial alternative being evaluated. Each ARAR evaluated shall be designated as "applicable" or "relevant and appropriate" and linked to the specific remedial activity being evaluated. The ARARs TM shall consider action-specific, chemical-specific, and location-specific ARARs as well as To Be Considered (TBC) criteria, including advisories or guidance that are not promulgated or independently enforceable but which may be used to set protective cleanup levels.

3.1.11. RI and FS Reports

The Work Plan shall include provisions for submittal to EPA and the State a draft RI Report and draft FS Report. The RI and FS Reports collectively shall provide, summarize, and discuss the following:

- Study Area background and setting;
- Sources, nature and extent of groundwater contamination;
- Results of groundwater modeling conducted in support of the RI/FS;
- Baseline human health risk assessment and evaluation of ecological risks;
- Data quality and usability;
- Remedial action objectives;
- ARARs;
- The identification and screening of remedial alternatives, including pilot testing;
- A detailed analysis of interim remedial alternatives, including an evaluation of ICs;
- The roles and responsibilities of the OCWD, water utilities, or other third parties required for implementation of each remedial alternative;
- Existing facilities (e.g., groundwater extraction wells, water treatment systems, pipelines) that may be used as part of a remedy, including their planned use, condition, expected life and the potential for increased maintenance or reduced lifespan compared to new facilities.

Upon review of the draft documents, EPA may require OCWD to revise the RI and FS Reports. When complete, the RI and FS reports, along with an Administrative Record, may provide the basis for a Proposed Plan and Record of Decision to be prepared by EPA in accordance with CERCLA Sections 113(k) and 117(a).

3.1.12. Updated Project Schedule.

The Work Plan shall include a schedule consistent with Attachment 2 of this SOW that provides dates for deliverables and other critical path activities required for the RI/FS. The schedule shall include time for EPA and State review of written deliverables and for meetings with EPA representatives when appropriate.

3.1.13. Roles and Responsibilities of Key Personnel and Organizations.

The Work Plan shall describe the roles and responsibilities of individuals and organizations involved in the RI/FS effort, including contractors and major subcontractors.

3.1.14. Permits, Access, Coordination, and Compliance with Substantive Requirements

The Work Plan shall list all permits, easements, access agreements, and approvals anticipated for implementation of the RI/FS.

3.2. Plans

3.2.1. Sampling and Analysis Plan

In accordance with Section IX of the Settlement Agreement, OCWD shall prepare a Sampling and Analysis Plan (SAP) for field and laboratory activities required to implement the RI/FS. SAPs are required for sample collection and analysis as well as physical measurements such as groundwater levels, borehole geophysics, aquifer parameters, and geodetic survey data.

The SAP submitted pursuant to this SOW shall consist of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP), as described in EPA guidance, including, without limitation, "EPA Guidance for Quality Assurance Project Plans (QA/G-5)"(EPA/600/R-02/009, December 2002 or subsequently issued guidance), and "EPA Requirements for Quality Assurance Project Plans (QA/R-5)" (EPA 240/B-01/003, March 2001 or subsequently issued guidance). Key guidance documents are listed in Attachment 3. The plans shall include, or be accompanied by, a schedule for implementation of the planned sampling, analysis, and reporting activities. The FSP and QAPP may be submitted separately or as one document. Upon EPA approval of a SAP, OCWD shall implement the activities described therein.

a. The FSP shall describe sampling and data gathering objectives; proposed monitoring well locations and planned uses of the data; well construction and well development procedures; sampling and data collection methods; sample frequencies; sampling equipment and equipment decontamination procedures; sample preservation, packing, labeling, and shipment

procedures; chain-of-custody procedures; numbers and types of samples (including quality control [QC] samples); use and maintenance of field logs; and management of investigation-derived wastes.

The FSP shall be written so that a field sampling team unfamiliar with the project would be able to gather the samples and field information required. The FSP shall include a schedule that describes activities that must be completed in advance of sampling, including access agreements and arrangements for disposal of investigation-derived waste. The FSP shall include provisions for the collection of split samples by EPA.

b. The QAPP shall describe the project objectives and organization, functional activities, data quality objectives (DQOs), and quality assurance and quality control (QA/QC) protocols that will be used to achieve the DQOs. In addition, the QAPP shall address personnel qualifications, sampling procedures, sample custody, analytical procedures, document control procedures, preservation of records (in accordance with Section XIV of the Settlement Agreement), and procedures that will be used to enter, store, manage, correct, manipulate, review, validate, transfer, and analyze data, and ensure that reported data are accurate and defensible.

OCWD shall be prepared to demonstrate to EPA's satisfaction that each laboratory it may use is qualified to conduct the proposed work. This includes use of methods and analytical protocols for the chemicals of concern, in the media of interest, at detection and quantification limits consistent with DQOs and requirements specified in the approved QAPP for the work. OCWD shall only use laboratories that have documented Quality Assurance Programs that comply with ANSI/ASQ E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs," (American National Standard, January 5, 1995) and "*EPA Requirements for Quality Management Plans (QA/R-2),*" EPA/240/B-01/002, March 2001**,** or equivalent documentation as determined by EPA . EPA may consider laboratories accredited under the National Environmental Laboratory Accreditation Program ("NELAP") as meeting the Quality System requirements. If the laboratory is not in the EPA Contract Laboratory Program ("CLP"), OCWD shall submit for EPA review and approval, if EPA requests, a laboratory QA program plan. EPA may require that OCWD submit detailed information to demonstrate that the laboratory is qualified to conduct the work, including information on personnel qualifications, equipment, and material specifications.

OCWD shall submit analytical data and well construction information to EPA and the State in accordance with the schedule included in Attachment 2.

3.2.2. Health and Safety Plan

OCWD shall prepare a Health and Safety Plan (HSP) in accordance with EPA's Standard Operating Safety Guide (PUB 9285.1-03, PB 92-963414, June 1992 or subsequently issued guidance). The HSP shall comply with all currently applicable Occupational Safety and

Health Administration (OSHA) regulations found at 29 C.F.R. Part 1910, as well as any related requirements specific to California. EPA will review but neither approve nor disapprove the HSP. The OCWD shall consider all changes to the plan recommended by EPA and shall implement the plan while conducting the RI/FS.

3.3. RI Field Work

OCWD shall conduct RI field work in accordance with any approved SAPs and the HSP. OCWD shall notify EPA at least two weeks in advance of any field effort.

3.4. Groundwater Flow Modeling Plan

OCWD shall submit a Groundwater Flow Modeling Plan in accordance with the approved Work Plan.

3.5. Groundwater Flow Modeling

OCWD shall conduct groundwater flow modeling in accordance with the approved Work Plan and approved Groundwater Flow Modeling Plan.

3.6. Groundwater Flow Modeling Reports

OCWD shall submit a report documenting the development and calibration of the OCWD model, preliminary modeling results, and a Groundwater Flow Modeling Report in accordance with the approved Work Plan and Groundwater Flow Modeling Plan.

3.7. Remedial Investigation Report

OCWD shall submit to EPA for review and approval a draft RI Report in accordance with the approved Work Plan, followed by a final RI Report incorporating any revisions required by EPA.

3.8. Remedial Alternatives Screening TM

OCWD shall submit a Remedial Alternatives Screening TM documenting the results of the screening of remedial alternatives in accordance with the approved Work Plan. This effort may include pilot testing as discussed in section 3.1.7.

3.9. Remedial Alternatives Evaluation TM

OCWD shall submit a Remedial Alternatives Evaluation TM documenting the results of the evaluation of remedial alternatives in accordance with the approved Work Plan.

3.10. ARARs TM

OCWD shall submit a TM identifying ARARs in accordance with the approved Work Plan.

3.11. Risk Assessment TM

OCWD shall submit a Risk Assessment TM documenting the results of the baseline human health risk assessment, and an ecological risk assessment if deemed necessary in accordance with the approved Work Plan.

3.12. FS Report

OCWD shall submit a draft FS Report in accordance with the approved Work Plan, and a final FS Report incorporating revisions required by EPA.

3.13. Community Involvement Activities

OCWD shall implement any community involvement activities specified in the approved Work Plan or that EPA directs OCWD to complete. EPA expects to take the lead role in implementing community involvement activities for the Study Area but may request that OCWD assist EPA by participating in public meetings, preparing fact sheets, placing documents in the local information repository, placing announcements in local newspapers, providing translation services, or conducting other community involvement activities. OCWD is a local public agency with independent community involvement responsibilities including conduct of OCWD-led community involvement activities. Where these activities may relate to this Work, OCWD will coordinate with EPA and, where applicable, the affected Cities.

Attachment 1 to the SOW: Study Area, Preliminary Target Area for Interim Remedy, and Monitoring Well Locations and Rationale



FIGURE 1. ORANGE COUNTY NORTH BASIN: PLANNED GROUNDWATER MONITORING WELL LOCATIONS APPROXIMATE EXTENT OF GROUNDWATER CONTAMINATION

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Table 1. Planned Groundwater Monitoring Wells – Orange County North Basin Remedial Investigation

Well No. [(a)]	Target Depth(s) of Screened Interval [(b)]	Justification/Notes
FM-7B	250-270	To evaluate the benefits of hydraulically containing contaminated groundwater at or near the FM-7 location. Adjacent FM-7A and FM-7 have shown decreasing VOC concentrations since they were installed in 2009. Vertical extent and presence of VOCs in the Principal Aquifer in this area is unknown.
FM-29A FM-29B FM-29C	110-130, 175-195, 240-260	To characterize the lateral and vertical extent of groundwater contamination in the vicinity of one-time grab samples MW-GW01, MW-GW02, OW-GW01, and OW-GW02Principal Aquifer well (FM-29C, 250-ft depth) may be eliminated if down-gradient Principal Aquifer well at FM-7B does not exhibit VOCs at concentrations greater than MCL/NL.
FM-30A	140-160	To characterize the extent of shallow groundwater contamination between the FM-7 and FM-23 locations
FM-31A FM-31B	130-150 230-250	To characterize the lateral and vertical extent of groundwater contamination down-gradient of FM-10, between the FM-11 and FM-15 locations.
FM-24B	320-340	To characterize the vertical extent of Principal Aquifer contamination observed in FM-24 (screened 271-291), which exhibits significantly higher VOC concentrations that adjacent Shallow Aquifer monitoring well FM-24A (screened 154-174).
FM-22B	310-330	To characterize the vertical extent of Principal Aquifer contamination observed in FM-22 (screened 242-262), which exhibits significantly higher VOC concentrations than adjacent Shallow Aquifer monitoring well FM-22A (screened 150-170). Provides data to evaluate the possible need to pump from deeper parts of the Principal Aquifer.
FM-33A FM-33B FM-33C	170-190, 270-290, 340-360	To characterize the lateral and vertical extent of groundwater contamination in the Shallow and Principal Aquifers, including helping to define the lateral down-gradient extent of Principal Aquifer contamination observed in FM-19C.
FM-34A FM-34B	140-160, 255-275	To characterize the extent of groundwater contamination downgradient of FM-18A/18. Additional downgradient monitoring may be needed if elevated VOCs are detected at this location.

Notes:

(a) Well locations shown on accompanying map have not been ground-truthed and are subject to change pending suitability for well construction and ability to secure access.

(b) Assume 20-ft-long screened intervals. Actual length and depth of screened intervals will depend on observed lithology.

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Attachment 2 to the SOW. Due Dates for Major Deliverables and Other Activities

Ref SOW Section	Ref Settlement Agreement Section	Activity or Deliverable	Due [1, 2, 3, 4, 5]
-	-	Effective Date of Settlement Agreement	
1.4	VIII	Notification of Personnel to be used for the Work, including submittal of QMP	Fourteen (14) days after the Effective Date of the Settlement Agreement
-	VIII	Notification of Project Coordinator	Fourteen (14) days after the Effective Date of the Settlement Agreement
-	XXV	Proof of commercial general liability and automobile liability insurance	Thirty (30) days before commencing any onsite Work
1.5	IX	Monthly Progress Reports	15th day of the following month
1.5	IX	Meeting Notes	5 days after any meeting where critical decisions are made or per EPA/State request.
3.1	IX	RI/FS Work Plan	Ninety (90) days after the Effective Date of the Settlement Agreement
3.3	IX	EPA notification of planned field work	Two weeks before field effort begins
3.2	IX	SAP and HSP for RI fieldwork	Ninety (90) days after the Effective Date of the Settlement Agreement
3.3	IX	RI fieldwork	As specified in approved SAP
3.7	IX	RI Report	As specified in approved Work Plan
3.4	IX	Groundwater Flow Modeling Plan	As specified in approved Work Plan
3.5	IX	Groundwater Flow Modeling	As specified in approved Work Plan or approved Groundwater Flow Modeling Plan
3.6	IX	Groundwater Flow Modeling Report	As specified in approved Work Plan or approved Groundwater Flow Modeling Plan
3.11	IX	Risk Assessment TM	As specified in approved Work Plan
3.10	IX	ARARs TM	As specified in approved Work Plan
3.8	IX	Remedial Alternatives Identification and Screening TM	As specified in approved Work Plan

Ref SOW Section	Ref Settlement Agreement Section	Activity or Deliverable	Due [1, 2, 3, 4, 5]
3.9	IX	Detailed Analysis of Remedial Alternatives TM	As specified in approved Work Plan
3.12	IX	FS Report	As specified in approved Work Plan
4	IX	Submittal of analytical data, whether or not validated	Forty-two (42) calendar days of sample shipment to the laboratory or 14 days of receipt of analytical results from the laboratory, whichever occurs first.
4	IX	Submittal of validated analytical data	Ninety (90) calendar days of the sample shipment to the laboratory
4	IX	Groundwater well construction information	Ninety (90) days after completion of a well.

[1] Unless otherwise indicated, all deliverables shall be provided in an electronic format (e.g., PDF) to EPA, EPA's contractor, the RWQCB, and DTSC.

[2] All deliverables set forth in Attachment 2 will be reviewed and approved by EPA in accordance with Section X of the Settlement Agreement, except for the Health and Safety Plan(s), which will be reviewed but neither approved nor disapproved.

[3] Revised versions of documents, if needed, are due 14 days after receipt of EPA comments, unless specified otherwise in the Settlement Agreement, this Attachment, or in writing by EPA

[4] Where possible, information presented in color should be interpretable when reproduced in black and white.

[5] Estimated time is in calendar days.

Attachment 3 to the SOW. Selected References and Guidance

Ahmed, Rafiq, Cal/EPA Department of Toxic Substances Control. *North Orange County Site Discovery Project.* Cooperative Agreement No. V-97999001-2 with U.S. EPA Region IX. February 2011.

Black, Stewart W., California Department of Toxic Substances Control. *Petition to Conduct a Preliminary Assessment of Hazardous Substance Releases in the North Orange County Basin Groundwater Plume Area.* Letter to Enrique Manzanilla, U.S. EPA Region IX. November 25, 2014.

Intera Geoscience and Engineering Solutions, for Orange County Water District. *Conceptual Model Refinement, North Basin Groundwater Modeling Project*. February 18, 2015.

National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule, Federal Register 40 CFR Part 300, March 8, 1990 and as revised

Guide to Management of Investigation-Derived Wastes, U.S. EPA, Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, January 1992

A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems, EPA/600/R-08/003, January 2008

Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER Directive 9283.1-33, June 26, 2009

Superfund Green Remediation Strategy, September 2010, available at: http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf

CERCLA Compliance with Other Laws Manual, Two Volumes, U.S. EPA, Office of Emergency and Remedial Response, (DRAFT), OSWER Directive No. 9234.1-01 and -02, August 1988

Superfund Community Involvement Handbook, U.S. EPA, Office of Solid Waste and Emergency Response, EPA-540-K-05-003, April 2005

Policy Guidance for Direct Domestic Use of Extremely Impaired Sources, California Department of Public Health Policy Memorandum 97-005

Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals Under CERCLA, EPA 540/F-97/008, OSWER 9200.4-23, August 1997

USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic

Methods Data Review, USEPA-540-R-08-01, June 2008, EPA Office of Emergency and Remedial Response (see http://www.epa.gov/superfund/programs/clp/ for most recent versions).

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, EPA 540-R-10-011, January 2010 (see http://www.epa.gov/superfund/programs/clp/ for most recent versions).

EPA Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4), February 2006.

EPA Requirements for Quality Management Plans (QA/R-2), EPA/240/B-01/002, March 2001.

EPA Requirements for Quality Assurance Project Plans (QA/R-5), EPA/240/B-01/003, March 2001.

EPA Region IX Sampling and Analysis Plan Guidance and Template, R9QA/002.1, April 2000.

Manzanilla, Enrique, EPA Region IX. Letter to Barbara A. Lee, California Department of Toxic Substances Control, and Kurt Berchtold, Santa Ana Regional Water Quality Control Board. September 3, 2015.

EPA Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. OSWER Publication 9200.2-154. June 2015.

Interim Final Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part A). EPA-540-1-89-002, OSWER Directive 9285.7-01A, December 1989.

Interim Final Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). EPA 540-R-97-033, OSWER Directive 9285.7-01D, January 1998.

EPA Region 9 Response Action Levels and Recommendations to Address Near-Term Inhalation Exposures to Trichloroethylene (TCE) in Air from Subsurface Vapor Intrusion. July 19, 2014.

Region 9 Superfund Data Evaluation/Validation Guidance (Draft), USEPA, Quality Assurance Office, R9QA/006.1, December 2001

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-10., U.S. EPA, Office of Emergency and Remedial Response, EPAlS40/G-89/004, October 1988.

Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, American National Standards Institute (ANSI), ANSI/ASQ E4 1994, January 5, 1995.

California Code of Regulations (CCR) Title 8, Article 109, Section 5192 Hazardous Waste Operations and Emergency Response (HAZWOPER), California Occupational Safety and Health Administration (Cal OSHA)

Code of Federal Regulations, Occupational Safety and Health Administration (OSHA), (CFR) Title 29, Section 1910.120

A Compendium of Superfund Field Operations Methods, EPA Office of Solid Waste and Emergency Response (OSWER), Directive No. 9355.0-14, August 1987.

CERCLA Compliance With Other Laws Manual, EPA Office of Solid Waste and Emergency Response (OSWER), Directive Nos. 9234.1 (part I) and 9234.1-02 (part 2), Part I -August 1988 and Part II -August 1989.

Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air, EPA Office of Solid Waste and Emergency Response (OSWER), Publication 9200.2-154, June 2015.

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APPENDIX B TO SETTLEMENT AGREEMENT 2016-03: APPROXIMATE EXTENT OF GROUNDWATER CONTAMINATION

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Appendix B
Applicable or Relevant and Appropriate Requirements

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
Chemical-specific ARARs							
1	Sources of Drinking Water Policy	SWRCB Res. 88-63 (Sources of Drinking Water Policy) and Regional Board Resolution 89-42	State	Designates all groundwater and surface waters of the state as drinking water except where the TDS is greater than 3,000 ppm, the well yield is less than 200 gpd from a single well, the water is a geothermal resource or in a water conveyance facility, or the water cannot reasonably be treated for domestic use using either best management practices or best economically achievable treatment practices. Incorporated into all regional board basin plans.	Applicable	Substantive requirements are potential ARARs. The aquifer underlying Orange County North Basin does not meet the exclusion criteria specified in the Res. 88-63, and is a drinking water source.	General
2	Primary Drinking Water Standards (MCLs)	Safe Drinking Water Act, 40 CFR §141.61(a)	Federal	Maximum contaminant Levels (MCLs) are promulgated and enforceable maximum concentrations of drinking water priority pollutants that are set as closely as feasible to maximum contaminant level goals (MCLGs), considering best technology, treatment techniques, and other factors. Primary drinking water standards are legally applicable only to drinking water at the tap but are relevant and appropriate as cleanup standards for groundwater and surface water that have been determined to be current or future drinking water sources. For site contaminants where there is not an MCL to serve as the ARAR or where there are multiple contaminants at the site, 40 CFR §§141.50 and .51 for non-zero MCLGs which may be considered on a site-specific basis for those contaminants in developing cleanup levels.	Relevant and appropriate	This regulation addresses drinking water-based cleanup standards for groundwater contaminant plumes at Orange County North Basin. MCLs for VOCs are the drinking-water based cleanup standards for groundwater at the Site and are relevant and appropriate requirements for groundwater that serves as a potential source of drinking water. The primary COCs at the site include trichloroethene (TCE) and tetrachloroethene (PCE) for which there are MCLs. MCLs for non-COCs including PFOA, PFOS, PFHxS, PFNA, HFPO-DA (GenX), PFBS, nitrate, and perchlorate have been promulgated as drinking water standards. These MCLs will be ARARs for cleanup levels in drinking water. The adoption of additional compounds as COCs would be completed through future decision documents. Although MCLGs may be considered for site-specific cleanup levels, there are no COCs at this site without an MCL or health-based notification level for development of cleanup levels.	General
3	State MCLs	Cal. Code Regs. Tit. 22, Div. 4, Ch. 15, Articles 4, 4.5, and 5.5, Section 64444	State	State MCL list. Establishes standards for public water supply systems, including primary MCLs. State MCLs must be at least as stringent as Federal MCLs. State MCLs are incorporated into State and Regional Water Quality Control Board Water Quality Control Plans as water quality objectives for protection of current and potential drinking water supply sources. MCLs are some of the applicable upper-end objectives for ambient groundwater and surface water where the water is a source of drinking water, as defined in the Water Quality Control Plans.	Relevant and appropriate	Like Federal MCLs, these are tap water standards and are relevant and appropriate as potential ARARs where the State MCLs are more stringent than corresponding Federal MCLs. The State MCL for 1,1-dicloroethene (6 µg/L) is more stringent than the corresponding Federal MCL (7 µg/L), and the State has promulgated a MCL for 1,2,3-trichloropropane (0.005 µg/L) while there is no Federal MCL.	General
4	Beneficial Use	Porter-Cologne Act §§ 100, 113, 13050(f),(h),(i) Cal. Water Code Section 13304.1(b); Water Quality Control Plan for the Santa Ana River Basin Plan, 1995 as updated through June 2019, Chapter 3.	State	The Porter-Cologne Water Quality Control Act establishes authority of the SWRCB and RWQCB to regulate discharges into Waters of the State. The Santa Ana River Basin Plan (Basin Plan) sets forth the Regional Board's policies for managing the Region's water quality including water quality objectives, beneficial uses, and the anti-degradation policy for the Region.	Relevant and appropriate	The beneficial uses listed in Chapter 3 of Chapter 4 of the Basin Plan are potentially relevant and appropriate state ARARs. Chapter 3 identifies waters of the state within the Santa Ana River Basin and establishes the beneficial uses of ground and surface waters (Orange County Management Zone Boundaries map, Figure 3-7).	General

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
		Porter-Cologne Act §§ 13050(h), 13241; Cal. Water Code Section 13304.1(b); Water Quality Control Plan for the Santa Ana River Basin Plan, 1995 as updated through June 2019, Chapter 4.	State	California Water Code Section 13304.1(b) establishes consultation with the regional board to ensure "discharges, spreading, or injection" of treated groundwater will not adversely affect beneficial uses of a groundwater basin. Chapter 4 of the Santa Ana River Basin Plan establishes water quality standards for the region's ground and surface waters, including northwestern Orange County where the site is located, to ensure the reasonable protection of beneficial uses and prevention of nuisance. The Basin Plan includes the actions that the RWQCB designates as necessary to achieve and maintain water quality standards.	TBC	Chapter 4 sets forth narrative Water Quality Objectives (WQOs) for protection of the beneficial uses. The Basin Plan does not establish numeric WQOs for organic compounds, but it does include WQOs of 580 mg/L for total dissolved solids (TDS) and 5.9 mg/L for nitrate as nitrogen for the Orange County Groundwater Management Zone. These should be considered when developing alternatives with potential impacts to groundwater at the site. Alternatives including discharge components should consider these standards to ensure discharge, spreading, or injection of treated groundwater does not adversely affect the beneficial uses of the receiving water.	General
5	State Water Resources Control Board Notification Levels	Cal. Health and Safety Code §116455	State	Notification levels (NLs) issued pursuant to Health and Safety Code section 116455 are health-based advisory levels set by the state's Department of Health Services (DHS). NLs are not compliance levels for potable water suppliers but rather are levels of chemicals above which a drinking water source must notify local governing bodies. Response Levels (RLs) are levels above which DHS recommends taking the drinking water source out of service.	TBC	Notification Levels are not ARARs but can be TBCs for Site COCs without MCLs. 1,4-dioxane has been identified as a COC at the North Basin site. The Notification Level for 1,4-dioxane is 1 µg/L and the Response Level is 35 µg/L. 1,4-dioxane has been detected in the North Basin at concentrations up to 206 µg/L (up to 770 µg/L in grab samples).	General
6	Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304	Calif. Water Code §13304; SWRCB Res. 92-49	State	Establishes the basis for determining cleanup levels of waters of the State. Dischargers are required to clean up and abate the effects of discharges "in a manner that promotes attainment of either background water quality, or the best water quality which is reasonable if background levels of water quality cannot be restored, . . ." Alternative cleanup levels less stringent than background must, among other things, not unreasonably affect present and anticipated beneficial uses of waters of the State. The Resolution also includes procedures to investigate the nature and horizontal and vertical extent of a discharge and procedures to determine appropriate cleanup and abatement measures.	TBC	This Resolution provides a policy description and administrative requirements for investigation and cleanup that can be considered for development of appropriate remediation.	General
Location-specific ARARs							
7	Floodplain Management	Executive order No. 11988, Section 2(a)(2)	Federal	Evaluate potential effects of actions in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development with a floodplain.	Relevant and Appropriate	A small portion of the areas overlying the Orange County North Basin-impacted groundwater are located within the 100-year floodplain. For that area, the substantive provisions of EO 11988 are potentially relevant and appropriate in locating facilities for the selected remedy in the 100-year floodplain area.	General
8	Within 100-year Floodplain	Cal. Code Regs. Tit. 22, §66264.18(b)	State	Hazardous waste facilities within the 100-year floodplain must be designed, constructed, operated, and maintained to avoid washout.	Relevant and Appropriate	A small portion of the areas overlying the Orange County North Basin-impacted groundwater are located within the 100-year floodplain. Potentially relevant and appropriate for those groundwater remedial action alternatives that include storage or treatment.	General
Action-specific ARARs							
9	Concentration Limits	Cal. Code of Reg. title 27, §20430(c); 23 CCR §2550.10(c)	State	Requirement for cleanups to attain concentration limits throughout the affected zone.	Relevant and Appropriate	These requirements are relevant and appropriate for remedial alternatives utilizing injection. Substantive requirements of the selected remedial alternative should meet the concentration limits in the zone(s) affected by injection.	Alternatives using injection.

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
10	On-site waste generation	Cal. Code Regs. Tit. 22, §66262.11	State	Persons that generate waste shall determine if that waste is a hazardous waste.	Relevant and Appropriate	Applicable for any operation where hazardous waste is generated. The determination of whether groundwater and/or wastes generated during remedial activities, such as soil cuttings from well installation and groundwater treatment residues, are hazardous to be made at the time the wastes are generated.	General
11		Cal. Code Regs. Tit. 22 § 66264.13(a) and (b)	State	Requirements for analyzing waste for determining whether waste is hazardous.	Relevant and Appropriate	Applicable requirements when analyzing waste generated during the groundwater remedial action (e.g., groundwater treatment residues such as spent carbon or ion exchange resin).	General
12	Hazardous waste accumulation	Cal. Code Regs. Tit. 22, § 66262.34	State	Requirements for onsite hazardous waste accumulation up to 90 days including that the waste is stored in containers in containers or in tanks, on drip pads, inside buildings, and is labeled and dated.	Relevant and Appropriate	Wastes are not planned to be stored on-site for greater than 90 days. For wastes stored on-site for shorter periods, these substantive requirements are potentially applicable for accumulation of hazardous waste generated during the groundwater remedial action (e.g., groundwater treatment residues such as spent carbon or ion exchange resin) stored on-site for 90 days or less. Upon selecting preferred alternative with generated waste, specific subsection requirements to be identified.	General
13	Container Storage	Cal. Code Regs. Tit. 22, § 66264.171, .172, .173	State	Containers of RCRA hazardous waste must be: • maintained in good condition, • compatible with hazardous waste to be stored, and • closed during storage except to add or remove waste.	Relevant and Appropriate	Substantive requirements are applicable for accumulation of hazardous waste generated during the groundwater remedial action (e.g., groundwater treatment residues such as spent carbon or ion exchange resin).	General
14		Cal. Code Regs. Tit. 22, 66264.175(b)	State	Containers must be placed on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.	Relevant and Appropriate	Potentially applicable if hazardous wastes generated during the groundwater remedial action (e.g., groundwater treatment residues such as spent carbon or ion exchange resin) are generated and stored in on-site containers.	General
15		Cal. Code Regs. Tit. 22, § 66264.177	State	Separate incompatible materials stored near each other by a dike or other barrier.	Relevant and Appropriate	Potentially applicable for storage of materials used in treatment processes that are incompatible	General
16		Cal. Code Regs. Tit. 22, § 66264.178	State	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	Relevant and Appropriate	First two sentences of this regulation are relevant and appropriate decontamination and removal requirements where RCRA hazardous wastes are generated during the groundwater remedial action (e.g., groundwater treatment residues such as spent carbon or ion exchange resin) and are present at the time of treatment plant closure.	General
17	Use of tank systems	Cal. Code Regs. Tit. 22, §66264.192(a), (b), (c), (e), (f), and (g)	State	Requirements for the design and installation of new tank systems including strength, tightness testing, damage control, support, corrosion control.	Relevant and Appropriate	Where selected remedy provides extracted groundwater or treatment residuals generated during the groundwater remedial action classified as RCRA hazardous to be stored in tank systems, the substantive requirements of this regulation may be potential ARARs. Specific requirements to be identified at remedy selection.	General

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
18		Cal. Code Regs. Tit. 22 §66264.193(b), (c), (d), and (e)	State	Requirements for secondary containment of tank systems.	Relevant and Appropriate	Substantive requirements of this section are potential ARARs where extracted groundwater or treatment residuals generated during the groundwater remedial action is classified as RCRA hazardous and tank systems are used for its storage. Upon selecting preferred alternative with generated waste, specific subsection requirements to be identified.	General
19		Cal. Code Regs. Tit. 22, §264.193(f)	State	Requirements for secondary containment of ancillary equipment.	Relevant and Appropriate	Substantive requirements of this section are potential ARARs where extracted groundwater or treatment residuals generated during the groundwater remedial action is classified as RCRA hazardous and tank systems are used for its storage.	General
20		Cal. Code Regs. Tit. 22, §66264.194(a) and (b)	State	Requirements for operation of tank systems for spill prevention and prohibition of materials that could cause failure.	Relevant and Appropriate	Substantive requirements of this section are potential ARARs where extracted groundwater or treatment residuals generated during the groundwater remedial action is classified as RCRA hazardous and tank systems are used for its storage. Specific subsection requirements to be identified at time of remedy selection.	General
21		Cal. Code Regs. Tit. 22, §66264.195(a), (b), and (c)	State	Requirements for routine inspection of tank systems for overflow protection, corrosion, release, detection equipment, and cathodic protection.	Relevant and Appropriate	Substantive requirements of this section are potential ARARs where extracted groundwater or treatment residuals generated during the groundwater remedial action is classified as RCRA hazardous and tank systems are used for its storage. Specific subsection requirements to be identified at time of remedy selection.	General
22		Cal. Code Regs. Tit. 22, §66264.196(b) except for (b)(5) and (b)(7)	State	Requirements for response to leaks and spills from tank systems: removal of system from use if appropriate, containment, cleanup, and emergency procedures, etc.	Relevant and Appropriate	Substantive requirements of this section are potential ARARs where extracted groundwater or treatment residuals generated during the groundwater remedial action is classified as RCRA hazardous and tank systems are used for its storage. Specific subsection requirements to be identified at time of remedy selection.	General
23		Cal. Code Regs. Tit. 22, §66264.197(a) and (b)	State	Requirements for closure and post-closure care of tank systems decontamination, clean closure and leaving waste in place.	Relevant and Appropriate	Substantive requirements of this section are potential ARARs where extracted groundwater or treatment residuals generated during the groundwater remedial action is classified as RCRA hazardous and tank systems are used for its storage. Specific subsection requirements to be identified at time of remedy selection.	General
24	Resource Conservation and Recovery Act (42 U.S.C., ch. 82, §§ 6901–6991[i])[(1)]	Cal. Code Regs. tit. 22, §§ 66261.20(a), 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100	State	Defines RCRA hazardous waste criteria and how to determine whether a hazardous waste is a RCRA hazardous waste.	Applicable	Applicable for determining whether groundwater treatment residues such as spent carbon or ion exchange resin are hazardous wastes. When hazardous waste streams are identified, the specific associated waste management actions should be identified as ARARs.	General

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
25		Cal. Code Regs. tit. 22, § 66261.3(a)(2)(C) or 66261.3(a)(2)(F), 66261.22(a)(3) and (4), 66261.24(a)(2)–(a)(8), 66261.101(a)(1) and (a)(2)	State	Defines "non-RCRA hazardous waste."	Applicable	Applicable for determining whether groundwater treatment residues such as spent carbon or ion exchange resin are non-RCRA hazardous wastes. When specific hazardous waste streams are identified, the specific associated waste management actions should be identified as ARARs.	General
26	Groundwater Protection Standard	Cal. Code Regs. Tit. 22, §66264.94	State	Owners/operators of regulated units performing RCRA treatment, storage, or disposal facilities required to comply with design conditions to ensure hazardous constituents entering the groundwater from a regulated unit do not exceed the concentration limits for contaminants of concern under Cal. Code Regs. tit. 22, § 66264.94 in the uppermost aquifer underlying the waste management area of concern at the Point of Compliance.	Relevant and appropriate	Treatment alternatives involving discharges to groundwater (i.e. injection or infiltration) must meet Groundwater Protection Standard requirements.	General
27		Cal. Code Regs. Tit. 22, §66268.1(f)	State	Land Disposal Requirements (LDRs) prohibit disposal of hazardous waste unless treatment standards are met.	Relevant and Appropriate	LDRs are potentially applicable to alternatives involving waste residuals (e.g., groundwater treatment residues such as spent carbon or ion exchange resin). Upon selecting preferred alternative with alternatives involving waste residuals, specific subsection requirements to be identified.	General
28	Waste	Cal. Code Regs. Tit. 27, §§20210, 20220, and 20230	State	Defines designated waste, nonhazardous waste, and inert waste for purpose of permissible discharge.	Applicable	Waste classification definitions applicable for determining discharge options for preferred alternative. Upon selecting preferred alternative with alternatives involving waste residuals, specific subsection requirements to be identified.	General
29		Cal. Code Regs. Tit. 27, §§ 20200(c)	State	Requirement that dischargers accurately characterize wastes, including determinations of whether wastes are compatible with containment features and other wastes, and whether they must be managed as hazardous wastes.	Applicable	Applicable for accurate characterization of wastes (e.g., groundwater treatment residuals).	General
30	DTSC Toxicity Criteria Rule for Human Health Risk Assessments	22 CCR §§68400.5 and 69020 (Toxicity Criteria Rule)	State	The Toxicity Criteria Rule requires use of specific toxicity criteria for specified chemicals, metals, and contaminants as inputs into human health risk assessments for hazardous substances where the state Office of Environmental Health Hazard Assessment (OEHHA) value of the substance is more stringent than those set by EPA's Integrated Risk Information System (IRIS).	TBC	Generally, toxicity criteria are used as inputs into human health risk assessments and to determine risk-based cleanup levels. California's Toxicity Criteria Rule sets narrative performance standards for cleanup goals and requires those goals to achieve the human health protection calculated using the listed toxicity criteria in Appendix 1 to 22 CCR § 69021, consistent with California Health & Safety and federal law and guidance. For those contaminants that have more stringent OEHHA toxicity criteria, the state values were considered in the North Basin site human health risk assessment.	General

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
31	Clean Water Act (CWA) of 1977, Section 402, as Amended	33 U.S.C. § 1314(a); NPDES CAG918001 (R8-2012-0027) Parts V and VI	Federal	The Clean Water Act controls the direct discharge of pollutants to surface waters. The direct discharge of pollutants to surface waters is controlled through the National Pollutant Discharge Elimination System (NPDES) program. NPDES permits contain limits based upon either effluent (discharge) standards, or, if they are more stringent, ambient (overall water quality) standards. NPDES permits in California are issued, monitored, and enforced by with the State agency authorized by EPA to administer the State program. The Regional Board has adopted general NPDES permits, each of which regulates discharges of similar types of wastes, including the following general permits: Order No. 91-63 (discharges from groundwater cleanup projects) and Order No. 93-49 (dewatering activities).	Relevant and appropriate	General permit requirements are relevant and appropriate for groundwater cleanup and dewatering where the remedial alternative includes discharge to ground or surface water or discharge to a POTW. Any on-site discharge to surface waters as part of the selected remedy must meet the substantive NPDES requirements. However, *off-site discharges* from the site to surface waters would be required to be permitted and meet both the substantive and the administrative NPDES permit requirements. Upon selecting a preferred alternative involving surface water or discharge to a POTW, specific selected requirements from the NPDES permit need to be identified. NPDES CAG918001 (R8-2012-0027) Parts V and VI include discharge prohibitions, effluent limitations, discharge specifications, receiving water limitations, and provisions and compliance determination.	Discharge to surface waters
32		Order No. R8-2013-0031	State	Order No.R8-2013-0031 regulates discharges to surface water from wellhead treatment systems, including from well installation and development, well blow-down during startup, water used for backwashing or fluffing of new carbon units, and disinfection and rinse water from new units.	Relevant and Appropriate	Requirements are relevant and appropriate for alternatives involving discharges to surface water. Parts IV, V, VI, and VII describe the discharge prohibitions, effluent limitations, discharge specifications, and receiving water limitations.	Discharge to surface water
33	Underground Injection Control Program	40 CFR § 144.12, excluding the reporting requirements in § 144.12(b) and 144.12(c)(1)	Federal	The UIC program governs injection activities, prohibiting actions that allow movement of contaminants into underground sources of drinking water that may result in violations of MCLs or adversely affect health.	Relevant and Appropriate	If groundwater recirculation is part of the selected remedy or if the treated groundwater is returned to the aquifer, injection wells for these remedial alternatives would be Class V wells under the UIC program. Substantive provisions of the UIC rules are relevant and appropriate to the extent necessary to ensure that reinjection of treated groundwater would not cause the aquifer to violate primary drinking water regulations or may otherwise adversely affect human health.	Injection of treated groundwater
34		40 CFR § 146.13(a), (b), (d)	Federal	Requirements for injection pressure maximums to ensure that injection does not initiate new fractures or propagate existing ones and cause the movement of fluids into an underground source of drinking water. Requirements include continuous monitoring of injection pressure, flow rate, and volume, and annual pressure.	Relevant and Appropriate	Substantive requirements are relevant and appropriate for alternatives employing groundwater reinjection.	Injection of treated groundwater
35		40 CFR § 148.1(d)	Federal	Provides conditions under which wastes that are only hazardous because they exhibit a hazardous characteristic are able to be disposed into nonhazardous or hazardous injection wells.	Relevant and Appropriate	Requirements for disposal of hazardous wastes through groundwater reinjection in Class V wells. Potentially relevant and appropriate for alternatives employing groundwater reinjection.	Injection of treated groundwater
36	Statement of Policy with Respect to Maintaining High Quality of Waters in California (Nondegradation Policy)	23 CCR § 2900; SWRCB Resolution Number 68-16	State	Resolution No. 68-16 (Nondegradation Policy) has been incorporated into all Regional Board Basin Plans. The Nondegradation Policy applies to discharges of waste to waters of the State, such as discharges to surface waters subject to NPDES permits, reinjection of treated water to ground water, and discharges to land that may impact waters of the State. This resolution requires that the quality of waters of the State be maintained and protected and that discharges to high quality waters be consistent with protection of beneficial uses of that water.	Relevant and appropriate	Substantive requirements are relevant and appropriate for alternatives that involve reinjection of treated groundwater to the aquifer. In addition to removal of Site chemicals of concern, alternatives utilizing reinjection or percolation must ensure that reinjection does not reduce the quality of protected water resources downgradient from the reinjection site. This may include siting of reinjection facilities in a manner that ensures reasonable protection of higher quality waters that may be impacted.	General

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
37	Policy on Onsite Wastewater Treatment Systems	California Water Code, Chapter 4.5, Division 7, § 13290-13291.7 Resolution No. R8-2014-0005 Resolution No. 2012-0032	State	Policy on Onsite Wastewater Treatment Systems (OWTS Policy) (Resolution No. 2012-0032, and Resolution No. R8-2014-0005) regulates the siting, design, operation, and maintenance of onsite wastewater treatment systems. The Policy implements the California Water Code, Chapter 4.5, Division 7, § 13290-13291.7 by establishing statewide regulations and standards for permitting onsite wastewater systems. The OWTS Policy specifies criteria for existing, new and replacement onsite systems and establishes a conditional waiver of waste discharge requirements for onsite systems that comply with the Policy.	TBC	May serve as guidance for development and design of alternatives that treat groundwater on site.	General
38	Construction Storm Water General Permit	SWRCB Adopted Order 2009-0009-DWQ (As amended by 2010-0014-DWQ and 2012-0006-DWQ)	State	This order requires a general permit to discharge storm water associated with construction activity including clearing, grading, and excavation activities that disturb greater than 1 acre of total land area. Development and implementation of a SWPPP and monitoring program are required to be in place by the start of construction.	Relevant and Appropriate	The substantive requirements in sections III.A-D; IV.A.2, D, E, L.4; V; VI; VIII; IX, X, and XI; XIII; and XIV.A, B of Order 2009-0009-DWQ are potential ARARs for stormwater discharge and SWPPP development.	General
39	Waste Discharge Requirements	SWRCB R8-2002-0033, as amended by Order Nos. R8-2003-0085 and R8-2013-0020	State	"General Waste Discharge Requirements for the Reinjection/Percolation of Extracted and Treated Groundwater Resulting from the Cleanup of Groundwater Polluted by Petroleum Hydrocarbons, Solvents and/or Petroleum Hydrocarbons Mixed with Lead and/or Solvents" for the Santa Ana Region. Parts A, B, C, and M&RP include discharge specifications.	Relevant and Appropriate	Discharge limits in Order R8-2013-0020 for 1,4-dioxane at 1 ug/l and perchlorate at 6 ug/l, as set forth are relevant and appropriate for reinjection or percolation of treated groundwater. The remaining requirements, including compliance monitoring, are administrative requirements and not ARARs for the remedy. Discharges that are considered off-site may be required to meet both substantive and administrative requirements.	Injection or percolation of treated groundwater
40	Sanitary Sewer Pretreatment Standards	33 U.S.C. 1251, et seq.; 40 CFR 403; Porter-Cologne Water Quality Control Act (Water Code Sections 13000, 13304.1); Orange County Sanitation District Ordinance No. OCSD-53	State	Regulation of wastewater discharges to OCSD's sewers, as required by federal and state law, including the Clean Water Act (33 U.S.C 1251 et.seq.), the General Pretreatment Regulations (40 CFR 403), and the Porter-Cologne Water Quality Control Act (Water Code sections 13000 et seq). Implementation and monitoring requirements in compliance with federal regulations in 40 CFR 403 for pretreatment programs dependent upon POTW design capacity: municipal sewage treatment facilities with design capacity is greater than five million gallons per day (MGD) and smaller municipal treatment systems if there are significant industrial contributions to their systems.	Relevant and Appropriate	These standards are relevant and appropriate to remedial alternatives involving discharge to OCSD's sanitary sewer prior to or after treatment of groundwater. Standards require that the POTW has an EPA-approved pretreatment program or has sufficient mechanisms and treatment capacity for meeting the discharge standards.	Discharge of extracted groundwater to sanitary sewer
41	Air Quality	South Coast AQMD Rules 201, 203, 403, 1166, 1403, and 1466	State	Requirements for discharges to air from remedial equipment.	Relevant and Appropriate.	Where the remedial alternative involves discharges to the air, such as with air stripping, SCAQMD requirements may be included as ARARs. Should the selected alternative include air stripping, the specific applicable sections of these rules should be identified as ARARs. However, use of an air stripper or another treatment technology that results in a discharge of VOCs to air is not expected to be implemented for the Interim Remedy.	If treatment includes an air stripper

TABLE B-1. POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS - ORANGE COUNTY NORTH BASIN

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments	Remedial Alternative to which ARAR Determination Applies
42	Water Well Standards: State of California	California Water Code, Chapter 10 § 13700-13808.8	State	Established minimum statewide standards for well construction and destruction, as outlined in California Department of Water Resources (DWR) Bulletin 74-81 and the Draft Supplemental Bulletin 74-90. The Draft supplemental DWR Bulletin 74-90 was not finalized by DWR, nor officially adopted into the Model Well Ordinance by the State Water Resources Control Board. However, it has been adopted into local ordinances.	Applicable	Applicable to installation of monitoring and extraction wells associated with the remedial action. State Water Well Standards are currently being updated with a projected publishing date of Spring 2026.	General
43	Land Use Covenants	Cal. Code Regs. Tit. 22, §67391.1 (a), (d), (f)	State	Requirements to execute and record land-use covenants imposing when response actions leave hazardous materials, hazardous wastes or constituents, or hazardous substances at levels that are not suitable for unrestricted use of the land.	Applicable	The interim remedy is not intended to leave waste in place such that deed restrictions would be necessary; this regulation can be considered for the final remedy if applicable. The regulation may be applicable where determined needed to protect remedial infrastructure.	General

Notes:

(1) California hazardous waste (as used in this table) is the same as non-RCRA hazardous waste as defined in Section 66261.101 of CCR Title 22.

(2) Local requirements can be ARARs under SWA pretreatment program.

ARAR	applicable or relevant and appropriate requirement
COC	contaminant of concern
COPC	contaminant of potential concern
DTSC	Department of Toxic Substances Control
IRIS	Integrated Risk Information System
MCL	maximum contaminant level
MGD	million gallons per day
NL	notification level
OEHHA	Office of Environmental Health Hazard Assessment
PCE	tetrachloroethylene
PFAA	per and polyfluoroalkyl acid
PFAS	per- and polyfluoroalkyl substances
PFBA	Perfluorobutanoic acid
PFBS	perfluorobutane sulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
POTW	publicly owned treatment works
RCRA	Resource Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board
SWRCB	State Water Resources Control Board
TBC	to be considered
TCE	trichloroethene
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

Appendix C
Groundwater Modeling of Plume Containment

TECHNICAL MEMORANDUM

To: Dave Mark, PG, CHG; Orange County Water District

CC: Roy Herndon, PG, CHG; Tim Sovich, PE; Orange County Water District

From: Abhishek Singh, PhD, PE; Mitsuyo Tsuda, GIT, EIT; Erick Fox, GISP; INTERA Incorporated

Date: February 14, 2024

Subject: Groundwater Modeling of North Basin Interim Remedy Plume Containment

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INTRODUCTION

The Orange County Groundwater Basin (”Basin”) is part of the 360-square-mile coastal plain of Orange County. The northern portion of the Basin (“North Basin”), which includes the cities of Fullerton, Anaheim and Placentia, falls within the region known as the Forebay, the predominant area of basin recharge. The North Basin area is surrounded by the Coyote Hills to the north, the Chino Hills and Santa Ana Mountains to the east, the central portion of the Basin to the south, and the Central Basin in Los Angeles County to the west (CA DWR, 2003; OCWD, 2015). The Santa Ana River, the primary surface water drainage feature in the area, is located east and southeast of this area. In the North Basin area, the Orange County Water District (OCWD) has identified three aquifer zones: Shallow, Principal and Deep. The Principal zone is the primary source of approximately 77 percent of the potable water supply within OCWD’s boundary. However, the Shallow zone is also locally used for potable water supply. Nearly all groundwater reaching the Principal and Deep zones originates from recharge into the Shallow zone. In portions of the North Basin, the boundary between the Shallow and Principal zones is generally delineated by the Upper Aquitard: a fine-grained layer at a depth of approximately 200 to 250 feet below ground surface (ft bgs); however, this fine-grained layer is locally absent or discontinuous, particularly in the eastern part of the study area.

Groundwater investigations and observed water quality from monitoring and production wells in the area have revealed an approximately 5-1/2-mile-long plume of contamination that has caused several potable water production wells to be taken out of service. The contamination consists of industrial solvents, referred to as volatile organic compounds (VOCs), that spilled into the ground from past industrial/manufacturing activities. **Figure 1** shows the area of groundwater contamination in the Shallow and Principal zones in the North Basin. OCWD is currently conducting an Interim Remedial Investigation and Feasibility Study (RI/FS) to address areas with elevated concentrations of contamination in the North Basin area.

As part of its initial groundwater cleanup efforts, in 2008 through 2013, OCWD installed six (6) extraction wells (OCWD-EW1; OCWD-EW2; OCWD-EW2A; OCWD-EW3; OCWD-EW3A; and OCWD-EW4) intended for hydraulic control and pump and treat remediation of the VOC plume. For several reasons, only one of the wells (OCWD-EW1) was placed on-line and the larger project was put on hold and is being reevaluated as part of the current RI/FS for an Interim Remedy. To support the on-going RI/FS, OCWD hired INTERA to evaluate several alternatives to contain the plume within an Interim Remedy 'target area' (shown in **Figure 1**) to protect water supply wells and groundwater resources threatened by the spread of the contamination. The target area for containment is described in detail in the Remedial Investigation Report (AECOM, 2022). The Interim Remedy target area, which was developed in consultation with the U.S. Environmental Protection Agency (EPA), includes areas with elevated VOC concentrations and most known sites where releases of VOC occurred.

GROUNDWATER MODEL BACKGROUND

In 2014, OCWD hired INTERA to build and calibrate a groundwater flow model (INTERA, 2017) of the North Basin. The OCWD North Basin model is based on the existing regional OCWD model, while being updated, refined, and calibrated to the most recent geologic, hydraulic and water quality data (from 2005-2014). The OCWD North Basin model is a transient, three-dimensional groundwater model constructed using the MODFLOW-NWT code (Niswonger et al., 2000; Harbaugh et al., 2000). The model simulates monthly water levels in the Shallow zone (Layer 1), the upper aquitard between the Shallow and Principal zones (Layer 2), the lower aquitard between the Principal and Deep zones (Layer 13), and the Deep zone (Layer 14) as single layers, with the Principal zone subdivided into 10 model layers of equal thickness (Layers 3 to 12). The model simulation period covers the period from July 2005 to June 2014, which encompasses both high and low water level periods in the Basin.

The model was calibrated to match observed lateral and vertical hydraulic heads and gradients (from July 2005 to June 2014) across the Shallow and upper Principal zones, and the calibrated model parameters were repeated for 3 cycles to cover the 27-year simulation period. These hydraulic gradients drive the lateral and vertical migration of VOCs across and within the Shallow and Principal zones. The numerical model has been documented in a comprehensive report (INTERA, 2017) and has been reviewed by EPA (Wallace, 2017), California Regional Water Quality Control Board (RWQCB) - Santa Ana Region, and the California Department of Toxic Substances Control (DTSC).

As part of the RI/FS, with field oversight by its consultant AECOM, OCWD drilled and constructed 23 new monitoring wells at 13 locations to augment the data from over 80 monitoring wells previously constructed by OCWD in the North Basin. With completion of the monitoring well installations and associated data collection from 2017-2018, INTERA refined the model by integrating the new site-specific data into the conceptual hydrogeologic framework and numerical model of the North Basin site. In addition, INTERA also refined the calibration of the North Basin model in response to review of the OCWD North Basin model (INTERA, 2017) by the EPA (Wallace, 2017). These model refinements focused on a) improved representation of the

Upper Aquitard (between the Shallow and Principal zones) as well as Shallow and upper Principal zone properties based on new borehole and monitoring well data, and b) improved water level calibration along the northern and northeastern model boundaries. These model revisions and refinements were documented in a Draft Technical Memorandum (INTERA, 2020).

The refined North Basin model has a grid resolution of 125 ft x 125 ft in the OCWD-EW1 area, with model stratigraphy and (horizontal and vertical) hydraulic conductivities calibrated to reflect lithological and geophysical data as well as match, as closely as possible, observed water levels at all OCWD monitoring wells. As discussed below, additional model grid refinement in the vicinity of EW-1 was conducted for the purpose of capture zone analysis.

The refined calibrated model has an overall normalized root mean square error (RMSE) (error between simulated and observed hydraulic head divided by the range in observed hydraulic head across the model domain) of approximately 2%. The normalized RMSE of the Shallow zone (model layer 1) and the upper Principal zone (model layers 3 to 7) were all within 5%. This is well within the industry standard of 10% normalized RMSE (Spitz and Moreno, 1996; Rumbaugh and Rumbaugh, 2005). In addition, the model was also calibrated qualitatively against hand-drawn water level contours and water quality data (INTERA, 2017, 2020).

Figures 2a – 2f show the calibrated horizontal hydraulic conductivities for the Shallow zone (Layer 1), the vertical hydraulic conductivity of the upper aquitard (Layer 2), the horizontal hydraulic conductivity of the upper Principal zone (Layer 3), and the thicknesses of the first three model layers. **Table 1** shows the range of horizontal and vertical hydraulic conductivities and thicknesses within the target area for containment for the Shallow zone (layer 1), upper aquitard (layer 2), and the upper Principal zone (layers 3 to 7). Additional details of model structure, boundary conditions, properties, and calibration can be found in the original model report (INTERA, 2017) and model refinement technical memorandum (INTERA, 2020).

Table 1: *Hydraulic Conductivities and Thickness Ranges within the Target Area for Hydraulic Containment*

Layer	Zone	Horizontal Hydraulic Conductivities (ft/d)	Vertical Hydraulic Conductivities (ft/d)	Thickness (ft)
1	Shallow Zone	1 – 1000	0.1 – 100	159 -308
2	Upper Aquitard	0.0001 – 10	0.0001 – 10	1 - 40
3	Principal Zone	1 – 1000	0.2 – 200	42 - 135
4	Principal Zone	10 – 1000	1.2 – 200	64 - 115
5	Principal Zone	28 – 312	1.4 – 45	62 - 115
6	Principal Zone	36 – 298	1.7 – 48	64 - 115
7	Principal Zone	15 – 275	1.6 – 63	64 - 115

GROUNDWATER MODELING TO ASSESS CONTAINMENT ALTERNATIVES

The refined and calibrated groundwater model was used to assess the feasibility of various scenarios to contain the plume within the target area. Using the calibrated model as a starting point, several predictive simulations were developed to assess the movement of contaminated groundwater (i.e., contaminant concentrations greater than Maximum Contaminant Levels [MCLs] and Notification Levels [NLs]) under future conditions. To assess long-term movement of the contamination in the subsurface, the historically calibrated model covering the simulation period from 2005 to 2014, was extended to 27 years, by repeating the 9-year historical period three times. All transient stresses and boundary conditions were kept the same for each 9-year cycle. The predictive simulations included a 'baseline' simulation - with adjustments to historical groundwater production and recharge but without pumping from existing or new plume containment extraction wells. The predictive simulations also included several configurations of existing and new extraction wells meant to contain the plume within the target area (**Figure 1**). The predictive simulations are described in the following sub-sections.

Particle tracking simulations were performed for each of the modeling scenarios using the MODPATH (Pollock, 1994) code to assess the degree of containment of the VOC plume for each of the predictive simulations. MODPATH is a particle-tracking post-processing model that computes three-dimensional flow paths using output from groundwater flow simulations. A particle's path is computed by tracking the particle from one cell to the next until it reaches a boundary, an internal sink/source, or satisfies another termination criterion. Particle tracking only accounts for advective transport, and does not account for dispersion, diffusion, sorption, or reactions in the subsurface. Based on EPA guidance (U.S. EPA, 2008), forward particle tracking simulations were carried out by releasing multiple particles and tracking them forward in time through the transient simulation. The EPA guidance document states:

"Tracking particles in reverse from initial locations around the extraction wells, to define the capture zone, is a commonly used approach. However, it can lead to erroneous interpretations in two and three dimensions. The apparent area of capture is highly controlled by the number of particles released, and the specific locations (horizontal and vertical) where particles are released."

As such, the backward particle tracking was not conducted, and forward particle tracking was used as the primary approach to assess containment in this analysis.

Particles were released only in the Shallow zone (Layer 1) in areas with high VOC concentrations (based on water quality data collected and mapped by AECOM) at and upgradient of sites with known releases. Three particles were released in each model grid cell at three different depths – just below the top of the water table, mid-point of the water table, and just above the bottom of Shallow zone (layer 1)[1]. Note that the lateral edges of the plume represent areas of dispersion/diffusion between contaminated and clean water. Per the Remedial Action

[1]These vertical release points were specified as "Z-Offset" values of 0.01, 0.5, and 0.99, representing depths at 99%, 50%, and 1% of the initial saturated column depth within each model grid cell in layer 1.

Objectives, the focus of interim remedy containment alternatives are parts of the plume with VOC concentrations that exceed MCLs/NLs within the Containment Area; hence, the particles were released within the plume in areas upgradient of the extraction wells with contaminant concentrations higher than 1X MCL/NL. This also reduced the potential for capture and containment of uncontaminated groundwater (i.e., lower than 1X MCL/NL). A total of 3,591 particles were used for the particle tracking simulations. **Figure 3** shows the locations of the particle starting points. Particles were tracked through the 27-year predictive simulation period to assess capture and containment within the target area. At the end of the particle tracking simulation, particle tracks were analyzed to identify particles that were a) captured by the extraction wells in the Shallow zone (Layer 1) , b) remained contained within the target containment area in the Shallow zone (Layer 1), and c) escaped the target containment area in the Shallow zone and migrated into the upper aquitard (Layer 2) or Principal zone (Layers 3 to 12). Note that uncaptured particles can remain within the target containment area due to the heterogeneities and stagnant zones in the Shallow zone as well as low hydraulic conductivity areas in the aquitard (where present). Particles can get 'trapped' in these low conductivity or low hydraulic gradient areas and not move out of this area within the simulation period. Any particles that left the boundary of the target containment area in the Shallow zone (Layer 1) or entered the upper aquitard (Layer 2) or Principal zone (Layers 3 to 12) were deemed to escape the target containment area. Modeling simulations (described below) entailed testing several configurations of pumping rates and well locations to maximize containment by reducing the percentage of particles escaping the target containment area. A goal of 90% volumetric containment (i.e. 90% of the contaminated volume of the plume to be captured or contained within the target containment area) was used for the containment alternatives analysis. Each particle was representative of a given volume of the plume based on the saturated volume of the starting grid cell (i.e. grid cell area times the initial saturated column in the grid cell) for the particle. Since each model grid cell included three particles, the grid cell volume was apportioned across the three particles – 25% for each of the boundary particles (top and bottom of the cell) and 50% for the middle particle. Containment statistics were calculated by normalizing the number of particles captured/contained with the initial plume volume they represented. The 90% containment objective was decided based on discussions with and approval from OCWD, EPA, and the RWQCB. The 90% containment objective is based on professional judgement and was chosen to be reasonably conservative from a remediation standpoint while also accounting for physical processes such as attenuation, dispersion, and dilution that cannot be simulated by particle tracking simulations but would lead to lower downstream concentrations.

Baseline

The baseline model represents a *'no-action'* case, with expected future hydrologic conditions and regional pumping/recharge operations but without any pumping from existing or new extraction wells to contain the VOC plume.

The calibrated model simulates groundwater conditions from July 2005 to June 2014. **Figures 4a** and **4b** show representative observed and simulated water levels at adjacent wells FFS-1

(screened in the Shallow zone) and FM-17 (screened in the Principal zone) during and after the calibration period. As can be seen, the model simulates historically low (from 2007 to 2010) and high water level (2005 to 2007 and 2011 to 2014) conditions. As such, this nine (9) year calibration period was considered representative of the range of future hydrologic conditions and repeated for 3 cycles to run the baseline case for 27-year simulation period.

Select boundary conditions corresponding to pumping (implemented using the MODFLOW WEL package) and managed recharge (implemented using the MODFLOW RCH package) were modified to represent future changes to groundwater extraction and recharge operations, based on input from OCWD. These changes are summarized below:

- Apart from pumping and managed recharge operations (discussed below) all boundary conditions and properties were kept the same as the historical (2005 - 2014) calibrated model.
- All extraction wells were retained from the historical (2005 – 2014) model. This included large municipal production wells, as well as domestic, irrigation, industrial, and AC Products remediation production wells within the model domain. To represent more recent groundwater extraction operations, pumping for the last three years (2012 – 2014) was repeated over the 27-year simulation period for each production well within the model domain. Attachment A shows a list of all wells within the model domain and well-use designations (provided by OCWD).
- Pumping at large municipal production wells was scaled up by 6% from the measured monthly volumes over the selected three-year historical period 2012-2014 to account for OCWD's final expansion of the Groundwater Replenishment System (GWRS). Pumping was kept the same for all other small production wells.
- None of the OCWD-EW wells were assumed to be operational under baseline conditions.
- AC Products remedial extraction well ACP-03 was turned off in the model, as it was no longer in operation.
- Future pumping at remedial extraction well ACP-02 was cycled through the last three years (2012 – 2014) of measured pumping rates.
- City of Fullerton F-7 was destroyed due to VOC contamination. At the time of this groundwater modeling, the City was in the process of replacing that well with an adjacent deeper well similar to nearby well F-3A. Consequently, well F-7 was inactivated in the model and replaced by a new well F-7A. The screen interval for replacement well F-7A is assumed to be the same as well F-3A and screened in layers 6 to 12 from -432 ft to -1,132 ft below ground surface (bgs). Historical pumping (from 2004 – 2014) for well F-7 was assumed to be representative of future pumping from well F-7A.
- 10 million gallons per day (mgd) of additional recharge on top of historical monthly recharge rates was assumed for Kraemer and Miller recharge basins, to account for expanded future capacity at OCWD's GWRS.

- For Miraloma Basin, measured monthly recharge volumes from 2014 were repeated for all years of the simulation.
- Recharge rates at other recharge basins were kept the same as measured monthly recharge volumes over the period 2005-2014.

Simulation 1: Existing Wells

Table 2: *Pumping Rates for the Existing Wells Simulation*

Extraction Well	Screened Layers	Screen Interval Elevations (ft amsl)	Pumping Rate (gpm)	Pumping Volume (Acre-feet/ Year)
OCWD-EW1	1	35.8 to -10.8	373	602
OCWD-EW2	1	24.9 to -41.2	650	1,048
OCWD-EW2A	1	12.8 to -53.2	500	807
OCWD-EW3	1	0.1 to -43.3	423	683
OCWD-EW4[1]	1	22.8 to -57.2	600	968
Total			2,547	4,108

Note: Totals may not equal the sums due to rounding.

The existing wells simulation built on the baseline simulation but included additional pumping at the six OCWD-EW wells. **Figure 1** shows the locations of the existing OCWD-EW wells. Pumping rates for the wells were based on the 'approximate sustainable capacity' for each well[2], as obtained from OCWD pump tests (included as Attachment B). All OCWD-EW pumping rates were kept constant during the simulation period. OCWD-EW1 and OCWD-EW3 are constructed with screens in the Shallow and Principal zones. However, since the containment objective was defined for the Shallow zone, pumping was focused in the Shallow zone for both wells. This would require the lower screened intervals of EW-1 and EW-3 to be temporarily or permanently sealed off. The pumping capacity for both wells was scaled based on the ratio of the screened transmissivity in the Shallow zone to the total screened transmissivity[3]. This represented a reduction in pumping capacity when both wells would pump only from the Shallow screened interval. Note, the actual pump capacities for both wells in the Shallow zone would need to be confirmed from field testing after the lower interval is permanently sealed off. In all of the subsequent simulations 1 to 5, the pumping rate for the OCWD-EW wells was made consistent, and the extraction was simulated only in the Shallow zone (Layer 1) for existing and new

[1]OCWD-EW4 is screened both in the Shallow zone (layer 1) and upper Principal zone (layer 3); however, pumping was only simulated in the Shallow zone (layer 1), due to reported plugging of the lower screened interval.

[2]Approximate sustainable capacity for the wells were as follows: OCWD-EW1 = 1000 gpm; OCWD-EW2 = 650 gpm; OCWD-2A = 500 gpm; OCWD-EW3 = 650 gpm; OCWD-EW4 = 650 gpm.

[3]OCWD-EW1 ratio of screened transmissivity in the Shallow to the Principal zone was 33% to 67%. OCWD-EW3 ratio of screened transmissivity in the Shallow to the Principal zone was 65% to 35%.

extraction wells. The existing wells simulation entailed a total extraction of 2,547 gpm (4,108 acre-feet/year (AFY)) from the OCWD-EW wells. **Table 2** gives the pumping rates used for the wells.

As discussed below, using only the existing OCWD extraction wells does not meet the 90% containment objective (as discussed in the "Containment Alternatives Modeling Results" section). This was primarily due to numerous particles migrating into the Principal zone in areas where the upper aquitard is absent or discontinuous. As such, increasing pumping rates at existing extraction wells was not considered a viable alternative to increasing containment and additional wells located upgradient of areas of vertical migration were recommended to maximize containment. However, increasing pumping rates at the existing extraction wells was considered as part of subsequent simulations, as described below. The subsequent simulations were developed and evaluated.

Simulation 2: Existing and New Wells

Table 3: *Pumping Rates for the Existing and New Wells Simulation*

Extraction Well	Screened Layer	Pumping Rate (gpm)	Pumping Volume (Acre-feet/Year)
OCWD-EW1	1	373	602
OCWD-EW2	1	650	1,048
OCWD-EW2A	1	500	807
OCWD-EW3	1	423	683
OCWD-EW4	1	600	968
EW-5	1	200	323
EW-6	1	200	323
EW-7	1	500	807
EW-8	1	500	807
EW-9	1	500	807
EW-10	1	200	323
EW-11	1	200	323
EW-12	1	200	323
EW-13	1	300	484
EW-14	1	205	330
EW-15	1	400	645
EW-16	1	400	645
Total		6,351	10,245

Note: Totals may not equal the sums due to rounding.

The existing and new wells simulation entailed adding additional extraction wells to reach the goal of 90% containment within the target area. Several different locations and pumping rates were evaluated for new extraction wells (along with pumping from existing wells) to reach this

goal. Preference was given to pumping in the Shallow zone, to reduce migration of contaminated groundwater into the Principal zone, which is the primary source of potable water supply within OCWD's boundary. As such, new extraction wells were located upgradient of higher conductivity zones in the upper aquitard (Layer 2) to capture particles before they migrated into the Principal zone (Layers 3 to 12).

For this simulation, a total of twelve (12) new extraction wells were included. **Figure 5** shows the locations of existing and new wells used for this simulation and **Table 3** shows the pumping rates for the wells. The pumping rates for the OCWD-EW wells are the same as those used in Simulation 1. The model assumes constant pumping at the given rates through the simulation period.

Simulation 3: Alternative Wells

Table 4: *Pumping Rates for the Alternative Wells Simulation*

Extraction Well	Screened Layer	Pumping Rate (gpm)	Pumping Volume (Acre-feet/year)
OCWD-EW2A	1	500	807
OCWD-EW4	1	600	968
EW-5	1	500	807
EW-6	1	1,000	1,613
EW-7	1	500	807
EW-8	1	500	807
EW-9	1	500	807
EW-10	1	200	323
EW-11	1	200	323
EW-12	1	200	323
EW-13	1	300	484
EW-14	1	256	413
EW-15	1	500	807
EW-16	1	200	323
EW-17	1	1,000	1,613
Total		6,956	11,220

Note: Totals may not equal the sums due to rounding.

The existing and new wells simulation (described above) entailed adding additional wells to augment the existing OCWD extraction wells. A separate simulation was created to assess alternatives to the existing extraction wells with the goal of improving capture and containment within the target area. As such all existing OCWD-EW wells except for OCWD-EW2A and OCWD-EW4 were turned off for this simulation, and alternative and additional wells were added to achieve the containment goal of 90%. A total of 15 wells were needed to achieve this goal. OCWD-EW2A and OCWD-EW4 were found to be desirable locations for optimal containment and capture and thus were included in the set of wells used for this simulation. Pumping at these two wells was kept consistent with the "existing well" simulations (simulations 1 and 2). OCWD-EW1

was replaced by well EW_6, downgradient and west of the OCWD-EW1 location. OCWD-EW3 was replaced by a new extraction well (EW_17) to the west. **Figure 6** shows the locations of alternative wells used for this simulation and **Table 4** shows the pumping rates for the wells. As before, the model used constant pumping at the given rates through the simulation period.

Simulation 4: Existing and New Wells with Injection

Water from the extraction wells may be treated and used to inject/recharge the groundwater basin. Therefore, an additional simulation was defined using the "existing and new wells simulation" (Simulation 2) as a starting point; however, all the extracted volume of water was assumed to be recharged at injection wells. Based on input from AECOM, it was assumed that all the injection would be in the Shallow zone (Layer 1) outside the plume to prevent lateral spreading of the plume and avoid the need to treat for non-Contaminants of Concern (e.g., total dissolved solids, nitrates, perchlorates), which would be required to meet the California antidegradation requirements if the treated water was injected into the Principal zone. For modeling purposes, the proposed injection locations intersected with four model grid cells. Injection was simulated as a specified flux boundary (using the MODFLOW WEL package) with the total volume of water applied uniformly across the four grid cells. The injection volume was kept equal to the total extraction volume of 6,546 gpm/10,560 AFY and applied at a constant rate throughout the simulation period. The additional injection in the Shallow zone increased water levels along the southern and western end of the target area. The location of the injection wells in relation to the plume extent influenced the vertical gradient between the Shallow zone, the underlying aquitard, and the Principal zone. Different injection locations were tested and the pumping rate at EW-14 was increased from 205 gpm/330 AFY to 400 gpm/645 AFY to ensure that containment within the Shallow zone would still be maintained at 90% with the injection wells injecting at target rates. **Figure 7a** shows the location of the injection wells that achieved more than 90% containment. Note, the locations of the injection wells is conceptual at this stage. Future siting and more detailed remedial design can assess if it is more cost effective to move injection wells further to the south, balancing the cost of longer pipeline versus the cost of increase in pumping from the extraction well closest to the injection wells.

Heads at the injection well location increased by approximately 14 ft compared to baseline conditions (**Figure 7b**) and by approximately 16 ft compared to Simulation 2 (**Figure 7c**). The highest simulated water level was approximately 93 ft below the top of layer 1, indicating no risk of localized mounding or surface flooding from the injection wells. **Figure 7d** shows the time-series of vertical gradient between the Shallow zone (layer 1) and the Principal zone (layer 3) for baseline, Simulation 2, and Simulation 4 at the southern end of the plume closest to the injection ("Sample Point" in **Figures 7b** and **7c**). Based on the model, the change in vertical gradients between Simulations 2 and 4 ranged from 0.004 to 0.017 ft/ft through the simulation period. However, the change in vertical gradient alone is not sufficient to determine the path that contamination takes. For contamination to migrate into the Principal zone, it has to overcome lateral gradients and also needs a conductive pathway through the intervening aquitard. The particle tracking analysis is a more robust indicator of the impact of injection on the vertical

migration of the contaminant. The results of the particle tracking analysis are summarized in **Tables 6a and 6b** and Attachment C.

Table 5: *Pumping Rates for the Existing and New Wells with Injection Simulation*

Extraction Well	Screened Layer	Pumping Rate (gpm)	Pumping Volume (Acre-feet/year)
OCWD-EW1	1	373	602
OCWD-EW2	1	650	1,048
OCWD-EW2A	1	500	807
OCWD-EW3	1	423	683
OCWD-EW4	1	600	968
EW-5	1	200	323
EW-6	1	200	323
EW-7	1	500	807
EW-8	1	500	807
EW-9	1	500	807
EW-10	1	200	323
EW-11	1	200	323
EW-12	1	200	323
EW-13	1	300	484
EW-14	1	400	645
EW-15	1	400	645
EW-16	1	400	645
Total		6,546	10,560

Note: Totals may not equal the sums due to rounding.

Simulation 5: Existing and New Wells with Recharge Basin

Water from the extraction wells may be treated and used to inject/recharge the groundwater basin. An alternative simulation was defined based on the existing and new wells simulation; however, all the extracted volume of water (6,351 gpm/10,245 AFY) was assumed to be recharged into the groundwater basin at a new recharge basin, instead of the injection well in Simulation 4. The location of the recharge basin was provided by AECOM and is shown in **Figure 7a**. For modeling purposes, the proposed recharge basin location intersected with seven model grid cells. Recharge was simulated as a specified flux boundary (using the MODFLOW WEL package) with the total volume of water applied uniformly across the seven grid cells. All other parts of the model were kept the same as Simulation 2. The additional recharge increased water levels locally at the new recharge basin location by approximately 28 ft compared to baseline conditions (**Figure 7e**). The highest simulated water level was approximately 86 ft below the top of layer 1, indicating no risk of localized mounding or surface flooding from the additional recharge. Simulated water levels along the eastern boundary of the containment area increased by approximately 2-4 ft from the additional recharge. Despite these local increase in heads, 90%

containment was found to be viable with the recharge basins. Pumping rates at the extraction wells were kept the same as the existing and new wells simulation (Simulation 2), as the desired level of containment was achieved with the given extraction wells and rates.

CONTAINMENT SIMULATION MODELING RESULTS

Particle tracking results for each of the simulations were imported into a geographical information system for visualization and analysis of capture and containment. Any particles leaving the boundary of the target containment area in the Shallow zone (Layer 1) or entering the upper aquitard (Layer 2) or Principal zone (Layers 3 to 12) were deemed to escape the target containment area. The counts of particles were normalized based on the volume of the model grid cell in which the particle started. The results were tabulated to assess the percentage of containment of particle tracks. **Tables 6a and 6b** provide a summary of the containment analysis results for all six simulations. **Table 6a** shows capture/containment statistics based on the percentage of particles captured by the extraction wells or contained within the target containment area in layer 1. Note, the particle statistics are based on weighted particle counts, wherein each particle is normalized based on the volume of the VOC plume it represents. Attachment C shows the particle statistics based on unweighted particle counts, and the tracks of these particles are illustrated in **Figures 8 – 13**.

Figures 8a – **8c** show the unweighted particles within and outside the target containment area for Baseline conditions, with 104 particles being captured or contained and 3,487 particles neither captured nor contained. Only 4% of the 360 volume-weighted particles released remained within the target containment area in the Shallow zone at the end of the modeling period. The remaining 96% left the target containment area by migrating past the containment boundary or into the upper aquitard or Principal zone.

Figures 9a – **9c** show the unweighted particles within and outside the target containment area for Existing Wells Simulation 1, with 2,053 particles being captured or contained and 1,538 particles neither captured nor contained. Pumping at the existing wells increased capture and containment within the target area and reduced the number of particles migrating past the containment boundary or into the upper aquitard or Principal zone. Approximately 56% of the 360 volume-weighted particles were captured or remained within the target containment area at the end of the modeling period. Of the particles released, approximately 53% were captured by the OCWD extraction wells, and 3% were captured by the ACP-02 extraction well. Overall, the existing extraction wells on their own were not sufficient to meet the 90% capture/containment goal. This was primarily due to several particles migrating into the Principal zone in areas where the upper aquitard is absent or discontinuous. As such, changes to pumping rates at existing wells was not considered a viable alternative to increasing containment and additional wells located in and upgradient of areas of mergence between the Shallow and Principal zones was seen as the viable alternative to increasing containment.

Figures 10a – **10c** show the unweighted particles within and outside the target containment area for Existing and New Wells Simulation 2, with 3,435 particles being captured or contained and

156 particles neither captured nor contained. With the additional extraction wells, no particles were seen to travel outside the containment area within the Shallow zone. Approximately 95% of the 360 volume-weighted particles released were either captured or contained within the target area. Of the particles released, approximately 92% were captured by the existing or new extraction wells, and 3% were captured by the ACP-02 extraction well.

Figures 11a – **11c** show the unweighted particles within and outside the target containment area for Alternative Wells Simulation 3, with 3,297 particles being captured or contained and 294 particles neither captured nor contained. Containment performance of Simulation 3 was lower than that of Simulation 2, with 90% of the 360 volume-weighted particles captured or contained within the target area. Only Simulation 2 was tested with the injection wells and recharge basin.

Figures 12a – **12c** show the unweighted particles within and outside the target containment area for Existing and New Wells with Injection Simulation 4, with 3,346 particles being captured or contained and 245 particles neither captured nor contained. With the injection wells, more particles migrated into the Principal zone likely due to the greater vertical gradient from the Shallow zone down into the Principal zone because of the higher heads in the Shallow zone. However, by adjusting the location of the injection wells, placing them sufficiently far away from the target containment area, 93% containment was achieved (333 out of 360 volume-weighted particles captured or contained).

Figures 13a – **13c** show the unweighted particles within and outside the target containment area for Existing and New Wells with Recharge Basin Simulation 5, with 3,419 particles being captured or contained and 172 particles neither captured nor contained. Containment performance for Simulation 5 was similar to that for the Simulation 4 with injection wells, with approximately 94% of containment achieved (340 out of 360 volume-weighted particles captured or contained).

Table 6a: *Summary of Particle Containment within Target Area for Baseline and Five Simulations*

Simulation ID	Simulation Name	Unweighted No. of Particles	Weighted No. of Particles	No. of Particles Captured by EW Wells*	No. of Particles Captured by ACP-02 Well*	No. of Particles Not Captured but Contained*	No. of Particles Neither Captured nor Contained*			% of Particles Captured or Contained*
				Shallow Zone (Lay 1)	Shallow Zone (Lay 1)	Shallow Zone (Lay 1)	Shallow Zone (Lay 1)	Lay 2	Principal Zone (Lay 3 – 12)	
-	**Baseline**	3,591	360	0	13	1	87	30	229	**4%**
1	**Existing Wells**	3,591	360	189	12	2	31	12	114	**56%**
2	**Existing & New Wells**	3,591	360	329	12	1	0	1	17	**95%**
3	**Alternative Wells**	3,591	360	311	12	1	1	4	31	**90%**
4	**Existing & New Wells with Injection**	3,591	360	320	12	1	0	2	25	**93%**
5	**Existing & New Wells with Recharge Basin**	3,591	360	327	12	1	1	1	18	**94%**

*Containment area statistics are based on the volume-weighted number of particles.

Table 6b: *Summary of Extraction/Injection and Particle Containment for Five Simulations*

Simulation ID	Simulation Name	No. of Existing Wells	No. of New Wells	Total Extraction Rate (gpm)	Total Injection/Recharge Rate (gpm)	% of Particles Captured or Contained*
-	**Baseline**	-	-	-	-	**4%**
1	**Existing Wells**	5	-	2,547	-	**56%**
2	**Existing & New Wells**	5	12	6,351	-	**95%**
3	**Alternative Wells**	2	13	6,956	-	**90%**
4	**Existing & New Wells with Injection**	5	12	6,546	6,546	**93%**
5	**Existing & New Wells with Recharge Basin**	5	12	6,351	6,351	**94%**

*Containment area statistics are based on the volume-weighted number of particles.

SUMMARY AND CONCLUSIONS

This technical memorandum summarizes the model input assumptions and results of several simulations for capture and containment of the VOC plume within a defined target area of the North Basin plume as part of the Interim RI/FS. A transient calibrated groundwater flow model was used to simulate future conditions, incorporating historical hydrologic variability in conjunction with anticipated future pumping and recharge operations. Forward particle tracking simulations were undertaken using the transient flow model results to evaluate containment of the VOC plume for several scenarios with different configurations of existing, new, and alternative extraction wells, both with and without recharging the pumped groundwater back into the Basin either via injection wells or a recharge basin.

Results indicated that a majority (96%) of the volume-weighted particles would escape containment (within the simulation period) under baseline conditions (no pumping for remediation, or no-action alternative). With the existing OCWD-EW wells pumping in Simulation 1, significantly more containment was achieved (56% compared to 4% for the no-action alternative). However, the existing wells alone were not sufficient to achieve the target 90% containment, due to the migration of particles into the upper aquitard or Principal zone in areas where the upper aquitard was absent or discontinuous. As such, additional extraction wells were necessary to increase containment and prevent migration of the particles into the upper aquitard or Principal zone. In Simulation 2, the additional new extraction wells were located along the particle flow paths and upgradient of the heterogeneities in the upper aquitard to maximize capture and containment in the Shallow zone, while reducing the downward migration of the particles into the upper aquitard or Principal zone. The existing and new wells (pumping at 6,351 gpm/10,245 AFY) in Simulation 2 were able to capture or contain 95% of the volume-weighted particles within the target area. In Simulation 3, alternative well locations (pumping at 6,956 gpm/11,220 AFY) were simulated to achieve 90% capture and containment of the volume-weighted particles with two less wells than Simulation 2. In Simulation 4, injecting the treated groundwater into the Shallow zone led to slightly lower containment due to higher heads in the Shallow zone and thus a larger downward gradient from the Shallow zone to the Principal zone. However, with the existing and new wells pumping at 6,546 gpm with 100% of the pumped groundwater being re-injected, approximately 93% capture/containment was achieved in Simulation 4. In Simulation 5, a proposed recharge basin was simulated instead of injection wells and had a similar containment performance to that of Simulation 4.

Note that these results are subject to inherent uncertainties and limitations of groundwater flow and particle track modeling. The groundwater flow model was well calibrated to available hydrologic and geologic data with a good match between simulated and observed water levels at numerous target wells. However, hydraulic properties and aquifer stratigraphy can never realistically be known or deterministically defined down to the localized grid cell level throughout the model domain; therefore, there will always be some residual error and uncertainty in the simulated groundwater conditions. Moreover, the modeling was based on a numerical grid of dimensions ranging from 125 ft x 125 ft to 500 ft x 500 ft. As such, the groundwater levels,

gradients, and velocities simulated represent average values at the model grid scale. Field scale heterogeneity can lead to variability at scales smaller than the model grid and, therefore, cannot be realistically simulated by a regional-scale model.

The model scenarios described herein assume that actual future groundwater conditions would be representative of the range of groundwater conditions simulated under Baseline conditions. If future groundwater conditions were to be very different from those assumed for the modeling, then the movement and migration of the VOC plume could be different from that simulated in these model scenarios.

Finally, the containment analysis relied on particle tracking that only simulated advective transport, without accounting for mixing, dispersion, diffusion, or retardation (adsorption) effects. However, groundwater flow is typically dominated by advection in highly permeable, fluvial depositional environments like the North Basin site. As such, the particle tracking simulations are considered to be a reasonable approximation of the advection-dominated transport of VOCs along the groundwater flow paths in the North Basin area. Localized field-scale behavior and actual performance of the containment alternatives may differ from the results of the modeled scenarios due to any combination of the above stated reasons.

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FIGURES

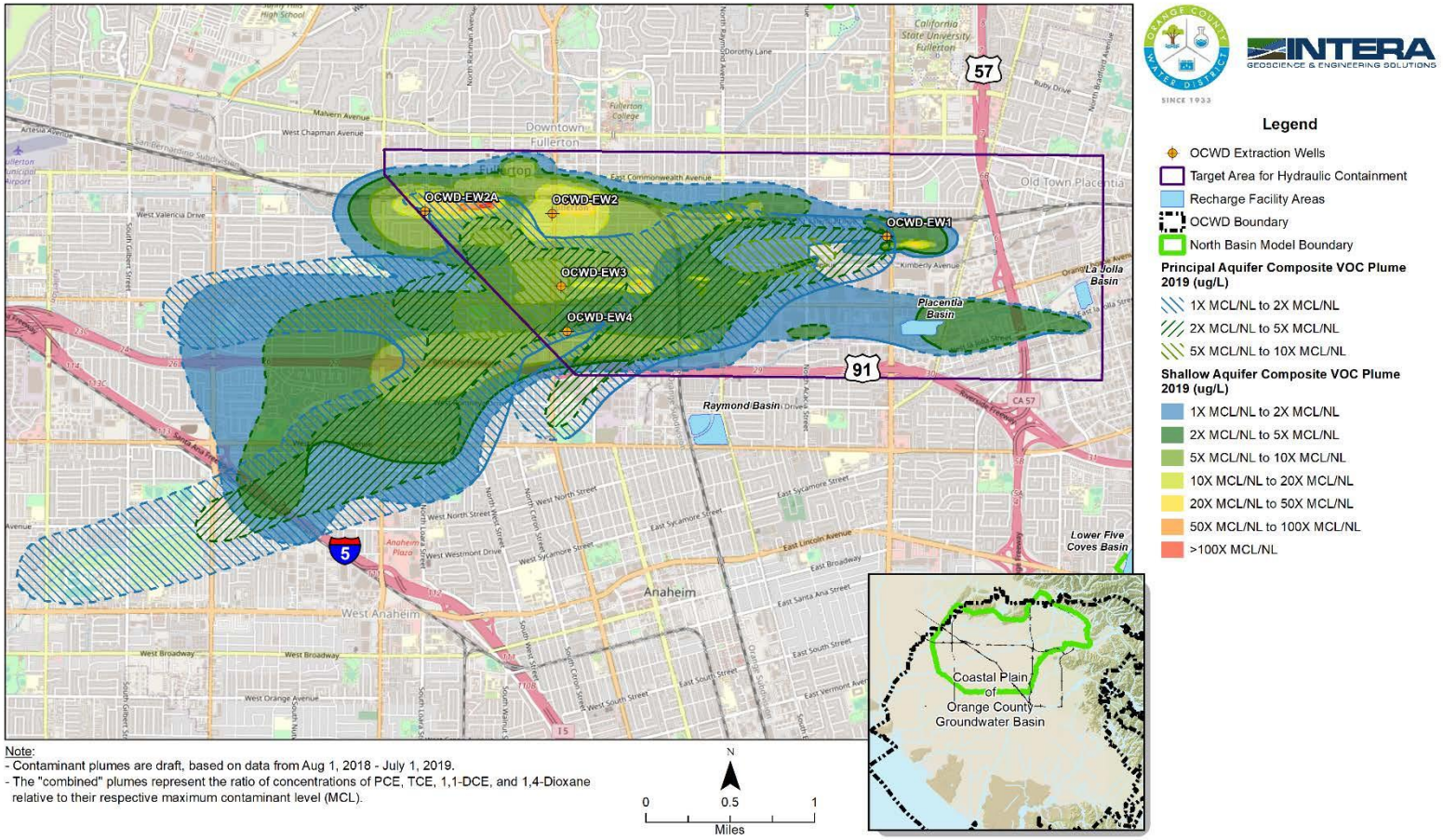


Figure 1: North Basin VOC contaminant plume and target area for hydraulic containment

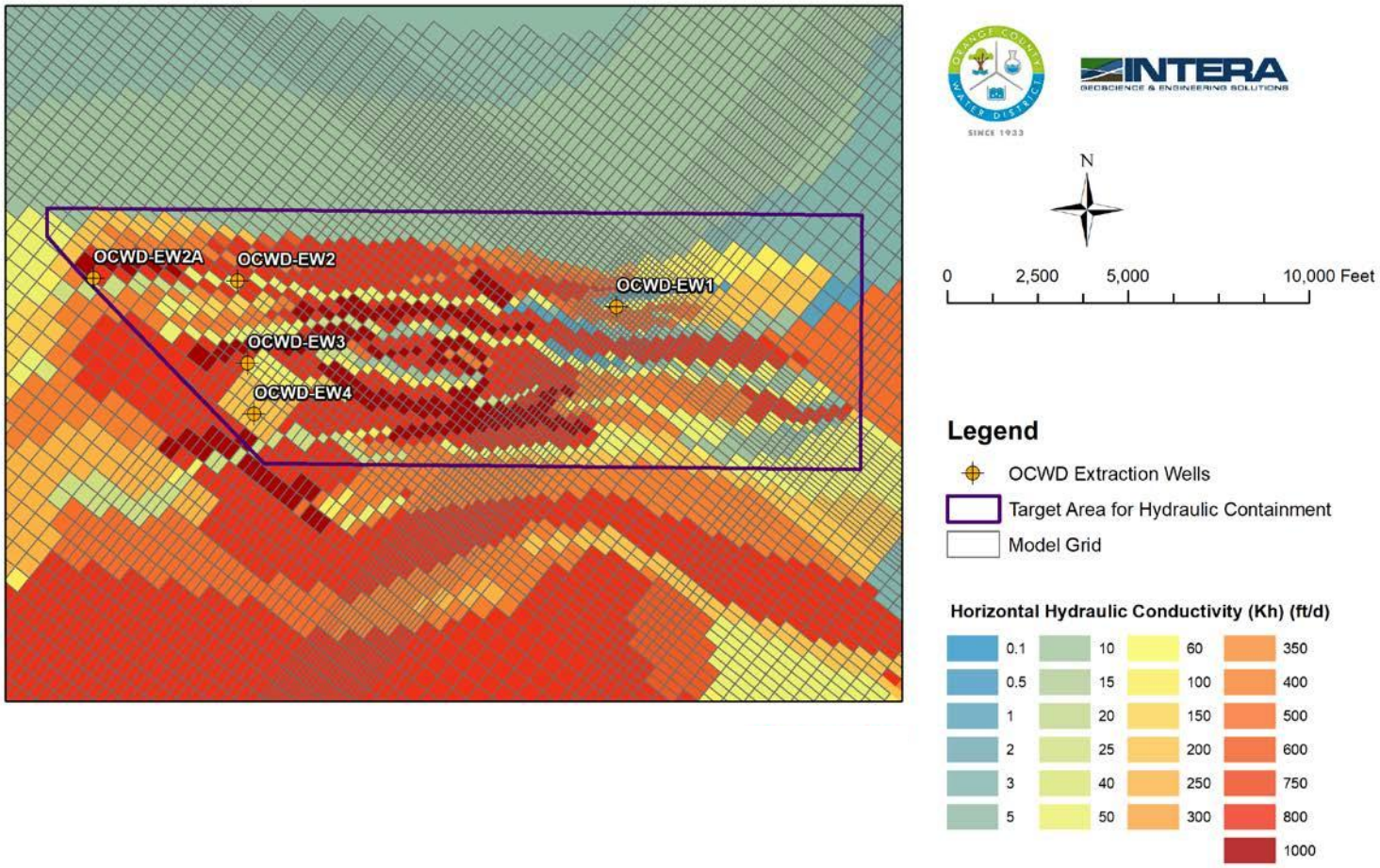


Figure 2a: North Basin Model horizontal hydraulic conductivities of Layer 1 (Shallow zone) in and around the hydraulic containment area

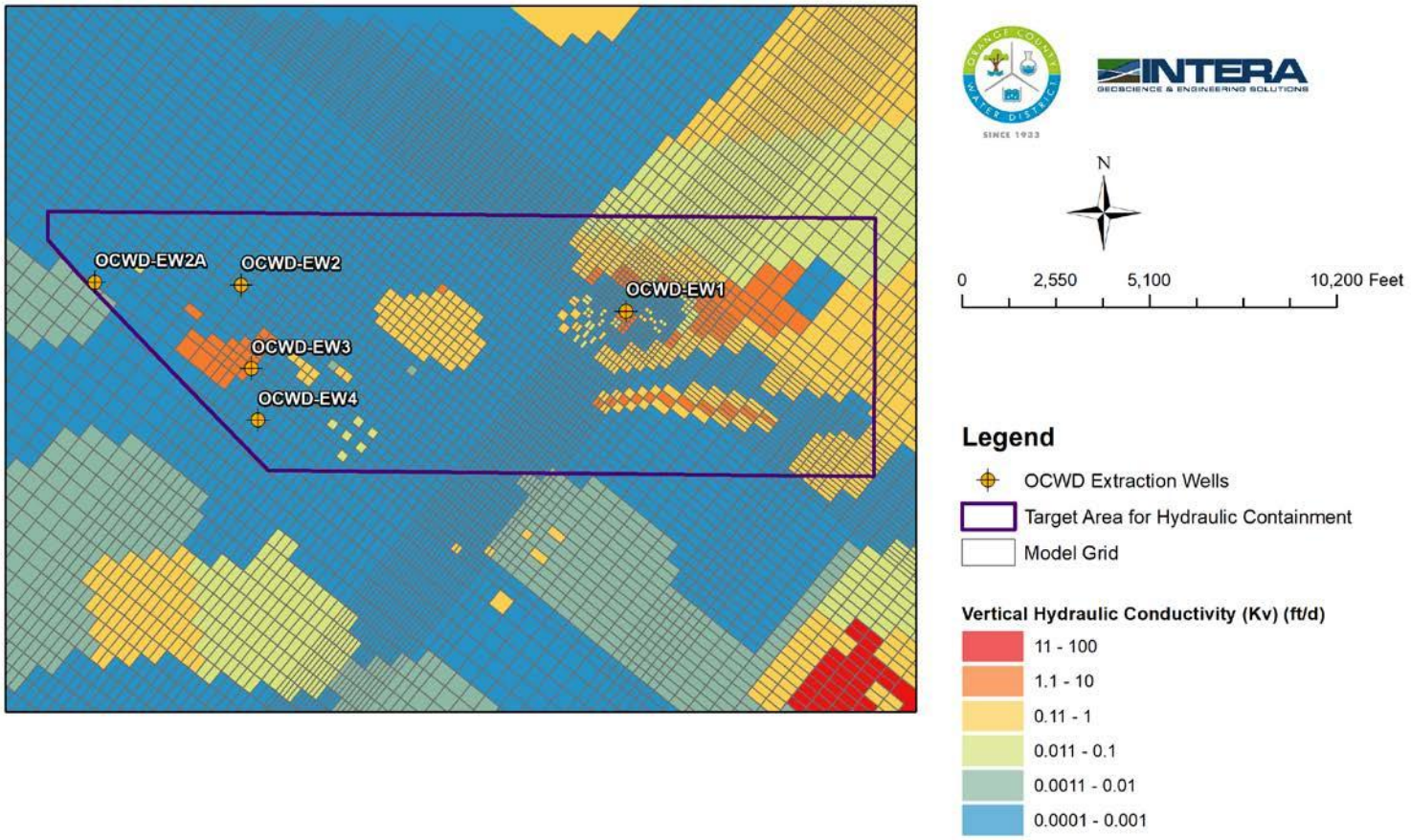


Figure 2b: North Basin Model vertical hydraulic conductivities of Layer 2 (upper aquitard) in and around the hydraulic containment area

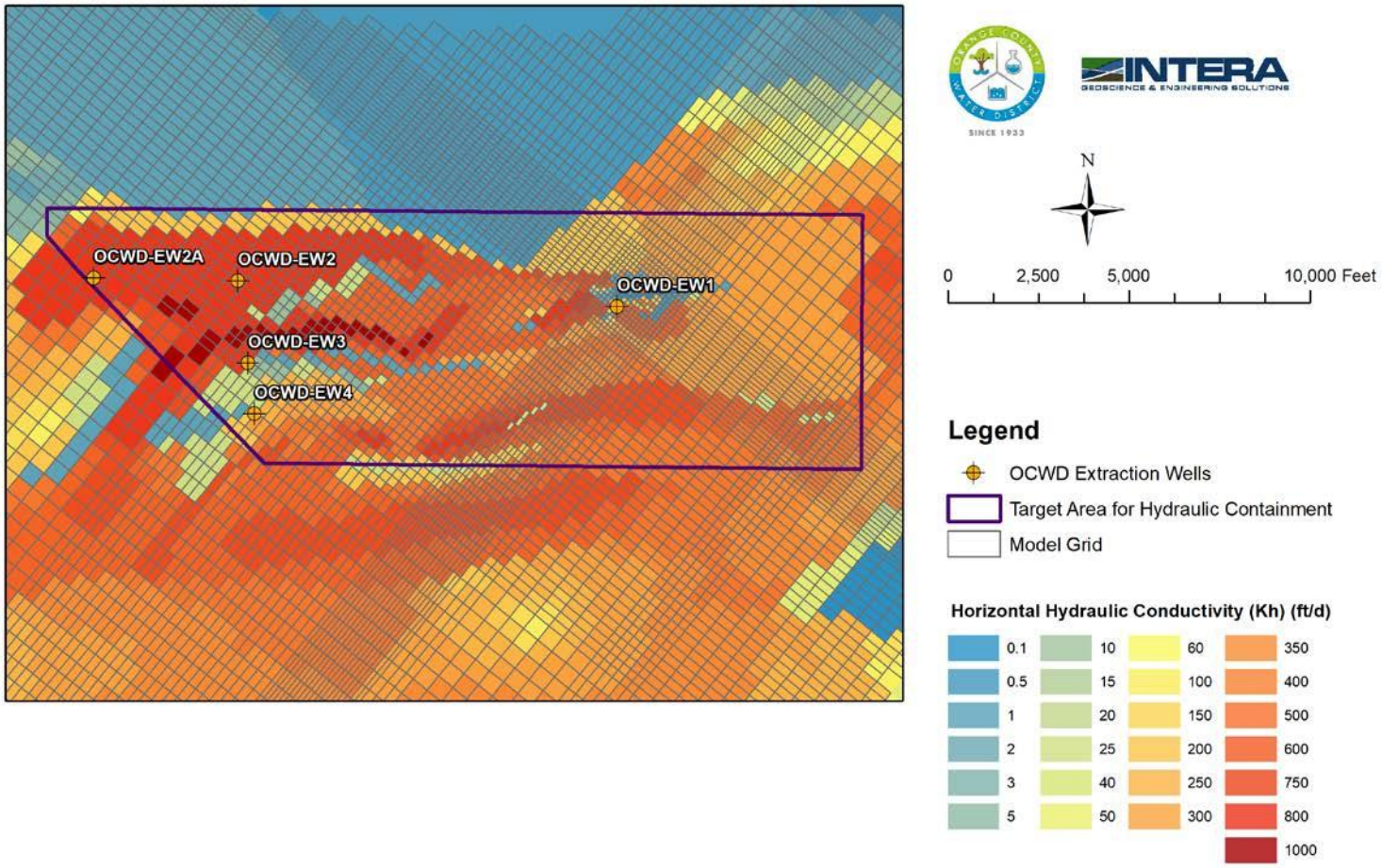


Figure 2c: North Basin Model horizontal hydraulic conductivities of Layer 3 (uppermost Principal zone) in and around the hydraulic containment area

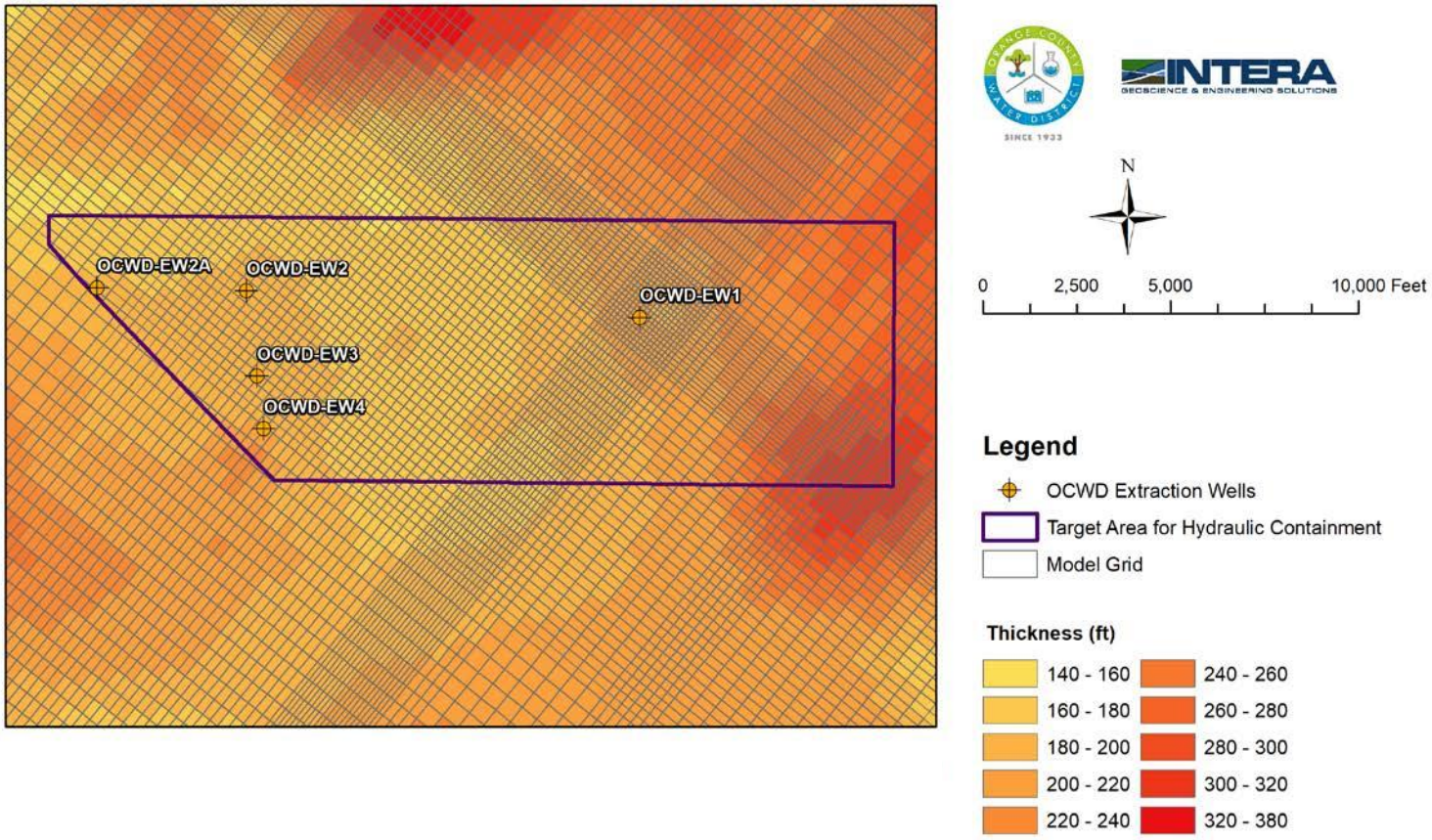


Figure 2d: North Basin Model thicknesses of Layer 1 (Shallow zone) in and around the hydraulic containment area

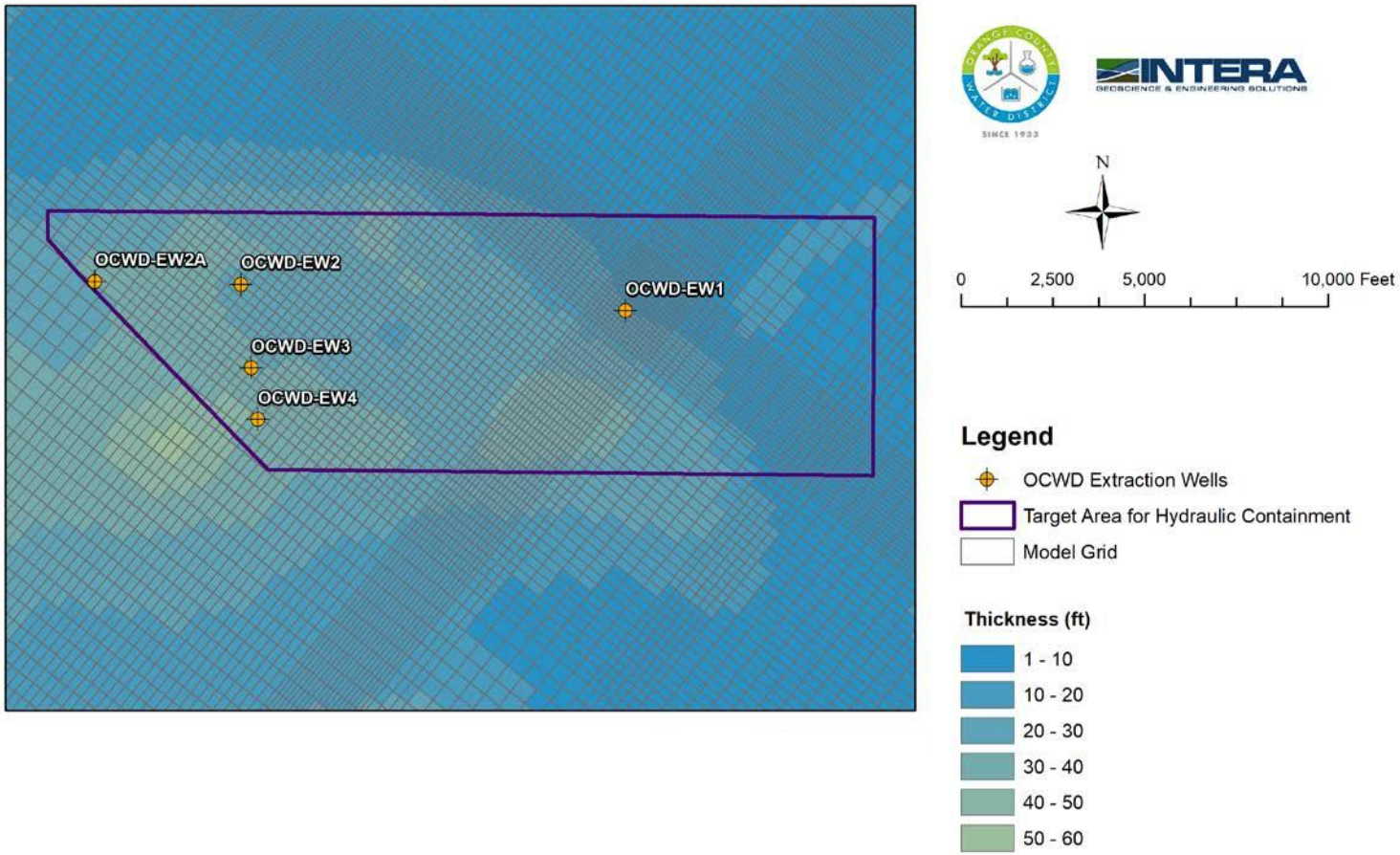


Figure 2e: North Basin Model thicknesses of Layer 2 (upper aquitard) in and around the hydraulic containment area

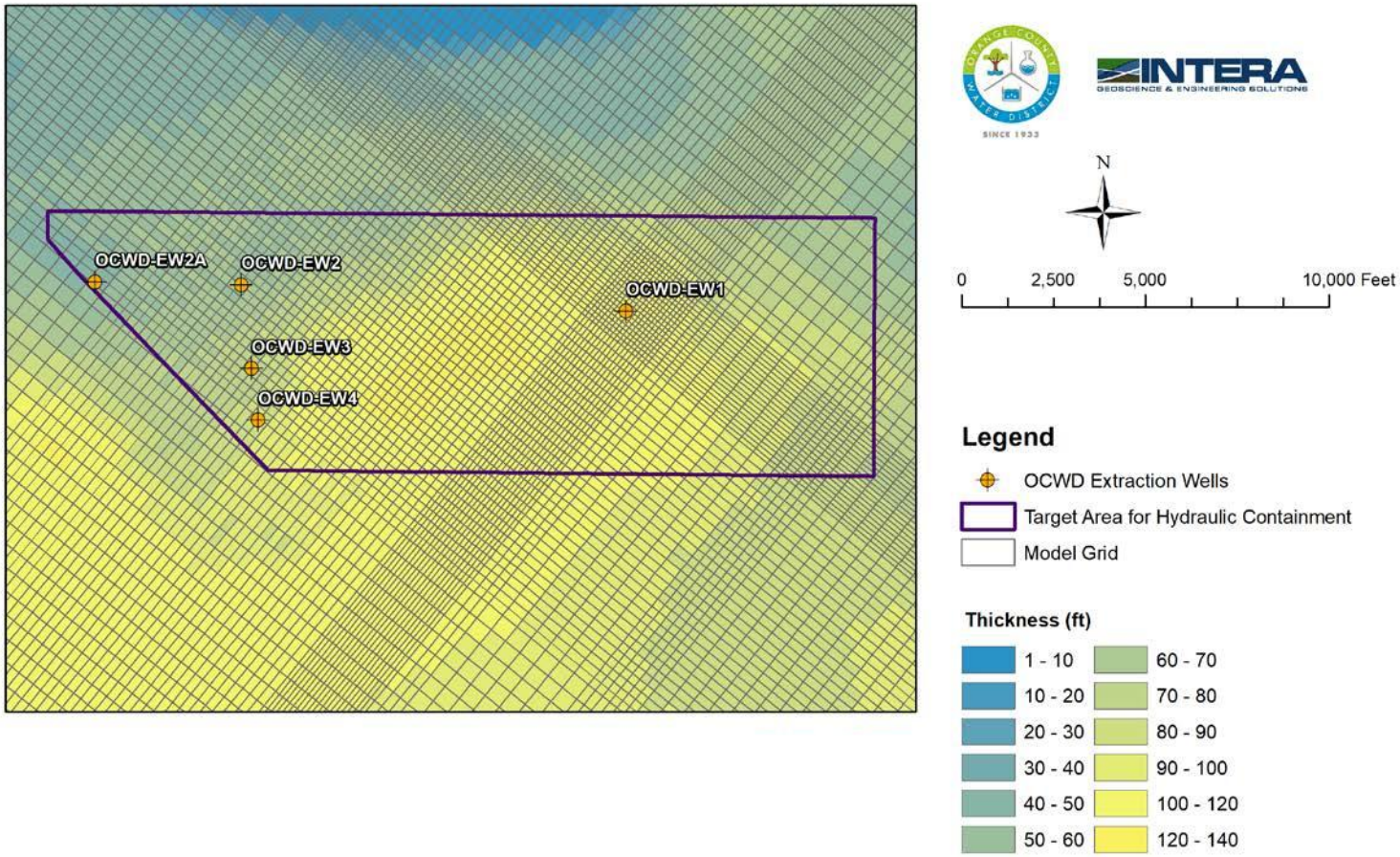


Figure 2f: North Basin Model thicknesses of Layer 3 (uppermost Principal zone) in and around the hydraulic containment area

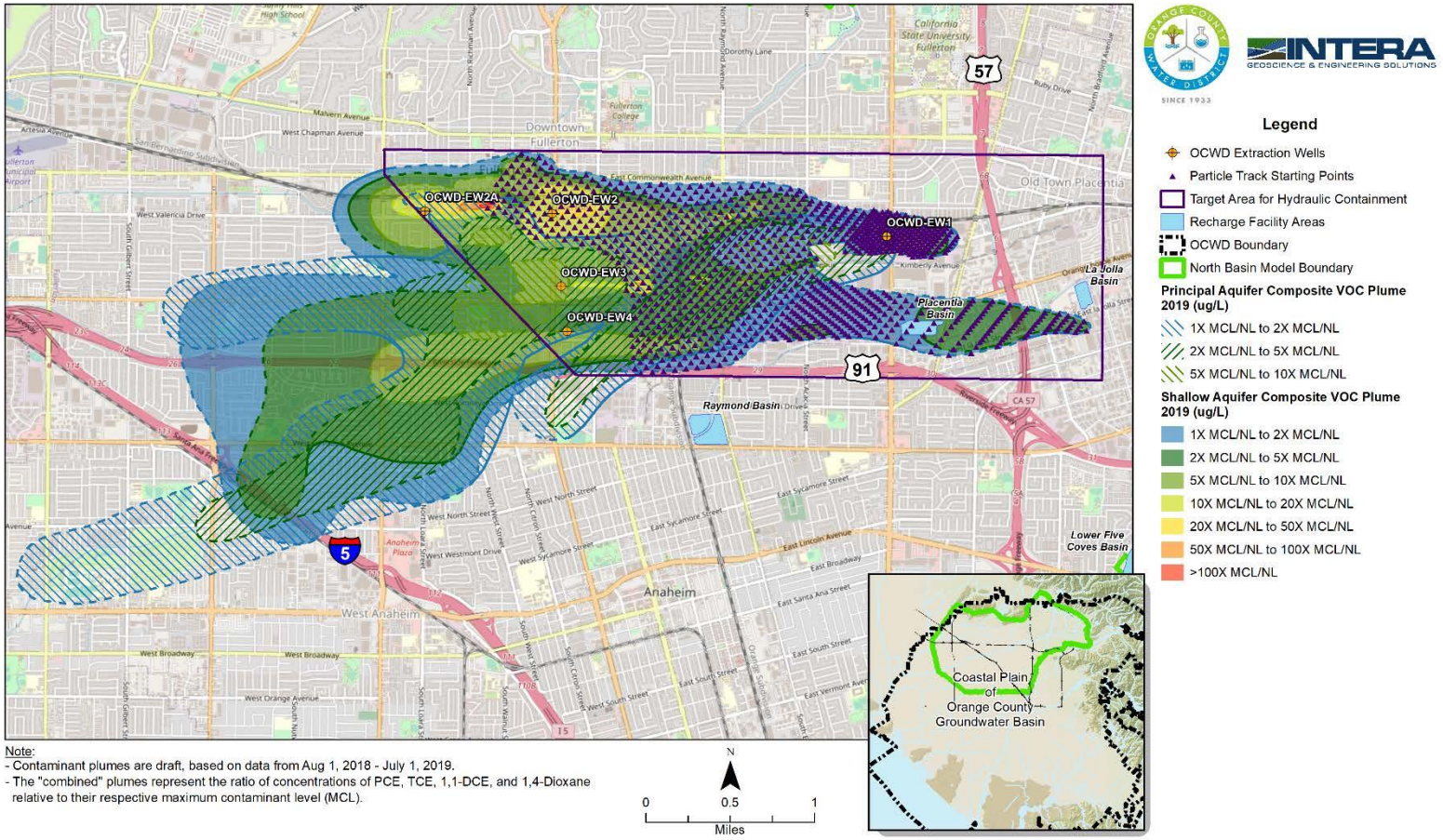


Figure 3: Shallow zone (Layer 1) particle starting locations

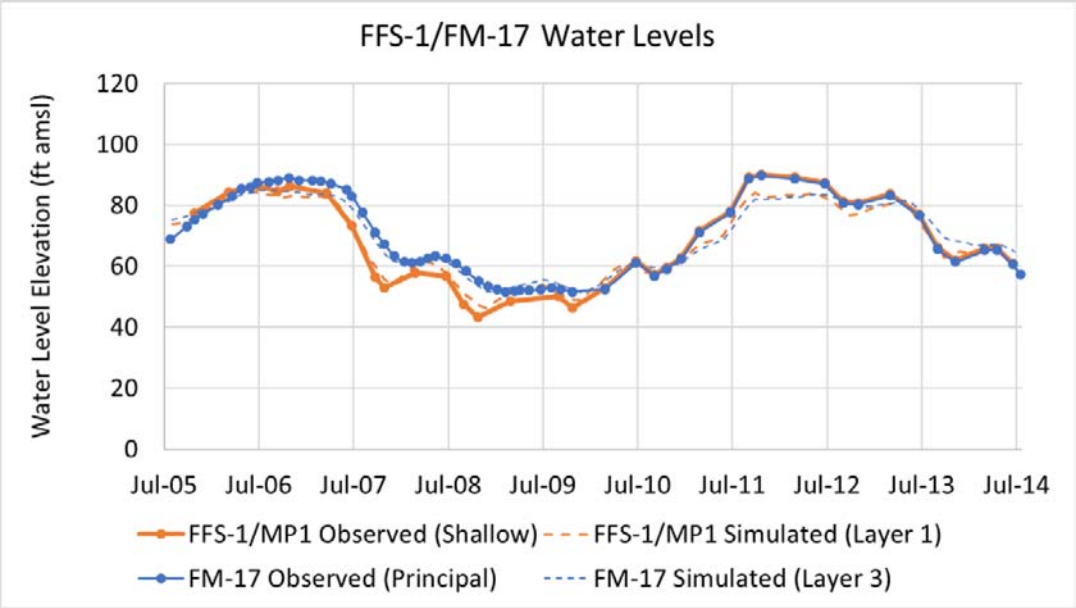


Figure 4a: Observed vs simulated water levels (2005 to 2014) at FFS-1/FM-17

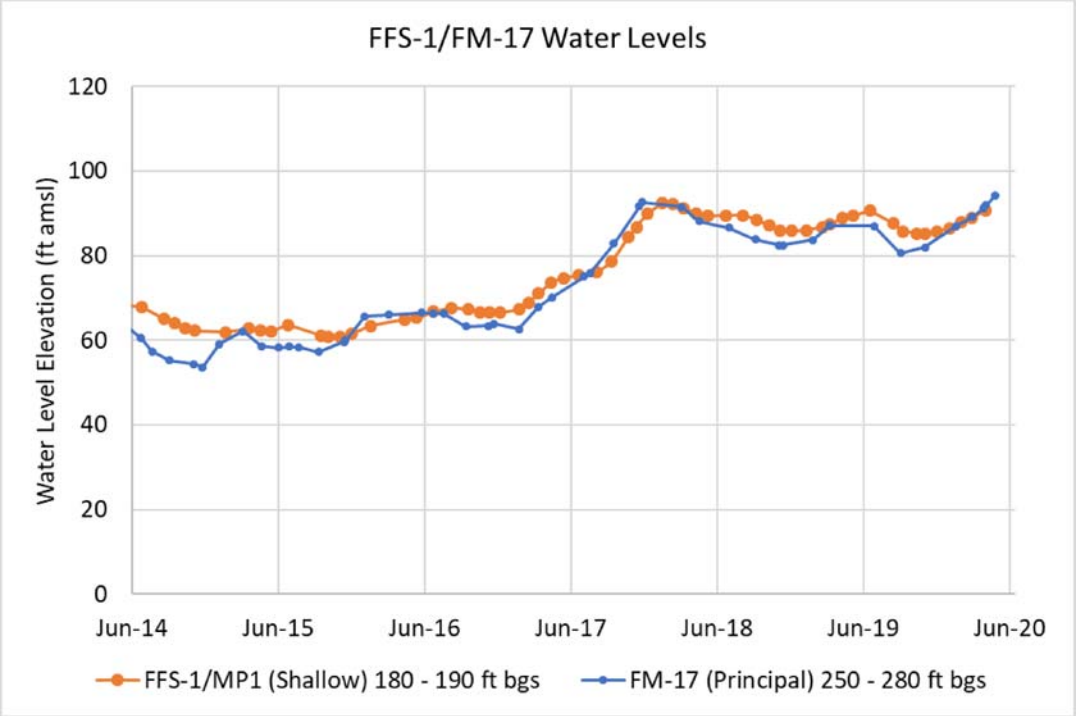


Figure 4b: Observed water levels (2014 to 2020) at FFS-1/FM-17

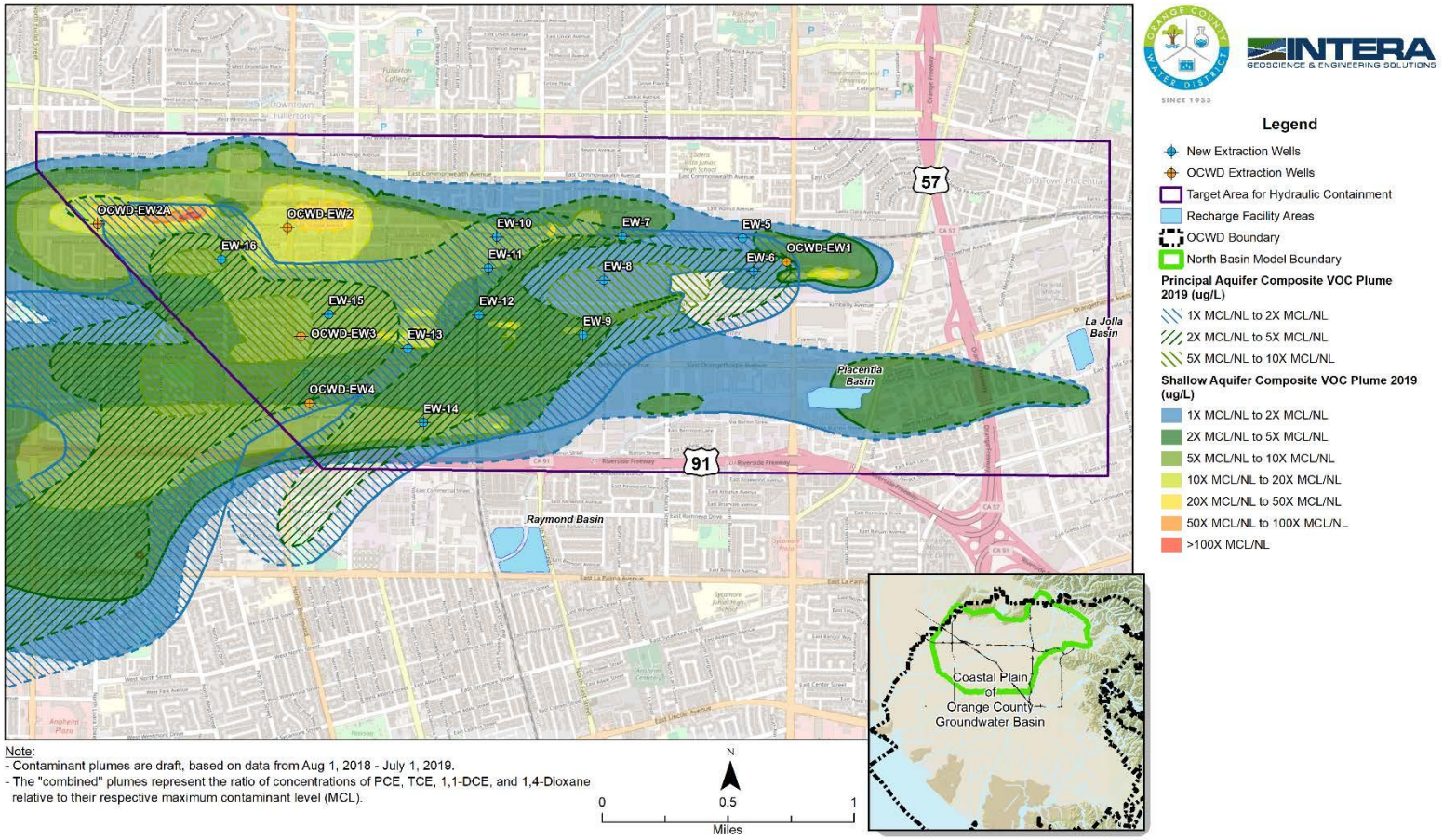


Figure 5: Simulation 2 locations of existing and new extraction wells

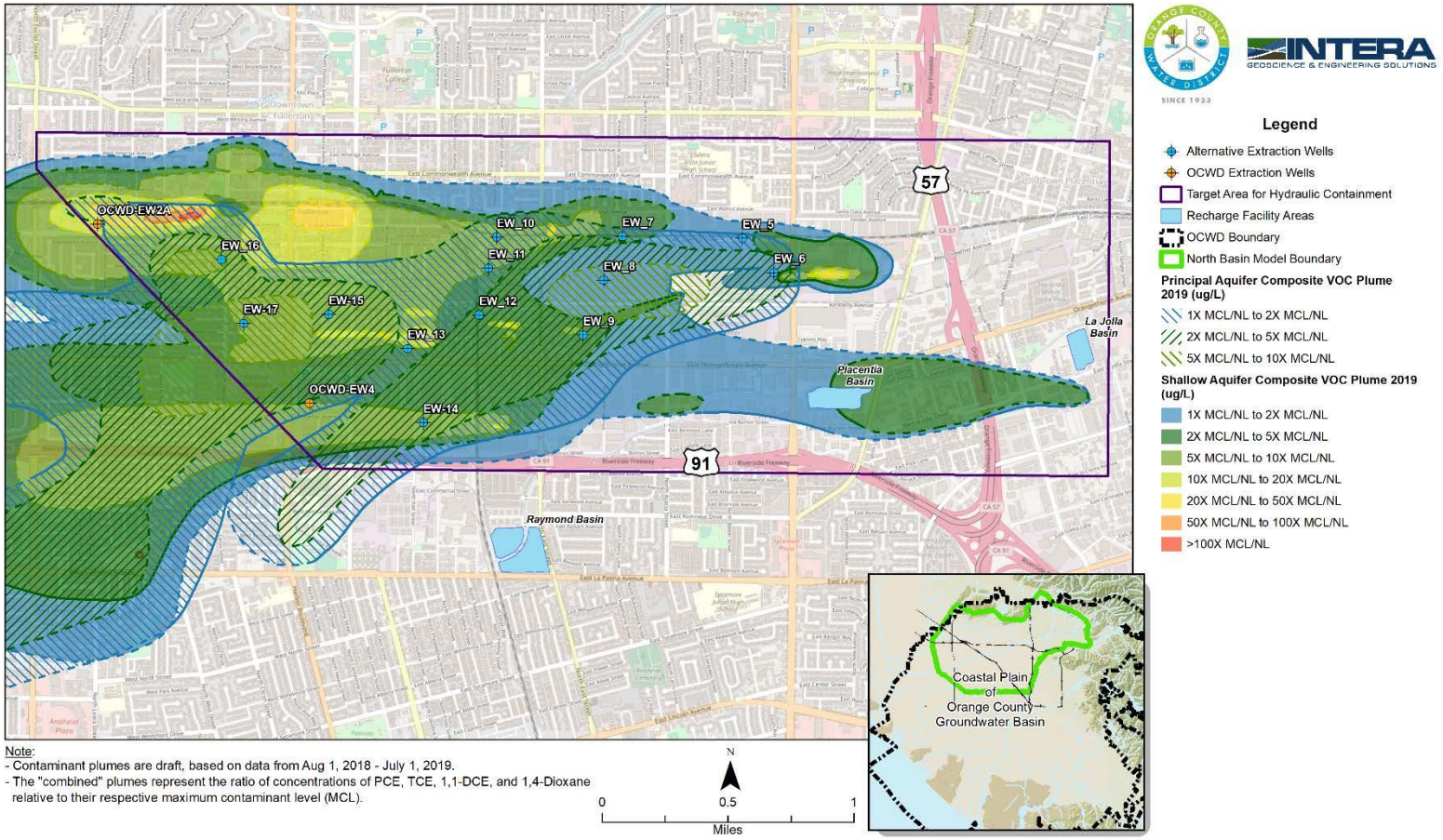


Figure 6: Simulation 3 locations of alternative extraction wells

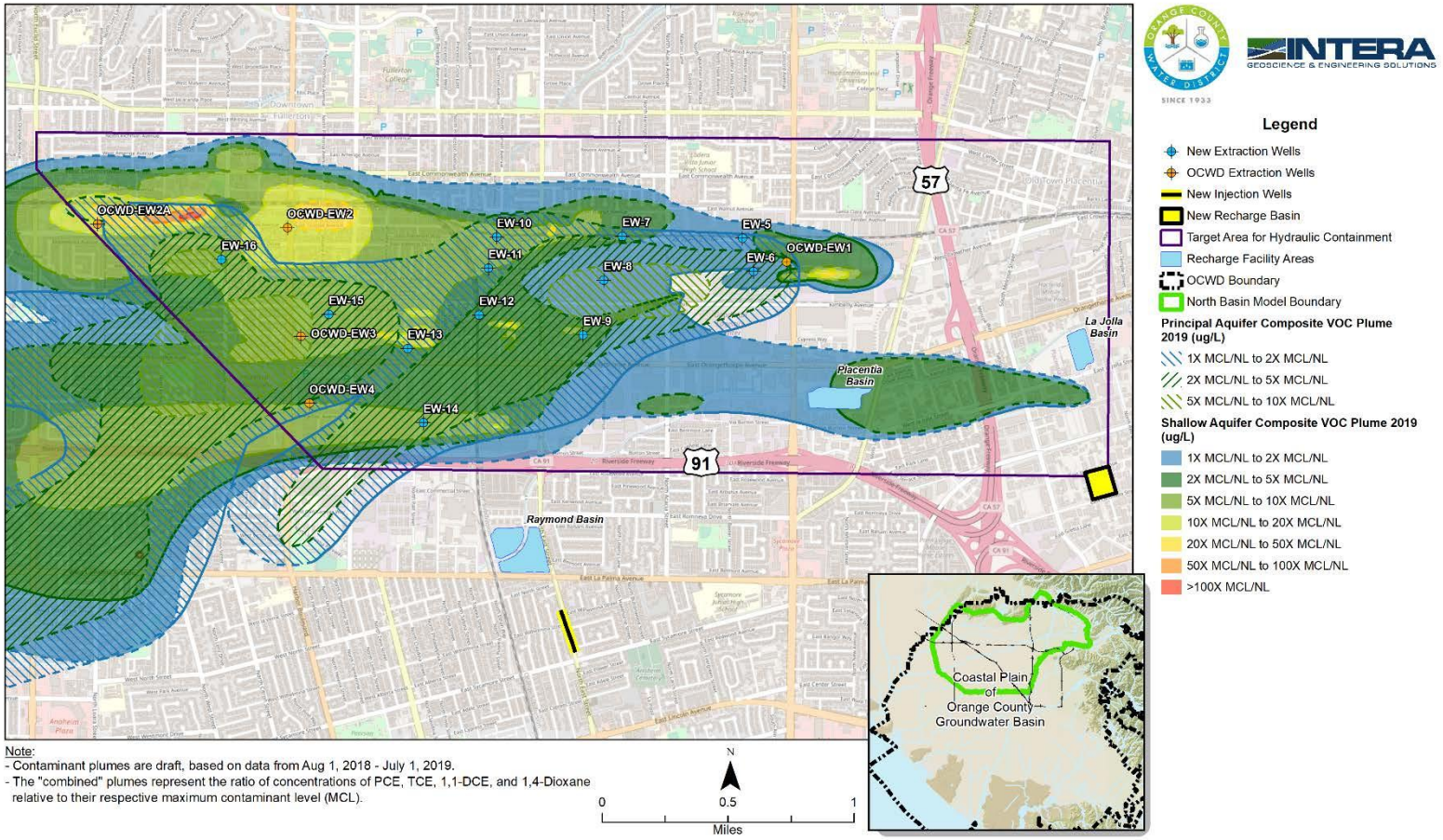


Figure 7a: Locations of proposed new injection wells (Simulation 4) and proposed recharge basin (Simulation 5)

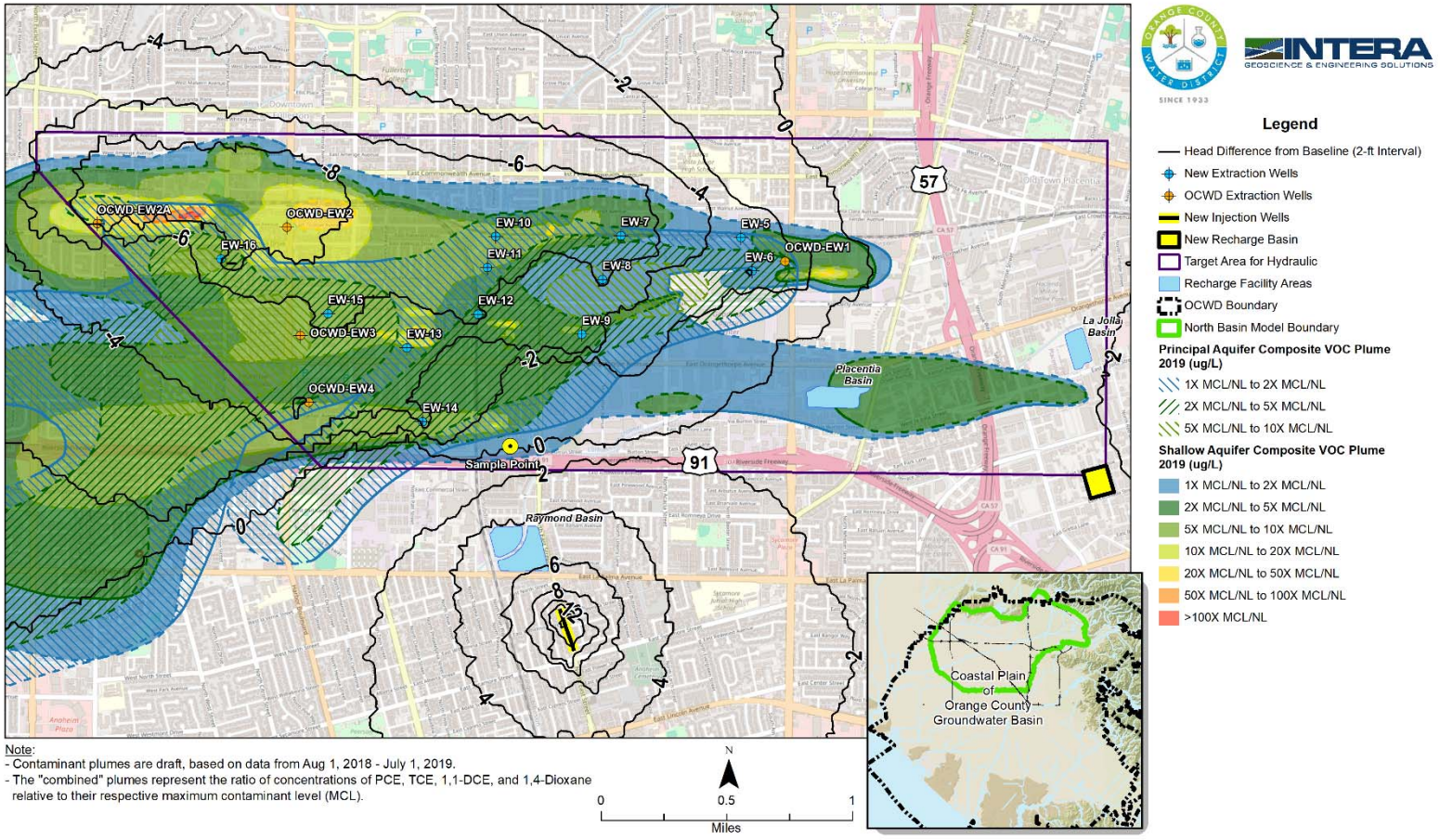


Figure 7b: Contours of head difference between Baseline and Simulation 4 (Existing and New Wells with Injection) at the end of simulation period

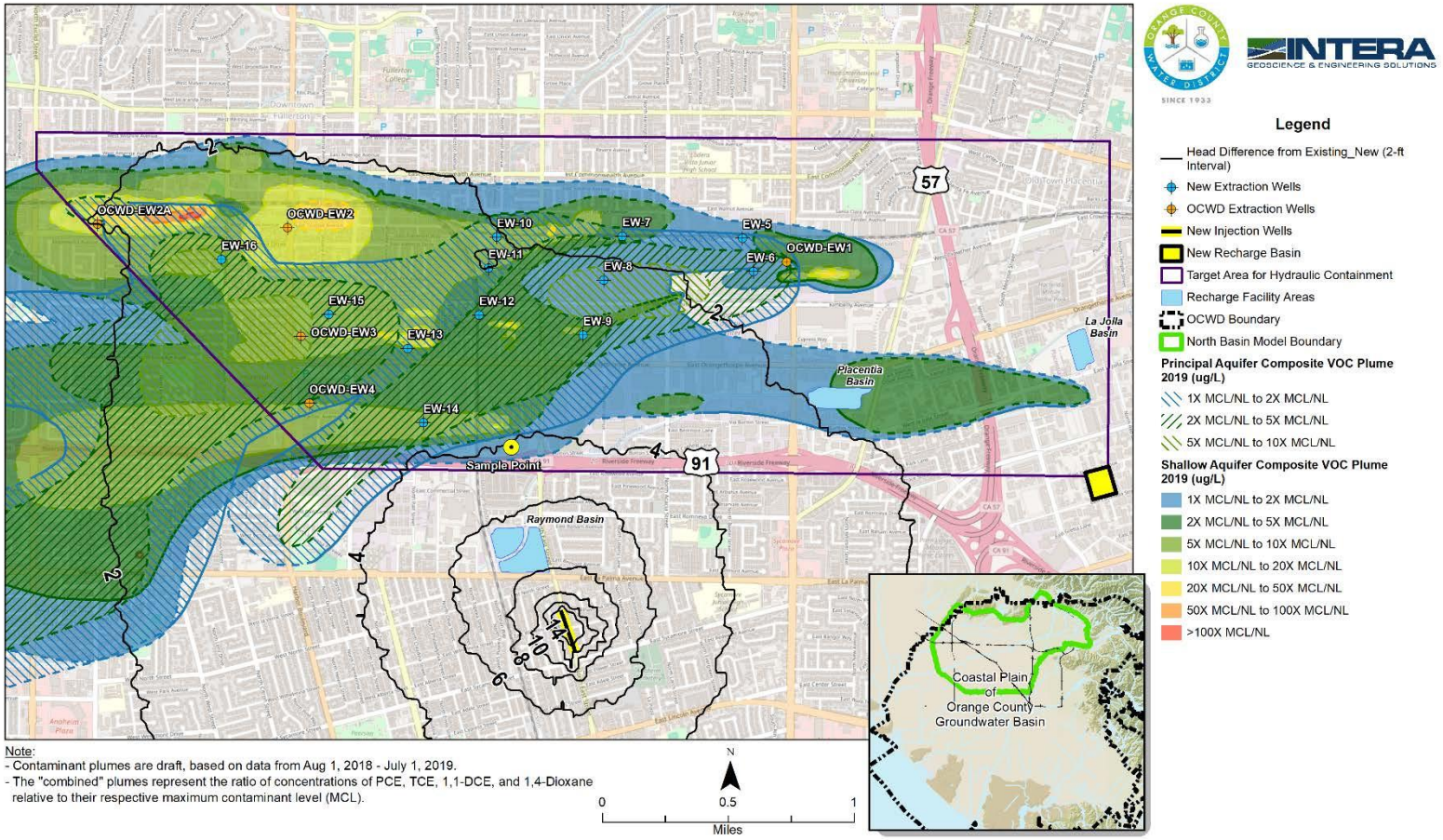


Figure 7c: Contours of head difference between Simulation 2 (Existing and New Wells) and Simulation 4 (Existing and New Wells with Injection) at the end of simulation period

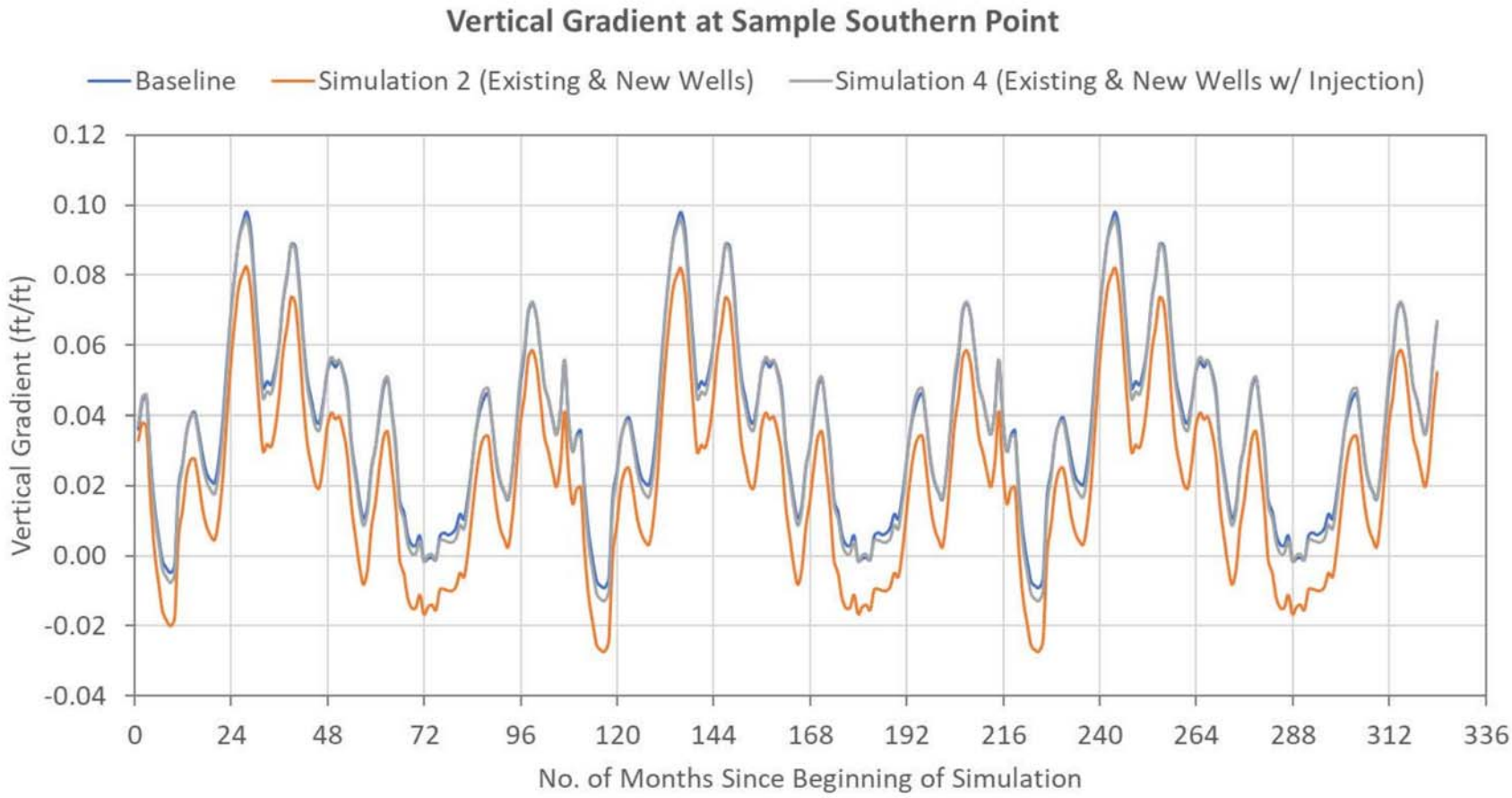


Figure 7d: Time-series of vertical gradient for Baseline, Simulation 2 (Existing and New Wells), and Simulation 4 (Existing and New Wells with Injection) at the southern end of the plume closest to the injection wells

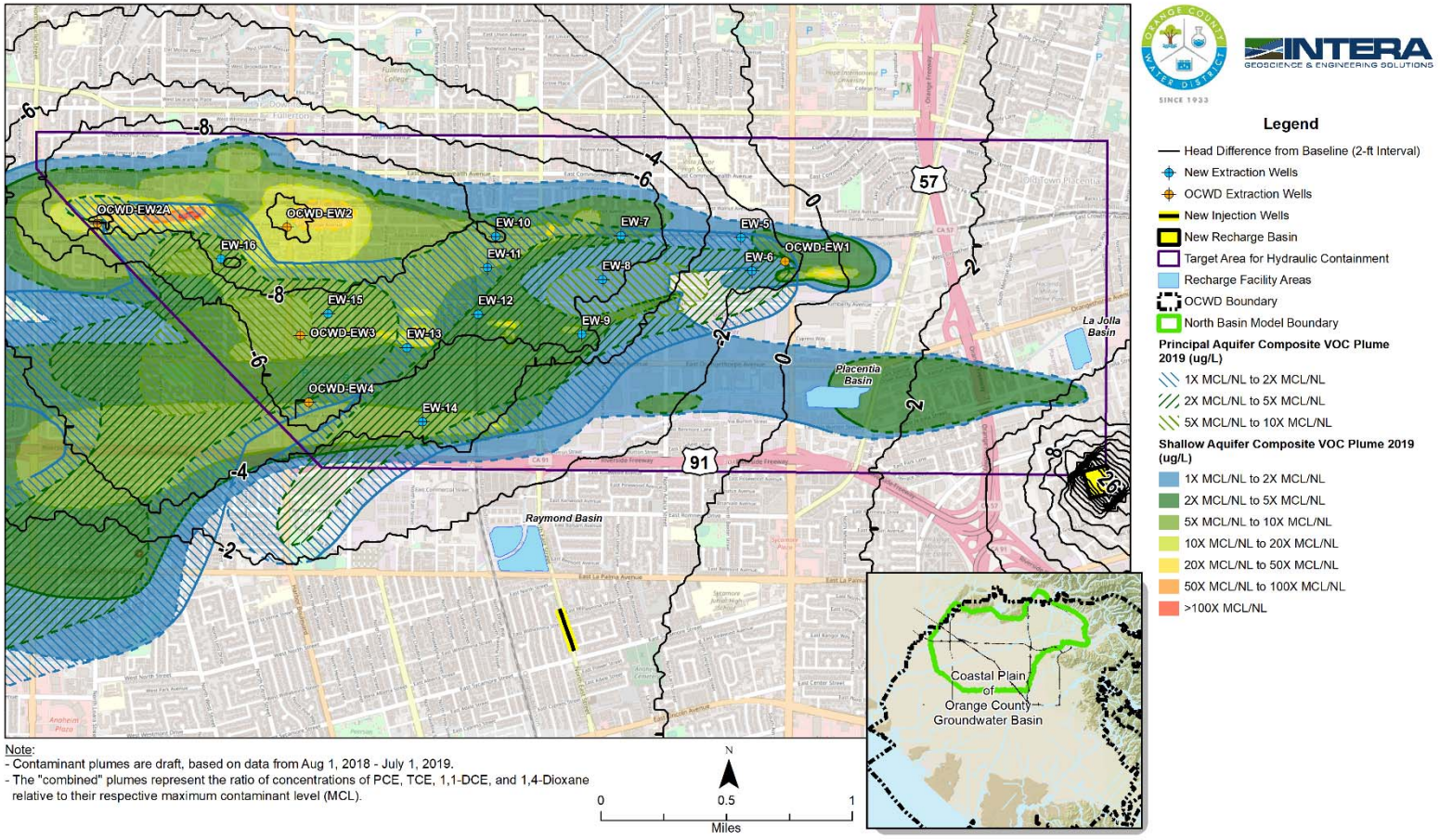


Figure 7e: Contours of head difference between Baseline and Simulation 5 (Existing and New Wells with Recharge Basin) at the end of simulation period

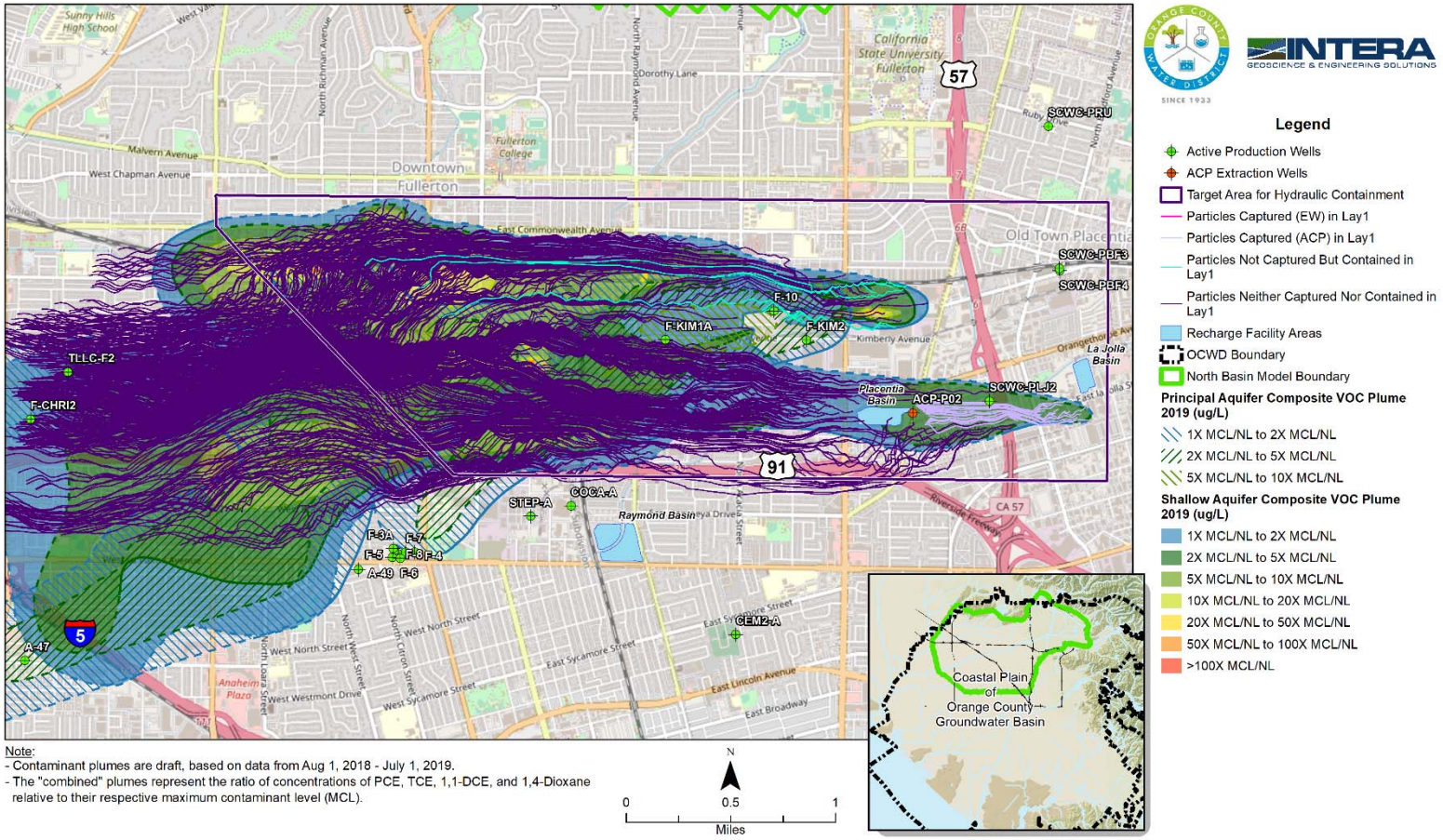


Figure 8a: Baseline simulation particle tracks in the Shallow zone (Layer 1) within and outside the target containment area

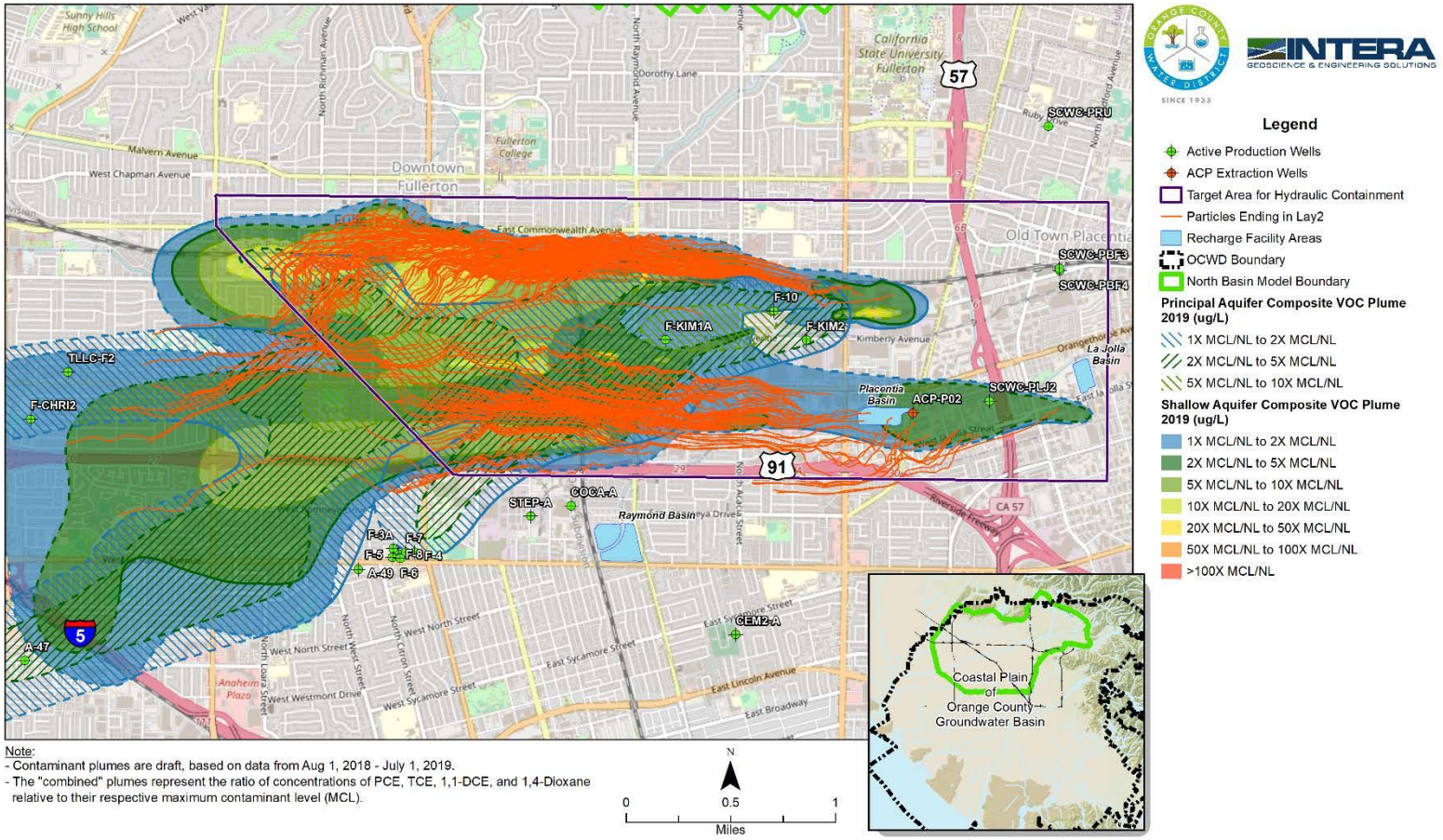


Figure 8b: Baseline simulation particle tracks in the upper aquitard (Layer 2) within and outside the target containment area

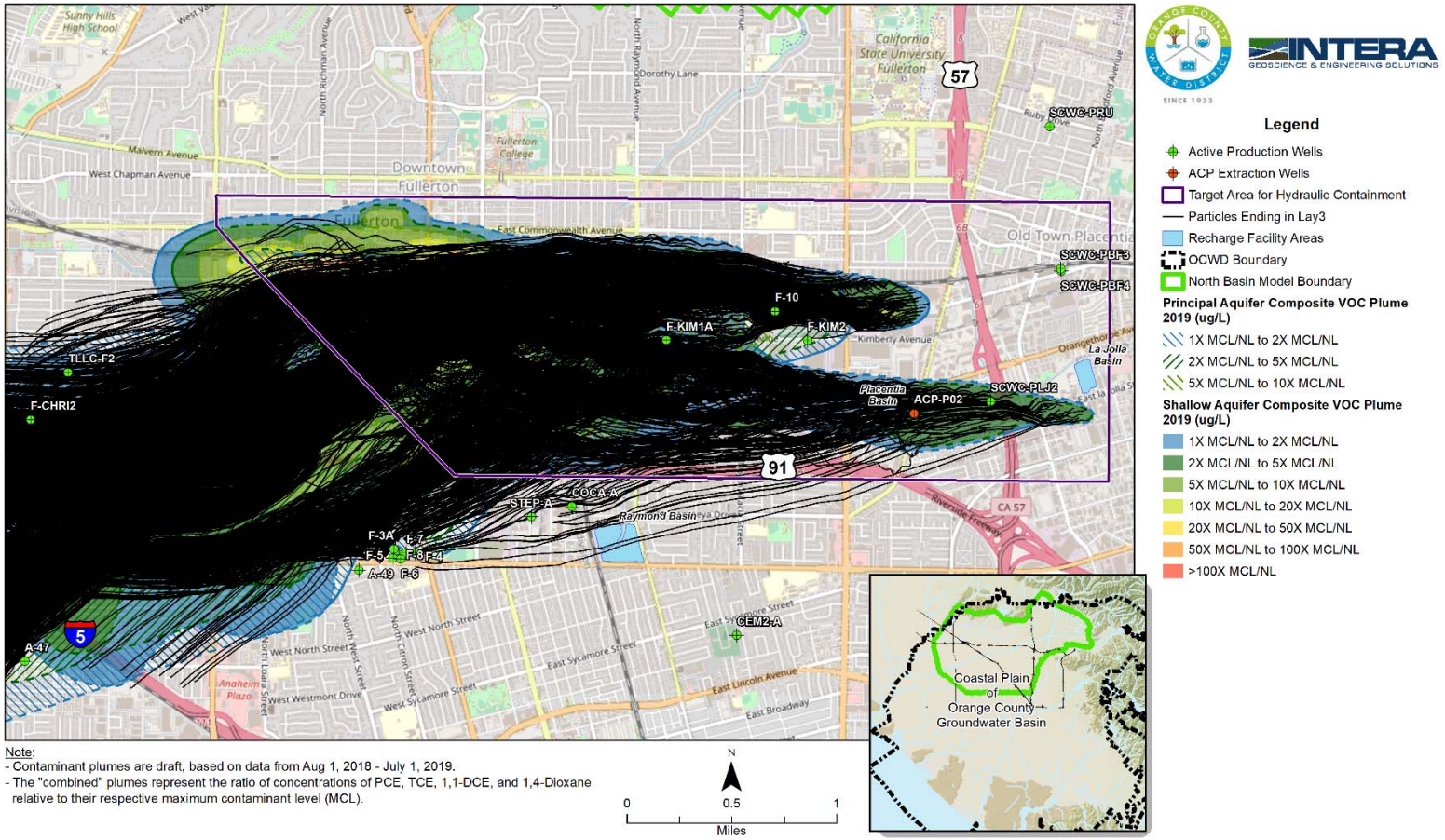


Figure 8c: Baseline simulation particle tracks in the Principal zone (Layers 3 – 12) within and outside the target containment area

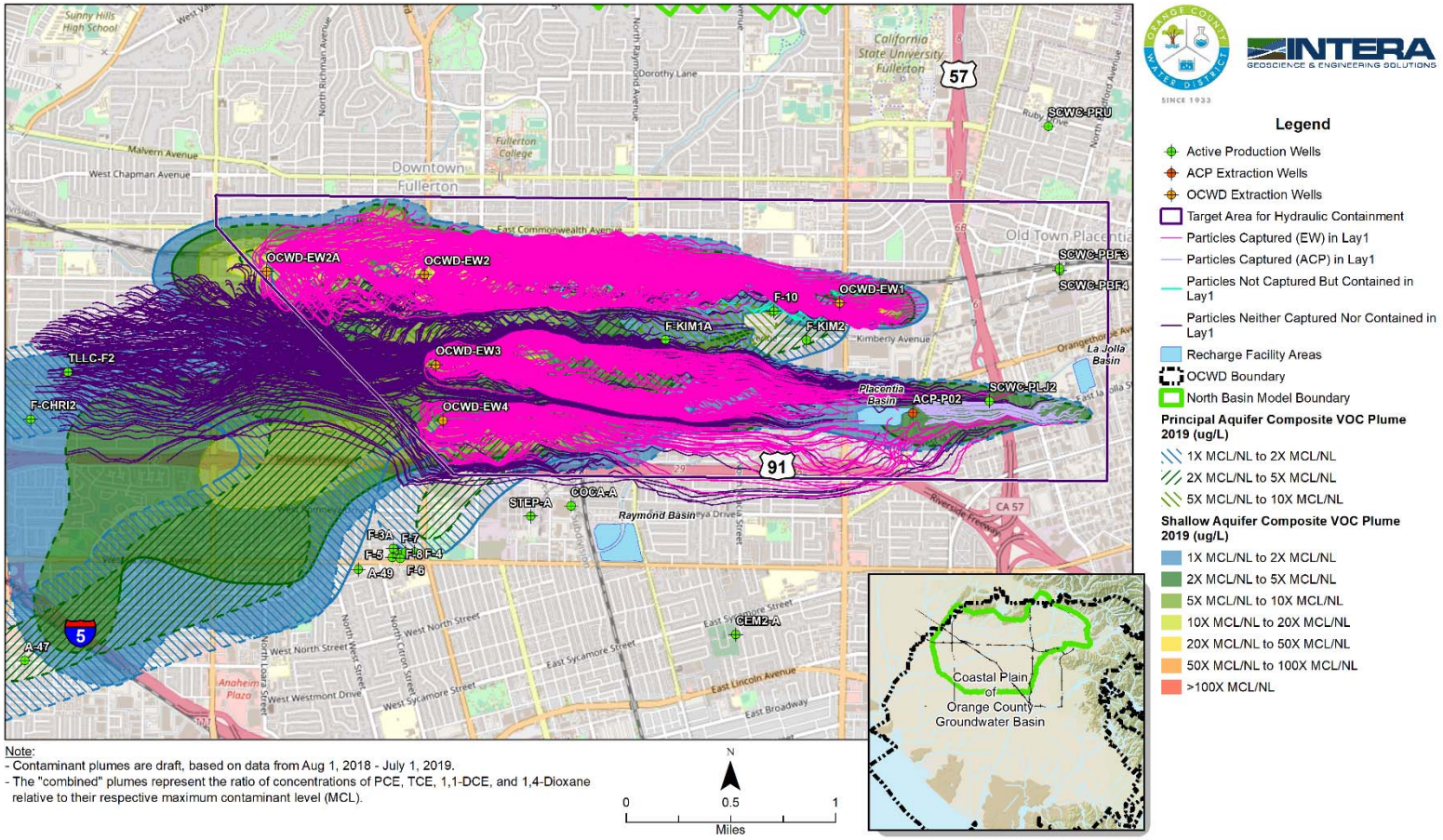


Figure 9a: Simulation 1 (Existing Wells) particle tracks in the Shallow zone (Layer 1) within and outside the target containment area

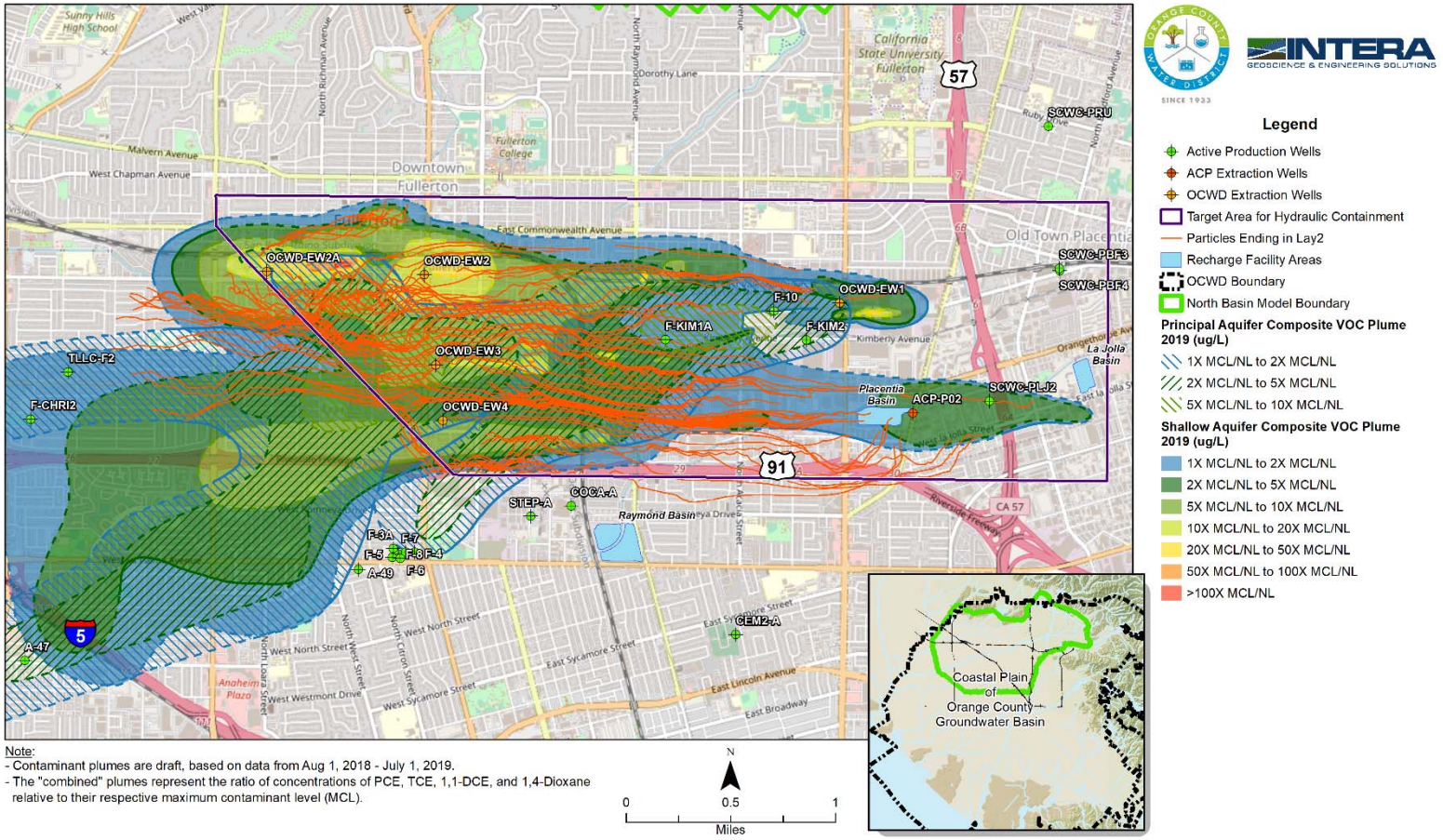


Figure 9b: Simulation 1 (Existing Wells) particle tracks in the upper aquitard (Layer 2) within and outside the target containment area

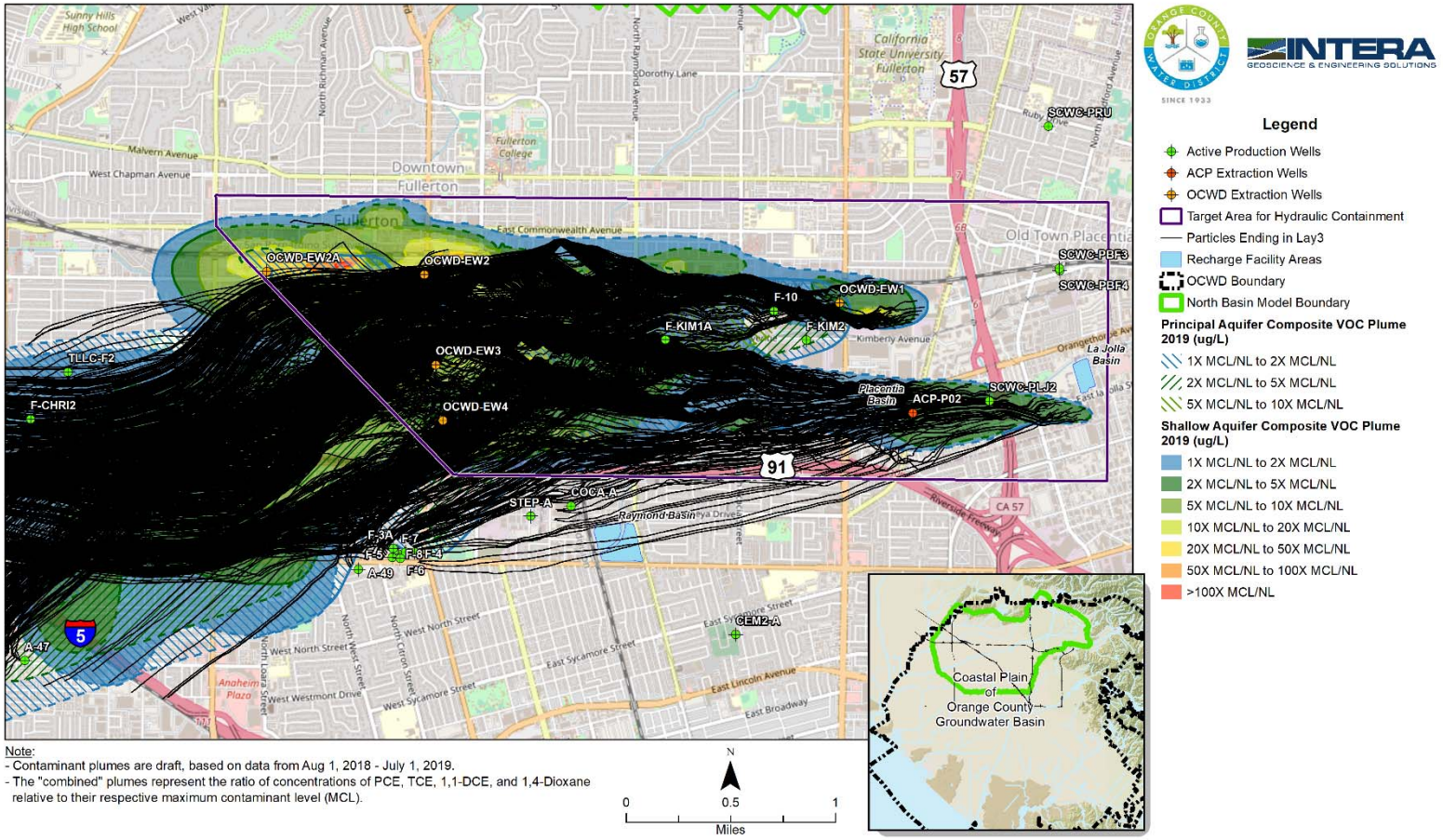


Figure 9c: Simulation 1 (Existing Wells) particle tracks in the Principal zone (Layers 3 – 12) within and outside the target containment area

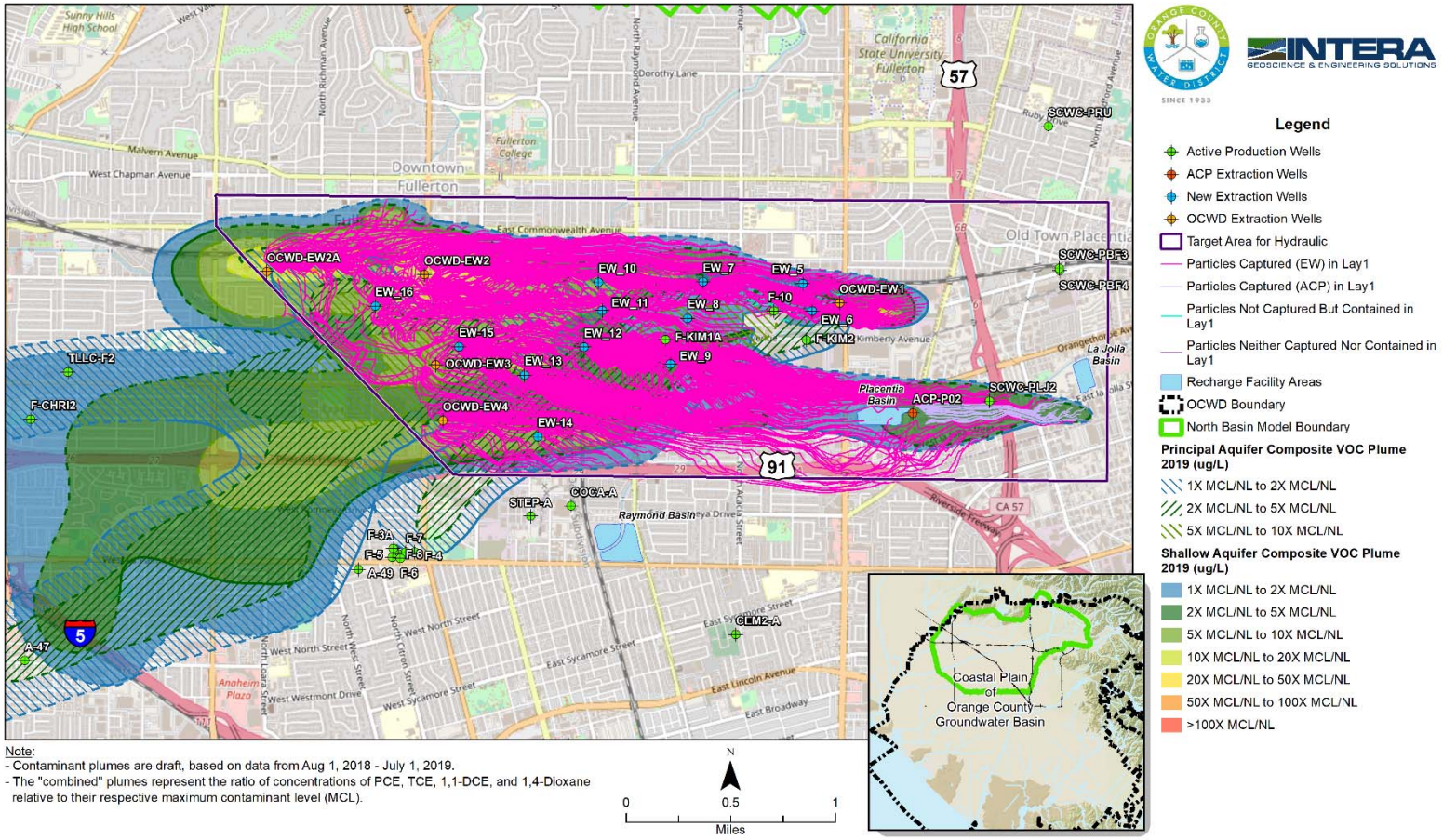


Figure 10a: Simulation 2 (Existing and New Wells) particle tracks in the Shallow zone (Layer 1) within and outside the target containment area

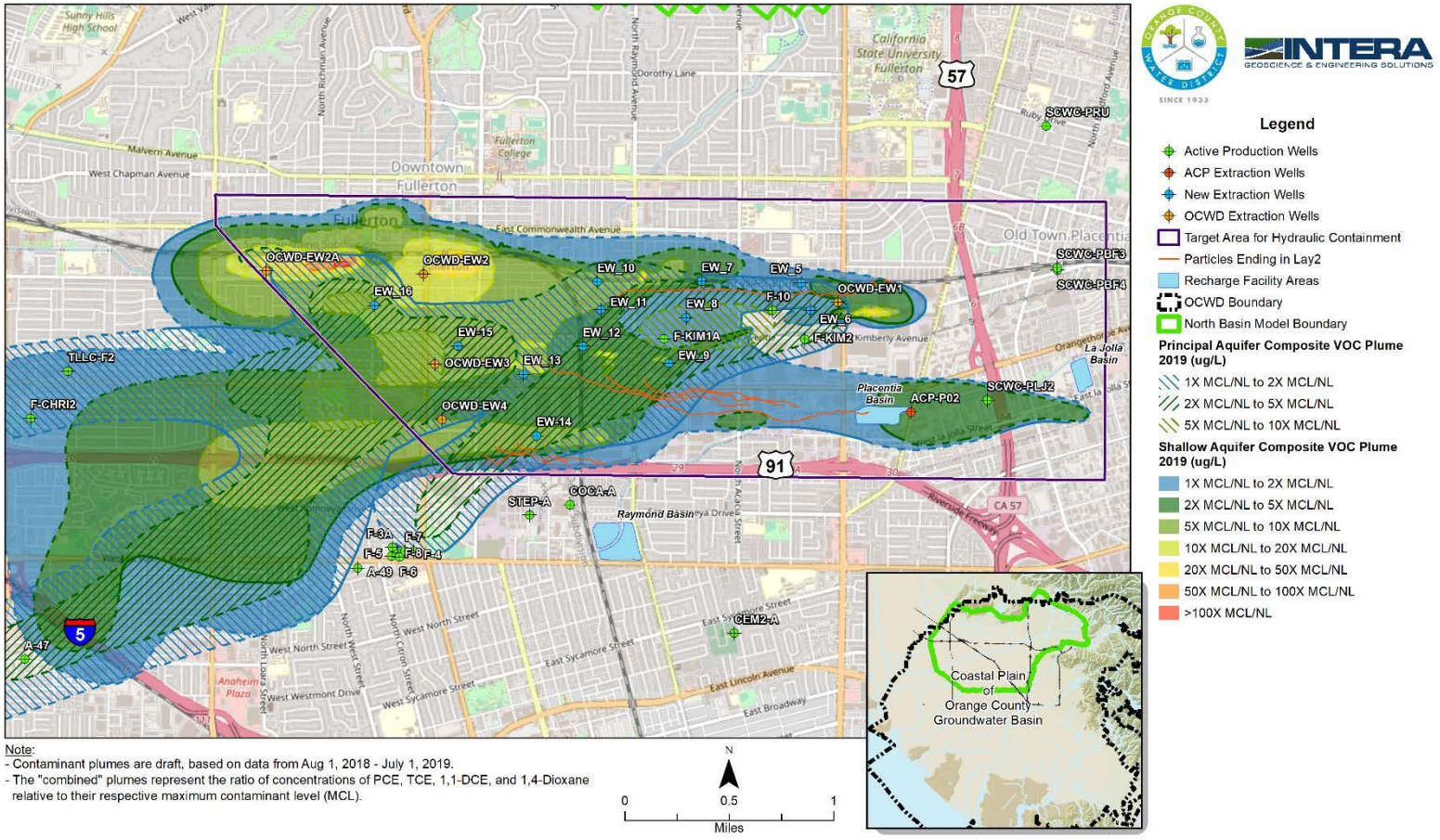


Figure 10b: Simulation 2 (Existing and New Wells) particle tracks in the upper aquitard (Layer 2) within and outside the target containment area

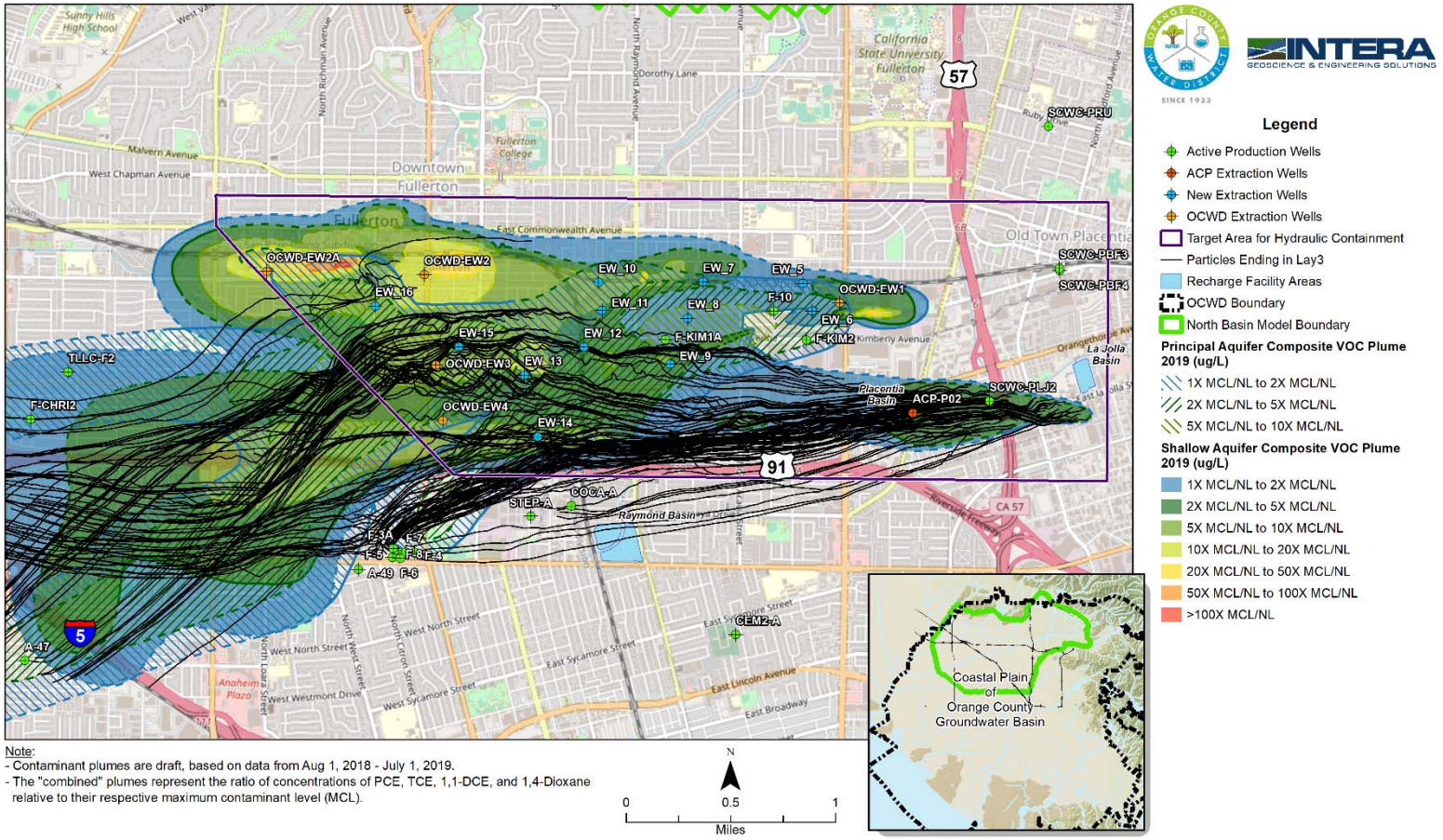


Figure 10c: Simulation 2 (Existing and New Wells) particle tracks in the Principal zone (Layers 3 – 12) within and outside the target containment area

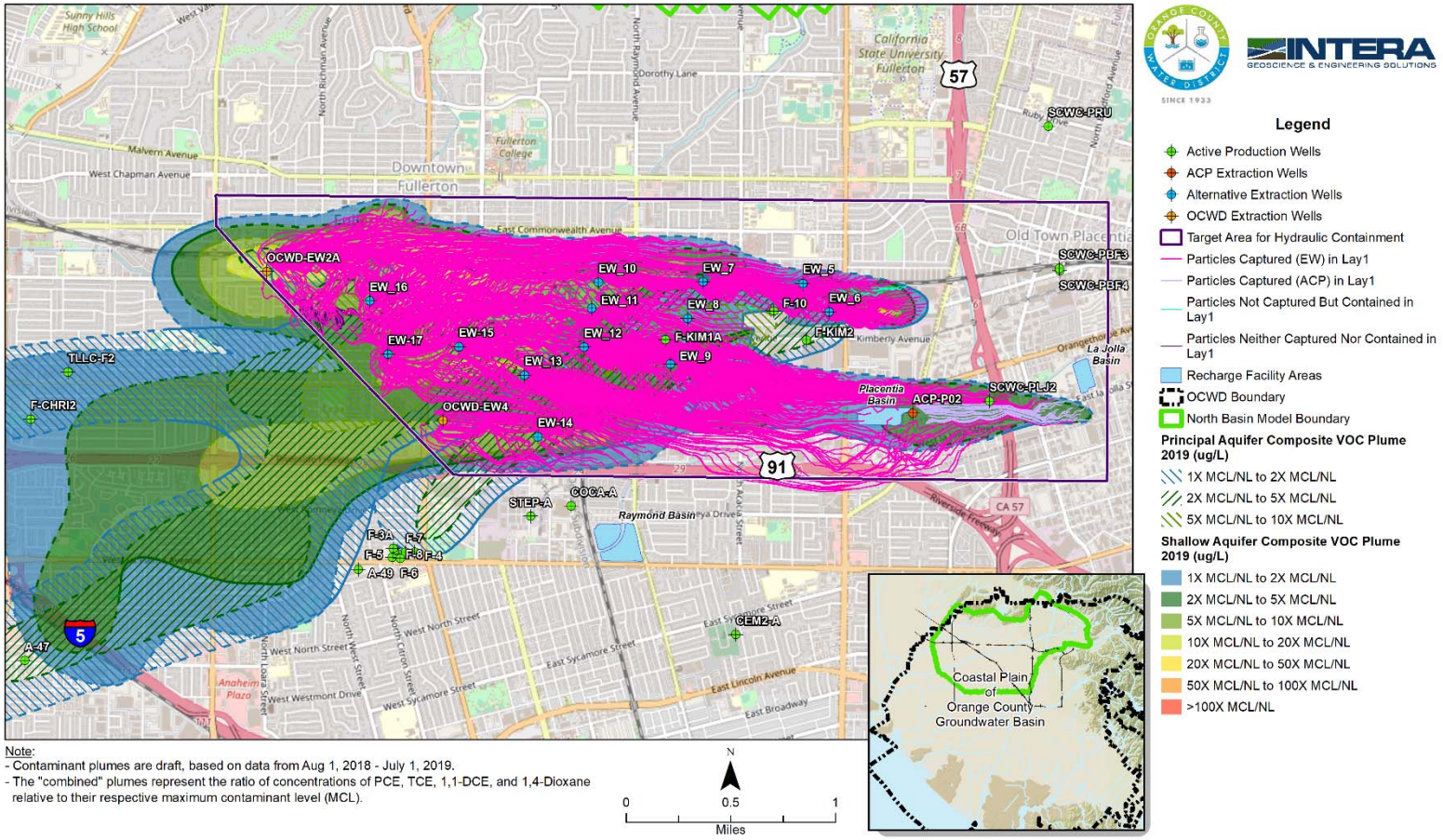


Figure 11a: Simulation 3 (Alternative Wells) particle tracks in the Shallow zone (Layer 1) within and outside the target containment area

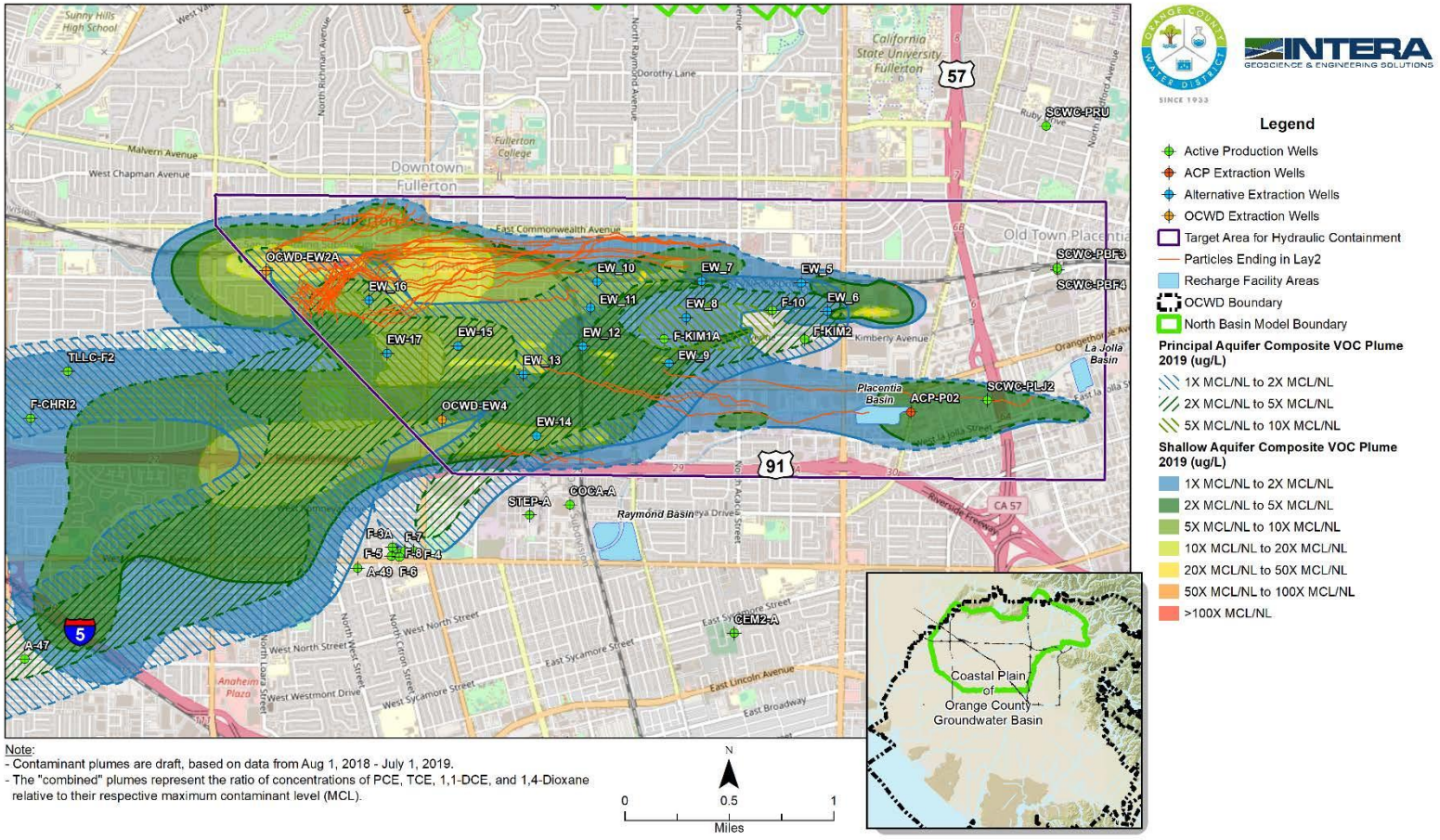


Figure 11b: Simulation 3 (Alternative Wells) particle tracks in the upper aquitard (Layer 2) within and outside the target containment area

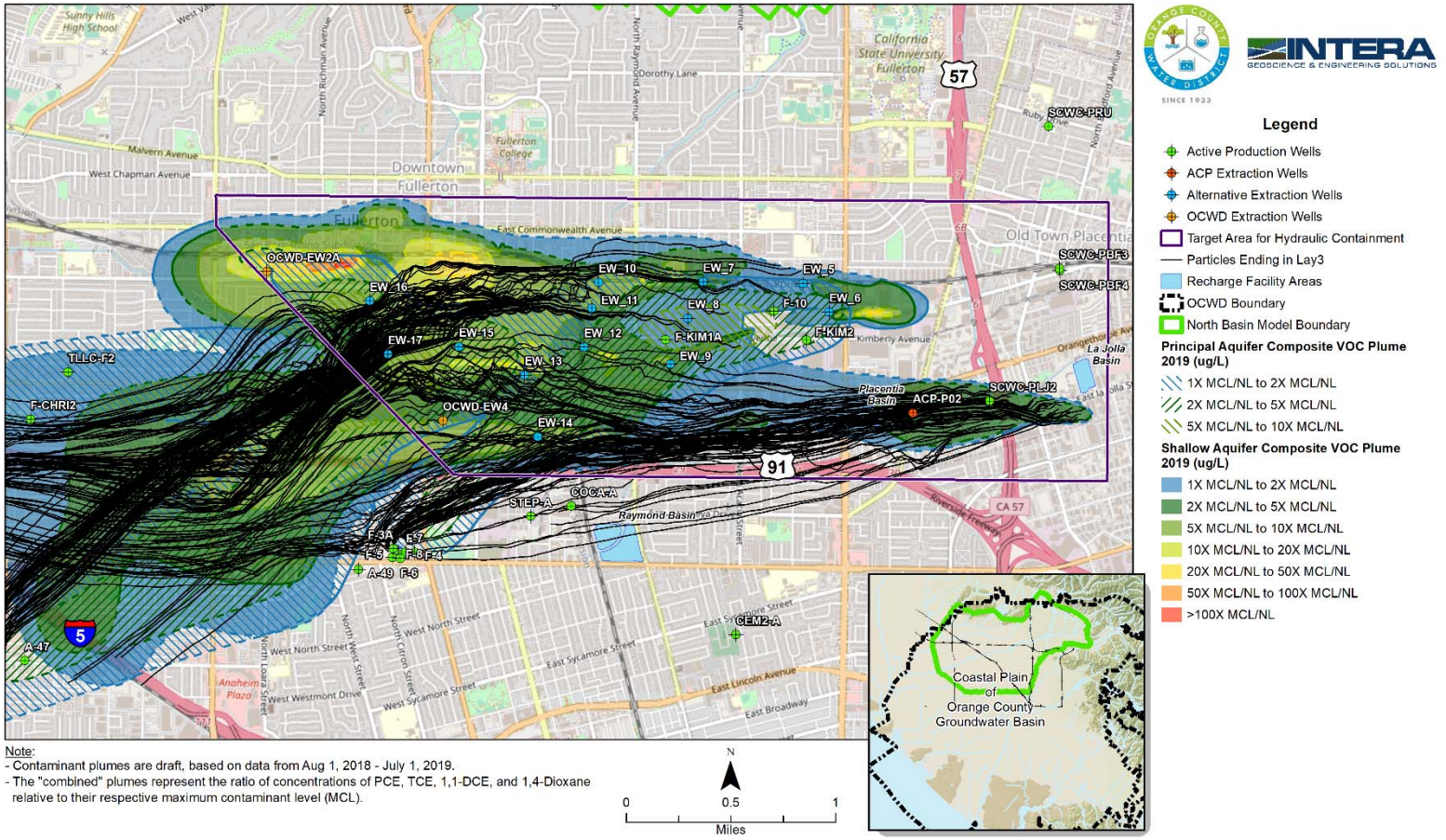


Figure 11c: Simulation 3 (Alternative Wells) particle tracks in the Principal zone (Layers 3 – 12) within and outside the target containment area

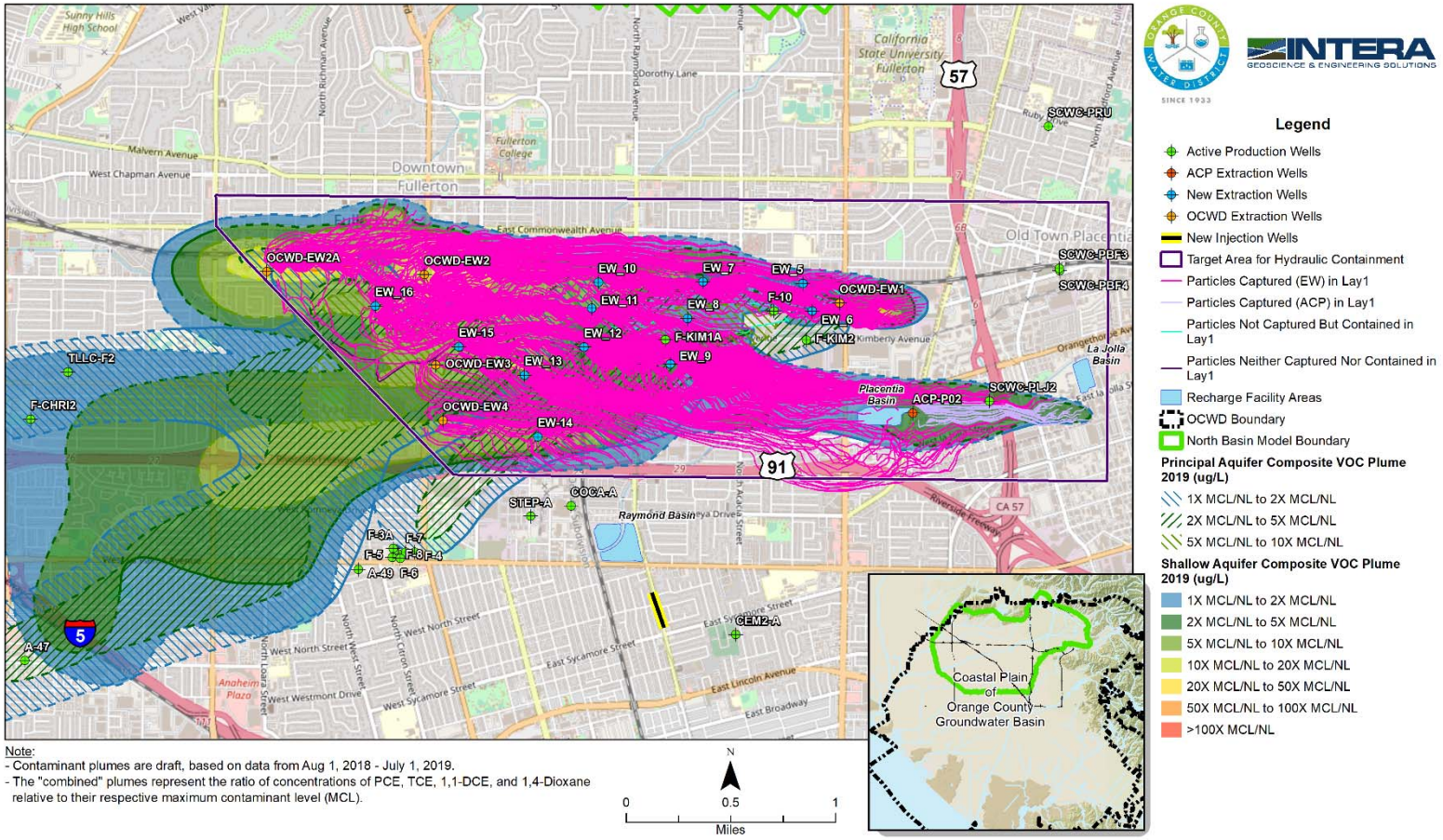


Figure 12a: Simulation 4 (Existing and New Wells with Injection) particle tracks in the Shallow zone (Layer 1) within and outside the target containment area

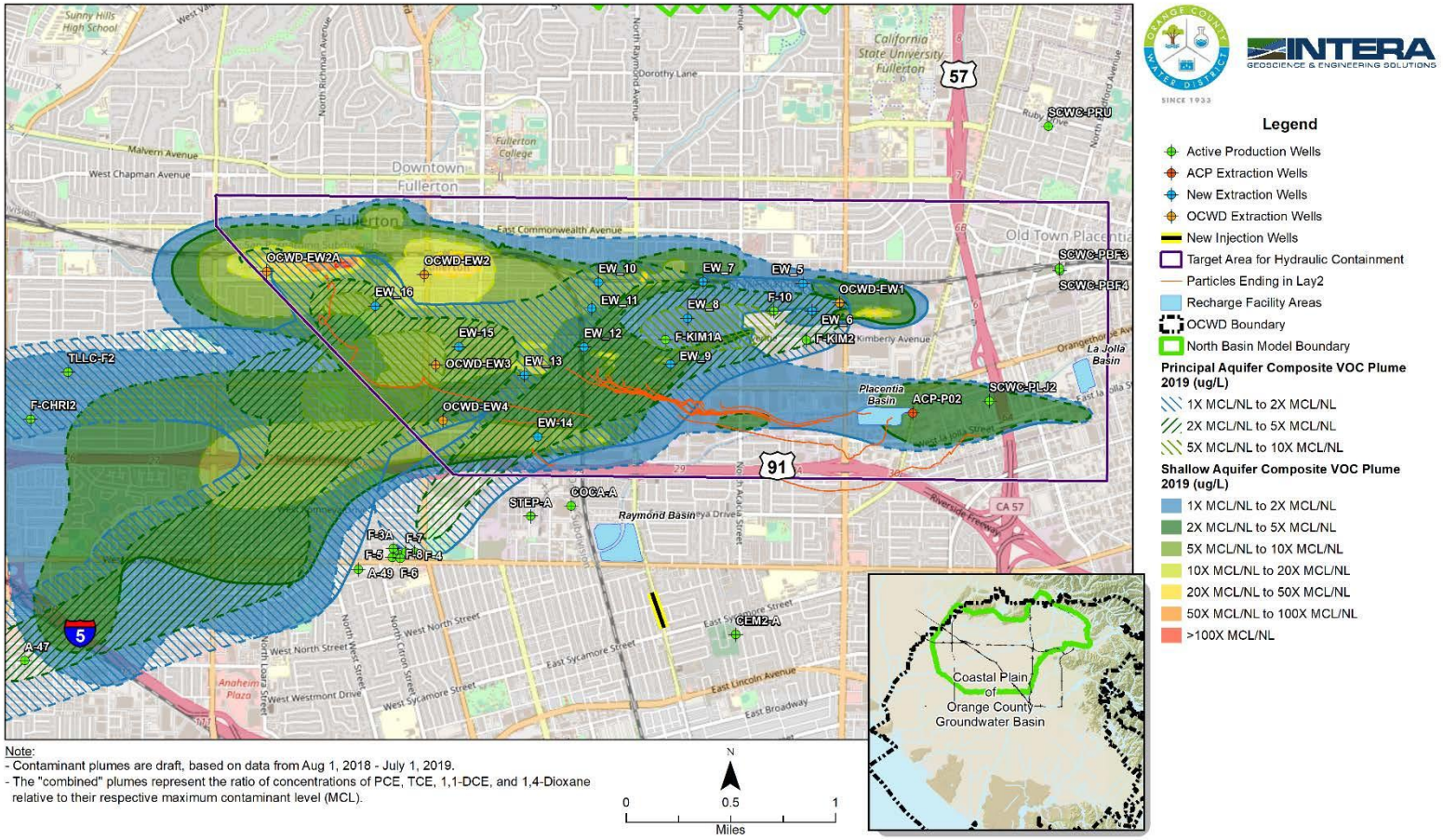


Figure 12b: Simulation 4 (Existing and New Wells with Injection) particle tracks in the upper aquitard (Layer 2) within and outside the target containment area

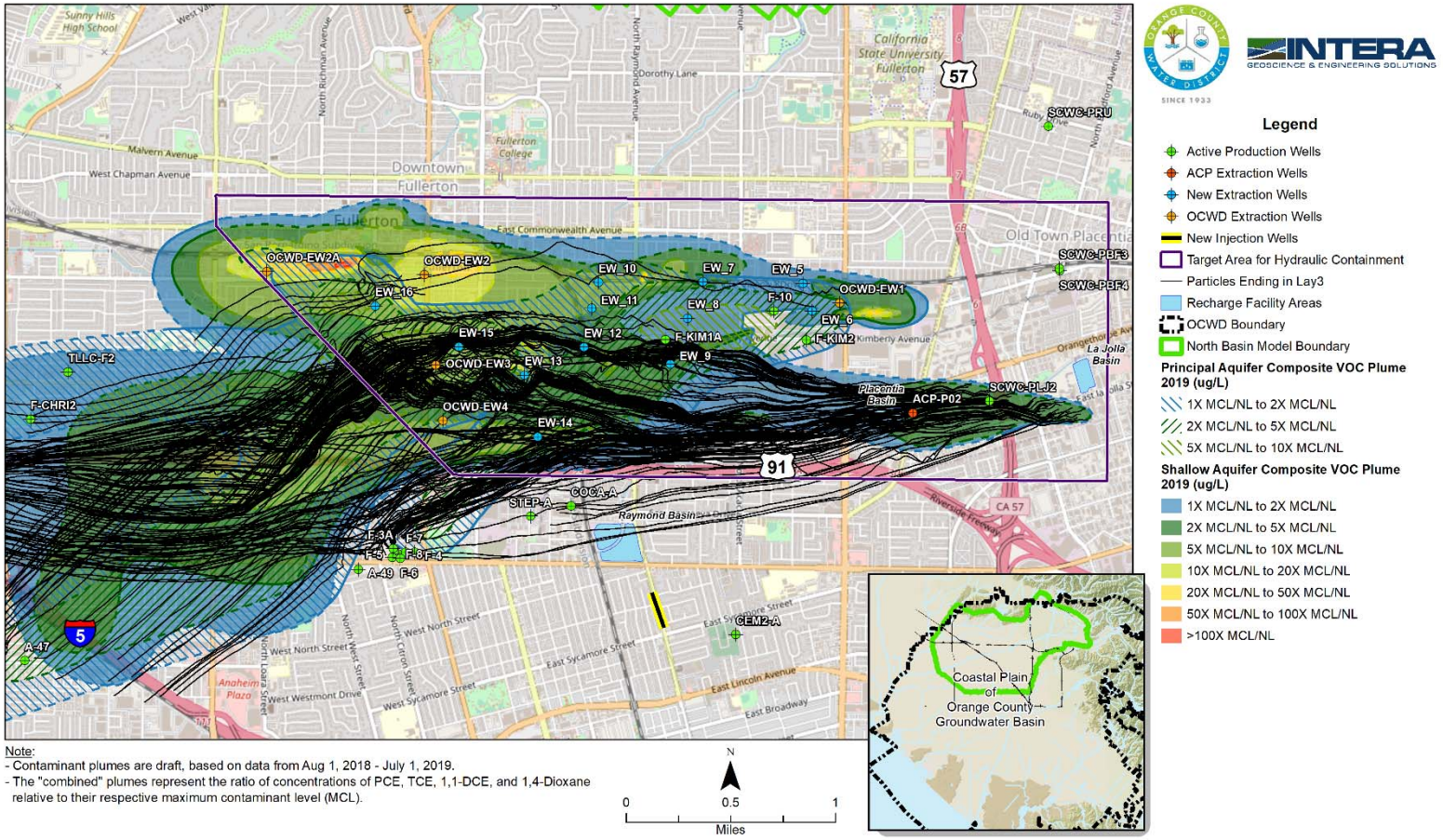


Figure 12c: Simulation 4 (Existing and New Wells with Injection) particle tracks in the Principal zone (Layers 3 – 12) within and outside the target containment area

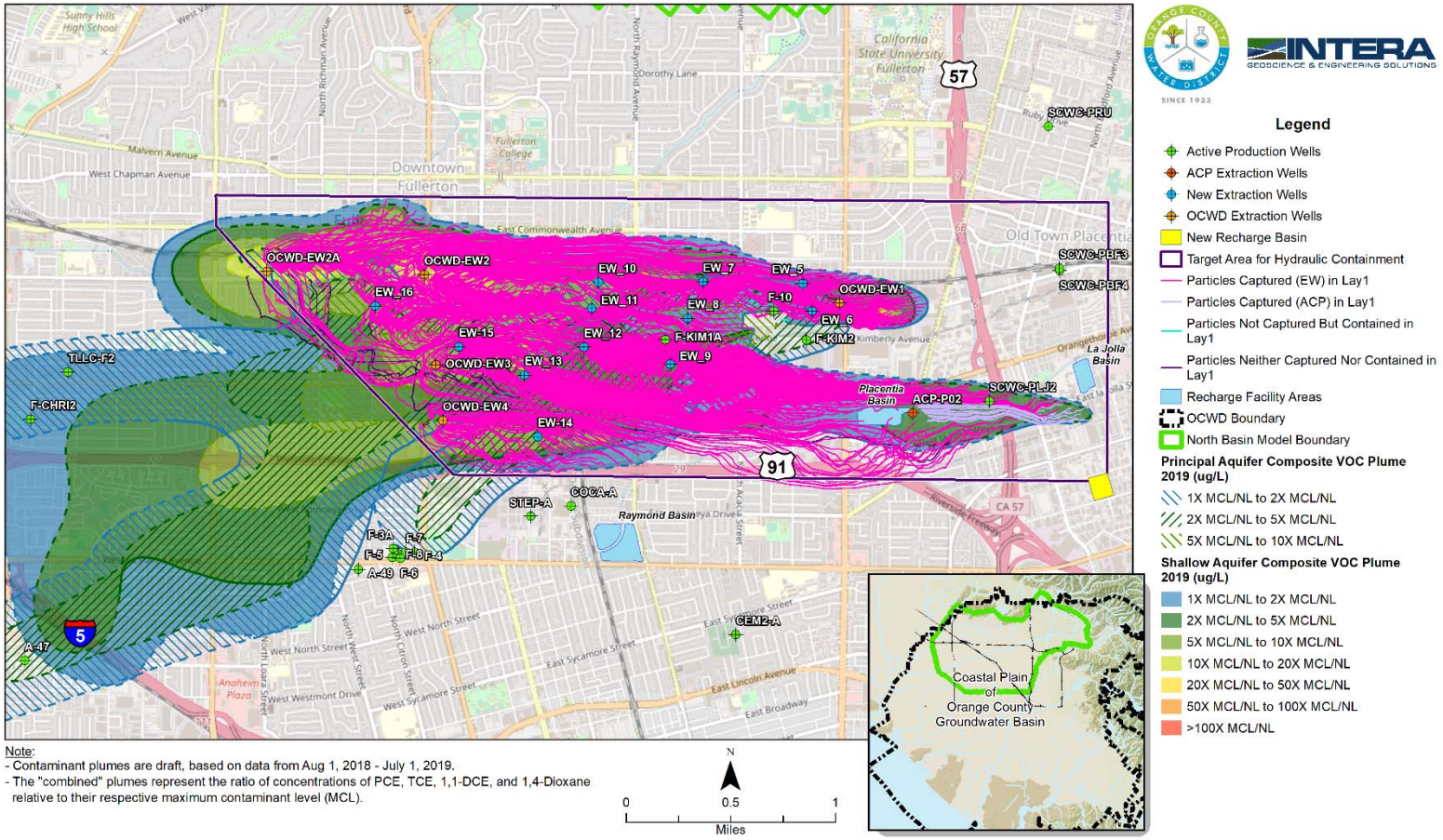


Figure 13a: Simulation 5 (Existing and New Wells with Recharge Basin) particle tracks in the Shallow zone (Layer 1) within and outside the target containment area

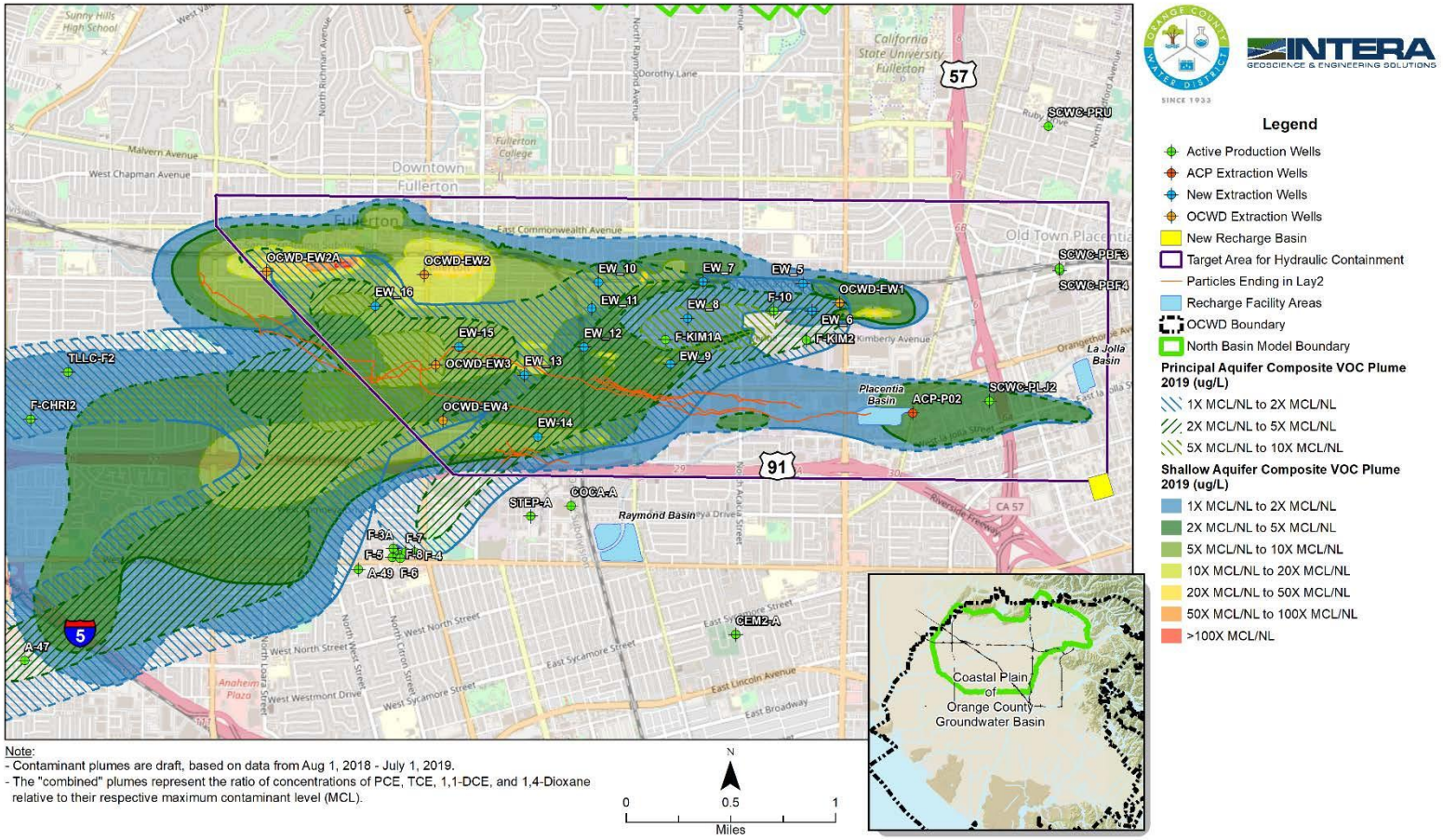


Figure 13b: Simulation 5 (Existing and New Wells with Recharge Basin) particle tracks in the upper aquitard (Layer 2) within and outside the target containment area

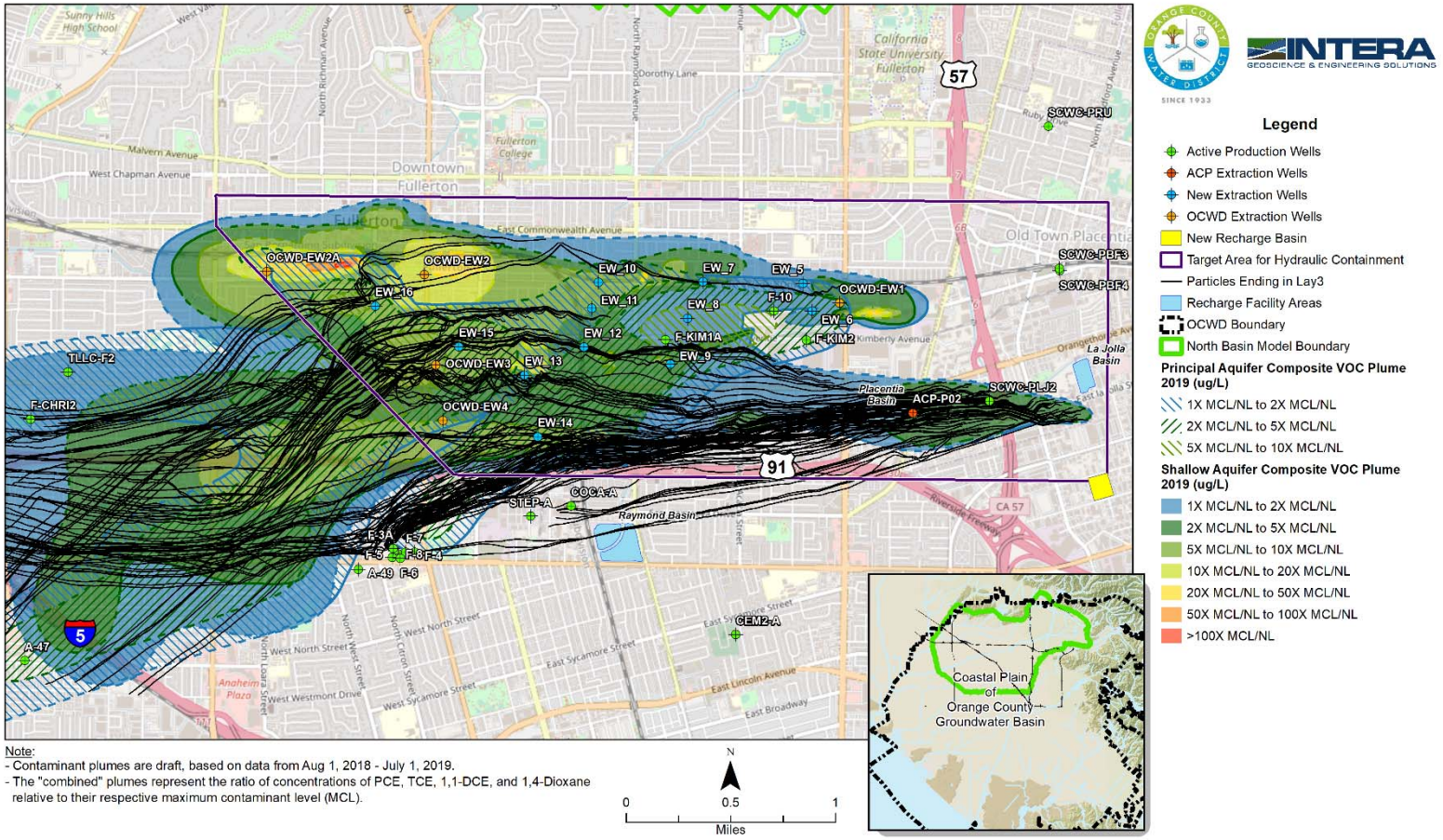


Figure 13c: Simulation 5 (Existing and New Wells with Recharge Basin) particle tracks in the Principal zone (Layers 3 - 12) within and outside the target containment area

ATTACHMENTS

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Attachment A

List of All Production Wells with Simulated Pumping within the Model Domain

Well Site	Well Type	Well Use	Model Layers	Average Pumping (AFY)
A-28	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 4	0.2
A-36	PRODUCTION	LARGE MUNICIPAL SYSTEM	5 - 6	487.8
A-40	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 8	1,009.3
A-41	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 10	3,794.6
A-42	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 14	2,834.2
A-43	PRODUCTION	LARGE MUNICIPAL SYSTEM	8 - 14	3,237.1
A-44	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 14	3,644.0
A-45	PRODUCTION	LARGE MUNICIPAL SYSTEM	5 - 14	3,216.9
A-46	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 14	4,680.2
A-47	PRODUCTION	LARGE MUNICIPAL SYSTEM	4 - 12	1,989.8
A-48	PRODUCTION	LARGE MUNICIPAL SYSTEM	7 - 9	2,640.4
A-49	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 14	4,605.2
A-51	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 6	1,813.7
A-52	PRODUCTION	LARGE MUNICIPAL SYSTEM	7 - 14	1,355.7
A-53	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 8	1,358.1
A-54	PRODUCTION	LARGE MUNICIPAL SYSTEM	7 - 14	3,651.2
A-55	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 11	3,709.6
ACP-P02	PRODUCTION	REMEDIATION	1	671.0
A-DMGC	PRODUCTION	IRRIGATION	3 - 4	376.7
AVCC-P	PRODUCTION	IRRIGATION	1 - 12	55.8
AVCC-P2	PRODUCTION	IRRIGATION	1 - 12	341.1
BP-BOIS	PRODUCTION	LARGE MUNICIPAL SYSTEM	4 - 10	3,869.3
BP-CABA	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 10	631.7
BP-FREE	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 8	702.5
BP-HOLD	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 6	1,538.8
BP-KNOT	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 11	1,269.3
BP-LIND	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 8	2,514.1
BP-SM	PRODUCTION	LARGE MUNICIPAL SYSTEM	4 - 14	535.9
CEM2-A	PRODUCTION	IRRIGATION	3 - 12	46.2
COCA-A	PRODUCTION	INDUSTRIAL	3 - 12	0.1
CRES-A	PRODUCTION	SMALL DOMESTIC SYSTEM	3 - 4	11.1
DISN-AE1	PRODUCTION	IRRIGATION	3 - 12	2.7
F-10	PRODUCTION	LARGE MUNICIPAL SYSTEM	5 - 12	2,697.3
F-3A	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 12	3,436.0
F-4	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 4	532.1
F-5	PRODUCTION	LARGE MUNICIPAL SYSTEM	4	1,944.3

F-6	PRODUCTION	LARGE MUNICIPAL SYSTEM	4	26.9
F-7A	PRODUCTION	LARGE MUNICIPAL SYSTEM	4	822.8
F-8	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 4	3,014.0
F-AIRP	PRODUCTION	LARGE MUNICIPAL SYSTEM	4 - 12	2,192.9
F-CHRI2	PRODUCTION	LARGE MUNICIPAL SYSTEM	4 - 13	2,645.5
F-KIM1A	PRODUCTION	LARGE MUNICIPAL SYSTEM	5 - 12	1,412.7
F-KIM2	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 6	1,781.7
GG-19	PRODUCTION	LARGE MUNICIPAL SYSTEM	5 - 6	974.2
GG-27	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 7	1,204.6
GSWC-POR1	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 14	28.7
HOLY-A	PRODUCTION	IRRIGATION	4	10.5
KNOT-BP	PRODUCTION	IRRIGATION	3 - 12	13.8
KNOT-BPBS	PRODUCTION	SMALL DOMESTIC SYSTEM	3 - 4	175.9
MKSSN-A	PRODUCTION	INDUSTRIAL	7 - 8	188.3
OCWD-ALK	PRODUCTION	IRRIGATION	1 - 4	31.1
OCWD-BESS	PRODUCTION	IRRIGATION	1 - 2	38.4
PAGE-F	PRODUCTION	SMALL DOMESTIC SYSTEM	1 - 3	51.9
PSCI-AM31	PRODUCTION	REMEDIATION	1	39.8
SAKH-A	PRODUCTION	IRRIGATION	1	39.9
SCE-AL1	PRODUCTION	IRRIGATION	1	2.2
SCWC-PBF3	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 6	277.3
SCWC-PBF4	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 6	1,470.5
SCWC-PLJ2	PRODUCTION	LARGE MUNICIPAL SYSTEM	4 - 5	1,138.8
SCWC-PRU	PRODUCTION	LARGE MUNICIPAL SYSTEM	6 - 11	421.1
SCWC-SCL4	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 3	337.2
SCWC-SSHR	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 4	646.3
STEP-A	PRODUCTION	INDUSTRIAL	3	4.3
YLWD-1	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 5	1,023.1
YLWD-10	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 7	1,763.0
YLWD-11	PRODUCTION	LARGE MUNICIPAL SYSTEM	2 - 11	0.3
YLWD-12	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 9	140.5
YLWD-15	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 3	118.5
YLWD-18	PRODUCTION	LARGE MUNICIPAL SYSTEM	3 - 10	2,404.7
YLWD-19	PRODUCTION	LARGE MUNICIPAL SYSTEM	4 - 11	503.9
YLWD-5	PRODUCTION	LARGE MUNICIPAL SYSTEM	1 - 5	1,107.8

Attachment B

Excel Spreadsheet with Step Drawdown Test for OCWD Extraction Wells

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Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
9/22/08 7:00 AM	0	0	147.40	147.40	0.00	0	
9/22/08 7:02 AM	2	2	147.40	152.58	5.18		
9/22/08 7:04 AM	4	4	147.40	152.65	5.25	729	138.86
9/22/08 7:06 AM	6	6	147.40	152.73	5.33	729	136.77
9/22/08 7:08 AM	8	8	147.40			729	
9/22/08 7:10 AM	10	10	147.40	152.85	5.45	729	133.76
9/22/08 7:15 AM	15	15	147.40	152.74	5.34	729	136.52
9/22/08 7:20 AM	20	20	147.40	152.83	5.43	728	134.07
9/22/08 7:25 AM	25	25	147.40	152.77	5.37		
9/22/08 7:30 AM	30	30	147.40	152.75	5.35	727	135.89
9/22/08 7:40 AM	40	40	147.40	152.79	5.39	725	134.51
9/22/08 7:50 AM	50	50	147.40	152.77	5.37	723	134.64
9/22/08 8:00 AM	60	60	147.40	152.77	5.37	723	134.64
9/22/08 8:02 AM	2	62	147.40	154.18	6.78		
9/22/08 8:04 AM	4	64	147.40	154.28	6.88	905	131.54
9/22/08 8:06 AM	6	66	147.40	154.30	6.90		
9/22/08 8:08 AM	8	68	147.40	154.32	6.92	904	130.64
9/22/08 8:10 AM	10	70	147.40	154.35	6.95	904	130.07
9/22/08 8:15 AM	15	75	147.40	154.36	6.96	904	129.89
9/22/08 8:20 AM	20	80	147.40	154.42	7.02	904	128.77
9/22/08 8:25 AM	25	85	147.40	154.46	7.06	903	127.90
9/22/08 8:30 AM	30	90	147.40	154.50	7.10	905	127.46
9/22/08 8:40 AM	40	100	147.40	154.52	7.12	905	127.11
9/22/08 8:50 AM	50	110	147.40	154.56	7.16	906	126.54
9/22/08 9:00 AM	60	120	147.40	154.58	7.18	906	126.18
9/22/08 9:15 AM	75	135	147.40	154.61	7.21	907	125.80
9/22/08 9:30 AM	90	150	147.40	154.63	7.23	907	125.45
9/22/08 9:45 AM	105	165	147.40	154.65	7.25	907	125.10
9/22/08 10:00 AM	120	180	147.40	154.63	7.23	907	125.45
9/22/08 10:30 AM	150	210	147.40	154.63	7.23	907	125.45
9/22/08 10:32 AM	2	212	147.40	156.10	8.70		
9/22/08 10:34 AM	4	214	147.40	156.18	8.78	1107	126.08
9/22/08 10:36 AM	6	216	147.40	156.21	8.81	1100	124.86
9/22/08 10:38 AM	8	218	147.40	156.23	8.83	1101	124.69
9/22/08 10:40 AM	10	220	147.40	156.26	8.86	1101	124.27
9/22/08 10:45 AM	15	225	147.40	156.28	8.88	1102	124.10
9/22/08 10:50 AM	20	230	147.40	156.30	8.90	1102	123.82
9/22/08 10:55 AM	25	235	147.40	156.33	8.93	1102	123.40
9/22/08 11:00 AM	30	240	147.40	156.37	8.97	1103	122.97
9/22/08 11:10 AM	40	250	147.40	156.40	9.00	1104	122.67
9/22/08 11:20 AM	50	260	147.40	156.43	9.03	1104	122.26
9/22/08 11:30 AM	60	270	147.40	156.45	9.05	1104	121.99
9/22/08 11:45 AM	75	285	147.40	156.47	9.07	1105	121.83
9/22/08 12:00 PM	90	300	147.40	156.50	9.10	1105	121.43
9/22/08 12:15 PM	105	315	147.40	156.54	9.14	1105	120.90
9/22/08 12:30 PM	120	330	147.40	156.58	9.18	1106	120.48
9/22/08 1:00 PM	150	360	147.40	156.61	9.21	1106	120.09
9/22/08 1:30 PM	180	390	147.40	156.63	9.23	1106	119.83

Average Discharge Rate From Totalizer (gpm)

Step 1:	728
Step 2:	902
Step 3:	1,107

Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
8/25/08 8:00 AM	0	0	104.55	104.55	0.00	0	
8/25/08 8:01 AM	1	1	104.55	112.95	8.40	419	49.88
8/25/08 8:02 AM	2	2	104.55	113.60	9.05	438	48.40
8/25/08 8:03 AM	3	3	104.55	113.77	9.22	436	47.29
8/25/08 8:04 AM	4	4	104.55	113.90	9.35	440	47.06
8/25/08 8:05 AM	5	5	104.55	113.95	9.40	440	46.81
8/25/08 8:07 AM	7	7	104.55	114.15	9.60	441	45.94
8/25/08 8:09 AM	9	9	104.55	114.20	9.65	440	45.60
8/25/08 8:11 AM	11	11	104.55	114.40	9.85	441	44.77
8/25/08 8:15 AM	15	15	104.55	114.42	9.87	441	44.68
8/25/08 8:20 AM	20	20	104.55	114.49	9.94	442	44.47
8/25/08 8:25 AM	25	25	104.55	114.52	9.97	440	44.13
8/25/08 8:30 AM	30	30	104.55	114.58	10.03	438	43.67
8/25/08 8:35 AM	35	35	104.55	114.49	9.94	439	44.16
8/25/08 8:40 AM	40	40	104.55	114.52	9.97	435	43.63
8/25/08 8:45 AM	45	45	104.55	114.54	9.99	434	43.44
8/25/08 8:50 AM	50	50	104.55	114.60	10.05	434	43.18
8/25/08 9:00 AM	60	60	104.55	114.64	10.09	433	42.91
8/25/08 9:10 AM	70	70	104.55	114.70	10.15	432	42.56
8/25/08 9:20 AM	80	80	104.55	114.75	10.20	432	42.35
8/25/08 9:30 AM	90	90	104.55	114.82	10.27	432	42.06
8/25/08 9:40 AM	100	100	104.55	114.90	10.35	433	41.84
8/25/08 10:00 AM	120	120	104.55	114.98	10.43	431	41.32
8/25/08 10:30 AM	150	150	104.55	115.08	10.53	431	40.93
8/25/08 11:00 AM	180	180	104.55	115.18	10.63	430	40.45
8/25/08 11:01 AM	1	181	104.55	119.55	15.00	583	38.87
8/25/08 11:02 AM	2	182	104.55	119.72	15.17	602	39.68
8/25/08 11:03 AM	3	183	104.55	120.00	15.45	621	40.19
8/25/08 11:04 AM	4	184	104.55	120.24	15.69	613	39.07
8/25/08 11:05 AM	5	185	104.55	120.29	15.74	621	39.45
8/25/08 11:07 AM	7	187	104.55	120.37	15.82	626	39.57
8/25/08 11:09 AM	9	189	104.55	120.47	15.92	627	39.38
8/25/08 11:11 AM	11	191	104.55	120.55	16.00		
8/25/08 11:15 AM	15	195	104.55	120.61	16.06	631	39.29
8/25/08 11:20 AM	20	200	104.55	120.72	16.17	632	39.08
8/25/08 11:25 AM	25	205	104.55	120.84	16.29	632	38.80
8/25/08 11:30 AM	30	210	104.55	120.90	16.35	636	38.90
8/25/08 11:35 AM	35	215	104.55	120.93	16.38	635	38.77
8/25/08 11:40 AM	40	220	104.55	120.97	16.42	635	38.67
8/25/08 11:45 AM	45	225	104.55	121.02	16.47	635	38.55
8/25/08 11:50 AM	50	230	104.55	121.10	16.55	635	38.37
8/25/08 12:00 PM	60	240	104.55	121.15	16.60	635	38.25
8/25/08 12:10 PM	70	250	104.55	121.22	16.67	636	38.15
8/25/08 12:20 PM	90	270	104.55	121.25	16.70	636	38.08
8/25/08 12:30 PM	100	280	104.55	121.28	16.73	636	38.02
8/25/08 12:40 PM	110	290	104.55	121.35	16.80	637	37.92
8/25/08 1:00 PM	120	300	104.55	121.45	16.90	637	37.69
8/25/08 1:30 PM	150	330	104.55	121.58	17.03	637	37.40
8/25/08 2:00 PM	180	360	104.55	121.68	17.13	637	37.19
8/25/08 2:01 PM	1	361	104.55	124.72	20.17		
8/25/08 2:02 PM	2	362	104.55	124.76	20.21	755	37.36

Average Discharge Rate From Totalizer (gpm)

Step 1:	430
Step 2:	637
Step 3:	806

Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
8/25/08 2:03 PM	3	363	104.55	124.75	20.20		
8/25/08 2:04 PM	4	364	104.55	125.90	21.35	766	35.88
8/25/08 2:05 PM	5	365	104.55	125.93	21.38	778	36.39
8/25/08 2:07 PM	7	367	104.55	126.00	21.45	785	36.60
8/25/08 2:09 PM	9	369	104.55	126.12	21.57	789	36.58
8/25/08 2:11 PM	11	371	104.55	126.17	21.62		
8/25/08 2:15 PM	15	375	104.55	126.20	21.65	800	36.95
8/25/08 2:20 PM	20	380	104.55	126.25	21.70	798	36.77
8/25/08 2:25 PM	25	385	104.55	126.30	21.75		
8/25/08 2:30 PM	30	390	104.55	126.35	21.80	803	36.83
8/25/08 2:35 PM	35	395	104.55	126.40	21.85	801	36.66
8/25/08 2:40 PM	40	400	104.55	126.45	21.90	802	36.62
8/25/08 2:45 PM	45	405	104.55	126.52	21.97	800	36.41
8/25/08 2:50 PM	50	410	104.55	126.57	22.02	797	36.19
8/25/08 3:00 PM	60	420	104.55	126.65	22.10	803	36.33
8/25/08 3:10 PM	70	430	104.55	126.74	22.19	803	36.19
8/25/08 3:20 PM	80	440	104.55	126.80	22.25	804	36.13
8/25/08 3:30 PM	90	450	104.55	126.85	22.30	804	36.05
8/25/08 3:40 PM	100	460	104.55	126.92	22.37	804	35.94
8/25/08 4:00 PM	120	480	104.55	127.02	22.47	804	35.78
8/25/08 4:30 PM	150	510	104.55	127.10	22.55	804	35.65
8/25/08 5:00 PM	180	540	104.55	127.23	22.68	806	35.54

Average Discharge Rate From Totalizer (gpm)

Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
7/10/08 8:30 AM	0	0	91.75				
7/10/08 8:32 AM	2	2	91.75	101.08	9.33	371	39.76
7/10/08 8:34 AM	4	4	91.75	101.70	9.95		
7/10/08 8:36 AM	6	6	91.75	102.08	10.33	371	35.91
7/10/08 8:38 AM	8	8	91.75	102.18	10.43		
7/10/08 8:40 AM	10	10	91.75	102.28	10.53	385	36.56
7/10/08 8:45 AM	15	15	91.75	102.58	10.83	389	35.92
7/10/08 8:50 AM	20	20	91.75	102.68	10.93	393	35.96
7/10/08 8:55 AM	25	25	91.75	102.75	11.00		
7/10/08 9:00 AM	30	30	91.75	102.85	11.10	394	35.50
7/10/08 9:10 AM	40	40	91.75	103.02	11.27	395	35.05
7/10/08 9:20 AM	50	50	91.75	103.14	11.39	395	34.68
7/10/08 9:30 AM	60	60	91.75	103.22	11.47	395	34.44
7/10/08 9:45 AM	75	75	91.75	103.32	11.57	397	34.31
7/10/08 9:47 AM	2		91.75	106.32	14.57		
7/10/08 9:49 AM	4		91.75	106.45	14.70	494	33.61
7/10/08 9:51 AM	6		91.75	106.48	14.73		
7/10/08 9:53 AM	8		91.75	106.58	14.83	491	33.11
7/10/08 9:55 AM	10		91.75	106.64	14.89		
7/10/08 10:00 AM	15		91.75	106.70	14.95	492	32.91
7/10/08 10:05 AM	20		91.75	106.82	15.07	491	32.58
7/10/08 10:10 AM	25		91.75	106.90	15.15	491	32.41
7/10/08 10:15 AM	30		91.75	106.94	15.19	492	32.39
7/10/08 10:25 AM	40		91.75	106.98	15.23	492	32.30
7/10/08 10:35 AM	50		91.75	107.07	15.32	491	32.05
7/10/08 10:45 AM	60		91.75	107.11	15.36		
7/10/08 11:00 AM	75		91.75	107.22	15.47	491	31.74
7/10/08 11:15 AM	90		91.75	107.28	15.53	491	31.62
7/10/08 11:30 AM	105		91.75	107.37	15.62	491	31.43
7/10/08 11:45 AM	120		91.75	107.40	15.65		
7/10/08 11:47 AM	2		91.75	109.57	17.82	598	33.56
7/10/08 11:49 AM	4		91.75	109.50	17.75		
7/10/08 11:51 AM	6		91.75	109.62	17.87		
7/10/08 11:53 AM	8		91.75	109.71	17.96		
7/10/08 11:55 AM	10		91.75	109.80	18.05	576	31.91
7/10/08 12:00 PM	15		91.75	109.82	18.07		
7/10/08 12:05 PM	20		91.75	111.30	19.55	582	29.77
7/10/08 12:10 PM	25		91.75	111.37	19.62	587	29.92
7/10/08 12:15 PM	30		91.75	111.43	19.68	591	30.03
7/10/08 12:25 PM	40		91.75	111.48	19.73	595	30.16
7/10/08 12:35 PM	50		91.75	111.59	19.84	598	30.14
7/10/08 12:45 PM	60		91.75	111.72	19.97	599	29.99
7/10/08 1:00 PM	75		91.75	111.88	20.13	601	29.86
7/10/08 1:15 PM	90		91.75	112.02	20.27	602	29.70
7/10/08 1:30 PM	105		91.75	112.09	20.34	604	29.70
7/10/08 1:45 PM	120		91.75	112.15	20.40		
7/10/08 1:47 PM	2		91.75	114.63	22.88	681	29.76
7/10/08 1:49 PM	4		91.75	114.75	23.00	696	30.26
7/10/08 1:51 PM	6		91.75	114.78	23.03		
7/10/08 1:53 PM	8		91.75	114.82	23.07		
7/10/08 1:55 PM	10		91.75	114.85	23.10	681	29.48

Average Discharge Rate From Totalizer (gpm)

Step 1:	397
Step 2:	491
Step 3:	604
Step 4:	686

Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
7/10/08 2:01 PM	16		91.75	114.90	23.15	683	29.50
7/10/08 2:05 PM	20		91.75	115.15	23.40	683	29.19
7/10/08 2:10 PM	25		91.75	115.18	23.43		
7/10/08 2:15 PM	30		91.75	115.25	23.50	683	29.06
7/10/08 2:25 PM	40		91.75	115.37	23.62	684	28.96
7/10/08 2:35 PM	50		91.75	115.45	23.70	686	28.95
7/10/08 2:45 PM	60		91.75	115.54	23.79	684	28.75
7/10/08 3:00 PM	75		91.75	115.67	23.92	685	28.64
7/10/08 3:15 PM	90		91.75	115.74	23.99	685	28.55
7/10/08 3:30 PM	105		91.75	115.85	24.10	687	28.51
7/10/08 3:45 PM	120		91.75	115.97	24.22	686	28.32

Average Discharge Rate From Totalizer (gpm)

Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
11/7/08 3:00 PM	0	0	107.85	107.85	0.00	0	
11/7/08 3:02 PM	2	2	107.85	119.14	11.29	285	25.24
11/7/08 3:04 PM	4	4	107.85	118.69	10.84	265	24.45
11/7/08 3:06 PM	6	6	107.85	118.89	11.04	258	23.37
11/7/08 3:08 PM	8	8	107.85	118.87	11.02	258	23.41
11/7/08 3:10 PM	10	10	107.85	118.77	10.92	253	23.17
11/7/08 3:15 PM	15	15	107.85	118.25	10.40	251	24.13
11/7/08 3:20 PM	20	20	107.85	118.14	10.29	247	24.00
11/7/08 3:25 PM	25	25	107.85	118.28	10.43	244	23.39
11/7/08 3:30 PM	30	30	107.85	118.15	10.30	242	23.50
11/7/08 3:40 PM	40	40	107.85	117.87	10.02	240	23.95
11/7/08 3:50 PM	50	50	107.85	117.88	10.03	237	23.63
11/7/08 4:00 PM	60	60	107.85	117.81	9.96	234	23.49
11/7/08 4:15 PM	75	75	107.85	117.63	9.78	231	23.62
11/7/08 4:30 PM	90	90	107.85	117.66	9.81	229	23.34
11/7/08 4:45 PM	105	105	107.85	122.42	14.57	317	21.76
11/7/08 4:47 PM	2	107	107.85	131.68	23.83		
11/7/08 4:49 PM	4	109	107.85	132.02	24.17	465	19.24
11/7/08 4:51 PM	6	111	107.85	131.94	24.09	468	19.43
11/7/08 4:53 PM	8	113	107.85	131.98	24.13	462	19.15
11/7/08 4:55 PM	10	115	107.85	131.77	23.92	464	19.40
11/7/08 5:00 PM	15	120	107.85	131.75	23.90	459	19.21
11/7/08 5:05 PM	20	125	107.85	131.72	23.87	459	19.23
11/7/08 5:10 PM	25	130	107.85	131.77	23.92	460	19.23
11/7/08 5:15 PM	30	135	107.85	131.96	24.11	460	19.08
11/7/08 5:25 PM	40	145	107.85	131.77	23.92	460	19.23
11/7/08 5:35 PM	50	155	107.85	132.07	24.22	460	18.99
11/7/08 5:45 PM	60	165	107.85	132.20	24.35	460	18.89
11/7/08 6:00 PM	75	180	107.85	131.94	24.09	460	19.10
11/7/08 6:15 PM	90	195	107.85	132.06	24.21	460	19.00
11/7/08 6:30 PM	105	210	107.85	132.24	24.39	460	18.86
11/7/08 6:45 PM	120	225	107.85	132.19	24.34	459	18.86
11/7/08 7:15 PM	150	255	107.85	132.18	24.33	459	18.87
11/7/08 7:45 PM	180	285	107.85	132.20	24.35	464	19.06
11/7/08 7:47 PM	2	287	107.85	141.66	33.81	565	16.71
11/7/08 7:49 PM	4	289	107.85	147.20	39.35	600	15.25
11/7/08 7:51 PM	6	291	107.85	147.45	39.60	617	15.58
11/7/08 7:53 PM	8	293	107.85	147.62	39.77	625	15.72
11/7/08 7:55 PM	10	295	107.85	147.68	39.83	630	15.82
11/7/08 8:00 PM	15	300	107.85	147.85	40.00	637	15.93
11/7/08 8:05 PM	20	305	107.85	148.04	40.19	641	15.95
11/7/08 8:10 PM	25	310	107.85	148.17	40.32	642	15.92
11/7/08 8:15 PM	30	315	107.85	148.22	40.37	644	15.95
11/7/08 8:25 PM	40	325	107.85	148.28	40.43	647	16.00
11/7/08 8:35 PM	50	335	107.85	148.42	40.57	648	15.97
11/7/08 8:45 PM	60	345	107.85	148.53	40.68	648	15.93
11/7/08 9:00 PM	75	360	107.85	148.75	40.90	649	15.87
11/7/08 9:15 PM	90	375	107.85	148.74	40.89	649	15.87
11/7/08 9:30 PM	105	390	107.85	148.90	41.05	650	15.83
11/7/08 9:45 PM	120	405	107.85	148.96	41.11	650	15.81
11/7/08 10:15 PM	150	435	107.85	148.99	41.14	650	15.80

Average Discharge Rate From Totalizer (gpm)

Step 1:	237
Step 2:	459
Step 3:	649

Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
11/7/08 10:45 PM	180	465	107.85	149.07	41.22	650	15.77
11/7/08 11:15 PM	210	495	107.85	149.16	41.31	650	15.73
11/7/08 11:45 PM	240	525	107.85	149.08	41.23	650	15.77
11/8/08 12:15 AM	270	555	107.85	149.16	41.31	650	15.73
11/8/08 12:45 AM	300	585	107.85	149.20	41.35	650	15.72
11/8/08 1:15 AM	330	615	107.85	149.25	41.40	649	15.68
11/8/08 1:45 AM	360	645	107.85	149.41	41.56	649	15.62
11/8/08 2:15 AM	390	675	107.85	149.41	41.56	649	15.62

Average Discharge Rate From Totalizer (gpm)

Date/Time	Step Time	Total Time	Static WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
4/1/13 8:00 AM	0	0	81.40	81.40			
4/1/13 8:02 AM	2	2	81.40	87.00	5.60		
4/1/13 8:04 AM	4	4	81.40	87.30	5.90		
4/1/13 8:06 AM	6	6	81.40	87.50	6.10		
4/1/13 8:08 AM	8	8	81.40	87.50	6.10		
4/1/13 8:10 AM	10	10	81.40	87.70	6.30		
4/1/13 8:12 AM	12	12	81.40	87.75	6.35		
4/1/13 8:14 AM	14	14	81.40	87.75	6.35		
4/1/13 8:16 AM	16	16	81.40	87.75	6.35		
4/1/13 8:18 AM	18	18	81.40	87.90	6.50		
4/1/13 8:20 AM	20	20	81.40	87.90	6.50		
4/1/13 8:25 AM	25	25	81.40	88.10	6.70		
4/1/13 8:30 AM	30	30	81.40	88.10	6.70		
4/1/13 8:40 AM	40	40	81.40	88.20	6.80		
4/1/13 8:50 AM	50	50	81.40	88.30	6.90		
4/1/13 9:00 AM	60	60	81.40	88.30	6.90		
4/1/13 9:30 AM	90	90	81.40	88.34	6.94		
4/1/13 9:45 AM	105	105	81.40	88.35	6.95		
4/1/13 10:00 AM	120	120	81.40	88.40	7.00	216.67	30.95
4/1/13 10:02 AM	2	122	81.40	91.10	9.70		
4/1/13 10:04 AM	4	124	81.40	91.23	9.83		
4/1/13 10:06 AM	6	126	81.40	91.25	9.85		
4/1/13 10:08 AM	8	128	81.40	91.25	9.85		
4/1/13 10:10 AM	10	130	81.40	91.25	9.85		
4/1/13 10:12 AM	12	132	81.40	91.35	9.95		
4/1/13 10:14 AM	14	134	81.40	91.35	9.95		
4/1/13 10:16 AM	16	136	81.40	91.35	9.95		
4/1/13 10:18 AM	18	138	81.40	91.40	10.00		
4/1/13 10:20 AM	20	140	81.40	91.40	10.00		
4/1/13 10:25 AM	25	145	81.40	91.40	10.00		
4/1/13 10:30 AM	30	150	81.40	91.42	10.02		
4/1/13 10:40 AM	40	160	81.40	91.40	10.00		
4/1/13 10:50 AM	50	170	81.40	91.45	10.05		
4/1/13 11:00 AM	60	180	81.40	91.45	10.05		
4/1/13 11:15 AM	75	195	81.40	91.53	10.13		
4/1/13 11:30 AM	90	210	81.40	91.55	10.15		
4/1/13 11:45 AM	105	225	81.40	91.55	10.15		
4/1/13 12:00 PM	120	240	81.40	91.56	10.16	312.50	30.76
4/1/13 12:02 PM	2	242	81.40	96.15	14.75		
4/1/13 12:04 PM	4	244	81.40	96.15	14.75		
4/1/13 12:06 PM	6	246	81.40	96.26	14.86		
4/1/13 12:08 PM	8	248	81.40	96.26	14.86		
4/1/13 12:10 PM	10	250	81.40	96.30	14.90		
4/1/13 12:12 PM	12	252	81.40	96.40	15.00		
4/1/13 12:14 PM	14	254	81.40	95.70	14.30		
4/1/13 12:16 PM	16	256	81.40	95.70	14.30		
4/1/13 12:18 PM	18	258	81.40	95.75	14.35		
4/1/13 12:20 PM	20	260	81.40	95.80	14.40		
4/1/13 12:25 PM	25	265	81.40	95.75	14.35		
4/1/13 12:30 PM	30	270	81.40	95.80	14.40		
4/1/13 12:40 PM	40	280	81.40	95.90	14.50		

Average Discharge Rate From Totalizer (gpm)

Step 1:	217
Step 2:	313
Step 3:	429
Step 4:	529

Date/Time	Step Time	Total Time	Static WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
4/1/13 12:50 PM	50	290	81.40	95.83	14.43		
4/1/13 1:00 PM	60	300	81.40	95.90	14.50		
4/1/13 1:15 PM	75	315	81.40	95.95	14.55		
4/1/13 1:30 PM	90	330	81.40	95.85	14.45		
4/1/13 1:45 PM	105	345	81.40	95.90	14.50		
4/1/13 2:00 PM	120	360	81.40	96.00	14.60	429.17	29.40
4/1/13 2:02 PM	2	362	81.40	100.80	19.40		
4/1/13 2:04 PM	4	364	81.40	100.85	19.45		
4/1/13 2:06 PM	6	366	81.40	99.80	18.40		
4/1/13 2:08 PM	8	368	81.40	99.85	18.45		
4/1/13 2:10 PM	10	370	81.40	99.50	18.10		
4/1/13 2:12 PM	12	372	81.40	99.55	18.15		
4/1/13 2:14 PM	14	374	81.40	99.60	18.20		
4/1/13 2:16 PM	16	376	81.40	99.61	18.21		
4/1/13 2:18 PM	18	378	81.40	99.50	18.10		
4/1/13 2:20 PM	20	380	81.40	99.55	18.15		
4/1/13 2:25 PM	25	385	81.40	99.60	18.20		
4/1/13 2:30 PM	30	390	81.40	99.55	18.15		
4/1/13 2:40 PM	40	400	81.40	99.65	18.25		
4/1/13 2:50 PM	50	410	81.40	99.55	18.15		
4/1/13 3:00 PM	60	420	81.40	99.65	18.25		
4/1/13 3:15 PM	75	435	81.40	99.65	18.25		
4/1/13 3:30 PM	90	450	81.40	100.00	18.60		
4/1/13 3:45 PM	105	465	81.40	100.10	18.70		
4/1/13 4:00 PM	120	480	81.40	100.10	18.70	529.17	28.30

Average Discharge Rate From Totalizer (gpm)

Date & Time	Step Time	Total Time	Staic WL	Pumping Level	Drawdown	Pumping Rate	Specific Capacity
9/14/09 7:30 AM	0	0	113.20	113.20	0.00	0	
9/14/09 7:32 AM	2	2	113.20	116.35	3.15	315	100.00
9/14/09 7:34 AM	4	4	113.20	116.10	2.90	325	112.07
9/14/09 7:36 AM	6	6	113.20	116.18	2.98	310	104.03
9/14/09 7:38 AM	8	8	113.20				
9/14/09 7:40 AM	10	10	113.20	116.44	3.24	325	100.31
9/14/09 7:45 AM	15	15	113.20	116.53	3.33	312	93.69
9/14/09 7:50 AM	20	20	113.20	116.87	3.67	348	94.82
9/14/09 7:55 AM	25	25	113.20	116.89	3.69	358	97.02
9/14/09 8:00 AM	30	30	113.20	116.90	3.70	360	97.30
9/14/09 8:10 AM	40	40	113.20	116.91	3.71	351	94.61
9/14/09 8:20 AM	50	50	113.20	116.92	3.72	351	94.35
9/14/09 8:30 AM	60	60	113.20	116.93	3.73	354	94.91
9/14/09 8:32 AM	2	62	113.20	118.32	5.12	495	96.68
9/14/09 8:34 AM	4	64	113.20	118.40	5.20	475	91.35
9/14/09 8:36 AM	6	66	113.20	118.37	5.17	475	91.88
9/14/09 8:38 AM	8	68	113.20	118.38	5.18	480	92.66
9/14/09 8:40 AM	10	70	113.20	118.33	5.13	495	96.49
9/14/09 8:45 AM	15	75	113.20	118.40	5.20	480	92.31
9/14/09 8:50 AM	20	80	113.20	118.42	5.22	483	92.53
9/14/09 8:55 AM	25	85	113.20	118.44	5.24	488	93.13
9/14/09 9:00 AM	30	90	113.20	118.46	5.26	490	93.16
9/14/09 9:10 AM	40	100	113.20	118.50	5.30	490	92.45
9/14/09 9:20 AM	50	110	113.20	118.60	5.40	484	89.63
9/14/09 9:30 AM	60	120	113.20	118.62	5.42	486	89.67
9/14/09 9:45 AM	75	135	113.20	118.64	5.44	487	89.52
9/14/09 10:00 AM	90	150	113.20	118.66	5.46	485	88.83
9/14/09 10:15 AM	105	165	113.20	118.67	5.47	490	89.58
9/14/09 10:30 AM	120	180	113.20	118.68	5.48	493	89.96
9/14/09 10:32 AM	2	182	113.20	119.50	6.30		0.00
9/14/09 10:34 AM	4	184	113.20	119.52	6.32	570	90.19
9/14/09 10:36 AM	6	186	113.20	119.55	6.35	565	88.98
9/14/09 10:38 AM	8	188	113.20	119.58	6.38	560	87.77
9/14/09 10:40 AM	10	190	113.20	119.62	6.42	575	89.56
9/14/09 10:45 AM	15	195	113.20	119.65	6.45	567	87.91
9/14/09 10:50 AM	20	200	113.20	119.68	6.48	580	89.51
9/14/09 10:55 AM	25	205	113.20	119.70	6.50	570	87.69
9/14/09 11:00 AM	30	210	113.20	119.72	6.52	568	87.12
9/14/09 11:10 AM	40	220	113.20	119.75	6.55	568	86.72
9/14/09 11:20 AM	50	230	113.20	119.75	6.55	572	87.33
9/14/09 11:30 AM	60	240	113.20	119.78	6.58	573	87.08
9/14/09 11:45 AM	75	255	113.20	119.79	6.59	570	86.49
9/14/09 12:00 PM	90	270	113.20	119.80	6.60	573	86.82
9/14/09 12:15 PM	105	285	113.20	119.81	6.61	567	85.78
9/14/09 12:30 PM	120	300	113.20	119.82	6.62	577	87.16
9/14/09 1:00 PM	150	330	113.20	119.84	6.64	565	85.09
9/14/09 1:30 PM	180	360	113.20	119.83	6.63	570	85.97
9/14/09 2:00 PM	210	390	113.20	119.82	6.62	567	85.65
9/14/09 2:30 PM	240	420	113.20	119.83	6.63	564	85.07
9/14/09 3:00 PM	270	450	113.20	119.84	6.64	565	85.09

Average Discharge Rate From Totalizer (gpm)

Step 1:	343
Step 2:	488
Step 3:	568

Attachment C

Summary of Particle Containment within Target Area for Baseline and Five Simulations (Unweighted Number of Particles)

Simulation ID	Simulation Name	Unweighted No. of Particles	No. of Particles Captured by EW Wells*	No. of Particles Captured by ACP-02 Well*	No. of Particles Not Captured but Contained*	No. of Particles Neither Captured nor Contained*			% of Particles Captured or Contained*
			Shallow Zone (Lay 1)	Shallow Zone (Lay 1)	Shallow Zone (Lay 1)	Shallow Zone (Lay 1)	Lay 2	Principal Zone (Lay 3 – 12)	
-	**Baseline**	3,591	0	82	22	752	355	2,380	3%
1	**Existing Wells**	3,591	1,946	79	28	267	131	1,140	57%
2	**Existing & New Wells**	3,591	3,340	79	16	0	10	146	96%
3	**Alternative Wells**	3,591	3,193	79	25	6	41	247	92%
4	**Existing & New Wells with Injection**	3,591	3,249	80	17	1	16	228	93%
5	**Existing & New Wells with Recharge Basin**	3,591	3,331	74	14	8	10	154	95%

*Containment area statistics are based on the non-volume-weighted number of particles.

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Appendix D
Cost Estimates for Remedial Alternatives–North Basin

Summary of Costs for Remedial Alternatives
North Basin Feasibility Study
Orange County Water District

	Alternative 1	**Additional Approach**	Alternative **2**	Alternative **3**	Alternative **4**	Alternative **5**	Alternative **6**
Description	No Action	MNA and ICs	Discharge to POTW/GWRS	Centralized Treatment Plant; Discharge to direct reuse	Centralized Treatment Plant; Discharge to injection wells	Centralized Treatment Plant; Discharge to infiltration basin	Two Treatment Plants; Discharge to injection wells and infiltration basin
Capital Cost	$ -	$ 2,495,000	$ 50,110,000	$ 113,540,000	$ 118,010,000	$ 147,710,000	$ 151,580,000
Annual O&M Cost (Year 1-30)	$ -	$ 193,000	$ 20,010,000	$ 9,390,000	$ 10,190,000	$ 9,450,000	$ 11,650,000
Total Periodic Cost	$ -	$ -	$ 8,460,000	$ 11,460,000	$ 12,480,000	$ 11,760,000	$ 12,210,000
Total Present Value	$ -	$ 6,230,000	$ 442,400,000	$ 302,150,000	$ 322,720,000	$ 337,660,000	$ 384,380,000
	Level III Estimates +50%/-30%						

Notes:
Present worth assumes 3.1% discount rate

Summary of Costs for Remedial Alternatives
North Basin Feasibility Study
Orange County Water District

	Alternative 1	**Additional Approach**	Alternative **2**	Alternative **3**	Alternative **4**	Alternative **5**	Alternative **6**
Description	No Action	MNA and ICs	Discharge to POTW/GWRS	Centralized Treatment Plant; Discharge to direct reuse	Centralized Treatment Plant; Discharge to injection wells	Centralized Treatment Plant; Discharge to infiltration basin	Two Treatment Plants; Discharge to injection wells and infiltration basin
Capital Cost	$ -	$ 2,495,000	$ 50,110,000	$ 113,540,000	$ 118,010,000	$ 147,710,000	$ 151,580,000
Annual O&M Cost (Year 1-30)	$ -	$ 193,000	$ 20,010,000	$ 9,390,000	$ 10,190,000	$ 9,450,000	$ 11,650,000
Total Periodic Cost	$ -	$ -	$ 8,460,000	$ 11,460,000	$ 12,480,000	$ 11,760,000	$ 12,210,000
Total Present Value Of Alternative	$ -	$ 4,890,000	$ 301,390,000	$ 234,110,000	$ 248,880,000	$ 269,130,000	$ 300,470,000
	Level III Estimates +50%/-30%						

Notes:
Present worth assumes 7% discount rate

A**DDITIONAL APPROACH**

MNA and ICs

Description: Groundwater plume remediation by naturally occurring MNA processes. ICs would be implemented to protect human health and the environment, and long-term groundwater monitoring conducted to track the progress of the natural attenuation

CAPITAL COSTS

Description	Quantity	Unit	Unit Cost	Total	Notes
Monitoring Well Installation					96 existing and 20 additional (10 shallow, 10 deep) monitoring wells
Install shallow monitoring wells	10	ea	65,000	$ 650,000	4" monitoring wells to a depth of 200 ft
Install deep monitoring wells	10	ea	115,000	$ 1,150,000	4" monitoring wells to a depth of 500 ft
SUBTOTAL				$ 1,800,000	
Bond (2%)	2%			$ 36,000.00	
SUBTOTAL				$ 1,836,000	
Contingency	15%			$ 275,400	15-35% based on engineering judgement
SUBTOTAL				$ 2,111,400	
Project Management	5%			$ 105,570	
Remedial Design	6%			$ 126,684	
Construction Management	6%			$ 126,684	
Institutional Controls					
Institutional Controls Plan	1	EA	$ 10,000	$ 10,000	
Groundwater Use Restriction	1	LS	$ 5,000	$ 5,000	
Site Information Database	1	LS	$ 10,000	$ 10,000	
SUBTOTAL				$ 25,000	
TOTAL CAPITAL COST				$ 2,495,000	Rounded to nearest $1000

A**DDITIONAL APPROACH**
MNA and ICs

O&M Costs

Description	Quantity	Unit	Unit Cost	Total	Notes
Groundwater Monitoring					
Groundwater monitoring	464	hr	$ 85	$ 39,440	Annual monitoring 116 wells; 4 hours per well, 96 existing +20 new; assumes IDW water is treated and discharged at well head similar to OCWD process
Consultant Oversight	100	hr	$ 100	$ 10,000	Engineers estimate
Reporting	240	hr	$ 100	$ 24,000	Engineers estimate
Lab Analysis	128	ea	$ 300	$ 38,280	96 existing +20 new +10% QAQC; analytical testing for VOCs, 1,4-dioxane, oxygenates, TPH, BTEX, inorganics (nitrate, sulfate, chloride, TDS), metals (arsenic, chromium, iron, manganese), methane, carbon dioxide
SUBTOTAL				$ 111,720	
Contingency	20%			$ 22,344	
Subtotal				$ 134,064	
Project Management	10%			$ 13,406	5-10% of annual
Technical Support	15%			$ 20,110	10-20% technical support
Institutional Controls				$ 25,000	Estimate
Total Annual O&M Cost				$ 193,000	rounded to the nearest $1000

PERIODIC COSTS

Description	Year	Quantity	Unit	Unit Cost	Total		Notes
TOTAL PERIODIC COSTS					$ -		

A**DDITIONAL APPROACH**

MNA and ICs

O&M Costs

NET PRESENT VALUE

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Discount Factor (3.1%)	Present Value at (7%)
Capital Cost	0	$ 2,495,000	$ 2,495,000	1.0	1.0	$ 2,495,000
Annual O&M Cost	1-30	$ 5,790,000	$ 193,000	12.409	19.349	$ 2,394,945
Periodic Cost	5	$ -	$ -	0.7		$ -
Periodic Cost	10	$ -	$ -	0.5		$ -
Periodic Cost	15	$ -	$ -	0.4		$ -
	SUBTOTAL	$ 8,285,000		SUBTOTAL		$ 4,889,945

TOTAL PRESENT VALUE (ROUNDED TO THE NEAREST $10,000)	$ 4,890,000

Level III Estimate +50%/-30%

ALTERNATIVE **2**
Discharge to POTW/GWRS

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be conveyed to existing sanitary sewer trunk lines, which convey wastewater to an existing POTW operated by the Orange County Sanitation District (OCSD). The POTW would discharge the treated effluent to OCWD's Groundwater Replenishment System (GWRS) for full advanced treatment and eventual reuse for managed aquifer recharge in the Orange County Groundwater Basin.

CAPITAL COSTS

Description	Quantity	Unit	Unit Cost	Total	Notes
Monitoring Well Installation					
Install shallow zone monitoring wells	10	ea	$ 65,000	$ 650,000	4" monitoring wells to a depth of 200 ft
Install deep zone monitoring wells	10	ea	115,000	$ 1,150,000	4" monitoring wells to a depth of 500 ft
EXTRACTION WELL INSTALLATION					
Property Acquistion	17	ls	$ 150,000	$ 2,550,000	Based on existing well installation
Permitting	1	ls	$ 40,000.00	$ 40,000.00	Engineers Estimate
Well Installation	17	wells	$ 250,000.00	$ 4,250,000.00	Based on 2020 drilling cost estimate for 12" dia and similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26", Carbon Steel, 50' long	600	ft		$ -	
Pilot Hole Installation	2400	ft		$ -	
Ream Pilot Hole	2400	ft		$ -	
Provide and install 18" Dia Casing, 200' long	1200	ft		$ -	
Provide and install 12" Dia Screen	1200	ft		$ -	
Provide and install 2" Filter Pack Line	1200	ft		$ -	
Centralizers	120	ea		$ -	
Sanitary Seal	1200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000.00	$ 320,000.00	actual EW-1 cost provided by OCWD
Well Development	17	ea	$ 27,530.00	$ 468,010.00	actual EW-1 cost provided by OCWD
Aquifer Testing	17	ea	$ 15,500.00	$ 263,500.00	actual EW-1 cost provided by OCWD
Well Head Works, Pumps, Electrical					
Provide and Install Vault	17	ea	$ 30,000.00	$ 510,000.00	(10'x10'x10); Actual cost to install similar sized well vaults for TGRS.
Well Head Manifolds and Instrumentation	17	ea	$ 30,000.00	$ 510,000.00	Actual cost from TGRS construction
Power drop, Transformer, and Controls	17	ea	$ 25,000.00	$ 425,000.00	Estimate by AECOM Water Div CJA
Pump and pump column	17	ea	$ 109,400.00	$ 1,859,800.00	actual EW-1 cost provided by OCWD
Mechanical Installation	1	ls	$ 224,000.00	$ 224,000.00	Estimate by AECOM Water Div Reaz A
Electrical (MCC, feeder, wiring)	1	ls	$ 600,000.00	$ 600,000.00	Estimate by AECOM Water Div CJA
Division 1 Costs (10%)	1	ls	$ 412,880	$ 412,880	hazardous materials, LEED requirements
PIPING NETWORK					
Permitting	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Property Negotiations	1	each	$ 140,000	$ 140,000	Engineers estimate
Geotechnical	1	each	$ 200,000	$ 200,000	AIS Construction estimate

ALTERNATIVE **2**
Discharge to POTW/GWRS

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be conveyed to existing sanitary sewer trunk lines, which convey wastewater to an existing POTW operated by the Orange County Sanitation District (OCSD). The POTW would discharge the treated effluent to OCWD's Groundwater Replenishment System (GWRS) for full advanced treatment and eventual reuse for managed aquifer recharge in the Orange County Groundwater Basin.

CAPITAL COSTS

Mobilization/Demobilization	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Traffic Control	1	each	$ 850,000	$ 850,000	AIS Construction estimate
Asphalt Cutting	52,403	sq ft	$ 11	$ 576,437	AIS Construction estimate
Sand Bedding	970	cu yd	$ 300	$ 291,130	AIS Construction estimate
Procure and Install 4" Dia Pipe	0	ft	$ 210	$ -	ICS Construction estimate
Procure and Install 6" Dia Pipe	2,796	ft	$ 240	$ 671,040	ICS Construction estimate
Procure and Install 8" Dia Pipe	10,234	ft	$ 280	$ 2,865,520	ICS Construction estimate
Procure and Install 10" Dia Pipe	2,160	ft	$ 310	$ 669,600	ICS Construction estimate
Procure and Install 12" Dia Pipe	1,762	ft	$ 365	$ 643,130	AIS Construction estimate
Procure and Install 14" Dia Pipe	3,548	ft	$ 425	$ 1,507,900	
Procure and Install 16" Dia Pipe	3,696	ft	$ 468	$ 1,727,880	AIS Construction estimate
Procure and Install 18" Dia Pipe	2,367	ft	$ 510	$ 1,207,170	Estimate by AECOM Water Div Ron M
Procure and Install 22" Dia Pipe	1,301	ft	$ 643	$ 835,893	AIS Construction estimate
Procure and Install 26" Dia Pipe	1,348	ft	$ 758	$ 1,022,233	Estimate by AECOM Water Div Ron M
Install Backfill and Compact	11,983	ft	$ 60	$ 718,997	ICS Construction estimate
Repair Asphalt and Pave	52,403	sq ft	$ 15	$ 786,050	ICS Construction estimate
Spoils Disposal 25% of total	3,238	cu yd	$ 50	$ 161,921	ICS Construction estimate
Fiber Optic Line 2" Conduit	29,212	ft	$ 10	$ 292,120	ICS Construction estimate
Fiber Optic Cable Plus Spare	58,424	ft	$ 25	$ 1,460,600	ICS Construction estimate
Discharge to POTW					
Manhole	2	ea	$ 10,000	$ 20,000	Construction cost from TGRS
SUBTOTAL				$ 31,080,811	
Bond (2%)	2%			$ 621,616.21	
SUBTOTAL				$ 31,702,427	
Contingency	35%			$ 11,095,849	15-35% based on engineering judgement
SUBTOTAL				$ 42,798,276	
Project Management	5%			$ 2,139,914	
Remedial Design	6%			$ 2,567,897	
Construction Management	6%			$ 2,567,897	
Institutional Controls					

ALTERNATIVE **2**
Discharge to POTW/GWRS

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be conveyed to existing sanitary sewer trunk lines, which convey wastewater to an existing POTW operated by the Orange County Sanitation District (OCSD). The POTW would discharge the treated effluent to OCWD's Groundwater Replenishment System (GWRS) for full advanced treatment and eventual reuse for managed aquifer recharge in the Orange County Groundwater Basin.

CAPITAL COSTS

Institutional Controls Plan	1	EA	$ 20,000	$ 20,000	Estimates
Groundwater Use Restriction	1	LS	$ 10,000	$ 10,000	Estimates
Site Information Database	1	LS	$ 10,000	$ 10,000	Estimates
SUBTOTAL				$ 40,000	
TOTAL CAPITAL COST				$ 50,110,000	Rounded to the nearest $10,000

ALTERNATIVE **2**
Discharge to POTW/GWRS

O&M Costs

Description	Quantity	Unit	Unit Cost	Total	Notes
Groundwater Monitoring					
Groundwater monitoring	532	hr	$ 85	$ 45,220	Annual monitoring; 4 hours per well, 96 existing +20 new, 17 extraction wells; assumes IDW water is treated and discharged at well head similar to OCWD process
Consultant Oversight	100	hr	$ 100	$ 10,000	
Reporting	240	hr	$ 100	$ 24,000	
Lab Analysis	146	ea	$ 300	$ 43,890	96 existing +20 new+17 ext +10% QAQC
EXTRACTION WELLS					
Annual Operating Cost (electricity)	17	ea	$ 80,000	$ 1,360,000	Based on pump HP rating ($0.16/kwh)
Annual Pump Maintenance	17	ea	$ 5,000	$ 85,000	Periodic pump maintenance
POTW Discharge Fees					System discharge at 7,800 gpm
OCSD Admin fee	1	ls	$ 1,138	$ 1,138	Special Purpose Discharge Permit Cost 2022
OCSD Discharge fee	3,337	MG	$ 1,545	$ 5,154,985	OC San rate for Special Purpose Discharge Permittees
OCSD SCFCC fee	3,327	MG	$ 1,984	$ 6,601,631	Supp Capital Facilities Capacity Charges 2022 per Ordinance No. OCSD-50 for over 25,000 gpd
GWRS Operation Cost	10,243	ac ft	$ -	$ -	
SUBTOTAL				$ 13,325,864	
Contingency	20%			$ 2,665,173	
Subtotal				$ 15,991,037	
Project Management	10%			$ 1,599,104	5-10% of annual
Technical Support	15%			$ 2,398,656	10-20% technical support
Institutional Controls				$ 25,000	Estimate
Total Annual O&M Cost				$ 20,010,000	Rounded to nearest $10,000

ALTERNATIVE **2**
Discharge to POTW/GWRS

O&M Costs

PERIODIC COSTS

Description	Year	Quantity	Unit	Unit Cost	Total	Notes
Recovery well redevelopment	5	17	ea	$ 10,000	$ 170,000	every 5 years
Recovery well redevelopment	10	17	ea	$ 10,000	$ 170,000	
Recovery well redevelopment	15	17	ea	$ 10,000	$ 170,000	
Recovery well redevelopment	20	17	ea	$ 10,000	$ 170,000	
Recovery well redevelopment	25	17	ea	$ 10,000	$ 170,000	
Extraction pump replacement	7	17	ea	$ 109,400	$ 1,859,800	every 7 years; vendor recom
Extraction pump replacement	14	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	21	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	28	17	ea	$ 109,400	$ 1,859,800	
Recovery well redevelopment	30	17	ea	$ 10,000	$ 170,000	
TOTAL PERIODIC COSTS					$ 8,460,000	Rounded to nearest $10,000

NET PRESENT VALUE

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital Cost	0	$ 50,110,000	$ 50,110,000	1.0	$ 50,110,000
Annual O&M Cost	1-30	$ 600,300,000	$ 20,010,000	12.4	$ 248,304,090
Periodic Cost	5	$ 170,000	$ 170,000	0.71	$ 121,208
Periodic Cost	10	$ 170,000	$ 170,000	0.51	$ 86,419
Periodic Cost	15	$ 170,000	$ 170,000	0.36	$ 61,616
Periodic Cost	20	$ 170,000	$ 170,000	0.26	$ 43,931
Periodic Cost	7	$ 1,859,800	$ 1,859,800	0.62	$ 1,158,190
Periodic Cost	14	$ 1,859,800	$ 1,859,800	0.39	$ 721,263
Periodic Cost	21	$ 1,859,800	$ 1,859,800	0.24	$ 449,166
Periodic Cost	28	$ 1,859,800	$ 1,859,800	0.15	$ 279,718
Periodic Cost	25	$ 170,000	$ 170,000	0.18	$ 31,322
Periodic Cost	30	$ 170,000	$ 170,000	0.13	$ 22,332
	SUBTOTAL	$ 658,869,200		SUBTOTAL	$ 301,389,255

TOTAL PRESENT VALUE OF ALTERNATIVE (ROUNDED TO THE NEAREST $10,000)	$ 301,390,000

Level III Estimate +50%/-30%

ALTERNATIVE **3**

Centralized Treatment Plant; Discharge to Direct Potable Reuse

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemente4d by the water purveyor and is not included as a project cost.

CAPITAL COSTS

Description	Quantity	Unit	Unit Cost	Total	Notes
Monitoring Well Installation					
Install monitoring wells	10	ea	$ 65,000	$ 650,000	4" monitoring wells to a depth of 200 ft
Install monitoring wells	10	ea	115,000	$ 1,150,000	4" monitoring wells to a depth of 500 ft
EXTRACTION WELL INSTALLATION					
Property Acquisition	17	ls	$ 150,000	$ 2,550,000	Unit costs from 2005 estimate in NNGPP report; inflated by 1.4.
Permitting	1	ls	$ 40,000	$ 40,000	Estimate
Well Installation	17	wells	$ 250,000	$ 4,250,000	Based on 2020 drilling cost estimate for 12" dia and similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26"	600	ft		$ -	
Pilot Hole Installation	2400	ft		$ -	
Pilot Hole Abandonment	0			$ -	
Ream Pilot Hole 20"	2400	ft		$ -	
Provide and install 12" Dia Casing	1200	ft		$ -	
Provide and install 12" Dia Louver Screen	1200	ft		$ -	
Provide and install 2" Filter Pack Line	1200	ft		$ -	
Centralizers	120	ea		$ -	
Sanitary Seal	1200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000	$ 320,000	actual EW-1 cost provided by OCWD
Well Development	17	ea	$ 27,530	$ 468,010	actual EW-1 cost provided by OCWD
Aquifer Testing	17	ea	$ 15,500	$ 263,500	actual EW-1 cost provided by OCWD

ALTERNATIVE **3**
Centralized Treatment Plant; Discharge to Direct Potable Reuse

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemente4d by the water purveyor and is not included as a project cost.

CAPITAL COSTS

WELL HEAD WORKS, PUMPS, ELECTRICAL					100 HP submersible pumps, 2,300VAC motor operating at 1,750 rpm
Provide and Install Vaults	17	ea	$ 30,000	$ 510,000	(10'x10'x10); Actual cost to install similar sized well vaults for TGRS.
Well Head Manifolds and Instrumentation	17	ea	$ 25,000	$ 425,000	Actual cost from TGRS construction
Power drop, Transformer, and Controls	17	ea	$ 15,000	$ 255,000	Actual cost from TGRS construction
Pump and pump column	17	ea	$ 109,400	$ 1,859,800	actual EW-1 cost provided by OCWD; 100 HP
Mechanical Installation	1	ls	$ 224,000	$ 224,000	Estimate by RA
Electrical (MCC, Feeder, Wiring)	1	ls	$ 600,000	$ 600,000	Estimate by CJA
Division 1 Costs (10%)	1	ls	$ 387,380	$ 387,380	Work restrictions, recycling reqts, security, Tree protection, Stormwater, reporting, hazardous materials, LEED requirements
TREATMENT PLANT					
Property Acquistion	1	ls	$ 2,500,000	$ 2,500,000	Assessed value for 1000 S Harbor Blvd
Clearing and grubbing, site prep:	1	ls	$ 100,000	$ 100,000	Engineers estimate
Site improvements	1	ls	$ 350,000	$ 350,000	block wall, fencing, paving
LGAC SYSTEM					AqueoUS Vets August 2023
GAC vessel foundation (7,000SF @1.5' deep)	1	ls	$ 250,000	$ 250,000	Estimate by AECOM Water Div Ron M
GAC vessel purchase (lead/lag pair) + 4 tier manifold	10	ea	$ 515,000	$ 5,150,000	20,000 lb vessel pairs; AqueoUS; Estimate by Reaz A
Tax and Delivery (13%)	1	ls	$ 669,500	$ 669,500	Estimate by AECOM Water Div Reaz A
First charge of GAC (20 x 20,000 lbs)	400,000	lb	$ 3.00	$ 1,200,000	20 vessels @ 20,000 lbs each; AqueoUS Vets quote, Reaz A
Vessel assembly / installation	1	ls	$ 1,368,000	$ 1,368,000	Estimate by AECOM Water Div Reaz A
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
Backwash supply pump and recycle pump	1	ls	$ 35,000	$ 35,000	Estimate by AECOM Water Div Reaz A
Backwash tank assembly 2x80,000 gal steel tanks	2	ls	$ 200,000	$ 400,000	Estimate by AECOM Water Div Reaz A
Bag filters, discharge pump, 50 gpm, 20 psig	1	ls	$ 35,000	$ 35,000	PRM quote: Reaz A
Backwash tank foundation	1	ls	$ 175,000	$ 175,000	Estimate by AECOM Water Div Ron M
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Piping Manifold and Supports	1	ls	$ 1,794,000	$ 1,794,000	Estimate by AECOM Water Div Reaz A
Electrical	1	ls	$ 350,000	$ 350,000	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 Costs (10%)	1	ls	$ 993,950	$ 993,950	Estimate by AECOM Water Div Reaz I
UV AOP					Trojan UV estimate based on 6,350 gpm and water quality values of 96% UVT
UV AOP equipment purchase	1	ls	$ 2,800,000	$ 2,800,000	4 trains of Flex 200 Two bank (144-1kW lamps)
4 trains Flex 200 Two bank, Power Dist Center					
Local Control Panel, Hydraulic Center Auto Wiper					
Hydrogen peroxide tank / pumping system (8,000 gal)					

ALTERNATIVE **3**

Centralized Treatment Plant; Discharge to Direct Potable Reuse

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemented by the water purveyor and is not included as a project cost.

CAPITAL COSTS

Peroxide tank foundation	1	ls	$ 75,000	$ 75,000	Estimate by AECOM Water Div Ron M
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
24"Magnetic flow meter	2		$ 45,000	$ 90,000	Estimate by AECOM Water Div Reaz A
Tax and Delivery (13%)	1	ls	$ 470,860	$ 470,860	Estimate by AECOM Water Div Reaz A
AOP system installation	1	ls	$ 900,000	$ 900,000	Estimate by AECOM Water Div Reaz A
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Mechanical/Piping (30%)	1	ls	$ 1,086,600	$ 1,086,600	Estimate by AECOM Water Div Reaz A
Electrical (35%)	1	ls	$ 1,267,700	$ 1,267,700	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 costs (10%)	1	ls	$ 362,200	$ 362,200	Estimate by AECOM Water Div Reaz A

ALTERNATIVE **3**
Centralized Treatment Plant; Discharge to Direct Potable Reuse

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CAPITAL COSTS

H2O2 QUENCH SYSTEM					
LGAC vessels 10 feet diameter	10	1	$ 243,000	$ 2,430,000	20,000 lb vessels, 10 ft dia; AqueoUS quote; Reaz A
Piping manifold	1	1	$ 215,000	$ 215,000	Estimate by AECOM Water Div Reaz A
Fresh Carbon, 200,000 lbs	200,000	1	$ 2.25	$ 450,000	10 vessels @20,000 lbs each; Estimate by AECOM Water Div Reaz A
Tax + Delivery @13%	1	ls	$ 402,350	$ 402,350	Estimate by AECOM Water Div Reaz A
Installation @ 20% Equipment	1	ls	$ 619,000	$ 619,000	Estimate by AECOM Water Div Reaz A
Electrical & I&C 5% equipment	1	ls	$ 174,868	$ 174,900	Estimate by AECOM Water Div Reaz A
Concrete Foundation 4,500 ft2 1.5 ft deep	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Ron M
Contractor	1	ls	$ 524,603	$ 524,600	Estimate by AECOM Water Div Reaz A
Division 1 Costs @10%	1	ls	$ 349,735	$ 349,700	Estimate by AECOM Water Div Reaz A
PIPING NETWORK					
Permitting	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Property Negotiations	1	each	$ 140,000	$ 140,000	Engineers estimate
Geotechnical	1	each	$ 200,000	$ 200,000	AIS Construction estimate
Mobilization/Demobilization	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Traffic Control	1	each	$ 850,000	$ 850,000	AIS Construction estimate
Asphalt Cutting	57,973	sq ft	$ 11	$ 637,707	AIS Construction estimate
Sand Bedding	1,074	cu yd	$ 300	$ 322,074	AIS Construction estimate
Procure and Install 4" Dia Pipe	0	ft	$ 210	$ -	ICS Construction estimate
Procure and Install 6" Dia Pipe	1,531	ft	$ 240	$ 367,440	ICS Construction estimate
Procure and Install 8" Dia Pipe	12,454	ft	$ 280	$ 3,487,120	ICS Construction estimate
Procure and Install 10" Dia Pipe	4,078	ft	$ 310	$ 1,264,180	ICS Construction estimate
Procure and Install 12" Dia Pipe	687	ft	$ 365	$ 250,755	AIS Construction estimate
Procure and Install 14" Dia Pipe	4,784	ft	$ 425	$ 2,033,200	
Procure and Install 18" Dia Pipe	4,888	ft	$ 510	$ 2,492,880	AIS Construction estimate
Procure and Install 20" Dia Pipe	2,625	ft	$ 585	$ 1,535,625	Estimate by AECOM Water Div Ron M
Procure and Install 24" Dia Pipe	0	ft	$ 700	$ -	AIS Construction estimate
Procure and Install 26" Dia Pipe	1,098	ft	$ 758	$ 832,650	Estimate by AECOM Water Div Ron M
Install Backfill and Compact	13,242	ft	$ 60	$ 794,547	ICS Construction estimate
Repair Asphalt and Pave	57,973	sq ft	$ 15	$ 869,600	ICS Construction estimate
Spoils Disposal 25% of total	3,579	cu yd	$ 50	$ 178,950	ICS Construction estimate
Fiber Optic Line 2" Conduit	32,145	ft	$ 10	$ 321,450	ICS Construction estimate
Fiber Optic Cable Plus Spare	64,290	ft	$ 25	$ 1,607,250	ICS Construction estimate
Storage Tanks					
1 million gallons Permeate Tank, carbon steel, welded	1	ls	$ 1,650,000	$ 1,650,000	Based on 2021 quote from Paseo Robles, scaled up
2 million gallons blended water Tank, carbon steel, welded, 124'	1	ls	$ 2,800,000	$ 2,800,000	Verbal quote from Superior Tanks, Reaz A
Earthwork	1	ls	$ 50,000	$ 50,000	Estimate by AECOM Water Div Reaz A

ALTERNATIVE **3**
Centralized Treatment Plant; Discharge to Direct Potable Reuse

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemented by the water purveyor and is not included as a project cost.

CAPITAL COSTS

Foundation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A

ALTERNATIVE **3**
Centralized Treatment Plant; Discharge to Direct Potable Reuse

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemented by the water purveyor and is not included as a project cost.

CAPITAL COSTS

Miscellaneous Facilities-1 Blending Station					
Blend Pumps Six (6) 2,000 gpm 75HP- (3) CS pumps and (3) stainless steel	6	unit	$ 50,000	$ 300,000	Estimate by AECOM Water Div Reaz A
Piping, Control valves	1	LS	$ 200,000	$ 200,000	Estimate by AECOM Water Div Reaz A
Overhead Crane	1	unit	$ 25,000	$ 25,000	Estimate by AECOM Water Div Reaz A
Motor Control center	1	unit	$ 150,000	$ 150,000	Estimate by AECOM Water Div Reaz A
Tax and delivery @13%	1	unit		$ 87,750	Estimate by AECOM Water Div Reaz A
Mechanical/Piping @40% of equipment	1	unit		$ 270,000	Estimate by AECOM Water Div Reaz A
Electrical & I&C @50%	1	unit		$ 337,500	Estimate by AECOM Water Div Reaz A
Division 1 Costs (10%)	1	unit		$ 137,025	Estimate by AECOM Water Div Reaz A
Miscellaneous Facilities-2 Pipeline Booster Station					
Pipeline Booster Pumps (Four 2,000 gpm, 200 HP pumps, 1 standby)	4	unit	$ 150,000	$ 600,000	Estimate by AECOM Water Div Reaz A
Piping- Control Valves	1	LS	$ 150,000	$ 150,000	Estimate by AECOM Water Div Reaz A
Overhead Crane	1	unit	$ 25,000	$ 25,000	Estimate by AECOM Water Div Reaz A
Motor Control Center	1	unit	$ 125,000	$ 125,000	Estimate by AECOM Water Div Reaz A
Tax and delivery @13%	1	unit	$ 78,000	$ 78,000	Estimate by AECOM Water Div Reaz A
Mechanical/Piping @40% of equipment	1	unit	$ 360,000	$ 360,000	Estimate by AECOM Water Div Reaz A
Electrical & I&C @40%	1	unit	$ 360,000	$ 360,000	Estimate by AECOM Water Div Reaz A
Building (1600 ft2 @ $350/ft2)	1	unit	$ 560,000	$ 560,000	Estimate by AECOM Water Div Reaz A
Division 1 Costs (10%)				$ 225,800	Estimate by AECOM Water Div Reaz A
SUBTOTAL				$ 70,331,553	
Bonds and Insurance (2%)	2%			$ 1,406,631.05	Estimate by AECOM Water Div Reaz A
SUBTOTAL				$ 71,738,184	
Contingency	35%			$ 25,108,364	15-35% based on engineering judgement; US EPA FS Guidance, 2000
SUBTOTAL				$ 96,846,548	

ALTERNATIVE **3**

Centralized Treatment Plant; Discharge to Direct Potable Reuse

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemented by the water purveyor and is not included as a project cost.

CAPITAL COSTS

Project Management	5%			$ 4,842,327	
Remedial Design	6%			$ 5,810,793	
Construction Management	6%			$ 5,810,793	
DDW 97-005 Process Memo Documentation	1	LS		$ 191,000	2024 cost based on $153,000 for 97-005 document for WNOU in 2018
Institutional Controls					
Institutional Controls Plan	1	EA	$ 20,000	$ 20,000	Engineers estimate
Groundwater Use Restriction	1	LS	$ 10,000	$ 10,000	Engineers estimate
Site Information Database	1	LS	$ 10,000	$ 10,000	Engineers estimate
SUBTOTAL				$ 40,000	
TOTAL CAPITAL COST				$ 113,540,000	Rounded to the nearest $10,000

ALTERNATIVE **3**

Centralized Treatment Plant; Discharge to Direct Potable Use

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemented by the water purveyor and is not included as a project cost.

O&M Costs

Description	Quantity	Unit	Unit Cost	Total	Notes
GROUNDWATER MONITORING					
Groundwater monitoring	532	hr	$ 85	$ 45,220	Annual monitoring; 4 hours per well, 96 existing +20 new, 17 extraction wells; assumes IDW water is treated and discharged at well head similar to OCWD process
Consultant Oversight	100	hr	$ 100	$ 10,000	
Reporting	240	hr	$ 100	$ 24,000	
Lab Analysis	146	ea	$ 300	$ 43,890	96 existing +20 new +17 ext +10% QAQC
EXTRACTION WELLS					
Annual Operating Cost (electricity)	17	ea	$ 80,000	$ 1,360,000	Based on pump HP rating ($0.16/kwh)
Annual Pump Maintenance	17	ea	$ 5,000	$ 85,000	Periodic pump maintenance
Groundwater Replenishment District Fees	12,581	acre/ft	$ -	$ -	Purveyor will pay fees
LGAC					Evoqua carbon usage estimate
GAC media change-out and disposal (qtrly)	800,000	lbs	$ 2.50	$ 2,000,000	$2.50/lb x 200,000 lb x 4 times/yr
Routine O&M	2,920	hr	$ 100	$ 292,000	8 hr/day @ $85/hr x 365 days/year
Non-routine labor	1	ls	$ 105,000	$ 105,000	
Oversight labor	1	ls	$ 247,240	$ 247,240	assume 20% of field labor costs
Equipment repair costs	1	ls	$ 105,000	$ 105,000	
Other materials	1	ls	$ 35,000	$ 35,000	
Electricity costs	1	ls	$ 56,700	$ 56,700	$0.16 /kWh
Lab analysis	1	ls	$ 127,000	$ 127,000	influent, mid, and effluent sampling of each GAC vessel pair
Reporting and annual fees	1	ls	$ 70,000	$ 70,000	
UV AOP					Trojan UV vendor
Routine O&M	1,460	hr	$ 100	$ 146,000	4 hr/day x 365 days/year
Non-routine labor	1	ls	$ 30,000	$ 30,000	
Oversight labor	1	ls	$ 30,800	$ 30,800	assume 20% of field labor costs
Lamp replacement	168	ea	$ 800	$ 134,400	15,000 hour warranty; Trojan UV
Equipment repair costs	1	ls	$ 20,000	$ 20,000	
Other materials	1	ls	$ 10,000	$ 10,000	
Electric costs	1	ls	$ 202,500	$ 202,500	$0.16 /kWh
Lab analysis	1	ls	$ 100,000	$ 100,000	engineers estimate
Reporting and annual fees	1	ls	$ 20,000	$ 20,000	
Peroxide	54,104	gal	$ 4	$ 221,826	10ppm at 183 gallons/dy
SUBTOTAL				$ 6,240,176	

ALTERNATIVE **3**

Centralized Treatment Plant; Discharge to Direct Potable Use

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemented by the water purveyor and is not included as a project cost.

Contingency	20%			$ 1,248,035	
Subtotal				$ 7,488,211	
Project Management	10%			$ 748,821	5-10% of annual
Technical Support	15%			$ 1,123,232	10-20% technical support
Institutional Controls				$ 25,000	Estimate
Total Annual O&M Cost				$ 9,390,000	Rounded to nearest $10,000

PERIODIC COSTS

Description	Year	Quantity	Unit	Unit Cost	Total	Notes
Recovery well redevelopment	5	17	ea	$ 10,000	$ 170,000	every 5 years
Recovery well redevelopment	10	17	ea	$ 10,000	$ 170,000	

ALTERNATIVE **3**

Centralized Treatment Plant; Discharge to Direct Potable Use

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,350 gpm would be treated to potable standards and conveyed to a local water purveyor (e.g., City of Fullerton) for distribution. Additional treatment processes required to reach non-ARAR standards (e.g. RO for TDS levels) would be implemented by the water purveyor and is not included as a project cost.

Recovery well redevelopment	15	17	ea	$ 10,000	$ 170,000	
Recovery well redevelopment	20	17	ea	$ 10,000	$ 170,000	
H2O2 Quench LGAC replacement	5	10	ea	$ 50,000	$ 500,000	10x20000 lbs LGAC changeout
H2O2 Quench LGAC replacement	10	10	ea	$ 50,000	$ 500,000	every 5 years
H2O2 Quench LGAC replacement	15	10	ea	$ 50,000	$ 500,000	
H2O2 Quench LGAC replacement	20	10	ea	$ 50,000	$ 500,000	
Extraction pump replacement	7	17	ea	$ 109,400	$ 1,859,800	every 7 years; vendor recom
Extraction pump replacement	14	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	21	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	28	17	ea	$ 109,400	$ 1,859,800	
Recovery well redevelopment	25	17	ea	$ 10,000	$ 170,000	
Recovery well redevelopment	30	17	ea	$ 10,000	$ 170,000	
H2O2 Quench LGAC replacement	25	10	ea	$ 50,000	$ 500,000	
H2O2 Quench LGAC replacement	30	10	ea	$ 50,000	$ 500,000	
TOTAL PERIODIC COSTS					$ 11,460,000	Rounded to nearest $10,000

NET PRESENT VALUE

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital Cost	0	$ 113,540,000	$ 113,540,000	1.0	$ 113,540,000
Annual O&M Cost	1-30	$ 281,700,000	$ 9,390,000	12.4	$ 116,520,510
Periodic Cost	5	$ 670,000	$ 670,000	0.71	$ 477,701
Periodic Cost	7	$ 1,859,800	$ 1,859,800	0.62	$ 1,158,190
Periodic Cost	10	$ 670,000	$ 670,000	0.51	$ 340,594
Periodic Cost	14	$ 1,859,800	$ 1,859,800	0.39	$ 721,263
Periodic Cost	15	$ 670,000	$ 670,000	0.36	$ 242,839
Periodic Cost	20	$ 670,000	$ 670,000	0.26	$ 173,141
Periodic Cost	21	$ 1,859,800	$ 1,859,800	0.24	$ 449,166
Periodic Cost	25	$ 670,000	$ 670,000	0.18	$ 123,447
Periodic Cost	28	$ 1,859,800	$ 1,859,800	0.15	$ 279,718
Periodic Cost	30	$ 670,000	$ 670,000	0.13	$ 88,016
	SUBTOTAL	$ 406,699,200		SUBTOTAL	$ 234,114,584

TOTAL PRESENT VALUE OF ALTERNATIVE (ROUNDED TO THE NEAREST $10,000)	$ 234,110,000

Level III Estimate +50%/-30%

ALTERNATIVE **4**
Centralized Treatment Plant; Discharge to Injection Wells

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,546 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 17 injection wells (based on 500 gpm per well plus 30% to account for clogging).

CAPITAL COSTS

Description	Quantity	Unit	Unit Cost	Total	Notes
Monitoring Well Installation					
Install shallow zone monitoring wells	10	ea	$ 65,000	$ 650,000	4" monitoring wells to a depth of 200 ft
Install deep zone monitoring wells	10	ea	115,000	$ 1,150,000	4" monitoring wells to a depth of 500 ft
EXTRACTION WELL INSTALLATION					
Property Acquisition	17	ls	$ 150,000	$ 2,550,000	Unit costs from 2005 estimate in NNGPP report; inflated by 1.4.
Permitting	1	ls	$ 40,000	$ 40,000	Estimate
Well Installation	17	wells	$ 250,000	$ 4,250,000	Based on 2020 drilling cost estimate for 12" dia and similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26"	600	ft		$ -	
Pilot Hole Installation	2400	ft		$ -	
Pilot Hole Abandonment	0			$ -	
Ream Pilot Hole 20"	2400	ft		$ -	
Provide and install 12" Dia Casing	1200	ft		$ -	
Provide and install 12" Dia Louver Screen	1200	ft		$ -	
Provide and install 2" Filter Pack Line	1200	ft		$ -	
Centralizers	120	ea		$ -	
Sanitary Seal	1200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000	$ 320,000	actual EW-1 cost provided by OCWD
Well Development	17	ea	$ 27,530	$ 468,010	actual EW-1 cost provided by OCWD
Aquifer Testing	17	ea	$ 15,500	$ 263,500	actual EW-1 cost provided by OCWD
WELL HEAD WORKS, PUMPS, ELECTRICAL					
Provide and Install Vaults (10'x10')	17	ea	$ 30,000	$ 510,000	Actual cost to install similar sized well vaults for TGRS.
Well Head Manifolds and Instrumentation	17	ea	$ 25,000	$ 425,000	Actual cost from TGRS construction
Power drop, Transformer, and Controls	17	ea	$ 15,000	$ 255,000	Actual cost from TGRS construction
Pump and pump column	17	ea	$ 109,400	$ 1,859,800	actual EW-1 cost provided by OCWD
Mechanical Installation	1	ls	$ 224,000	$ 224,000	Estimate by AECOM Water Div Reaz A
Electrical (MCC, Feeder, Wiring)	1	ls	$ 600,000	$ 600,000	Estimate by AECOM Water Div CJA
Division 1 Costs (10%)	1	ls	$ 387,380	$ 387,380	Work restrictions, recycling reqts, security, Tree protection, Stormwater,

ALTERNATIVE **4**
Centralized Treatment Plant; Discharge to Injection Wells

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,546 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 17 injection wells (based on 500 gpm per well plus 30% to account for clogging).

TREATMENT PLANT					
Property Acquisition	1	ls	$ 1,500,000	$ 1,500,000	Assumed value of 1-acre property
Demolition of existing building	1	ls	$ 500,000	$ 500,000	Assumed demolition cost
Clearing and grubbing, site prep:	1	ls	$ 100,000	$ 100,000	Engineers estimate
Site improvements	1	ls	$ 350,000	$ 350,000	block wall, fencing, paving based on TGRS project
LGAC SYSTEM					AqueoUS Vets August 2023
GAC vessel foundation (7,000SF @1.5' deep)	1	ls	$ 250,000	$ 250,000	Estimate by AECOM Water Div Ron M
GAC vessel purchase (lead/lag pair) + 4 tier manifold	10	ea	$ 515,000	$ 5,150,000	20,000 lb vessel pairs; AqueoUS; Estimate by Reaz A
Tax and Delivery (13%)	1	ls	$ 669,500	$ 669,500	Estimate by AECOM Water Div Reaz A
First charge of GAC	400,000	lb	$ 3.00	$ 1,200,000	20 vessels @ 20,000 lbs each; AqueoUS Vets quote, Reaz A
Vessel assembly / installation	1	ls	$ 1,368,000	$ 1,368,000	Estimate by AECOM Water Div Reaz A
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
Backwash supply pump and recycle pump	1	ls	$ 35,000	$ 35,000	Estimate by AECOM Water Div Reaz A
Backwash tank assembly 2x80,000 gal steel tanks	2	ls	$ 200,000	$ 400,000	Estimate by AECOM Water Div Reaz A
Backwash tank foundation	1	ls	$ 175,000	$ 175,000	Estimate by AECOM Water Div Ron M
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Piping Manifold and Supports	1	ls	$ 1,794,000	$ 1,794,000	Estimate by AECOM Water Div Reaz A
Electrical	1	ls	$ 350,000	$ 350,000	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 Costs (10%)	1	ls	$ 990,450	$ 990,450	Estimate by AECOM Water Div Reaz I
UV AOP					Trojan UV estimate based on 6,350 gpm and water quality values of 96% UVT
UV AOP equipment purchase	1	ls	$ 2,800,000	$ 2,800,000	4 trains of Flex 200 Two bank (144-1kW lamps)
4 trains Flex 200 Two bank, Power Dist Center					
Local Control Panel, Hydraulic Center Auto Wiper					
Hydrogen peroxide tank / pumping system (8,000 gal)					
Peroxide tank foundation	1	ls	$ 75,000	$ 75,000	Estimate by AECOM Water Div Ron M
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
24"Magnetic flow meter	2		$ 45,000	$ 90,000	Estimate by AECOM Water Div Reaz A
Tax and Delivery (13%)	1	ls	$ 470,860	$ 470,860	Estimate by AECOM Water Div Reaz A
AOP system installation	1	ls	$ 900,000	$ 900,000	Estimate by AECOM Water Div Reaz A
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Mechanical/Piping (30%)	1	ls	$ 1,086,600	$ 1,086,600	Estimate by AECOM Water Div Reaz A
Electrical (35%)	1	ls	$ 1,267,700	$ 1,267,700	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 costs (10%)	1	ls	$ 362,200	$ 362,200	Estimate by AECOM Water Div Reaz A

ALTERNATIVE **4**
Centralized Treatment Plant; Discharge to Injection Wells

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,546 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 17 injection wells (based on 500 gpm per well plus 30% to account for clogging).

H2O2 QUENCH SYSTEM					
LGAC vessels 10 feet diameter	10	1	$ 243,000	$ 2,430,000	20,000 lb vessels, 10 ft dia; AqueoUS quote; Reaz A
Piping manifold	1	1	215,000	$ 215,000	Estimate by AECOM Water Div Reaz A
Carbon, 200,000 lbs	200,000	1	2.25	$ 450,000	10 vessels @20,000 lbs each; Estimate by AECOM Water Div Reaz A
Tax + Delivery @13%	1	ls	$ 402,350	$ 402,350	Estimate by AECOM Water Div Reaz A
Installation @ 20% Equipment	1	ls	$ 619,000	$ 619,000	Estimate by AECOM Water Div Reaz A
Electrical & I&C 5% equipment	1	ls	$ 174,868	$ 174,900	Estimate by AECOM Water Div Reaz A
Concrete Foundation 4,500 ft2 1.5 ft deep	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Ron M
Contractor	1	ls	$ 524,603	$ 524,600	Estimate by AECOM Water Div Reaz A
Division 1 Costs @10%	1	ls	$ 349,735	$ 349,700	Estimate by AECOM Water Div Reaz A
PIPING NETWORK					
Permitting	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Property Negotiations	1	each	$ 140,000	$ 140,000	Engineers estimate
Geotechnical	1	each	$ 200,000	$ 200,000	AIS Construction estimate
Mobilization/Demobilization	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Traffic Control	1	each	$ 850,000	$ 850,000	AIS Construction estimate
Asphalt Cutting	73,155	sq ft	$ 11	$ 804,701	AIS Construction estimate
Sand Bedding	1,355	cu yd	$ 300	$ 406,415	AIS Construction estimate
Procure and Install 4" Dia Pipe	0	ft	$ 210	$ -	ICS Construction estimate
Procure and Install 6" Dia Pipe	1,531	ft	$ 240	$ 367,440	ICS Construction estimate
Procure and Install 8" Dia Pipe	10,693	ft	$ 280	$ 2,994,040	ICS Construction estimate
Procure and Install 10" Dia Pipe	4,701	ft	$ 310	$ 1,457,310	ICS Construction estimate
Procure and Install 12" Dia Pipe	687	ft	$ 365	$ 250,755	AIS Construction estimate
Procure and Install 14" Dia Pipe	4,784	ft	$ 425	$ 2,033,200	AIS Construction estimate
Procure and Install 20" Dia Pipe	2,625	ft	$ 585	$ 1,535,625	AIS Construction estimate
Procure and Install 22" Dia Pipe	4,912	ft	$ 643	$ 3,155,960	Estimate by AECOM Water Div Ron M
Procure and Install 28" Dia Pipe	5,362	ft	$ 817	$ 4,378,967	Estimate by AECOM Water Div Ron M
Install Backfill and Compact	17,570	ft	$ 60	$ 1,054,202	ICS Construction estimate
Repair Asphalt and Pave	73,155	sq ft	$ 15	$ 1,097,320	ICS Construction estimate
Spoils Disposal 25% of total	4,731	cu yd	$ 50	$ 236,559	ICS Construction estimate
Fiber Optic Line 2" Conduit	35,295	ft	$ 10	$ 352,950	ICS Construction estimate
Fiber Optic Cable Plus Spare	70,590	ft	$ 25	$ 1,764,750	ICS Construction estimate
INJECTION WELL INSTALLATION					
Property Acquisition	17	each	$ -	$ -	
Permitting	17	wells	$ 1,500	$ 25,500	City of Anaheim well construction permit

ALTERNATIVE **4**
Centralized Treatment Plant; Discharge to Injection Wells

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,546 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 17 injection wells (based on 500 gpm per well plus 30% to account for clogging).

Well Installation	17	wells	$ 250,000	$ 4,250,000	Based on 2020 drilling cost estimate for 12" dia and similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26"	1100	ft		$ -	
Pilot Hole Installation	4400	ft		$ -	
Pilot Hole Abandonment	0			$ -	
Ream Pilot Hole 20"	4400	ft		$ -	
Provide and install 12" Dia Casing	2200	ft		$ -	
Provide and install 12" Dia Louver Screen	2200	ft		$ -	
Provide and install 2" Filter Pack Line	2200	ft		$ -	
Centralizers	220	ea		$ -	
Sanitary Seal	2200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000	$ 320,000	actual EW-1 cost provided by OCWD
Well Development	17	ea	$ 38,542	$ 655,214	
Aquifer Testing	17	ea	$ 21,700	$ 368,900	
Well Head				$ -	
Provide and Install Vault (10'x10'x10)	12	ea	$ 30,000	$ 360,000	two days at each well
Well Head Manifolds and Instrumentation	12	ea	$ 25,000	$ 300,000	Only 12 new wells need vaults, manifolds and instrumentation
Piping					
Procure and Install 30" Dia Pipe	550	ft	$ 875	$ 481,250	Estimate by AECOM Water Div Ron M
Procure and Install 12" Dia Pipe	550	ft	$ 365	$ 200,750	AIS Construction estimate
Install Backfill and Compact	183	cu yd	$ 60	$ 11,000	ICS Construction estimate
Repair Asphalt and Pave	1,650	sq ft	$ 70	$ 115,500	ICS Construction estimate
Spoils Disposal 25% of total	46	cu yd	$ 50	$ 2,292	ICS Construction estimate
Fiber Optic Line 2" Conduit	1,100	ft	$ 10	$ 11,000	ICS Construction estimate
Fiber Optic Cable Plus Spare	1,100	ft	$ 25	$ 27,500	ICS Construction estimate
SUBTOTAL				$ 73,225,650	
Bonds and Insurance (2%)	2%			$ 1,464,512.99	
SUBTOTAL				$ 74,690,163	
Contingency	35%			$ 26,141,557	15-35% based on engineering judgement
SUBTOTAL				$ 100,831,719	

ALTERNATIVE **4**
Centralized Treatment Plant; Discharge to Injection Wells

Description: Extracted groundwater from 17 extraction wells at a flow rate of 6,546 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 17 injection wells (based on 500 gpm per well plus 30% to account for clogging).

Project Management	5%			$ 5,041,586	
Remedial Design	6%			$ 6,049,903	
Construction Management	6%			$ 6,049,903	
Institutional Controls					
Institutional Controls Plan	1	EA	$ 20,000	$ 20,000	
Groundwater Use Restriction	1	LS	$ 10,000	$ 10,000	
Site Information Database	1	LS	$ 10,000	$ 10,000	
SUBTOTAL				$ 40,000	
TOTAL CAPITAL COST				$ 118,010,000	rounded to the nearest $10,000

ALTERNATIVE **4**
Centralized Treatment Plant; Discharge to Injection Wells

O&M Costs

Description	Quantity	Unit	Unit Cost	Total	Notes
GROUNDWATER MONITORING					
Groundwater monitoring	532	hr	$ 85	$ 45,220	Annual monitoring; 4 hours per well, 96 existing +20 new; 17 extraction wells; assumes IDW water is treated and discharged at well head similar to OCWD process
Consultant Oversight	100	hr	$ 100	$ 10,000	
Reporting	240	hr	$ 100	$ 24,000	
Lab Analysis	146	ea	$ 300	$ 43,890	96 existing +20 new +10% QAQC
EXTRACTION WELLS					
Annual Operating Cost (electricity)	17	ea	$ 80,000	$ 1,360,000	Based on pump HP rating ($0.16/kwh)
Annual Pump Maintenance	17	ea	$ 5,000	$ 85,000	Periodic pump maintenance
LGAC					
GAC media change-out and disposal (qtrly)	800,000	lbs	$ 2.50	$ 2,000,000	$2.50/lb x 200,000 lb x 4 times/yr
Routine O&M	2,920	hr	$ 100	$ 292,000	8 hr/day @ $85/hr x 365 days/year
Non-routine labor	1	ls	$ 105,000	$ 105,000	
Oversight labor	1	ls	$ 247,240	$ 247,240	assume 20% of field labor costs
Equipment repair costs	1	ls	$ 105,000	$ 105,000	
Other materials	1	ls	$ 35,000	$ 35,000	
Electric costs	1	ls	$ 58,800	$ 58,800	reduced by flow rate ratio 0.84
Lab analysis	1	ls	$ 127,000	$ 127,000	influent, mid, and effluent sampling of each GAC vessel pair
Reporting and annual fees	1	ls	$ 70,000	$ 70,000	

UV AOP					
Routine O&M	1,460	hr	$ 100	$ 146,000	4 hr/day x 365 days/year
Non-routine labor	1	ls	$ 30,000	$ 30,000	
Oversight labor	1	ls	$ 30,800	$ 30,800	assume 20% of field labor costs
Lamp replacement	168	ea	$ 800	$ 134,400	15,000 hour warranty
Equipment repair costs	1	ls	$ 20,000	$ 20,000	
Other materials	1	ls	$ 10,000	$ 10,000	
Electric costs	1	ls	$ 210,000	$ 210,000	$0.16 /kWh; reduce by 0.84 factor
Lab analysis	1	ls	$ 100,000	$ 100,000	
Reporting and annual fees	1	ls	$ 20,000	$ 20,000	
Peroxide	56,108	gal	$ 4	$ 230,042	10ppm at 183 gallons/dy; 0.84 factor
INJECTION WELLS					
Redevelopment	17	ea	$ 28,000	$ 476,000	mechanical & chemical redevelopment, based on recent quote
City Inspection Fee	17	ea	$ 2,500	$ 42,500	
SUBTOTAL				$ 6,776,492	
Contingency	20%			$ 1,355,298	
Subtotal				$ 8,131,790	
Project Management	10%			$ 813,179	5-10% of annual
Technical Support	15%			$ 1,219,769	10-20% technical support
Institutional Controls				$ 25,000	Estimate
Total Annual O&M Cost				$ 10,190,000	Rounded to nearest $10,000

PERIODIC COSTS

Description	Year	Quantity	Unit	Unit Cost	Total	Notes
Ext and Inj well redevelopment	5	34	ea	$ 10,000	$ 340,000	every 5 years
Ext and Inj well redevelopment	10	34	ea	$ 10,000	$ 340,000	
Ext and Inj well redevelopment	15	34	ea	$ 10,000	$ 340,000	
Ext and Inj well redevelopment	20	34	ea	$ 10,000	$ 340,000	
H2O2 Quench LGAC replacement	5	10	ea	$ 50,000	$ 500,000	10x20000 lbs LGAC changeout
H2O2 Quench LGAC replacement	10	10	ea	$ 50,000	$ 500,000	every 5 years
H2O2 Quench LGAC replacement	15	10	ea	$ 50,000	$ 500,000	
H2O2 Quench LGAC replacement	20	10	ea	$ 50,000	$ 500,000	
Extraction pump replacement	7	17	ea	$ 109,400	$ 1,859,800	every 7 years; vendor recom
Extraction pump replacement	14	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	21	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	28	17	ea	$ 109,400	$ 1,859,800	
H2O2 Quench LGAC replacement	25	10	ea	$ 50,000	$ 500,000	
H2O2 Quench LGAC replacement	30	10	ea	$ 50,000	$ 500,000	
Ext and Inj well redevelopment	25	34	ea	$ 10,000	$ 340,000	
Ext and Inj well redevelopment	30	34	ea	$ 10,000	$ 340,000	
TOTAL PERIODIC COSTS					$ 12,480,000	Rounded to nearest $10,000

NET PRESENT VALUE

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital Cost	0	$ 118,010,000	$ 118,010,000	1.0	$ 118,010,000
Annual O&M Cost	1-30	$ 305,700,000	$ 10,190,000	12.4	$ 126,447,710
Periodic Cost	5	$ 840,000	$ 840,000	0.71	$ 598,908
Periodic Cost	10	$ 840,000	$ 840,000	0.51	$ 427,013
Periodic Cost	15	$ 840,000	$ 840,000	0.36	$ 304,455
Periodic Cost	20	$ 840,000	$ 840,000	0.26	$ 217,072
Periodic Cost	25	$ 840,000	$ 840,000	0.18	$ 154,769
Periodic Cost	7	$ 1,859,800	$ 1,859,800	0.62	$ 1,158,190
Periodic Cost	14	$ 1,859,800	$ 1,859,800	0.39	$ 721,263
Periodic Cost	21	$ 1,859,800	$ 1,859,800	0.24	$ 449,166
Periodic Cost	28	$ 1,859,800	$ 1,859,800	0.15	$ 279,718
Periodic Cost	30	$ 840,000	$ 840,000	0.13	$ 110,348
	SUBTOTAL	$ 436,189,200		SUBTOTAL	$ 248,878,613

TOTAL PRESENT VALUE OF ALTERNATIVE (ROUNDED TO THE NEAREST $10,000)	$ 248,880,000

Level III Estimate +50%/-30%

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

Description: Extracted groundwater from 17 extraction wells at 6,350 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (6 acres) plus 1 acre for treatment compound. Six acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

CAPITAL COSTS

Description	Quantity	Unit	Unit Cost	Total	Notes
Monitoring Well Installation					
Install shallow zone monitoring wells	10	ea	$ 65,000	$ 650,000	4" monitoring wells to a depth of 200 ft
Install deep zone monitoring wells	10	ea	115,000	$ 1,150,000	4" monitoring wells to a depth of 500 ft
EXTRACTION WELL INSTALLATION					
Property Acquisition	17	ls	$ 150,000	$ 2,550,000	Unit costs from 2005 estimate in NNGPP report; inflated by 1.4.
Permitting	1	ls	$ 40,000	$ 40,000	Engineer's Estimate
Well Installation	17	wells	$ 250,000	$ 4,250,000	Based on 2020 drilling cost estimate for 12-inch deep wells of similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26"	600	ft		$ -	
Pilot Hole Installation, 200 feet deep	2400	ft		$ -	
Pilot Hole Abandonment	0			$ -	
Ream Pilot Hole 20"	2400	ft		$ -	
Provide and install 12" Dia Casing	1200	ft		$ -	
Provide and install 12" Dia Louver Screen	1200	ft		$ -	
Provide and install 2" Filter Pack Line	1200	ft		$ -	
Centralizers	120	ea		$ -	
Sanitary Seal	1200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000	$ 320,000	actual EW-1 cost provided by OCWD
Well Development	17	ea	$ 27,530	$ 468,010	actual EW-1 cost provided by OCWD
Aquifer Testing	17	ea	$ 15,500	$ 263,500	actual EW-1 cost provided by OCWD
WELL HEAD WORKS, PUMPS, ELECTRICAL					
Provide and Install Vaults (10'x10')	17	ea	$ 30,000	$ 510,000	Actual cost to install similar sized well vaults for TGRS.
Well Head Manifolds and Instrumentation	17	ea	$ 25,000	$ 425,000	Actual cost from TGRS construction
Power drop, Transformer, and Controls	17	ea	$ 15,000	$ 255,000	Actual cost from TGRS construction
Pump and pump column	17	ea	$ 109,400	$ 1,859,800	actual EW-1 cost provided by OCWD
Mechanical Installation	1	ls	$ 224,000	$ 224,000	Estimate by RA
Electrical (MCC, Feeder, Wiring)	1	ls	$ 600,000	$ 600,000	Estimate by CJA
Division 1 Costs (10%)	1	ls	$ 387,380	$ 387,380	Work restrictions, recycling reqts, security, Tree protection, Stormwater, reporting, hazardous materials, LEED requirements
TREATMENT PLANT					
Property Acquisition	1	ls	$ 1,500,000	$ 1,500,000	Assume cost of 1-acre property

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

Description: Extracted groundwater from 17 extraction wells at 6,350 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (6 acres) plus 1 acre for treatment compound. Six acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

Demolition of existing building	1	ls	$ 500,000	$ 500,000	Assumed demolition cost
Clearing and grubbing, site prep:	1	ls	$ 100,000	$ 100,000	Engineers estimate
Site improvements	1	ls	$ 100,000	$ 100,000	block wall, fencing, paving
LGAC SYSTEM					AqueoUS Vets August 2023
GAC vessel foundation (7,000SF @1.5' deep)	1	ls	$ 250,000	$ 250,000	Estimate by AECOM Water Div Ron M
GAC vessel purchase (lead/lag pair) + 4 tier manifold	10	ea	$ 515,000	$ 5,150,000	20,000 lb vessel pairs; AqueoUS; Estimate by Reaz A
Tax and Delivery (13%)	1	ls	$ 669,500	$ 669,500	Estimate by AECOM Water Div Reaz A
First charge of GAC	400,000	lb	$ 3.00	$ 1,200,000	20 vessels @ 20,000 lbs each; AqueoUS Vets quote, Reaz A
Vessel assembly / installation	1	ls	$ 1,368,000	$ 1,368,000	Estimate by AECOM Water Div Reaz A
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
Backwash supply pump and recycle pump	1	ls	$ 35,000	$ 35,000	Estimate by AECOM Water Div Reaz A
Backwash tank assembly 2x80,000 gal steel tanks	2	ls	$ 200,000	$ 400,000	Estimate by AECOM Water Div Reaz A
Backwash tank foundation	1	ls	$ 175,000	$ 175,000	Estimate by AECOM Water Div Ron M
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Piping Manifold and Supports	1	ls	$ 1,794,000	$ 1,794,000	Estimate by AECOM Water Div Reaz A
Electrical	1	ls	$ 350,000	$ 350,000	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 Costs (10%)	1	ls	$ 990,450	$ 990,450	Estimate by AECOM Water Div Reaz I
UV AOP					UVT
UV AOP equipment purchase	1	ls	$ 2,800,000	$ 2,800,000	4 trains of Flex 200 Two bank (144-1kW lamps)
4 trains Flex 200 Two bank, Power Dist Center					
Local Control Panel, Hydraulic Center Auto Wiper					
Hydrogen peroxide tank / pumping system (8,000 gal)					
Peroxide tank foundation	1	ls	$ 75,000	$ 75,000	Estimate by AECOM Water Div Ron M
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
24"Magnetic flow meter	2		$ 45,000	$ 90,000	Estimate by AECOM Water Div Reaz A
Tax and Delivery (13%)	1	ls	$ 470,860	$ 470,860	Estimate by AECOM Water Div Reaz A
AOP system installation	1	ls	$ 900,000	$ 900,000	Estimate by AECOM Water Div Reaz A
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Mechanical/Piping (30%)	1	ls	$ 1,086,600	$ 1,086,600	Estimate by AECOM Water Div Reaz A
Electrical (35%)	1	ls	$ 1,267,700	$ 1,267,700	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 costs (10%)	1	ls	$ 362,200	$ 362,200	Estimate by AECOM Water Div Reaz A
H2O2 QUENCH SYSTEM					

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

Description: Extracted groundwater from 17 extraction wells at 6,350 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (6 acres) plus 1 acre for treatment compound. Six acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

LGAC vessels 10 feet diameter	10	1	$ 243,000	$ 2,430,000	20,000 lb vessels, 10 ft dia; AqueoUS quote; Reaz A
Piping manifold	1	1	215,000	$ 215,000	Estimate by AECOM Water Div Reaz A
Carbon, 200,000 lbs	200,000	1	2.25	$ 450,000	10 vessels @20,000 lbs each; Estimate by AECOM Water Div Reaz A
Tax + Delivery @13%	1	ls	$ 402,350	$ 402,350	Estimate by AECOM Water Div Reaz A
Installation @ 20% Equipment	1	ls	$ 619,000	$ 619,000	Estimate by AECOM Water Div Reaz A
Electrical & I&C 5% equipment	1	ls	$ 174,868	$ 174,900	Estimate by AECOM Water Div Reaz A
Concrete Foundation 4,500 ft2 1.5 ft deep	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Ron M
Contractor	1	ls	$ 524,603	$ 524,600	Estimate by AECOM Water Div Reaz A
Division 1 Costs @10%	1	ls	$ 349,735	$ 349,700	Estimate by AECOM Water Div Reaz A
PIPING NETWORK					
Permitting	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Property Negotiations	1	each	$ 140,000	$ 140,000	Engineers estimate
Geotechnical	1	each	$ 200,000	$ 200,000	AIS Construction estimate
Mobilization/Demobilization	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Traffic Control	1	each	$ 850,000	$ 850,000	AIS Construction estimate
Asphalt Cutting	98,487	sq ft	$ 11	$ 1,083,359	AIS Construction estimate
Sand Bedding	1,824	cu yd	$ 300	$ 547,151	AIS Construction estimate
Procure and Install 4" Dia Pipe	0	ft	$ 210	$ -	ICS Construction estimate
Procure and Install 6" Dia Pipe	2,755	ft	$ 240	$ 661,200	ICS Construction estimate
Procure and Install 8" Dia Pipe	7,980	ft	$ 280	$ 2,234,400	ICS Construction estimate
Procure and Install 10" Dia Pipe	2,179	ft	$ 310	$ 675,490	ICS Construction estimate
Procure and Install 12" Dia Pipe	1,221	ft	$ 365	$ 445,665	AIS Construction estimate
Procure and Install 14" Dia Pipe	3,406	ft	$ 425	$ 1,447,550	AIS Construction estimate
Procure and Install 20" Dia Pipe	4,903	ft	$ 585	$ 2,868,255	AIS Construction estimate
Procure and Install 22" Dia Pipe	3,978	ft	$ 643	$ 2,555,865	Estimate by AECOM Water Div Ron M
Procure and Install 24" Dia Pipe	0	ft	$ 700	$ -	AIS Construction estimate
Procure and Install 26" Dia Pipe	15,240	ft	$ 758	$ 11,557,000	Estimate by AECOM Water Div Ron M
Install Backfill and Compact	24,497	ft	$ 60	$ 1,469,819	ICS Construction estimate
Repair Asphalt and Pave	98,487	sq ft	$ 15	$ 1,477,308	ICS Construction estimate
Spoils Disposal 25% of total	6,580	cu yd	$ 50	$ 329,010	ICS Construction estimate
Fiber Optic Line 2" Conduit	41,662	ft	$ 10	$ 416,620	ICS Construction estimate
Fiber Optic Cable Plus Spare	83,324	ft	$ 25	$ 2,083,100	ICS Construction estimate
INFILTRATION BASIN					
Acquire property	7	acres	$ 1,500,000	$ 10,500,000	Assumed property value of $1.5M per acre
Building Demolition	7	acres	$ 400,000	$ 2,800,000	Engineer's estimate
Infiltration Basin Construction	6	acres	$ 757,944	$ 4,547,664	Factor of 3 was used for difficult install in highly urban settings.

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

Description: Extracted groundwater from 17 extraction wells at 6,350 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (6 acres) plus 1 acre for treatment compound. Six acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

SUBTOTAL				$ 91,656,006	
Bond (2%)	2%			$ 1,833,120	
SUBTOTAL				$ 93,489,126	
Contingency	35%			$ 32,721,194	15-35% based on engineering judgement
SUBTOTAL				$ 126,210,320	
Project Management	5%			$ 6,310,516	
Remedial Design	6%			$ 7,572,619	
Construction Management	6%			$ 7,572,619	
Institutional Controls					
Institutional Controls Plan	1	EA	$ 20,000	$ 20,000	
Groundwater Use Restriction	1	LS	$ 10,000	$ 10,000	
Site Information Database	1	LS	$ 10,000	$ 10,000	
SUBTOTAL				$ 40,000	
TOTAL CAPITAL COST				$ 147,710,000	rounded to the nearest $10,000

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

O&M Costs

Description	Quantity	Unit	Unit Cost	Total	Notes
GROUNDWATER MONITORING					
Groundwater monitoring	532	hr	$ 85	$ 45,220	Annual monitoring; 4 hours per well, 96 existing +20 new; 17 extraction wells; assumes IDW water is treated and discharged at well head similar to OCWD process
Consultant Oversight	100	hr	$ 100	$ 10,000	
Reporting	240	hr	$ 100	$ 24,000	
Lab Analysis	146	ea	$ 300	$ 43,890	96 existing +20 new +10% QAQC
EXTRACTION WELLS					
Annual Operating Cost (electricity)	17	ea	$ 80,000	$ 1,360,000	Based on pump HP rating ($0.16/kwh)
Annual Pump Maintenance	17	ea	$ 5,000	$ 85,000	Periodic pump maintenance
LGAC					
GAC media change-out and disposal	800,000	lbs	$ 2.50	$ 2,000,000	$2.50/lb x 200,000 lb x 4 times/yr
Routine O&M	2,920	hr	$ 100	$ 292,000	8 hr/day @ $85/hr x 365 days/year
Non-routine labor	1	ls	$ 105,000	$ 105,000	
Oversight labor	1	ls	$ 247,240	$ 247,240	assume 20% of field labor costs
Equipment repair costs	1	ls	$ 105,000	$ 105,000	
Other materials	1	ls	$ 35,000	$ 35,000	
Electric costs	1	ls	$ 56,700	$ 56,700	
Lab analysis	1	ls	$ 127,000	$ 127,000	influent, mid, and effluent sampling of each GAC vessel pair
Reporting and annual fees	1	ls	$ 70,000	$ 70,000	

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

O&M Costs

UV AOP					
Routine O&M	1,460	hr	$ 100	$ 146,000	4 hr/day x 365 days/year
Non-routine labor	1	ls	$ 30,000	$ 30,000	
Oversight labor	1	ls	$ 30,800	$ 30,800	assume 20% of field labor costs
Lamp replacement	168	ls	$ 800	$ 134,400	15,000 hour warranty
Equipment repair costs	1	ls	$ 20,000	$ 20,000	
Other materials	1	ls	$ 10,000	$ 10,000	
Electric costs	1	ls	$ 202,500	$ 202,500	$0.16 /kWh
Lab analysis	1	ls	$ 100,000	$ 100,000	
Reporting and annual fees	1	ls	$ 20,000	$ 20,000	
Peroxide	54,104	gal	$ 4	$ 221,826	10ppm at 183 gallons/dy
INFILTRATION BASIN					
Routine O&M	192	hr	$ 85	$ 16,320	8 hours/day twice a month
Annual Maintenance Costs	1	ls	$ 30,000	$ 30,000	remove bio/sediment accumulation and regrade
SUBTOTAL				$ 6,286,496	
Contingency	20%			$ 1,257,299	
Subtotal				$ 7,543,795	
Project Management	10%			$ 754,380	5-10% of annual
Technical Support	15%			$ 1,131,569	10-20% technical support
Institutional Controls				$ 25,000	Estimate
Total Annual O&M Cost				$ 9,450,000	Rounded to nearest $10,000

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

O&M Costs

PERIODIC COSTS

Description	Year	Quantity	Unit	Unit Cost	Total	Notes
Recovery well redevelopment	5	17	ea	$ 10,000	$ 170,000	
Erosion Repair	5	1	ls	$ 25,000	$ 25,000	
Recovery well redevelopment	10	17	ea	$ 10,000	$ 170,000	
Sediment Removal	10	1	ls	$ 50,000	$ 50,000	
Erosion Repair	10	1	ls	$ 25,000	$ 25,000	
Recovery well redevelopment	15	17	ea	$ 10,000	$ 170,000	
Erosion Repair	15	1	ls	$ 25,000	$ 25,000	
Recovery well redevelopment	20	17	ea	$ 10,000	$ 170,000	
Sediment Removal	20	1	ls	$ 50,000	$ 50,000	
Erosion Repair	20	1	ls	$ 25,000	$ 25,000	
Extraction pump replacement	7	17	ea	$ 109,400	$ 1,859,800	every 7 years; vendor recom
Extraction pump replacement	14	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	21	17	ea	$ 109,400	$ 1,859,800	
Extraction pump replacement	28	17	ea	$ 109,400	$ 1,859,800	
H2O2 Quench LGAC replacement	5	10	ea	$ 50,000	$ 500,000	10x20000 lbs LGAC changeout
H2O2 Quench LGAC replacement	10	10	ea	$ 50,000	$ 500,000	every 5 years
H2O2 Quench LGAC replacement	15	10	ea	$ 50,000	$ 500,000	
H2O2 Quench LGAC replacement	20	10	ea	$ 50,000	$ 500,000	
H2O2 Quench LGAC replacement	25	10	ea	$ 50,000	$ 500,000	
H2O2 Quench LGAC replacement	30	10	ea	$ 50,000	$ 500,000	
Recovery well redevelopment	25	17	ea	$ 10,000	$ 170,000	
Erosion Repair	25	1	ls	$ 25,000	$ 25,000	
Recovery well redevelopment	30	17	ea	$ 10,000	$ 170,000	
Sediment Removal	30	1	ls	$ 50,000	$ 50,000	
Erosion Repair	30	1	ls	$ 25,000	$ 25,000	
TOTAL PERIODIC COSTS					$ 11,760,000	Rounded to nearest $10,000

ALTERNATIVE **5**
Centralized Treatment Plant; Discharge to Infiltration Basin

O&M Costs

NET PRESENT VALUE

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital Cost	0	$ 147,710,000	$ 147,710,000	1.0	$ 147,710,000
Annual O&M Cost	1-30	$ 283,500,000	$ 9,450,000	12.4	$ 117,265,050
Periodic Cost	5	$ 695,000	$ 695,000	0.7	$ 495,525
Periodic Cost	10	$ 745,000	$ 745,000	0.5	$ 378,720
Periodic Cost	15	$ 695,000	$ 695,000	0.4	$ 251,900
Periodic Cost	20	$ 745,000	$ 745,000	0.26	$ 192,522
Periodic Cost	7	$ 1,859,800	$ 1,859,800	0.62	$ 1,158,190
Periodic Cost	14	$ 1,859,800	$ 1,859,800	0.39	$ 721,263
Periodic Cost	21	$ 1,859,800	$ 1,859,800	0.24	$ 449,166
Periodic Cost	28	$ 1,859,800	$ 1,859,800	0.15	$ 279,718
Periodic Cost	25	$ 695,000	$ 695,000	0.18	$ 128,053
Periodic Cost	30	$ 745,000	$ 745,000	0.13	$ 97,869
	SUBTOTAL	$ 442,969,200		SUBTOTAL	$ 269,127,976

TOTAL PRESENT VALUE OF ALTERNATIVE (ROUNDED TO THE NEAREST $10,000)	$ 269,130,000

Level III Estimate +50%/-30%

ALTERNATIVE **6** GROUP 2
Multiple Treatment Plants; Group 2: Treatment Plant #2; Discharge to Injection Wells

Description: Extracted groundwater from 8 extraction wells (Group 2) at a flow rate of 3,673 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 10 injection wells (based on 500 gpm per well plus 30% to account for clogging).

CAPITAL COSTS

Description	Quantity	Unit	Unit Cost	Total	Notes
Monitoring Well Installation					
Install shallow zone monitoring wells	6	ea	$ 65,000	$ 390,000	4" monitoring wells to a depth of 200 ft
Install deep zone monitoring wells	6	ea	115,000	$ 690,000	4" monitoring wells to a depth of 500 ft
EXTRACTION WELL INSTALLATION					
Property Acquisition	8	ls	$ 150,000	$ 1,200,000	Unit costs from 2005 estimate in NNGPP report; inflated by 1.4.
Permitting	1	ls	$ 40,000	$ 40,000	Estimate
Well Installation	8	wells	$ 250,000	$ 2,000,000	Based on 2020 drilling cost estimate for 12" dia and similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26"	600	ft		$ -	
Pilot Hole Installation	2400	ft		$ -	
Pilot Hole Abandonment	0			$ -	
Ream Pilot Hole 20"	2400	ft		$ -	
Provide and install 12" Dia Casing	1200	ft		$ -	
Provide and install 12" Dia Louver Screen	1200	ft		$ -	
Provide and install 2" Filter Pack Line	1200	ft		$ -	
Centralizers	120	ea		$ -	
Sanitary Seal	1200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000	$ 320,000	actual EW-1 cost provided by OCWD
Well Development	8	ea	$ 27,530	$ 220,240	actual EW-1 cost provided by OCWD
Aquifer Testing	8	ea	$ 15,500	$ 124,000	actual EW-1 cost provided by OCWD
WELL HEAD WORKS, PUMPS, ELECTRICAL					
Provide and Install Vaults (10'x10')	8	ea	$ 30,000	$ 240,000	Actual cost to install similar sized well vaults for TGRS.
Well Head Manifolds and Instrumentation	8	ea	$ 25,000	$ 200,000	Actual cost from TGRS construction
Power drop, Transformer, and Controls	8	ea	$ 15,000	$ 120,000	Actual cost from TGRS construction
Pump and pump column	8	ea	$ 109,400	$ 875,200	actual EW-1 cost provided by OCWD
Mechanical Installation	1	ls	$ 74,667	$ 74,667	Estimate by AECOM Water Div Reaz A
Electrical (MCC, Feeder, Wiring)	1	ls	$ 200,000	$ 200,000	Estimate by AECOM Water Div CJA
Division 1 Costs (10%)	1	ls	$ 170,987	$ 170,987	Work restrictions, recycling reqts, security, Tree protection, Stormwater,

ALTERNATIVE **6** GROUP 2

Multiple Treatment Plants; Group 2: Treatment Plant #2; Discharge to Injection Wells

Description: Extracted groundwater from 8 extraction wells (Group 2) at a flow rate of 3,673 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 10 injection wells (based on 500 gpm per well plus 30% to account for clogging).

TREATMENT PLANT					
Property Acquisition	1	ls	$ 1,500,000	$ 1,500,000	Assumed value of 1-acre property
Demolition of existing building	1	ls	$ 500,000	$ 500,000	Assumed demolition cost
Clearing and grubbing, site prep:	1	ls	$ 100,000	$ 100,000	Engineers estimate
Site improvements	1	ls	$ 350,000	$ 350,000	block wall, fencing, paving based on TGRS project
LGAC SYSTEM					AqueoUS Vets August 2023
GAC vessel foundation (7,000SF @1.5' deep)	1	ls	$ 150,000	$ 150,000	Estimate by AECOM Water Div Ron M
GAC vessel purchase (lead/lag pair) + 4 tier manifold	6	ea	$ 515,000	$ 3,090,000	20,000 lb vessel pairs; AqueoUS; Estimate by Reaz A
Tax and Delivery (13%)	1	ls	$ 401,700	$ 401,700	Estimate by AECOM Water Div Reaz A
First charge of GAC	240,000	lb	$ 3.00	$ 720,000	Reaz A
Vessel assembly / installation	1	ls	$ 820,800	$ 820,800	Estimate by AECOM Water Div Reaz A
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
Backwash supply pump and recycle pump	1	ls	$ 35,000	$ 35,000	Estimate by AECOM Water Div Reaz A
Backwash tank assembly 2x80,000 gal steel tanks	2	ls	$ 200,000	$ 400,000	Estimate by AECOM Water Div Reaz A
Backwash tank foundation	1	ls	$ 175,000	$ 175,000	Estimate by AECOM Water Div Ron M
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Piping Manifold and Supports	1	ls	$ 1,076,400	$ 1,076,400	Estimate by AECOM Water Div Reaz A
Electrical	1	ls	$ 210,000	$ 210,000	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 Costs (10%)	1	ls	$ 644,950	$ 644,950	Estimate by AECOM Water Div Reaz I
UV AOP					Trojan UV estimate based on 6,350 gpm and water quality values of 96% UVT
UV AOP equipment purchase	1	ls	$ 1,400,000	$ 1,400,000	2 trains of Flex 200 Two bank (144-1kW lamps)
2 trains Flex 200 Two bank, Power Dist Center					
Local Control Panel, Hydraulic Center Auto Wiper					
Hydrogen peroxide tank / pumping system (8,000 gal)					
Peroxide tank foundation	1	ls	$ 75,000	$ 75,000	Estimate by AECOM Water Div Ron M
Particulate filters	3	ea	$ 219,000	$ 657,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
24"Magnetic flow meter	2		$ 45,000	$ 90,000	Estimate by AECOM Water Div Reaz A
Tax and Delivery (13%)	1	ls	$ 288,860	$ 288,860	Estimate by AECOM Water Div Reaz A
AOP system installation	1	ls	$ 450,000	$ 450,000	Estimate by AECOM Water Div Reaz A
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Mechanical/Piping (30%)	1	ls	$ 666,600	$ 666,600	Estimate by AECOM Water Div Reaz A
Electrical (35%)	1	ls	$ 777,700	$ 777,700	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 costs (10%)	1	ls	$ 222,200	$ 222,200	Estimate by AECOM Water Div Reaz A

ALTERNATIVE **6** GROUP 2

Multiple Treatment Plants; Group 2: Treatment Plant #2; Discharge to Injection Wells

Description: Extracted groundwater from 8 extraction wells (Group 2) at a flow rate of 3,673 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 10 injection wells (based on 500 gpm per well plus 30% to account for clogging).

H2O2 QUENCH SYSTEM					
LGAC vessels 10 feet diameter	6	1	$ 243,000	$ 1,458,000	20,000 lb vessels, 10 ft dia; AqueoUS quote; Reaz A
Piping manifold	1	1	129,000	$ 129,000	Estimate by AECOM Water Div Reaz A
Carbon, 120,000 lbs	120,000	1	2.25	$ 270,000	Water Div Reaz A
Tax + Delivery @13%	1	ls	$ 241,410	$ 241,410	Estimate by AECOM Water Div Reaz A
Installation @ 20% Equipment	1	ls	$ 371,400	$ 371,400	Estimate by AECOM Water Div Reaz A
Electrical & I&C 5% equipment	1	ls	$ 104,921	$ 104,900	Estimate by AECOM Water Div Reaz A
Concrete Foundation 4,500 ft2 1.5 ft deep	1	ls	$ 60,000	$ 60,000	Estimate by AECOM Water Div Ron M
Contractor	1	ls	$ 314,762	$ 314,800	Estimate by AECOM Water Div Reaz A
Division 1 Costs @10%	1	ls	$ 209,841	$ 209,800	Estimate by AECOM Water Div Reaz A
PIPING NETWORK					
Permitting	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Property Negotiations	1	each	$ 84,000	$ 84,000	Engineers estimate
Geotechnical	1	each	$ 120,000	$ 120,000	AIS Construction estimate
Mobilization/Demobilization	1	each	$ 60,000	$ 60,000	AIS Construction estimate
Traffic Control	1	each	$ 850,000	$ 850,000	AIS Construction estimate
Asphalt Cutting	50,000	sq ft	$ 11	$ 550,000	AIS Construction estimate
Sand Bedding	1,000	cu yd	$ 300	$ 300,000	AIS Construction estimate
Procure and Install 4" Dia Pipe	0	ft	$ 210	$ -	ICS Construction estimate
Procure and Install 6" Dia Pipe	390	ft	$ 240	$ 93,600	ICS Construction estimate
Procure and Install 8" Dia Pipe	7,157	ft	$ 280	$ 2,003,960	ICS Construction estimate
Procure and Install 10" Dia Pipe	1,556	ft	$ 310	$ 482,360	ICS Construction estimate
Procure and Install 12" Dia Pipe	384	ft	$ 365	$ 140,160	AIS Construction estimate
Procure and Install 14" Dia Pipe	3,406	ft	$ 425	$ 1,447,550	AIS Construction estimate
Procure and Install 16" Dia Pipe	0	ft	$ 468	$ -	AIS Construction estimate
Procure and Install 18" Dia Pipe	623	ft	$ 510	$ 317,730	Estimate by AECOM Water Div Ron M
Procure and Install 20" Dia Pipe	2,625	ft	$ 585	$ 1,535,625	AIS Construction estimate
Procure and Install 22" Dia Pipe	7,893	ft	$ 643	$ 5,071,253	Estimate by AECOM Water Div Ron M
Install Backfill and Compact	11,913	ft	$ 60	$ 714,765	ICS Construction estimate
Repair Asphalt and Pave	50,000	sq ft	$ 15	$ 750,000	ICS Construction estimate
Spoils Disposal 25% of total	3,209	cu yd	$ 50	$ 160,471	ICS Construction estimate
Fiber Optic Line 2" Conduit	24,034	ft	$ 10	$ 240,340	ICS Construction estimate
Fiber Optic Cable Plus Spare	48,068	ft	$ 25	$ 1,201,700	ICS Construction estimate
INJECTION WELL INSTALLATION					
Property Acquisition	10	each	$ -	$ -	
Permitting	10	wells	$ 1,500	$ 15,000	City of Anaheim well construction permit

ALTERNATIVE **6** GROUP 2

Multiple Treatment Plants; Group 2: Treatment Plant #2; Discharge to Injection Wells

Description: Extracted groundwater from 8 extraction wells (Group 2) at a flow rate of 3,673 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 10 injection wells (based on 500 gpm per well plus 30% to account for clogging).

Well Installation	10	wells	$ 250,000	$ 2,500,000	Based on 2020 drilling cost estimate for 12" dia and similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26"	1100	ft		$ -	
Pilot Hole Installation	4400	ft		$ -	
Pilot Hole Abandonment	0			$ -	
Ream Pilot Hole 20"	4400	ft		$ -	
Provide and install 12" Dia Casing	2200	ft		$ -	
Provide and install 12" Dia Louver Screen	2200	ft		$ -	
Provide and install 2" Filter Pack Line	2200	ft		$ -	
Centralizers	220	ea		$ -	
Sanitary Seal	2200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000	$ 320,000	actual EW-1 cost provided by OCWD
Well Development	10	ea	$ 38,542	$ 385,420	
Aquifer Testing	10	ea	$ 21,700	$ 217,000	
Well Head				$ -	
Provide and Install Vault (10'x10'x10)	10	ea	$ 30,000	$ 300,000	two days at each well
Well Head Manifolds and Instrumentation	10	ea	$ 25,000	$ 250,000	Only 12 new wells need vaults, manifolds and instrumentation
Piping					
Procure and Install 14" Dia Pipe	250	ft	$ 425	$ 106,250	Estimate by AECOM Water Div Ron M
Procure and Install 8" Dia Pipe	250	ft	$ 280	$ 70,000	AIS Construction estimate
Install Backfill and Compact	83	cu yd	$ 60	$ 5,000	ICS Construction estimate
Repair Asphalt and Pave	750	sq ft	$ 70	$ 52,500	ICS Construction estimate
Spoils Disposal 25% of total	21	cu yd	$ 50	$ 1,042	ICS Construction estimate
Fiber Optic Line 2" Conduit	2,659	ft	$ 10	$ 26,590	ICS Construction estimate
Fiber Optic Cable Plus Spare	2,659	ft	$ 25	$ 66,475	ICS Construction estimate
SUBTOTAL				$ 46,421,403	
Bonds and Insurance (2%)	2%			$ 928,428.07	
SUBTOTAL				$ 47,349,831	
Contingency	35%			$ 16,572,441	15-35% based on engineering judgement
SUBTOTAL				$ 63,922,273	

ALTERNATIVE **6** GROUP 2

Multiple Treatment Plants; Group 2: Treatment Plant #2; Discharge to Injection Wells

Description: Extracted groundwater from 8 extraction wells (Group 2) at a flow rate of 3,673 gpm would be treated to standards consistent with the Regional Water Quality Control Board, Santa Ana Region (RWQCB) requirements for recharge of treated groundwater and would be returned to the aquifer system via 10 injection wells (based on 500 gpm per well plus 30% to account for clogging).

Project Management	5%			$ 3,196,114	
Remedial Design	6%			$ 3,835,336	
Construction Management	6%			$ 3,835,336	
Institutional Controls					
Institutional Controls Plan	1	EA	$ 20,000	$ 20,000	
Groundwater Use Restriction	1	LS	$ 10,000	$ 10,000	
Site Information Database	1	LS	$ 10,000	$ 10,000	
SUBTOTAL				$ 40,000	
TOTAL CAPITAL COST				$ 74,830,000	rounded to the nearest $10,000

ALTERNATIVE **6** GROUP 2

Multiple Treatment Plants; Group 2: Treatment Plant #2; Discharge to Injection Wells

O&M Costs

Description	Quantity	Unit	Unit Cost	Total	Notes
GROUNDWATER MONITORING					
Groundwater monitoring	310	hr	$ 85	$ 26,384	Annual monitoring; 4 hours per well, 6/10 percentage of the 96 existing +20 new wells of Group 2; 9 out of 17 extraction wells in Group 2; assumes IDW water is treated and discharged at well head similar to OCWD process
Consultant Oversight	60	hr	$ 100	$ 6,000	
Reporting	144	hr	$ 100	$ 14,400	
Lab Analysis	85	ea	$ 300	$ 25,608	6/10 percentage of (96 existing +20 new +10% QAQC) in Group 2
EXTRACTION WELLS					
Annual Operating Cost (electricity)	8	ea	$ 80,000	$ 640,000	Based on pump HP rating ($0.16/kwh)
Annual Pump Maintenance	8	ea	$ 5,000	$ 40,000	Periodic pump maintenance
LGAC					
GAC media change-out and disposal (qtrly)	480,000	lbs	$ 2.50	$ 1,200,000	$2.50/lb x (6/10 percent of 200,000 lb in Group 2) x 4 times/yr
Routine O&M	2,920	hr	$ 100	$ 292,000	8 hr/day @ $85/hr x 365 days/year
Non-routine labor	1	ls	$ 63,000	$ 63,000	
Oversight labor	1	ls	$ 148,344	$ 148,344	assume 20% of field labor costs
Equipment repair costs	1	ls	$ 63,000	$ 63,000	
Other materials	1	ls	$ 21,000	$ 21,000	
Electric costs	1	ls	$ 35,280	$ 35,280	reduced by flow rate ratio 0.84
Lab analysis	1	ls	$ 76,200	$ 76,200	influent, mid, and effluent sampling of each GAC vessel pair
Reporting and annual fees	1	ls	$ 70,000	$ 70,000	

UV AOP					
Routine O&M	730	hr	$ 100	$ 73,000	2 hr/day in Group 1 x 365 days/year
Non-routine labor	1	ls	$ 18,000	$ 18,000	
Oversight labor	1	ls	$ 18,480	$ 18,480	assume 20% of field labor costs
Lamp replacement	84	ea	$ 800	$ 67,200	15,000 hour warranty
Equipment repair costs	1	ls	$ 12,000	$ 12,000	
Other materials	1	ls	$ 6,000	$ 6,000	
Electric costs	1	ls	$ 126,000	$ 126,000	$0.16 /kWh; reduce by 0.84 factor
Lab analysis	1	ls	$ 50,000	$ 50,000	
Reporting and annual fees	1	ls	$ 20,000	$ 20,000	
Peroxide	33,665	gal	$ 4	$ 138,025	10ppm at 183 gallons/dy; 0.84 factor
INJECTION WELLS					
Redevelopment	10	ea	$ 28,000	$ 280,000	mechanical & chemical redevelopment, based on recent quote
City Inspection Fee	10	ea	$ 2,500	$ 25,000	
SUBTOTAL				$ 4,273,521	
Contingency	20%			$ 854,704	
Subtotal				$ 5,128,225	
Project Management	10%			$ 512,823	5-10% of annual
Technical Support	15%			$ 769,234	10-20% technical support
Institutional Controls				$ 25,000	Estimate
Total Annual O&M Cost				$ 6,440,000	Rounded to nearest $10,000

PERIODIC COSTS

Description	Year	Quantity	Unit	Unit Cost	Total	Notes
Ext and Inj well redevelopment	5	18	ea	$ 10,000	$ 180,000	every 5 years
Ext and Inj well redevelopment	10	18	ea	$ 10,000	$ 180,000	
Ext and Inj well redevelopment	15	18	ea	$ 10,000	$ 180,000	
Ext and Inj well redevelopment	20	18	ea	$ 10,000	$ 180,000	
H2O2 Quench LGAC replacement	5	6	ea	$ 50,000	$ 300,000	10x20000 lbs LGAC changeout
H2O2 Quench LGAC replacement	10	6	ea	$ 50,000	$ 300,000	every 5 years
H2O2 Quench LGAC replacement	15	6	ea	$ 50,000	$ 300,000	
H2O2 Quench LGAC replacement	20	6	ea	$ 50,000	$ 300,000	
Extraction pump replacement	7	8	ea	$ 109,400	$ 875,200	every 7 years; vendor recom
Extraction pump replacement	14	8	ea	$ 109,400	$ 875,200	
Extraction pump replacement	21	8	ea	$ 109,400	$ 875,200	
Extraction pump replacement	28	8	ea	$ 109,400	$ 875,200	
H2O2 Quench LGAC replacement	25	6	ea	$ 50,000	$ 300,000	
H2O2 Quench LGAC replacement	30	6	ea	$ 50,000	$ 300,000	
Ext and Inj well redevelopment	25	18	ea	$ 10,000	$ 180,000	
Ext and Inj well redevelopment	30	18	ea	$ 10,000	$ 180,000	
TOTAL PERIODIC COSTS					$ 6,380,000	Rounded to nearest $10,000

NET PRESENT VALUE

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital Cost	0	$ 74,830,000	$ 74,830,000	1.0	$ 74,830,000
Annual O&M Cost	1-30	$ 193,200,000	$ 6,440,000	12.4	$ 79,913,960
Periodic Cost	5	$ 480,000	$ 480,000	0.71	$ 342,233
Periodic Cost	10	$ 480,000	$ 480,000	0.51	$ 244,008
Periodic Cost	15	$ 480,000	$ 480,000	0.36	$ 173,974
Periodic Cost	20	$ 480,000	$ 480,000	0.26	$ 124,041
Periodic Cost	25	$ 480,000	$ 480,000	0.18	$ 88,440
Periodic Cost	7	$ 875,200	$ 875,200	0.62	$ 545,031
Periodic Cost	14	$ 875,200	$ 875,200	0.39	$ 339,418
Periodic Cost	21	$ 875,200	$ 875,200	0.24	$ 211,372
Periodic Cost	28	$ 875,200	$ 875,200	0.15	$ 131,632
Periodic Cost	30	$ 480,000	$ 480,000	0.13	$ 63,056
	SUBTOTAL	$ 274,410,800		SUBTOTAL	$ 157,007,165

TOTAL PRESENT VALUE OF ALTERNATIVE (ROUNDED TO THE NEAREST $10,000)	$ 157,010,000

Level III Estimate +50%/-30%

ALTERNATIVE **6** GROUP 1
Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

Description: Extracted groundwater from 9 extraction wells (Group 1) at 2,873 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (3 acres) plus 1 acre for treatment compound. Three acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

CAPITAL COSTS

Description	Quantity	Unit	Unit Cost	Total	Notes
Monitoring Well Installation					
Install shallow zone monitoring wells	4	ea	$ 65,000	$ 260,000	4" monitoring wells to a depth of 200 ft
Install deep zone monitoring wells	4	ea	115,000	$ 460,000	4" monitoring wells to a depth of 500 ft
EXTRACTION WELL INSTALLATION					
Property Acquisition	9	ls	$ 150,000	$ 1,350,000	Unit costs from 2005 estimate in NNGPP report; inflated by 1.4.
Permitting	1	ls	$ 40,000	$ 40,000	Engineer's Estimate
Well Installation	9	wells	$ 250,000	$ 2,250,000	Based on 2020 drilling cost estimate for 12-inch deep wells of similar depth in Houston, TX
Mobilization/Demobilization	1	ls		$ -	
Conductor Casing 26"	600	ft		$ -	
Pilot Hole Installation, 200 feet deep	2400	ft		$ -	
Pilot Hole Abandonment	0			$ -	
Ream Pilot Hole 20"	2400	ft		$ -	
Provide and install 12" Dia Casing	1200	ft		$ -	
Provide and install 12" Dia Louver Screen	1200	ft		$ -	
Provide and install 2" Filter Pack Line	1200	ft		$ -	
Centralizers	120	ea		$ -	
Sanitary Seal	1200	ft		$ -	
Mobile Treatment System	1	LS	$ 320,000	$ 320,000	actual EW-1 cost provided by OCWD
Well Development	9	ea	$ 27,530	$ 247,770	actual EW-1 cost provided by OCWD
Aquifer Testing	9	ea	$ 15,500	$ 139,500	actual EW-1 cost provided by OCWD
WELL HEAD WORKS, PUMPS, ELECTRICAL					
Provide and Install Vaults (10'x10')	9	ea	$ 30,000	$ 270,000	Actual cost to install similar sized well vaults for TGRS.
Well Head Manifolds and Instrumentation	9	ea	$ 25,000	$ 225,000	Actual cost from TGRS construction
Power drop, Transformer, and Controls	9	ea	$ 15,000	$ 135,000	Actual cost from TGRS construction
Pump and pump column	9	ea	$ 109,400	$ 984,600	actual EW-1 cost provided by OCWD
Mechanical Installation	1	ls	$ 149,333	$ 149,333	Estimate by RA
Electrical (MCC, Feeder, Wiring)	1	ls	$ 400,000	$ 400,000	Estimate by CJA
Division 1 Costs (10%)	1	ls	$ 216,393	$ 216,393	Work restrictions, recycling reqts, security, Tree protection, Stormwater, reporting, hazardous materials, LEED requirements
TREATMENT PLANT					
Property Acquisition	1	ls	$ 1,500,000	$ 1,500,000	Assume cost of 1-acre property

ALTERNATIVE **6** GROUP 1
Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

Description: Extracted groundwater from 9 extraction wells (Group 1) at 2,873 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (3 acres) plus 1 acre for treatment compound. Three acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

Demolition of existing building	1	ls	$ 500,000	$ 500,000	Assumed demolition cost
Clearing and grubbing, site prep:	1	ls	$ 100,000	$ 100,000	Engineers estimate
Site improvements	1	ls	$ 100,000	$ 100,000	block wall, fencing, paving
LGAC SYSTEM					AqueoUS Vets August 2023
GAC vessel foundation (7,000SF @1.5' deep)	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Ron M
GAC vessel purchase (lead/lag pair) + 4 tier manifold	4	ea	$ 515,000	$ 2,060,000	20,000 lb vessel pairs; AqueoUS; Estimate by Reaz A
Tax and Delivery (13%)	1	ls	$ 267,800	$ 267,800	Estimate by AECOM Water Div Reaz A
First charge of GAC	160,000	lb	$ 3.00	$ 480,000	quote, Reaz A
Vessel assembly / installation	1	ls	$ 547,200	$ 547,200	Estimate by AECOM Water Div Reaz A
Particulate filters	2	ea	$ 219,000	$ 438,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
Backwash supply pump and recycle pump	1	ls	$ 35,000	$ 35,000	Estimate by AECOM Water Div Reaz A
Backwash tank assembly 2x80,000 gal steel tanks	1	ls	$ 200,000	$ 200,000	Estimate by AECOM Water Div Reaz A
Backwash tank foundation	1	ls	$ 175,000	$ 175,000	Estimate by AECOM Water Div Ron M
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Piping Manifold and Supports	1	ls	$ 717,600	$ 717,600	Estimate by AECOM Water Div Reaz A
Electrical	1	ls	$ 140,000	$ 140,000	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 Costs (10%)	1	ls	$ 430,300	$ 430,300	Estimate by AECOM Water Div Reaz I
UV AOP					UVT
UV AOP equipment purchase	1	ls	$ 1,400,000	$ 1,400,000	2 trains of Flex 200 Two bank (144-1kW lamps)
2 trains Flex 200 Two bank, Power Dist Center					
Local Control Panel, Hydraulic Center Auto Wiper					
Hydrogen peroxide tank / pumping system (8,000 gal)					
Peroxide tank foundation	1	ls	$ 75,000	$ 75,000	Estimate by AECOM Water Div Ron M
Particulate filters	2	ea	$ 219,000	$ 438,000	Filtrek Model S6UFH36 with 19 x 40-inch long 10 micron elements
24"Magnetic flow meter	2		$ 45,000	$ 90,000	Estimate by AECOM Water Div Reaz A
Tax and Delivery (13%)	1	ls	$ 260,390	$ 260,390	Estimate by AECOM Water Div Reaz A
AOP system installation	1	ls	$ 450,000	$ 450,000	Estimate by AECOM Water Div Reaz A
Control panel / PLC programming	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Mechanical/Piping (30%)	1	ls	$ 600,900	$ 600,900	Estimate by AECOM Water Div Reaz A
Electrical (35%)	1	ls	$ 701,050	$ 701,050	Estimate by AECOM Water Div CJA
SCADA and instrumentation	1	ls	$ 100,000	$ 100,000	Estimate by AECOM Water Div Reaz A
Division 1 costs (10%)	1	ls	$ 200,300	$ 200,300	Estimate by AECOM Water Div Reaz A
H2O2 QUENCH SYSTEM					

ALTERNATIVE **6** GROUP 1
Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

Description: Extracted groundwater from 9 extraction wells (Group 1) at 2,873 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (3 acres) plus 1 acre for treatment compound. Three acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

LGAC vessels 10 feet diameter	4	1	$ 243,000	$ 972,000	20,000 lb vessels, 10 ft dia; AqueoUS quote; Reaz A
Piping manifold	1	1	86,000	$ 86,000	Estimate by AECOM Water Div Reaz A
Carbon, 200,000 lbs	80,000	1	2.25	$ 180,000	Div Reaz A
Tax + Delivery @13%	1	ls	$ 160,940	$ 160,940	Estimate by AECOM Water Div Reaz A
Installation @ 20% Equipment	1	ls	$ 247,600	$ 247,600	Estimate by AECOM Water Div Reaz A
Electrical & I&C 5% equipment	1	ls	$ 69,947	$ 69,900	Estimate by AECOM Water Div Reaz A
Concrete Foundation 4,500 ft2 1.5 ft deep	1	ls	$ 40,000	$ 40,000	Estimate by AECOM Water Div Ron M
Contractor	1	ls	$ 209,841	$ 209,800	Estimate by AECOM Water Div Reaz A
Division 1 Costs @10%	1	ls	$ 139,894	$ 139,900	Estimate by AECOM Water Div Reaz A
PIPING NETWORK					
Permitting	1	each	$ 100,000	$ 100,000	AIS Construction estimate
Property Negotiations	1	each	$ 56,000	$ 56,000	Engineers estimate
Geotechnical	1	each	$ 80,000	$ 80,000	AIS Construction estimate
Mobilization/Demobilization	1	each	$ 40,000	$ 40,000	AIS Construction estimate
Traffic Control	1	each	$ 850,000	$ 850,000	AIS Construction estimate
Asphalt Cutting	50,000	sq ft	$ 11	$ 550,000	AIS Construction estimate
Sand Bedding	1,000	cu yd	$ 300	$ 300,000	AIS Construction estimate
Procure and Install 4" Dia Pipe	0	ft	$ 210	$ -	ICS Construction estimate
Procure and Install 6" Dia Pipe	2,035	ft	$ 240	$ 488,400	ICS Construction estimate
Procure and Install 8" Dia Pipe	5,131	ft	$ 280	$ 1,436,680	ICS Construction estimate
Procure and Install 12" Dia Pipe	837	ft	$ 365	$ 305,505	ICS Construction estimate
Procure and Install 14" Dia Pipe	303	ft	$ 425	$ 128,775	AIS Construction estimate
Procure and Install 18" Dia Pipe	4,113	ft	$ 510	$ 2,097,630	AIS Construction estimate
Procure and Install 20" Dia Pipe	10,824	ft	$ 585	$ 6,332,040	Estimate by AECOM Water Div Ron M
Procure and Install 24" Dia Pipe	0	ft	$ 700	$ -	AIS Construction estimate
Procure and Install 30" Dia Pipe	0	ft	$ 875	$ -	Estimate by AECOM Water Div Ron M
Install Backfill and Compact	11,830	ft	$ 60	$ 709,779	ICS Construction estimate
Repair Asphalt and Pave	50,000	sq ft	$ 15	$ 750,000	ICS Construction estimate
Spoils Disposal 25% of total	3,187	cu yd	$ 50	$ 159,372	ICS Construction estimate
Fiber Optic Line 2" Conduit	23,243	ft	$ 10	$ 232,430	ICS Construction estimate
Fiber Optic Cable Plus Spare	46,486	ft	$ 25	$ 1,162,150	ICS Construction estimate
INFILTRATION BASIN					
Acquire property	4	acres	$ 1,500,000	$ 6,000,000	Assumed property value of $1.5M per acre
Building Demolition	4	acres	$ 400,000	$ 1,600,000	Engineer's estimate
Infiltration Basin Construction	3	acres	$ 757,944	$ 2,273,832	Factor of 3 was used for difficult install in highly urban settings.

ALTERNATIVE **6** GROUP 1
Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

Description: Extracted groundwater from 9 extraction wells (Group 1) at 2,873 gpm would be treated to standards consistent with the RWQCB Santa Ana Region discharge standards and would be returned to the aquifer system via infiltration basins (3 acres) plus 1 acre for treatment compound. Three acres is consistent with the CalTrans Infiltration Basin guidance using a safety factor of 10% at 2.5 inches/hour infiltration.

SUBTOTAL				$ 47,612,870	
Bond (2%)	2%			$ 952,257	
SUBTOTAL				$ 48,565,127	
Contingency	35%			$ 16,997,795	15-35% based on engineering judgement
SUBTOTAL				$ 65,562,922	
Project Management	5%			$ 3,278,146	
Remedial Design	6%			$ 3,933,775	
Construction Management	6%			$ 3,933,775	
Institutional Controls					
Institutional Controls Plan	1	EA	$ 20,000	$ 20,000	
Groundwater Use Restriction	1	LS	$ 10,000	$ 10,000	
Site Information Database	1	LS	$ 10,000	$ 10,000	
SUBTOTAL				$ 40,000	
TOTAL CAPITAL COST				$ 76,750,000	rounded to the nearest $10,000

ALTERNATIVE **6** GROUP 1

Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

O&M Costs

Description	Quantity	Unit	Unit Cost	Total	Notes
GROUNDWATER MONITORING					
Groundwater monitoring	222	hr	$ 85	$ 18,836	Annual monitoring; 4 hours per well, 6/10 percent of 96 existing +20 new; 9 extraction wells; assumes IDW water is treated and discharged at well head similar to OCWD process
Consultant Oversight	40	hr	$ 100	$ 4,000	
Reporting	96	hr	$ 100	$ 9,600	
Lab Analysis	61	ea	$ 300	$ 18,282	6/10 percentage of 96 existing +20 new +10% QAQC
EXTRACTION WELLS					
Annual Operating Cost (electricity)	9	ea	$ 80,000	$ 720,000	Based on pump HP rating ($0.16/kwh)
Annual Pump Maintenance	9	ea	$ 5,000	$ 45,000	Periodic pump maintenance
LGAC					
GAC media change-out and disposal	320,000	lbs	$ 2.50	$ 800,000	$2.50/lb x 200,000 lb x 4 times/yr
Routine O&M	2,920	hr	$ 100	$ 292,000	8 hr/day @ $85/hr x 365 days/year
Non-routine labor	1	ls	$ 42,000	$ 42,000	
Oversight labor	1	ls	$ 98,896	$ 98,896	assume 20% of field labor costs
Equipment repair costs	1	ls	$ 42,000	$ 42,000	
Other materials	1	ls	$ 14,000	$ 14,000	
Electric costs	1	ls	$ 22,680	$ 22,680	
Lab analysis	1	ls	$ 50,800	$ 50,800	influent, mid, and effluent sampling of each GAC vessel pair
Reporting and annual fees	1	ls	$ 70,000	$ 70,000	

ALTERNATIVE **6** GROUP 1

Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

O&M Costs

UV AOP					
Routine O&M	730	hr	$ 100	$ 73,000	2 hr/day x 365 days/year
Non-routine labor	1	ls	$ 15,000	$ 15,000	
Oversight labor	1	ls	$ 15,400	$ 15,400	assume 20% of field labor costs
Lamp replacement	84	ls	$ 800	$ 67,200	15,000 hour warranty
Equipment repair costs	1	ls	$ 10,000	$ 10,000	
Other materials	1	ls	$ 5,000	$ 5,000	
Electric costs	1	ls	$ 101,250	$ 101,250	$0.16 /kWh
Lab analysis	1	ls	$ 50,000	$ 50,000	
Reporting and annual fees	1	ls	$ 20,000	$ 20,000	
Peroxide	21,642	gal	$ 4	$ 88,730	10ppm at 183 gallons/dy
INFILTRATION BASIN					
Routine O&M	192	hr	$ 85	$ 16,320	8 hours/day twice a month
Annual Maintenance Costs	1	ls	$ 30,000	$ 30,000	remove bio/sediment accumulation and regrade
SUBTOTAL				$ 3,458,594	
Contingency	20%			$ 691,719	
Subtotal				$ 4,150,313	
Project Management	10%			$ 415,031	5-10% of annual
Technical Support	15%			$ 622,547	10-20% technical support
Institutional Controls				$ 25,000	Estimate
Total Annual O&M Cost				$ 5,210,000	Rounded to nearest $10,000

ALTERNATIVE **6** GROUP 1

Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

O&M Costs

PERIODIC COSTS

Description	Year	Quantity	Unit	Unit Cost	Total	Notes
Recovery well redevelopment	5	9	ea	$ 10,000	$ 90,000	
Erosion Repair	5	1	ls	$ 12,500	$ 12,500	
Recovery well redevelopment	10	9	ea	$ 10,000	$ 90,000	
Sediment Removal	10	1	ls	$ 25,000	$ 25,000	
Erosion Repair	10	1	ls	$ 12,500	$ 12,500	
Recovery well redevelopment	15	9	ea	$ 10,000	$ 90,000	
Erosion Repair	15	1	ls	$ 12,500	$ 12,500	
Recovery well redevelopment	20	9	ea	$ 10,000	$ 90,000	
Sediment Removal	20	1	ls	$ 25,000	$ 25,000	
Erosion Repair	20	1	ls	$ 12,500	$ 12,500	
Extraction pump replacement	7	9	ea	$ 109,400	$ 984,600	every 7 years; vendor recom
Extraction pump replacement	14	9	ea	$ 109,400	$ 984,600	
Extraction pump replacement	21	9	ea	$ 109,400	$ 984,600	
Extraction pump replacement	28	9	ea	$ 109,400	$ 984,600	
H2O2 Quench LGAC replacement	5	4	ea	$ 50,000	$ 200,000	10x20000 lbs LGAC changeout
H2O2 Quench LGAC replacement	10	4	ea	$ 50,000	$ 200,000	every 5 years
H2O2 Quench LGAC replacement	15	4	ea	$ 50,000	$ 200,000	
H2O2 Quench LGAC replacement	20	4	ea	$ 50,000	$ 200,000	
H2O2 Quench LGAC replacement	25	4	ea	$ 50,000	$ 200,000	
H2O2 Quench LGAC replacement	30	4	ea	$ 50,000	$ 200,000	
Recovery well redevelopment	25	9	ea	$ 10,000	$ 90,000	
Erosion Repair	25	1	ls	$ 12,500	$ 12,500	
Recovery well redevelopment	30	9	ea	$ 10,000	$ 90,000	
Sediment Removal	30	1	ls	$ 25,000	$ 25,000	
Erosion Repair	30	1	ls	$ 12,500	$ 12,500	
TOTAL PERIODIC COSTS					$ 5,830,000	Rounded to nearest $10,000

ALTERNATIVE **6** GROUP 1

Multiple Treatment Plants; Group 1: Treatment Plant #1; Discharge to Infiltration Basin

O&M Costs

NET PRESENT VALUE

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital Cost	0	$ 76,750,000	$ 76,750,000	1.0	$ 76,750,000
Annual O&M Cost	1-30	$ 156,300,000	$ 5,210,000	12.4	$ 64,650,890
Periodic Cost	5	$ 302,500	$ 302,500	0.7	$ 215,678
Periodic Cost	10	$ 327,500	$ 327,500	0.5	$ 166,484
Periodic Cost	15	$ 302,500	$ 302,500	0.4	$ 109,640
Periodic Cost	20	$ 327,500	$ 327,500	0.26	$ 84,632
Periodic Cost	7	$ 984,600	$ 984,600	0.62	$ 613,159
Periodic Cost	14	$ 984,600	$ 984,600	0.39	$ 381,845
Periodic Cost	21	$ 984,600	$ 984,600	0.24	$ 237,794
Periodic Cost	28	$ 984,600	$ 984,600	0.15	$ 148,086
Periodic Cost	25	$ 302,500	$ 302,500	0.18	$ 55,735
Periodic Cost	30	$ 327,500	$ 327,500	0.13	$ 43,023
	SUBTOTAL	$ 238,878,400		SUBTOTAL	$ 143,456,967

TOTAL PRESENT VALUE OF ALTERNATIVE (ROUNDED TO THE NEAREST $10,000)	$ 143,460,000

Level III Estimate +50%/-30%

Appendix E
Liquid-Phase Granular-Activated Carbon Adsorption Isotherms

LIQUID-PHASE CARBON ADSORPTION MODEL CALCULATIONS

EVOQUA WATER TEHNOLOGIES LLC

CARBON ADSORBERS:	HP1020
NO OF ADSORBERS IN SERIES:	1
TOTAL MASS OF CARBON (LBS):	20000.
CARBON BULK DENSITY (LBS/FT3):	30.600
CARBON MESH SIZE:	12x40
FLOW RATE (GPM):	780.00
HYDRAULIC LOADING (GPM/SQ.FT):	10.049
EMPTY BED CONTACT TIME (MIN.):	6.2818
DESIGN COMPOUND:	1,1-DCE
EXPECTED INFLUENT CONCENTRATION (PPB):	7.3000
MODEL INFLUENT CONCENTRATION (PPB):	14.000
EFFLUENT CRITERIA (PPB):	6.0000
EFFECTIVE K-VALUE (%):	50.000

TIME(DAYS)	VOLUME TREATED(GAL)	EFF. CONC.(PPB)	
10.0	11232000.	0.0000	
20.0	22464000.	0.0000	
30.0	33696000.	0.0000	
40.0	44928000.	0.0000	
50.0	56160000.	0.0000	
60.0	67392000.	0.0000	
70.0	78624000.	0.0000	
80.0	89856000.	0.4648	
90.0	101088000.	2.8205	
100.0	112320000.	5.7034	BREAKTHROUGH
110.0	123552000.	8.1383	
120.0	134784000.	9.9779	
130.0	146016000.	11.2946	
140.0	157248000.	12.2058	
150.0	168480000.	12.8230	
160.0	179712000.	13.2347	
170.0	190944000.	13.5067	
180.0	202176000.	13.6856	
190.0	213408000.	13.8008	
200.0	224640000.	13.8746	
200.0	224640000.	13.8746	

Note: The model influent concentration results from the impact of the other background compounds, which is determined by using a competitive adsorption model

DISCLAIMER: ACTUAL RESULTS MAY VARY SIGNIFICANTLY FROM THE MODEL. THE MODEL IS BASED ON THE ASSUMPTIONS THAT THE FLOW RATE AND INFLUENT CONCENTRATION ARE CONSTANT, AND ONLY THE CONTAMINANTS PROVIDED TO EVOQUA ARE PRESENT IN THE WATER. VARYING OPERATING CONDITIONS CAN HAVE ADVERSE EFFECTS ON CARBON ADSORPTIVE CAPACITY. THE PREDICTED BED LIFE IS NOT GUARANTEED.

Rev. 7 – 05/26/15

HP®1220SYS

GAC ADSORPTION SYSTEM SPECIFICATION SUMMARY

HP®1220SYS Liquid Phase Adsorption Systems are designed to treat a wide range of contaminated process streams. Piping and valves are configured for series, parallel, or vessel isolation flows. System includes GAC inlet and outlet piping, and backwash capabilities. The system consists of two adsorbers, with all piping, valves, and gauges assembled for ease of operation. The adsorbers are equipped with underdrains capable of maximum series flow rate of 1100 GPM.

EACH VESSEL:

Vessel Diameter	144”
Side Shell Height	60”
Overall Height (Approx.)	16’-4”
Maximum Working Pressure	125 psi @ 140 °F
Manway:	
Flanged at side shell	20”
Elliptical type at head	14” x 18”
Vessel Volume	7,520 gal.
Carbon Capacity	20,000 lbs.
Carbon Bed Volume-Typical (29.5 lb/cu-ft)	678 Ft^3
Maximum Flow Rate	1100 GPM
Empty Bed Contact Time	4.6 min/vessel @ 1100 GPM
ASME Code Stamping	YES
Material	Carbon Steel
Supports	Wide Flange Legs
Lifting	Lifting Lugs
Seismic	Current IBC
Interior Surface Prep	SSPC-SP5
Interior Surface Coating	Plasite 4110 35 mil dft min
Exterior Surface Primer	Epoxy 3 mil min dft
Exterior Surface Coating	Urethane 3mil min dft
Standard Color	Desert Sand (#9225)

CONNECTIONS:

Inlet / Outlet	8” 150# ANSI Flanged
Carbon Fill / Discharge	4” Kamlock
Backwash	8” Flanged
Utility Water	2” Kamlock

All information presented herein is believed reliable and in accordance with accepted engineering practices. Evoqua makes no warranties as to completeness of information. Users are responsible for evaluating individual product suitability for specific applications. Evoqua assumes no liability whatsoever for any special, indirect or consequential damages arising from the sale, resale or misuse of its products.

Evoqua reserves the right to change the specifications referred to in this literature at any time, without prior notice.

UNDERDRAINS:

External Ring Header..... 8” Sch. 40 Carbon Steel
Screens .....8 ea 316L Stainless Steel V-Wire Screens 4 ½” dia. x 10”

VALVE ASSEMBLY AND PIPING:

Piping:
Process Piping.....8” Schedule 40 Carbon Steel
GAC Transfer Piping..... 4” Sch 40 Carbon Steel, Epoxy Lined
Valves:
Process .....8” Butterfly, Cast Iron Body w/SS Disk, Gear Operator
GAC Transfer ..... 4” Flanged 316 Stainless Steel Ball Valve
Drain/Wash ..... 2” Bronze Ball Valve
Sample Ports (3) ..... 1/2” Bronze Ball Valve

SYSTEM WEIGHT:

System Shipping weight (Two Vessels Piping & Manifold) .....35,000 lbs.
Carbon Weight .....40,000 lbs.
Operating Weight .....160,000 lbs.

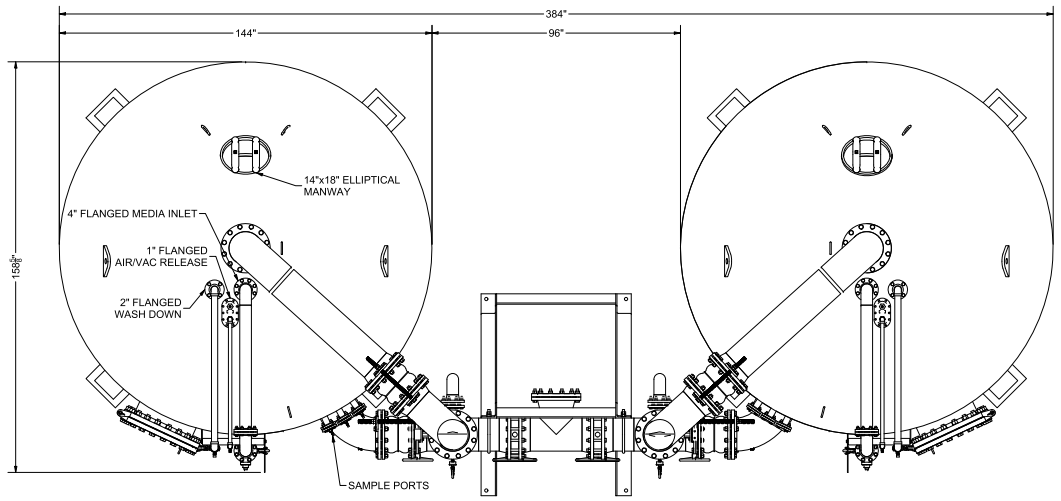
FOR ADDITIONAL INFORMATION, PLEASE CONTACT YOUR NEAREST CARBON SERVICE BRANCH AT:

866-613-5620

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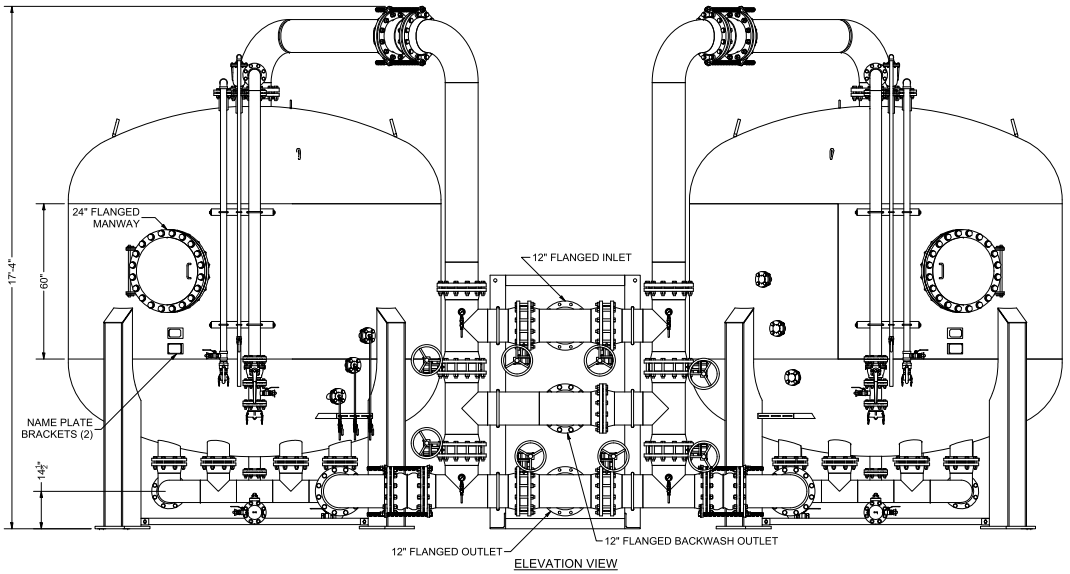
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PLAN VIEW





ELEVATION VIEW

ADDITIONAL NOTES:

1.) THIS DRAWING IS TO SHOW PIPING AND EQUIPMENT FOR CUSTOMER APPROVAL.
2.) ALL BUTTERFLY VALVES ARE DUCTILE IRON WITH STAINLESS TRIM, STAINLESS STEEL DISK.
3.) PROVIDE 316 STAINLESS STEEL SEPTA UNDER DRAIN SCREENS.
4.) VESSELS SHALL BE 125 PSI, ASME CODE.
5.) FINISH INTERIOR WITH PLASITE 4110, PREPARE AND APPLY STRICTLY IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS TO MEET NSF STD 61 REQUIREMENTS.
6.) PIPING MATERIALS SHALL MEET: CS PIPE ASTM A-53 GRADE B (ERW); CS FITTINGS SA-234, ASME B16.9; SS THREADED FITTINGS ASTM A-351; SS PIPE ASTM A-312; SS BW FITTINGS ASTM A-403; MI THREADED FITTINGS ASME B-16.3.
7.) FINISH EXTERIOR WITH CARBOGAURD 133 URETHANE COLOR TO BE 9225 CASHEW OVER CARBOLINE 880 RUST PREVENTATIVE EPOXY PRIMER APPLIED PER MFG. RECOMMENDATIONS.
8.) MEDIA SLURRY LINES TO BE INTERNALLY COATED WITH SCOTCHKOTE 206N.
9.) SYSTEM ESTIMATED SHIPPING WEIGHT: 35,000 LBS.
10.) GROUTING BY OTHERS IF REQUIRED.
11.) DESIGNED FOR SEISMIC ZONE 4.
12.) SYSTEM PROCESS CONNECTIONS: 12" 150# RF FLANGES, BOLTS STRADDLE CENTERLINE AS SHOWN.
13.) MEDIA CAPACITY: VARIES.
14.) MAX. PROCESS FLOW: 1,100 GPM SERIES, 2,000 GPM PARALLEL.
15.) TYPICAL BACKWASH RATE (8X30 CARBON 55°F): 1000 GPM.
16.) OPERATING TEMPERATURE 140° F MAX.
17.) ± 2" TOLERANCE ON CONNECTION DIMENSIONS.

COMPANY CONFIDENTIAL INFORMATION
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DWN BY: AJA	DATE 2/22/2016	TITLE: HP1220HF 125 PSI SYSTEM SALES
CKD BY:	DATE	CLIENT
APPD BY:	DATE	
MGD BY:		EVOQUA WATER TECHNOLOGIES RED BLUFF CA USA (530) 527-2664
REF:		
SCALE: NOT TO SCALE		

PROJECT	PART NUMBER	DMS REFERENCE	SHEET	REV
	SALES		1 OF 1	0

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STD-22x34_D_v

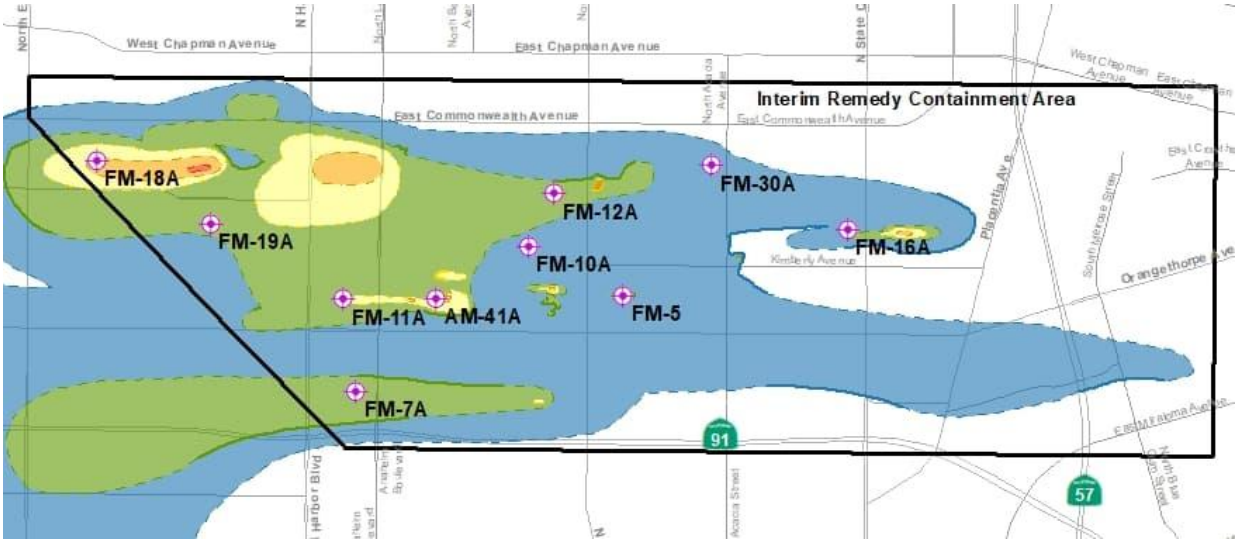
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Appendix F
PFAS TOP Analysis

North Basin Interim Remedy Containment Area Samples Analyzed for PFAS
Total Oxidizable Precursors (TOP) Analysis

Summary of sampling

- 10 Shallow zone wells throughout the North Basin Interim Remedy Containment Area were sampled for PFAS TOP analysis:



Summary of analysis and results

- Samples were analyzed for 24 PFAS compounds using Method 537 (modified), before and after an oxidation procedure. The oxidation procedure involves treating the water with persulfate, hydroxide and heat to create hydroxyl radical oxidation. This is a more aggressive oxidation process than what would occur with the advanced oxidation process used to treat groundwater for 1,4-dioxane (UV/H_2O_2).

- Two samples exceeded holding times: FM-11A and AM-41A. OCWD sent Eurofins lab three sets of samples each from those two wells, and holding times were exceeded with all three sets of samples. However, according to Eurofins, the method holding times are expected to increase in the future, and holding times did not exceed those expected future limits. Due to schedule concerns preparing the revised draft FS, OCWD requested the TOP analytical results for the third set of samples for FM-11A and AM-41A.

- Summary of TOP results for the detected PFAS compounds in the North Basin samples:

PFAS	Average change based on 10 sampled North Basin monitoring wells (ng/L)	Average change w/o AM-41A and FM-11A results which exceeded currently established holding time (ng/L)
Perfluorobutanoic acid (PFBA)	19.2	20.3
Perfluoropentanoic acid (PFPeA)	0.5	-0.9
Perfluorohexanoic acid (PFHxA)	1.0	0.8
Perfluorooctanoic acid (PFOA)	-1.2	-1.4
Perfluorobutanesulfonic acid (PFBS)	-0.3	-0.2
Perfluorohexanesulfonic acid (PFHxS)	-1.5	-2.0
Perfluorooctanesulfonic acid (PFOS)	-2.6	-2.5

- PFBA is the only PFAS compound that exhibited an increase greater than 1 ng/L.

Key points regarding PFBA

- Only a few states have advisory-type drinking water values for PFBA. The lowest one we have seen is 7 ug/L (7,000 ng/L) from the State of Minnesota. No MCLs have been adopted anywhere nor are we aware of any effort to do so.

- PFBA is a short-chain PFAS that doesn't appear to be well-removed by currently available GAC or IX resins. You would likely need reverse osmosis or possibly nanofiltration to remove effectively, which would significantly increase treatment costs.

- Requiring treatment for PFBA would be comparable to requiring treatment for TCE if concentrations increased from 1 ug/L to 1.01 ug/L.

PFAS Total Oxidizable Precursor Analysis Results for 10 North Basin Shallow Zone Monitoring Wells

Monitoring Well	PFAS	Pre-oxidation (ng/L)	Post-oxidation (ng/L)	Reporting Limit	Difference*	Average change based on 10 sampled North Basin monitoring wells	Average change w/o AM-41A and FM-11A results which exceeded currently estabilished holding time
FM-16A	Perfluorobutanoic acid (PFBA)	ND	34	13	32.7	**19.2**	**20.3**
	Perfluoropentanoic acid (PFPeA)	14	13	5	-1	**0.5**	**-0.9**
	Perfluorohexanoic acid (PFHxA)	11	11	5	0	**1.0**	**0.8**
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-		
	Perfluorooctanoic acid (PFOA)	8.2	6.7	5	-1.5	**-1.2**	**-1.4**
	Perfluorononanoic acid (PFNA)	ND	ND	5	-		
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-		
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-		
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-		
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-		
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-		
	Perfluorobutanesulfonic acid (PFBS)	9.2	8.4	5	-0.8	**-0.3**	**-0.2**
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-		
	Perfluorohexanesulfonic acid (PFHxS)	5.4	ND	5	-4.9	**-1.5**	**-2.0**
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-		
	Perfluorooctanesulfonic acid (PFOS)	7.4	16	5	8.6	**-2.6**	**-2.5**
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-		
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-		
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-		
	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	ND	ND	13	-		
	N-ethylperfluoro-1-octanesulfonamidoacetic acid (NEtFOSAA)	ND	ND	13	-		
	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	ND	ND	5	-		
	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	ND	ND	13	-		
	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	ND	ND	5	-		
		* ND assumed = 0.1 X Reporting Limit when calculating difference					
FM-18A	Perfluorobutanoic acid (PFBA)	ND	13	13	11.7		
	Perfluoropentanoic acid (PFPeA)	ND	5.6	5	5.1		
	Perfluorohexanoic acid (PFHxA)	5.1	7	5	1.9		
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-		
	Perfluorooctanoic acid (PFOA)	7.2	5.9	5	-1.3		
	Perfluorononanoic acid (PFNA)	ND	ND	5	-		
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-		
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-		
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-		
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-		
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-		
	Perfluorobutanesulfonic acid (PFBS)	ND	ND	5	-		
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-		
	Perfluorohexanesulfonic acid (PFHxS)	11	10	5	-1		
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-		
	Perfluorooctanesulfonic acid (PFOS)	ND	ND	5	-		
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-		
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-		
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-		
	NMeFOSAA	ND	ND	13	-		
	NEtFOSAA	ND	ND	13	-		
	4:2 FTS	ND	ND	5	-		
	6:2 FTS	ND	ND	13	-		
	8:2 FTS	ND	ND	5	-		
FM-5	Perfluorobutanoic acid (PFBA)	ND	25	13	23.7		
	Perfluoropentanoic acid (PFPeA)	11	10	5	-1		
	Perfluorohexanoic acid (PFHxA)	8.3	8.3	5	0		
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-		
	Perfluorooctanoic acid (PFOA)	8.1	6.8	5	-1.3		
	Perfluorononanoic acid (PFNA)	ND	ND	5	-		
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-		
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-		
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-		
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-		
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-		
	Perfluorobutanesulfonic acid (PFBS)	7.9	7.1	5	-0.8		
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-		
	Perfluorohexanesulfonic acid (PFHxS)	5.3	ND	5	-4.8		
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-		
	Perfluorooctanesulfonic acid (PFOS)	23	17	5	-6		
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-		
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-		
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-		
	NMeFOSAA	ND	ND	13	-		
	NEtFOSAA	ND	ND	13	-		
	4:2 FTS	ND	ND	5	-		
	6:2 FTS	ND	ND	13	-		
	8:2 FTS	ND	ND	5	-		

Monitoring Well	PFAS	Pre-oxidation (ng/L)	Post-oxidation (ng/L)	Reporting Limit	Difference*
FM-10A	Perfluorobutanoic acid (PFBA)	ND	28	13	26.7
	Perfluoropentanoic acid (PFPeA)	7.8	8.8	5	1
	Perfluorohexanoic acid (PFHxA)	6.3	7.9	5	1.6
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-
	Perfluorooctanoic acid (PFOA)	9.1	8.9	5	-0.2
	Perfluorononanoic acid (PFNA)	ND	ND	5	-
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-
	Perfluorobutanesulfonic acid (PFBS)	6.3	6.4	5	0.1
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-
	Perfluorohexanesulfonic acid (PFHxS)	5.4	6.6	5	1.2
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-
	Perfluorooctanesulfonic acid (PFOS)	19	19	5	0
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-
	NMeFOSAA	ND	ND	13	-
	NEtFOSAA	ND	ND	13	-
	4:2 FTS	ND	ND	5	-
	6:2 FTS	ND	ND	13	-
	8:2 FTS	ND	ND	5	-
FM-19A	Perfluorobutanoic acid (PFBA)	ND	ND	13	-
	Perfluoropentanoic acid (PFPeA)	6.7	ND	5	-6.2
	Perfluorohexanoic acid (PFHxA)	5.6	6.3	5	0.7
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-
	Perfluorooctanoic acid (PFOA)	7.3	5.8	5	-1.5
	Perfluorononanoic acid (PFNA)	ND	ND	5	-
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-
	Perfluorobutanesulfonic acid (PFBS)	ND	ND	5	-
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-
	Perfluorohexanesulfonic acid (PFHxS)	8.5	7	5	-1.5
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-
	Perfluorooctanesulfonic acid (PFOS)	5.6	ND	5	-5.1
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-
	NMeFOSAA	ND	ND	13	-
	NEtFOSAA	ND	ND	13	-
	4:2 FTS	ND	ND	5	-
	6:2 FTS	ND	ND	13	-
	8:2 FTS	ND	ND	5	-
FM-30A	Perfluorobutanoic acid (PFBA)	ND	20	13	18.7
	Perfluoropentanoic acid (PFPeA)	5.3	5.5	5	0.2
	Perfluorohexanoic acid (PFHxA)	ND	ND	5	-
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-
	Perfluorooctanoic acid (PFOA)	9.1	6	5	-3.1
	Perfluorononanoic acid (PFNA)	ND	ND	5	-
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-
	Perfluorobutanesulfonic acid (PFBS)	ND	ND	5	-
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-
	Perfluorohexanesulfonic acid (PFHxS)	7.8	6.5	5	-1.3
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-
	Perfluorooctanesulfonic acid (PFOS)	6.7	ND	5	-6.2
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-
	NMeFOSAA	ND	ND	13	-
	NEtFOSAA	ND	ND	13	-
	4:2 FTS	ND	ND	5	-
	6:2 FTS	ND	ND	13	-
	8:2 FTS	ND	ND	5	-

Monitoring Well	PFAS	Pre-oxidation (ng/L)	Post-oxidation (ng/L)	Reporting Limit	Difference*
FM-7A	Perfluorobutanoic acid (PFBA)	ND	14	13	12.7
	Perfluoropentanoic acid (PFPeA)	14	9.6	5	-4.4
	Perfluorohexanoic acid (PFHxA)	11	10	5	-1
	Perfluoroheptanoic acid (PFHpA)	6	ND	5	-5.5
	Perfluorooctanoic acid (PFOA)	13	11	5	-2
	Perfluorononanoic acid (PFNA)	ND	ND	5	-
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-
	Perfluorobutanesulfonic acid (PFBS)	5.6	5.7	5	0.1
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-
	Perfluorohexanesulfonic acid (PFHxS)	10	7.1	5	-2.9
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-
	Perfluorooctanesulfonic acid (PFOS)	32	21	5	-11
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-
	NMeFOSAA	ND	ND	13	-
	NEtFOSAA	ND	ND	13	-
	4:2 FTS	ND	ND	5	-
	6:2 FTS	ND	ND	13	-
	8:2 FTS	ND	ND	5	-
FM-12A	Perfluorobutanoic acid (PFBA)	ND	17	13	15.7
	Perfluoropentanoic acid (PFPeA)	9.8	9.1	5	-0.7
	Perfluorohexanoic acid (PFHxA)	6.7	8.9	5	2.2
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-
	Perfluorooctanoic acid (PFOA)	9.9	9.7	5	-0.2
	Perfluorononanoic acid (PFNA)	ND	ND	5	-
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-
	Perfluorobutanesulfonic acid (PFBS)	5.4	5.7	5	0.3
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-
	Perfluorohexanesulfonic acid (PFHxS)	8.4	7.8	5	-0.6
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-
	Perfluorooctanesulfonic acid (PFOS)	12	14	5	2
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-
	NMeFOSAA	ND	ND	13	-
	NEtFOSAA	ND	ND	13	-
	4:2 FTS	ND	ND	5	-
	6:2 FTS	ND	ND	13	-
	8:2 FTS	ND	ND	5	-
AM-41A	Perfluorobutanoic acid (PFBA)	ND	ND	13	-
	Perfluoropentanoic acid (PFPeA)	6.6	6.6	5	0
	Perfluorohexanoic acid (PFHxA)	5.2	7.7	5	2.5
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-
	Perfluorooctanoic acid (PFOA)	8.6	8.3	5	-0.3
	Perfluorononanoic acid (PFNA)	ND	ND	5	-
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-
	Perfluorobutanesulfonic acid (PFBS)	ND	ND	5	-
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-
	Perfluorohexanesulfonic acid (PFHxS)	5.2	5.3	5	0.1
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-
	Perfluorooctanesulfonic acid (PFOS)	22	19	5	-3
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-
	NMeFOSAA	ND	ND	13	-
	NEtFOSAA	ND	ND	13	-
	4:2 FTS	ND	ND	5	-
	6:2 FTS	ND	ND	13	-
	8:2 FTS	ND	ND	5	-

Monitoring Well	PFAS	Pre-oxidation (ng/L)	Post-oxidation (ng/L)	Reporting Limit	Difference*
FM-11A	Perfluorobutanoic acid (PFBA)	ND	13	13	11.7
	Perfluoropentanoic acid (PFPeA)	9.2	9.7	5	0.5
	Perfluorohexanoic acid (PFHxA)	7.1	8.3	5	1.2
	Perfluoroheptanoic acid (PFHpA)	ND	ND	5	-
	Perfluorooctanoic acid (PFOA)	12	11	5	-1
	Perfluorononanoic acid (PFNA)	ND	ND	5	-
	Perfluorodecanoic acid (PFDA)	ND	ND	5	-
	Perfluoroundecanoic acid (PFUnA)	ND	ND	5	-
	Perfluorododecanoic acid (PFDoA)	ND	ND	5	-
	Perfluorotridecanoic acid (PFTrDA)	ND	ND	5	-
	Perfluorotetradecanoic acid (PFTeA)	ND	ND	5	-
	Perfluorobutanesulfonic acid (PFBS)	5.1	5	5	-0.1
	Perfluoropentanesulfonic acid (PFPeS)	ND	ND	5	-
	Perfluorohexanesulfonic acid (PFHxS)	6.9	7.3	5	0.4
	Perfluoroheptanesulfonic acid (PFHpS)	ND	ND	5	-
	Perfluorooctanesulfonic acid (PFOS)	23	20	5	-3
	Perfluorononanesulfonic acid (PFNS)	ND	ND	5	-
	Perfluorodecanesulfonic acid (PFDS)	ND	ND	5	-
	Perfluorooctanesulfonamide (FOSA)	ND	ND	5	-
	NMeFOSAA	ND	ND	13	-
	NEtFOSAA	ND	ND	13	-

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ANALYTICAL REPORT

PREPARED FOR

Attn: Patrick Versluis
Orange County Water District
18700 Ward Street
Fountain Valley, California 92708

Generated 3/15/2023 11:27:23 AM

JOB DESCRIPTION

FBVOC

JOB NUMBER

320-96808-1

Eurofins Sacramento
880 Riverside Parkway
West Sacramento CA 95605

See page two for job notes and contact information.

myEOL

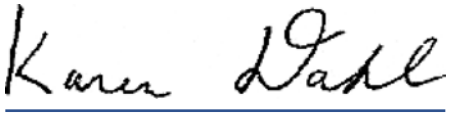
Job Notes

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The data in the report relate to the field sample(s) as received by the laboratory and associated QC. All results have been reviewed and have been found to be compliant with laboratory and accreditation requirements, with the exception of the noted deviation(s). For questions, please contact the Project Manager.

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Environment Testing Northern California, LLC Project Manager.

Authorization



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Definitions/Glossary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Qualifiers

LCMS

Qualifier	Qualifier Description
*+	LCS and/or LCSD is outside acceptance limits, high biased.
*5-	Isotope dilution analyte is outside acceptance limits, low biased.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 320-96808-1

Laboratory: Eurofins Sacramento

Narrative

Comments
No additional comments.

Receipt
The samples were received on 2/15/2023 9:25 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 0.6º C.

Receipt Exceptions
The containers for sample FM-5/1 (320-96808-1) were labeled with a collection time of 12:35. As requested, the time of 12:35 was used in the report. A revised chain of custody has been included in the report.

LCMS
Method 537 (modified): One Isotope Dilution Analyte (IDA) recovery is below the method recommended limit for the following samples (post treatment): FM-5/1 (320-96808-1), FM-16A/1 (320-96808-2), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDAs for these samples.

Method 537 (modified): The labeled analyte M2-4:2FTS is employed in this analysis as a “Reverse Surrogate”. It is used to monitor the oxidation efficiency of the TOP assay. This analyte is fortified into all sample fractions prior to any processing. The recovery of this analyte should be 0% in Post-Treatment fractions, indicating complete oxidation of the sample. FM-5/1 (320-96808-1), FM-16A/1 (320-96808-2), FM-18A/1 (320-96808-3), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A)

Method 537 (modified): Zero percent recovery of precursor analytes (such as 4:2 FTS, 6:2 FTS, 8:2 FTS, FOSA, NMeFOSAA, NEtFOSAA, etc.) and enhanced recoveries of PFCA is observed in the Post-Treatment Laboratory Control Sample (LCS) and Post-Treatment Laboratory Control Sample Duplicate (LCSD) associated with these samples, consistent with the expected oxidation of precursor analytes. The existing LCS control limits are based upon our historical performance for a set of 24-36 analytes in the LCS solution. We have recently expanded to 70+ analytes. As the LCS solution now contains new/additional precursor analytes we are seeing enhanced recoveries for some PFCA vs. the historical limits as a result. The LCS results are flagged as being high and outside of the established limits for some analytes; however, this is a function of the new analytes in the LCS solution and not indicative of an “out of control” process. FM-5/1 (320-96808-1), FM-16A/1 (320-96808-2), FM-18A/1 (320-96808-3), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Client Sample ID: FM-5/1 — Lab Sample ID: 320-96808-1

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	11		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	8.3		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	8.1		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanesulfonic acid (PFBS)	7.9		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	5.3		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	23		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	25	*+	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	10	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	8.3	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	6.8		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorobutanesulfonic acid (PFBS)	7.1		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	17		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	25				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	0.0044				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	23				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	27				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	50				ng/L	1		Total PFCA-Sum	Post-Treatment

Client Sample ID: FM-16A/1 — Lab Sample ID: 320-96808-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	14		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	11		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	8.2		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanesulfonic acid (PFBS)	9.2		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	5.4		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	7.4		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	34	*+	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	13	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	11	*+	5.0		ng/L	1		537 (modified)	Post-Treatment

This Detection Summary does not include radiochemical test results.

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Client Sample ID: FM-16A/1 (Continued) — Lab Sample ID: 320-96808-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluorooctanoic acid (PFOA)	6.7		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorobutanesulfonic acid (PFBS)	8.4		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	16		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	34				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	32				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	33				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	65				ng/L	1		Total PFCA-Sum	Post-Treatment

Client Sample ID: FM-18A/1 — Lab Sample ID: 320-96808-3

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanoic acid (PFHxA)	5.1		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	7.2		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	11		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	13	*+	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	5.6	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	7.0	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	5.9		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	10		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	13				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	5.6				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	2.0				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	19				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	12				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	32				ng/L	1		Total PFCA-Sum	Post-Treatment

This Detection Summary does not include radiochemical test results.

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Client Sample ID: FM-5/1

Date Collected: 02/13/23 12:35
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-1

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluoropentanoic acid (PFPeA)	**11**		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorohexanoic acid (PFHxA)	**8.3**		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorooctanoic acid (PFOA)	**8.1**		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorobutanesulfonic acid (PFBS)	**7.9**		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorohexanesulfonic acid (PFHxS)	**5.3**		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorooctanesulfonic acid (PFOS)	**23**		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 14:37	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 14:37	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 14:37	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:37	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C5 PFPeA	*115*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C2 PFHxA	*117*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C4 PFHpA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C4 PFOA	*114*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C5 PFNA	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C2 PFDA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C2 PFUnA	*103*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C2 PFDoA	*103*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C2 PFTeDA	*107*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C3 PFBS	*113*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
18O2 PFHxS	*123*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C4 PFOS	*106*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
13C8 FOSA	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
d3-NMeFOSAA	*106*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
d5-NEtFOSAA	*107*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
M2-6:2 FTS	*131*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
M2-8:2 FTS	*132*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*
M2-4:2 FTS	*128*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:37*	*1*

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Client Sample ID: FM-5/1

Date Collected: 02/13/23 12:35
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-1

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**25**	*+	13		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluoropentanoic acid (PFPeA)	**10**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorohexanoic acid (PFHxA)	**8.3**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorooctanoic acid (PFOA)	**6.8**		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorobutanesulfonic acid (PFBS)	**7.1**		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorooctanesulfonic acid (PFOS)	**17**		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 11:45	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 11:45	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 11:45	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:45	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*14*	*5-	*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C5 PFPeA	*108*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C2 PFHxA	*109*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C4 PFHpA	*113*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C4 PFOA	*110*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C5 PFNA	*108*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C2 PFDA	*103*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C2 PFUnA	*99*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C2 PFDoA	*99*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C2 PFTeDA	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C3 PFBS	*105*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
18O2 PFHxS	*117*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C4 PFOS	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
13C8 FOSA	*106*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
d3-NMeFOSAA	*100*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
d5-NEtFOSAA	*107*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
M2-6:2 FTS	*132*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
M2-8:2 FTS	*120*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:45*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 11:45*	*1*

Client Sample ID: FM-5/1

Lab Sample ID: 320-96808-1

Date Collected: 02/13/23 12:35

Matrix: Water

Date Received: 02/15/23 09:25

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**25**				ng/L			03/15/23 15:52	1
PFPA	**0.00**				ng/L			03/15/23 15:52	1
PFHxA	**0.0044**				ng/L			03/15/23 15:52	1
PFHpA	**0.00**				ng/L			03/15/23 15:52	1
PFOA	**0.00**				ng/L			03/15/23 15:52	1
PFNA	**0.00**				ng/L			03/15/23 15:52	1
Total PFCA	**23**				ng/L			03/15/23 15:52	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**27**				ng/L			03/15/23 15:47	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**50**				ng/L			03/15/23 15:50	1

Client Sample ID: FM-16A/1

Lab Sample ID: 320-96808-2

Date Collected: 02/13/23 11:05

Matrix: Water

Date Received: 02/15/23 09:25

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluoropentanoic acid (PFPeA)	**14**		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorohexanoic acid (PFHxA)	**11**		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorooctanoic acid (PFOA)	**8.2**		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorobutanesulfonic acid (PFBS)	**9.2**		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorohexanesulfonic acid (PFHxS)	**5.4**		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorooctanesulfonic acid (PFOS)	**7.4**		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 14:47	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 14:47	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 14:47	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:47	1

Client Sample ID: FM-16A/1

Date Collected: 02/13/23 11:05
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-2

Matrix: Water

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*76*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C5 PFPeA	*79*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C2 PFHxA	*79*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C4 PFHpA	*80*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C4 PFOA	*78*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C5 PFNA	*77*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C2 PFDA	*76*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C2 PFUnA	*73*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C2 PFDoA	*73*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C2 PFTeDA	*76*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C3 PFBS	*80*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
18O2 PFHxS	*83*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C4 PFOS	*73*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
13C8 FOSA	*74*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
d3-NMeFOSAA	*71*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
d5-NEtFOSAA	*73*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
M2-6:2 FTS	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
M2-8:2 FTS	*81*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*
M2-4:2 FTS	*85*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:47*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**34**	*+	13		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluoropentanoic acid (PFPeA)	**13**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorohexanoic acid (PFHxA)	**11**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorooctanoic acid (PFOA)	**6.7**		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorobutanesulfonic acid (PFBS)	**8.4**		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorooctanesulfonic acid (PFOS)	**16**		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 11:55	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 11:55	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 11:55	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 11:55	1

Client Sample ID: FM-16A/1

Date Collected: 02/13/23 11:05
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-2

Matrix: Water

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*16*	**5-*	*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C5 PFPeA	*106*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C2 PFHxA	*107*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C4 PFHpA	*108*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C4 PFOA	*108*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C5 PFNA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C2 PFDA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C2 PFUnA	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C2 PFDoA	*100*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C2 PFTeDA	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C3 PFBS	*105*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
18O2 PFHxS	*110*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C4 PFOS	*95*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
13C8 FOSA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
d3-NMeFOSAA	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
d5-NEtFOSAA	*105*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
M2-6:2 FTS	*125*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
M2-8:2 FTS	*118*		*25 - 150*	*02/27/23 11:37*	*03/08/23 11:55*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 11:55*	*1*

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**34**				ng/L			03/15/23 15:52	1
PFPA	**0.00**				ng/L			03/15/23 15:52	1
PFHxA	**0.00**				ng/L			03/15/23 15:52	1
PFHpA	**0.00**				ng/L			03/15/23 15:52	1
PFOA	**0.00**				ng/L			03/15/23 15:52	1
PFNA	**0.00**				ng/L			03/15/23 15:52	1
Total PFCA	**32**				ng/L			03/15/23 15:52	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**33**				ng/L			03/15/23 15:47	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**65**				ng/L			03/15/23 15:50	1

Client Sample ID: FM-18A/1

Date Collected: 02/13/23 14:55
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-3

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorohexanoic acid (PFHxA)	**5.1**		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorooctanoic acid (PFOA)	**7.2**		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1

Client Sample ID: FM-18A/1
Date Collected: 02/13/23 14:55
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-3
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorohexanesulfonic acid (PFHxS)	**11**		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 14:57	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 14:57	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 14:57	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 14:57	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C5 PFPeA	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C2 PFHxA	*96*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C4 PFHpA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C4 PFOA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C5 PFNA	*96*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C2 PFDA	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C2 PFUnA	*87*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C2 PFDoA	*92*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C2 PFTeDA	*93*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C3 PFBS	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
18O2 PFHxS	*100*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C4 PFOS	*89*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
13C8 FOSA	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
d3-NMeFOSAA	*88*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
d5-NEtFOSAA	*91*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
M2-6:2 FTS	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
M2-8:2 FTS	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*
M2-4:2 FTS	*96*		*25 - 150*	*02/27/23 11:57*	*03/08/23 14:57*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**13**	*+	13		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluoropentanoic acid (PFPeA)	**5.6**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorohexanoic acid (PFHxA)	**7.0**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorooctanoic acid (PFOA)	**5.9**		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1

Client Sample ID: FM-18A/1
Date Collected: 02/13/23 14:55
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-3
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorohexanesulfonic acid (PFHxS)	**10**		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:05	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:05	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 12:05	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:05	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C5 PFPeA	*106*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C2 PFHxA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C4 PFHpA	*115*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C4 PFOA	*107*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C5 PFNA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C2 PFDA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C2 PFUnA	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C2 PFDoA	*99*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C2 PFTeDA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C3 PFBS	*100*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
18O2 PFHxS	*110*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C4 PFOS	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
13C8 FOSA	*99*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
d3-NMeFOSAA	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
d5-NEtFOSAA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
M2-6:2 FTS	*128*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
M2-8:2 FTS	*126*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:05*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 12:05*	*1*

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**13**				ng/L			03/15/23 15:52	1
PFPA	**5.6**				ng/L			03/15/23 15:52	1
PFHxA	**2.0**				ng/L			03/15/23 15:52	1
PFHpA	**0.00**				ng/L			03/15/23 15:52	1
PFOA	**0.00**				ng/L			03/15/23 15:52	1
PFNA	**0.00**				ng/L			03/15/23 15:52	1
Total PFCA	**19**				ng/L			03/15/23 15:52	1

Client Sample Results

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Client Sample ID: FM-18A/1

Date Collected: 02/13/23 14:55
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96808-3

Matrix: Water

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	12				ng/L			03/15/23 15:47	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	32				ng/L			03/15/23 15:50	1

Total Oxidation Precursors

Client: Orange County Water District
Project/Site: FBVOC

TestAmerica Job ID: 320-96808-1

Client Sample ID: FM-5/1

Lab Sample ID: 320-96808-1
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	25		ng/L	25	ng/L
Perfluoropentanoic acid (PFPeA)	11		ng/L	10		ng/L	0.00	ng/L
Perfluorohexanoic acid (PFHxA)	8.3		ng/L	8.3		ng/L	0.0044	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	8.1		ng/L	6.8		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	27		ng/L	50		ng/L	23	ng/L

Client Sample ID: FM-16A/1

Lab Sample ID: 320-96808-2
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	34		ng/L	34	ng/L
Perfluoropentanoic acid (PFPeA)	14		ng/L	13		ng/L	0.00	ng/L
Perfluorohexanoic acid (PFHxA)	11		ng/L	11		ng/L	0.00	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	8.2		ng/L	6.7		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	33		ng/L	65		ng/L	32	ng/L

Client Sample ID: FM-18A/1

Lab Sample ID: 320-96808-3
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	13		ng/L	13	ng/L
Perfluoropentanoic acid (PFPeA)	ND		ng/L	5.6		ng/L	5.6	ng/L
Perfluorohexanoic acid (PFHxA)	5.1		ng/L	7.0		ng/L	2.0	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	7.2		ng/L	5.9		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	12		ng/L	32		ng/L	19	ng/L

[1] Difference = Post-Treatment - Pre-Treament

Isotope Dilution Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Pre-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96808-1	FM-5/1	109	115	117	112	114	110	111	103
320-96808-2	FM-16A/1	76	79	79	80	78	77	76	73
320-96808-3	FM-18A/1	94	97	96	104	98	96	94	87
LCS 320-656952/2-A	Lab Control Sample	115	119	118	120	115	114	115	109
LCSD 320-656952/3-A	Lab Control Sample Dup	106	109	109	115	109	109	108	107
MB 320-656952/1-A	Method Blank	111	110	111	113	112	112	111	104

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96808-1	FM-5/1	103	107	113	123	106	109	106	107
320-96808-2	FM-16A/1	73	76	80	83	73	74	71	73
320-96808-3	FM-18A/1	92	93	94	100	89	90	88	91
LCS 320-656952/2-A	Lab Control Sample	109	105	115	126	116	94	112	101
LCSD 320-656952/3-A	Lab Control Sample Dup	110	103	105	115	102	90	106	101
MB 320-656952/1-A	Method Blank	105	99	108	115	109	89	104	97

		Percent Isotope Dilution Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (25-150)
320-96808-1	FM-5/1	131	132	128
320-96808-2	FM-16A/1	90	81	85
320-96808-3	FM-18A/1	110	111	96
LCS 320-656952/2-A	Lab Control Sample	131	142	123
LCSD 320-656952/3-A	Lab Control Sample Dup	126	134	121
MB 320-656952/1-A	Method Blank	135	126	120

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Isotope Dilution Summary

Client: Orange County Water District
Job ID: 320-96808-1
Project/Site: FBVOC

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Post-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96808-1	FM-5/1	14 *5-	108	109	113	110	108	103	99
320-96808-2	FM-16A/1	16 *5-	106	107	108	108	102	101	97
320-96808-3	FM-18A/1	98	106	102	115	107	102	101	97
LCS 320-656915/2-A	Lab Control Sample	15 *5-	113	110	116	112	112	116	107
LCSD 320-656915/3-A	Lab Control Sample Dup	15 *5-	113	113	112	109	115	112	104
MB 320-656915/1-A	Method Blank	21 *5-	122	120	128	119	120	121	115

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96808-1	FM-5/1	99	97	105	117	98	106	100	107
320-96808-2	FM-16A/1	100	97	105	110	95	102	97	105
320-96808-3	FM-18A/1	99	101	100	110	97	99	98	101
LCS 320-656915/2-A	Lab Control Sample	109	105	115	119	109	112	110	111
LCSD 320-656915/3-A	Lab Control Sample Dup	102	105	109	117	108	112	109	112
MB 320-656915/1-A	Method Blank	114	113	114	131	115	117	118	117

		Percent Isotope Dilution Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (0-10)
320-96808-1	FM-5/1	132	120	0
320-96808-2	FM-16A/1	125	118	0
320-96808-3	FM-18A/1	128	126	0
LCS 320-656915/2-A	Lab Control Sample	124	145	0
LCSD 320-656915/3-A	Lab Control Sample Dup	131	130	0
MB 320-656915/1-A	Method Blank	142	136	0

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Lab Sample ID: MB 320-656952/1-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Method Blank
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFPeA	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFHxA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFHpA	*113*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFNA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFUnA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDoA	*105*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFTeDA	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C3 PFBS	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
18O2 PFHxS	*115*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOS	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C8 FOSA	*89*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d3-NMeFOSAA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d5-NEtFOSAA	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-6:2 FTS	*135*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-8:2 FTS	*126*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-4:2 FTS	*120*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	107		ng/L		107	76 - 136
Perfluoropentanoic acid (PFPeA)	100	103		ng/L		103	71 - 131
Perfluorohexanoic acid (PFHxA)	100	97.6		ng/L		98	73 - 133
Perfluoroheptanoic acid (PFHpA)	100	104		ng/L		104	72 - 132
Perfluorooctanoic acid (PFOA)	100	111		ng/L		111	70 - 130
Perfluorononanoic acid (PFNA)	100	106		ng/L		106	75 - 135
Perfluorodecanoic acid (PFDA)	100	103		ng/L		103	76 - 136
Perfluoroundecanoic acid (PFUnA)	100	110		ng/L		110	68 - 128
Perfluorododecanoic acid (PFDoA)	100	104		ng/L		104	71 - 131
Perfluorotridecanoic acid (PFTrDA)	100	91.9		ng/L		92	71 - 131
Perfluorotetradecanoic acid (PFTeA)	100	73.2		ng/L		73	70 - 130
Perfluorobutanesulfonic acid (PFBS)	88.8	93.8		ng/L		106	67 - 127
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		109	66 - 126
Perfluorohexanesulfonic acid (PFHxS)	91.2	86.0		ng/L		94	59 - 119
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	76 - 136
Perfluorooctanesulfonic acid (PFOS)	93.0	100		ng/L		108	70 - 130
Perfluorononanesulfonic acid (PFNS)	96.2	103		ng/L		107	75 - 135
Perfluorodecanesulfonic acid (PFDS)	96.4	96.3		ng/L		100	71 - 131
Perfluorooctanesulfonamide (FOSA)	100	97.1		ng/L		97	73 - 133
NMeFOSAA	100	97.8		ng/L		98	76 - 136
NEtFOSAA	100	104		ng/L		104	76 - 136
4:2 FTS	93.8	110		ng/L		117	79 - 139
6:2 FTS	95.2	104		ng/L		109	59 - 175
8:2 FTS	96.0	102		ng/L		106	75 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*115*		*25 - 150*
13C5 PFPeA	*119*		*25 - 150*
13C2 PFHxA	*118*		*25 - 150*
13C4 PFHpA	*120*		*25 - 150*
13C4 PFOA	*115*		*25 - 150*
13C5 PFNA	*114*		*25 - 150*
13C2 PFDA	*115*		*25 - 150*
13C2 PFUnA	*109*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*126*		*25 - 150*
13C4 PFOS	*116*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C8 FOSA	94		25 - 150
d3-NMeFOSAA	112		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	131		25 - 150
M2-8:2 FTS	142		25 - 150
M2-4:2 FTS	123		25 - 150

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	107		ng/L		107	76 - 136	0	30
Perfluoropentanoic acid (PFPeA)			100	101		ng/L		101	71 - 131	2	30
Perfluorohexanoic acid (PFHxA)			100	100		ng/L		100	73 - 133	3	30
Perfluoroheptanoic acid (PFHpA)			100	102		ng/L		102	72 - 132	1	30
Perfluorooctanoic acid (PFOA)			100	105		ng/L		105	70 - 130	6	30
Perfluorononanoic acid (PFNA)			100	105		ng/L		105	75 - 135	1	30
Perfluorodecanoic acid (PFDA)			100	103		ng/L		103	76 - 136	1	30
Perfluoroundecanoic acid (PFUnA)			100	106		ng/L		106	68 - 128	4	30
Perfluorododecanoic acid (PFDoA)			100	99.4		ng/L		99	71 - 131	5	30
Perfluorotridecanoic acid (PFTrDA)			100	88.0		ng/L		88	71 - 131	4	30
Perfluorotetradecanoic acid (PFTeA)			100	82.1		ng/L		82	70 - 130	11	30
Perfluorobutanesulfonic acid (PFBS)			88.8	95.4		ng/L		107	67 - 127	2	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	105		ng/L		111	66 - 126	2	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	86.4		ng/L		95	59 - 119	0	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	107		ng/L		113	76 - 136	2	30
Perfluorooctanesulfonic acid (PFOS)			93.0	103		ng/L		111	70 - 130	3	30
Perfluorononanesulfonic acid (PFNS)			96.2	106		ng/L		110	75 - 135	3	30
Perfluorodecanesulfonic acid (PFDS)			96.4	101		ng/L		105	71 - 131	5	30
Perfluorooctanesulfonamide (FOSA)			100	98.2		ng/L		98	73 - 133	1	30
NMeFOSAA			100	99.2		ng/L		99	76 - 136	1	30
NEtFOSAA			100	100		ng/L		100	76 - 136	4	30
4:2 FTS			93.8	114		ng/L		122	79 - 139	4	30
6:2 FTS			95.2	99.9		ng/L		105	59 - 175	4	30
8:2 FTS			96.0	102		ng/L		107	75 - 135	0	30

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	106		25 - 150
13C5 PFPeA	109		25 - 150

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C2 PFHxA	109		25 - 150
13C4 PFHpA	115		25 - 150
13C4 PFOA	109		25 - 150
13C5 PFNA	109		25 - 150
13C2 PFDA	108		25 - 150
13C2 PFUnA	107		25 - 150
13C2 PFDoA	110		25 - 150
13C2 PFTeDA	103		25 - 150
13C3 PFBS	105		25 - 150
18O2 PFHxS	115		25 - 150
13C4 PFOS	102		25 - 150
13C8 FOSA	90		25 - 150
d3-NMeFOSAA	106		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	126		25 - 150
M2-8:2 FTS	134		25 - 150
M2-4:2 FTS	121		25 - 150

Lab Sample ID: MB 320-656915/1-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	21	*5-	25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFPeA	122		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFHxA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFHpA	128		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOA	119		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFNA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDA	121		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFUnA	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDoA	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFTeDA	113		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C3 PFBS	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
18O2 PFHxS	131		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOS	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C8 FOSA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d3-NMeFOSAA	118		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d5-NEtFOSAA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-6:2 FTS	142		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-8:2 FTS	136		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-4:2 FTS	0		0 - 10	02/27/23 11:37	03/08/23 10:54	1

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	398	*+	ng/L		398	93 - 153
Perfluoropentanoic acid (PFPeA)	100	199	*+	ng/L		199	85 - 145
Perfluorohexanoic acid (PFHxA)	100	239	*+	ng/L		239	81 - 141
Perfluoroheptanoic acid (PFHpA)	100	210	*+	ng/L		210	104 - 171
Perfluorooctanoic acid (PFOA)	100	411		ng/L		411	158 - 454
Perfluorononanoic acid (PFNA)	100	153	*+	ng/L		153	66 - 126
Perfluorodecanoic acid (PFDA)	100	144	*+	ng/L		144	65 - 125
Perfluoroundecanoic acid (PFUnA)	100	113		ng/L		113	57 - 117
Perfluorododecanoic acid (PFDoA)	100	96.0		ng/L		96	66 - 126
Perfluorotridecanoic acid (PFTrDA)	100	82.4		ng/L		82	65 - 136
Perfluorotetradecanoic acid (PFTeA)	100	66.9		ng/L		67	63 - 123
Perfluorobutanesulfonic acid (PFBS)	88.8	98.7		ng/L		111	75 - 135
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		108	70 - 130
Perfluorohexanesulfonic acid (PFHxS)	91.2	90.0		ng/L		99	64 - 124
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	70 - 131
Perfluorooctanesulfonic acid (PFOS)	93.0	105		ng/L		113	68 - 128
Perfluorononanesulfonic acid (PFNS)	96.2	101		ng/L		105	70 - 130
Perfluorodecanesulfonic acid (PFDS)	96.4	94.5		ng/L		98	66 - 126

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10		
NMeFOSAA			100	ND		ng/L		0	0 - 10		
NEtFOSAA			100	ND		ng/L		0	0 - 10		
4:2 FTS			93.8	ND		ng/L		0	0 - 10		
6:2 FTS			95.2	ND		ng/L		0	0 - 10		
8:2 FTS			96.0	ND		ng/L		0	0 - 10		

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*15*	*5-	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*110*		*25 - 150*
13C4 PFHpA	*116*		*25 - 150*
13C4 PFOA	*112*		*25 - 150*
13C5 PFNA	*112*		*25 - 150*
13C2 PFDA	*116*		*25 - 150*
13C2 PFUnA	*107*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*119*		*25 - 150*
13C4 PFOS	*109*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*110*		*25 - 150*
d5-NEtFOSAA	*111*		*25 - 150*
M2-6:2 FTS	*124*		*25 - 150*
M2-8:2 FTS	*145*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	330	*+	ng/L		330	93 - 153	19	30
Perfluoropentanoic acid (PFPeA)			100	188	*+	ng/L		188	85 - 145	5	30
Perfluorohexanoic acid (PFHxA)			100	228	*+	ng/L		228	81 - 141	5	30
Perfluoroheptanoic acid (PFHpA)			100	198	*+	ng/L		198	104 - 171	6	30
Perfluorooctanoic acid (PFOA)			100	379		ng/L		379	158 - 454	8	30
Perfluorononanoic acid (PFNA)			100	138	*+	ng/L		138	66 - 126	10	30
Perfluorodecanoic acid (PFDA)			100	134	*+	ng/L		134	65 - 125	7	30
Perfluoroundecanoic acid (PFUnA)			100	120	*+	ng/L		120	57 - 117	6	30
Perfluorododecanoic acid (PFDoA)			100	93.2		ng/L		93	66 - 126	3	30
Perfluorotridecanoic acid (PFTrDA)			100	81.1		ng/L		81	65 - 136	1	30
Perfluorotetradecanoic acid (PFTeA)			100	65.1		ng/L		65	63 - 123	3	30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanesulfonic acid (PFBS)			88.8	101		ng/L		114	75 - 135	2	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	99.9		ng/L		106	70 - 130	2	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	87.7		ng/L		96	64 - 124	3	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	97.1		ng/L		102	70 - 131	7	30
Perfluorooctanesulfonic acid (PFOS)			93.0	94.2		ng/L		101	68 - 128	11	30
Perfluorononanesulfonic acid (PFNS)			96.2	91.2		ng/L		95	70 - 130	10	30
Perfluorodecanesulfonic acid (PFDS)			96.4	87.4		ng/L		91	66 - 126	8	30
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10	NC	30
NMeFOSAA			100	ND		ng/L		0	0 - 10	NC	30
NEtFOSAA			100	ND		ng/L		0	0 - 10	NC	30
4:2 FTS			93.8	ND		ng/L		0	0 - 10	NC	30
6:2 FTS			95.2	ND		ng/L		0	0 - 10	NC	30
8:2 FTS			96.0	ND		ng/L		0	0 - 10	NC	30

Isotope Dilution	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
13C4 PFBA	*15*	**5-*	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*113*		*25 - 150*
13C4 PFHpA	*112*		*25 - 150*
13C4 PFOA	*109*		*25 - 150*
13C5 PFNA	*115*		*25 - 150*
13C2 PFDA	*112*		*25 - 150*
13C2 PFUnA	*104*		*25 - 150*
13C2 PFDoA	*102*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*109*		*25 - 150*
18O2 PFHxS	*117*		*25 - 150*
13C4 PFOS	*108*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*109*		*25 - 150*
d5-NEtFOSAA	*112*		*25 - 150*
M2-6:2 FTS	*131*		*25 - 150*
M2-8:2 FTS	*130*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

LCMS

Prep Batch: 656915

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96808-1	FM-5/1	Post-Treatment	Water	TOP Post Prep	
320-96808-2	FM-16A/1	Post-Treatment	Water	TOP Post Prep	
320-96808-3	FM-18A/1	Post-Treatment	Water	TOP Post Prep	
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	TOP Post Prep	
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	TOP Post Prep	
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	TOP Post Prep	

Prep Batch: 656952

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96808-1	FM-5/1	Pre-Treatment	Water	TOP Pre - Prep	
320-96808-2	FM-16A/1	Pre-Treatment	Water	TOP Pre - Prep	
320-96808-3	FM-18A/1	Pre-Treatment	Water	TOP Pre - Prep	
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	TOP Pre - Prep	
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	TOP Pre - Prep	
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	TOP Pre - Prep	

Analysis Batch: 659747

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96808-1	FM-5/1	Post-Treatment	Water	537 (modified)	656915
320-96808-2	FM-16A/1	Post-Treatment	Water	537 (modified)	656915
320-96808-3	FM-18A/1	Post-Treatment	Water	537 (modified)	656915
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	537 (modified)	656915
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	537 (modified)	656915
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	537 (modified)	656915

Analysis Batch: 659748

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96808-1	FM-5/1	Pre-Treatment	Water	537 (modified)	656952
320-96808-2	FM-16A/1	Pre-Treatment	Water	537 (modified)	656952
320-96808-3	FM-18A/1	Pre-Treatment	Water	537 (modified)	656952
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	537 (modified)	656952
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	537 (modified)	656952
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	537 (modified)	656952

Analysis Batch: 660832

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96808-1	FM-5/1	Pre-Treatment	Water	Total PFCA-Sum	
320-96808-2	FM-16A/1	Pre-Treatment	Water	Total PFCA-Sum	
320-96808-3	FM-18A/1	Pre-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 660833

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96808-1	FM-5/1	Post-Treatment	Water	Total PFCA-Sum	
320-96808-2	FM-16A/1	Post-Treatment	Water	Total PFCA-Sum	
320-96808-3	FM-18A/1	Post-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 660837

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96808-1	FM-5/1	Total/NA	Water	Total PFCA-Dif	
320-96808-2	FM-16A/1	Total/NA	Water	Total PFCA-Dif	
320-96808-3	FM-18A/1	Total/NA	Water	Total PFCA-Dif	

Lab Chronicle

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Client Sample ID: FM-5/1

Lab Sample ID: 320-96808-1

Date Collected: 02/13/23 12:35

Matrix: Water

Date Received: 02/15/23 09:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 11:45	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 14:37	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			660837	03/15/23 15:52	VSG	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			660833	03/15/23 15:50	VSG	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			660832	03/15/23 15:47	VSG	EET SAC

Client Sample ID: FM-16A/1

Lab Sample ID: 320-96808-2

Date Collected: 02/13/23 11:05

Matrix: Water

Date Received: 02/15/23 09:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 11:55	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 14:47	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			660837	03/15/23 15:52	VSG	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			660833	03/15/23 15:50	VSG	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			660832	03/15/23 15:47	VSG	EET SAC

Client Sample ID: FM-18A/1

Lab Sample ID: 320-96808-3

Date Collected: 02/13/23 14:55

Matrix: Water

Date Received: 02/15/23 09:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 12:05	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 14:57	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			660837	03/15/23 15:52	VSG	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			660833	03/15/23 15:50	VSG	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			660832	03/15/23 15:47	VSG	EET SAC

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Accreditation/Certification Summary

Client: Orange County Water District
Job ID: 320-96808-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
California	State	2897	01-22-24

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Post Prep	Water	4:2 FTS
537 (modified)	TOP Post Prep	Water	6:2 FTS
537 (modified)	TOP Post Prep	Water	8:2 FTS
537 (modified)	TOP Post Prep	Water	NEtFOSAA
537 (modified)	TOP Post Prep	Water	NMeFOSAA
537 (modified)	TOP Post Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Post Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Post Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Post Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Post Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Post Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Post Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Post Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Post Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Post Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Post Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Post Prep	Water	Perfluoropentanoic acid (PFPeA)
537 (modified)	TOP Post Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Post Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Post Prep	Water	Perfluoroundecanoic acid (PFUnA)
537 (modified)	TOP Pre - Prep	Water	4:2 FTS
537 (modified)	TOP Pre - Prep	Water	6:2 FTS
537 (modified)	TOP Pre - Prep	Water	8:2 FTS
537 (modified)	TOP Pre - Prep	Water	NEtFOSAA
537 (modified)	TOP Pre - Prep	Water	NMeFOSAA
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Pre - Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanoic acid (PFPeA)

Accreditation/Certification Summary

Client: Orange County Water District
Job ID: 320-96808-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento (Continued)

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Pre - Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Pre - Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroundecanoic acid (PFUnA)
Total PFCA-Dif		Water	PFBA
Total PFCA-Dif		Water	PFHpA
Total PFCA-Dif		Water	PFHxA
Total PFCA-Dif		Water	PFNA
Total PFCA-Dif		Water	PFOA
Total PFCA-Dif		Water	PFPA
Total PFCA-Dif		Water	Total PFCA
Total PFCA-Sum		Water	Total PFCA

Method Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Method	Method Description	Protocol	Laboratory
537 (modified)	Fluorinated Alkyl Substances	EPA	EET SAC
Total PFCA-Dif	Total PFCA (Treatment Difference)	TAL SOP	EET SAC
Total PFCA-Sum	Total PFCA (Summary)	TAL SOP	EET SAC
TOP Post Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC
TOP Pre - Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL SOP = TestAmerica Laboratories, Standard Operating Procedure

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96808-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-96808-1	FM-5/1	Water	02/13/23 12:35	02/15/23 09:25
320-96808-2	FM-16A/1	Water	02/13/23 11:05	02/15/23 09:25
320-96808-3	FM-18A/1	Water	02/13/23 14:55	02/15/23 09:25

Eurofins Sacramento
880 Riverside Pkwy
West Sacramento, CA 95605
Phone (916) 373-5600 Fax (916) 372-1059

Chain of Custody Record

eurofins

3/15/2023

Client Information	Sampler: Zach Barker / Ely Davidson	Lab PM: Karen Dahl	Carrier Tracking No(s):	COC No:
Client Contact: Patrick Versluis	Phone: 714-378-3200	E-Mail: Karen.Dahl@ET.Eurofins.com		Page: Page 1 of 1
Company: Orange County Water District				Job #:
Address: P.O. Box 8300	Due Date Requested:			
City: Fountain Valley	TAT Requested (days): Normal - 2 weeks			
State, Zip: California, 92728-8300	PO #:			
Phone: (714) 378 - 8241	WO #:			
Email: pversluis@ocwd.com	Project #:			
Project Name: FBVOC				

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	537.1 MOD TOPS	Total Number of containers
FM-5/1	2/13/23	~~11:50~~ 1235	G	W	N		X	
FM-16A/1	2/13/23	11:05	G	W	N		X	
FM-18A/1	2/13/23	14:55	G	W	N		X	

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Special Instructions/Note:

Please Call Pat Versluis if ANY detections are noted during analysis.

(714) 378 - 8241

Email Results to :

pversluis@ocwd.com

rhintlian@ocwd.com

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
1	[signature]	2/13/23 1630	OCWD	[signature]	2/14/23 / 1445	OCWD
2	Craig Patterson [signature]	2/14/23 / 1445	Company	Received by:	Date/Time:	Company
3	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No

Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks:

Ver: 08/04/2016

Eurofins Sacramento
880 Riverside Parkway
West Sacramento, Ca 95605
Phone (916) 373-5600 Fax (916) 372-1059

Chain of Custody Record

eurofins

Client Information	Sampler: Zach Barker / Ely Davidson	Lab PM: Karen Dahl	Carrier Tracking No(s):	COC No:
Client Contact: Patrick Versluis	Phone: 714-378-3200	E-Mail: Karen.Dahl@ET.Eurofins.com		Page: Page 1 of 1
Company: Orange County Water District				Job #:
Address: P.O. Box 8300	Due Date Requested:			
City: Fountain Valley	TAT Requested (days): Normal - 2 weeks			
State, Zip: California, 92728-8300				
Phone: (714) 378 - 8241	PO #:			
Email: pversluis@ocwd.com	WO #:			
Project Name: FBVOC	Project #:			

Analysis Requested

320-96808 Chain of Custody

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	537.1 MOD TOPS	Total Number of containers	Special Instructions/Note:
FM-5/1	2/13/23	11:50	G	W	N		X	4	
FM-16A/1	2/13/23	11:05	G	W	N		X	4	
FM-18A/1	2/13/23	14:55	G	W	N		X	4	*Please Call Pat Versluis if ANY detections are noted during analysis.*
									(714) 378 - 8241
									Email Results to :
									pversluis@ocwd.com
									rhintlian@ocwd.com

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
1	[signature]	2/13/23 1630	OCWD	[signature]	2/14/23 1445	OCWD
2	Craig Petrovich [signature]	2/14/23 1445		[signature]	2/15/23 925	EEI SAC
3						

Custody Seals Intact: Δ Yes Δ No

Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks: 0.6

Ver: 08/04/2016

Login Sample Receipt Checklist

Client: Orange County Water District

Job Number: 320-96808-1

Login Number: 96808
List Number: 1
Creator: Oropeza, Salvador

List Source: Eurofins Sacramento

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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ANALYTICAL REPORT

PREPARED FOR

Attn: Patrick Versluis
Orange County Water District
18700 Ward Street
Fountain Valley, California 92708

Generated 3/15/2023 11:39:41 AM

JOB DESCRIPTION

FBVOC

JOB NUMBER

320-96810-1

Eurofins Sacramento
880 Riverside Parkway
West Sacramento CA 95605

See page two for job notes and contact information.

my EOL

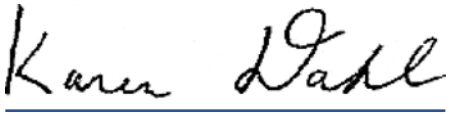
Job Notes

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The data in the report relate to the field sample(s) as received by the laboratory and associated QC. All results have been reviewed and have been found to be compliant with laboratory and accreditation requirements, with the exception of the noted deviation(s). For questions, please contact the Project Manager.

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Environment Testing Northern California, LLC Project Manager.

Authorization



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3/15/2023 11:39:41 AM

Authorized for release by
Karen Dahl, Senior Project Manager
Karen.Dahl@et.eurofinsus.com
(916)374-4384

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Definitions/Glossary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Qualifiers

LCMS

Qualifier	Qualifier Description
*+	LCS and/or LCSD is outside acceptance limits, high biased.
*5-	Isotope dilution analyte is outside acceptance limits, low biased.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 320-96810-1

Laboratory: Eurofins Sacramento

Narrative

Comments
No additional comments.

Receipt
The samples were received on 2/15/2023 9:25 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 0.6º C.

LCMS
Method 537 (modified): One Isotope Dilution Analyte (IDA) recovery is below the method recommended limit for the following samples (post treatment): FM-10A/1 (320-96810-1), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDAs for these samples.

Method 537 (modified): The labeled analyte M2-4:2FTS is employed in this analysis as a “Reverse Surrogate”. It is used to monitor the oxidation efficiency of the TOP assay. This analyte is fortified into all sample fractions prior to any processing. The recovery of this analyte should be 0% in Post-Treatment fractions, indicating complete oxidation of the sample. FM-10A/1 (320-96810-1), FM-19A/1 (320-96810-2), FM-30A/1 (320-96810-3), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A)

Method 537 (modified): Zero percent recovery of precursor analytes (such as 4:2 FTS, 6:2 FTS, 8:2 FTS, FOSA, NMeFOSAA, NEtFOSAA, etc.) and enhanced recoveries of PFCA is observed in the Post-Treatment Laboratory Control Sample (LCS) and Post-Treatment Laboratory Control Sample Duplicate (LCSD) associated with these samples, consistent with the expected oxidation of precursor analytes. The existing LCS control limits are based upon our historical performance for a set of 24-36 analytes in the LCS solution. We have recently expanded to 70+ analytes. As the LCS solution now contains new/additional precursor analytes we are seeing enhanced recoveries for some PFCA vs. the historical limits as a result. The LCS results are flagged as being high and outside of the established limits for some analytes; however, this is a function of the new analytes in the LCS solution and not indicative of an “out of control” process. FM-10A/1 (320-96810-1), FM-19A/1 (320-96810-2), FM-30A/1 (320-96810-3), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Client Sample ID: FM-10A/1 — Lab Sample ID: 320-96810-1

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	7.8		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	6.3		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	9.1		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanesulfonic acid (PFBS)	6.3		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	5.4		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	19		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	28	*+	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	8.8	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	7.9	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	8.9		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorobutanesulfonic acid (PFBS)	6.4		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	6.6		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	19		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	28				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	1.0				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	1.6				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	30				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	23				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	54				ng/L	1		Total PFCA-Sum	Post-Treatment

Client Sample ID: FM-19A/1 — Lab Sample ID: 320-96810-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	6.7		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	5.6		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	7.3		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	8.5		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	5.6		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluoropentanoic acid (PFPeA)	6.1	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	6.3	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	5.8		5.0		ng/L	1		537 (modified)	Post-Treatment

This Detection Summary does not include radiochemical test results.

Eurofins Sacramento

Client Sample ID: FM-19A/1 (Continued) — Lab Sample ID: 320-96810-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanesulfonic acid (PFHxS)	7.0		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	0.62				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	20				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	18				ng/L	1		Total PFCA-Sum	Post-Treatment

Client Sample ID: FM-30A/1 — Lab Sample ID: 320-96810-3

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	5.3		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	9.1		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	7.8		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	6.7		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	20	*+	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	5.5	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	6.0		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	6.5		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	20				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.18				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	17				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	14				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	32				ng/L	1		Total PFCA-Sum	Post-Treatment

This Detection Summary does not include radiochemical test results.

Client Sample ID: FM-10A/1
Date Collected: 02/14/23 09:45
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-1
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluoropentanoic acid (PFPeA)	**7.8**		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorohexanoic acid (PFHxA)	**6.3**		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorooctanoic acid (PFOA)	**9.1**		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorobutanesulfonic acid (PFBS)	**6.3**		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorohexanesulfonic acid (PFHxS)	**5.4**		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorooctanesulfonic acid (PFOS)	**19**		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:07	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:07	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 15:07	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:07	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*83*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C5 PFPeA	*86*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C2 PFHxA	*83*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C4 PFHpA	*87*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C4 PFOA	*83*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C5 PFNA	*80*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C2 PFDA	*80*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C2 PFUnA	*76*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C2 PFDoA	*79*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C2 PFTeDA	*78*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C3 PFBS	*82*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
18O2 PFHxS	*87*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C4 PFOS	*75*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
13C8 FOSA	*78*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
d3-NMeFOSAA	*74*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
d5-NEtFOSAA	*79*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
M2-6:2 FTS	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
M2-8:2 FTS	*89*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*
M2-4:2 FTS	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:07*	*1*

Client Sample ID: FM-10A/1

Date Collected: 02/14/23 09:45
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-1

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**28**	***+**	13		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluoropentanoic acid (PFPeA)	**8.8**	***+**	5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorohexanoic acid (PFHxA)	**7.9**	***+**	5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorooctanoic acid (PFOA)	**8.9**		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorobutanesulfonic acid (PFBS)	**6.4**		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorohexanesulfonic acid (PFHxS)	**6.6**		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorooctanesulfonic acid (PFOS)	**19**		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:15	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:15	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 12:15	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:15	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*22*	**5-*	*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C5 PFPeA	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C2 PFHxA	*95*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C4 PFHpA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C4 PFOA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C5 PFNA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C2 PFDA	*94*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C2 PFUnA	*92*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C2 PFDoA	*94*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C2 PFTeDA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C3 PFBS	*93*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
18O2 PFHxS	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C4 PFOS	*87*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
13C8 FOSA	*92*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
d3-NMeFOSAA	*94*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
d5-NEtFOSAA	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
M2-6:2 FTS	*117*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
M2-8:2 FTS	*110*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:15*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 12:15*	*1*

Client Sample ID: FM-10A/1

Lab Sample ID: 320-96810-1

Date Collected: 02/14/23 09:45

Matrix: Water

Date Received: 02/15/23 09:25

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**28**				ng/L			03/16/23 08:26	1
PFPA	**1.0**				ng/L			03/16/23 08:26	1
PFHxA	**1.6**				ng/L			03/16/23 08:26	1
PFHpA	**0.00**				ng/L			03/16/23 08:26	1
PFOA	**0.00**				ng/L			03/16/23 08:26	1
PFNA	**0.00**				ng/L			03/16/23 08:26	1
Total PFCA	**30**				ng/L			03/16/23 08:26	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**23**				ng/L			03/16/23 08:22	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**54**				ng/L			03/16/23 08:24	1

Client Sample ID: FM-19A/1

Lab Sample ID: 320-96810-2

Date Collected: 02/14/23 10:40

Matrix: Water

Date Received: 02/15/23 09:25

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluoropentanoic acid (PFPeA)	**6.7**		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorohexanoic acid (PFHxA)	**5.6**		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorooctanoic acid (PFOA)	**7.3**		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorohexanesulfonic acid (PFHxS)	**8.5**		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorooctanesulfonic acid (PFOS)	**5.6**		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:18	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:18	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 15:18	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:18	1

Client Sample ID: FM-19A/1

Date Collected: 02/14/23 10:40
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-2

Matrix: Water

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*102*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C5 PFPeA	*102*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C2 PFHxA	*103*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C4 PFHpA	*106*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C4 PFOA	*102*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C5 PFNA	*100*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C2 PFDA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C2 PFUnA	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C2 PFDoA	*95*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C2 PFTeDA	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C3 PFBS	*100*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
18O2 PFHxS	*103*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C4 PFOS	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
13C8 FOSA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
d3-NMeFOSAA	*95*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
d5-NEtFOSAA	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
M2-6:2 FTS	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
M2-8:2 FTS	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*
M2-4:2 FTS	*102*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:18*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND	*+	13		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluoropentanoic acid (PFPeA)	**6.1**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorohexanoic acid (PFHxA)	**6.3**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorooctanoic acid (PFOA)	**5.8**		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorohexanesulfonic acid (PFHxS)	**7.0**		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:25	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:25	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 12:25	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:25	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*77*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*

Client Sample ID: FM-19A/1

Date Collected: 02/14/23 10:40
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-2

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C5 PFPeA	*104*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C2 PFHxA	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C4 PFHpA	*109*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C4 PFOA	*104*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C5 PFNA	*100*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C2 PFDA	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C2 PFUnA	*93*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C2 PFDoA	*94*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C2 PFTeDA	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C3 PFBS	*93*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
18O2 PFHxS	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C4 PFOS	*89*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
13C8 FOSA	*94*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
d3-NMeFOSAA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
d5-NEtFOSAA	*97*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
M2-6:2 FTS	*128*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
M2-8:2 FTS	*111*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:25*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 12:25*	*1*

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**0.00**				ng/L			03/16/23 08:26	1
PFPA	**0.00**				ng/L			03/16/23 08:26	1
PFHxA	**0.62**				ng/L			03/16/23 08:26	1
PFHpA	**0.00**				ng/L			03/16/23 08:26	1
PFOA	**0.00**				ng/L			03/16/23 08:26	1
PFNA	**0.00**				ng/L			03/16/23 08:26	1
Total PFCA	**0.00**				ng/L			03/16/23 08:26	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**20**				ng/L			03/16/23 08:22	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**18**				ng/L			03/16/23 08:24	1

Client Sample ID: FM-30A/1

Date Collected: 02/14/23 11:40
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-3

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluoropentanoic acid (PFPeA)	**5.3**		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorooctanoic acid (PFOA)	**9.1**		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1

Client Sample ID: FM-30A/1
Date Collected: 02/14/23 11:40
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-3
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorohexanesulfonic acid (PFHxS)	**7.8**		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorooctanesulfonic acid (PFOS)	**6.7**		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:38	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:38	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 15:38	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:38	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C5 PFPeA	*107*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C2 PFHxA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C4 PFHpA	*107*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C4 PFOA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C5 PFNA	*102*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C2 PFDA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C2 PFUnA	*95*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C2 PFDoA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C2 PFTeDA	*96*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C3 PFBS	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
18O2 PFHxS	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C4 PFOS	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
13C8 FOSA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
d3-NMeFOSAA	*92*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
d5-NEtFOSAA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
M2-6:2 FTS	*116*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
M2-8:2 FTS	*119*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*
M2-4:2 FTS	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:38*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**20**	***+**	13		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluoropentanoic acid (PFPeA)	**5.5**	***+**	5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorohexanoic acid (PFHxA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorooctanoic acid (PFOA)	**6.0**		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Client Sample ID: FM-30A/1
Date Collected: 02/14/23 11:40
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-3
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorohexanesulfonic acid (PFHxS)	**6.5**		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:46	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:46	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 12:46	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:46	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*34*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C5 PFPeA	*113*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C2 PFHxA	*109*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C4 PFHpA	*116*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C4 PFOA	*109*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C5 PFNA	*105*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C2 PFDA	*104*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C2 PFUnA	*99*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C2 PFDoA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C2 PFTeDA	*90*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C3 PFBS	*106*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
18O2 PFHxS	*112*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C4 PFOS	*99*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
13C8 FOSA	*107*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
d3-NMeFOSAA	*100*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
d5-NEtFOSAA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
M2-6:2 FTS	*132*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
M2-8:2 FTS	*122*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:46*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 12:46*	*1*

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**20**				ng/L			03/16/23 08:26	1
PFPA	**0.18**				ng/L			03/16/23 08:26	1
PFHxA	**0.00**				ng/L			03/16/23 08:26	1
PFHpA	**0.00**				ng/L			03/16/23 08:26	1
PFOA	**0.00**				ng/L			03/16/23 08:26	1
PFNA	**0.00**				ng/L			03/16/23 08:26	1
Total PFCA	**17**				ng/L			03/16/23 08:26	1

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Client Sample ID: FM-30A/1
Date Collected: 02/14/23 11:40
Date Received: 02/15/23 09:25

Lab Sample ID: 320-96810-3
Matrix: Water

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	14				ng/L			03/16/23 08:22	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	32				ng/L			03/16/23 08:24	1

Total Oxidation Precursors

Client: Orange County Water District
Project/Site: FBVOC

TestAmerica Job ID: 320-96810-1

Client Sample ID: FM-10A/1

Lab Sample ID: 320-96810-1
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	28		ng/L	28	ng/L
Perfluoropentanoic acid (PFPeA)	7.8		ng/L	8.8		ng/L	1.0	ng/L
Perfluorohexanoic acid (PFHxA)	6.3		ng/L	7.9		ng/L	1.6	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	9.1		ng/L	8.9		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	23		ng/L	54		ng/L	30	ng/L

Client Sample ID: FM-19A/1

Lab Sample ID: 320-96810-2
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluoropentanoic acid (PFPeA)	6.7		ng/L	6.1		ng/L	0.00	ng/L
Perfluorohexanoic acid (PFHxA)	5.6		ng/L	6.3		ng/L	0.62	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	7.3		ng/L	5.8		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	20		ng/L	18		ng/L	0.00	ng/L

Client Sample ID: FM-30A/1

Lab Sample ID: 320-96810-3
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	20		ng/L	20	ng/L
Perfluoropentanoic acid (PFPeA)	5.3		ng/L	5.5		ng/L	0.18	ng/L
Perfluorohexanoic acid (PFHxA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	9.1		ng/L	6.0		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	14		ng/L	32		ng/L	17	ng/L

[1] Difference = Post-Treatment - Pre-Treament

Isotope Dilution Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Pre-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96810-1	FM-10A/1	83	86	83	87	83	80	80	76
320-96810-2	FM-19A/1	102	102	103	106	102	100	98	94
320-96810-3	FM-30A/1	98	107	104	107	104	102	98	95
LCS 320-656952/2-A	Lab Control Sample	115	119	118	120	115	114	115	109
LCSD 320-656952/3-A	Lab Control Sample Dup	106	109	109	115	109	109	108	107
MB 320-656952/1-A	Method Blank	111	110	111	113	112	112	111	104

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96810-1	FM-10A/1	79	78	82	87	75	78	74	79
320-96810-2	FM-19A/1	95	97	100	103	94	98	95	99
320-96810-3	FM-30A/1	98	96	99	110	98	98	92	98
LCS 320-656952/2-A	Lab Control Sample	109	105	115	126	116	94	112	101
LCSD 320-656952/3-A	Lab Control Sample Dup	110	103	105	115	102	90	106	101
MB 320-656952/1-A	Method Blank	105	99	108	115	109	89	104	97

		Percent Isotope Dilution Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (25-150)
320-96810-1	FM-10A/1	99	89	90
320-96810-2	FM-19A/1	112	108	102
320-96810-3	FM-30A/1	116	119	108
LCS 320-656952/2-A	Lab Control Sample	131	142	123
LCSD 320-656952/3-A	Lab Control Sample Dup	126	134	121
MB 320-656952/1-A	Method Blank	135	126	120

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Isotope Dilution Summary

Client: Orange County Water District
Job ID: 320-96810-1
Project/Site: FBVOC

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Post-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96810-1	FM-10A/1	22 *5-	98	95	101	96	96	94	92
320-96810-2	FM-19A/1	77	104	98	109	104	100	98	93
320-96810-3	FM-30A/1	34	113	109	116	109	105	104	99
LCS 320-656915/2-A	Lab Control Sample	15 *5-	113	110	116	112	112	116	107
LCSD 320-656915/3-A	Lab Control Sample Dup	15 *5-	113	113	112	109	115	112	104
MB 320-656915/1-A	Method Blank	21 *5-	122	120	128	119	120	121	115

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96810-1	FM-10A/1	94	96	93	98	87	92	94	98
320-96810-2	FM-19A/1	94	97	93	102	89	94	96	97
320-96810-3	FM-30A/1	96	90	106	112	99	107	100	102
LCS 320-656915/2-A	Lab Control Sample	109	105	115	119	109	112	110	111
LCSD 320-656915/3-A	Lab Control Sample Dup	102	105	109	117	108	112	109	112
MB 320-656915/1-A	Method Blank	114	113	114	131	115	117	118	117

		Percent Isotope Dilution Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (0-10)
320-96810-1	FM-10A/1	117	110	0
320-96810-2	FM-19A/1	128	111	0
320-96810-3	FM-30A/1	132	122	0
LCS 320-656915/2-A	Lab Control Sample	124	145	0
LCSD 320-656915/3-A	Lab Control Sample Dup	131	130	0
MB 320-656915/1-A	Method Blank	142	136	0

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Lab Sample ID: MB 320-656952/1-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Method Blank
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFPeA	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFHxA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFHpA	*113*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFNA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFUnA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDoA	*105*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFTeDA	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C3 PFBS	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
18O2 PFHxS	*115*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOS	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C8 FOSA	*89*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d3-NMeFOSAA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d5-NEtFOSAA	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-6:2 FTS	*135*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-8:2 FTS	*126*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-4:2 FTS	*120*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	107		ng/L		107	76 - 136
Perfluoropentanoic acid (PFPeA)	100	103		ng/L		103	71 - 131
Perfluorohexanoic acid (PFHxA)	100	97.6		ng/L		98	73 - 133
Perfluoroheptanoic acid (PFHpA)	100	104		ng/L		104	72 - 132
Perfluorooctanoic acid (PFOA)	100	111		ng/L		111	70 - 130
Perfluorononanoic acid (PFNA)	100	106		ng/L		106	75 - 135
Perfluorodecanoic acid (PFDA)	100	103		ng/L		103	76 - 136
Perfluoroundecanoic acid (PFUnA)	100	110		ng/L		110	68 - 128
Perfluorododecanoic acid (PFDoA)	100	104		ng/L		104	71 - 131
Perfluorotridecanoic acid (PFTrDA)	100	91.9		ng/L		92	71 - 131
Perfluorotetradecanoic acid (PFTeA)	100	73.2		ng/L		73	70 - 130
Perfluorobutanesulfonic acid (PFBS)	88.8	93.8		ng/L		106	67 - 127
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		109	66 - 126
Perfluorohexanesulfonic acid (PFHxS)	91.2	86.0		ng/L		94	59 - 119
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	76 - 136
Perfluorooctanesulfonic acid (PFOS)	93.0	100		ng/L		108	70 - 130
Perfluorononanesulfonic acid (PFNS)	96.2	103		ng/L		107	75 - 135
Perfluorodecanesulfonic acid (PFDS)	96.4	96.3		ng/L		100	71 - 131
Perfluorooctanesulfonamide (FOSA)	100	97.1		ng/L		97	73 - 133
NMeFOSAA	100	97.8		ng/L		98	76 - 136
NEtFOSAA	100	104		ng/L		104	76 - 136
4:2 FTS	93.8	110		ng/L		117	79 - 139
6:2 FTS	95.2	104		ng/L		109	59 - 175
8:2 FTS	96.0	102		ng/L		106	75 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*115*		*25 - 150*
13C5 PFPeA	*119*		*25 - 150*
13C2 PFHxA	*118*		*25 - 150*
13C4 PFHpA	*120*		*25 - 150*
13C4 PFOA	*115*		*25 - 150*
13C5 PFNA	*114*		*25 - 150*
13C2 PFDA	*115*		*25 - 150*
13C2 PFUnA	*109*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*126*		*25 - 150*
13C4 PFOS	*116*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C8 FOSA	94		25 - 150
d3-NMeFOSAA	112		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	131		25 - 150
M2-8:2 FTS	142		25 - 150
M2-4:2 FTS	123		25 - 150

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	107		ng/L		107	76 - 136	0	30
Perfluoropentanoic acid (PFPeA)			100	101		ng/L		101	71 - 131	2	30
Perfluorohexanoic acid (PFHxA)			100	100		ng/L		100	73 - 133	3	30
Perfluoroheptanoic acid (PFHpA)			100	102		ng/L		102	72 - 132	1	30
Perfluorooctanoic acid (PFOA)			100	105		ng/L		105	70 - 130	6	30
Perfluorononanoic acid (PFNA)			100	105		ng/L		105	75 - 135	1	30
Perfluorodecanoic acid (PFDA)			100	103		ng/L		103	76 - 136	1	30
Perfluoroundecanoic acid (PFUnA)			100	106		ng/L		106	68 - 128	4	30
Perfluorododecanoic acid (PFDoA)			100	99.4		ng/L		99	71 - 131	5	30
Perfluorotridecanoic acid (PFTrDA)			100	88.0		ng/L		88	71 - 131	4	30
Perfluorotetradecanoic acid (PFTeA)			100	82.1		ng/L		82	70 - 130	11	30
Perfluorobutanesulfonic acid (PFBS)			88.8	95.4		ng/L		107	67 - 127	2	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	105		ng/L		111	66 - 126	2	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	86.4		ng/L		95	59 - 119	0	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	107		ng/L		113	76 - 136	2	30
Perfluorooctanesulfonic acid (PFOS)			93.0	103		ng/L		111	70 - 130	3	30
Perfluorononanesulfonic acid (PFNS)			96.2	106		ng/L		110	75 - 135	3	30
Perfluorodecanesulfonic acid (PFDS)			96.4	101		ng/L		105	71 - 131	5	30
Perfluorooctanesulfonamide (FOSA)			100	98.2		ng/L		98	73 - 133	1	30
NMeFOSAA			100	99.2		ng/L		99	76 - 136	1	30
NEtFOSAA			100	100		ng/L		100	76 - 136	4	30
4:2 FTS			93.8	114		ng/L		122	79 - 139	4	30
6:2 FTS			95.2	99.9		ng/L		105	59 - 175	4	30
8:2 FTS			96.0	102		ng/L		107	75 - 135	0	30

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	106		25 - 150
13C5 PFPeA	109		25 - 150

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C2 PFHxA	109		25 - 150
13C4 PFHpA	115		25 - 150
13C4 PFOA	109		25 - 150
13C5 PFNA	109		25 - 150
13C2 PFDA	108		25 - 150
13C2 PFUnA	107		25 - 150
13C2 PFDoA	110		25 - 150
13C2 PFTeDA	103		25 - 150
13C3 PFBS	105		25 - 150
18O2 PFHxS	115		25 - 150
13C4 PFOS	102		25 - 150
13C8 FOSA	90		25 - 150
d3-NMeFOSAA	106		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	126		25 - 150
M2-8:2 FTS	134		25 - 150
M2-4:2 FTS	121		25 - 150

Lab Sample ID: MB 320-656915/1-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	21	*5-	25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFPeA	122		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFHxA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFHpA	128		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOA	119		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFNA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDA	121		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFUnA	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDoA	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFTeDA	113		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C3 PFBS	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
18O2 PFHxS	131		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOS	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C8 FOSA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d3-NMeFOSAA	118		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d5-NEtFOSAA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-6:2 FTS	142		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-8:2 FTS	136		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-4:2 FTS	0		0 - 10	02/27/23 11:37	03/08/23 10:54	1

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	398	*+	ng/L		398	93 - 153
Perfluoropentanoic acid (PFPeA)	100	199	*+	ng/L		199	85 - 145
Perfluorohexanoic acid (PFHxA)	100	239	*+	ng/L		239	81 - 141
Perfluoroheptanoic acid (PFHpA)	100	210	*+	ng/L		210	104 - 171
Perfluorooctanoic acid (PFOA)	100	411		ng/L		411	158 - 454
Perfluorononanoic acid (PFNA)	100	153	*+	ng/L		153	66 - 126
Perfluorodecanoic acid (PFDA)	100	144	*+	ng/L		144	65 - 125
Perfluoroundecanoic acid (PFUnA)	100	113		ng/L		113	57 - 117
Perfluorododecanoic acid (PFDoA)	100	96.0		ng/L		96	66 - 126
Perfluorotridecanoic acid (PFTrDA)	100	82.4		ng/L		82	65 - 136
Perfluorotetradecanoic acid (PFTeA)	100	66.9		ng/L		67	63 - 123
Perfluorobutanesulfonic acid (PFBS)	88.8	98.7		ng/L		111	75 - 135
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		108	70 - 130
Perfluorohexanesulfonic acid (PFHxS)	91.2	90.0		ng/L		99	64 - 124
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	70 - 131
Perfluorooctanesulfonic acid (PFOS)	93.0	105		ng/L		113	68 - 128
Perfluorononanesulfonic acid (PFNS)	96.2	101		ng/L		105	70 - 130
Perfluorodecanesulfonic acid (PFDS)	96.4	94.5		ng/L		98	66 - 126

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10		
NMeFOSAA			100	ND		ng/L		0	0 - 10		
NEtFOSAA			100	ND		ng/L		0	0 - 10		
4:2 FTS			93.8	ND		ng/L		0	0 - 10		
6:2 FTS			95.2	ND		ng/L		0	0 - 10		
8:2 FTS			96.0	ND		ng/L		0	0 - 10		

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*15*	*5-	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*110*		*25 - 150*
13C4 PFHpA	*116*		*25 - 150*
13C4 PFOA	*112*		*25 - 150*
13C5 PFNA	*112*		*25 - 150*
13C2 PFDA	*116*		*25 - 150*
13C2 PFUnA	*107*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*119*		*25 - 150*
13C4 PFOS	*109*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*110*		*25 - 150*
d5-NEtFOSAA	*111*		*25 - 150*
M2-6:2 FTS	*124*		*25 - 150*
M2-8:2 FTS	*145*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	330	*+	ng/L		330	93 - 153	19	30
Perfluoropentanoic acid (PFPeA)			100	188	*+	ng/L		188	85 - 145	5	30
Perfluorohexanoic acid (PFHxA)			100	228	*+	ng/L		228	81 - 141	5	30
Perfluoroheptanoic acid (PFHpA)			100	198	*+	ng/L		198	104 - 171	6	30
Perfluorooctanoic acid (PFOA)			100	379		ng/L		379	158 - 454	8	30
Perfluorononanoic acid (PFNA)			100	138	*+	ng/L		138	66 - 126	10	30
Perfluorodecanoic acid (PFDA)			100	134	*+	ng/L		134	65 - 125	7	30
Perfluoroundecanoic acid (PFUnA)			100	120	*+	ng/L		120	57 - 117	6	30
Perfluorododecanoic acid (PFDoA)			100	93.2		ng/L		93	66 - 126	3	30
Perfluorotridecanoic acid (PFTrDA)			100	81.1		ng/L		81	65 - 136	1	30
Perfluorotetradecanoic acid (PFTeA)			100	65.1		ng/L		65	63 - 123	3	30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanesulfonic acid (PFBS)			88.8	101		ng/L		114	75 - 135	2	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	99.9		ng/L		106	70 - 130	2	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	87.7		ng/L		96	64 - 124	3	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	97.1		ng/L		102	70 - 131	7	30
Perfluorooctanesulfonic acid (PFOS)			93.0	94.2		ng/L		101	68 - 128	11	30
Perfluorononanesulfonic acid (PFNS)			96.2	91.2		ng/L		95	70 - 130	10	30
Perfluorodecanesulfonic acid (PFDS)			96.4	87.4		ng/L		91	66 - 126	8	30
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10	NC	30
NMeFOSAA			100	ND		ng/L		0	0 - 10	NC	30
NEtFOSAA			100	ND		ng/L		0	0 - 10	NC	30
4:2 FTS			93.8	ND		ng/L		0	0 - 10	NC	30
6:2 FTS			95.2	ND		ng/L		0	0 - 10	NC	30
8:2 FTS			96.0	ND		ng/L		0	0 - 10	NC	30

Isotope Dilution	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
13C4 PFBA	*15*	**5-*	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*113*		*25 - 150*
13C4 PFHpA	*112*		*25 - 150*
13C4 PFOA	*109*		*25 - 150*
13C5 PFNA	*115*		*25 - 150*
13C2 PFDA	*112*		*25 - 150*
13C2 PFUnA	*104*		*25 - 150*
13C2 PFDoA	*102*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*109*		*25 - 150*
18O2 PFHxS	*117*		*25 - 150*
13C4 PFOS	*108*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*109*		*25 - 150*
d5-NEtFOSAA	*112*		*25 - 150*
M2-6:2 FTS	*131*		*25 - 150*
M2-8:2 FTS	*130*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

LCMS

Prep Batch: 656915

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96810-1	FM-10A/1	Post-Treatment	Water	TOP Post Prep	
320-96810-2	FM-19A/1	Post-Treatment	Water	TOP Post Prep	
320-96810-3	FM-30A/1	Post-Treatment	Water	TOP Post Prep	
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	TOP Post Prep	
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	TOP Post Prep	
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	TOP Post Prep	

Prep Batch: 656952

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96810-1	FM-10A/1	Pre-Treatment	Water	TOP Pre - Prep	
320-96810-2	FM-19A/1	Pre-Treatment	Water	TOP Pre - Prep	
320-96810-3	FM-30A/1	Pre-Treatment	Water	TOP Pre - Prep	
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	TOP Pre - Prep	
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	TOP Pre - Prep	
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	TOP Pre - Prep	

Analysis Batch: 659747

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96810-1	FM-10A/1	Post-Treatment	Water	537 (modified)	656915
320-96810-2	FM-19A/1	Post-Treatment	Water	537 (modified)	656915
320-96810-3	FM-30A/1	Post-Treatment	Water	537 (modified)	656915
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	537 (modified)	656915
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	537 (modified)	656915
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	537 (modified)	656915

Analysis Batch: 659748

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96810-1	FM-10A/1	Pre-Treatment	Water	537 (modified)	656952
320-96810-2	FM-19A/1	Pre-Treatment	Water	537 (modified)	656952
320-96810-3	FM-30A/1	Pre-Treatment	Water	537 (modified)	656952
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	537 (modified)	656952
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	537 (modified)	656952
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	537 (modified)	656952

Analysis Batch: 660912

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96810-1	FM-10A/1	Pre-Treatment	Water	Total PFCA-Sum	
320-96810-2	FM-19A/1	Pre-Treatment	Water	Total PFCA-Sum	
320-96810-3	FM-30A/1	Pre-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 660913

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96810-1	FM-10A/1	Post-Treatment	Water	Total PFCA-Sum	
320-96810-2	FM-19A/1	Post-Treatment	Water	Total PFCA-Sum	
320-96810-3	FM-30A/1	Post-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 660914

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96810-1	FM-10A/1	Total/NA	Water	Total PFCA-Dif	
320-96810-2	FM-19A/1	Total/NA	Water	Total PFCA-Dif	
320-96810-3	FM-30A/1	Total/NA	Water	Total PFCA-Dif	

Lab Chronicle

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Client Sample ID: FM-10A/1

Lab Sample ID: 320-96810-1

Date Collected: 02/14/23 09:45

Matrix: Water

Date Received: 02/15/23 09:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 12:15	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 15:07	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			660914	03/16/23 08:26	VSG	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			660913	03/16/23 08:24	VSG	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			660912	03/16/23 08:22	VSG	EET SAC

Client Sample ID: FM-19A/1

Lab Sample ID: 320-96810-2

Date Collected: 02/14/23 10:40

Matrix: Water

Date Received: 02/15/23 09:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 12:25	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 15:18	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			660914	03/16/23 08:26	VSG	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			660913	03/16/23 08:24	VSG	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			660912	03/16/23 08:22	VSG	EET SAC

Client Sample ID: FM-30A/1

Lab Sample ID: 320-96810-3

Date Collected: 02/14/23 11:40

Matrix: Water

Date Received: 02/15/23 09:25

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 12:46	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 15:38	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			660914	03/16/23 08:26	VSG	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			660913	03/16/23 08:24	VSG	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			660912	03/16/23 08:22	VSG	EET SAC

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Accreditation/Certification Summary

Client: Orange County Water District
Job ID: 320-96810-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
California	State	2897	01-22-24

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Post Prep	Water	4:2 FTS
537 (modified)	TOP Post Prep	Water	6:2 FTS
537 (modified)	TOP Post Prep	Water	8:2 FTS
537 (modified)	TOP Post Prep	Water	NEtFOSAA
537 (modified)	TOP Post Prep	Water	NMeFOSAA
537 (modified)	TOP Post Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Post Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Post Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Post Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Post Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Post Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Post Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Post Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Post Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Post Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Post Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Post Prep	Water	Perfluoropentanoic acid (PFPeA)
537 (modified)	TOP Post Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Post Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Post Prep	Water	Perfluoroundecanoic acid (PFUnA)
537 (modified)	TOP Pre - Prep	Water	4:2 FTS
537 (modified)	TOP Pre - Prep	Water	6:2 FTS
537 (modified)	TOP Pre - Prep	Water	8:2 FTS
537 (modified)	TOP Pre - Prep	Water	NEtFOSAA
537 (modified)	TOP Pre - Prep	Water	NMeFOSAA
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Pre - Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanoic acid (PFPeA)

Accreditation/Certification Summary

Client: Orange County Water District
Job ID: 320-96810-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento (Continued)

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Pre - Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Pre - Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroundecanoic acid (PFUnA)
Total PFCA-Dif		Water	PFBA
Total PFCA-Dif		Water	PFHpA
Total PFCA-Dif		Water	PFHxA
Total PFCA-Dif		Water	PFNA
Total PFCA-Dif		Water	PFOA
Total PFCA-Dif		Water	PFPA
Total PFCA-Dif		Water	Total PFCA
Total PFCA-Sum		Water	Total PFCA

Method Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Method	Method Description	Protocol	Laboratory
537 (modified)	Fluorinated Alkyl Substances	EPA	EET SAC
Total PFCA-Dif	Total PFCA (Treatment Difference)	TAL SOP	EET SAC
Total PFCA-Sum	Total PFCA (Summary)	TAL SOP	EET SAC
TOP Post Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC
TOP Pre - Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL SOP = TestAmerica Laboratories, Standard Operating Procedure

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96810-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-96810-1	FM-10A/1	Water	02/14/23 09:45	02/15/23 09:25
320-96810-2	FM-19A/1	Water	02/14/23 10:40	02/15/23 09:25
320-96810-3	FM-30A/1	Water	02/14/23 11:40	02/15/23 09:25

Eurofins Sacramento
880 Riverside Parkway
West Sacramento, Ca 95605
Phone (916) 373-5600 Fax (916) 372-1059

Chain of Custody Record

eurofins

Client Information	Sampler: Craig Patterson / Matt Drain	Lab PM: Karen Dahl	Carrier Tracking No(s):	COC No:
Client Contact: Patrick Versluis	Phone: 714-378-3200	E-Mail: Karen.Dahl@ET.Eurofins.com		Page: Page 1 of 1
Company: Orange County Water District				Job #:
Address: P.O. Box 8300	Due Date Requested:	Analysis Requested		
City: Fountain Valley	TAT Requested (days): Normal - 2 weeks			
State, Zip: California, 92728-8300				
Phone: (714) 378 - 8241	PO #:			
Email: pversluis@ocwd.com	WO #:			
Project Name: FBVOC	Project #:			

320-96810 Chain of Custody

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	537.1 MOD TOPS	Total Number of containers	Special Instructions/Note:
FM-10A/1	2/14/23	0945	G	W	N		X	4	
FM-19A/1	2/14/23	1040	G	W	N		X	4	
FM-30A/1	2/14/23	1140	G	W	N		X	4	*Please Call Pat Versluis if ANY detections are noted during analysis.*
									(714) 378 - 8241
									Email Results to :
									pversluis@ocwd.com
									rhintlian@ocwd.com

Possible Hazard Identification
☒ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☒ *Disposal By Lab* ☐ *Archive For _____ Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
1		2/14/23 / 1445	OCWD		2/15/23 925	EET SAC
2	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
3	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 0.6

Ver: 08/04/2016

Login Sample Receipt Checklist

Client: Orange County Water District

Job Number: 320-96810-1

Login Number: 96810
List Number: 1
Creator: Oropeza, Salvador

List Source: Eurofins Sacramento

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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ANALYTICAL REPORT

PREPARED FOR

Attn: Patrick Versluis
Orange County Water District
18700 Ward Street
Fountain Valley, California 92708

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JOB DESCRIPTION

FBVOC

JOB NUMBER

320-96904-1

Eurofins Sacramento
880 Riverside Parkway
West Sacramento CA 95605

See page two for job notes and contact information.

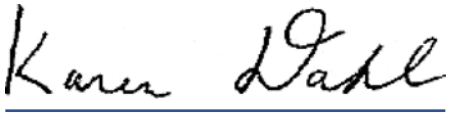
Job Notes

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The data in the report relate to the field sample(s) as received by the laboratory and associated QC. All results have been reviewed and have been found to be compliant with laboratory and accreditation requirements, with the exception of the noted deviation(s). For questions, please contact the Project Manager.

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Environment Testing Northern California, LLC Project Manager.

Authorization



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Authorized for release by
Karen Dahl, Senior Project Manager
Karen.Dahl@et.eurofinsus.com
(916)374-4384

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Definitions/Glossary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Qualifiers

LCMS

Qualifier	Qualifier Description
*+	LCS and/or LCSD is outside acceptance limits, high biased.
*5-	Isotope dilution analyte is outside acceptance limits, low biased.
H	Sample was prepped or analyzed beyond the specified holding time

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 320-96904-1

Laboratory: Eurofins Sacramento

Narrative

Comments
No additional comments.

Receipt
The samples were received on 2/17/2023 9:20 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 3.2º C.

LCMS
Method 537 (modified): The Isotope Dilution Analyte (IDA) recovery associated with the following samples is below the method recommended limit: (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s).

Method 537 (modified): The labeled analyte M2-4:2FTS is employed in this analysis as a “Reverse Surrogate”. It is used to monitor the oxidation efficiency of the TOP assay. This analyte is fortified into all sample fractions prior to any processing. The recovery of this analyte should be 0% in Post-Treatment fractions, indicating complete oxidation of the sample. FM-12A/1 (320-96904-1), (LCS 320-656915/2-A), (LCSD 320-656915/3-A), (MB 320-656915/1-A), FM-11A/1 (320-96904-2), AM-41A/1 (320-96904-3), (LCS 320-661235/2-A), (LCSD 320-661235/3-A), (MB 320-661235/1-A), (LCS 320-664631/2-A), (LCSD 320-664631/3-A), and (MB 320-664631/1-A).
.
Method 537 (modified): Zero percent recovery of precursor analytes (such as 4:2 FTS, 6:2 FTS, 8:2 FTS, FOSA, NMeFOSAA, NEtFOSAA, etc.) and enhanced recoveries of PFCA is observed in the Post-Treatment Laboratory Control Sample (LCS) and Post-Treatment Laboratory Control Sample Duplicate (LCSD) associated with these samples, consistent with the expected oxidation of precursor analytes. The existing LCS control limits are based upon our historical performance for a set of 24-36 analytes in the LCS solution. We have recently expanded to 70+ analytes. As the LCS solution now contains new/additional precursor analytes we are seeing enhanced recoveries for some PFCA vs. the historical limits as a result. The LCS results are flagged as being high and outside of the established limits for some analytes; however, this is a function of the new analytes in the LCS solution and not indicative of an “out of control” process. (LCS 320-656915/2-A), (LCSD 320-656915/3-A), (LCS 320-661235/2-A), and (LCSD 320-661235/3-A)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep
Method TOP Post Prep: The following samples inadvertently capsized and were lost during the oxidation step for post treatment: FM-11A/1 (320-96904-2) and AM-41A/1 (320-96904-3). The samples were re-extracted outside of the recommended preparation holding time.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Client Sample ID: FM-12A/1 — Lab Sample ID: 320-96904-1

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	9.8		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	6.7		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	9.9		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.4		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	8.4		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	12		5.0		ng/L	1		537 (modified)	Pre-Treatment
6:2 FTS	13		13		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	17	*+	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	9.1	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	8.9	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	9.7		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.7		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	7.8		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	14		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	17				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	2.1				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	18				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	26				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	45				ng/L	1		Total PFCA-Sum	Post-Treatment

Client Sample ID: FM-11A/1 — Lab Sample ID: 320-96904-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	9.7		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	7.4		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	12		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.3		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	6.8		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	23		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluoropentanoic acid (PFPeA)	11	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment

This Detection Summary does not include radiochemical test results.

Eurofins Sacramento

Client Sample ID: FM-11A/1 (Continued)

Lab Sample ID: 320-96904-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanoic acid (PFHxA)	9.6	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	12	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.4	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	8.2	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	22	H	5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	1.6				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	2.1				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	3.5				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	29				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	33				ng/L	1		Total PFCA-Sum	Post-Treatment

Client Sample ID: AM-41A/1

Lab Sample ID: 320-96904-3

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	7.2		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	5.9		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	9.8		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	5.8		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	25		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluoropentanoic acid (PFPeA)	7.7	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	7.5	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	9.2	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	5.9	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	24	H	5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.41				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	1.6				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	1.5				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	23				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	24				ng/L	1		Total PFCA-Sum	Post-Treatment

This Detection Summary does not include radiochemical test results.

Client Sample ID: FM-12A/1
Date Collected: 02/15/23 09:55
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-1
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluoropentanoic acid (PFPeA)	**9.8**		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorohexanoic acid (PFHxA)	**6.7**		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorooctanoic acid (PFOA)	**9.9**		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorobutanesulfonic acid (PFBS)	**5.4**		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorohexanesulfonic acid (PFHxS)	**8.4**		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorooctanesulfonic acid (PFOS)	**12**		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:48	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:48	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1
6:2 FTS	**13**		13		ng/L		02/27/23 11:57	03/08/23 15:48	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:48	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*101*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C5 PFPeA	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C2 PFHxA	*105*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C4 PFHpA	*107*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C4 PFOA	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C5 PFNA	*101*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C2 PFDA	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C2 PFUnA	*92*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C2 PFDoA	*93*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C2 PFTeDA	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C3 PFBS	*105*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
18O2 PFHxS	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C4 PFOS	*96*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
13C8 FOSA	*101*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
d3-NMeFOSAA	*91*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
d5-NEtFOSAA	*93*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
M2-6:2 FTS	*118*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
M2-8:2 FTS	*122*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*
M2-4:2 FTS	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:48*	*1*

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Client Sample ID: FM-12A/1

Date Collected: 02/15/23 09:55
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-1

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**17**	*+	13		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluoropentanoic acid (PFPeA)	**9.1**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorohexanoic acid (PFHxA)	**8.9**	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorooctanoic acid (PFOA)	**9.7**		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorobutanesulfonic acid (PFBS)	**5.7**		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorohexanesulfonic acid (PFHxS)	**7.8**		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorooctanesulfonic acid (PFOS)	**14**		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:56	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 12:56	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 12:56	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 12:56	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*87*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C5 PFPeA	*106*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C2 PFHxA	*107*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C4 PFHpA	*113*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C4 PFOA	*107*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C5 PFNA	*108*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C2 PFDA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C2 PFUnA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C2 PFDoA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C2 PFTeDA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C3 PFBS	*103*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
18O2 PFHxS	*113*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C4 PFOS	*99*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
13C8 FOSA	*105*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
d3-NMeFOSAA	*100*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
d5-NEtFOSAA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
M2-6:2 FTS	*134*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
M2-8:2 FTS	*125*		*25 - 150*	*02/27/23 11:37*	*03/08/23 12:56*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 12:56*	*1*

Client Sample ID: FM-12A/1

Lab Sample ID: 320-96904-1

Date Collected: 02/15/23 09:55

Matrix: Water

Date Received: 02/17/23 09:20

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**17**				ng/L			04/10/23 07:53	1
PFPA	**0.00**				ng/L			04/10/23 07:53	1
PFHxA	**2.1**				ng/L			04/10/23 07:53	1
PFHpA	**0.00**				ng/L			04/10/23 07:53	1
PFOA	**0.00**				ng/L			04/10/23 07:53	1
PFNA	**0.00**				ng/L			04/10/23 07:53	1
Total PFCA	**18**				ng/L			04/10/23 07:53	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**26**				ng/L			04/10/23 07:47	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**45**				ng/L			04/10/23 07:50	1

Client Sample ID: FM-11A/1

Lab Sample ID: 320-96904-2

Date Collected: 02/15/23 11:15

Matrix: Water

Date Received: 02/17/23 09:20

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluoropentanoic acid (PFPeA)	**9.7**		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorohexanoic acid (PFHxA)	**7.4**		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorooctanoic acid (PFOA)	**12**		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorobutanesulfonic acid (PFBS)	**5.3**		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorohexanesulfonic acid (PFHxS)	**6.8**		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorooctanesulfonic acid (PFOS)	**23**		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:58	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 15:58	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 15:58	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 15:58	1

Client Sample ID: FM-11A/1
Date Collected: 02/15/23 11:15
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-2
Matrix: Water

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C5 PFPeA	*114*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C2 PFHxA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C4 PFHpA	*118*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C4 PFOA	*115*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C5 PFNA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C2 PFDA	*107*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C2 PFUnA	*102*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C2 PFDoA	*103*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C2 PFTeDA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C3 PFBS	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
18O2 PFHxS	*120*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C4 PFOS	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
13C8 FOSA	*105*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
d3-NMeFOSAA	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
d5-NEtFOSAA	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
M2-6:2 FTS	*125*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
M2-8:2 FTS	*120*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*
M2-4:2 FTS	*117*		*25 - 150*	*02/27/23 11:57*	*03/08/23 15:58*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluoropentanoic acid (PFPeA)	**11**	**H *+**	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorohexanoic acid (PFHxA)	**9.6**	**H *+**	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluoroheptanoic acid (PFHpA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorooctanoic acid (PFOA)	**12**	**H**	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorononanoic acid (PFNA)	ND	H *+	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorodecanoic acid (PFDA)	ND	H *+	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluoroundecanoic acid (PFUnA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorododecanoic acid (PFDoA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorotridecanoic acid (PFTrDA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorobutanesulfonic acid (PFBS)	**5.4**	**H**	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluoropentanesulfonic acid (PFPeS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorohexanesulfonic acid (PFHxS)	**8.2**	**H**	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluoroheptanesulfonic acid (PFHpS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorooctanesulfonic acid (PFOS)	**22**	**H**	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorononanesulfonic acid (PFNS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorodecanesulfonic acid (PFDS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
Perfluorooctanesulfonamide (FOSA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
NMeFOSAA	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:33	1
NEtFOSAA	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:33	1
4:2 FTS	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1
6:2 FTS	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:33	1
8:2 FTS	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:33	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*103*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*

Client Sample ID: FM-11A/1

Date Collected: 02/15/23 11:15
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-2

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C5 PFPeA	*108*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C2 PFHxA	*113*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C4 PFHpA	*115*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C4 PFOA	*110*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C5 PFNA	*109*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C2 PFDA	*110*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C2 PFUnA	*98*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C2 PFDoA	*103*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C3 PFBS	*105*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
18O2 PFHxS	*116*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C4 PFOS	*104*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
13C8 FOSA	*100*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
d3-NMeFOSAA	*82*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
d5-NEtFOSAA	*83*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
M2-6:2 FTS	*108*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
M2-8:2 FTS	*122*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:33*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*03/15/23 21:24*	*03/17/23 23:33*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment - RE

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorotetradecanoic acid (PFTeA)	ND	H	5.0		ng/L		03/30/23 21:26	04/07/23 12:31	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C2 PFTeDA	*114*		*25 - 150*	*03/30/23 21:26*	*04/07/23 12:31*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*03/30/23 21:26*	*04/07/23 12:31*	*1*

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**0.00**				ng/L			04/10/23 07:53	1
PFPA	**1.6**				ng/L			04/10/23 07:53	1
PFHxA	**2.1**				ng/L			04/10/23 07:53	1
PFHpA	**0.00**				ng/L			04/10/23 07:53	1
PFOA	**0.00**				ng/L			04/10/23 07:53	1
PFNA	**0.00**				ng/L			04/10/23 07:53	1
Total PFCA	**3.5**				ng/L			04/10/23 07:53	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**29**				ng/L			04/10/23 07:47	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**33**				ng/L			04/10/23 07:50	1

Client Sample ID: AM-41A/1

Date Collected: 02/15/23 12:25
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-3

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluoropentanoic acid (PFPeA)	**7.2**		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1

Client Sample ID: AM-41A/1
Date Collected: 02/15/23 12:25
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-3
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorohexanoic acid (PFHxA)	**5.9**		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorooctanoic acid (PFOA)	**9.8**		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorohexanesulfonic acid (PFHxS)	**5.8**		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorooctanesulfonic acid (PFOS)	**25**		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 16:08	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 16:08	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 16:08	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:08	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C5 PFPeA	*92*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C2 PFHxA	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C4 PFHpA	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C4 PFOA	*92*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C5 PFNA	*88*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C2 PFDA	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C2 PFUnA	*83*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C2 PFDoA	*86*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C2 PFTeDA	*88*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C3 PFBS	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
18O2 PFHxS	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C4 PFOS	*85*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
13C8 FOSA	*86*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
d3-NMeFOSAA	*81*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
d5-NEtFOSAA	*87*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
M2-6:2 FTS	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
M2-8:2 FTS	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*
M2-4:2 FTS	*103*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:08*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:43	1

Client Sample ID: AM-41A/1
Date Collected: 02/15/23 12:25
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-3
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoropentanoic acid (PFPeA)	**7.7**	**H *+**	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorohexanoic acid (PFHxA)	**7.5**	**H *+**	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluoroheptanoic acid (PFHpA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorooctanoic acid (PFOA)	**9.2**	**H**	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorononanoic acid (PFNA)	ND	H *+	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorodecanoic acid (PFDA)	ND	H *+	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluoroundecanoic acid (PFUnA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorododecanoic acid (PFDoA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorotridecanoic acid (PFTrDA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorobutanesulfonic acid (PFBS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluoropentanesulfonic acid (PFPeS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorohexanesulfonic acid (PFHxS)	**5.9**	**H**	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluoroheptanesulfonic acid (PFHpS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorooctanesulfonic acid (PFOS)	**24**	**H**	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorononanesulfonic acid (PFNS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorodecanesulfonic acid (PFDS)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
Perfluorooctanesulfonamide (FOSA)	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
NMeFOSAA	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:43	1
NEtFOSAA	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:43	1
4:2 FTS	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1
6:2 FTS	ND	H	13		ng/L		03/15/23 21:24	03/17/23 23:43	1
8:2 FTS	ND	H	5.0		ng/L		03/15/23 21:24	03/17/23 23:43	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*103*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C5 PFPeA	*109*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C2 PFHxA	*109*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C4 PFHpA	*115*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C4 PFOA	*110*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C5 PFNA	*107*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C2 PFDA	*105*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C2 PFUnA	*100*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C2 PFDoA	*102*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C3 PFBS	*108*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
18O2 PFHxS	*115*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C4 PFOS	*100*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
13C8 FOSA	*83*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
d3-NMeFOSAA	*82*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
d5-NEtFOSAA	*82*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
M2-6:2 FTS	*103*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
M2-8:2 FTS	*114*		*25 - 150*	*03/15/23 21:24*	*03/17/23 23:43*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*03/15/23 21:24*	*03/17/23 23:43*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment - RE

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorotetradecanoic acid (PFTeA)	ND	H	5.0		ng/L		03/30/23 21:26	04/07/23 12:41	1

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Client Sample ID: AM-41A/1

Date Collected: 02/15/23 12:25
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-3

Matrix: Water

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C2 PFTeDA	*115*		*25 - 150*	*03/30/23 21:26*	*04/07/23 12:41*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*03/30/23 21:26*	*04/07/23 12:41*	*1*

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	**0.00**				ng/L			04/10/23 07:53	1
PFPA	**0.41**				ng/L			04/10/23 07:53	1
PFHxA	**1.6**				ng/L			04/10/23 07:53	1
PFHpA	**0.00**				ng/L			04/10/23 07:53	1
PFOA	**0.00**				ng/L			04/10/23 07:53	1
PFNA	**0.00**				ng/L			04/10/23 07:53	1
Total PFCA	**1.5**				ng/L			04/10/23 07:53	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**23**				ng/L			04/10/23 07:47	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	**24**				ng/L			04/10/23 07:50	1

Total Oxidation Precursors

Client: Orange County Water District
Project/Site: FBVOC

TestAmerica Job ID: 320-96904-1

Client Sample ID: FM-12A/1

Lab Sample ID: 320-96904-1
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	17		ng/L	17	ng/L
Perfluoropentanoic acid (PFPeA)	9.8		ng/L	9.1		ng/L	0.00	ng/L
Perfluorohexanoic acid (PFHxA)	6.7		ng/L	8.9		ng/L	2.1	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	9.9		ng/L	9.7		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	26		ng/L	45		ng/L	18	ng/L

Client Sample ID: FM-11A/1

Lab Sample ID: 320-96904-2
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluoropentanoic acid (PFPeA)	9.7		ng/L	11		ng/L	1.6	ng/L
Perfluorohexanoic acid (PFHxA)	7.4		ng/L	9.6		ng/L	2.1	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	12		ng/L	12		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	29		ng/L	33		ng/L	3.5	ng/L

Client Sample ID: AM-41A/1

Lab Sample ID: 320-96904-3
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluoropentanoic acid (PFPeA)	7.2		ng/L	7.7		ng/L	0.41	ng/L
Perfluorohexanoic acid (PFHxA)	5.9		ng/L	7.5		ng/L	1.6	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	9.8		ng/L	9.2		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	23		ng/L	24		ng/L	1.5	ng/L

[1] Difference = Post-Treatment - Pre-Treament

Isotope Dilution Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Pre-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96904-1	FM-12A/1	101	108	105	107	108	101	97	92
320-96904-2	FM-11A/1	109	114	111	118	115	112	107	102
320-96904-3	AM-41A/1	90	92	94	94	92	88	90	83
LCS 320-656952/2-A	Lab Control Sample	115	119	118	120	115	114	115	109
LCSD 320-656952/3-A	Lab Control Sample Dup	106	109	109	115	109	109	108	107
MB 320-656952/1-A	Method Blank	111	110	111	113	112	112	111	104

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96904-1	FM-12A/1	93	94	105	109	96	101	91	93
320-96904-2	FM-11A/1	103	104	109	120	108	105	98	99
320-96904-3	AM-41A/1	86	88	90	98	85	86	81	87
LCS 320-656952/2-A	Lab Control Sample	109	105	115	126	116	94	112	101
LCSD 320-656952/3-A	Lab Control Sample Dup	110	103	105	115	102	90	106	101
MB 320-656952/1-A	Method Blank	105	99	108	115	109	89	104	97

		Percent Isotope Dilution Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (25-150)
320-96904-1	FM-12A/1	118	122	110
320-96904-2	FM-11A/1	125	120	117
320-96904-3	AM-41A/1	104	104	103
LCS 320-656952/2-A	Lab Control Sample	131	142	123
LCSD 320-656952/3-A	Lab Control Sample Dup	126	134	121
MB 320-656952/1-A	Method Blank	135	126	120

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Isotope Dilution Summary

Client: Orange County Water District
Job ID: 320-96904-1
Project/Site: FBVOC

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Post-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96904-1	FM-12A/1	87	106	107	113	107	108	101	96
320-96904-2	FM-11A/1	103	108	113	115	110	109	110	98
320-96904-2 - RE	FM-11A/1								
320-96904-3	AM-41A/1	103	109	109	115	110	107	105	100
320-96904-3 - RE	AM-41A/1								
LCS 320-656915/2-A	Lab Control Sample	15 *5-	113	110	116	112	112	116	107
LCS 320-661235/2-A	Lab Control Sample	86	93	95	98	95	99	95	96
LCS 320-664631/2-A	Lab Control Sample								
LCSD 320-656915/3-A	Lab Control Sample Dup	15 *5-	113	113	112	109	115	112	104
LCSD 320-661235/3-A	Lab Control Sample Dup	105	116	114	122	116	118	115	110
LCSD 320-664631/3-A	Lab Control Sample Dup								
MB 320-656915/1-A	Method Blank	21 *5-	122	120	128	119	120	121	115
MB 320-661235/1-A	Method Blank	104	104	106	112	106	103	101	92
MB 320-664631/1-A	Method Blank								

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96904-1	FM-12A/1	96	102	103	113	99	105	100	102
320-96904-2	FM-11A/1	103		105	116	104	100	82	83
320-96904-2 - RE	FM-11A/1		114						
320-96904-3	AM-41A/1	102		108	115	100	83	82	82
320-96904-3 - RE	AM-41A/1		115						
LCS 320-656915/2-A	Lab Control Sample	109	105	115	119	109	112	110	111
LCS 320-661235/2-A	Lab Control Sample	104	98	93	102	91	88	83	87
LCS 320-664631/2-A	Lab Control Sample		120						
LCSD 320-656915/3-A	Lab Control Sample Dup	102	105	109	117	108	112	109	112
LCSD 320-661235/3-A	Lab Control Sample Dup	113	114	110	123	106	96	84	85
LCSD 320-664631/3-A	Lab Control Sample Dup		112						
MB 320-656915/1-A	Method Blank	114	113	114	131	115	117	118	117
MB 320-661235/1-A	Method Blank	98	94	103	114	95	71	65	66
MB 320-664631/1-A	Method Blank		123						

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (0-10)					
320-96904-1	FM-12A/1	134	125	0					
320-96904-2	FM-11A/1	108	122	0					
320-96904-2 - RE	FM-11A/1			0					
320-96904-3	AM-41A/1	103	114	0					
320-96904-3 - RE	AM-41A/1			0					
LCS 320-656915/2-A	Lab Control Sample	124	145	0					
LCS 320-661235/2-A	Lab Control Sample	93	109	0					
LCS 320-664631/2-A	Lab Control Sample			0					
LCSD 320-656915/3-A	Lab Control Sample Dup	131	130	0					
LCSD 320-661235/3-A	Lab Control Sample Dup	109	125	0					
LCSD 320-664631/3-A	Lab Control Sample Dup			0					
MB 320-656915/1-A	Method Blank	142	136	0					
MB 320-661235/1-A	Method Blank	99	103	0					
MB 320-664631/1-A	Method Blank			0					

Surrogate Legend

Isotope Dilution Summary

Client: Orange County Water District
Job ID: 320-96904-1
Project/Site: FBVOC

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Lab Sample ID: MB 320-656952/1-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Method Blank
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFPeA	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFHxA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFHpA	*113*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFNA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFUnA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDoA	*105*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFTeDA	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C3 PFBS	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
18O2 PFHxS	*115*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOS	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C8 FOSA	*89*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d3-NMeFOSAA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d5-NEtFOSAA	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-6:2 FTS	*135*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-8:2 FTS	*126*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-4:2 FTS	*120*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	107		ng/L		107	76 - 136
Perfluoropentanoic acid (PFPeA)	100	103		ng/L		103	71 - 131
Perfluorohexanoic acid (PFHxA)	100	97.6		ng/L		98	73 - 133
Perfluoroheptanoic acid (PFHpA)	100	104		ng/L		104	72 - 132
Perfluorooctanoic acid (PFOA)	100	111		ng/L		111	70 - 130
Perfluorononanoic acid (PFNA)	100	106		ng/L		106	75 - 135
Perfluorodecanoic acid (PFDA)	100	103		ng/L		103	76 - 136
Perfluoroundecanoic acid (PFUnA)	100	110		ng/L		110	68 - 128
Perfluorododecanoic acid (PFDoA)	100	104		ng/L		104	71 - 131
Perfluorotridecanoic acid (PFTrDA)	100	91.9		ng/L		92	71 - 131
Perfluorotetradecanoic acid (PFTeA)	100	73.2		ng/L		73	70 - 130
Perfluorobutanesulfonic acid (PFBS)	88.8	93.8		ng/L		106	67 - 127
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		109	66 - 126
Perfluorohexanesulfonic acid (PFHxS)	91.2	86.0		ng/L		94	59 - 119
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	76 - 136
Perfluorooctanesulfonic acid (PFOS)	93.0	100		ng/L		108	70 - 130
Perfluorononanesulfonic acid (PFNS)	96.2	103		ng/L		107	75 - 135
Perfluorodecanesulfonic acid (PFDS)	96.4	96.3		ng/L		100	71 - 131
Perfluorooctanesulfonamide (FOSA)	100	97.1		ng/L		97	73 - 133
NMeFOSAA	100	97.8		ng/L		98	76 - 136
NEtFOSAA	100	104		ng/L		104	76 - 136
4:2 FTS	93.8	110		ng/L		117	79 - 139
6:2 FTS	95.2	104		ng/L		109	59 - 175
8:2 FTS	96.0	102		ng/L		106	75 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*115*		*25 - 150*
13C5 PFPeA	*119*		*25 - 150*
13C2 PFHxA	*118*		*25 - 150*
13C4 PFHpA	*120*		*25 - 150*
13C4 PFOA	*115*		*25 - 150*
13C5 PFNA	*114*		*25 - 150*
13C2 PFDA	*115*		*25 - 150*
13C2 PFUnA	*109*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*126*		*25 - 150*
13C4 PFOS	*116*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C8 FOSA	94		25 - 150
d3-NMeFOSAA	112		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	131		25 - 150
M2-8:2 FTS	142		25 - 150
M2-4:2 FTS	123		25 - 150

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	107		ng/L		107	76 - 136	0	30
Perfluoropentanoic acid (PFPeA)			100	101		ng/L		101	71 - 131	2	30
Perfluorohexanoic acid (PFHxA)			100	100		ng/L		100	73 - 133	3	30
Perfluoroheptanoic acid (PFHpA)			100	102		ng/L		102	72 - 132	1	30
Perfluorooctanoic acid (PFOA)			100	105		ng/L		105	70 - 130	6	30
Perfluorononanoic acid (PFNA)			100	105		ng/L		105	75 - 135	1	30
Perfluorodecanoic acid (PFDA)			100	103		ng/L		103	76 - 136	1	30
Perfluoroundecanoic acid (PFUnA)			100	106		ng/L		106	68 - 128	4	30
Perfluorododecanoic acid (PFDoA)			100	99.4		ng/L		99	71 - 131	5	30
Perfluorotridecanoic acid (PFTrDA)			100	88.0		ng/L		88	71 - 131	4	30
Perfluorotetradecanoic acid (PFTeA)			100	82.1		ng/L		82	70 - 130	11	30
Perfluorobutanesulfonic acid (PFBS)			88.8	95.4		ng/L		107	67 - 127	2	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	105		ng/L		111	66 - 126	2	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	86.4		ng/L		95	59 - 119	0	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	107		ng/L		113	76 - 136	2	30
Perfluorooctanesulfonic acid (PFOS)			93.0	103		ng/L		111	70 - 130	3	30
Perfluorononanesulfonic acid (PFNS)			96.2	106		ng/L		110	75 - 135	3	30
Perfluorodecanesulfonic acid (PFDS)			96.4	101		ng/L		105	71 - 131	5	30
Perfluorooctanesulfonamide (FOSA)			100	98.2		ng/L		98	73 - 133	1	30
NMeFOSAA			100	99.2		ng/L		99	76 - 136	1	30
NEtFOSAA			100	100		ng/L		100	76 - 136	4	30
4:2 FTS			93.8	114		ng/L		122	79 - 139	4	30
6:2 FTS			95.2	99.9		ng/L		105	59 - 175	4	30
8:2 FTS			96.0	102		ng/L		107	75 - 135	0	30

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	106		25 - 150
13C5 PFPeA	109		25 - 150

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C2 PFHxA	109		25 - 150
13C4 PFHpA	115		25 - 150
13C4 PFOA	109		25 - 150
13C5 PFNA	109		25 - 150
13C2 PFDA	108		25 - 150
13C2 PFUnA	107		25 - 150
13C2 PFDoA	110		25 - 150
13C2 PFTeDA	103		25 - 150
13C3 PFBS	105		25 - 150
18O2 PFHxS	115		25 - 150
13C4 PFOS	102		25 - 150
13C8 FOSA	90		25 - 150
d3-NMeFOSAA	106		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	126		25 - 150
M2-8:2 FTS	134		25 - 150
M2-4:2 FTS	121		25 - 150

Lab Sample ID: MB 320-656915/1-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	21	*5-	25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFPeA	122		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFHxA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFHpA	128		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOA	119		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFNA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDA	121		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFUnA	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDoA	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFTeDA	113		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C3 PFBS	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
18O2 PFHxS	131		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOS	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C8 FOSA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d3-NMeFOSAA	118		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d5-NEtFOSAA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-6:2 FTS	142		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-8:2 FTS	136		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-4:2 FTS	0		0 - 10	02/27/23 11:37	03/08/23 10:54	1

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	398	*+	ng/L		398	93 - 153
Perfluoropentanoic acid (PFPeA)	100	199	*+	ng/L		199	85 - 145
Perfluorohexanoic acid (PFHxA)	100	239	*+	ng/L		239	81 - 141
Perfluoroheptanoic acid (PFHpA)	100	210	*+	ng/L		210	104 - 171
Perfluorooctanoic acid (PFOA)	100	411		ng/L		411	158 - 454
Perfluorononanoic acid (PFNA)	100	153	*+	ng/L		153	66 - 126
Perfluorodecanoic acid (PFDA)	100	144	*+	ng/L		144	65 - 125
Perfluoroundecanoic acid (PFUnA)	100	113		ng/L		113	57 - 117
Perfluorododecanoic acid (PFDoA)	100	96.0		ng/L		96	66 - 126
Perfluorotridecanoic acid (PFTrDA)	100	82.4		ng/L		82	65 - 136
Perfluorotetradecanoic acid (PFTeA)	100	66.9		ng/L		67	63 - 123
Perfluorobutanesulfonic acid (PFBS)	88.8	98.7		ng/L		111	75 - 135
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		108	70 - 130
Perfluorohexanesulfonic acid (PFHxS)	91.2	90.0		ng/L		99	64 - 124
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	70 - 131
Perfluorooctanesulfonic acid (PFOS)	93.0	105		ng/L		113	68 - 128
Perfluorononanesulfonic acid (PFNS)	96.2	101		ng/L		105	70 - 130
Perfluorodecanesulfonic acid (PFDS)	96.4	94.5		ng/L		98	66 - 126

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10		
NMeFOSAA			100	ND		ng/L		0	0 - 10		
NEtFOSAA			100	ND		ng/L		0	0 - 10		
4:2 FTS			93.8	ND		ng/L		0	0 - 10		
6:2 FTS			95.2	ND		ng/L		0	0 - 10		
8:2 FTS			96.0	ND		ng/L		0	0 - 10		

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*15*	*5-	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*110*		*25 - 150*
13C4 PFHpA	*116*		*25 - 150*
13C4 PFOA	*112*		*25 - 150*
13C5 PFNA	*112*		*25 - 150*
13C2 PFDA	*116*		*25 - 150*
13C2 PFUnA	*107*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*119*		*25 - 150*
13C4 PFOS	*109*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*110*		*25 - 150*
d5-NEtFOSAA	*111*		*25 - 150*
M2-6:2 FTS	*124*		*25 - 150*
M2-8:2 FTS	*145*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	330	*+	ng/L		330	93 - 153	19	30
Perfluoropentanoic acid (PFPeA)			100	188	*+	ng/L		188	85 - 145	5	30
Perfluorohexanoic acid (PFHxA)			100	228	*+	ng/L		228	81 - 141	5	30
Perfluoroheptanoic acid (PFHpA)			100	198	*+	ng/L		198	104 - 171	6	30
Perfluorooctanoic acid (PFOA)			100	379		ng/L		379	158 - 454	8	30
Perfluorononanoic acid (PFNA)			100	138	*+	ng/L		138	66 - 126	10	30
Perfluorodecanoic acid (PFDA)			100	134	*+	ng/L		134	65 - 125	7	30
Perfluoroundecanoic acid (PFUnA)			100	120	*+	ng/L		120	57 - 117	6	30
Perfluorododecanoic acid (PFDoA)			100	93.2		ng/L		93	66 - 126	3	30
Perfluorotridecanoic acid (PFTrDA)			100	81.1		ng/L		81	65 - 136	1	30
Perfluorotetradecanoic acid (PFTeA)			100	65.1		ng/L		65	63 - 123	3	30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanesulfonic acid (PFBS)			88.8	101		ng/L		114	75 - 135	2	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	99.9		ng/L		106	70 - 130	2	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	87.7		ng/L		96	64 - 124	3	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	97.1		ng/L		102	70 - 131	7	30
Perfluorooctanesulfonic acid (PFOS)			93.0	94.2		ng/L		101	68 - 128	11	30
Perfluorononanesulfonic acid (PFNS)			96.2	91.2		ng/L		95	70 - 130	10	30
Perfluorodecanesulfonic acid (PFDS)			96.4	87.4		ng/L		91	66 - 126	8	30
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10	NC	30
NMeFOSAA			100	ND		ng/L		0	0 - 10	NC	30
NEtFOSAA			100	ND		ng/L		0	0 - 10	NC	30
4:2 FTS			93.8	ND		ng/L		0	0 - 10	NC	30
6:2 FTS			95.2	ND		ng/L		0	0 - 10	NC	30
8:2 FTS			96.0	ND		ng/L		0	0 - 10	NC	30

Isotope Dilution	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
13C4 PFBA	*15*	**5-*	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*113*		*25 - 150*
13C4 PFHpA	*112*		*25 - 150*
13C4 PFOA	*109*		*25 - 150*
13C5 PFNA	*115*		*25 - 150*
13C2 PFDA	*112*		*25 - 150*
13C2 PFUnA	*104*		*25 - 150*
13C2 PFDoA	*102*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*109*		*25 - 150*
18O2 PFHxS	*117*		*25 - 150*
13C4 PFOS	*108*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*109*		*25 - 150*
d5-NEtFOSAA	*112*		*25 - 150*
M2-6:2 FTS	*131*		*25 - 150*
M2-8:2 FTS	*130*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

Lab Sample ID: MB 320-661235/1-A
Matrix: Water
Analysis Batch: 661770

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 661235

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: MB 320-661235/1-A
Matrix: Water
Analysis Batch: 661770

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 661235

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
NMeFOSAA	ND		13		ng/L		03/15/23 21:24	03/17/23 22:42	1
NEtFOSAA	ND		13		ng/L		03/15/23 21:24	03/17/23 22:42	1
4:2 FTS	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1
6:2 FTS	ND		13		ng/L		03/15/23 21:24	03/17/23 22:42	1
8:2 FTS	ND		5.0		ng/L		03/15/23 21:24	03/17/23 22:42	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*104*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C5 PFPeA	*104*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C2 PFHxA	*106*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C4 PFHpA	*112*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C4 PFOA	*106*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C5 PFNA	*103*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C2 PFDA	*101*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C2 PFUnA	*92*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C2 PFDoA	*98*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C2 PFTeDA	*94*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C3 PFBS	*103*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
18O2 PFHxS	*114*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C4 PFOS	*95*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
13C8 FOSA	*71*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
d3-NMeFOSAA	*65*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
d5-NEtFOSAA	*66*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
M2-6:2 FTS	*99*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
M2-8:2 FTS	*103*		*25 - 150*	*03/15/23 21:24*	*03/17/23 22:42*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*03/15/23 21:24*	*03/17/23 22:42*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-661235/2-A
Matrix: Water
Analysis Batch: 661770

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 661235

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	146		ng/L		146	93 - 153
Perfluoropentanoic acid (PFPeA)	100	155	*+	ng/L		155	85 - 145
Perfluorohexanoic acid (PFHxA)	100	176	*+	ng/L		176	81 - 141
Perfluoroheptanoic acid (PFHpA)	100	163		ng/L		163	104 - 171
Perfluorooctanoic acid (PFOA)	100	251		ng/L		251	158 - 454
Perfluorononanoic acid (PFNA)	100	134	*+	ng/L		134	66 - 126
Perfluorodecanoic acid (PFDA)	100	132	*+	ng/L		132	65 - 125
Perfluoroundecanoic acid (PFUnA)	100	96.2		ng/L		96	57 - 117
Perfluorododecanoic acid (PFDoA)	100	79.0		ng/L		79	66 - 126
Perfluorotridecanoic acid (PFTrDA)	100	71.5		ng/L		72	65 - 136
Perfluorobutanesulfonic acid (PFBS)	88.8	88.2		ng/L		99	75 - 135
Perfluoropentanesulfonic acid (PFPeS)	94.0	91.9		ng/L		98	70 - 130
Perfluorohexanesulfonic acid (PFHxS)	91.2	76.5		ng/L		84	64 - 124
Perfluoroheptanesulfonic acid (PFHpS)	95.4	89.8		ng/L		94	70 - 131
Perfluorooctanesulfonic acid (PFOS)	93.0	82.2		ng/L		88	68 - 128
Perfluorononanesulfonic acid (PFNS)	96.2	84.9		ng/L		88	70 - 130
Perfluorodecanesulfonic acid (PFDS)	96.4	80.1		ng/L		83	66 - 126
Perfluorooctanesulfonamide (FOSA)	100	ND		ng/L		0	0 - 10
NMeFOSAA	100	ND		ng/L		0	0 - 10
NEtFOSAA	100	ND		ng/L		0	0 - 10
4:2 FTS	93.8	ND		ng/L		0	0 - 10
6:2 FTS	95.2	ND		ng/L		0	0 - 10
8:2 FTS	96.0	ND		ng/L		0	0 - 10

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*86*		*25 - 150*
13C5 PFPeA	*93*		*25 - 150*
13C2 PFHxA	*95*		*25 - 150*
13C4 PFHpA	*98*		*25 - 150*
13C4 PFOA	*95*		*25 - 150*
13C5 PFNA	*99*		*25 - 150*
13C2 PFDA	*95*		*25 - 150*
13C2 PFUnA	*96*		*25 - 150*
13C2 PFDoA	*104*		*25 - 150*
13C2 PFTeDA	*98*		*25 - 150*
13C3 PFBS	*93*		*25 - 150*
18O2 PFHxS	*102*		*25 - 150*
13C4 PFOS	*91*		*25 - 150*
13C8 FOSA	*88*		*25 - 150*
d3-NMeFOSAA	*83*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-661235/2-A
Matrix: Water
Analysis Batch: 661770

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 661235

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
d5-NEtFOSAA	87		25 - 150
M2-6:2 FTS	93		25 - 150
M2-8:2 FTS	109		25 - 150
M2-4:2 FTS	0		0 - 10

Lab Sample ID: LCSD 320-661235/3-A
Matrix: Water
Analysis Batch: 661770

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 661235

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	150		ng/L		150	93 - 153	2	30
Perfluoropentanoic acid (PFPeA)			100	143		ng/L		143	85 - 145	8	30
Perfluorohexanoic acid (PFHxA)			100	182	*+	ng/L		182	81 - 141	4	30
Perfluoroheptanoic acid (PFHpA)			100	160		ng/L		160	104 - 171	2	30
Perfluorooctanoic acid (PFOA)			100	294		ng/L		294	158 - 454	16	30
Perfluorononanoic acid (PFNA)			100	139	*+	ng/L		139	66 - 126	4	30
Perfluorodecanoic acid (PFDA)			100	129	*+	ng/L		129	65 - 125	2	30
Perfluoroundecanoic acid (PFUnA)			100	89.6		ng/L		90	57 - 117	7	30
Perfluorododecanoic acid (PFDoA)			100	70.9		ng/L		71	66 - 126	11	30
Perfluorotridecanoic acid (PFTrDA)			100	64.9		ng/L		65	65 - 136	10	30
Perfluorobutanesulfonic acid (PFBS)			88.8	88.8		ng/L		100	75 - 135	1	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	92.4		ng/L		98	70 - 130	1	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	76.0		ng/L		83	64 - 124	1	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	90.9		ng/L		95	70 - 131	1	30
Perfluorooctanesulfonic acid (PFOS)			93.0	85.7		ng/L		92	68 - 128	4	30
Perfluorononanesulfonic acid (PFNS)			96.2	85.2		ng/L		89	70 - 130	0	30
Perfluorodecanesulfonic acid (PFDS)			96.4	70.1		ng/L		73	66 - 126	13	30
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10	NC	30
NMeFOSAA			100	ND		ng/L		0	0 - 10	NC	30
NEtFOSAA			100	ND		ng/L		0	0 - 10	NC	30
4:2 FTS			93.8	ND		ng/L		0	0 - 10	NC	30
6:2 FTS			95.2	ND		ng/L		0	0 - 10	NC	30
8:2 FTS			96.0	ND		ng/L		0	0 - 10	NC	30

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	105		25 - 150
13C5 PFPeA	116		25 - 150
13C2 PFHxA	114		25 - 150
13C4 PFHpA	122		25 - 150
13C4 PFOA	116		25 - 150
13C5 PFNA	118		25 - 150

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-661235/3-A
Matrix: Water
Analysis Batch: 661770

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 661235

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C2 PFDA	115		25 - 150
13C2 PFUnA	110		25 - 150
13C2 PFDoA	113		25 - 150
13C2 PFTeDA	114		25 - 150
13C3 PFBS	110		25 - 150
18O2 PFHxS	123		25 - 150
13C4 PFOS	106		25 - 150
13C8 FOSA	96		25 - 150
d3-NMeFOSAA	84		25 - 150
d5-NEtFOSAA	85		25 - 150
M2-6:2 FTS	109		25 - 150
M2-8:2 FTS	125		25 - 150
M2-4:2 FTS	0		0 - 10

Lab Sample ID: MB 320-664631/1-A
Matrix: Water
Analysis Batch: 666487

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 664631

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		03/30/23 21:26	04/07/23 11:50	1

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C2 PFTeDA	123		25 - 150	03/30/23 21:26	04/07/23 11:50	1
M2-4:2 FTS	0		0 - 10	03/30/23 21:26	04/07/23 11:50	1

Lab Sample ID: LCS 320-664631/2-A
Matrix: Water
Analysis Batch: 666487

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 664631

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Perfluorotetradecanoic acid (PFTeA)			100	80.3		ng/L		80	63 - 123		

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C2 PFTeDA	120		25 - 150
M2-4:2 FTS	0		0 - 10

Lab Sample ID: LCSD 320-664631/3-A
Matrix: Water
Analysis Batch: 666487

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 664631

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorotetradecanoic acid (PFTeA)			100	79.3		ng/L		79	63 - 123	1	30

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C2 PFTeDA	112		25 - 150
M2-4:2 FTS	0		0 - 10

LCMS

Prep Batch: 656915

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-1	FM-12A/1	Post-Treatment	Water	TOP Post Prep	
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	TOP Post Prep	
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	TOP Post Prep	
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	TOP Post Prep	

Prep Batch: 656952

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-1	FM-12A/1	Pre-Treatment	Water	TOP Pre - Prep	
320-96904-2	FM-11A/1	Pre-Treatment	Water	TOP Pre - Prep	
320-96904-3	AM-41A/1	Pre-Treatment	Water	TOP Pre - Prep	
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	TOP Pre - Prep	
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	TOP Pre - Prep	
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	TOP Pre - Prep	

Analysis Batch: 659747

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-1	FM-12A/1	Post-Treatment	Water	537 (modified)	656915
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	537 (modified)	656915
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	537 (modified)	656915
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	537 (modified)	656915

Analysis Batch: 659748

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-1	FM-12A/1	Pre-Treatment	Water	537 (modified)	656952
320-96904-2	FM-11A/1	Pre-Treatment	Water	537 (modified)	656952
320-96904-3	AM-41A/1	Pre-Treatment	Water	537 (modified)	656952
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	537 (modified)	656952
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	537 (modified)	656952
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	537 (modified)	656952

Prep Batch: 661235

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-2	FM-11A/1	Post-Treatment	Water	TOP Post Prep	
320-96904-3	AM-41A/1	Post-Treatment	Water	TOP Post Prep	
MB 320-661235/1-A	Method Blank	Post-Treatment	Water	TOP Post Prep	
LCS 320-661235/2-A	Lab Control Sample	Post-Treatment	Water	TOP Post Prep	
LCSD 320-661235/3-A	Lab Control Sample Dup	Post-Treatment	Water	TOP Post Prep	

Analysis Batch: 661770

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-2	FM-11A/1	Post-Treatment	Water	537 (modified)	661235
320-96904-3	AM-41A/1	Post-Treatment	Water	537 (modified)	661235
MB 320-661235/1-A	Method Blank	Post-Treatment	Water	537 (modified)	661235
LCS 320-661235/2-A	Lab Control Sample	Post-Treatment	Water	537 (modified)	661235
LCSD 320-661235/3-A	Lab Control Sample Dup	Post-Treatment	Water	537 (modified)	661235

Prep Batch: 664631

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-2 - RE	FM-11A/1	Post-Treatment	Water	TOP Post Prep	
320-96904-3 - RE	AM-41A/1	Post-Treatment	Water	TOP Post Prep	
MB 320-664631/1-A	Method Blank	Post-Treatment	Water	TOP Post Prep	

LCMS (Continued)

Prep Batch: 664631 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 320-664631/2-A	Lab Control Sample	Post-Treatment	Water	TOP Post Prep	
LCSD 320-664631/3-A	Lab Control Sample Dup	Post-Treatment	Water	TOP Post Prep	

Analysis Batch: 666487

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-2 - RE	FM-11A/1	Post-Treatment	Water	537 (modified)	664631
320-96904-3 - RE	AM-41A/1	Post-Treatment	Water	537 (modified)	664631
MB 320-664631/1-A	Method Blank	Post-Treatment	Water	537 (modified)	664631
LCS 320-664631/2-A	Lab Control Sample	Post-Treatment	Water	537 (modified)	664631
LCSD 320-664631/3-A	Lab Control Sample Dup	Post-Treatment	Water	537 (modified)	664631

Analysis Batch: 666521

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-1	FM-12A/1	Pre-Treatment	Water	Total PFCA-Sum	
320-96904-2	FM-11A/1	Pre-Treatment	Water	Total PFCA-Sum	
320-96904-3	AM-41A/1	Pre-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 666522

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-1	FM-12A/1	Post-Treatment	Water	Total PFCA-Sum	
320-96904-2	FM-11A/1	Post-Treatment	Water	Total PFCA-Sum	
320-96904-3	AM-41A/1	Post-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 666523

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96904-1	FM-12A/1	Total/NA	Water	Total PFCA-Dif	
320-96904-2	FM-11A/1	Total/NA	Water	Total PFCA-Dif	
320-96904-3	AM-41A/1	Total/NA	Water	Total PFCA-Dif	

Lab Chronicle

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Client Sample ID: FM-12A/1

Date Collected: 02/15/23 09:55
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-1

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 12:56	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 15:48	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			666523	04/10/23 07:53	MKW	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			666522	04/10/23 07:50	MKW	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			666521	04/10/23 07:47	MKW	EET SAC

Client Sample ID: FM-11A/1

Date Collected: 02/15/23 11:15
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-2

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	661235	03/15/23 21:24	JER	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	661770	03/17/23 23:33	D1R	EET SAC
Post-Treatment	Prep	TOP Post Prep	RE		100.0 mL	10.0 mL	664631	03/30/23 21:26	JER	EET SAC
Post-Treatment	Analysis	537 (modified)	RE	1	1 mL	1 mL	666487	04/07/23 12:31	AF	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 15:58	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			666523	04/10/23 07:53	MKW	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			666522	04/10/23 07:50	MKW	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			666521	04/10/23 07:47	MKW	EET SAC

Client Sample ID: AM-41A/1

Date Collected: 02/15/23 12:25
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96904-3

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	661235	03/15/23 21:24	JER	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	661770	03/17/23 23:43	D1R	EET SAC
Post-Treatment	Prep	TOP Post Prep	RE		100.0 mL	10.0 mL	664631	03/30/23 21:26	JER	EET SAC
Post-Treatment	Analysis	537 (modified)	RE	1	1 mL	1 mL	666487	04/07/23 12:41	AF	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 16:08	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			666523	04/10/23 07:53	MKW	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			666522	04/10/23 07:50	MKW	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			666521	04/10/23 07:47	MKW	EET SAC

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Accreditation/Certification Summary

Client: Orange County Water District
Job ID: 320-96904-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
California	State	2897	01-22-24

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Post Prep	Water	4:2 FTS
537 (modified)	TOP Post Prep	Water	6:2 FTS
537 (modified)	TOP Post Prep	Water	8:2 FTS
537 (modified)	TOP Post Prep	Water	NEtFOSAA
537 (modified)	TOP Post Prep	Water	NMeFOSAA
537 (modified)	TOP Post Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Post Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Post Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Post Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Post Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Post Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Post Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Post Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Post Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Post Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Post Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Post Prep	Water	Perfluoropentanoic acid (PFPeA)
537 (modified)	TOP Post Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Post Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Post Prep	Water	Perfluoroundecanoic acid (PFUnA)
537 (modified)	TOP Pre - Prep	Water	4:2 FTS
537 (modified)	TOP Pre - Prep	Water	6:2 FTS
537 (modified)	TOP Pre - Prep	Water	8:2 FTS
537 (modified)	TOP Pre - Prep	Water	NEtFOSAA
537 (modified)	TOP Pre - Prep	Water	NMeFOSAA
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Pre - Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanoic acid (PFPeA)

Client: Orange County Water District
Job ID: 320-96904-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento (Continued)

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Pre - Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Pre - Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroundecanoic acid (PFUnA)
Total PFCA-Dif		Water	PFBA
Total PFCA-Dif		Water	PFHpA
Total PFCA-Dif		Water	PFHxA
Total PFCA-Dif		Water	PFNA
Total PFCA-Dif		Water	PFOA
Total PFCA-Dif		Water	PFPA
Total PFCA-Dif		Water	Total PFCA
Total PFCA-Sum		Water	Total PFCA

Method Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Method	Method Description	Protocol	Laboratory
537 (modified)	Fluorinated Alkyl Substances	EPA	EET SAC
Total PFCA-Dif	Total PFCA (Treatment Difference)	TAL SOP	EET SAC
Total PFCA-Sum	Total PFCA (Summary)	TAL SOP	EET SAC
TOP Post Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC
TOP Pre - Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL SOP = TestAmerica Laboratories, Standard Operating Procedure

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96904-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-96904-1	FM-12A/1	Water	02/15/23 09:55	02/17/23 09:20
320-96904-2	FM-11A/1	Water	02/15/23 11:15	02/17/23 09:20
320-96904-3	AM-41A/1	Water	02/15/23 12:25	02/17/23 09:20

Eurofins Sacramento
880 Riverside Parkway
West Sacramento, Ca 95605
Phone (916) 373-5600 Fax (916) 372-1059

Chain of Custody Record

eurofins

Client Information	Sampler: John Merlo / Matt Drain	Lab PM: Karen Dahl	Carrier Tracking No(s):	COC No:
Client Contact: Patrick Versluis	Phone: 714-378-3200	E-Mail: Karen.Dahl@ET.Eurofins.com		Page: Page 1 of 1
Company: Orange County Water District				Job #
Address: P.O. Box 8300	Due Date Requested:			
City: Fountain Valley	TAT Requested (days): Normal - 2 weeks			
State, Zip: California, 92728-8300				
Phone: (714) 378 - 8241	PO #:			
Email: pversluis@ocwd.com	WO #:			
Project Name: FBVOC	Project #:			

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=wasteoil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	537.1 MOD TOPS	Total Number of containers	Special Instructions/Note:
FM-12A/1	2/15/23	0955	G	W	N		X	4	
FM-11A/1	2/15/23	1115	G	W	N		X	4	
AM-41A/1	2/15/23	1225	G	W	N		X	4	*Please Call Pat Versluis if ANY detections are noted during analysis.*
									(714) 378 - 8241
									Email Results to:
									pversluis@ocwd.com
									rhintlian@ocwd.com

320-96904 Chain of Custody

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by	Date/Time	Company	Received by	Date/Time	Company
1	John Merlo	2/16/2023 1400	OCWD		2/17/23 920	ET SAC
2	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
3	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 3.2

Ver: 08/04/2016

Login Sample Receipt Checklist

Client: Orange County Water District

Job Number: 320-96904-1

Login Number: 96904
List Number: 1
Creator: Fisher, Jamyiah L

List Source: Eurofins Sacramento

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	Not requested on COC.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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ANALYTICAL REPORT

PREPARED FOR

Attn: Patrick Versluis
Orange County Water District
18700 Ward Street
Fountain Valley, California 92708

Generated 3/15/2023 11:46:14 AM

JOB DESCRIPTION

FBVOC

JOB NUMBER

320-96906-1

Eurofins Sacramento
880 Riverside Parkway
West Sacramento CA 95605

See page two for job notes and contact information.

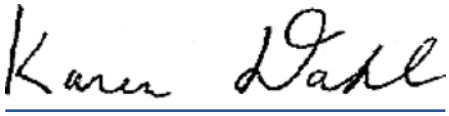
Job Notes

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The data in the report relate to the field sample(s) as received by the laboratory and associated QC. All results have been reviewed and have been found to be compliant with laboratory and accreditation requirements, with the exception of the noted deviation(s). For questions, please contact the Project Manager.

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Environment Testing Northern California, LLC Project Manager.

Authorization



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Authorized for release by
Karen Dahl, Senior Project Manager
Karen.Dahl@et.eurofinsus.com
(916)374-4384

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Definitions/Glossary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Qualifiers

LCMS

Qualifier	Qualifier Description
*+	LCS and/or LCSD is outside acceptance limits, high biased.
*5-	Isotope dilution analyte is outside acceptance limits, low biased.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 320-96906-1

Laboratory: Eurofins Sacramento

Narrative

Comments
No additional comments.

Receipt
The sample was received on 2/17/2023 9:20 AM. Unless otherwise noted below, the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 3.2º C.

LCMS
Method 537 (modified): One Isotope Dilution Analyte (IDA) recovery is below the method recommended limit for the following samples (post treatment): (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDAs for these samples.

Method 537 (modified): The labeled analyte M2-4:2FTS is employed in this analysis as a “Reverse Surrogate”. It is used to monitor the oxidation efficiency of the TOP assay. This analyte is fortified into all sample fractions prior to any processing. The recovery of this analyte should be 0% in Post-Treatment fractions, indicating complete oxidation of the sample. FM-7A/1 (320-96906-1), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A)

Method 537 (modified): Zero percent recovery of precursor analytes (such as 4:2 FTS, 6:2 FTS, 8:2 FTS, FOSA, NMeFOSAA, NEtFOSAA, etc.) and enhanced recoveries of PFCA is observed in the Post-Treatment Laboratory Control Sample (LCS) and Post-Treatment Laboratory Control Sample Duplicate (LCSD) associated with these samples, consistent with the expected oxidation of precursor analytes. The existing LCS control limits are based upon our historical performance for a set of 24-36 analytes in the LCS solution. We have recently expanded to 70+ analytes. As the LCS solution now contains new/additional precursor analytes we are seeing enhanced recoveries for some PFCA vs. the historical limits as a result. The LCS results are flagged as being high and outside of the established limits for some analytes; however, this is a function of the new analytes in the LCS solution and not indicative of an “out of control” process. FM-7A/1 (320-96906-1), (LCS 320-656915/2-A), (LCSD 320-656915/3-A) and (MB 320-656915/1-A)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Client Sample ID: FM-7A/1

Lab Sample ID: 320-96906-1

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	14		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	11		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluoroheptanoic acid (PFHpA)	6.0		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	13		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.6		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	10		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	32		5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	14	*+	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	9.6	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	10	*+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	11		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.7		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	7.1		5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	21		5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	14				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	0.60				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	44				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	45				ng/L	1		Total PFCA-Sum	Post-Treatment

This Detection Summary does not include radiochemical test results.

Client Sample ID: FM-7A/1

Date Collected: 02/16/23 11:30
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96906-1

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluoropentanoic acid (PFPeA)	**14**		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorohexanoic acid (PFHxA)	**11**		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluoroheptanoic acid (PFHpA)	**6.0**		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorooctanoic acid (PFOA)	**13**		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorobutanesulfonic acid (PFBS)	**5.6**		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorohexanesulfonic acid (PFHxS)	**10**		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorooctanesulfonic acid (PFOS)	**32**		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 16:18	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 16:18	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 16:18	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 16:18	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*91*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C5 PFPeA	*93*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C2 PFHxA	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C4 PFHpA	*95*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C4 PFOA	*94*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C5 PFNA	*95*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C2 PFDA	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C2 PFUnA	*86*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C2 PFDoA	*90*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C2 PFTeDA	*89*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C3 PFBS	*88*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
18O2 PFHxS	*98*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C4 PFOS	*86*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
13C8 FOSA	*84*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
d3-NMeFOSAA	*82*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
d5-NEtFOSAA	*88*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
M2-6:2 FTS	*106*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
M2-8:2 FTS	*102*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*
M2-4:2 FTS	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 16:18*	*1*

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Client Sample ID: FM-7A/1

Date Collected: 02/16/23 11:30
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96906-1

Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**14**	***+**	13		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluoropentanoic acid (PFPeA)	**9.6**	***+**	5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorohexanoic acid (PFHxA)	**10**	***+**	5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluoroheptanoic acid (PFHpA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorooctanoic acid (PFOA)	**11**		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorononanoic acid (PFNA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorodecanoic acid (PFDA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluoroundecanoic acid (PFUnA)	ND	*+	5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorobutanesulfonic acid (PFBS)	**5.7**		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorohexanesulfonic acid (PFHxS)	**7.1**		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorooctanesulfonic acid (PFOS)	**21**		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 13:06	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 13:06	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 13:06	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 13:06	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C5 PFPeA	*114*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C2 PFHxA	*106*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C4 PFHpA	*110*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C4 PFOA	*110*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C5 PFNA	*108*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C2 PFDA	*104*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C2 PFUnA	*92*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C2 PFDoA	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C2 PFTeDA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C3 PFBS	*108*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
18O2 PFHxS	*112*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C4 PFOS	*96*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
13C8 FOSA	*98*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
d3-NMeFOSAA	*102*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
d5-NEtFOSAA	*101*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
M2-6:2 FTS	*139*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
M2-8:2 FTS	*128*		*25 - 150*	*02/27/23 11:37*	*03/08/23 13:06*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*02/27/23 11:37*	*03/08/23 13:06*	*1*

Client: Orange County Water District
Job ID: 320-96906-1
Project/Site: FBVOC

Client Sample ID: FM-7A/1
Lab Sample ID: 320-96906-1
Date Collected: 02/16/23 11:30
Matrix: Water
Date Received: 02/17/23 09:20

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	14				ng/L			03/15/23 16:04	1
PFPA	0.00				ng/L			03/15/23 16:04	1
PFHxA	0.00				ng/L			03/15/23 16:04	1
PFHpA	0.00				ng/L			03/15/23 16:04	1
PFOA	0.00				ng/L			03/15/23 16:04	1
PFNA	0.00				ng/L			03/15/23 16:04	1
Total PFCA	0.60				ng/L			03/15/23 16:04	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	44				ng/L			03/15/23 16:00	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	45				ng/L			03/15/23 16:02	1

Total Oxidation Precursors

Client: Orange County Water District
Project/Site: FBVOC

TestAmerica Job ID: 320-96906-1

Client Sample ID: FM-7A/1

Lab Sample ID: 320-96906-1
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	14		ng/L	14	ng/L
Perfluoropentanoic acid (PFPeA)	14		ng/L	9.6		ng/L	0.00	ng/L
Perfluorohexanoic acid (PFHxA)	11		ng/L	10		ng/L	0.00	ng/L
Perfluoroheptanoic acid (PFHpA)	6.0		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	13		ng/L	11		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	44		ng/L	45		ng/L	0.60	ng/L

[1] Difference = Post-Treatment - Pre-Treament

Isotope Dilution Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Pre-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96906-1	FM-7A/1	91	93	90	95	94	95	90	86
LCS 320-656952/2-A	Lab Control Sample	115	119	118	120	115	114	115	109
LCSD 320-656952/3-A	Lab Control Sample Dup	106	109	109	115	109	109	108	107
MB 320-656952/1-A	Method Blank	111	110	111	113	112	112	111	104

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96906-1	FM-7A/1	90	89	88	98	86	84	82	88
LCS 320-656952/2-A	Lab Control Sample	109	105	115	126	116	94	112	101
LCSD 320-656952/3-A	Lab Control Sample Dup	110	103	105	115	102	90	106	101
MB 320-656952/1-A	Method Blank	105	99	108	115	109	89	104	97

		Percent Isotope Dilution Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (25-150)
320-96906-1	FM-7A/1	106	102	97
LCS 320-656952/2-A	Lab Control Sample	131	142	123
LCSD 320-656952/3-A	Lab Control Sample Dup	126	134	121
MB 320-656952/1-A	Method Blank	135	126	120

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Post-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFBA (25-150)	PFPeA (25-150)	PFHxA (25-150)	C4PFHA (25-150)	PFOA (25-150)	PFNA (25-150)	PFDA (25-150)	PFUnA (25-150)
320-96906-1	FM-7A/1	102	114	106	110	110	108	104	92
LCS 320-656915/2-A	Lab Control Sample	15 *5-	113	110	116	112	112	116	107
LCSD 320-656915/3-A	Lab Control Sample Dup	15 *5-	113	113	112	109	115	112	104
MB 320-656915/1-A	Method Blank	21 *5-	122	120	128	119	120	121	115

Isotope Dilution Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Matrix: Water

Prep Type: Post-Treatment

		Percent Isotope Dilution Recovery (Acceptance Limits)							
Lab Sample ID	Client Sample ID	PFDoA (25-150)	PFTDA (25-150)	C3PFBS (25-150)	PFHxS (25-150)	PFOS (25-150)	PFOSA (25-150)	d3NMFOS (25-150)	d5NEFOS (25-150)
320-96906-1	FM-7A/1	96	101	108	112	96	98	102	101
LCS 320-656915/2-A	Lab Control Sample	109	105	115	119	109	112	110	111
LCSD 320-656915/3-A	Lab Control Sample Dup	102	105	109	117	108	112	109	112
MB 320-656915/1-A	Method Blank	114	113	114	131	115	117	118	117

		Percent Isotope Dilution Recovery (Acceptance Limits)		
Lab Sample ID	Client Sample ID	M262FTS (25-150)	M282FTS (25-150)	M242FTS (0-10)
320-96906-1	FM-7A/1	139	128	0
LCS 320-656915/2-A	Lab Control Sample	124	145	0
LCSD 320-656915/3-A	Lab Control Sample Dup	131	130	0
MB 320-656915/1-A	Method Blank	142	136	0

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Lab Sample ID: MB 320-656952/1-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Method Blank
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1
6:2 FTS	ND		13		ng/L		02/27/23 11:57	03/08/23 13:47	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:57	03/08/23 13:47	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFPeA	*110*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFHxA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFHpA	*113*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C5 PFNA	*112*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDA	*111*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFUnA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFDoA	*105*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C2 PFTeDA	*99*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C3 PFBS	*108*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
18O2 PFHxS	*115*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C4 PFOS	*109*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
13C8 FOSA	*89*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d3-NMeFOSAA	*104*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
d5-NEtFOSAA	*97*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-6:2 FTS	*135*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-8:2 FTS	*126*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*
M2-4:2 FTS	*120*		*25 - 150*	*02/27/23 11:57*	*03/08/23 13:47*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	107		ng/L		107	76 - 136
Perfluoropentanoic acid (PFPeA)	100	103		ng/L		103	71 - 131
Perfluorohexanoic acid (PFHxA)	100	97.6		ng/L		98	73 - 133
Perfluoroheptanoic acid (PFHpA)	100	104		ng/L		104	72 - 132
Perfluorooctanoic acid (PFOA)	100	111		ng/L		111	70 - 130
Perfluorononanoic acid (PFNA)	100	106		ng/L		106	75 - 135
Perfluorodecanoic acid (PFDA)	100	103		ng/L		103	76 - 136
Perfluoroundecanoic acid (PFUnA)	100	110		ng/L		110	68 - 128
Perfluorododecanoic acid (PFDoA)	100	104		ng/L		104	71 - 131
Perfluorotridecanoic acid (PFTrDA)	100	91.9		ng/L		92	71 - 131
Perfluorotetradecanoic acid (PFTeA)	100	73.2		ng/L		73	70 - 130
Perfluorobutanesulfonic acid (PFBS)	88.8	93.8		ng/L		106	67 - 127
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		109	66 - 126
Perfluorohexanesulfonic acid (PFHxS)	91.2	86.0		ng/L		94	59 - 119
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	76 - 136
Perfluorooctanesulfonic acid (PFOS)	93.0	100		ng/L		108	70 - 130
Perfluorononanesulfonic acid (PFNS)	96.2	103		ng/L		107	75 - 135
Perfluorodecanesulfonic acid (PFDS)	96.4	96.3		ng/L		100	71 - 131
Perfluorooctanesulfonamide (FOSA)	100	97.1		ng/L		97	73 - 133
NMeFOSAA	100	97.8		ng/L		98	76 - 136
NEtFOSAA	100	104		ng/L		104	76 - 136
4:2 FTS	93.8	110		ng/L		117	79 - 139
6:2 FTS	95.2	104		ng/L		109	59 - 175
8:2 FTS	96.0	102		ng/L		106	75 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*115*		*25 - 150*
13C5 PFPeA	*119*		*25 - 150*
13C2 PFHxA	*118*		*25 - 150*
13C4 PFHpA	*120*		*25 - 150*
13C4 PFOA	*115*		*25 - 150*
13C5 PFNA	*114*		*25 - 150*
13C2 PFDA	*115*		*25 - 150*
13C2 PFUnA	*109*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*126*		*25 - 150*
13C4 PFOS	*116*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656952/2-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C8 FOSA	94		25 - 150
d3-NMeFOSAA	112		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	131		25 - 150
M2-8:2 FTS	142		25 - 150
M2-4:2 FTS	123		25 - 150

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)	100	107		ng/L		107	76 - 136	0	30
Perfluoropentanoic acid (PFPeA)	100	101		ng/L		101	71 - 131	2	30
Perfluorohexanoic acid (PFHxA)	100	100		ng/L		100	73 - 133	3	30
Perfluoroheptanoic acid (PFHpA)	100	102		ng/L		102	72 - 132	1	30
Perfluorooctanoic acid (PFOA)	100	105		ng/L		105	70 - 130	6	30
Perfluorononanoic acid (PFNA)	100	105		ng/L		105	75 - 135	1	30
Perfluorodecanoic acid (PFDA)	100	103		ng/L		103	76 - 136	1	30
Perfluoroundecanoic acid (PFUnA)	100	106		ng/L		106	68 - 128	4	30
Perfluorododecanoic acid (PFDoA)	100	99.4		ng/L		99	71 - 131	5	30
Perfluorotridecanoic acid (PFTrDA)	100	88.0		ng/L		88	71 - 131	4	30
Perfluorotetradecanoic acid (PFTeA)	100	82.1		ng/L		82	70 - 130	11	30
Perfluorobutanesulfonic acid (PFBS)	88.8	95.4		ng/L		107	67 - 127	2	30
Perfluoropentanesulfonic acid (PFPeS)	94.0	105		ng/L		111	66 - 126	2	30
Perfluorohexanesulfonic acid (PFHxS)	91.2	86.4		ng/L		95	59 - 119	0	30
Perfluoroheptanesulfonic acid (PFHpS)	95.4	107		ng/L		113	76 - 136	2	30
Perfluorooctanesulfonic acid (PFOS)	93.0	103		ng/L		111	70 - 130	3	30
Perfluorononanesulfonic acid (PFNS)	96.2	106		ng/L		110	75 - 135	3	30
Perfluorodecanesulfonic acid (PFDS)	96.4	101		ng/L		105	71 - 131	5	30
Perfluorooctanesulfonamide (FOSA)	100	98.2		ng/L		98	73 - 133	1	30
NMeFOSAA	100	99.2		ng/L		99	76 - 136	1	30
NEtFOSAA	100	100		ng/L		100	76 - 136	4	30
4:2 FTS	93.8	114		ng/L		122	79 - 139	4	30
6:2 FTS	95.2	99.9		ng/L		105	59 - 175	4	30
8:2 FTS	96.0	102		ng/L		107	75 - 135	0	30

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	106		25 - 150
13C5 PFPeA	109		25 - 150

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656952/3-A
Matrix: Water
Analysis Batch: 659748

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 656952

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C2 PFHxA	109		25 - 150
13C4 PFHpA	115		25 - 150
13C4 PFOA	109		25 - 150
13C5 PFNA	109		25 - 150
13C2 PFDA	108		25 - 150
13C2 PFUnA	107		25 - 150
13C2 PFDoA	110		25 - 150
13C2 PFTeDA	103		25 - 150
13C3 PFBS	105		25 - 150
18O2 PFHxS	115		25 - 150
13C4 PFOS	102		25 - 150
13C8 FOSA	90		25 - 150
d3-NMeFOSAA	106		25 - 150
d5-NEtFOSAA	101		25 - 150
M2-6:2 FTS	126		25 - 150
M2-8:2 FTS	134		25 - 150
M2-4:2 FTS	121		25 - 150

Lab Sample ID: MB 320-656915/1-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
NMeFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
NEtFOSAA	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
4:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1
6:2 FTS	ND		13		ng/L		02/27/23 11:37	03/08/23 10:54	1
8:2 FTS	ND		5.0		ng/L		02/27/23 11:37	03/08/23 10:54	1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	21	*5-	25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFPeA	122		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFHxA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFHpA	128		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOA	119		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C5 PFNA	120		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDA	121		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFUnA	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFDoA	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C2 PFTeDA	113		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C3 PFBS	114		25 - 150	02/27/23 11:37	03/08/23 10:54	1
18O2 PFHxS	131		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C4 PFOS	115		25 - 150	02/27/23 11:37	03/08/23 10:54	1
13C8 FOSA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d3-NMeFOSAA	118		25 - 150	02/27/23 11:37	03/08/23 10:54	1
d5-NEtFOSAA	117		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-6:2 FTS	142		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-8:2 FTS	136		25 - 150	02/27/23 11:37	03/08/23 10:54	1
M2-4:2 FTS	0		0 - 10	02/27/23 11:37	03/08/23 10:54	1

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	398	*+	ng/L		398	93 - 153
Perfluoropentanoic acid (PFPeA)	100	199	*+	ng/L		199	85 - 145
Perfluorohexanoic acid (PFHxA)	100	239	*+	ng/L		239	81 - 141
Perfluoroheptanoic acid (PFHpA)	100	210	*+	ng/L		210	104 - 171
Perfluorooctanoic acid (PFOA)	100	411		ng/L		411	158 - 454
Perfluorononanoic acid (PFNA)	100	153	*+	ng/L		153	66 - 126
Perfluorodecanoic acid (PFDA)	100	144	*+	ng/L		144	65 - 125
Perfluoroundecanoic acid (PFUnA)	100	113		ng/L		113	57 - 117
Perfluorododecanoic acid (PFDoA)	100	96.0		ng/L		96	66 - 126
Perfluorotridecanoic acid (PFTrDA)	100	82.4		ng/L		82	65 - 136
Perfluorotetradecanoic acid (PFTeA)	100	66.9		ng/L		67	63 - 123
Perfluorobutanesulfonic acid (PFBS)	88.8	98.7		ng/L		111	75 - 135
Perfluoropentanesulfonic acid (PFPeS)	94.0	102		ng/L		108	70 - 130
Perfluorohexanesulfonic acid (PFHxS)	91.2	90.0		ng/L		99	64 - 124
Perfluoroheptanesulfonic acid (PFHpS)	95.4	105		ng/L		110	70 - 131
Perfluorooctanesulfonic acid (PFOS)	93.0	105		ng/L		113	68 - 128
Perfluorononanesulfonic acid (PFNS)	96.2	101		ng/L		105	70 - 130
Perfluorodecanesulfonic acid (PFDS)	96.4	94.5		ng/L		98	66 - 126

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-656915/2-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10		
NMeFOSAA			100	ND		ng/L		0	0 - 10		
NEtFOSAA			100	ND		ng/L		0	0 - 10		
4:2 FTS			93.8	ND		ng/L		0	0 - 10		
6:2 FTS			95.2	ND		ng/L		0	0 - 10		
8:2 FTS			96.0	ND		ng/L		0	0 - 10		

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*15*	*5-	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*110*		*25 - 150*
13C4 PFHpA	*116*		*25 - 150*
13C4 PFOA	*112*		*25 - 150*
13C5 PFNA	*112*		*25 - 150*
13C2 PFDA	*116*		*25 - 150*
13C2 PFUnA	*107*		*25 - 150*
13C2 PFDoA	*109*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*115*		*25 - 150*
18O2 PFHxS	*119*		*25 - 150*
13C4 PFOS	*109*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*110*		*25 - 150*
d5-NEtFOSAA	*111*		*25 - 150*
M2-6:2 FTS	*124*		*25 - 150*
M2-8:2 FTS	*145*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	330	*+	ng/L		330	93 - 153	19	30
Perfluoropentanoic acid (PFPeA)			100	188	*+	ng/L		188	85 - 145	5	30
Perfluorohexanoic acid (PFHxA)			100	228	*+	ng/L		228	81 - 141	5	30
Perfluoroheptanoic acid (PFHpA)			100	198	*+	ng/L		198	104 - 171	6	30
Perfluorooctanoic acid (PFOA)			100	379		ng/L		379	158 - 454	8	30
Perfluorononanoic acid (PFNA)			100	138	*+	ng/L		138	66 - 126	10	30
Perfluorodecanoic acid (PFDA)			100	134	*+	ng/L		134	65 - 125	7	30
Perfluoroundecanoic acid (PFUnA)			100	120	*+	ng/L		120	57 - 117	6	30
Perfluorododecanoic acid (PFDoA)			100	93.2		ng/L		93	66 - 126	3	30
Perfluorotridecanoic acid (PFTrDA)			100	81.1		ng/L		81	65 - 136	1	30
Perfluorotetradecanoic acid (PFTeA)			100	65.1		ng/L		65	63 - 123	3	30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-656915/3-A
Matrix: Water
Analysis Batch: 659747

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 656915

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanesulfonic acid (PFBS)			88.8	101		ng/L		114	75 - 135	2	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	99.9		ng/L		106	70 - 130	2	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	87.7		ng/L		96	64 - 124	3	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	97.1		ng/L		102	70 - 131	7	30
Perfluorooctanesulfonic acid (PFOS)			93.0	94.2		ng/L		101	68 - 128	11	30
Perfluorononanesulfonic acid (PFNS)			96.2	91.2		ng/L		95	70 - 130	10	30
Perfluorodecanesulfonic acid (PFDS)			96.4	87.4		ng/L		91	66 - 126	8	30
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10	NC	30
NMeFOSAA			100	ND		ng/L		0	0 - 10	NC	30
NEtFOSAA			100	ND		ng/L		0	0 - 10	NC	30
4:2 FTS			93.8	ND		ng/L		0	0 - 10	NC	30
6:2 FTS			95.2	ND		ng/L		0	0 - 10	NC	30
8:2 FTS			96.0	ND		ng/L		0	0 - 10	NC	30

Isotope Dilution	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
13C4 PFBA	*15*	**5-*	*25 - 150*
13C5 PFPeA	*113*		*25 - 150*
13C2 PFHxA	*113*		*25 - 150*
13C4 PFHpA	*112*		*25 - 150*
13C4 PFOA	*109*		*25 - 150*
13C5 PFNA	*115*		*25 - 150*
13C2 PFDA	*112*		*25 - 150*
13C2 PFUnA	*104*		*25 - 150*
13C2 PFDoA	*102*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*109*		*25 - 150*
18O2 PFHxS	*117*		*25 - 150*
13C4 PFOS	*108*		*25 - 150*
13C8 FOSA	*112*		*25 - 150*
d3-NMeFOSAA	*109*		*25 - 150*
d5-NEtFOSAA	*112*		*25 - 150*
M2-6:2 FTS	*131*		*25 - 150*
M2-8:2 FTS	*130*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

QC Association Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

LCMS

Prep Batch: 656915

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96906-1	FM-7A/1	Post-Treatment	Water	TOP Post Prep	
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	TOP Post Prep	
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	TOP Post Prep	
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	TOP Post Prep	

Prep Batch: 656952

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96906-1	FM-7A/1	Pre-Treatment	Water	TOP Pre - Prep	
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	TOP Pre - Prep	
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	TOP Pre - Prep	
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	TOP Pre - Prep	

Analysis Batch: 659747

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96906-1	FM-7A/1	Post-Treatment	Water	537 (modified)	656915
MB 320-656915/1-A	Method Blank	Post-Treatment	Water	537 (modified)	656915
LCS 320-656915/2-A	Lab Control Sample	Post-Treatment	Water	537 (modified)	656915
LCSD 320-656915/3-A	Lab Control Sample Dup	Post-Treatment	Water	537 (modified)	656915

Analysis Batch: 659748

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96906-1	FM-7A/1	Pre-Treatment	Water	537 (modified)	656952
MB 320-656952/1-A	Method Blank	Pre-Treatment	Water	537 (modified)	656952
LCS 320-656952/2-A	Lab Control Sample	Pre-Treatment	Water	537 (modified)	656952
LCSD 320-656952/3-A	Lab Control Sample Dup	Pre-Treatment	Water	537 (modified)	656952

Analysis Batch: 660840

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96906-1	FM-7A/1	Pre-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 660844

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96906-1	FM-7A/1	Post-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 660845

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-96906-1	FM-7A/1	Total/NA	Water	Total PFCA-Dif	

Lab Chronicle

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Client Sample ID: FM-7A/1

Date Collected: 02/16/23 11:30
Date Received: 02/17/23 09:20

Lab Sample ID: 320-96906-1

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	656915	02/27/23 11:37	RAC	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659747	03/08/23 13:06	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	656952	02/27/23 11:57	RAC	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	659748	03/08/23 16:18	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			660845	03/15/23 16:04	VSG	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			660844	03/15/23 16:02	VSG	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			660840	03/15/23 16:00	VSG	EET SAC

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Accreditation/Certification Summary

Client: Orange County Water District
Job ID: 320-96906-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
California	State	2897	01-22-24

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Post Prep	Water	4:2 FTS
537 (modified)	TOP Post Prep	Water	6:2 FTS
537 (modified)	TOP Post Prep	Water	8:2 FTS
537 (modified)	TOP Post Prep	Water	NEtFOSAA
537 (modified)	TOP Post Prep	Water	NMeFOSAA
537 (modified)	TOP Post Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Post Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Post Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Post Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Post Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Post Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Post Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Post Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Post Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Post Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Post Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Post Prep	Water	Perfluoropentanoic acid (PFPeA)
537 (modified)	TOP Post Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Post Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Post Prep	Water	Perfluoroundecanoic acid (PFUnA)
537 (modified)	TOP Pre - Prep	Water	4:2 FTS
537 (modified)	TOP Pre - Prep	Water	6:2 FTS
537 (modified)	TOP Pre - Prep	Water	8:2 FTS
537 (modified)	TOP Pre - Prep	Water	NEtFOSAA
537 (modified)	TOP Pre - Prep	Water	NMeFOSAA
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Pre - Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanoic acid (PFPeA)

Accreditation/Certification Summary

Client: Orange County Water District
Job ID: 320-96906-1
Project/Site: FBVOC

Laboratory: Eurofins Sacramento (Continued)

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Pre - Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Pre - Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroundecanoic acid (PFUnA)
Total PFCA-Dif		Water	PFBA
Total PFCA-Dif		Water	PFHpA
Total PFCA-Dif		Water	PFHxA
Total PFCA-Dif		Water	PFNA
Total PFCA-Dif		Water	PFOA
Total PFCA-Dif		Water	PFPA
Total PFCA-Dif		Water	Total PFCA
Total PFCA-Sum		Water	Total PFCA

Method Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Method	Method Description	Protocol	Laboratory
537 (modified)	Fluorinated Alkyl Substances	EPA	EET SAC
Total PFCA-Dif	Total PFCA (Treatment Difference)	TAL SOP	EET SAC
Total PFCA-Sum	Total PFCA (Summary)	TAL SOP	EET SAC
TOP Post Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC
TOP Pre - Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL SOP = TestAmerica Laboratories, Standard Operating Procedure

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-96906-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-96906-1	FM-7A/1	Water	02/16/23 11:30	02/17/23 09:20

Eurofins Sacramento
880 Riverside Parkway
West Sacramento, Ca 95605
Phone (916) 373-5600 Fax (916) 372-1059

Chain of Custody Record

eurofins

Client Information	Sampler: Matt Drain / Ely Davidson	Lab PM: Karen Dahl	Carrier Tracking No(s):	COC No:
Client Contact: Patrick Versluis	Phone: 714-378-3200	E-Mail: Karen.Dahl@ET.Eurofins.com		Page: Page 1 of 1
Company: Orange County Water District				Job #:

Address: P.O. Box 8300	Due Date Requested:
City: Fountain Valley	TAT Requested (days): Normal - 2 weeks
State, Zip: California, 92728-8300	
Phone: (714) 378 - 8241	PO #:
Email: pversluis@ocwd.com	WO #:
Project Name: FBVOC	Project #:

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	537.1 MOD TOPS	Total Number of containers	Special Instructions/Note:
FM-7A/1	2/16/23	1130	G	W	N		X	4	
								4	
								4	*Please Call Pat Versluis if ANY detections are noted during analysis.*
									(714) 378 - 8241
									Email Results to :
									pversluis@ocwd.com
									rhintlian@ocwd.com

320-96906 Chain of Custody

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Matt Drain	2/16/2023 1500	OCWD		2/17/23 800	FEDEX
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 3.2

Ver: 08/04/2016

Login Sample Receipt Checklist

Client: Orange County Water District

Job Number: 320-96906-1

Login Number: 96906
List Number: 1
Creator: Fisher, Jamyiah L

List Source: Eurofins Sacramento

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

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ANALYTICAL REPORT

PREPARED FOR

Attn: Patrick Versluis
Orange County Water District
18700 Ward Street
Fountain Valley, California 92708

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JOB DESCRIPTION

FBVOC

JOB NUMBER

320-102726-1

Eurofins Sacramento
880 Riverside Parkway
West Sacramento CA 95605

See page two for job notes and contact information.

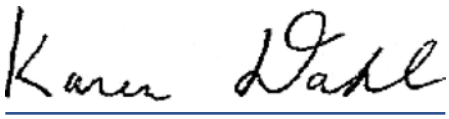
Eurofins Sacramento

Job Notes

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The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins Environment Testing Northern California, LLC Project Manager.

Authorization



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Authorized for release by
Karen Dahl, Senior Project Manager
Karen.Dahl@et.eurofinsus.com
(916)374-4384

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Definitions/Glossary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Qualifiers

LCMS

Qualifier	Qualifier Description
*-	LCS and/or LCSD is outside acceptance limits, low biased.
*+	LCS and/or LCSD is outside acceptance limits, high biased.
*1	LCS/LCSD RPD exceeds control limits.
CI	The peak identified by the data system exhibited chromatographic interference that could not be resolved. There is reason to suspect there may be a high bias.
H	Sample was prepped or analyzed beyond the specified holding time. This does not meet regulatory requirements.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 320-102726-1

Laboratory: Eurofins Sacramento

Narrative

Comments
No additional comments.

Receipt
The samples were received on 7/20/2023 10:00 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 2.3º C.

LCMS
Method 537 (modified): The labeled analyte M2-4:2FTS is employed in this analysis as a “Reverse Surrogate”. It is used to monitor the oxidation efficiency of the TOP assay. This analyte is fortified into all sample fractions prior to any processing. The recovery of this analyte should be 0% in Post-Treatment fractions, indicating complete oxidation of the sample.

Method 537 (modified): Zero percent recovery of precursor analytes (such as 4:2 FTS, 6:2 FTS, 8:2 FTS, FOSA, NMeFOSAA, NEtFOSAA, etc.) and enhanced recoveries of PFCA is observed in the Post-Treatment Laboratory Control Sample (LCS) and Post-Treatment Laboratory Control Sample Duplicate (LCSD) associated with these samples, consistent with the expected oxidation of precursor analytes. The existing LCS control limits are based upon our historical performance for a set of 24-36 analytes in the LCS solution. We have recently expanded to 70+ analytes. As the LCS solution now contains new/additional precursor analytes we are seeing enhanced recoveries for some PFCA vs. the historical limits as a result. The LCS results are flagged as being high and outside of the established limits for some analytes; however, this is a function of the new analytes in the LCS solution and not indicative of an “out of control” process.

Method 537 (modified): The RPD of the laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) for preparation batch 320-697729 and analytical batch 320-698216 recovered outside control limits for the following analyte: Perfluorobutanoic acid (PFBA).

Method 537 (modified): Some or all of the following analytes recovered low outside the control limits in laboratory control sample (LCS) and the laboratory control sample duplicate in preparation batch 320-697729 and analytical batch 320-698216: PFDoA, PFTrDA, PFTeA, & PFDS . There was insufficient sample volume left to re-extract the samples a second time.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep
Method TOP Post Prep: The following samples were re-prepared outside of preparation holding time due to a laboratory contamination event: AM-41A/1 (320-102726-1) and FM-11A/1 (320-102726-2).

Method TOP Pre - Prep: The following samples were re-prepared outside of preparation holding time due to a laboratory contamination event: AM-41A/1 (320-102726-1) and FM-11A/1 (320-102726-2).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Client Sample ID: AM-41A/1 — Lab Sample ID: 320-102726-1

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	6.6	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	5.2	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	8.6	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	5.2	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	22	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluoropentanoic acid (PFPeA)	6.6	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	7.7	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	8.3	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanesulfonic acid (PFHxS)	5.3	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	19	H	5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	2.5				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	2.2				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	20				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	23				ng/L	1		Total PFCA-Sum	Post-Treatment

Client Sample ID: FM-11A/1 — Lab Sample ID: 320-102726-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluoropentanoic acid (PFPeA)	9.2	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanoic acid (PFHxA)	7.1	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanoic acid (PFOA)	12	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.1	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorohexanesulfonic acid (PFHxS)	6.9	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorooctanesulfonic acid (PFOS)	23	H	5.0		ng/L	1		537 (modified)	Pre-Treatment
Perfluorobutanoic acid (PFBA)	13	*+ H *1 CI	13		ng/L	1		537 (modified)	Post-Treatment
Perfluoropentanoic acid (PFPeA)	9.7	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorohexanoic acid (PFHxA)	8.3	H *+	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanoic acid (PFOA)	11	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorobutanesulfonic acid (PFBS)	5.0	H	5.0		ng/L	1		537 (modified)	Post-Treatment

This Detection Summary does not include radiochemical test results.

Client Sample ID: FM-11A/1 (Continued)

Lab Sample ID: 320-102726-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanesulfonic acid (PFHxS)	7.3	H	5.0		ng/L	1		537 (modified)	Post-Treatment
Perfluorooctanesulfonic acid (PFOS)	20	H	5.0		ng/L	1		537 (modified)	Post-Treatment
PFBA	13				ng/L	1		Total PFCA-Dif	Total/NA
PFPA	0.52				ng/L	1		Total PFCA-Dif	Total/NA
PFHxA	1.2				ng/L	1		Total PFCA-Dif	Total/NA
PFHpA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFOA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
PFNA	0.00				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	14				ng/L	1		Total PFCA-Dif	Total/NA
Total PFCA	28				ng/L	1		Total PFCA-Sum	Pre-Treatment
Total PFCA	42				ng/L	1		Total PFCA-Sum	Post-Treatment

This Detection Summary does not include radiochemical test results.

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Client Sample ID: AM-41A/1
Date Collected: 07/19/23 13:15
Date Received: 07/20/23 10:00

Lab Sample ID: 320-102726-1
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluoropentanoic acid (PFPeA)	**6.6**	**H**	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorohexanoic acid (PFHxA)	**5.2**	**H**	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluoroheptanoic acid (PFHpA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorooctanoic acid (PFOA)	**8.6**	**H**	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorononanoic acid (PFNA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorodecanoic acid (PFDA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluoroundecanoic acid (PFUnA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorododecanoic acid (PFDoA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorotridecanoic acid (PFTrDA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorotetradecanoic acid (PFTeA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorobutanesulfonic acid (PFBS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluoropentanesulfonic acid (PFPeS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorohexanesulfonic acid (PFHxS)	**5.2**	**H**	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluoroheptanesulfonic acid (PFHpS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorooctanesulfonic acid (PFOS)	**22**	**H**	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorononanesulfonic acid (PFNS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorodecanesulfonic acid (PFDS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
Perfluorooctanesulfonamide (FOSA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
NMeFOSAA	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:03	1
NEtFOSAA	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:03	1
4:2 FTS	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1
6:2 FTS	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:03	1
8:2 FTS	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:03	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*97*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C5 PFPeA	*99*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C2 PFHxA	*97*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C4 PFHpA	*106*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C4 PFOA	*107*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C5 PFNA	*103*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C2 PFDA	*108*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C2 PFUnA	*100*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C2 PFDoA	*98*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C2 PFTeDA	*95*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C3 PFBS	*107*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
18O2 PFHxS	*112*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C4 PFOS	*105*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
13C8 FOSA	*109*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
d3-NMeFOSAA	*109*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
d5-NEtFOSAA	*102*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
M2-6:2 FTS	*117*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
M2-8:2 FTS	*111*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*
M2-4:2 FTS	*110*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:03*	*1*

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Client Sample ID: AM-41A/1
Date Collected: 07/19/23 13:15
Date Received: 07/20/23 10:00

Lab Sample ID: 320-102726-1
Matrix: Water

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND	H *+ *1	13		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluoropentanoic acid (PFPeA)	**6.6**	**H *+**	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorohexanoic acid (PFHxA)	**7.7**	**H *+**	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluoroheptanoic acid (PFHpA)	ND	H *+	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorooctanoic acid (PFOA)	**8.3**	**H**	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorononanoic acid (PFNA)	ND	H *+	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorodecanoic acid (PFDA)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluoroundecanoic acid (PFUnA)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorododecanoic acid (PFDoA)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorotridecanoic acid (PFTrDA)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorotetradecanoic acid (PFTeA)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorobutanesulfonic acid (PFBS)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluoropentanesulfonic acid (PFPeS)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorohexanesulfonic acid (PFHxS)	**5.3**	**H**	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluoroheptanesulfonic acid (PFHpS)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorooctanesulfonic acid (PFOS)	**19**	**H**	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorononanesulfonic acid (PFNS)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorodecanesulfonic acid (PFDS)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
Perfluorooctanesulfonamide (FOSA)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
NMeFOSAA	ND	H	13		ng/L		08/10/23 21:54	08/13/23 02:21	1
NEtFOSAA	ND	H	13		ng/L		08/10/23 21:54	08/13/23 02:21	1
4:2 FTS	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1
6:2 FTS	ND	H	13		ng/L		08/10/23 21:54	08/13/23 02:21	1
8:2 FTS	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:21	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*101*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C5 PFPeA	*101*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C2 PFHxA	*93*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C4 PFHpA	*105*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C4 PFOA	*102*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C5 PFNA	*105*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C2 PFDA	*105*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C2 PFUnA	*107*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C2 PFDoA	*95*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C2 PFTeDA	*101*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C3 PFBS	*108*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
18O2 PFHxS	*105*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C4 PFOS	*106*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
13C8 FOSA	*112*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
d3-NMeFOSAA	*100*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
d5-NEtFOSAA	*104*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
M2-6:2 FTS	*110*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
M2-8:2 FTS	*119*		*25 - 150*	*08/10/23 21:54*	*08/13/23 02:21*	*1*
M2-4:2 FTS	*0*		*0 - 10*	*08/10/23 21:54*	*08/13/23 02:21*	*1*

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Client Sample ID: AM-41A/1

Lab Sample ID: 320-102726-1

Date Collected: 07/19/23 13:15

Matrix: Water

Date Received: 07/20/23 10:00

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	0.00				ng/L			08/15/23 13:37	1
PFPA	0.00				ng/L			08/15/23 13:37	1
PFHxA	2.5				ng/L			08/15/23 13:37	1
PFHpA	0.00				ng/L			08/15/23 13:37	1
PFOA	0.00				ng/L			08/15/23 13:37	1
PFNA	0.00				ng/L			08/15/23 13:37	1
Total PFCA	2.2				ng/L			08/15/23 13:37	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	20				ng/L			08/15/23 13:31	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	23				ng/L			08/15/23 13:33	1

Client Sample ID: FM-11A/1

Lab Sample ID: 320-102726-2

Date Collected: 07/19/23 10:50

Matrix: Water

Date Received: 07/20/23 10:00

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Pre-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluoropentanoic acid (PFPeA)	9.2	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorohexanoic acid (PFHxA)	7.1	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluoroheptanoic acid (PFHpA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorooctanoic acid (PFOA)	12	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorononanoic acid (PFNA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorodecanoic acid (PFDA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluoroundecanoic acid (PFUnA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorododecanoic acid (PFDoA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorotridecanoic acid (PFTrDA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorotetradecanoic acid (PFTeA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorobutanesulfonic acid (PFBS)	5.1	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluoropentanesulfonic acid (PFPeS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorohexanesulfonic acid (PFHxS)	6.9	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluoroheptanesulfonic acid (PFHpS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorooctanesulfonic acid (PFOS)	23	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorononanesulfonic acid (PFNS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorodecanesulfonic acid (PFDS)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
Perfluorooctanesulfonamide (FOSA)	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
NMeFOSAA	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:14	1
NEtFOSAA	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:14	1
4:2 FTS	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1
6:2 FTS	ND	H	13		ng/L		08/10/23 21:40	08/13/23 01:14	1
8:2 FTS	ND	H	5.0		ng/L		08/10/23 21:40	08/13/23 01:14	1

Client Sample ID: FM-11A/1
Date Collected: 07/19/23 10:50
Date Received: 07/20/23 10:00

Lab Sample ID: 320-102726-2
Matrix: Water

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*98*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C5 PFPeA	*97*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C2 PFHxA	*102*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C4 PFHpA	*103*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C4 PFOA	*107*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C5 PFNA	*106*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C2 PFDA	*105*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C2 PFUnA	*104*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C2 PFDoA	*100*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C2 PFTeDA	*101*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C3 PFBS	*101*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
18O2 PFHxS	*112*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C4 PFOS	*106*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
13C8 FOSA	*117*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
d3-NMeFOSAA	*104*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
d5-NEtFOSAA	*114*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
M2-6:2 FTS	*115*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
M2-8:2 FTS	*119*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*
M2-4:2 FTS	*106*		*25 - 150*	*08/10/23 21:40*	*08/13/23 01:14*	*1*

Method: EPA 537 (modified) - Fluorinated Alkyl Substances - Post-Treatment

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	**13**	***+ H *1 CI**	13		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluoropentanoic acid (PFPeA)	**9.7**	**H *+**	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorohexanoic acid (PFHxA)	**8.3**	**H *+**	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluoroheptanoic acid (PFHpA)	ND	H *+	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorooctanoic acid (PFOA)	**11**	**H**	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorononanoic acid (PFNA)	ND	H *+	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorodecanoic acid (PFDA)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluoroundecanoic acid (PFUnA)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorododecanoic acid (PFDoA)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorotridecanoic acid (PFTrDA)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorotetradecanoic acid (PFTeA)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorobutanesulfonic acid (PFBS)	**5.0**	**H**	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluoropentanesulfonic acid (PFPeS)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorohexanesulfonic acid (PFHxS)	**7.3**	**H**	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluoroheptanesulfonic acid (PFHpS)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorooctanesulfonic acid (PFOS)	**20**	**H**	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorononanesulfonic acid (PFNS)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorodecanesulfonic acid (PFDS)	ND	H *-	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
Perfluorooctanesulfonamide (FOSA)	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
NMeFOSAA	ND	H	13		ng/L		08/10/23 21:54	08/13/23 02:32	1
NEtFOSAA	ND	H	13		ng/L		08/10/23 21:54	08/13/23 02:32	1
4:2 FTS	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1
6:2 FTS	ND	H	13		ng/L		08/10/23 21:54	08/13/23 02:32	1
8:2 FTS	ND	H	5.0		ng/L		08/10/23 21:54	08/13/23 02:32	1

Client Sample ID: FM-11A/1
Date Collected: 07/19/23 10:50
Date Received: 07/20/23 10:00

Lab Sample ID: 320-102726-2
Matrix: Water

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	96		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C5 PFPeA	99		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C2 PFHxA	92		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C4 PFHpA	102		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C4 PFOA	101		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C5 PFNA	98		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C2 PFDA	103		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C2 PFUnA	105		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C2 PFDoA	97		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C2 PFTeDA	97		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C3 PFBS	105		25 - 150	08/10/23 21:54	08/13/23 02:32	1
18O2 PFHxS	110		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C4 PFOS	104		25 - 150	08/10/23 21:54	08/13/23 02:32	1
13C8 FOSA	110		25 - 150	08/10/23 21:54	08/13/23 02:32	1
d3-NMeFOSAA	111		25 - 150	08/10/23 21:54	08/13/23 02:32	1
d5-NEtFOSAA	103		25 - 150	08/10/23 21:54	08/13/23 02:32	1
M2-6:2 FTS	110		25 - 150	08/10/23 21:54	08/13/23 02:32	1
M2-8:2 FTS	104		25 - 150	08/10/23 21:54	08/13/23 02:32	1
M2-4:2 FTS	0		0 - 10	08/10/23 21:54	08/13/23 02:32	1

Method: TAL SOP Total PFCA-Dif - Total PFCA (Treatment Difference)

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
PFBA	13				ng/L			08/15/23 13:37	1
PFPA	0.52				ng/L			08/15/23 13:37	1
PFHxA	1.2				ng/L			08/15/23 13:37	1
PFHpA	0.00				ng/L			08/15/23 13:37	1
PFOA	0.00				ng/L			08/15/23 13:37	1
PFNA	0.00				ng/L			08/15/23 13:37	1
Total PFCA	14				ng/L			08/15/23 13:37	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Pre-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	28				ng/L			08/15/23 13:31	1

Method: TAL SOP Total PFCA-Sum - Total PFCA (Summary) - Post-Treatment

Analyte	Result	Qualifier	NONE	NONE	Unit	D	Prepared	Analyzed	Dil Fac
Total PFCA	42				ng/L			08/15/23 13:33	1

Total Oxidation Precursors

Client: Orange County Water District
Project/Site: FBVOC

TestAmerica Job ID: 320-102726-1

Client Sample ID: AM-41A/1

Lab Sample ID: 320-102726-1
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	100		ng/L	100	ng/L
Perfluoropentanoic acid (PFPeA)	6.6		ng/L	6.6		ng/L	0.00	ng/L
Perfluorohexanoic acid (PFHxA)	5.2		ng/L	7.7		ng/L	2.5	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	8.6		ng/L	8.3		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	20		ng/L	120		ng/L	100	ng/L

Client Sample ID: FM-11A/1

Lab Sample ID: 320-102726-2
Matrix: Water

Analyte	Pre-Treatment Method 537 (modified) Result	Qualifier	Unit	Post-Treatment Method 537 (modified) Result	Qualifier	Unit	Difference [1] Result	Unit
Perfluorobutanoic acid (PFBA)	ND		ng/L	66		ng/L	66	ng/L
Perfluoropentanoic acid (PFPeA)	9.2		ng/L	9.7		ng/L	0.52	ng/L
Perfluorohexanoic acid (PFHxA)	7.1		ng/L	8.3		ng/L	1.2	ng/L
Perfluoroheptanoic acid (PFHpA)	ND		ng/L	ND		ng/L	0.00	ng/L
Perfluorooctanoic acid (PFOA)	12		ng/L	11		ng/L	0.00	ng/L
Perfluorononanoic acid (PFNA)	ND		ng/L	ND		ng/L	0.00	ng/L
Total PFCA	28		ng/L	95		ng/L	67	ng/L

[1] Difference = Post-Treatment - Pre-Treament

Isotope Dilution Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Pre-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
		PFBA	PFPeA	PFHxA	C4PFHA	PFOA	PFNA	PFDA	PFUnA
Lab Sample ID	Client Sample ID	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)
320-102726-1	AM-41A/1	97	99	97	106	107	103	108	100
320-102726-2	FM-11A/1	98	97	102	103	107	106	105	104
LCS 320-697726/2-A	Lab Control Sample	100	99	97	106	108	106	107	106
LCSD 320-697726/3-A	Lab Control Sample Dup	100	97	95	103	101	100	104	102
MB 320-697726/1-A	Method Blank	100	101	101	104	105	110	110	106

		Percent Isotope Dilution Recovery (Acceptance Limits)							
		PFDoA	PFTDA	C3PFBS	PFHxS	PFOS	PFOSA	d3NMFOS	d5NEFOS
Lab Sample ID	Client Sample ID	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)
320-102726-1	AM-41A/1	98	95	107	112	105	109	109	102
320-102726-2	FM-11A/1	100	101	101	112	106	117	104	114
LCS 320-697726/2-A	Lab Control Sample	98	98	106	106	103	105	107	107
LCSD 320-697726/3-A	Lab Control Sample Dup	96	93	104	105	102	103	109	109
MB 320-697726/1-A	Method Blank	102	102	109	112	103	109	108	113

		Percent Isotope Dilution Recovery (Acceptance Limits)		
		M262FTS	M282FTS	M242FTS
Lab Sample ID	Client Sample ID	(25-150)	(25-150)	(25-150)
320-102726-1	AM-41A/1	117	111	110
320-102726-2	FM-11A/1	115	119	106
LCS 320-697726/2-A	Lab Control Sample	119	116	115
LCSD 320-697726/3-A	Lab Control Sample Dup	117	118	112
MB 320-697726/1-A	Method Blank	122	114	121

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Matrix: Water **Prep Type: Post-Treatment**

		Percent Isotope Dilution Recovery (Acceptance Limits)							
		PFBA	PFPeA	PFHxA	C4PFHA	PFOA	PFNA	PFDA	PFUnA
Lab Sample ID	Client Sample ID	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)
320-102726-1	AM-41A/1	101	101	93	105	102	105	105	107

Isotope Dilution Summary

Client: Orange County Water District
Job ID: 320-102726-1
Project/Site: FBVOC

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Matrix: Water
Prep Type: Post-Treatment

		Percent Isotope Dilution Recovery (Acceptance Limits)							
		PFBA	PFPeA	PFHxA	C4PFHA	PFOA	PFNA	PFDA	PFUnA
Lab Sample ID	Client Sample ID	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)
320-102726-2	FM-11A/1	96	99	92	102	101	98	103	105
LCS 320-697729/2-A	Lab Control Sample	104	101	106	107	104	107	108	106
LCSD 320-697729/3-A	Lab Control Sample Dup	98	100	101	107	102	102	105	98
MB 320-697729/1-A	Method Blank	97	97	99	110	103	106	108	105

		Percent Isotope Dilution Recovery (Acceptance Limits)							
		PFDoA	PFTDA	C3PFBS	PFHxS	PFOS	PFOSA	d3NMFOS	d5NEFOS
Lab Sample ID	Client Sample ID	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)	(25-150)
320-102726-1	AM-41A/1	95	101	108	105	106	112	100	104
320-102726-2	FM-11A/1	97	97	105	110	104	110	111	103
LCS 320-697729/2-A	Lab Control Sample	103	105	106	109	104	113	103	108
LCSD 320-697729/3-A	Lab Control Sample Dup	94	98	108	112	104	111	106	106
MB 320-697729/1-A	Method Blank	101	102	109	106	100	109	105	111

		Percent Isotope Dilution Recovery (Acceptance Limits)		
		M262FTS	M282FTS	M242FTS
Lab Sample ID	Client Sample ID	(25-150)	(25-150)	(0-10)
320-102726-1	AM-41A/1	110	119	0
320-102726-2	FM-11A/1	110	104	0
LCS 320-697729/2-A	Lab Control Sample	112	111	0
LCSD 320-697729/3-A	Lab Control Sample Dup	114	106	0
MB 320-697729/1-A	Method Blank	112	112	0

Surrogate Legend

PFBA = 13C4 PFBA
PFPeA = 13C5 PFPeA
PFHxA = 13C2 PFHxA
C4PFHA = 13C4 PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFDA = 13C2 PFDA
PFUnA = 13C2 PFUnA
PFDoA = 13C2 PFDoA
PFTDA = 13C2 PFTeDA
C3PFBS = 13C3 PFBS
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS
PFOSA = 13C8 FOSA
d3NMFOS = d3-NMeFOSAA
d5NEFOS = d5-NEtFOSAA
M262FTS = M2-6:2 FTS
M282FTS = M2-8:2 FTS
M242FTS = M2-4:2 FTS

Method: 537 (modified) - Fluorinated Alkyl Substances

Lab Sample ID: MB 320-697726/1-A
Matrix: Water
Analysis Batch: 698215

Client Sample ID: Method Blank
Prep Type: Pre-Treatment
Prep Batch: 697726

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
NMeFOSAA	ND		13		ng/L		08/10/23 21:40	08/13/23 00:29	1
NEtFOSAA	ND		13		ng/L		08/10/23 21:40	08/13/23 00:29	1
4:2 FTS	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1
6:2 FTS	ND		13		ng/L		08/10/23 21:40	08/13/23 00:29	1
8:2 FTS	ND		5.0		ng/L		08/10/23 21:40	08/13/23 00:29	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFBA	*100*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C5 PFPeA	*101*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C2 PFHxA	*101*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C4 PFHpA	*104*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C4 PFOA	*105*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C5 PFNA	*110*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C2 PFDA	*110*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C2 PFUnA	*106*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C2 PFDoA	*102*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C2 PFTeDA	*102*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C3 PFBS	*109*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
18O2 PFHxS	*112*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C4 PFOS	*103*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
13C8 FOSA	*109*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
d3-NMeFOSAA	*108*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
d5-NEtFOSAA	*113*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
M2-6:2 FTS	*122*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
M2-8:2 FTS	*114*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*
M2-4:2 FTS	*121*		*25 - 150*	*08/10/23 21:40*	*08/13/23 00:29*	*1*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-697726/2-A
Matrix: Water
Analysis Batch: 698215

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 697726

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	107		ng/L		107	76 - 136
Perfluoropentanoic acid (PFPeA)	100	102		ng/L		102	71 - 131
Perfluorohexanoic acid (PFHxA)	100	105		ng/L		105	73 - 133
Perfluoroheptanoic acid (PFHpA)	100	105		ng/L		105	72 - 132
Perfluorooctanoic acid (PFOA)	100	108		ng/L		108	70 - 130
Perfluorononanoic acid (PFNA)	100	98.6		ng/L		99	75 - 135
Perfluorodecanoic acid (PFDA)	100	104		ng/L		104	76 - 136
Perfluoroundecanoic acid (PFUnA)	100	105		ng/L		105	68 - 128
Perfluorododecanoic acid (PFDoA)	100	104		ng/L		104	71 - 131
Perfluorotridecanoic acid (PFTrDA)	100	87.6		ng/L		88	71 - 131
Perfluorotetradecanoic acid (PFTeA)	100	75.5		ng/L		75	70 - 130
Perfluorobutanesulfonic acid (PFBS)	88.8	87.2		ng/L		98	67 - 127
Perfluoropentanesulfonic acid (PFPeS)	94.0	92.0		ng/L		98	66 - 126
Perfluorohexanesulfonic acid (PFHxS)	91.2	91.4		ng/L		100	59 - 119
Perfluoroheptanesulfonic acid (PFHpS)	95.4	104		ng/L		109	76 - 136
Perfluorooctanesulfonic acid (PFOS)	93.0	99.5		ng/L		107	70 - 130
Perfluorononanesulfonic acid (PFNS)	96.2	94.8		ng/L		99	75 - 135
Perfluorodecanesulfonic acid (PFDS)	96.4	94.1		ng/L		98	71 - 131
Perfluorooctanesulfonamide (FOSA)	100	78.1		ng/L		78	73 - 133
NMeFOSAA	100	97.4		ng/L		97	76 - 136
NEtFOSAA	100	91.9		ng/L		92	76 - 136
4:2 FTS	93.8	99.4		ng/L		106	79 - 139
6:2 FTS	95.2	82.1		ng/L		86	59 - 175
8:2 FTS	96.0	95.4		ng/L		99	75 - 135

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*100*		*25 - 150*
13C5 PFPeA	*99*		*25 - 150*
13C2 PFHxA	*97*		*25 - 150*
13C4 PFHpA	*106*		*25 - 150*
13C4 PFOA	*108*		*25 - 150*
13C5 PFNA	*106*		*25 - 150*
13C2 PFDA	*107*		*25 - 150*
13C2 PFUnA	*106*		*25 - 150*
13C2 PFDoA	*98*		*25 - 150*
13C2 PFTeDA	*98*		*25 - 150*
13C3 PFBS	*106*		*25 - 150*
18O2 PFHxS	*106*		*25 - 150*
13C4 PFOS	*103*		*25 - 150*

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-697726/2-A
Matrix: Water
Analysis Batch: 698215

Client Sample ID: Lab Control Sample
Prep Type: Pre-Treatment
Prep Batch: 697726

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C8 FOSA	105		25 - 150
d3-NMeFOSAA	107		25 - 150
d5-NEtFOSAA	107		25 - 150
M2-6:2 FTS	119		25 - 150
M2-8:2 FTS	116		25 - 150
M2-4:2 FTS	115		25 - 150

Lab Sample ID: LCSD 320-697726/3-A
Matrix: Water
Analysis Batch: 698215

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 697726

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	114		ng/L		114	76 - 136	6	30
Perfluoropentanoic acid (PFPeA)			100	105		ng/L		105	71 - 131	3	30
Perfluorohexanoic acid (PFHxA)			100	106		ng/L		106	73 - 133	1	30
Perfluoroheptanoic acid (PFHpA)			100	109		ng/L		109	72 - 132	3	30
Perfluorooctanoic acid (PFOA)			100	114		ng/L		114	70 - 130	5	30
Perfluorononanoic acid (PFNA)			100	103		ng/L		103	75 - 135	4	30
Perfluorodecanoic acid (PFDA)			100	104		ng/L		104	76 - 136	0	30
Perfluoroundecanoic acid (PFUnA)			100	101		ng/L		101	68 - 128	4	30
Perfluorododecanoic acid (PFDoA)			100	108		ng/L		108	71 - 131	4	30
Perfluorotridecanoic acid (PFTrDA)			100	85.1		ng/L		85	71 - 131	3	30
Perfluorotetradecanoic acid (PFTeA)			100	79.8		ng/L		80	70 - 130	6	30
Perfluorobutanesulfonic acid (PFBS)			88.8	87.3		ng/L		98	67 - 127	0	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	91.3		ng/L		97	66 - 126	1	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	93.9		ng/L		103	59 - 119	3	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	106		ng/L		111	76 - 136	2	30
Perfluorooctanesulfonic acid (PFOS)			93.0	100		ng/L		108	70 - 130	1	30
Perfluorononanesulfonic acid (PFNS)			96.2	101		ng/L		105	75 - 135	6	30
Perfluorodecanesulfonic acid (PFDS)			96.4	100		ng/L		104	71 - 131	7	30
Perfluorooctanesulfonamide (FOSA)			100	80.1		ng/L		80	73 - 133	3	30
NMeFOSAA			100	95.8		ng/L		96	76 - 136	2	30
NEtFOSAA			100	85.1		ng/L		85	76 - 136	8	30
4:2 FTS			93.8	94.8		ng/L		101	79 - 139	5	30
6:2 FTS			95.2	83.7		ng/L		88	59 - 175	2	30
8:2 FTS			96.0	98.5		ng/L		103	75 - 135	3	30

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C4 PFBA	100		25 - 150
13C5 PFPeA	97		25 - 150

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-697726/3-A
Matrix: Water
Analysis Batch: 698215

Client Sample ID: Lab Control Sample Dup
Prep Type: Pre-Treatment
Prep Batch: 697726

Isotope Dilution	LCSD %Recovery	LCSD Qualifier	Limits
13C2 PFHxA	95		25 - 150
13C4 PFHpA	103		25 - 150
13C4 PFOA	101		25 - 150
13C5 PFNA	100		25 - 150
13C2 PFDA	104		25 - 150
13C2 PFUnA	102		25 - 150
13C2 PFDoA	96		25 - 150
13C2 PFTeDA	93		25 - 150
13C3 PFBS	104		25 - 150
18O2 PFHxS	105		25 - 150
13C4 PFOS	102		25 - 150
13C8 FOSA	103		25 - 150
d3-NMeFOSAA	109		25 - 150
d5-NEtFOSAA	109		25 - 150
M2-6:2 FTS	117		25 - 150
M2-8:2 FTS	118		25 - 150
M2-4:2 FTS	112		25 - 150

Lab Sample ID: MB 320-697729/1-A
Matrix: Water
Analysis Batch: 698216

Client Sample ID: Method Blank
Prep Type: Post-Treatment
Prep Batch: 697729

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		13		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluoropentanoic acid (PFPeA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorohexanoic acid (PFHxA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluoroheptanoic acid (PFHpA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorooctanoic acid (PFOA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorononanoic acid (PFNA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorodecanoic acid (PFDA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluoroundecanoic acid (PFUnA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorododecanoic acid (PFDoA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorotridecanoic acid (PFTrDA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorotetradecanoic acid (PFTeA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorobutanesulfonic acid (PFBS)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluoropentanesulfonic acid (PFPeS)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorohexanesulfonic acid (PFHxS)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorooctanesulfonic acid (PFOS)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorononanesulfonic acid (PFNS)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorodecanesulfonic acid (PFDS)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
Perfluorooctanesulfonamide (FOSA)	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
NMeFOSAA	ND		13		ng/L		08/10/23 21:54	08/13/23 01:47	1
NEtFOSAA	ND		13		ng/L		08/10/23 21:54	08/13/23 01:47	1
4:2 FTS	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1
6:2 FTS	ND		13		ng/L		08/10/23 21:54	08/13/23 01:47	1
8:2 FTS	ND		5.0		ng/L		08/10/23 21:54	08/13/23 01:47	1

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	97		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C5 PFPeA	97		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C2 PFHxA	99		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C4 PFHpA	110		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C4 PFOA	103		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C5 PFNA	106		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C2 PFDA	108		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C2 PFUnA	105		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C2 PFDoA	101		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C2 PFTeDA	102		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C3 PFBS	109		25 - 150	08/10/23 21:54	08/13/23 01:47	1
18O2 PFHxS	106		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C4 PFOS	100		25 - 150	08/10/23 21:54	08/13/23 01:47	1
13C8 FOSA	109		25 - 150	08/10/23 21:54	08/13/23 01:47	1
d3-NMeFOSAA	105		25 - 150	08/10/23 21:54	08/13/23 01:47	1
d5-NEtFOSAA	111		25 - 150	08/10/23 21:54	08/13/23 01:47	1
M2-6:2 FTS	112		25 - 150	08/10/23 21:54	08/13/23 01:47	1
M2-8:2 FTS	112		25 - 150	08/10/23 21:54	08/13/23 01:47	1
M2-4:2 FTS	0		0 - 10	08/10/23 21:54	08/13/23 01:47	1

Lab Sample ID: LCS 320-697729/2-A
Matrix: Water
Analysis Batch: 698216

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 697729

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorobutanoic acid (PFBA)	100	275	*+	ng/L		275	93 - 153
Perfluoropentanoic acid (PFPeA)	100	183	*+	ng/L		183	85 - 145
Perfluorohexanoic acid (PFHxA)	100	208	*+	ng/L		208	81 - 141
Perfluoroheptanoic acid (PFHpA)	100	203	*+	ng/L		203	104 - 171
Perfluorooctanoic acid (PFOA)	100	364		ng/L		364	158 - 454
Perfluorononanoic acid (PFNA)	100	121		ng/L		121	66 - 126
Perfluorodecanoic acid (PFDA)	100	123		ng/L		123	65 - 125
Perfluoroundecanoic acid (PFUnA)	100	72.1		ng/L		72	57 - 117
Perfluorododecanoic acid (PFDoA)	100	61.6	*-	ng/L		62	66 - 126
Perfluorotridecanoic acid (PFTrDA)	100	40.1	*-	ng/L		40	65 - 136
Perfluorotetradecanoic acid (PFTeA)	100	23.7	*-	ng/L		24	63 - 123
Perfluorobutanesulfonic acid (PFBS)	88.8	91.9		ng/L		103	75 - 135
Perfluoropentanesulfonic acid (PFPeS)	94.0	96.4		ng/L		103	70 - 130
Perfluorohexanesulfonic acid (PFHxS)	91.2	91.1		ng/L		100	64 - 124
Perfluoroheptanesulfonic acid (PFHpS)	95.4	94.7		ng/L		99	70 - 131
Perfluorooctanesulfonic acid (PFOS)	93.0	82.8		ng/L		89	68 - 128
Perfluorononanesulfonic acid (PFNS)	96.2	71.6		ng/L		74	70 - 130
Perfluorodecanesulfonic acid (PFDS)	96.4	66.5		ng/L		69	66 - 126

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCS 320-697729/2-A
Matrix: Water
Analysis Batch: 698216

Client Sample ID: Lab Control Sample
Prep Type: Post-Treatment
Prep Batch: 697729

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10		
NMeFOSAA			100	ND		ng/L		0	0 - 10		
NEtFOSAA			100	ND		ng/L		0	0 - 10		
4:2 FTS			93.8	ND		ng/L		0	0 - 10		
6:2 FTS			95.2	ND		ng/L		0	0 - 10		
8:2 FTS			96.0	ND		ng/L		0	0 - 10		

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C4 PFBA	*104*		*25 - 150*
13C5 PFPeA	*101*		*25 - 150*
13C2 PFHxA	*106*		*25 - 150*
13C4 PFHpA	*107*		*25 - 150*
13C4 PFOA	*104*		*25 - 150*
13C5 PFNA	*107*		*25 - 150*
13C2 PFDA	*108*		*25 - 150*
13C2 PFUnA	*106*		*25 - 150*
13C2 PFDoA	*103*		*25 - 150*
13C2 PFTeDA	*105*		*25 - 150*
13C3 PFBS	*106*		*25 - 150*
18O2 PFHxS	*109*		*25 - 150*
13C4 PFOS	*104*		*25 - 150*
13C8 FOSA	*113*		*25 - 150*
d3-NMeFOSAA	*103*		*25 - 150*
d5-NEtFOSAA	*108*		*25 - 150*
M2-6:2 FTS	*112*		*25 - 150*
M2-8:2 FTS	*111*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

Lab Sample ID: LCSD 320-697729/3-A
Matrix: Water
Analysis Batch: 698216

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 697729

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanoic acid (PFBA)			100	202	*+ *1	ng/L		202	93 - 153	31	30
Perfluoropentanoic acid (PFPeA)			100	164	*+	ng/L		164	85 - 145	11	30
Perfluorohexanoic acid (PFHxA)			100	199	*+	ng/L		199	81 - 141	4	30
Perfluoroheptanoic acid (PFHpA)			100	184	*+	ng/L		184	104 - 171	10	30
Perfluorooctanoic acid (PFOA)			100	319		ng/L		319	158 - 454	13	30
Perfluorononanoic acid (PFNA)			100	129	*+	ng/L		129	66 - 126	6	30
Perfluorodecanoic acid (PFDA)			100	120		ng/L		120	65 - 125	3	30
Perfluoroundecanoic acid (PFUnA)			100	71.9		ng/L		72	57 - 117	0	30
Perfluorododecanoic acid (PFDoA)			100	57.4	*-	ng/L		57	66 - 126	7	30
Perfluorotridecanoic acid (PFTrDA)			100	35.7	*-	ng/L		36	65 - 136	12	30
Perfluorotetradecanoic acid (PFTeA)			100	19.1	*-	ng/L		19	63 - 123	22	30

Method: 537 (modified) - Fluorinated Alkyl Substances (Continued)

Lab Sample ID: LCSD 320-697729/3-A
Matrix: Water
Analysis Batch: 698216

Client Sample ID: Lab Control Sample Dup
Prep Type: Post-Treatment
Prep Batch: 697729

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Perfluorobutanesulfonic acid (PFBS)			88.8	91.4		ng/L		103	75 - 135	1	30
Perfluoropentanesulfonic acid (PFPeS)			94.0	93.2		ng/L		99	70 - 130	3	30
Perfluorohexanesulfonic acid (PFHxS)			91.2	89.0		ng/L		98	64 - 124	2	30
Perfluoroheptanesulfonic acid (PFHpS)			95.4	94.9		ng/L		100	70 - 131	0	30
Perfluorooctanesulfonic acid (PFOS)			93.0	84.9		ng/L		91	68 - 128	2	30
Perfluorononanesulfonic acid (PFNS)			96.2	68.9		ng/L		72	70 - 130	4	30
Perfluorodecanesulfonic acid (PFDS)			96.4	59.6	*-	ng/L		62	66 - 126	11	30
Perfluorooctanesulfonamide (FOSA)			100	ND		ng/L		0	0 - 10	NC	30
NMeFOSAA			100	ND		ng/L		0	0 - 10	NC	30
NEtFOSAA			100	ND		ng/L		0	0 - 10	NC	30
4:2 FTS			93.8	ND		ng/L		0	0 - 10	NC	30
6:2 FTS			95.2	ND		ng/L		0	0 - 10	NC	30
8:2 FTS			96.0	ND		ng/L		0	0 - 10	NC	30

Isotope Dilution	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
13C4 PFBA	*98*		*25 - 150*
13C5 PFPeA	*100*		*25 - 150*
13C2 PFHxA	*101*		*25 - 150*
13C4 PFHpA	*107*		*25 - 150*
13C4 PFOA	*102*		*25 - 150*
13C5 PFNA	*102*		*25 - 150*
13C2 PFDA	*105*		*25 - 150*
13C2 PFUnA	*98*		*25 - 150*
13C2 PFDoA	*94*		*25 - 150*
13C2 PFTeDA	*98*		*25 - 150*
13C3 PFBS	*108*		*25 - 150*
18O2 PFHxS	*112*		*25 - 150*
13C4 PFOS	*104*		*25 - 150*
13C8 FOSA	*111*		*25 - 150*
d3-NMeFOSAA	*106*		*25 - 150*
d5-NEtFOSAA	*106*		*25 - 150*
M2-6:2 FTS	*114*		*25 - 150*
M2-8:2 FTS	*106*		*25 - 150*
M2-4:2 FTS	*0*		*0 - 10*

LCMS

Prep Batch: 697726

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-102726-1	AM-41A/1	Pre-Treatment	Water	TOP Pre - Prep	
320-102726-2	FM-11A/1	Pre-Treatment	Water	TOP Pre - Prep	
MB 320-697726/1-A	Method Blank	Pre-Treatment	Water	TOP Pre - Prep	
LCS 320-697726/2-A	Lab Control Sample	Pre-Treatment	Water	TOP Pre - Prep	
LCSD 320-697726/3-A	Lab Control Sample Dup	Pre-Treatment	Water	TOP Pre - Prep	

Prep Batch: 697729

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-102726-1	AM-41A/1	Post-Treatment	Water	TOP Post Prep	
320-102726-2	FM-11A/1	Post-Treatment	Water	TOP Post Prep	
MB 320-697729/1-A	Method Blank	Post-Treatment	Water	TOP Post Prep	
LCS 320-697729/2-A	Lab Control Sample	Post-Treatment	Water	TOP Post Prep	
LCSD 320-697729/3-A	Lab Control Sample Dup	Post-Treatment	Water	TOP Post Prep	

Analysis Batch: 698215

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-102726-1	AM-41A/1	Pre-Treatment	Water	537 (modified)	697726
320-102726-2	FM-11A/1	Pre-Treatment	Water	537 (modified)	697726
MB 320-697726/1-A	Method Blank	Pre-Treatment	Water	537 (modified)	697726
LCS 320-697726/2-A	Lab Control Sample	Pre-Treatment	Water	537 (modified)	697726
LCSD 320-697726/3-A	Lab Control Sample Dup	Pre-Treatment	Water	537 (modified)	697726

Analysis Batch: 698216

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-102726-1	AM-41A/1	Post-Treatment	Water	537 (modified)	697729
320-102726-2	FM-11A/1	Post-Treatment	Water	537 (modified)	697729
MB 320-697729/1-A	Method Blank	Post-Treatment	Water	537 (modified)	697729
LCS 320-697729/2-A	Lab Control Sample	Post-Treatment	Water	537 (modified)	697729
LCSD 320-697729/3-A	Lab Control Sample Dup	Post-Treatment	Water	537 (modified)	697729

Analysis Batch: 698860

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-102726-1	AM-41A/1	Pre-Treatment	Water	Total PFCA-Sum	
320-102726-2	FM-11A/1	Pre-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 698861

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-102726-1	AM-41A/1	Post-Treatment	Water	Total PFCA-Sum	
320-102726-2	FM-11A/1	Post-Treatment	Water	Total PFCA-Sum	

Analysis Batch: 698862

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-102726-1	AM-41A/1	Total/NA	Water	Total PFCA-Dif	
320-102726-2	FM-11A/1	Total/NA	Water	Total PFCA-Dif	

Lab Chronicle

Client: Orange County Water District
Job ID: 320-102726-1
Project/Site: FBVOC

Client Sample ID: AM-41A/1
Lab Sample ID: 320-102726-1
Date Collected: 07/19/23 13:15
Matrix: Water
Date Received: 07/20/23 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	697729	08/10/23 21:54	JER	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	698216	08/13/23 02:21	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	697726	08/10/23 21:40	JER	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	698215	08/13/23 01:03	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			698862	08/15/23 13:37	MKW	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			698861	08/15/23 13:33	MKW	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			698860	08/15/23 13:31	MKW	EET SAC

Client Sample ID: FM-11A/1
Lab Sample ID: 320-102726-2
Date Collected: 07/19/23 10:50
Matrix: Water
Date Received: 07/20/23 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Post-Treatment	Prep	TOP Post Prep			100.0 mL	10.0 mL	697729	08/10/23 21:54	JER	EET SAC
Post-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	698216	08/13/23 02:32	D1R	EET SAC
Pre-Treatment	Prep	TOP Pre - Prep			100.0 mL	10.0 mL	697726	08/10/23 21:40	JER	EET SAC
Pre-Treatment	Analysis	537 (modified)		1	1 mL	1 mL	698215	08/13/23 01:14	D1R	EET SAC
Total/NA	Analysis	Total PFCA-Dif		1			698862	08/15/23 13:37	MKW	EET SAC
Post-Treatment	Analysis	Total PFCA-Sum		1			698861	08/15/23 13:33	MKW	EET SAC
Pre-Treatment	Analysis	Total PFCA-Sum		1			698860	08/15/23 13:31	MKW	EET SAC

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Accreditation/Certification Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Laboratory: Eurofins Sacramento

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
California	State	2897	01-22-24

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Post Prep	Water	4:2 FTS
537 (modified)	TOP Post Prep	Water	6:2 FTS
537 (modified)	TOP Post Prep	Water	8:2 FTS
537 (modified)	TOP Post Prep	Water	NEtFOSAA
537 (modified)	TOP Post Prep	Water	NMeFOSAA
537 (modified)	TOP Post Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Post Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Post Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Post Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Post Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Post Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Post Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Post Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Post Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Post Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Post Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Post Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Post Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Post Prep	Water	Perfluoropentanoic acid (PFPeA)
537 (modified)	TOP Post Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Post Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Post Prep	Water	Perfluoroundecanoic acid (PFUnA)
537 (modified)	TOP Pre - Prep	Water	4:2 FTS
537 (modified)	TOP Pre - Prep	Water	6:2 FTS
537 (modified)	TOP Pre - Prep	Water	8:2 FTS
537 (modified)	TOP Pre - Prep	Water	NEtFOSAA
537 (modified)	TOP Pre - Prep	Water	NMeFOSAA
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanesulfonic acid (PFBS)
537 (modified)	TOP Pre - Prep	Water	Perfluorobutanoic acid (PFBA)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanesulfonic acid (PFDS)
537 (modified)	TOP Pre - Prep	Water	Perfluorodecanoic acid (PFDA)
537 (modified)	TOP Pre - Prep	Water	Perfluorododecanoic acid (PFDoA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanesulfonic acid (PFHpS)
537 (modified)	TOP Pre - Prep	Water	Perfluoroheptanoic acid (PFHpA)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanesulfonic acid (PFHxS)
537 (modified)	TOP Pre - Prep	Water	Perfluorohexanoic acid (PFHxA)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanesulfonic acid (PFNS)
537 (modified)	TOP Pre - Prep	Water	Perfluorononanoic acid (PFNA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonamide (FOSA)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanesulfonic acid (PFOS)
537 (modified)	TOP Pre - Prep	Water	Perfluorooctanoic acid (PFOA)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanesulfonic acid (PFPeS)
537 (modified)	TOP Pre - Prep	Water	Perfluoropentanoic acid (PFPeA)

Laboratory: Eurofins Sacramento (Continued)

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
537 (modified)	TOP Pre - Prep	Water	Perfluorotetradecanoic acid (PFTeA)
537 (modified)	TOP Pre - Prep	Water	Perfluorotridecanoic acid (PFTrDA)
537 (modified)	TOP Pre - Prep	Water	Perfluoroundecanoic acid (PFUnA)
Total PFCA-Dif		Water	PFBA
Total PFCA-Dif		Water	PFHpA
Total PFCA-Dif		Water	PFHxA
Total PFCA-Dif		Water	PFNA
Total PFCA-Dif		Water	PFOA
Total PFCA-Dif		Water	PFPA
Total PFCA-Dif		Water	Total PFCA
Total PFCA-Sum		Water	Total PFCA

Method Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Method	Method Description	Protocol	Laboratory
537 (modified)	Fluorinated Alkyl Substances	EPA	EET SAC
Total PFCA-Dif	Total PFCA (Treatment Difference)	TAL SOP	EET SAC
Total PFCA-Sum	Total PFCA (Summary)	TAL SOP	EET SAC
TOP Post Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC
TOP Pre - Prep	Solid-Phase Extraction (SPE)	SW846	EET SAC

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL SOP = TestAmerica Laboratories, Standard Operating Procedure

Laboratory References:

EET SAC = Eurofins Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Orange County Water District
Project/Site: FBVOC

Job ID: 320-102726-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-102726-1	AM-41A/1	Water	07/19/23 13:15	07/20/23 10:00
320-102726-2	FM-11A/1	Water	07/19/23 10:50	07/20/23 10:00

Eurofins Sacramento
880 Riverside Parkway
West Sacramento, Ca 95605
Phone (916) 373-5600 Fax (916) 372-1059

Chain of Custody Record

eurofins

Client Information	Sampler: Matt Drain	Lab PM: Karen Dahl	Carrier Tracking No(s):	COC No:
Client Contact: Patrick Versluis	Phone: 714-378-3200	E-Mail: Karen.Dahl@ET.Eurofins.com		Page: Page 1 of 1
Company: Orange County Water District				Job #:
Address: P O. Box 8300	Due Date Requested:			
City: Fountain Valley	TAT Requested (days): Normal 2 weeks			
State, Zip: California, 92728-8300				
Phone: (714) 378 8241	PO #:			
Email: pversluis@ocwd.com	WO #:			
Project Name: FBVOC	Project #:			

Analysis Requested

Preservation Codes:

A	HCL	M	Hexane
B	NaOH	N	None
C	Zn Acetate	O	AsNaO2
D	Nitric Acid	P	Na2O4S
E	NaHSO4	Q	Na2SO3
F	MeOH	R	Na2S2O3
G	Amchlor	S	H2SO4
H	Ascorbic Acid	T	TSP Dodecahydrate
I	Ice	U	Acetone
J	DI Water	V	MCAA
K	EDTA	W	pH 4-5
L	EDA	Z	other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	537.1 MOD TOPS	Total Number of containers	Special Instructions/Note:
AM-41A/1 ~~AM-41A/1~~ MRD 7/19/23	7/19/23	1315	G	W	N		X	4	
FM-11A/1	7/19/23	1050	G	W	N		X	4	
								4	*Please Call Pat Versluis if ANY detections are noted during analysis.*
									(714) 378 8241
									Email Results to
									pversluis@ocwd.com
									rhintlian@ocwd.com

320-102726 Chain of Custody

Possible Hazard Identification
☒ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☒ *Disposal By Lab* ☐ *Archive For _____ Months*

Deliverable Requested: I II, III IV Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
		7/19/2023 1545	OCWD		7/20/23 1000	
	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.	Cooler Temperature(s) °C and Other Remarks: 2.3

Ver: 08/04/2016

8/15/2023

eurofins | Environment Testing America

Sacramento Sample Receiving Notes

Place Field Sheet Label Here

Tracking # 7727 8776 4915

Job _____

SO / PO / FO / SAT / 2-Day / Ground / UPS / CDO / Courier

GSL / OnTrac / Goldstreak / USPS / Other _____

Use this form to record Sample Custody Seal Cooler Custody Seal Temperature & corrected Temperature & other observations.
File in the job folder with the COC

Therm ID C10 Corr Factor (+ / -) _____ °C

Ice ~ Wet _____ Gel _____ Other _____

Cooler Custody Seal ~

Cooler ID ✓

Temp Observed 2.3 °C Corrected 2.3 °C

From Temp Blank ☐ Sample ☑

Opening/Processing The Shipment	Yes	No	NA
Cooler compromised/tampered with?	☐	☑	☐
Cooler Temperature is acceptable?	☑	☐	☐
Frozen samples show signs of thaw?	☐	☐	☑

Initials. JF Date 7/20/23

Unpacking/Labeling The Samples	Yes	No	NA
Containers are not broken or leaking?	☑	☐	☐
Samples compromised/tampered with?	☐	☑	☐
COC is complete w/o discrepancies	☑	☐	☐
Sample custody seal?	☐	☐	☑
Sample containers have legible labels?	☑	☐	☐
Sample date/times are provided?	☑	☐	☐
Appropriate containers are used?	☑	☐	☐
Sample bottles are completely filled?	☑	☐	☐
Sample preservatives verified?	☐	☐	☑
Is the Field Sampler's name on COC?	☑	☐	☐
Samples w/o discrepancies?	☑	☐	☑ SO 7/20/23
Zero headspace?*	☐	☐	☑
Alkalinity has no headspace?	☐	☐	☑
Perchlorate has headspace? (Methods 314, 331 6850)	☐	☐	☑
Multiphasic samples are not present?	☑	☐	☐

*Containers requiring zero headspace have no headspace, or bubble < 6 mm (1/4")

Initials. SO Date 7/20/23

Notes _____

Trizma Lot #(s) _____

Ammonium Acetate Lot #(s) _____

Login Completion	Yes	No	NA
Receipt Temperature on COC?	☑	☐	☐
NCM Filed?	☐	☐	☑
Log Release checked in TALS?	☑	☐	☐

Initials. SO Date 7/20/23

Login Sample Receipt Checklist

Client: Orange County Water District

Job Number: 320-102726-1

Login Number: 102726

List Source: Eurofins Sacramento

List Number: 1

Creator: Oropeza, Salvador

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	