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California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, California 90013

July 2, 2019

Subject: Natural Source Zone Depletion Work Plan
SFPP Norwalk Pump Station, 15306 Norwalk Boulevard, Norwalk, California

Dear Mr. Cho,

This work plan was prepared by Jacobs Engineering Group Inc. (Jacobs), on behalf of Kinder Morgan, Inc. (Kinder Morgan), to conduct a Natural Source Zone Depletion (NSZD) evaluation at the SFPP, L.P. (SFPP) Norwalk Pump Station site, located at 15306 Norwalk Boulevard, Norwalk, California (the site; Figure 1). The overall goal of this project is to evaluate the rate of NSZD under ambient conditions. To that end, the scope of this work plan includes a temporary cessation of current remedies in the south-central area of the site, with a contingency plan that will be implemented to address unanticipated changes in site conditions.

NSZD processes occur in the subsurface and are often capable of contaminant reduction rates of active remedies. This site provides opportunities to evaluate NSZD rates under the following conditions:

1. South-central area prior to horizontal biosparging operations based on historical soil vapor probe data
2. South-central area following nearly 3 years of treatment with horizontal biosparging
3. Southeastern area prior to the startup of the recently installed horizontal biosparging system
4. Southeastern area following the operation of the recently installed horizontal biosparging system

A comparison of NSZD rates during the abovementioned conditions will provide a basis for transition from one remedial approach to another.

Introduction and Transition Plan

This work plan is based on information and recommendations included in the following documents previously submitted to the Regional Water Quality Board (Water Board):

- CH2M HILL[1] (CH2M). 2015. *Horizontal Biosparge Well and Soil Vapor Monitoring Probe Completion Report, SFPP Norwalk Pump Station, Norwalk, California*. February 18.
- CH2M HILL (CH2M). 2018. *Light Non-aqueous Phase Liquid Conceptual Site Model Update, Defense Fuel Support Point, Norwalk, California*. March 21.

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[1] CH2M is now part of Jacobs.

- Jacobs. 2018. *First Semiannual 2018 Groundwater Monitoring Report, Defense Fuel Support Point, Norwalk, California*. July.
- Jacobs. 2019a. *Biosparging Effectiveness Evaluation and Recommendations – South-Central Area, SFPP Norwalk Pump Station, Norwalk, California*. February 21.
- Jacobs. 2019b. *2018 Annual Soil Vapor Monitoring Report, SFPP Norwalk Pump Station, Norwalk, California*. May 10.

The scope of work includes the collection of carbon dioxide (CO_2) efflux measurements and analysis of historical soil vapor monitoring to assess NSZD rates during different site remedial configurations to inform the approach for transitioning to NSZD at the site. The NSZD evaluation will include the following three complementary methodologies, each of which may be more appropriate for certain areas of the site:

- LI-COR Biosciences Inc. (LI-COR) CO_2 efflux measurements
- E-Flux, LLC (E-Flux) CO_2 traps
- Gradient method using existing vapor monitoring probes (VMPs)

An NSZD evaluation report will be prepared and submitted to the Water Board describing the results of this work and providing the path forward for future remedial operations.

The following sections summarize the remedy transition and contingency plan, provide relevant background information, state the objectives of the planned work and the proposed approach, describe the proposed scope of work and methods, present a general schedule of the implementation of this work plan, and briefly describe proposed long-term NSZD monitoring.

Remedy Transition

As part of this effort, active remedies at the site will be transitioned from their current operation to a configuration that allows the assessment of the NSZD rates under ambient conditions. Specifically, this involves a temporary suspension of hydraulic control and recovery (i.e., groundwater pump and treat), soil vapor extraction (SVE), and biosparging in the south-central area, as recommended in the *Biosparging Effectiveness Evaluation and Recommendations – South-Central Area, SFPP Norwalk Pump Station, Norwalk, California* (Jacobs, 2019a).

The remedy transition plan will be implemented with the approval of this work plan and will serve as a template to transition from active remediation to NSZD in other areas of the site when remedial goals have been accomplished, and with concurrence from the Water Board.

Contingency Plan

In the event of unanticipated changes in site conditions, and to continue remedial progress at the site during the NSZD evaluation period, the following contingency measures will be implemented, as necessary:

- Light nonaqueous phase liquid (LNAPL) presence in wells: As noted in previous documents, LNAPL present at the site is primarily in the residual phase and will continue to degrade due to NSZD. The presence and low mobility of LNAPL in wells historically containing LNAPL may continue to vary under ambient conditions; however, concerns with LNAPL mobility will continue to decrease over time. To verify that LNAPL mobility does not worsen at the site, the following contingencies will be implemented:
    1) Wells that continue to accumulate LNAPL in this area will be mobility tested once per year until two consecutive measurements indicate LNAPL mobility remains below the remedial metric (0.8 square foot per day) (Jacobs, 2018), does not change, or decreases.

2) If wells that have never contained LNAPL start to accumulate LNAPL, mobility testing will be performed on these wells and remedial measures such as enhancing biodegradation with localized bioventing may be implemented to ensure LNAPL mobility does not increase at these locations.

It is anticipated that LNAPL thicknesses at the site will fluctuate in response to water level fluctuations due to perched and confined LNAPL conditions, not due to changes in LNAPL mobility.

- Dissolved-phase extent: As noted in previous documents, the dissolved-phase extent of chemicals of potential concern (COPCs) at the site has fluctuated over time in spatial extent and concentration; however, in general, the concentrations have decreased several orders of magnitude due to the operation of the biosparging systems. The dissolved-phase extent is anticipated to be stable during the NSZD evaluation period. The following contingencies will be implemented should conditions change:

1) The dissolved-phase extent of COPCs will be evaluated semiannually using temporal and spatial statistical indicators (i.e., dissolved-phase center of mass, total volume, and average concentration) with tools such as the Monitoring and Remediation Optimization System software tool (MAROS) (EPA, 2019). Should these statistical indicators demonstrate that the dissolved-phase extent is expanding or increasing in concentration at a continuing accelerated rate, additional remedial actions will be considered such as bioventing to enhance biodegradation.

2) Dissolved-phase trends in downgradient wells (e.g., from west to east, GMW-28, GMW-3, GMW-9, GMW-22, GMW-SF-13, MW-18, MW-SF-3, MW-SF-1, MW-SF-16, MW-SF-4, MW-15R, and GMW-4R) will be evaluated semiannually using statistical methods (for example, Mann-Kendall analysis) to illuminate data trends. Should trends in these monitoring wells indicate that dissolved concentrations are not stabilizing within a 12-month period, additional remedial actions will be considered such as bioventing to enhance biodegradation.

A temporary increase in dissolved-phase concentrations and extent is likely with the suspension of active remedial operations; however, these temporary increases are expected to stabilize and eventually decrease in the area already treated by the biosparging system.

Background Information

This section summarizes relevant project background information including a generalized site description and an overview of the existing remedial approach at the site. Additional details on site background are available in the *Biosparging Effectiveness Evaluation and Recommendations – South-Central Area, SFPP Norwalk Pump Station, Norwalk, California* (Jacobs, 2019a).

Site Description

The Defense Fuel Support Point (DFSP) facility formerly was occupied by 12 aboveground fuel storage tanks and associated piping and facilities. The tanks had a maximum capacity of 35 million gallons and were used to store and distribute refined petroleum products including gasoline, diesel, and jet propellant numbers 5 and 8 (JP-5 and JP-8). In addition, the tanks also reportedly stored aviation gasoline and jet propellant number 4 (JP-4). Kinder Morgan had equipment on 2 acres at the DFSP facility and has easements for its pipelines along the southern and eastern boundaries of the facility (Figure 2).

Previously, Kinder Morgan operated a pump station near the south-central area of the site. The pump station was decommissioned in 2001, but three pipelines (two 16-inch and one 24-inch) heading eastward along the southern boundary of the DFSP facility (one of which bends at the southeastern corner of the facility and continues northward within the eastern easement) remain in service, and they continue to convey refined petroleum fuels including gasoline, diesel, and jet fuel. The pipelines were fitted with two block valves along a 24-inch-diameter pipeline; one block valve was the "intermediate 24-inch block valve" located in the south-central area of the site. Between the third quarter of 2016 and the second quarter of 2017, these pipelines were modified to remove all equipment such as valves and connections, which included the intermediate 24-inch block valve, so that the pipelines now span across the site in a continuous manner. The other block valve, which is located offsite near the southeastern area of the site and is referred to as the "southeastern 24-inch block valve" or "offsite 24-inch block valve," was not removed.

Subsurface assessments have been performed at the site since 1986. Groundwater monitoring and remediation wells have been installed at the site to investigate contaminants and monitor remediation system performance over time (Figure 2). The investigations have evaluated and defined subsurface soil and groundwater within the uppermost groundwater zone that has been impacted by historical releases of fuel-related hydrocarbons from Kinder Morgan's pipelines at the site. The primary impacts are to groundwater associated with fuel product that historically leaked from block valves and migrated vertically downward to the water table. Separate-phase fuel hydrocarbons have been delineated in areas beneath the site and at offsite properties to the south, west, and east.

Site assessments indicate that the COPCs are total petroleum hydrocarbons (TPH), including TPH quantified as gasoline (TPH-g), diesel (TPH-d), JP-4, JP-5, and JP-8; benzene, toluene, ethylbenzene, and total xylenes (BTEX); 1,2-dichloroethane (1,2-DCA); methyl tertiary butyl ether (MTBE); and tertiary butyl alcohol (TBA). A groundwater Monitoring and Reporting Program (MRP) has been in effect at the site since 1995. The current groundwater MRP is described in the *Revised Groundwater Sampling and Analysis Plan, SFPP Norwalk Pump Station, 15306 Norwalk Boulevard, Norwalk, California* (CH2M, 2013).

Hydrogeologic conditions and information regarding the current distribution of LNAPL at the site can be found in the *Biosparging Effectiveness Evaluation and Recommendations – South-Central Area, SFPP Norwalk Pump Station, Norwalk, California* (Jacobs, 2019a).

Overview of Existing Remedial Approach

Kinder Morgan operates remediation systems consisting of biosparging, SVE, total fluids extraction (TFE; extraction of free product, groundwater, or both, using a top-loading pump), and groundwater extraction (GWE; extraction of groundwater using a bottom-loading pump) within the following areas:

- South-Central Area – LNAPL and dissolved-phase hydrocarbons occur in the south-central area beneath the site and offsite beneath the residential area to the south (Figure 2). These impacts occurred from a historical release from the intermediate 24-inch block valve and potentially other unidentified sources at the former pump station.
- Southeastern Area – LNAPL and dissolved-phase hydrocarbons occur in the southeastern area beneath the facility and offsite in the Holifield Park area (Figure 2). These impacts occurred from a historical release from the southeastern 24-inch block valve in this area.

The existing layout of remediation systems in the south-central and southeastern areas, including SVE, TFE, GWE, and biosparge operations, is illustrated on Figure 2. Since recovery operations began in 1995, approximately 4.0 million pounds of LNAPL (or product equivalent) have been removed from the subsurface based on four main components: vapor extraction, LNAPL extraction, GWE (dissolved phase), and biodegradation (see Exhibit 1) (Jacobs, 2019b).

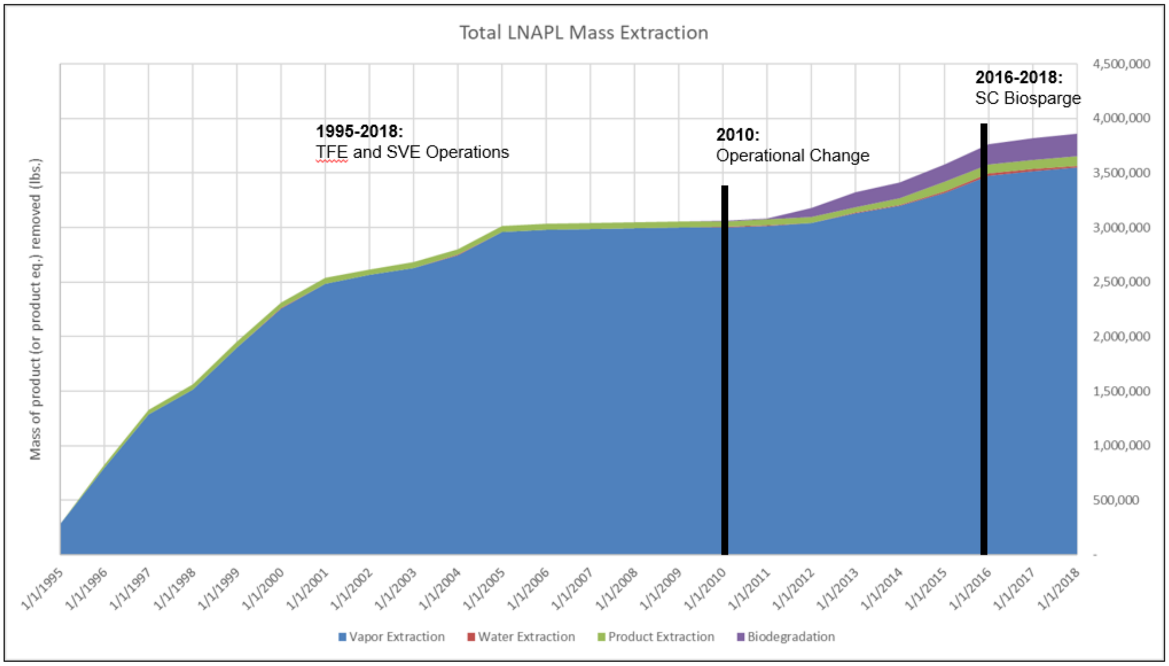

Exhibit 1. Total LNAPL Mass Extraction (Vapor, Water, Product and Biodegradation) since Operational Data Collection Began in 1995

As illustrated in Exhibit 1, near asymptotic mass removal conditions were observed starting in 2005 and continued until 2010. In 2010, mass recovery increased, partially due to optimization of the remedial systems at the site and improvements in the data collection. The persistent decline in water levels from 2010 to 2016 contributed to an increase in mass recovery, exposing more of the previously submerged contaminated zone (expanding the vadose zone). More recently, the biosparging system operated from 2016 to 2018 caused a relatively small increase in mass recovery. The mass recovery at the site is anticipated to trend toward asymptotic conditions with small temporary increases as remaining impacted areas of the site are treated using biosparging technologies. As illustrated in Exhibit 2 (a closer analysis than Exhibit 1), biodegradation is approximately two orders of magnitude greater than the mass of liquid product removed, and accounts for approximately one-quarter of all mass removed since 2010. This trend highlights the significant role biodegradation and NSZD have played and will continue to play in mass removal at the site (Jacobs, 2019a).

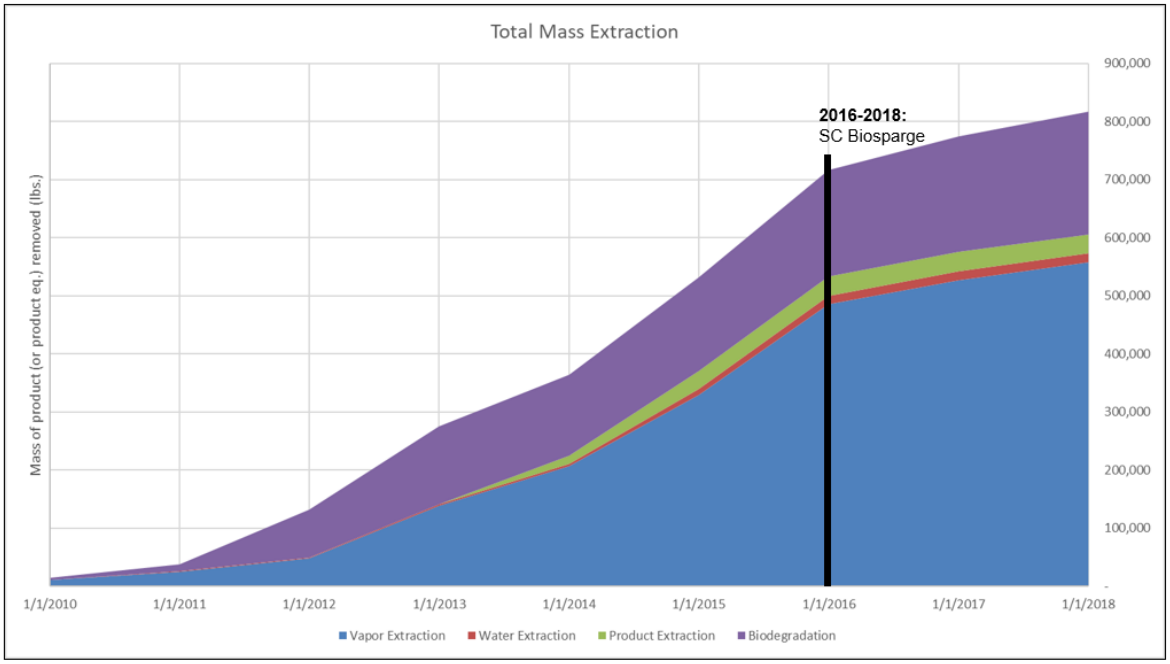

Exhibit 2. Total Mass Extraction (Vapor, Water, Product and Biodegradation) from 2010 to 2018

The effectiveness of the current remediation approach is fully summarized in the *Biosparging Effectiveness Evaluation and Recommendations – South-Central Area, SFPP Norwalk Pump Station, Norwalk, California* (Jacobs, 2019a).

Project Objectives and Approach

This work plan describes activities for the evaluation of NSZD processes within the south-central area of the site. Project objectives are as follows:

- Evaluate historical vapor probe data to estimate historical (i.e., pre-biosparging) NSZD rates and NSZD rates in the south-central area after the remediation systems have been suspended (i.e., post-sparging).
- Evaluate NSZD rates before startup of the southeastern biosparge system, and evaluate the operating conditions of the southeastern biosparge system, using three methodologies:
  - LI-COR CO_2 efflux measurements
  - E-Flux CO_2 traps
  - Gradient method using existing VMPs
- Compare the calculated NSZD rates to SVE mass removal and mass degradation estimates.
- Develop a long-term NSZD approach for the south-central area and justify to stakeholders.
- Evaluate NSZD rates in the southeastern area in respect to biosparging operation and duration.

Overview of Natural Source Zone Depletion

Petroleum hydrocarbon constituents in LNAPL undergo a variety of degradation processes, including volatilization, dissolution, and biodegradation (Kostecki and Calabrese, 1989; NRC, 2000; Johnson et al., 2006). NSZD is a term used to describe the collective, naturally occurring processes of dissolution, volatilization, and biodegradation in the subsurface that act to degrade LNAPL and convert petroleum hydrocarbon constituents to innocuous aqueous and gaseous by-products. These processes physically degrade the LNAPL by mass transfer of chemical components to the aqueous phase where they are biologically broken down. Within the saturated zone and overlying capillary fringe, methanogenesis is typically the most dominant biodegradation process (Wiedemeier et al., 1999), resulting in generation and subsequent transport of methane (CH_4) and lesser amounts of CO_2 to the vadose zone. Within the vadose zone, LNAPL (if present) and volatile hydrocarbons are also anaerobically biodegraded producing additional CH_4 and CO_2. Above this zone, where oxygen (O_2) permeates downward from the atmosphere, aerobic biodegradation occurs, removing CH_4 and O_2 from the soil gas, adding more CO_2, and releasing heat to the soil.

Measurement Methods and Approach

Three methods will be used to estimate NSZD rates within the south-central area of the site: dynamic close chamber (DCC) measurement using the LI-COR 8100A soil flux system, passive flux traps using the E-Flux CO_2 traps, and the gradient method using existing VMPs. The survey network is focused on residual LNAPL areas within the south-central area and includes surrounding areas for background monitoring. The initial survey network is designed to be reasonably comprehensive in order to provide a detailed snapshot of CO_2 efflux across the site. As discussed in subsequent sections, the CO_2 efflux monitoring will be performed using a real-time, dynamic data collection and analysis routine, and, therefore, the actual survey network may vary slightly from this work plan. Additional details on the data acquisition methodology and monitoring approach are provided in the following subsections.

LI-COR Biosciences Inc. 8100A Soil Flux System

The LI-COR 8100A soil flux system is a DCC system. The DCC system is an active, specially adapted direct-measurement approach to measure soil gas efflux at the ground surface. The LI-COR 8100A infrared CO_2 gas analyzer (IRGA) and chamber setup is a method of measuring the CO_2 efflux from soil (Exhibit 3). The 8100A uses a pneumatic, bellows-actuated, vented, domed chamber, a vapor pump, a temperature and moisture analyzer, an IRGA, and a control unit. The 8100A can be controlled either with a laptop computer or a smartphone using the LI-8100A application.

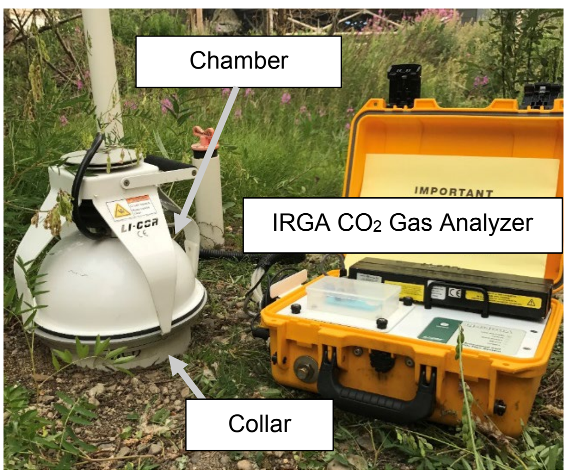

Exhibit 3. LI-COR Biosciences Field Setup
Typical LI-COR IRGA, chamber and collar field setup

The LI-COR 8100A automated soil flux system, including the 20-centimeter (cm) diameter, single-survey chamber system with integrated pump, IRGA, and control unit, will be used to survey CO_2 efflux at all prescribed locations within the site boundary. The survey chamber will be set on a polyvinyl chloride (PVC) collar placed approximately 1 to 3 inches deep on the ground surface at each location. The CO_2 efflux survey will be performed in the following general sequence: vegetation removal and collar installation followed by 12 to 24 hours of soil vapor re-equilibration, CO_2 efflux measurements, data review and quality assurance measurements, collar removal, and demobilization. The results of the measurements will be periodically reviewed to determine if additional locations or modifications in the procedures are necessary.

Increase in CO_2 concentration inside the chamber is related to the influx of soil vapor into the open bottom of the collar from subsurface sources of CO_2. The time rate of CO_2 concentration rise, or the slope of the best fit curve to the time series trend, can be equated proportionally to the CO_2 efflux. Given user-supplied parameters, the software automatically renders a best fit curve and reports the estimated CO_2 efflux. Data are post-processed using LI-COR's SoilFluxPro software to ensure consistent data handling.

E-Flux CO_2 Trap

The CO_2 traps were designed by Colorado State University and were made commercially available by E-Flux. The E-Flux traps are designed for longer-term, in situ monitoring of CO_2 efflux. The E-Flux trap assembly consists of three parts: an approximately 6-inch (15-cm) length of 4-inch (10-cm) inside-diameter PVC receiver pipe with basal metal angle anchors, a short PVC E-Flux trap equipped with a moisture-resistant media (SODASORB) that adsorbs CO_2, and a 6-inch (15-cm)-diameter protective rain cover. The receiver pipe is installed in the shallow ground surface and soil is compacted to pre-existing conditions inside and outside of the pipe to allow soil vapor to pass up through the pipe in approximately undisturbed conditions (E-Flux, 2019).

The E-Flux trap is a flow-through methodology intended to capture and sorb CO_2 as it migrates upward through the receiver pipe (Exhibit 4). The E-Flux trap contains two sorbent pucks; the upper sorbent is used to scrub atmospheric CO_2 and prevent it from migrating into the lower sorbent puck. The lower sorbent is used to capture the CO_2 solely emitted from the underlying subsurface. The upper sorbent puck is discarded at the laboratory after verifying that atmospheric CO_2 did not break through the upper puck, and the lower puck is analyzed to estimate the efflux. Unlike the LI-COR system, no pumping or field measurements are required. Over a pre-established period of time, on the order of 2 to 3 weeks, the E-Flux trap passively allows soil vapor to move through and sorbs the CO_2 mass. Analogous to a trip blank used for a groundwater volatile organic compound (VOC) sampling program, a separate E-Flux trap accompanies the samples and remains capped, containerized, and onsite for the duration of deployment. Upon termination of the deployment period, the sorbent E-Flux traps are sent back to the E-Flux laboratory for CO_2 and ^{14}C analysis.

Exhibit 4. E-Flux Trap Apparatus and Setup
Typical E-Flux trap as installed

The purpose of the traps is to supplement the LI-COR and VMP data and facilitate more accurate background correction. CO_2 traps will be installed in varied release areas atop the known residual LNAPL footprint and in various types of ground cover (e.g., light and heavy vegetation) and subsurface lithology (e.g., shallow and deep bedrock). The locations of the E-Flux CO_2 traps will be based on the results of the LI-COR efflux measurements, and the number of traps may be adjusted as needed to achieve the data objectives. The E-Flux traps will be installed according to manufacturer's recommendations. Radiocarbon (^{14}C) analysis will be performed on all traps to estimate the fossil fuel fraction of the CO_2 efflux and determine NSZD rates.

Gradient Method Using Soil Gas Profiles

Using existing VMPs, the change in soil vapor concentrations within the vadose zone can be measured and used to estimate the flux, which can subsequently be stoichiometrically converted to an NSZD rate. The method involves soil vapor sampling, including O_2, CO_2, CH_4, and VOCs, from nested vapor monitoring points installed at different depths, as well as deployment of an in situ tracer gas to estimate a range of soil vapor diffusion coefficients. Following sample collection, the data can be plotted and the concentration gradient estimated. Background O_2 consumption and CO_2 production must be assessed and compensated for in the NSZD calculations (CRC CARE, 2018).

Scope of Work

The proposed scope of work to accomplish the objectives of this work includes the deployment of three NSZD technologies. A summary of samples and sample points is provided in Tables 1 and 2 and on Figure 3. Primary activities associated with the scope of work are as follows:

- Premobilization activities, including review of historical vapor data
- Field activities
  - South-central and southeastern areas
    - Conduct location mark-out and survey
    - Install LI-COR soil collars
    - Suspend south-central active remedial systems (hydraulic control and recovery, SVE, and biosparging)
    - Conduct LI-COR survey and soil vapor monitoring
    - Install CO_2 traps
  - Southeastern area
    - Start up southeastern biosparge and new SVE wells
    - Conduct LI-COR survey
    - Install CO_2 traps
  - Southeastern and south-central areas
    - Start up southeastern biosparge and new SVE wells
    - Conduct LI-COR survey
    - Install CO_2 traps
- Data analysis and reporting

Premobilization Activities

Jacobs will perform the following permitting and field preparation tasks prior to commencement of field activities:

- Suspend active remediation in the south-central area of the site a minimum of 7 days prior to the anticipated start of field activities.
- Update the existing site-specific Health and Safety Plan and an Activity Hazard Analysis to incorporate the planned fieldwork.
- Verify that Jacobs and subcontractor personnel have all the required health and safety training required by Kinder Morgan and possess the required identification cards to enter Kinder Morgan facilities.
- Notify the Water Board, DLA Energy, and the City of Norwalk a minimum of 1 week in advance of the planned field activities.
- Notify Underground Service Alert (USA). As required by USA, the LI-COR locations will be called in and marked-out in white paint at least 3 business days prior to collar and trap installations.
- Coordinate with Kinder Morgan personnel to arrange for a Kinder Morgan field inspector to be present during field activities near Kinder Morgan pipelines, if necessary.
- Review historical vapor data.
- Prepare a fieldwork plan to be followed by field personnel when onsite.
- Conduct an internal Jacobs project team field charter meeting to communicate key tasks and operational methods required to carry out the fieldwork.
- Set up order for necessary field equipment and supplies to be used in the field.

Field Activities

Location Mark-out, Survey, and Utility Location

In advance of field activities, the LI-COR collar and CO_2 trap locations will be marked on the ground surface with white spray paint, pin flags, or both, with each location surveyed by a licensed surveyor for location and elevation.

Following location mark-out and surveying, a geophysical survey will be performed using a private utility-locating subcontractor. Jacobs and the subcontractor will coordinate with Kinder Morgan operations staff to clear all locations of potential underground utilities and other infrastructure.

Natural Source Zone Depletion Evaluation

LI-COR CO_2 Efflux Survey. A total of 60 LI-COR collars, including 6 duplicates (42 collars in the south-central area and 18 collars in the southeastern area), will be installed at the site. Each LI-COR location will be clearly marked for current and future locating with surveyor markings (e.g., stake, flagging, and whiskers). Those within regular pedestrian and vehicular traffic areas will be marked with stakes and caution tape for the duration of the effort to avoid disturbance. However, reasonable efforts will be made to put efflux measurement locations away from heavy use and vehicular traffic type areas. At each survey location, an 8-inch-diameter, 5-inch-long PVC collar will be installed using hand tools (hand trowel and rubber mallet). The surficial root zone (anticipated to be 6 to 12 inches thick) will be removed using a small spade, and the PVC collar will be installed inside the excavated area beneath the root zone.

Two rounds of CO_2 efflux measurements following standard operating procedures (SOPs) with the LI-COR 8100A will be completed. One measurement will be conducted prior to installing the CO_2 traps; the second measurement will be conducted upon retrieval of the CO_2 traps approximately 2 weeks later. Vapor grab samples will also be collected from the return air stream from the LI-COR flux system for field measurement of O_2, CH_4, and CO_2, using a landfill gas meter (e.g., Landtec GEM2000 or equal) and CH_4 and VOCs using a flame ionization detector equipped with and without a carbon/charcoal filter. The results will be used to validate the basis for the NSZD calculations, namely that the majority or all of CH_4 and VOC vapors emitted at the ground surface are oxidized to CO_2. The raw CO_2 efflux data will be corrected for background efflux using standardized procedures.

E-Flux CO_2 Trap. Using the results from the first round of LI-COR CO_2 efflux measurements, 15 E-Flux CO_2 traps (including 2 duplicates) will be installed and deployed following SOPs. Ten CO_2 traps will be deployed in the south-central area and five CO_2 traps will be deployed in the southeastern area. After an approximately 2-week deployment, the sorbent traps will be retrieved and returned to the E-Flux laboratory for specialty analysis. This analysis includes total carbon and radiocarbon (^{14}C). A second round of LI-COR soil gas CO_2 efflux measurements will be collected concurrently with trap retrieval.

Gradient Method Using Soil Gas Profiles. Prior to collecting vapor samples, each VMP will be purged of at least three volumes using a vacuum/ pressure sampling pump calibrated to a flow rate of 200 milliliters per minute (mL/min). The use of a consistent low rate at each sample location will limit stripping and ambient air intrusion. Following purging, soil vapor profile measurements will be collected from VMPs installed in the vadose zone by connecting a vacuum pump to the tubing of a particular VMP and extracting soil gas into a 1-liter (L) Tedlar bag at a rate of approximately 200 mL/min.

A landfill gas detector (GEM 5000 equipped with O_2, CO_2, CH_4, hydrogen sulfide, and carbon monoxide or equal sensors) and a flame ionization detector will be used to collect measurements from the soil vapor extracted into the Tedlar bags. The results will be used to validate the basis for the NSZD calculations, namely that the majority or all of CH_4 and VOC vapors emitted at the ground surface are oxidized to CO_2.

In addition to the soil vapor profile measurements described above, the effective vapor-phase porous media diffusion coefficient will be estimated by performing helium diffusion tests at selected VMP locations and depths. A known volume (typically 1 L) and concentration (typically 5 percent) of helium gas will be injected using a vacuum pump at a constant rate (approximately 200 mL/min) into a particular VMP tube and subsequently plugged off. After 10 to 30 minutes, approximately 1 L of soil vapor from the same VMP will be collected into a 1-L Tedlar bag. The helium concentration will then be measured from the Tedlar bag using an MGD-2002 helium gas detector.

Quality Assurance and Quality Control

In addition to the manufacturer's recommended quality assurance and quality control (QA/QC) (e.g., instrument calibrations), the following procedures will also be implemented:

- Field blank – Relevant to the DCC method, the chamber is placed on an airtight collar and allowed to collect a series of blank measurements. One field blank will be analyzed per field day during the assessment. The field blank results are used to determine the instrument detection limit.
- Trip blank – Relevant to the passive flux trap method, a laboratory-sealed trip blank trap accompanies the shipment from point of origin through field deployment and back to laboratory. Results are used to measure the incidental amount of CO_2 sorbed during transport and deployment. This is subtracted from all other traps to correct for atmospheric cross-contamination due to imperfect seal on traps during shipment.
- Duplicate – Relevant to all methods, duplicates are used to assess repeatability of measurements either side by side or immediately sequential in time. Duplicates will be collected at a frequency of 1 per every 10 parent samples.

The results of the QA/QC samples will be used to perform a data quality evaluation, similar to that performed on groundwater analytical chemistry results. For example, detection limits will be assigned, results adjusted for cross-contamination during transport, and data will be qualified if there is poor duplicate correlation in the field using a relative percentage difference value.

Data Analysis and Reporting

The following data analysis tasks will be conducted following completion of each CO_2 efflux field survey event, and upon receipt of the laboratory analytical data (typically within 4 to 6 weeks of sample receipt):

- Perform QA/QC on the analytical data received from the laboratory and field.
- Correct the LI-COR data for background CO_2 efflux following the standard procedures.
- Calculate the NSZD rate for each LI-COR and CO_2 trap monitoring location.
- Plot the NSZD rates for the monitoring events and estimate a sitewide NSZD rate.
- Prepare an NSZD assessment report to summarize the results of the NSZD evaluation and evaluate the effectiveness of NSZD as a remedial strategy for the site. The report will include graphics, a tabulated summary of the data analysis, appendixes with the CO_2 trap laboratory reports, and raw data from the LI-COR CO_2 efflux survey and soil gas profiles.

Schedule

The CO_2 efflux monitoring event will be conducted in coordination with system biosparge shutdown in the south-central area and startup in the southeastern area. Field activities for these events vary from 1 to 10 days as specified in Table 1. The report documenting field activities, data evaluation, and conclusions will be completed following receipt of the final test results from E-Flux.

Long-term NSZD Monitoring

After the initial comprehensive NSZD monitoring events, a long-term NSZD monitoring plan will be developed based on the evaluation results. It is anticipated that quarterly vapor monitoring data could be used to continue this analysis, but supplemental NSZD measurement may be needed on a biannual or less frequent basis. The long-term NSZD monitoring plan will verify remedial progress at the site and quantify changes in NSZD rates at selected locations across the site. Reporting of long-term NSZD monitoring will be included in future quarterly remediation progress reports.

References

CH2M. 2013. *Revised Groundwater Sampling and Analysis Plan, SFPP Norwalk Pump Station, 15306 Norwalk Boulevard, Norwalk, California*.

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If you have any questions regarding this work plan, please contact Mr. Eric Davis/Jacobs at 213.228.8262, or Mr. Alan Van Antwerp, Kinder Morgan's Remediation Project Manager, at 619.285.5705 ext. 222.

Regards,

Eric Davis
Project Manager

Trevre Andrews
Senior Technical Consultant

Attachments:

Table 1 – Proposed Schedule for Natural Source Zone Depletion Evaluation
Table 2 – Proposed Analytical Schedule for Natural Source Zone Depletion – Baseline Evaluation

Figure 1 – Site Location Map
Figure 2 – Site Layout
Figure 3 – Proposed Natural Source Zone Depletion Layout

Tables

Table 1. Proposed Schedule for Natural Source Zone Depletion Evaluation
SFPP Norwalk Pump Station, Norwalk, California

Locations / Method[a]	South-Central Onsite Active Remediation Shutdown	Baseline NSZD (South-Central Onsite and Southeastern)	Southeastern SVE and Biosparge Startup	Southeastern System Active	Southeastern System Active, South-Central Onsite (Ambient)
				1-month post-startup	6-12 months post-startup
		(3 days for collar installation, 5 days for LI-COR Survey and Flux Trap Installation)		(2 days for LI-COR Survey and Flux Trap Installation)	(5 days for LI-COR Survey and Flux Trap Installation)
	August 1, 2019	July 7, 2019	August 1, 2019	September 1, 2019	January - June 2020
Southeastern Area					
E-Flux Traps		4		4	4
LI-COR		16		16	16
SVMP		7		7	7
South-Central Area (Onsite)					
E-Flux Traps		9		9	9
LI-COR		38		0	38
SVMP		7		7	7
South-Central Area (Offsite)					
E-Flux Traps		0		0	0
LI-COR		0		0	0
SVMP		10		10	10

Notes:

[a] Total numbers do not include duplicates.

NSZD = natural source zone depletion

SVE = soil vapor extraction

SVMP = soil vapor monitoring point

Table 2. Proposed Analytical Schedule for Natural Source Zone Depletion – Baseline Evaluation
SFPP Norwalk Pump Station, Norwalk, California

Location ID	Sample Interval (feet)	Field				E-Flux	LI-COR
		VOC	O_2	CO_2	CH_4		
Southeastern Area							
SVM-9-5	5 - 5.5	1	1	1	1	4	16
SVM-9-14.5	14.5 - 15	1	1	1	1		
SVM-17-5	5 - 5.5	1	1	1	1		
SVM-17-14.5	14.5 - 15	1	1	1	1		
SVM-18-5	5 - 5.5	1	1	1	1		
SVM-18-14.5	14.5 - 15	1	1	1	1		
SVM-20-5	5 - 5.5	1	1	1	1		
SVM-20-14.5	14.5 - 15	1	1	1	1		
SVM-21-5	5 - 5.5	1	1	1	1		
SVM-21-14.5	14.5 - 15	1	1	1	1		
SVM-22-5	5 - 5.5	1	1	1	1		
SVM-22-14.5	14.5 - 15	1	1	1	1		
SVM-23-5	5 - 5.5	1	1	1	1		
SVM-23-14.5	14.5 - 15	1	1	1	1		
	Total	14	14	14	14	4	16
	QA/QC	2	2	2	2	1	2
	Total (including QA/QC)	16	16	16	16	5	18
South-Central Area (Onsite)							
SVM-11-7	7 - 7.5	1	1	1	1	9	38
SVM-11-15	15 - 15.5	1	1	1	1		
SVM-11-22	22 - 22.5	1	1	1	1		
SVM-12-7	7 - 7.5	1	1	1	1		
SVM-12-15	15 - 15.5	1	1	1	1		
SVM-12-22	22 - 22.5	1	1	1	1		
SVM-13-7	7 - 7.5	1	1	1	1		
SVM-13-15	15 - 15.5	1	1	1	1		
SVM-13-22	22 - 22.5	1	1	1	1		
SVM-14R-8	8 - 8.5	1	1	1	1		
SVM-14R-16	16 - 16.5	1	1	1	1		
SVM-14R-22	22 - 22.5	1	1	1	1		
SVP-106-4.5	4.5 - 5	1	1	1	1		
SVP-106-9.5	9.5 - 10	1	1	1	1		
SVP-107-4.5	4.5 - 5	1	1	1	1		
SVP-107-9.5	9.5 - 10	1	1	1	1		
SVP-108-4.5	4.5 - 5	1	1	1	1		
SVP-108-9.5	9.5 - 10	1	1	1	1		
	Total	18	18	18	18	9	38
	QA/QC	2	2	2	2	1	4
	Total (including QA/QC)	20	20	20	20	10	42

Table 2. Proposed Analytical Schedule for Natural Source Zone Depletion – Baseline Evaluation

SFPP Norwalk Pump Station, Norwalk, California

Location ID	Sample Interval (feet)	Field				E-Flux	LI-COR
		VOC	O_2	CO_2	CH_4		
South-Central Area (Offsite)							
SVM-1-5	5 - 5.5	1	1	1	1	0	0
SVM-1-15	15 - 15.5	1	1	1	1		
SVM-2-4	4 - 4.5	1	1	1	1		
SVM-2-13.5	13.5 - 14	1	1	1	1		
SVM-3-5	5 - 5.5	1	1	1	1		
SVM-3-15	15 - 15.5	1	1	1	1		
SVM-5-5	5 - 5.5	1	1	1	1		
SVM-5-15	15 - 15.5	1	1	1	1		
SVM-6-7	7 - 7.5	1	1	1	1		
SVM-6-13	13 - 13.5	1	1	1	1		
SVM-7-7	7 - 7.5	1	1	1	1		
SVM-7-13	13 - 13.5	1	1	1	1		
SVM-8-5	5 - 5.5	1	1	1	1		
SVM-8-15	15 - 15.5	1	1	1	1		
SVM-10-5	5 - 5.5	1	1	1	1		
SVM-10-15	15 - 15.5	1	1	1	1		
SVM-15-7	7 - 7.5	1	1	1	1		
SVM-15-15	15 - 15.5	1	1	1	1		
SVM-15-22	22 - 22.5	1	1	1	1		
SVM-16-7	7 - 7.5	1	1	1	1		
SVM-16-15	15 - 15.5	1	1	1	1		
SVM-16-22	22 - 22.5	1	1	1	1		
	Total	18	18	18	18	0	0
	QA/QC	2	2	2	2	0	0
	Total (including QA/QC)	20	20	20	20	0	0

Notes:

CH_4 = methane

CO_2 = carbon dioxide

ID - identification

O_2 = oxygen

QA/QC = quality assurance/quality control

VOC = volatile organic compound

Figures

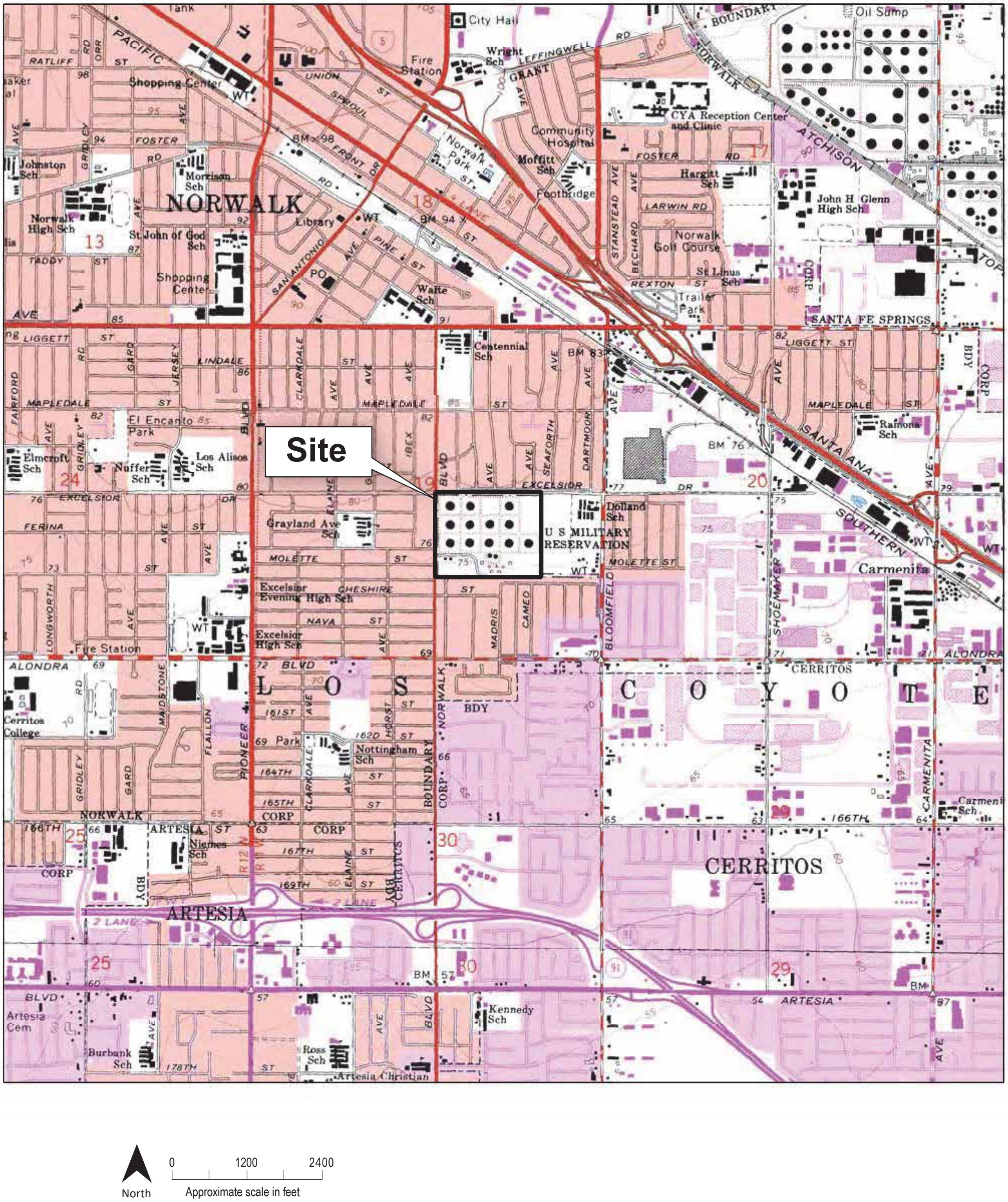

Figure 1. Site Location Map
SFPP Norwalk Pump Station
Norwalk, California

BASEMAP MODIFIED FROM U.S.G.S. 7.5 MINUTE QUADRANGLE MAP
LOS ALAMITOS 1964, CALIFORNIA. PHOTO-REVISED 1981.
WHITTIER 1965, CALIFORNIA. PHOTO-REVISED 1981.

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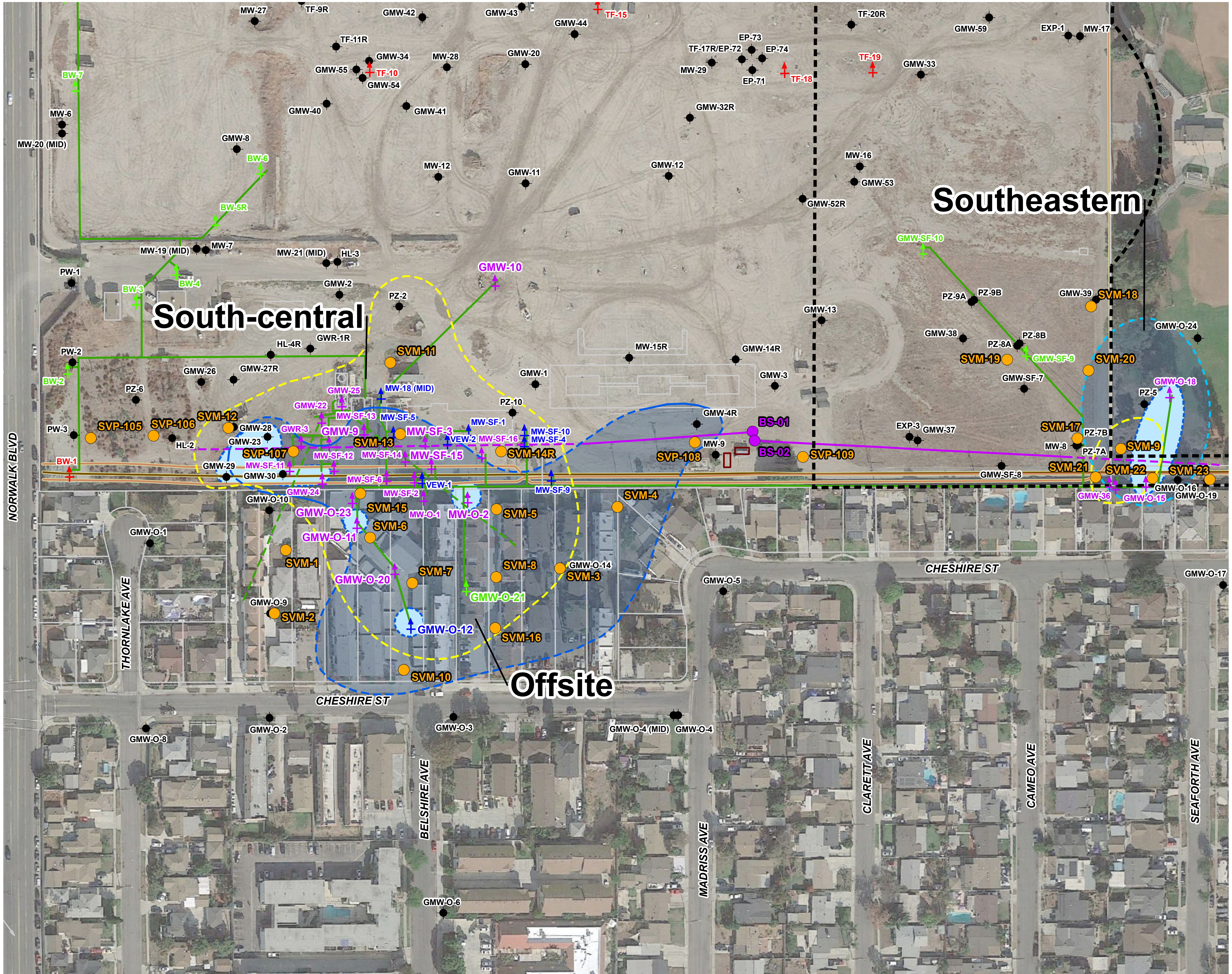

LEGEND

- Soil Vapor Probe/Soil Vapor Monitoring Probe
- Horizontal Biosparge Well Entry Point
- Existing Groundwater Monitoring Well
- Existing Remediation Well
- Kinder Morgan Combined Soil Vapor and Total Fluids Extraction Wells
- Kinder Morgan Soil Vapor Extraction Wells
- Kinder Morgan Total Fluids and/or Groundwater Extraction Wells
- Kinder Morgan Remediation Piping Layout (Above Ground and Below Ground)
- Horizontal Vapor Extraction Well Piping
- Horizontal Biosparge Well (Dashed Line Depicts Approximate Lateral Extent of Well Screen)
- Inferred Historical Extent of LNAPL Zone (Smear Zone) from LNAPL Characterization Work Plan (AMEC Geomatrix, 2010)
- Approximate Extent of Dissolved Phase in Groundwater in the Southeastern Area. Based on April 2017 Semi-annual Groundwater Monitoring Event.
- Estimated Extent of Detected Dissolved Benzene in Groundwater. Based on April 2018 Semi-annual Groundwater Monitoring Event. Dashed Where Inferred.
- Estimated Extent of Measurable LNAPL on Groundwater. Based on April 2017/2018 Semiannual Groundwater Monitoring Event. Dashed Where Inferred.
- Air Compressor System
- 16" Pipline (approximate)
- 24" Pipeline (approximate)
- Eastern 15-Acre Property Boundary

Imagery Source:
Google Earth December 3, 2017.

N

0 75 150 300
Feet

1 inch = 150 feet

Figure 2. Site Layout
SFPP Norwalk Pump Station
Norwalk, California

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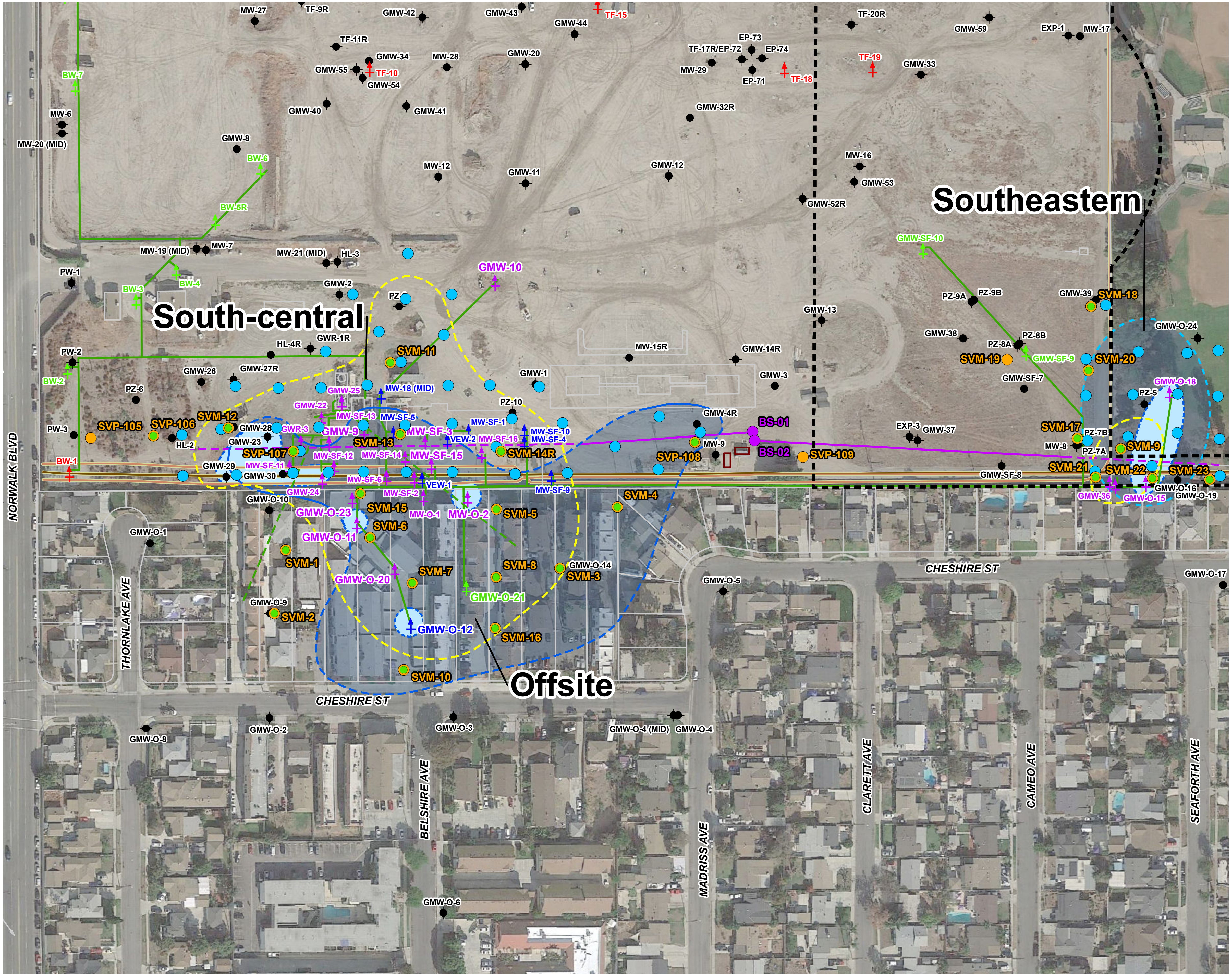

R:\ENBG\00_PROJ\K\KINDERMORGAN\NORWALK\MAPFILES\2019\NSZD\FIGURE_3_NSZD_LAYOUT.MXD AESPEJO 6/13/2019

LEGEND

- LI-COR Collar Location
- Vapor Monitoring Point for NSZD Evaluation
- Soil Vapor Probe/Soil Vapor Monitoring Probe
- Horizontal Biosparge Well Entry Point
- Existing Groundwater Monitoring Well
- Existing Remediation Well
- Kinder Morgan Combined Soil Vapor and Total Fluids Extraction Wells
- Kinder Morgan Soil Vapor Extraction Wells
- Kinder Morgan Total Fluids and/or Groundwater Extraction Wells
- Kinder Morgan Remediation Piping Layout (Above Ground and Below Ground)
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- Estimated Extent of Detected Dissolved Benzene in Groundwater. Based on April 2018 Semi-annual Groundwater Monitoring Event. Dashed Where Inferred.
- Estimated Extent of Measurable LNAPL on Groundwater. Based on April 2017/2018 Semiannual Groundwater Monitoring Event. Dashed Where Inferred.
- Air Compressor System
- 16" Pipline (approximate)
- 24" Pipeline (approximate)
- Eastern 15-Acre Property Boundary

Imagery Source:
Google Earth December 3, 2017.

Note:
Trap locations will be selected based on the preliminary LI-COR results at ~10 locations.

N

0 75 150 300
Feet

1 inch = 150 feet

Figure 3. Proposed Natural Source Zone Depletion Layout
SFPP Norwalk Pump Station
Norwalk, California

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