Corrective Measures Implementation Work Plan

Revision 1

Raytheon Company

(Former Hughes Aircraft Company)

1901 West Malvern Avenue

Fullerton, California

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ACRONYMS AND ABBREVIATIONS

1,1-DCE	1,1-dichloroethylene
AOP	advanced oxidation process
CACA	Corrective Action Consent Agreement
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CMT	Corrective Measures Termination
COCs	compounds of concern
DCHDPE	double-contained high-density polyethylene
DTSC	Department of Toxic Substances Control
EA	Engineering Analytics, Inc
EHS	Environmental Health & Safety
EPA	Environmental Protection Agency
gpm	gallons per minute
GAC	granular active carbon
H2O2	hydrogen peroxide
HAC	Hughes Aircraft Company
HDPE	high-density polyethylene
HOA	Homeowners Association
H+A	Hargis + Associates, Inc.
MCL	maximum contaminant level
OCWD	Orange County District
OCPW/FCD	Orange County Public Works / Flood Control District
O&M	Operation and Maintenance
OMM	operation, maintenance and monitoring
PLC	programmable logic controller
POCs	points of compliance
Psig	per square inch gauge
RAOs	Remedial Action Objectives
Raytheon	Raytheon Company
RCRA	Resource Conservation and Recovery Act
ROW	rights-of-way

ACRONYMS AND ABBREVIATIONS (CONTINUED)

RWQCB-SA	Regional Water Quality Control Board – Santa Ana
SCE	Southern California Edison
SDR	standard dimension ratio
the Site	1901 West Malvern Avenue, Fullerton, California
SWPPP	Storm Water Pollution Prevention Plan
SVOC	semi-volatile organic compounds
TCE	trichloroethylene
UV	ultraviolet
VFD	Variable Frequency Drive
VOC	volatile organic compounds
WDR	Waste Discharge Requirement

1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Corrective Measures Implementation (CMI) Work Plan Revision has been prepared by Engineering Analytics, Inc (EA) on behalf of Raytheon Company (Raytheon) (formerly Hughes Aircraft Company [HAC]) for the Site located at 1901 West Malvern Avenue which is northeast of the intersection of Malvern Avenue and Gilbert Street in Fullerton, California (the Site) (Figures 1 and 2). This revision to the CMI Work Plan provides updates to the original CMI Work Plan prepared by Hargis + Associates, Inc. (H+A) dated April 16, 2018 (H+A, 2018) and is prepared in accordance with requirements of the Corrective Action Consent Agreement (CACA) between Raytheon and the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) of January 15, 2003 (DTSC, 2003).

1.1 Purpose and Scope

This CMI Work Plan Revision presents a strategy for the implementation of the selected corrective measures for groundwater impacted with volatile organic compounds (VOCs), primarily 1,1 dichloroethylene (1,1 DCE) and to a lesser extent trichloroethylene (TCE), and the semi volatile organic compound (SVOC) 1,4 dioxane, associated with two former areas of the Site (former Building 609 area and former Building 601 area) in accordance with the CACA as outlined in the Corrective Measures Study (CMS) and DTSC's Final Statement of Basis for the Site (DTSC, 2018a and 2018b; H+A, 2015 and 2017). This update has been prepared to reflect the substantial completion of access agreements completed to date and includes relevant updates to the approach outline in the original version of the CMI Work Plan.

1.2 Work Plan Outline

This CMI Work Plan Revision has been organized into the following sections:

- Section 1 provides an introduction, the overall purpose and scope of the CMI Work Plan Revision, and an outline of the scope of this document;
- Section 2 outlines the Conceptual Site Model;
- Section 3 presents a Corrective Measures Objectives;
- Section 4 provides a description of the selected Corrective Measures;
- Section 5 provides a consideration of groundwater data sufficiency;
- Section 6 outlines project management and schedule;
- Section 7 outlines the Corrective Measures design criteria and basis;
- Section 8 provides a description of the Conceptual Design for the selected Corrective Measures;

- Section 9 outlines process flexibility requirements to accommodate contingencies in design and operation of treatment systems during CMI;
- Section 10 outlines waste management considerations;
- Section 11 lists required construction/building and operational permits; and
- Section 12 lists references cited.

2.0 CONCEPTUAL SITE MODEL

Groundwater impacts at the Site and a Conceptual Site Model have been summarized in the CMS (Figure 3) (H+A, 2015). Key elements of the Conceptual Site Model were summarized in the Statement of Basis as follows (DTSC, 2018b).

> The Site is located on the southern portion of the West Coyote Hills in Fullerton, California. The Coyote Hills have formed due to complex folding and faulting in the area. The Conceptual Site Model includes the following key elements:
>
> 1 Relatively low concentrations of residual compounds of concern (COCs) are at the two former source areas. The primary COCs at former Building 609 area are 1,1-DCE and 1,4 dioxane. Prior remediation in this area significantly reduced both residual concentrations and mass in the soil underlying the former building and the perched zone (Northern Perched Zone). Residual COCs in the soil and the Northern Perched Zone enter a portion of the regional groundwater system near the southern terminus of the Northern Perched Zone (toe of perched zone) (Figure 3). The primary COCs at former Building 601 area are TCE and 1,1-DCE. There is no perched zone in the vicinity of the Building 601 area; therefore, the residual COCs from this former source area enter a portion of the regional groundwater system near the southwest corner of former Building 601. The results of prior health risk assessments at both of these former source areas and the area overlying the Northern Perched Zone coupled with the depth to regional groundwater (over 100 feet below land surface [bls]) indicate that the only potential pathway for human exposure to COCs is from groundwater extraction from the portions of the regional aquifer system containing COCs. No groundwater use, other than for sole purposes of treatment, is allowed on the Site.
>
> 2 Residual COCs enter portions of the regional groundwater in two general areas: a) at the toe of the perched zone south of former Building 609; and b) in the vicinity of the southwest corner of former Building 601. The hydrostratigraphic units within the regional groundwater system slope (dip) to the south in the area north of Malvern Avenue due to deep faulting in this area (Figure 4). The primary transport zone within the regional groundwater system for COCs from both of the areas is a relatively coarse zone referred to as "Unit B" or the "Target Zone". Given the dip of the hydrostratigraphic units north of Malvern Avenue and the depth of the regional groundwater table (first groundwater in regional groundwater system), the depth to first groundwater in Unit B near the toe of the perched zone and southwest corner of Building 601 is about 120 feet bls. The depth to Unit B is approximately 1,000 feet bls south of these two areas along Malvern Avenue. North of these two areas Unit B becomes unsaturated.
>
> 3 Once the COCs have entered respective portions of the regional groundwater system, the COCs appear to be transported to the west at and near the Site and appear to be transported in a more southwesterly direction farther downgradient

from the Site. The COCs remain in Unit B downgradient from the Site due to the lower water level elevations in Unit B as compared to water level elevations in overlying and underlying hydrostratigraphic units. Given the preferential transport within Unit B, the depth to groundwater containing COCs increases as one approaches Malvern Avenue, such that the COCs are encountered at depths of approximately 1,000 feet bls in groundwater near and to the south of Malvern Avenue.

4 Well 9 (also sometimes referred to as F-AIRP) is located at the Fullerton Municipal Airport approximately 4,000 feet downgradient of the Site boundary (Figure 3). Unit B is within the two deepest screen intervals of this well. A temporary (2018) and then a subsequent semi-permanent packer system (2021) have been installed to isolate the bottom two screens of Well 9. These packer systems were installed and are operated under an agreement between the City of Fullerton and Raytheon and are not subject to the CMI. Although 1,1-DCE was present in the deepest screened zone in Well 9, it was historically detected below the drinking water maximum contaminant level (MCL), and as such meets drinking water standards of protection for human health established by Federal and State agencies. Depth-specific sampling of Well 9 was conducted in April and May 2014 by Raytheon with cooperation and input from the City of Fullerton and the Orange County Water District (OCWD). In addition, packer testing of Well 9 was completed in 2016. The results of depth-specific sampling and packer testing indicate that 1,1 DCE appears to be entering Well 9 from the lowermost two screen intervals and not from the uppermost or intermediate screen intervals. The concentration of 1,1-DCE and TCE detected from the deepest screen interval during depth-specific sampling was less than the drinking water MCL. TCE was not detected in the wellhead samples collected from Well 9, which represents a composite sample of water contributed from all screen intervals. 1,4-Dioxane was not detected in groundwater samples collected as part of the depth-specific sampling program or in wellhead samples during the packer testing program. 1,1-DCE has not been detected in Well 9 well head samples since the packer systems became operational in 2018 (Figure 5).

Operations of the current pilot groundwater extraction and treatment system have reduced the COC mass in the regional groundwater and have reduced off-site migration of COCs.

3.0 CORRECTIVE MEASURES OBJECTIVES

Corrective Measures Objectives include general and specific Remedial Action Objectives (RAOs) for groundwater. General RAOs for groundwater at the Site are to protect human health and the environment. Specific RAOs for groundwater were outlined in the CMS and reiterated in the Statement of Basis:

- Prevent unacceptable exposure to groundwater containing COCs;
- Establish containment areas within the regional groundwater system to control future residual COC migration from former source areas; and
- Contain COCs in groundwater to protect current and future uses of groundwater with a short-term goal of not exceeding Federal and California State drinking water MCLs at points of compliance (POCs) and a long-term goal of attaining drinking water MCLs in groundwater to the extent practical.

Corrective measures for groundwater were evaluated in the CMS Report with respect to the RAOs for groundwater listed above and the following drinking water standards at existing and potential receptors: Federal and California State drinking water MCLs and California Notification Levels (H+A, 2015).

4.0 DESCRIPTION OF CORRECTIVE MEASURES

The recommended groundwater corrective measures alternatives presented in the CMS were selected by the DTSC as outlined in the Final Statement of Basis (DTSC, 2018a and 2018b; H+A, 2015 and 2017). The following sections summarize the selected corrective measures for the Site as presented in the CMS and summarized in the Final Statement of Basis.

4.1 Selected Remedy for Groundwater

The selected remedy for the Site was developed using the retained groundwater corrective measures alternatives outlined in the CMS Report and incorporates respective contingency actions to ensure that proposed groundwater RAOs are met (H+A 2015).

The selected groundwater remedy is On-Site and Brea Creek Alignment Extraction with On- and Off-Site Injection of treated groundwater into the Unit B (CMS Alternative GW5A; Figure 6). The selected remedy also includes a provision for non-potable reuse of the treated groundwater while maintaining some off-site injection of treated groundwater into the Unit B (CMS Alternative GW5B). The CMS indicates that if non-potable reuse is incorporated into the remedy, the extracted groundwater would be treated to standards required as part of the Waste Discharge Requirements (WDR) permit for groundwater reinjection issued by the Regional Water Quality Control Board, Santa Ana (RWQCB-SA). The treated water would be provided to the purveyor of non-potable water who is responsible for the construction, permitting, and operation of the non-potable distribution system. In addition, any tertiary treatment exceeding WDR standards that may be required for non-potable reuse will be the responsibility of the water purveyor. The determination of whether non-potable water reuse will be incorporated into the remedy will be made by Raytheon and the purveyor of non-potable water after the CMI design. At this time, it is not expected that non-potable water reuse would be incorporated in the foreseeable future. However, this determination could also be made at some time in the future after CMI design is complete as long as the initial CMI design incorporated an injection wellfield with sufficient capacity to accept the entire volume of groundwater extracted and treated.

The selected remedy will extract groundwater using five existing wells, EW-01, EW-02, MW 21, MW-29, MW-31, and four proposed extraction wells nominally identified as EW-03, EW-04, EW-06, and EW 07, at a total design flowrate of 490 gallons per minute (gpm) (Figure 6). The five existing wells and proposed extraction well EW-07 are located on-Site. Proposed extraction wells EW-03, EW 04, and EW-06 are located off-site. Proposed extraction well EW-06 is adjacent to existing monitoring well MW-33. The concentration of COCs in monitoring well MW-33 are relatively low, and have been consistently below drinking water MCLs (for 1,1-DCE and TCE) and below the notification level (for 1,4-dixane) since about mid-2018 (Figure 7). Given these low concentrations, extraction well EW-06 and associated conveyance pipeline between the intersection of Brea Creek and Burning Tree Road to the extraction will not be installed during construction of the groundwater corrective measure (Figure 6). However, the pipeline from the intersection of Brea Creek and Burning Tree Road to the treatment system and the treatment system itself will be sized to accommodate addition of extraction well EW-06 in the future to the extent required. Five injection wells will be installed as originally planned. These five injection wells would also accommodate potential future extraction from EW-06, if needed. The location and target zone for injection wells is relatively flexible; however, the selected remedy conceptually incorporates reinjection into Unit B on the southeast portion of the Site (IW-01 and IW-02), and in the residential neighborhood to the west of the Site (IW-03 to IW-05).

The treatment system location to be incorporated into the CMI design is in the general vicinity of the existing pilot groundwater treatment system (Figures 2 and 6). The treatment processes would include filtration of groundwater followed by an Advanced Oxidation Process (AOP) to treat 1,4-dioxane and some of the VOCs, followed by liquid-phase granular activated carbon (GAC) to serve as a final polish for VOC treatment and for reduction of residual hydrogen peroxide (H2O2) from the AOP (Figure 8). The AOP that will be used in the treatment system employs ultraviolet (UV) light and H2O2. This configuration is currently being used as part of the pilot groundwater extraction and treatment system located at the Site.

The Institutional Controls for the selected groundwater corrective measure alternative consist of the following:

- deed restrictions to prohibit future well installations at the Site, with exception of wells installed as part of the groundwater corrective measures, thereby minimizing potential risks of exposure;
- submittal of system performance reports to nearby water users (Cities of Fullerton and Buena Park);
- annual review of water production and water quality data from Fullerton Well 9 and Buena Park BP-SM1;
- annual review of well permits issued in areas from near the Site to within 0.5 mile of point-of-compliance wells to determine if new groundwater extraction wells have been installed in the area;
- annual review of water production from OCWD for selected wells in the Site vicinity (identified on Figure 9) and any other new production wells that may be installed in this vicinity.

It is anticipated that off-site groundwater will meet RAOs prior to on-site groundwater, in which case the off-site extraction wells could be turned off while on-site extraction wells continue to operate until RAOs are met in on-site groundwater as well. Upon substantially meeting RAOs, a Corrective Measures Completion report will be prepared and submitted to the DTSC recommending Corrective Measures Termination (CMT). Following DTSC approval of CMT, the treatment system will be demobilized. Demobilization will include teardown of remediation system equipment, decommission of the extraction/collection system, and removal of equipment from the Site.

4.2 Corrective Measures Contingencies

Contingencies for groundwater corrective measures may be implemented in order to address specific human health or environmental concerns or may be implemented to modify the scope of the respective program in response to changes in field conditions or observations during CMI, thus increasing the flexibility of the respective corrective measure based on an ongoing evaluation of the results of the associated monitoring programs.

The following outlines a description of contingencies along with associated triggers for the selected groundwater corrective alternative described above. The initial contingency action would be implemented first, with the secondary contingency action being implemented if the initial does not achieve performance requirements. The decision analysis for contingency actions associated with groundwater corrective measures alternatives were outlined in the CMS.

Four contingency actions have been identified for the on- and off-site portions of the selected groundwater corrective measures as summarized in the following:

IDENTIFIER	TRIGGER	INITIAL CONTINGENCY ACTION	SECONDARY CONTINGENCY ACTION
GW5/6a	Increasing concentration trends in one or more of the POC monitor wells at end of first 5 years of monitoring	Evaluate increasing extraction rate at existing off-site extraction wells	Add additional off-site extraction wells
GW5/6b	Fullerton Well 9 exceeds 50 percent of MCL for more than 6 months	Monitor AND evaluate increasing extraction rate at existing off-site extraction wells or adding an additional off-site extraction well	Assess alternate sources of potable water OR relocate well
GW5/6c	Water level, model simulations and/or long-term water quality trend indicating on-site containment not adequate	Evaluate increasing extraction rate at existing on-site extraction wells	Add additional on-site extraction wells
GW5/6d	Water level, model simulations and/or long-term water quality trend indicating off-site containment not adequate	Evaluate increasing extraction rate at existing off-site extraction wells	Add additional off-site extraction wells

5.0 DATA SUFFICIENCY

CMS supporting activities have been conducted in accordance with the CMS and Groundwater Assessment work plans and associated addenda since the initial 2003 CMS Work Plan was prepared. These activities included groundwater monitoring and assessment, groundwater treatment bench-testing and extended groundwater extraction and treatment pilot testing, and numerical groundwater monitoring. These activities were conducted to provide sufficient data to support completion of the groundwater assessment and evaluation of groundwater corrective measures alternatives as summarized in the CMS Report (H+A, 2015). The sufficiency of existing groundwater data collected at the Site to support the corrective measures design is considered below.

Routine groundwater monitoring has been conducted quarterly since 2003. Additional groundwater assessment was conducted in several phases between 2003 and 2014, in accordance with multiple addenda of the Additional Groundwater Assessment Work Plan that have been implemented at the Site. Monitor wells have been installed to more fully delineate the distribution of VOCs, principally 1,1 DCE and 1,4-dioxane, in the Target Zone (H+A, 2003, 2004, 2008, 2010, 2011, 2013a, 2013b, and 2014). In 2019, an additional downgradient POC and a monitor well were installed (H+A, 2019). Results from the additional groundwater assessments completed through 2014 and ongoing groundwater monitoring indicate that groundwater assessment is sufficiently complete (H+A, 2022).

Several field and bench tests evaluating various groundwater treatment technologies have been conducted since 2004 and an extended groundwater extraction and treatment pilot test has been operating at the Site since 2008 (H+A, 2015 and 2022). The current AOP treatment technology uses UV light and H2O2 and is followed by GAC as a polishing step in the treatment process. The current treatment process is effectively removing VOCs and 1,4 dioxane from extracted groundwater, and has maintained the treatment goals of Federal and California State drinking water MCLs for VOCs, and the California Notification Level for 1,4 dioxane since installation of the technology. Hydraulic testing, groundwater capture zone analysis and groundwater modeling suggest extraction is effective for capture of groundwater at the Site. Results from the ongoing groundwater extraction and treatment pilot testing indicate existing data are sufficient to support CMI design.

6.0 PROJECT MANAGEMENT

Project management, including project organization, roles responsibilities and the estimated project schedule are included in the following sections.

6.1 Roles and Responsibilities

The following outlines general roles, responsibilities and qualifications for primary elements of the CMI. An Organizational Chart has been prepared (Figure 10).

COMPANY	PERSON	ROLE	QUALIFICATION
Raytheon Company	Daniel Samorano, PE	Manager Remediation Programs, Corporate EHS Primary Project Contact	Professional Engineer
	Jonathan Hone	Project Manager	Environment, Health & Safety Manager
EA and H+A	Chris Ross, PG, CHG	Senior Project Management, Principal, Technical Review	Professional Geologist
	Lisa Wahl, PE	Project Management CMI Oversight	Professional Engineer
	Kevin Coons, PE	Engineering Design/Review; CMI Oversight	Professional Engineer
	Steve Netto, PG, CHG	CMI well installation oversight and OMM	Professional Geologist
Licensed Environmental Construction Contractor	---	Treatment system/ pipeline construction implementation	General Contractor's License
Licensed Environmental Well Drilling Contractor	---	Drilling/Well Construction implementation	C57 License

Primary lines of communication will be between Raytheon and Raytheon's project management/CMI oversight contractor (EA and H+A), who will work as an extension of Raytheon and will communicate directly with well installation and general construction contractors. EA will also support Raytheon in communications with property owners. Lines of communication between contractors and property owners, property managers, and tenants will be channeled through Raytheon or EA/H+A.

6.2 Project Schedule

An estimated project schedule for CMI has been prepared (Figure 11). The project schedule presents key milestones and deliverables and includes the following components:

- CMI Work Plan, which outlines Conceptual Design including schedule, sequencing and deliverables associated with the CMI;
- The design process includes Final Plans and Specifications; Updated Cost Estimate; and Construction Completion Report, along with submittal of Final Plans to obtain construction permits. Note, to stream line process, the specifications will include information presented in a Construction Work Plan, such that a formal Construction Work Plan will not be required;
- The Operations and Maintenance Plan and operating permits are integrated to maximize schedule efficiencies;
- Operation, maintenance and monitoring (OMM) of the corrective measure includes startup of the system and long-term OMM including periodic monitoring reports.

A critical pathway to the overall schedule is completion of access to off-site private properties. CMI design and construction/building permitting cannot be completed until agreement on the off-site property access from the respective property owners are obtained (Figure 11). On site access was maintained through sale of the Site property, and Raytheon has presented the conceptual CMI plans to on-site property owners and has received access. In addition, Raytheon has completed access agreements with the City of Fullerton for public rights of way and the Orange County Public Works / Flood Control District (OCPW/FCD) for extraction wells and/or associated pipeline along the Brea Creek Alignment. Access to a private bridge owner to span the pipeline across Brea Creek; and a private Home Owners Association (HOA) for injection well control panels in the residential neighborhood to the west of the Site is on-going.

Raytheon will continue to pursue access to the off-site properties; however, the timing of the access approvals is somewhat out of the direct control of Raytheon, and therefore, there is some uncertainty in the overall schedule for design, permit and construction of the CMI.

7.0 DESIGN CRITERIA/BASIS

Design criteria, design basis, and performance requirements for the groundwater corrective measures are outlined as follows:

- On-site and off-site plume capture pump and treat
    - Hydraulically contain on-site groundwater exceeding drinking water MCLs for VOCs and 1,4-dioxane and hydraulically capture off-site plume, to the extent practicable.
        - Location and pumping rates of extraction wells evaluated by numerical modeling of groundwater flow and aquifer testing;
            - Six on-site extraction wells located along downgradient Site boundary and toe of the perched zone with combined projected extraction rate of approximately 190 gpm.
            - Two off-site extraction wells with combined projected extraction rate of approximately 200 gpm[1].
            - Extraction wells screened within the Unit B.
        - Treated water to be returned to groundwater via on- and off-site injection wells. Sanitary sewer connection to be maintained for short-term temporary discharges of up to 50 gpm, primarily for treatment system testing purposes. Treated water may be split to provide non-potable use of portion of treated water in the future.
            - Two on-site injection wells to operate at a combined injection rate of 150 gpm.
            - Three injection wells off-site to operate at a combined injection rate of 240 gpm.
    - Extracted groundwater to be treated for VOCs and 1,4-dioxane through an AOP utilizing UV light and H2O2 followed by liquid-phase GAC as a polish to remove remaining VOCs following the AOP at a projected combined extraction rate of 490 gpm. Treatment system to be designed and constructed to accommodate a contingency to scale-up the AOP and liquid-phase GAC treatment should it become necessary.
    - Generally, below-grade infrastructure including new extraction wells and extraction conveyance piping and electrical conduits will be designed to accommodate contingency flowrates and electrical demands. Contingency flow rates for wells and pipelines are generally 150 percent to 200 percent of the

[1] A third extraction well, EW-06, can be installed to the extent required based on future performance monitoring; The treatment system and pipeline from the treatment system to the intersection of Brea Creek and Burning Tree Road will be designed to accommodate flow from EW-06 as part of the base case remedy design to facilitate efficient future installation of EW-06 to the extent needed.

planned Base Case flowrates that were determined from model projections. Select above-grade treatment equipment will be designed with a capacity of approximately 150 percent over the planned Base Case flowrate capacity, to accommodate increased flow, should it become required.

- Preferred system up-time goal of 90 percent; minimum system up-time goal of 70 percent;
- Automated alarm notification system with automated system shutdowns to be included in system design.
- Anticipated remedy duration of one to several decades based on numeric modeling to achieve MCLs in groundwater, to the extent practicable.
- Contingencies are built in to corrective measure to adjust pumping rates and/or expand extraction wellfield further downgradient, if needed. Contingencies are designed to provide levels of flexibility in selected corrective measure.
- Two existing monitor wells were selected as downgradient points of compliance.

8.0 CONCEPTUAL DESIGN

This section describes design elements of the preferred groundwater corrective action alternative GW5A. The design elements have been grouped into the following elements: extraction system; treatment system; and the injection system.

There are two key terms used to describe Basis of Design for different design elements of the groundwater corrective action: 1) Base Case; and 2) Contingency Case. The Base Case refers to parameters such as flow and/or concentration, which are based on the CMS model projections (flow) and/or currently available groundwater quality data (concentration). The Contingency Case refers to increases to Base Case respective parameters that attempt to capture and incorporate some of the uncertainties associated with those parameters as basis of design for specific design elements.

8.1 Extraction System

The extraction system consists of the following major elements: extraction well field; conveyance pipelines and electrical as described further in the following sections.

8.1.1 Extraction Well Field

The location, extraction pumping rates, estimated COC concentrations, extraction well construction, extraction pumps and extraction well vaults are described in the following sections.

8.1.1.1 Extraction Well Locations

The general locations of the extraction wells are based upon the CMS Report (H+A, 2015). Groundwater will be extracted using five existing wells, EW-01, EW-02, MW-21, MW-29, MW-31, and four proposed extraction wells EW-03, EW-04, EW-06, and EW-07 (Figure 6). Three of the four proposed wells will be installed as part of the initial corrective measure construction. The fourth, EW-06, may be installed in the future based on performance monitoring results. The location of the proposed extraction wells may be adjusted during design process to accommodate access constraints

8.1.1.2 Extraction Pumping Rates

The Base Case extraction rates for alternative GW-5A are based on CMS Report modeling and are summarized in Table 1. The total Base Case extraction rate is 490[2] gpm. The Contingency Case extraction rates for alternative GW-5A are summarized in Table 1.

The Base Case or Contingency extraction rates are used as Basis of Design for different design elements as described in the respective sections below and are summarized in Table 1.

[2] The 490 gallons per minute includes extraction from EW-06, to the extent it is needed in the future.

8.1.1.3 Estimated Concentration of COCs

The concentrations of primary COCs for each of the extraction wells has been estimated based on average concentrations in the respective well, a nearby well or a group of monitor wells (Table 2). The average concentration for each well was rounded up to one significant figure.

The average concentrations of compounds for each extraction well were used to estimate the influent concentration to the treatment system (refer to respective treatment system sections below).

8.1.1.4 Extraction Well Construction

Five of the nine extraction wells have already been constructed. Four of these five wells are or have been operated as part of the pilot groundwater extraction system (Figure 6). Three of the four remaining extraction wells will be installed by a licensed drilling contractor to the targeted extraction interval during construction of the corrective measure. The extraction well installation will be conducted in compliance with the California Department of Water Resources and California Well Standards. The design life for the new extraction wells will be 30 years given the challenges in constructing deep wells in off-site locations. As such, each extraction well will be constructed of stainless-steel well screen and stainless-steel blank casing. The nominal casing diameter for new deep extraction wells will be 8 inches to allow installation of downhole equipment. Centralizers will be installed to center the well casing within the borehole.

Well construction methods will be briefly summarized in an extraction/injection well installation work plan that will be provided to DTSC in the third quarter of 2022.

8.1.1.5 Groundwater Extraction Well Pumps

Groundwater extraction rates for each extraction well were based on the Base Case extraction rates for the respective wells (Table 1). The pumps will be sized to extract groundwater from the respective extraction well to the treatment system without the need for booster pumps. If higher extraction rates (up to the Contingency Case) are required based on results of performance monitoring during operations and monitoring (O&M), then the pump would be upsized to accomplish the increased extraction rate.

A hydraulic model of the groundwater extraction system will be developed to allow the extraction system pumps to overcome frictional losses in the pipeline and deliver the water to the treatment plant, including overcoming the height of the influent storage tank.

Each extraction pump will be constructed of stainless-steel material. Extraction rate-flow control will be provided by a Variable Frequency Drive (VFD) located in an adjacent well distribution and control panel. The VFD will speed up or slow down the pump motor to maintain flow at any set point within the pump’s range of operation. This arrangement gives flexibility to the output flow of the individual pumps. The pumps will be operated to maintain a pre-set extraction flowrate, with shutdown based on water levels in the extraction wells to prevent running the pumps dry, as well as levels in the receiving tanks at the treatment plant to prevent overflows, and flow balancing with the injection wellfield. Each pump will include interlocks that will shut down the pump based upon high or low pressure and high or low flow set points. The final design of the pump installation will include provisions for pump cooling and may require shrouds in certain wells to maximize flow past the pump motor for cooling purposes. The extraction pumps for extraction wells with screen interval at or near the water table will be located in the screened interval allowing for maximum operational flexibility. The extraction pumps for the deeper extraction wells will be set above the screened interval and approximately 100 feet below anticipated pumping levels to account for seasonal variations. Pump set depths will be included in the Final Design Drawings.

8.1.1.6 Extraction Well Vaults

Extraction wellheads will be located in below grade pre-cast concrete vaults. The wellhead casing will extend into the vault. Each vault lid will include an appropriate traffic-rating for protection and provide unobstructed access to the components within the vaults. The vaults will be designed to minimize surface water from entering vault. Vaults will have concrete bottom to contain and detect leaks, however there will be a drain with plug to allow surface water collected during rain events to empty out, if necessary.

Well pipe and vault piping will be stainless steel and will transition to double-contained high-density polyethylene (DCHDPE) as the piping exits the well vault. Stainless steel piping in the vault will be sized based on the Base Case extraction rate for the respective extraction well. Stainless steel pipe is the preferred material because it is rigid and resists corrosion. Well vaults will be sized to accommodate the Contingency Case flow rates and larger vault piping.

8.1.2 Extraction Conveyance Piping

The extraction pipeline construction and pipeline routing are described in the following sections.

8.1.2.1 Extraction Pipeline Construction

DCHDPE pipe will be utilized for underground extraction pipelines throughout the system in order to provide secondary containment during groundwater conveyance. DCHDPE pipe is easier to install than other traditional piping materials and is cost effective, flexible, durable, and corrosion resistant. The underground carrier piping shall be standard dimension ratio (SDR) SDR 11 with a maximum recommended operating pressure of 160 pounds per square inch gauge (psig) at 73 degrees Fahrenheit (°F). The underground containment piping shall be high-density polyethylene (HDPE) SDR 17 with a maximum recommended operating pressure of 100 psig at 73°F. The DCHDPE pipe will originate from within each vault and will convey the groundwater from each vault to the groundwater treatment system. On- and off-site extraction pipelines will combine into a single manifold at the treatment plant for transmission to the treatment plant equipment.

The majority of the pipeline will be installed underground. In locations where the pipeline will be above ground at bridge crossings, the DCHDPE will transition to double-contained Centricast CL 1520® fiberglass piping. Double-contained Centricast piping was chosen because of material strength and thermal expansion properties. At the treatment plant, the DCHDPE will transition to single-wall corrosion-resistant piping and secondary containment will be achieved by way of the treatment plant building and concrete slab floor.

The Basis of Design for sizing pipelines incorporates Contingency Case extraction rates from respective extraction wells (Table 1) and maintaining pipeline velocities less than 7 feet per second and greater than 2 feet per second.

8.1.2.2 Extraction Piping Routing

The majority of the pipe routing will be located on-Site, within public rights-of-way (ROWs) and the OCPW-FCD easement along Brea Creek Channel (Figure 6). The routing may be refined or revised during the design process.

8.1.3 Extraction Well Electrical Service

The two extraction wells located in close proximity to the treatment plant location (EW-01 and MW-21) will be powered from the treatment plant using a new 480-volt service. Extraction well MW-29 is currently operated as part of the pilot treatment plant and is connected to a satellite power station. Neither the existing downhole equipment nor electrical service at this location require upgrades or modifications. Extraction well EW-02 is currently operated as part of the pilot treatment plant with a 50 gpm, 220-volt three (3) phase submersible pump connected to a satellite power station. The submersible pump in this well will be replaced with a 100 gpm 480-volt 3 phase submersible pump. The existing electrical service does not appear to require upgrades with possible exception of upsizing wire between the transformer and extraction well.

On-site extraction well EW-07 is a relatively low-rate extraction well and is located in a residential development. It is anticipated that 480-volt, 3 phase power for this extraction well's submersible pump will be powered from a satellite station located nearby. The remaining extraction wells (on site MW-31 and off-site EW-03, EW-04 and EW-06[3]) will also be powered and controlled from individual local satellite stations. It is anticipated these submersible pumps will be 480-volt, 3 phase power.

The new satellite power stations will be located in non-traffic areas and will be sized to meet the Contingency Case extraction rates for their respective extraction wells (Table 1).

8.2 Treatment System

The treatment system is designed to reduce concentrations of COCs in extracted groundwater to levels that comply with the RWQCB-SA general WDR permit for reinjection of treated groundwater. The simplified process flow diagram for alternative GW5A has been prepared (Figure 8).

The following sections describe the Basis of Design for: treatment plant location/building and materials of construction; selected elements of the treatment plant; treatment plant and well field control summary; and utility requirements.

8.2.1 Treatment Plant Location, Building Considerations and Materials of Construction

The treatment plant will be in the vicinity of the existing pilot treatment plant (Figures 2 and 6).

[3] The local power drop for EW-06 would be installed at the time of extraction well construction, if needed.

The treatment plant equipment will be located on a raised concrete containment dike within a concrete masonry block wall building. The building specifications will be developed during design and incorporate current property owner requirements.

The groundwater corrective action is expected to be operated continuously for over 30 years. Pressure vessels, tanks, and process pipelines will be designed and specified to have a design life of 30 years, typical for remediation systems. Mechanical equipment utilized (i.e., pumps, valve, controllers, etc.), the control system, and the advanced oxidation system are not expected to last the entire period of operation and so will be designed and specified in a manner that replacement can be readily performed as this equipment reaches the end of its useful life.

The preliminary construction materials for above ground process pipe within the treatment plant will most likely be single-wall corrosion-resistant piping for both untreated and treated water, however material selections may change during the corrective measures design process, which includes evaluation of cost and commercial availability.

8.2.2 Treatment System Elements

8.2.2.1 Influent Storage Tank T-2001

The influent storage tank T-2001 will receive unfiltered groundwater from the on- and off-site extraction wells and filtered water from the utility tank (T-4001) (Figure 8). The influent storage tank will be stainless steel or fiberglass. This tank will be designed for atmospheric pressure with a minimum of 15 minutes hydraulic residence time (the Contingency Case, Table 1). The tank will include level sensors that will be used in the control system to maintain a constant level in the tank. Since the influent storage tank has the largest volume of untreated groundwater, it will be evaluated in accordance with South Coast Air Quality Management District Rule 219 to determine whether the tank would be conditionally exempt from emission control requirements based on emissions being below respective thresholds.

8.2.2.2 Influent Transfer Pump PC-2001

The water from the influent storage tank T-2001 is pumped through a particulate filter FX-2001 (Figure 8). The influent centrifugal transfer pump is sized to handle the Base Case 390 gpm process stream flow (Table 1). The pump pad for the influent centrifugal transfer pump will be designed to accommodate a larger replacement transfer pump to handle the Contingency Case flow of 750 gpm. The transfer pump will be controlled using a VFD to match the treatment plant flowrate to that being produced by the extraction wellfield and being processed by the advanced oxidation system.

8.2.2.3 Particulate Filter FX-2001

Extracted groundwater from the on- and off-site extraction wells will be pumped from the influent storage tank T-2001 through particulate filter FX-2001 to the advanced oxidation system PX-2100 (Figure 8). The filter will be designed to remove particles 10 microns and larger. The particulate filter will have a stainless-steel housing and hydraulic capacity of 750 gpm and a pressure rating of 150 psig. The particulate filter system would operate at a maximum recommended differential pressure (high pressure alarm setting) to prevent filter bag failure.

8.2.2.4 Advanced Oxidation System PX-2100

Extracted groundwater from the on- and off-site extraction wells will be pumped from the influent storage tank T-2001 through particulate filter FX-2001 to advanced oxidation system PX 2100 (Figure 8). The advanced oxidation system currently used at the pilot treatment system for destruction of 1,4 dioxane and chlorinated alkenes dissolved in groundwater is the Trojan UVPhox™ Model 12AL30 developed by Trojan Technologies which uses UV light in combination with H2O2. The new advanced oxidation system will be supplied by Trojan Technologies and be designed to destroy 1,4-dioxane from the estimated influent concentration (Table 2) to approximately 0.5 micrograms per liter (50 percent of the RWQCB-SA WDR Permit level for 1,4 dioxane) at 490 gpm (Base Case flowrate, Table 1). An additional AOP reactor can be added to handle the Contingency Case flow of 750 gpm.

8.2.2.5 Liquid Phase Carbon Adsorption V-2001 and V-2002

Treated groundwater from the advanced oxidation system PA-2001 will be pumped through liquid phase carbon adsorption vessels (V-2001 and V-2002) (Figure 8). The liquid-phase carbon adsorption vessels V-2001 and V-2002 are provided to remove residual VOCs in extracted groundwater not otherwise destroyed by the advanced oxidation system PA-2001 to levels meeting RWQCB-LA WDR permit requirements (non-detect at effluent of lag vessel to extent practical) and residual H2O2. It is expected that the liquid-phase carbon adsorption vessels will receive treated water, and therefore a small amount of carbon consumption is anticipated. The design flowrate for the liquid phase carbon adsorption vessels will be 750 gpm (the Contingency Case, Table 1).

The two liquid-phase carbon adsorption vessels will be operated in series, each filled with 20,000 pounds of virgin GAC. During the design phase, use of the existing two 20,000-pound liquid-phase carbon adsorption vessels at the HAC Former Building 684 site will be evaluated for use versus purchasing new liquid-phase carbon adsorption vessels.

8.2.2.6 Effluent Storage Tank T-2002

The effluent storage tank T-2002 will receive treated groundwater from the liquid-phase carbon adsorption vessels V-2001 and V-2002 (Figure 8). The effluent storage tank will be stainless steel or fiberglass. This tank will be designed and sized the same as the influent storage tank T-2001 (the Contingency Case, Table 1). The tank will include level sensors that will be used in the control system to maintain a constant level in the tank.

8.2.2.7 Injection Transfer Pump P-2002

The water from the effluent storage tank T-2002 is pumped to injection wells using injection transfer pump P-2002 (Figure 8). The transfer pump is sized to handle the Base Case 390 gpm process stream flow (Table 1). The pump pad for the injection transfer pump will be designed to accommodate a larger replacement transfer pump to handle the Contingency Case flow of 750 gpm. The transfer pump will be controlled using a VFD to match the treatment plant flowrate and the water being delivered to the injection wellfield.

8.2.2.8 Utility Storage Tank T-4001 / Transfer Pump PC-4001 / Particulate Filter FX-4001

The utility storage tank T-4001 will receive liquid-phase carbon backwash water, groundwater sampling and development water, injection well development water, storm water, and sump water. The utility tank T-4001 will be stainless steel or fiberglass and will be designed for atmospheric pressure operation. The storage tank will include level sensors that will be used in the control system to start and stop the transfer pump P-4001.

The water from the utility storage tank T-4001 is pumped to influent storage tank T-2001 using transfer pump P-4001 (Figure 8). The speed of the utility tank transfer pump P-4001 will be controlled using a VFD, so as not to exceed the hydraulic capacity of the treatment units downstream of influent storage tank T-2001.

Particulate filter P-4001 removes sediments prior to utility storage tank T-4001 (Figure 8). The particulate filter will be designed to remove particles 10 microns and larger and have a stainless-steel housing.

8.2.3 Treatment System and Well Field Control System

The control system will be designed to allow unattended operation and limit the need for operator interaction. The system will allow off-site monitoring of the treatment plant, the extraction and injection wells, and will also provide for response to notifications and alarms. Overall, the treatment plant operations will be controlled using a programmable logic controller (PLC) based system at the treatment plant with local PLC systems at the extraction wells and grouped PLC control systems for on- and off-site injection wells. The PLC system at the treatment plant will communicate to local PLC systems using a fiber optic-based communication. The control system will be described in greater detail through the design process.

8.2.4 Utility Requirements

The electrical service requirements for the treatment plant will be provided by Southern California Edison (SCE). The requested electrical service will be part of design. The feeder, transformer, and meter locations will be based on the technical requirements of SCE, the City of Fullerton and OCPW/FCD. The treatment system does not incorporate a redundant power supply (e.g., generators), since a power failure at the treatment plant would shut down the extraction well pumps. Battery backups are planned for critical control system components, such as alarm call outs, PLCs, computers, and emergency lighting.

Potable water is available from an existing City of Fullerton connection located at the pilot treatment plant. Potable water would be used for sanitary purposes, emergency eyewashes, and used in the treatment process for liquid phase carbon backwashes. The capacity of the existing connection will be assessed during design.

There is an existing sanitary sewer connection to the pilot treatment plant that can be used for temporary discharge of treated groundwater during maintenance activities. This connection is anticipated to be maintained. An additional connection may be required for sanitary facilities provided in the control room only which will be evaluated during the design process.

Preliminary telecommunication requirements for the treatment plant will include up to two voice lines and a data communication line. Two phone lines were selected to allow simultaneous operator communication with auto dialer alarm callout. Telecommunications services are available from Verizon and other major telecommunications service providers in the City of Fullerton.

8.3 Injection System

The injection system consists of the following major elements: injection well field; conveyance pipelines and electrical as described further in the following sections.

8.3.1 Injection Well Field

The location, injection rates, injection well construction, injection tubing and injection well vaults are described in the following sections.

8.3.1.1 Injection Well Locations

The general locations of the injection wells are based upon the CMS Report (H+A, 2015). Groundwater will be injected using one existing well, MW-40 (identified as IW 2 on Figure 6); and four proposed injection wells IW-01, IW-03, IW-04 and IW-05 (Figure 6). The location of the proposed injection wells may be adjusted during design process to accommodate access constraints. It is also possible that the off-site injection well field may be reduced if access to Sunny Ridge Drive is not feasible or practical.

8.3.1.2 Injection Rates

The Base Case injection rates for alternative GW-5A are based on CMS Report modeling and are summarized in Table 1. The total Base Case injection rate is 490[4] gpm. The Contingency Case injection rates for alternative GW-5A are summarized in Table 1.

The Base Case or Contingency Case injection rates are used as Basis of Design for different design elements as described in the respective sections herein and summarized in Table 1.

8.3.1.3 Injection Well Construction

One of the five injection wells have already been constructed. The four remaining injection wells will be installed by a licensed drilling contractor to the targeted injection interval. The injection well installation will be conducted in compliance with the California Department of Water Resources and California Well Standards. The design life for the new injection wells will be 30 years given the challenges in constructing deep wells in off-site locations. As such, each injection

[4] The injection base case will be 490 gpm to accommodate potential future addition of EW-06. The base case injection rate without extraction well EW-06 is 390 gpm.

well will be constructed of stainless-steel well screen and stainless-steel blank casing. The casing diameter for new injection wells will be 8-inch nominal diameter to allow installation of downhole equipment. Centralizers will be installed to center the well casing within the borehole.

Well construction methods will be briefly summarized in an extraction/injection well installation work plan that will be provided to DTSC in the third quarter of 2022.

8.3.1.4 Groundwater Injection Tubes

Groundwater injection rates for each injection well were based on the Base Case injection rates for the respective wells (Table 1). The injection tubes will be sized to inject treated groundwater from the treatment plant to the respective injection well under pressure. If higher injection rates (up to the Contingency Case) are required based on results of performance monitoring during O&M, then the injection tubing would be upsized to accomplish the increased injection rate.

Stainless steel injection tubes will be set above the screened interval and approximately 50 feet below anticipated non-injection levels accounting for seasonal variations. Injection tube depth will be included in the final design drawings.

8.3.1.5 Injection Well Vaults

Pre-cast concrete vaults will be installed around each groundwater injection wellhead. The wellhead casing will extend into the vault. Each vault lid will include an appropriate traffic-rating for protection and provide unobstructed access to the components within the vaults. The vaults will be designed to minimize surface water from entering vault. In cases where there is a high risk for surface water inflow to vault, electrical equipment will be placed in nearby above grade panels to the extent possible. Vaults will have concrete bottom to contain and detect leaks, however there will be a drain with plug to allow surface water collected during rain events to empty out, if necessary.

Injection well vault piping will be stainless steel and will transition from single-walled HDPE as the piping enters the well vault. Stainless steel piping in the vault will be sized based on the Base Case injection rate for the respective injection well. Stainless steel pipe is the preferred material because it is rigid and resists corrosion.

The injection wells will include automated valves to control flow and which can be operated from the treatment plant PLC or the wellhead control panels. The automated valves reduce the need to physically access the wells. In addition, the water level in the injection wells will be monitored with pressure transmitters to prevent excessive water mounding and shut the control valves if the mounding exceeds set points.

8.3.2 Injection Conveyance Piping

The injection pipeline construction and pipeline routing are described in the following sections.

8.3.2.1 Injection Pipeline Construction

Single-walled HDPE pipe will be utilized for underground injection piping throughout the system. HDPE pipe is easier to install than other traditional piping materials and is cost effective, flexible, durable, and corrosion resistant. The piping shall be HDPE SDR 11 with a maximum recommended operating pressure of 160 psig at 73°F. The pipe will originate from within each vault and will convey the treated groundwater from treatment plant to each injection well. A pipeline manifold north of the treatment plant will segregate on- and off-site injection wells.

The Basis of Design for sizing pipelines incorporates Contingency Case injection rates from respective injection wells (Table 1) and maintaining pipeline velocities less than 7 feet per second. In addition, approximately four stub-out locations for future injection wells will be included on the injection pipeline on the southeastern portion of the Property.

8.3.2.2 Injection Pipeline Routing

The majority of the pipe routing will be located on the Property and within public ROWs (Figure 6). The routing may be refined or revised based on the design process.

8.3.3 Injection Well Electrical Service

The on-site injection wells will have a single power source from a satellite station. Likewise, the off-site injection wells will have a single power source from a satellite station. The new satellite power stations will be located in non-traffic areas.

9.0 PROCESS FLEXIBILITY

As outlined in Section 8, the following minimum process flexibilities are required to accommodate contingencies in design and operation of treatment systems during CMI.

- The groundwater system will be designed to permit turndown to effect end of remedy operation conditions.
- The groundwater treatment system will be designed to accommodate up scaling capacity if higher flowrates are required to achieve target pore velocities or capture zones or in the event that contingency additional extraction wells become required.
    - Below-grade groundwater piping will be sized to accommodate additional flow from contingency extraction wells, should they become required.
    - The groundwater advanced oxidation treatment system will be a modular design and additional modules can be added to accommodate the contingency flowrate, should it become necessary.
    - All submersible extraction well pumps and treatment system pumps will be operated using VFDs to allow for increases and/or decreases in flowrates to handle contingency flowrates, should they become required.
    - Spare capacity will be provided in all control panels for additional electrical loads and PLC inputs/outputs for instrumentation, should it become required.

10.0 WASTE MANAGEMENT

Best management practices for the handling of waste generated will be implemented during the construction of the proposed groundwater corrective measures. There are two kinds of waste that will be generated during the construction of the proposed corrective measures at the Site, excavated soil and runoff water. Excess excavated soil generated during the construction process is not expected to contain COCs, as such the excess excavated soil will be managed in local stock piles in accordance with applicable Storm Water Pollution Prevention Plan (SWPPP) permits for construction projects. The excess excavated soil will be sampled and hauled off site to a location/disposal facility capable of handling the soil in accordance with the sample results. In order to manage rainwater runoff, a SWPPP will be prepared as part of the construction permit process. Like excess excavated soil, rainwater runoff is not expected to contain COCs and will be managed in accordance with the approved SWPPP for construction.

In normal operations, waste streams will include treated groundwater and spent liquid-phase GAC. All waste will be disposed of in accordance with applicable operating permits or will be profiled and shipped to an off-site facility for regeneration or disposal. Wastes generated during normal operations will be managed in accordance with procedures outlined in the O&M Plan which will be prepared after the design process and major equipment has been procured
(Figure 11).

11.0 REQUIRED PERMITS

Construction and operating permits will be required in order to construct and operate the proposed corrective measures at the Site. The required permits for CMI are as follows:

- Construction permits:
    - City of Fullerton Construction/Building/Encroachment Permits
    - SWPPP to support construction activities
    - Orange County Health Care Agency, Well Construction Permits
    - OCPW/OFD approved plans consistent with completed access agreement.
- Operating permits:
    - Southern California Air Quality Management District Air Discharge Permit, if required based on influent groundwater VOC concentrations at influent storage tank T-2001.
    - Orange County Sanitation District Sewer Discharge Permit
    - Los Angeles Regional Water Quality Control Board Waste Discharge Requirements Groundwater Injection Permit.
    - Orange County Health Care Agency, Hazardous Materials Business Emergency Plan for storage of H2O2. Note, the H2O2 concentration is expected to be below the Department of Homeland Security chemicals of interest.
    - OCPW/FCD, City of Fullerton and private property terms of access for O&M of the corrective measure consistent with yet to be completed access agreements.

12.0 REFERENCES

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TABLES

Table 1. Base And Contingency Case Flowrates, Basis Of Design

		ALTERNATIVE		BASIS OF DESIGN FOR RESPECTIVE ELEMENT										
		(gpm)		EXTRACTION/INJECTION SYSTEMS					TREATMENT SYSTEM					
				WELL		DROP PIPE	PIPELINE	ELECTRICAL	INFLUENT CONCENTRATION[1]	COMPONENT (FLOW)				
LOCATION	**WELL IDENTIFIER**	BC	CC	DIAMETER	PUMP					Tanks T2001 / T2002	Filters F2001 / F4001	AOP PA2001	GAC V2001 / V2002	Transfer Pumps
On-Property	MW-21	10	20	Existing	BC		CC	CC	BC[3]					
	EW-01	10	20	Existing	BC		CC	CC	BC[3]					
	EW-02	120	180	Existing	BC		CC	CC	BC[3]					
	MW-29	20	40	Existing	BC		CC	CC	BC[3]					
	MW-31	20	60	Existing	BC		CC	CC	BC[3]					
	EW-07	10	20	CC[6]	BC		CC	CC	BC[3]					
Off-Property	EW-03	100	200	CC[6]	BC		CC	CC	BC[3]					
	EW-04	100	200	CC[6]	BC		CC[4]	CC	BC[3]					
	EW-06	0[8]	200				CC[9]	CC[10]						
Both	TOTAL	490[8]	750[7]							1.5 x BC	1.5 x BC	BC	1.5 x BC	BC[8]
On-Property	SEWER	50[5]	NA	Existing										
NA	RECLAIM	NA	NA	NA										
On-Property	IW-01	75	200[2]	CC[2,6]		BC	CC[2]							
	MW-40	75	200[2]	Existing		BC	CC[2]							
Off-Property	IW-03	80	100	BC[6]		BC	BC							
	IW-04	80	100	BC[6]		BC	BC							
	IW-05	80	100	BC[6]		BC	BC							

[1] Influent concentration to treatment system is based on base case extraction rates and associated estimated concentrations (see Table 2).

[2] Contingency injection capacity reserved for on-Property injection wells, which can include future injection wells (4 additional pipeline stub outs), total flow 600 gpm.

[3] Influent concentration to treatment system will also consider temporary shut down of high-flowrate, low-concentration extraction well to confirm system can handle upsets.

[4] Cumulative off-property extraction rate limited to 600 gpm, however, pipeline from EW-04 to EW-03 to be sized for 400 gpm and EW-03 to Burning tree to be sized for 500 gpm.

[5] Existing sewer connection to be kept for maintenance activities, the nominal capacity is 50 gpm, but use would be infrequent.

[6] Minimum well casing diameter is 6-inches inside casing diameter to provide space for downhole equipment.

[7] Treatment system Contingency Case capacity (750 gpm) is capped at 150% of Base Case flow (490 gpm); increasing all wells simultaneously to Contingency Case flow rates is a remote possibility.

[8] Base Case does not include installation of EW-06 as average concentration of COCs in this well since 2018 are less than respective maximum contaminant/notification levels; however, the base case flow for treatment system will be 490 gpm to accommodate the potential future addition of EW-06. The base case flow for the transfer pumps will be 390 gpm.

[9] Pipeline will be designed to accommodate EW-06 in future by installing tee near crossing of Burning Tree and Brea Creek Channel

[10] Electrical power drop for EW-06 would be in area of EW-06 and would be installed in the future if this well is added.

BC = Base Case
CC = Contingency Case
AOP = Advanced oxidation process
GAC = Granular activated carbon

COC = compounds of concern
gpm = Gallons per minute
NA = Not applicable

Table 2. Base And Contingency Case Concentrations, Basis Of Design

LOCATION	WELL IDENTIFIER	FLOWRATE (gpm)		CONCENTRATION (ug/l)					BASIS OF DESIGN	
									AOP	GAC
		BC[1]	CC[2]	BASIS[3]	1,1-DCE	1,1-DCA	TCE	1,4-Dioxane	PA2001	V2001 / V2002
On-Property	MW-21	10	10	Well	1000	20		400		
	EW-01	10	10	Well	70	0.8	0.5	40		
	EW-02	120	120	Well	20	0.5	0.5	7		
	MW-29	20	20	Well	200	2	2	100		
	MW-31	20	20	Well	200	2	9	20		
	EW-07	10	10	MW-8	50	0.6	90	3		
Off-Property	EW-03	100	100	MW-32B, MW-34B, MW-36	90	0.9	20	9		
	EW-04	100	100	MW-36	80	0.7	0.6	8		
	EW-06	0[6]	100	MW-33	4	0.5	0.5	0.2		
Both	TOTAL	390[6]	490							
	ESTIMATED BC CONCENTRATION[4]				100	2	9	30		
	ESTIMATED CC CONCENTRATION[4]				80	2	8	20	X[5]	X[5]

[1] Base case flowrate (see Table 1).

[2] Contingency case includes low concentration well (EW-06).

[3] Influent concentration based on average of samples collected from respective wells since beginning of 2018. The average is rounded up to one significant figure.

[4] Total influent concentration based on concentration and flowrate for each extraction well rounded up to one significant figure.

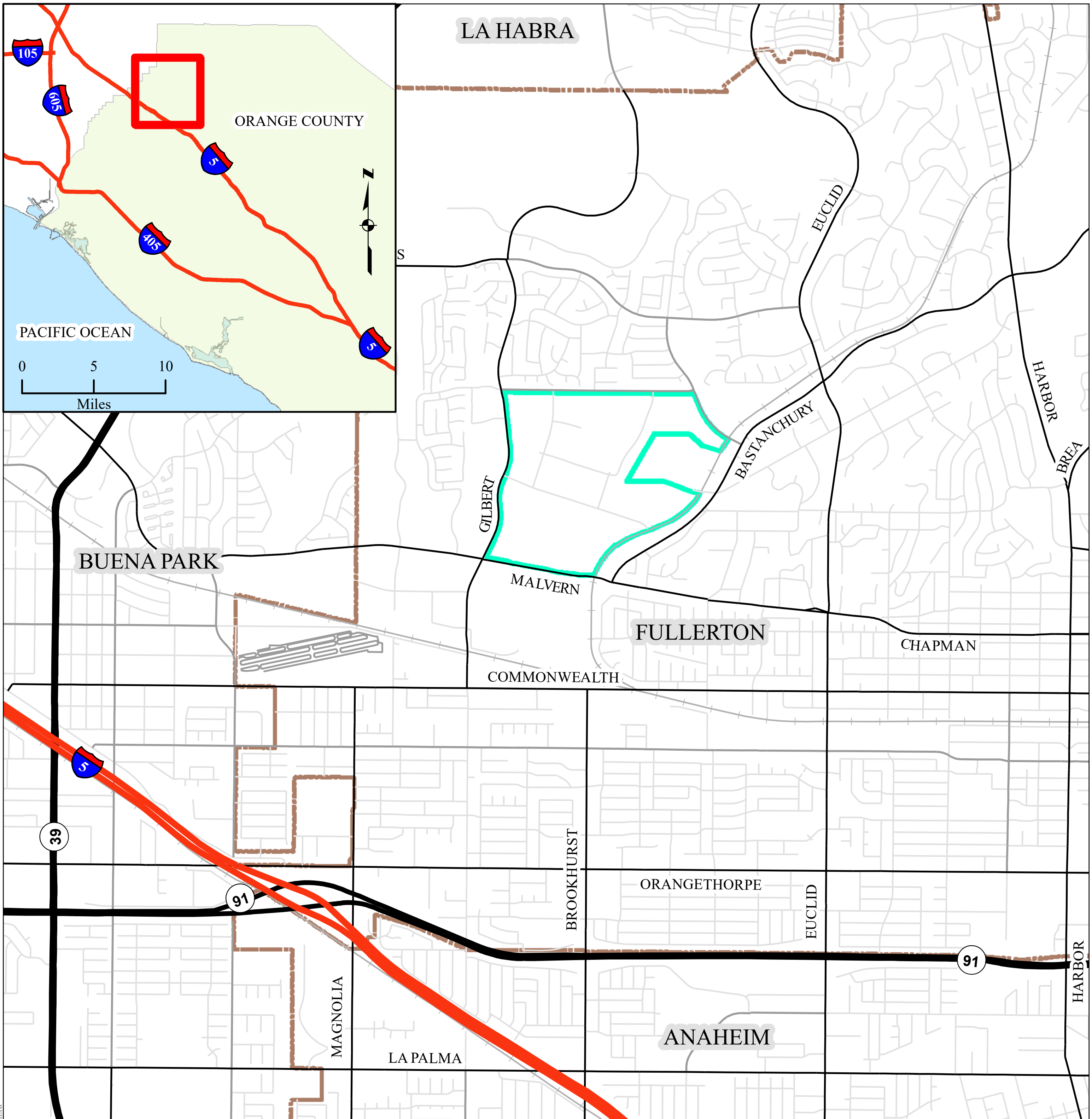
[5] Basis of Design will be concentrations specified in this table and flowrates specified in Table 1.

[6] Base Case does not include installation of EW-06 as concentrations of COCs in this well since mid-2018 are less than respective maximum contaminant/notification levels; however, the base case flow for treatment system will be 490 gpm to accommodate the potential future addition of EW-06.

BC = Base Case
CC = Contingency Case
AOP = Advanced oxidation process
GAC = Granular activated carbon
1,1-DCE = 1,1-Dichloroethylene
1,1-DCA = 1,1-Dichloroethane
TCE = Trichloroethylene

ug/l = Micrograms per liter
gpm = Gallons per minute
COC = compounds of concern

FIGURES



EXPLANATION

City Boundaries

Former Hughes Aircraft Facility

0 2,500 5,000

FEET

FIGURE 1: SITE LOCATION

CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN

FORMER HUGHES AIRCRAFT COMPANY
1901 WEST MALVERN AVE, FULLERTON, CA

Engineering Analytics, Inc.

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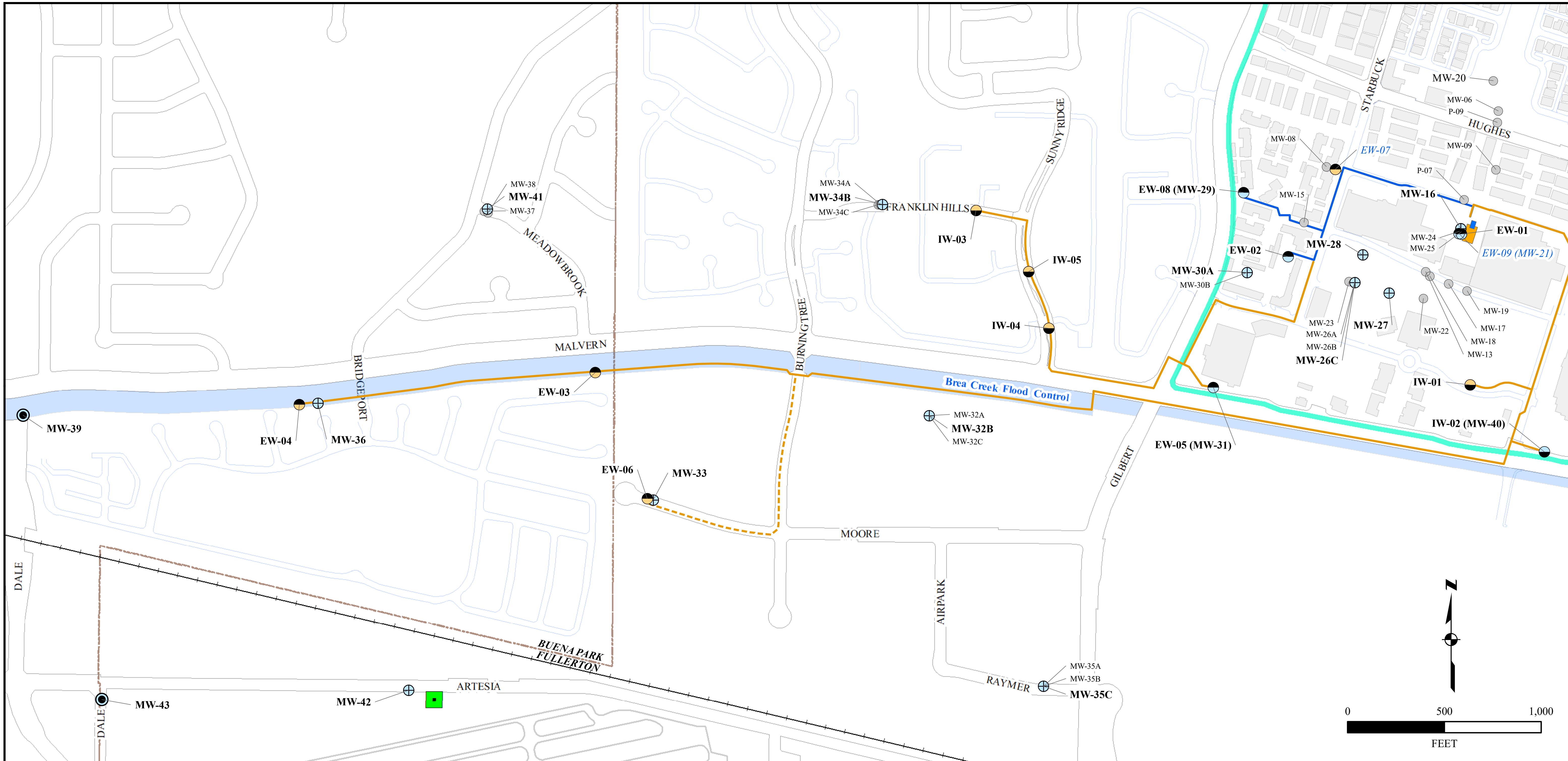


City Boundaries
Former Hughes Aircraft Company Property
Flood Control Channel Parcels
On Property Current Buildings
Fullerton Airport Well

Site Related Wells

- Existing Extraction
- Future Extraction
- Existing Injection
- Future Injection
- Existing Point of Compliance
- Existing Performance Monitoring
- Existing Monitoring Other

Pipelines

- Existing
- Future
- Potential Future

Treatment Building

- Existing Pilot
- Future Full Scale

NOTES:

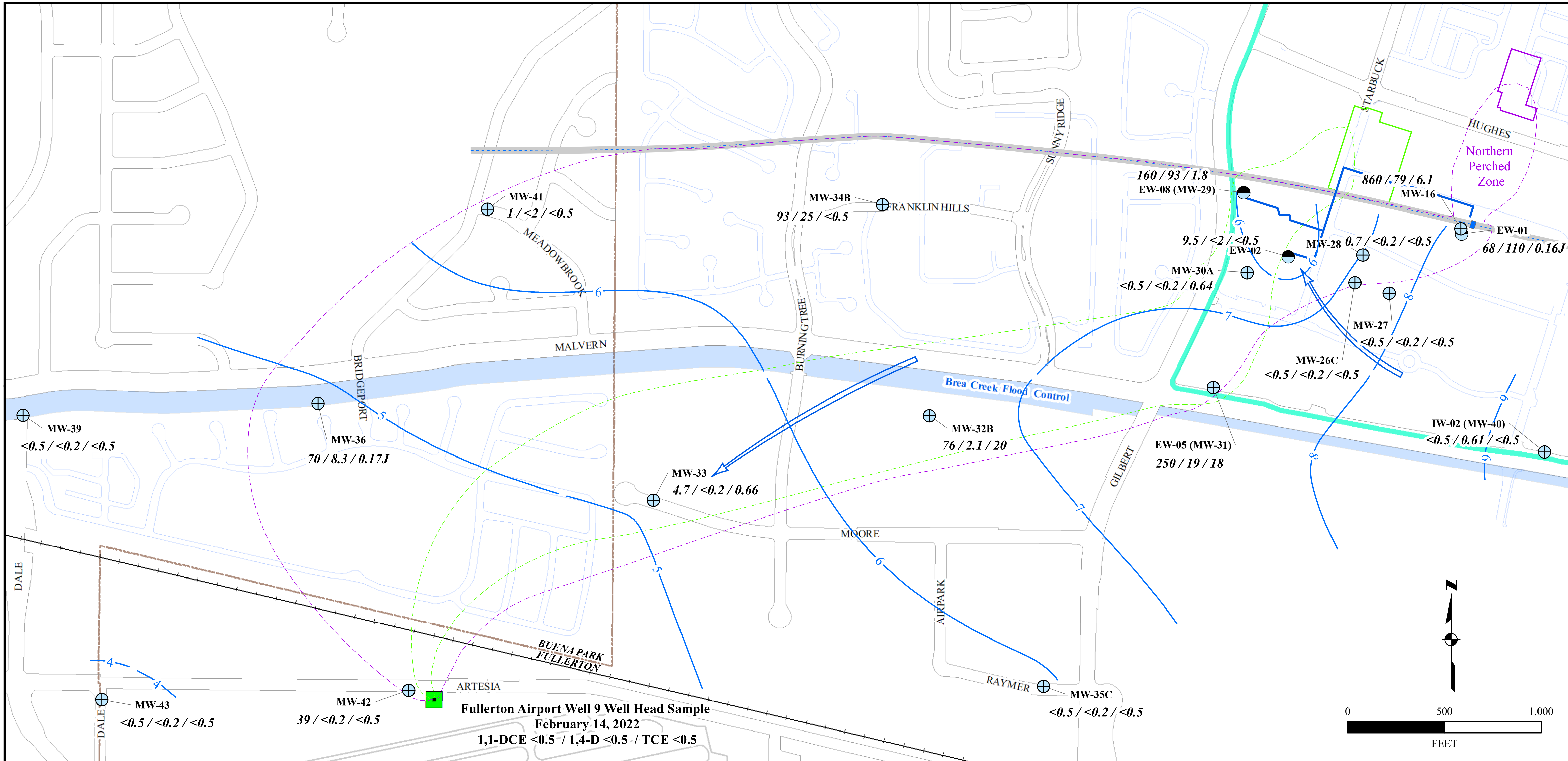
1, Light blue colored streets are private.
2. Bold well IDs completed in Unit B
3. Blue italicized well IDs are extraction wells completed in Unit BC
4. Small well IDs completed in units other than B
5. Piezometer P-07 and P-09 completed in perched zone
6. Extraction well EW-06 may be installed at future time based on performance monitoring results.
7. Dashed line on Burning Tree and Moore is pipeline for EW-06, would be installed if EW-06 is installed.

FIGURE 2. WELL AND PIEZOMETER LOCATIONS

CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN

FORMER HUGHES AIRCRAFT COMPANY
1901 WEST MALVERN AVE, FULLERTON, CA

Engineering Analytics, Inc.



City Boundaries
Former Hughes Aircraft Company Property
Flood Control Channel Parcels
Fullerton Airport Well 9

Pipelines

Existing

Treatment Building

Existing Pilot

Existing Unit B Extraction Well
Existing Unit B Extraction Well

Most Recent 2021 COC Concentrations

1,1-DCE / 1,4-D / TCE (ug/l)

Unit B Water Level Elevation Contour, November 2021

Approximate saturated extent of Unit B (unsaturated or not present to north)

Approximate Area of Compounds from Former Buildings 601 and 609

Former Building 601
Former Building 609

Former Building

601
609

NOTES:

1. Light blue colored streets are private.
2. Approximate area of compounds from former Buildings 601 and 609 based on CMS Report (H+A, 2015)
3. Approximate saturated extent of Unit B from CMS Report (H+A, 2015)
4. Water level contour and flow directions from 2021 Annual Report, elevation feet above datum (H+A, 2022)
5. COC posting based on most recent data from 2021 Annual Report (H+A, 2022)

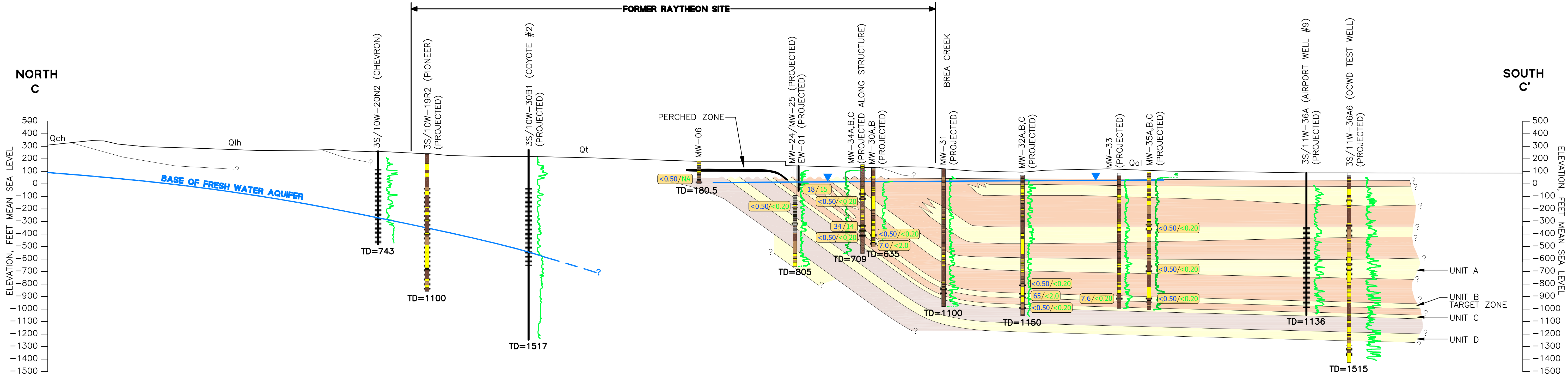
CMS = Corrective Measures Study
COC = Compounds of Concern
H+A = Hargis + Associates, Inc
1,1-DCE = 1,1-dichloroethylene
TCE = Trichloroethylene
1,4-D = 1,4-Dixoane
ug/l = micrograms per liter
< = Less than, numerical value is reporting limit. (J) = estimated value

FIGURE 3. CONCEPTUAL SITE MODEL OVERVIEW, UNIT B/TARGET ZONE

CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN

FORMER HUGHES AIRCRAFT COMPANY
1901 WEST MALVERN AVE, FULLERTON, CA

Engineering Analytics, Inc.

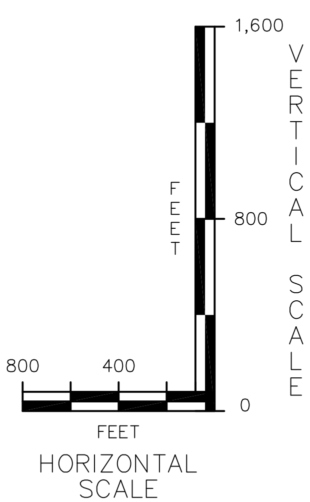


EXPLANATION

- RELATIVELY COARSE ZONE, PREDOMINANTLY SANDS WITH LITTLE TO NO SILT OR CLAY
- MIXED ZONE, MIXTURES OF SANDS, CLAYS, AND SILTS
- RELATIVELY FINE ZONE, PREDOMINANTLY SILTS OR CLAYS WITH LITTLE TO NO SAND
- PREDOMINANTLY COARSE ZONE
- MIXED ZONE
- RELATIVELY FINE ZONE
- SCREENED INTERVAL OF MONITOR WELL

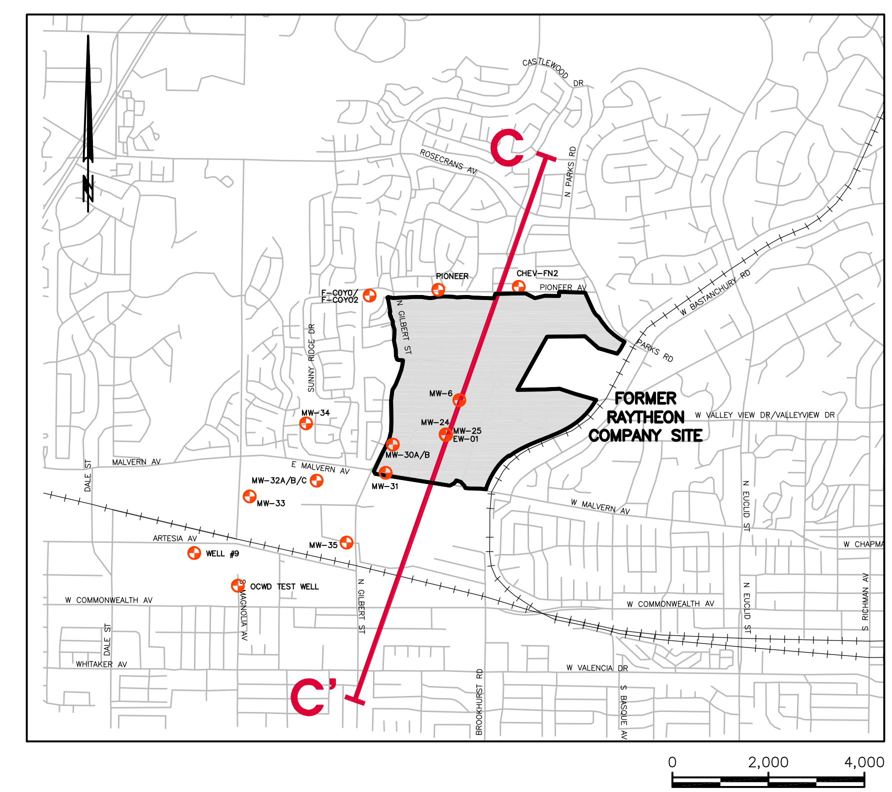
LGRD
0 (OHM−M) 100 500

RESISTIVITY LOG (ohm−m) (LATERAL OR SHORT−NORMAL) OF WELL BOREHOLE. RIGHT EDGE OF THE LITHOLOGIC LOG COLUMN IS THE ZERO ohm−m LINE.



Qal	ALLUVIUM, HOLOCENE: UNCONSOLIDATED AND POORLY CONSOLIDATED GRAVEL, SAND AND SILT.
Qt/ Qoa	TERRACE DEPOSITS/OLDER ALLUVIUM, UPPER PLEISTOCENE TO HOLOCENE: POORLY CONSOLIDATED GRAVEL, SAND AND SILT, COMMONLY REDDISH−BROWN; LOCALLY RED−BROWN SILT.
Qlh	LA HABRA FORMATION, UPPER PLEISTOCENE: OLIVE−GRAY TO RED−BROWN SILTSTONE; PALE YELLOW−BROWN TO RED−BROWN THICK−BEDDED FRIABLE SANDSTONE; PALE−YELLOW−GRAY POORLY BEDDED PEBBLY SANDSTONE; AND PALE−YELLOW−BROWN UNSORTED PEBBLE−COBBLE CONGLOMERATE; BASAL PART FILLS IRREGULAR CHANNELS CUT INTO UNDERLYING STRATA.
Qch	COYOTE HILLS FORMATION, UPPER PLEISTOCENE: MODERATE YELLOW−BROWN TO MODERATE BROWN THICK−BEDDED TO MASSIVE FRIABLE PEBBLY SANDSTONE; OLIVE−GRAY TO GRAY−BROWN MASSIVE SILTSTONE; AND YELLOW−BROWN MASSIVE SANDSTONE AND PEBBLE CONGLOMERATE.
18	1,1−DICHLOROETHYLENE CONCENTRATION, MICROGRAMS PER LITER, FEBRUARY 2022 UNLESS OTHERWISE INDICATED
15	1,4−DIOXANE CONCENTRATION, MICROGRAMS PER LITER, FEBRUARY 2022 UNLESS OTHERWISE INDICATED
NA	NOT ANALYZED FOR (SPECIFIC ANALYTE) IN FEBRUARY 2022
	NOTE: SURFACE DISTRIBUTION OF STRATIGRAPHIC UNITS AND DESCRIPTIONS OF STRATIGRAPHIC UNITS EXCERPTED FROM YERKES, 1972.
▼	APPROXIMATE UNIT B GROUNDWATER LEVEL, FEBRUARY 2022
?	QUERIED WHERE INFERRED

CROSS SECTION LOCATION



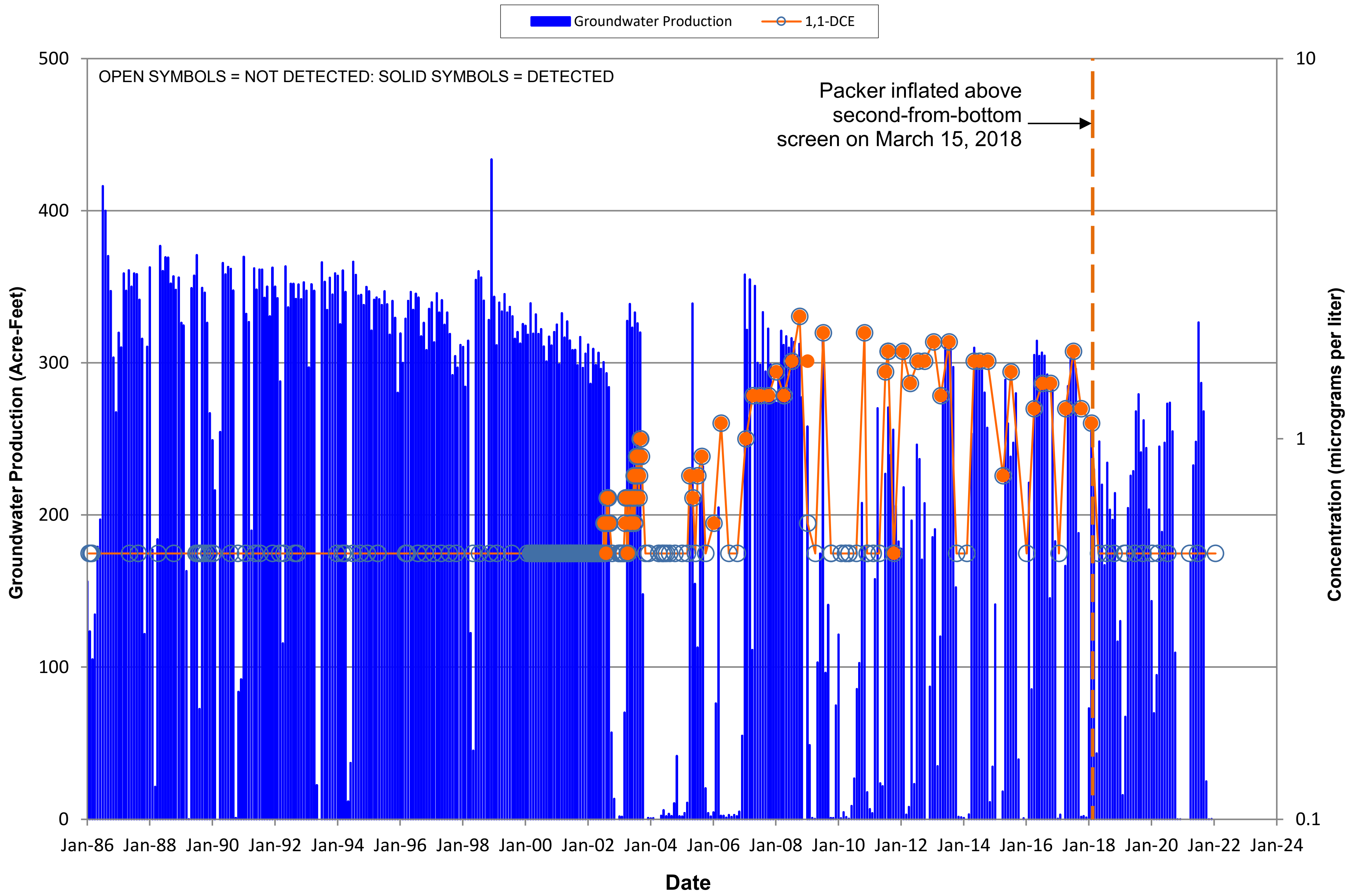
NOTE: NOT ALL ON−SITE WELLS ARE DEPICTED ON CROSS SECTION

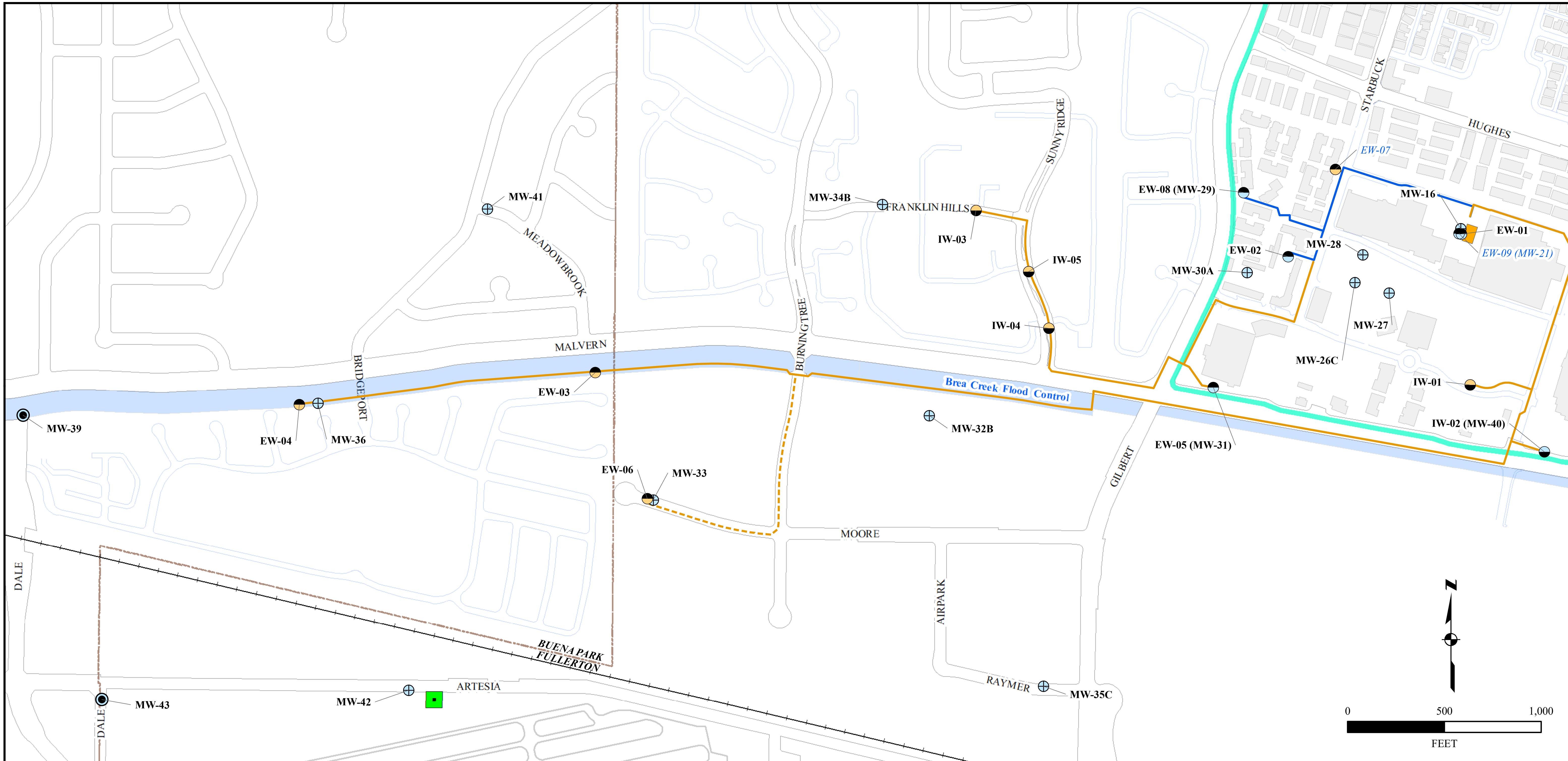
FIGURE 4

REGIONAL CONCEPTUAL GROUNDWATER MODEL HYDROGEOLOGIC CROSS−SECTION C−C'

HARGIS+ASSOCIATES, INC.

FIGURE 5
F-AIRP WELL PRODUCTION AND 1,1-DICHLOROETHYLENE CONCENTRATIONS





City Boundaries
Former Hughes Aircraft Company Property
Flood Control Channel Parcels
On Property Current Buildings
Fullerton Airport Well 9

Site Related Wells

Existing Extraction
Future Extraction
Existing Injection
Future Injection
Existing Point of Compliance
Existing Performance Monitoring

Pipelines

Existing
Future
Potential Future

Treatment Building

Future Full Scale

NOTES:

1. Light blue colored streets are private.
2. Bold well IDs completed in Unit B
3. Blue italicized well IDs are extraction wells completed in Unit BC
4. Extraction well EW-06 may be installed at future time based on performance monitoring results.
5. Dashed line on Burning Tree and Moore is pipeline for EW-06, would be installed if EW-06 is installed.

FIGURE 6. SELECTED GROUNDWATER CORRECTIVE MEASURE

CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN

FORMER HUGHES AIRCRAFT COMPANY
1901 WEST MALVERN AVE, FULLERTON, CA

Engineering Analytics, Inc.

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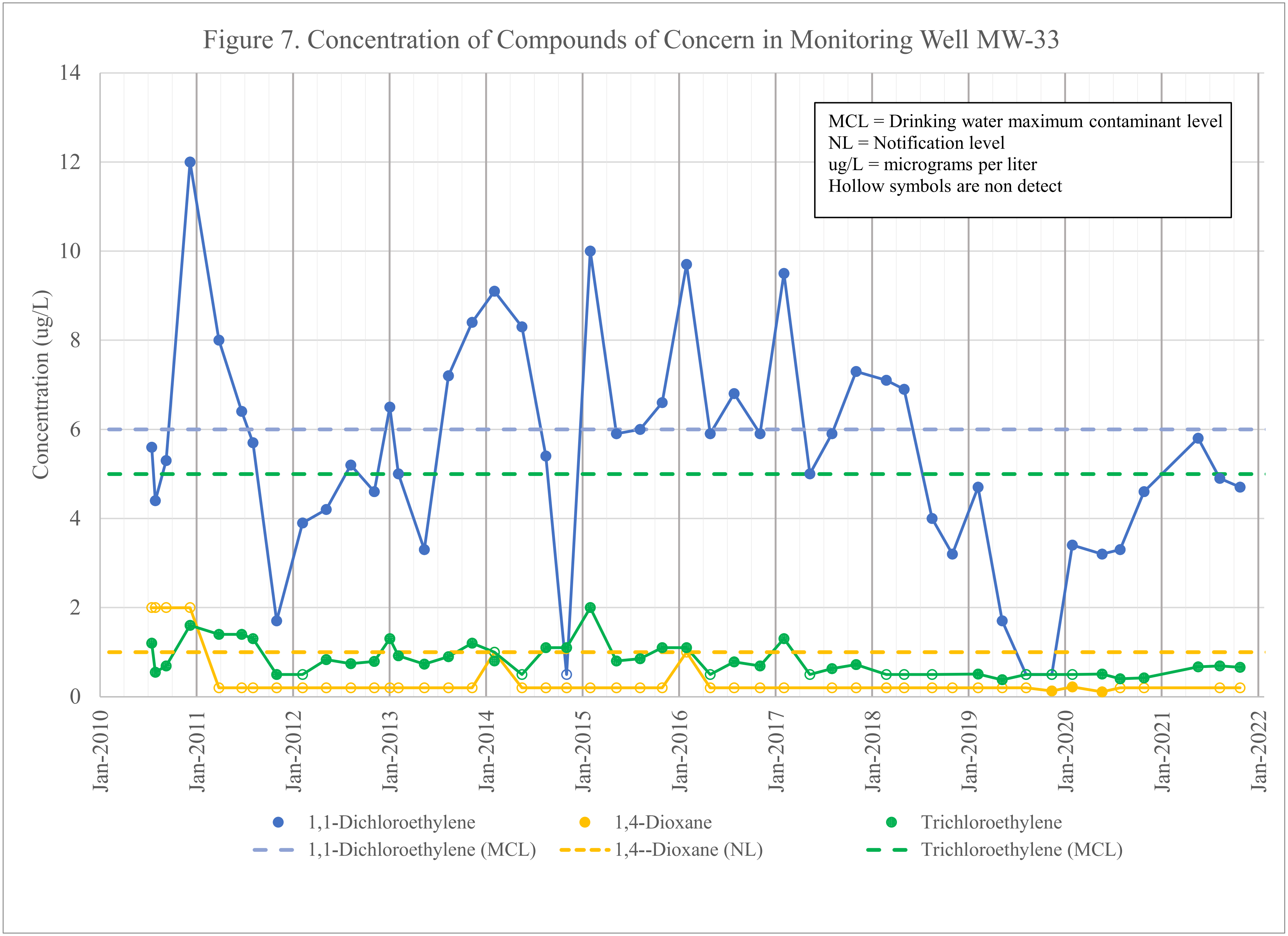
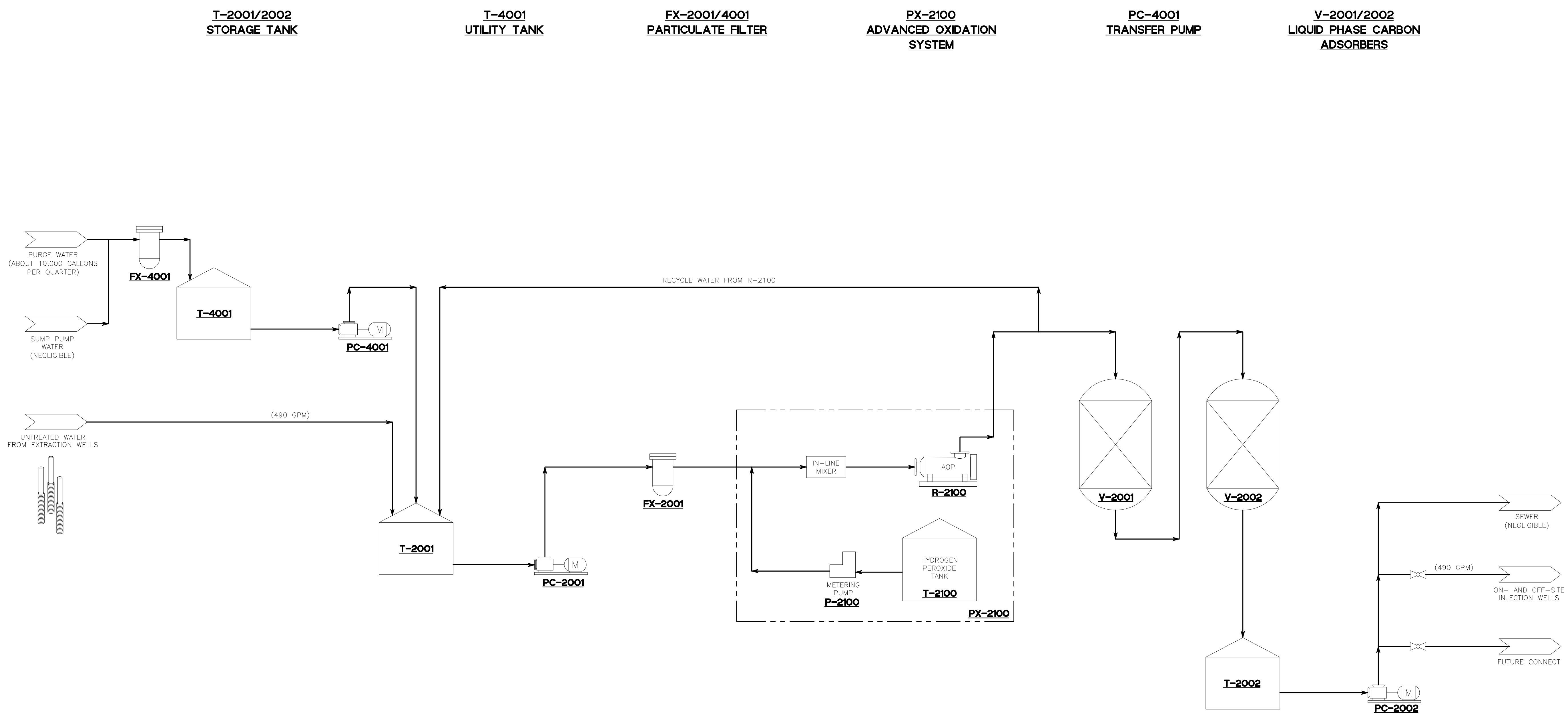


Figure 7. Concentration of Compounds of Concern in Monitoring Well MW-33
Concentration (ug/L)
14
12
10
8
6
4
2
0
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
Jan-2019
Jan-2020
Jan-2021
Jan-2022
MCL = Drinking water maximum contaminant level
NL = Notification level
ug/L = micrograms per liter
Hollow symbols are non detect
1,1-Dichloroethylene
1,4-Dioxane
Trichloroethylene
1,1-Dichloroethylene (MCL)
1,4--Dioxane (NL)
Trichloroethylene (MCL)



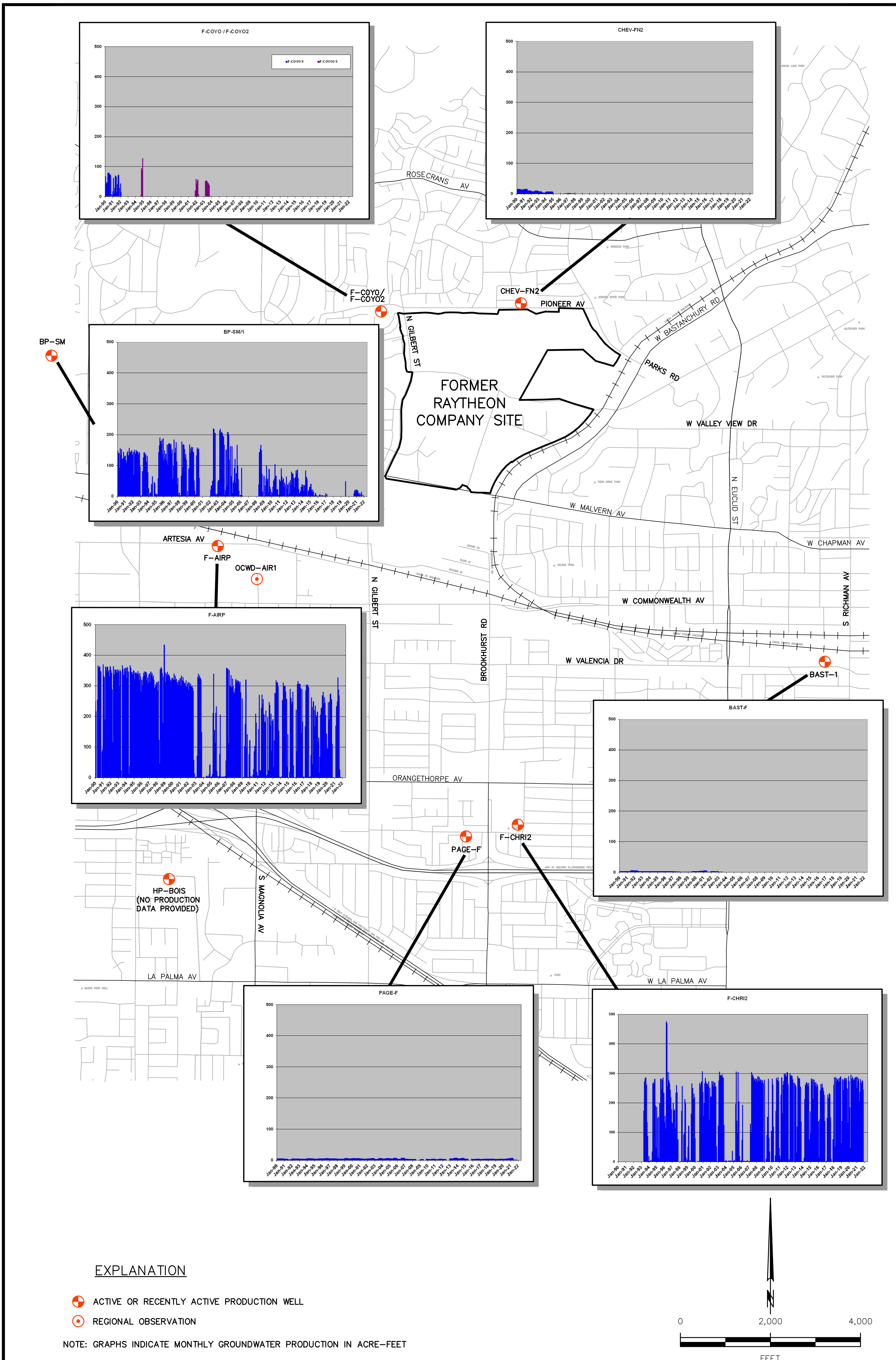
EXPLANATION

AOP ADVANCED OXIDATION PROCESS
GPM GALLONS PER MINUTE

HARGIS + ASSOCIATES, INC
Hydrogeology/Engineering

FIGURE 8. ALTERNATIVE GW5A: ON-SITE AND BREA CREEK ALIGNMENT EXTRACTION WITH ON-SITE AND OFF-SITE UNIT B INJECTION SIMPLIFIED PROCESS FLOW DIAGRAM

04/18 | RPT NO. 532.72 | 560-0381 | A



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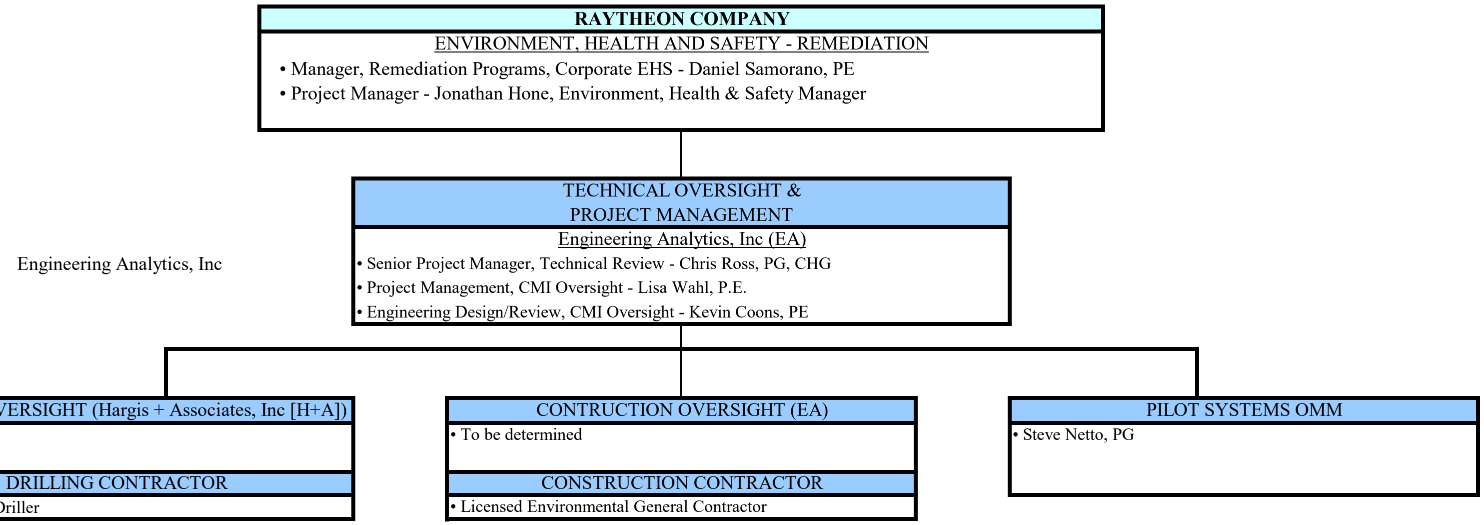
HARGIS + ASSOCIATES, INC.
Hydrogeology/Engineering

FIGURE 9
REGIONAL PRODUCTION WELLS

ORGANIZATIONAL STRUCTURE FOR CORRECTIVE MEASURES IMPLEMENTATION
FORMER RAYTHEON (FORMERLY HAC) FACILITY, 1901 WEST MALVERN AVENUE, FULLERTON, CALIFORNIA



FOOTNOTES:

HAC = Hughes Aircraft Company
EHS = Environment, Health and Safety
PG = Professional Geologist
PE = Professional Engineer
CHG = Certified Hydrogeologist

OMM = OPERATIONS, MONITORING AND MAINTENANCE

FIGURE 10. ORGANIZATIONAL CHART

Figure 11. Corrective Measures Implementation Schedule

TASK	CONCEPTUAL DURATION (MONTHS)	FROM MILESTONE	DELIVERABLES	CONCEPTUAL SCHEDULE 2022	2023	2024	2025
Corrective Measures Study	Complete						
Corrective Measures Implementation (CMI)							
Pilot Test OMM	On-Going	Operate through start of construction	Periodic submittals to DTSC				
CMI Work Plan							
Submit to DTSC	Complete						
DTSC Review and Approval		In progress, anticipate completion in September 2022	Approval from DTSC				
Finalize Terms of Access Agreement							
Brea Creek	Complete						
City of Fullerton Rights of Way	Complete						
Private Property	2	In progress, anticipate completion in October 2022	Concurrence on terms of access				
Design							
30 Percent (Raytheon and Property Owners)	Complete						
Potholing	3	Approval of CMI Work Plan and Permitting	Included in 60% design				
Progress Report 60 Percent (DTSC)	4	Potholing completion	Progress report submittal to DTSC				
Progress Report 90 Percent (DTSC)	3	Completion of 60 percent design	Progress report submittal to DTSC				
100 Percent	1	90 percent design	Submittal to City and County for permitting, DTSC cc'ed.				
Plans and Specifications	3	60 percent design	Provided to DTSC for informational purposes				
Updated Cost Estimate	3	90 percent design	Cost estimate provided to DTSC				
Construction							
Construction Work Plan	Not applicable	Integrated into specifications	None				
Wells		30 percent design and contractor availability	Specifications for well construction provided to DTSC[1]				
City Rights of Way	4	*Start may later depending on contractor availability*					
Flood Control District	3	*Not during wet season*					
Retail Area	2	*Not during Holidays*					
Residential Area	1	*Not during Holidays*					
Pipelines and Electrical		Receipt of construction permits	As built drawings				
City Rights of Way	6						
Brea Creek	4	*Not during wet season*					
Retail Area (Target)	3	*Not during Holidays*					
Retail Area (Other)	3	*Not during Holidays*					
Fabricate Major Treatment Equipment	9	Receipt of construction permits	None				
Construct Treatment System	6	Receipt of construction permits, not during Holidays	As built drawings				
Construction Complete Report	3	Completion of construction	Simple summary document with as-builts provided to Stakeholders				
Operating Permits and Plan							
Confirm performance specifications		Part of CMI work plan approval and WDR permit	None				
Obtain operating permits	6	WDR complete, receipt of treatment system specs	RWQCB WDR, OCSD, OCHCA HMBEP, OCPW/FCD				
Operation and Maintenance Plan	4	Receipt of treatment system specs	Submittal to DTSC				
Approved Operation and Maintenance Plan	2	Submittal of operations and maintenance plan	Approval from DTSC				
OMM							
Start-Up	3	Completion of Construction	None				
Normal Operations and Monitoring	Long-Term	Completion of start-up	Periodic reports to DTSC and permitting agencies				

[1] Use existing quality assurance project plan and Corrective Measures Study work plans for well construction.

DTSC = California Department of Toxic Substances Control
HMBEP = Hazardous Materials Business Emergency Plan
OCHCA = Orange County Health Care Agency
OCPW/FCD = Orange County Department of Public Works, Flood Control District
OCSD = Orange County Sanitation District
OMM = Operations, Maintenance and Monitoring
RWQCB = California Regional Water Quality Control Board, Santa Ana Region
WDR = Waste Discharge Requirement