

Current Status of Vapor Intrusion Assessment, Montrose and Del Amo Superfund Sites, Torrance, California

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1. Introduction

In response to a request from the United States Environmental Protection Agency (USEPA), CH2M HILL has prepared this technical memorandum to summarize the current knowledge base and status of vapor intrusion (VI) assessments at the Montrose and Del Amo Superfund Sites. The VI pathways have been separately assessed to varying degrees in the operable units (OUs) associated with the Montrose and Del Amo Superfund Sites. This memorandum seeks to integrate these efforts and briefly discusses a generalized conceptual site model (CSM) and fundamental data used for assessing VI, and summarizes the site-specific VI assessments that have been performed to date for the Montrose and Del Amo OUs, as documented in published reports.

The technical memorandum is organized as follows:

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2. Vapor Intrusion Fundamentals

2.1 Generalized VI Conceptual Site Model (CSM)

VI occurs when volatile organic compounds (VOCs) present in the subsurface enter a structure at the ground surface. For VI to occur, a complete uninterrupted migration pathway must exist from the subsurface VOC source to the building occupant (the receptor). VOCs can exist beneath a building, but if the chemicals do not migrate upward to the surface and then enter and accumulate inside the surface structure through a complete pathway, VI does not occur.

VI is considered potentially significant or actionable to EPA (i.e., requires further evaluation) when:

1. The residential or commercial structures where vapors are entering are regularly occupied (i.e., there are either residential or occupational receptors), and
2. The indoor air VOC concentrations resulting from VI exceed site-appropriate screening or action levels.

Figure 2-1 illustrates a generic CSM for VI. The three main components of any VI CSM are vapor sources, receptors, and vapor migration pathways. A key consideration is that many of the same VOCs that are present in soil or groundwater beneath a structure are also used in common consumer and industrial products and motor fuels. Therefore, these VOCs may be present inside structure due to background sources unrelated to VI. VOCs can also enter structures from outdoor ambient air. The main components of the VI CSM and background VOCs are further discussed below.

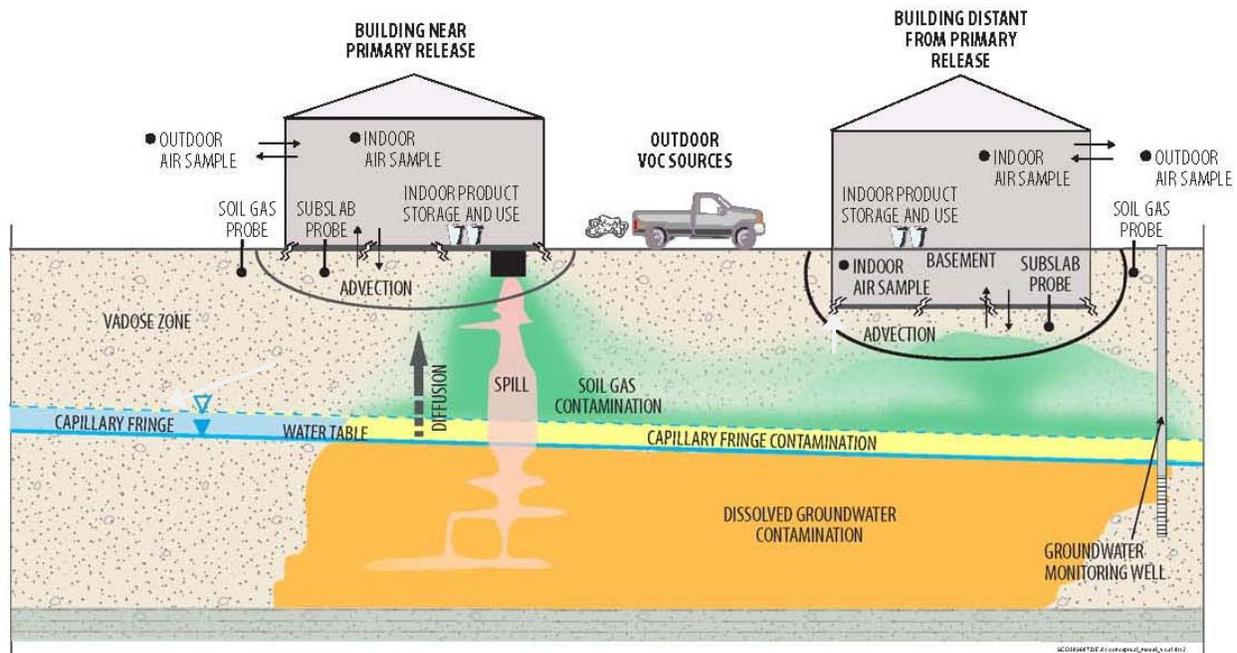


FIGURE 2-1
Example Conceptual Site Model

Vapor Sources. Subsurface VOC sources fall into three main types:

1. Contaminated vadose zone soil
2. Immiscible VOC chemical product at or below the water table

3. Dissolved VOCs in groundwater

The first two types (soil contamination and free product) are located near the area where VOCs were spilled or released into the subsurface, that is, the “primary release.” In contrast, dissolved VOC plumes in groundwater may migrate quite far (sometimes miles) from the primary release. This leads to a major distinction when evaluating VI near or distant from the primary release – buildings near a primary release may have multiple vapor sources (soil, free product, and groundwater), whereas shallow groundwater is the only vapor source for buildings located at a distance from a primary release.

Vapor Receptors. Potential receptors include residents or workers in homes or commercial buildings overlying subsurface VOC contamination.

Vapor Migration. In order for the VI pathway to be complete and significant, vapors must migrate from the source to the receptor located inside a building in sufficient amounts to cause the indoor air concentrations to be above health-based screening or action levels. The processes impacting vapor migration include:

1. Volatilization of VOCs from groundwater, soil, or free product into soil gas.
2. Diffusion of vapors through the soil.
3. Degradation of contaminants by biological (e.g., bacterial) or nonbiological reactions.
4. Movement of VOCs from soil gas beneath the building to the interior of the building through cracks or other openings in the slab.
5. Mixing of the VOC vapors with the air inside the building.
6. Mixing of indoor and outdoor air.

If these processes result in attenuation of vapors to such a degree that vapors do not enter the building (the pathway is incomplete) or so that indoor concentrations are below levels of concern, the pathway is considered to be insignificant.

The USEPA (2002) and California Environmental Protection Agency (Cal-EPA) (2011) recommend under most conditions that buildings located more than 100 feet from a vapor source do not require further evaluation of VI. With this separation, VI attenuation processes tend to render potential indoor VOC concentrations insignificant. Petroleum hydrocarbons such as the benzene found at the Montrose/Del Amo Site typically attenuate below levels of concern within much smaller distances. This is because petroleum hydrocarbons are particularly prone to destruction by naturally occurring bacteria in the presence of oxygen. Current research is showing that distances as little as 30 feet from a strong petroleum vapor source (i.e., with concentrations similar to and higher than those observed at the Del Amo and Montrose Superfund Sites) will result in attenuation of petroleum hydrocarbons¹ below risk-based screening levels and even shorter distances are needed for weaker vapor sources such as a benzene groundwater plume. In general, a distance of 100 feet for chlorinated solvents and 30 feet for petroleum hydrocarbons applied in both vertical and lateral directions is typically considered to be a threshold limit within which VI may require further evaluation. Please note that this generalization does not account for site-specific soil type and contaminant properties, magnitude of contaminant sources, and contaminant-specific attenuation factors, which need to be considered as part of further analysis.

Background VOCs. Many of the same chemicals that are the subject of VI investigations commonly are used in homes, businesses, and transportation. Benzene and chloroform, for example, often can be found in either indoor and/or outdoor air for reasons unrelated to contaminated sites (Battelle et al.,

¹ See, for example: <https://iavi.rti.org/WorkshopsAndConferences.cfm?PageID=documentDetails&AttachID=547>

2011). Careful analysis, often using multiple sources of data, is typically required to discern between VOCs related to VI and those resulting from background sources.

2.2 Vapor Intrusion Data and Analysis

Evaluating the VI pathway typically requires evaluating various types of data related to the nature and extent of contamination and other site characteristics. The types of analyses can range from simple screening of groundwater data to building-specific evaluations including indoor- and outdoor-air data collection.

Subsurface Data. At a minimum, most VI assessments start with a review of subsurface VOC data to determine if and where a subsurface vapor source exists. Subsurface data can be used to address two aspects of the VI CSM discussed above:

1. The existence and strength of a subsurface vapor source
2. The degree of attenuation between the source and the building

Subsurface data can only be used to estimate the potential for VI, and to rule out VI in cases where (1) the source strength is too low, or (2) attenuation is adequately reducing the VOC concentrations beneath the building. Conservative assumptions are commonly used when estimating potential indoor-air impacts based on subsurface data. Subsurface data alone can never be used to confirm the occurrence or significance of VI; this requires indoor air data and evaluation of background VOC sources. Subsurface data may include:

1. Groundwater data: Only groundwater data collected at the water table are useful for VI assessments because that is where vapors volatilize into the soil. Data from deeper aquifers are not typically used for evaluating VI, because these aquifers are separated from the vadose zone and surface receptors by the water table aquifer and aquitard materials, if present.
2. Exterior soil gas data: These data are collected from the soil above the water table from probes located outside of the building footprint. They can be used to assess the strength of a vapor source as well as profile the vapor attenuation between the sources and a building.
3. Subslab soil gas data: If determined necessary, subslab samples may be collected from directly beneath a building's foundation slab. Since subslab soil gas provides the closest subsurface sample to the indoor air, there are fewer uncertainties with predicting indoor air concentrations than with other subsurface data. Subslab sampling may involve drilling small holes into or under building foundations, and may not be determined necessary in all cases if other sufficient data are available.

Indoor and Outdoor Air Data. Indoor air data are collected to directly measure impacts to the medium to which receptors may be exposed. Since no predictions or calculations are required (as opposed to subsurface data) there may be less uncertainty associated with indoor air data. However, indoor or outdoor background sources of VOCs frequently complicate the analysis of indoor air data. Outdoor air samples are almost always collected at the same time as indoor samples to provide one line of evidence regarding background VOC sources. Other data and methods are also used to assess background sources (Battelle et al., 2011).

Soil Data. Measurements of VOC concentrations in soil can be useful for understanding the overall CSM; for example, the location and size of a primary release. Soil data are no longer used to quantitatively evaluate the potential for VI due to the high degree of uncertainty with predicting vapor concentrations from soil data (USEPA, 2002).

Site-Characteristics Data. Much of the focus of VI investigations is on the VOC concentration data described above. However, there are other types of data that can be critical in evaluating VI. Subsurface

characteristic information such as soil type, depth to groundwater, the presence of clay layers, and other factors are essential to developing the CSM.

Characteristics of Buildings and Slabs. It is equally important to understand the characteristics of the building. Buildings may exhibit vastly different degrees of vapor attenuation due to factors such as size, condition, ventilation, construction (e.g., basement), and operation. In addition, the degree to which vapors may enter the building in the first place can be greatly affected by the condition of the concrete slab and the ventilation system and other factors. In some cases, multiple samples must be taken at different locations inside individual buildings to account for the high degree of spatial variability.

Vapor intrusion data evaluation. A common way of evaluating VOC concentration data is to compare concentrations to conservative, health-based screening levels. Vapor intrusion screening levels are risk-based, chemical-specific concentrations for individual chemicals in indoor air, soil gas or groundwater that, when exceeded, may warrant further evaluation of the vapor intrusion pathway at a site.

Vapor intrusion screening levels typically incorporate a number of conservative factors and assumptions and therefore exceedance of a vapor intrusion screening level does not directly equate to an unacceptable exposure or risk, often because of the uncertainties associated with predicting indoor air concentrations based on subsurface analytical data.

Generally, vapor intrusion screening levels are not enforceable standards or final cleanup goals. This is consistent with current USEPA guidance on the use of risk-based screening levels, which states, "SLs [screening levels] are generic screening values, not de facto cleanup standards."²

Vapor intrusion screening levels are always based on an acceptable indoor air concentration. When evaluating indoor air data, the measured indoor air concentration (the "exposure point concentration") is compared directly to the acceptable indoor air concentration/screening level. Screening levels for soil gas or groundwater incorporate conservative factors that relate the subsurface VOC concentration to a potential indoor air concentration.

Vapor intrusion practitioners also consider site-characteristics data and the overall CSM when evaluating whether vapor intrusion is occurring and significant.

3. Vapor Intrusion Assessments at the Del Amo and Montrose Sites

This section provides a summary of previous VI assessments performed at Del Amo and Montrose OUs.

3.1 Site Background and Operable Unit Description

The Montrose and Del Amo Superfund Sites are situated near the City of Torrance, California. Brief descriptions of each site and corresponding OUs are presented below.

The Del Amo Superfund Site is a former synthetic rubber manufacturing plant, which was constructed between 1942 and 1943. From 1943 until 1972, the Del Amo plant site was a center of large-scale industrial activities. Originally built to produce synthetic rubber during World War II and owned by the United States government, the 280-acre operation consisted of a styrene plant operated by Dow Chemical Company, a butadiene plant operated by Shell Oil Company, and a synthetic rubber plant operated by U.S. Rubber Company, Goodyear Tire & Rubber Company, and others. In 1955, the United States government sold all three plants to Shell Oil Company and Shell continued to operate these plants until 1971. Most of the former Del Amo plant property has since been developed as an industrial park.

² http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/fag.htm

Over the years of its operation, the Del Amo plant released hazardous substances, pollutants, and contaminants into the environment, which resulted in the presence of light nonaqueous phase liquid (LNAPL) and soil and groundwater contamination beneath the site. In 1984, contamination was discovered in the waste pit disposal area and underlying soils. Groundwater located beneath the site is also heavily contaminated with LNAPL and dissolved contaminants. Benzene is the predominant contaminant encountered in groundwater beneath the Del Amo site.

In September 2002, USEPA placed the former plant property on the USEPA National Priorities List (NPL). The Del Amo Superfund Site is divided into three OUs, each of which addresses benzene and other VOCs that could potentially cause VI. The Del Amo OUs discussed in this memorandum are listed below:

- OU-1 – Soil and NAPL
- OU-2 – Waste Pits
- OU-3 – Dual Site Groundwater

Montrose Chemical Corporation of California (Montrose) manufactured the technical grade of the pesticide DDT (dichloro-diphenyl-trichloroethane) from 1947 until 1982 at a 13-acre plant located west of the Del Amo Site. The plant was dismantled and demolished by 1983. In its 35 years of operation, the Montrose facility released hazardous substances into the surrounding environment, including surface soil, groundwater, stormwater drainage ditches and sewers, sanitary sewers, and ultimately the Pacific Ocean. Contaminants, including chlorobenzene, entered the ground within the former plant property by way of a rework facility, leaks from valves and clogged lines, and other elements of the DDT manufacturing process. Soil and groundwater beneath the former plant property also contains a DNAPL that consists of chlorobenzene and DDT. The chlorobenzene plume originating from the DNAPL source is present in multiple aquifer units and extends for more than 1.5 miles downgradient of the former Montrose plant property. This plume is commingled with the benzene plume originating at the Del Amo site.

In addition to the Montrose operations, Jones Chemicals Industries (Jones) leased 5 acres generally south and immediately adjacent to the Montrose plant property from at least 1963 until 1968, when Jones purchased the land from Stauffer. Jones was in the business of manufacturing, storing, repackaging, and distributing water treatment chemicals and other chemicals used by the public and industry. The Jones facility manufactured sodium hypochlorite, sodium bisulfite, and ammonium hydroxide and repackaged chlorine, sulfur dioxide, anhydrous ammonia, sodium hydroxide, potassium hydroxide, hydrochloric acid, acetic acid, nitric acid, hydrofluosilicic acid, phosphoric acid and various solvents, including tetrachloroethene (PCE), into smaller Department of Transportation (DOT)-approved containers. Prior to Jones' use of the property, Stauffer operated a sulfuric acid manufacturing plant there. The sulfuric acid plant was operated from the early 1940s until approximately 1952, and dismantled after 1965. Current operations at Jones include manufacturing of sodium hypochlorite (Sunny Sol "150") and sodium bisulfate; and repackaging chlorine, sulfur dioxide, and sodium hydroxide for distribution. A variety of chlorinated VOCs including PCE and trichloroethene (TCE) have been identified in the subsurface at the Jones property and an investigation is currently underway by the site owner.

USEPA proposed the Montrose Site for the NPL in 1984, and the site was listed in 1989. The Montrose Superfund Site includes the 13-acre former plant property, the 5-acre Jones property, and other areas impacted by the former plant operations. It is divided into seven OUs, of which, three address VOC contamination in soil, soil vapor, groundwater, and DNAPL that could potentially result in VI. The other four OUs pertain to DDT, which is not volatile and thus does not pose a VI risk.

The following Montrose OUs that could potentially result in VI are discussed in this memorandum:

- OU-1 – On- and Near-Property Soils
- OU-3 – Dual Site Groundwater /Montrose DNAPL
- OU-7 – Jones Oversight

The Del Amo and Montrose Superfund Site OUs addressed in this technical memorandum are shown in Figure 3-1.

Note that OU-3 addresses groundwater contamination for both the Montrose and Del Amo Superfund Sites, and therefore USEPA uses the term ‘Dual Site Groundwater.’ In addition, this OU includes the plume of dissolved TCE, originating at Jones and upgradient sources such as the former Boeing facility, APC, PACCAR, etc., that is commingled with the groundwater contamination from the Montrose and Del Amo Superfund Sites. This is because commingling of dissolved contaminants from different sources makes it impractical to remediate them separately. While Jones is addressed by Montrose OU-7, the cleanup of the upgradient sources of the TCE contamination is not included in the Montrose and Del Amo OUs. However, OU-3 - Dual Site Groundwater includes containment of these sources to prevent further migration of dissolved contaminants into the Montrose and Del Amo Superfund Sites (Section 3.4).

Areas where potential for VI has been previously assessed include Montrose OU-1, Del Amo OUs-1 and -2, Montrose OU-7, and portion of OU-3, Dual Site Groundwater (See Figure 3-2). Note that Montrose OU-1 and OU-3 – Montrose DNAPL, Del Amo OUs-1 and -2, and Montrose OU-7 address the primary release areas, and include several potential VI sources such as contaminated vadose zone soil, LNAPL and/or DNAPL, and contaminated groundwater. VI impacts associated with OU-3-Dual Site Groundwater outside these primary release areas are limited to the dissolved VOC contamination at the water table. The water table unit serves as a barrier to upward vertical migration of VOC vapors from deeper aquifer units.

3.2 VI Assessment at Del Amo OU-1 – Soil and NAPL

3.2.1 Current Status

The remedial investigation/feasibility study (RI/FS) is complete for OU-1, and a Record of Decision (ROD) was signed in 2011. This OU is currently in the ROD stage, as the Consent Decree has yet to be signed. Thereafter, the remedial design phase of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process will begin. The selected remedy consists of a combination of institutional controls; capping, SVE, and building engineering controls for shallow soil contamination; and in situ chemical oxidation (ISCO) and SVE for deep soil contamination and areas contaminated with LNAPL.

3.2.2 Conceptual Site Model

Del Amo OU-1 includes the VOC and Polycyclic Aromatic Hydrocarbon (PAH) contamination in the shallow vadose zone, VOC contamination in the deep vadose zone, and LNAPL in the deep vadose zone and water table aquifer beneath the former plant site outside the Waste Pits Area (see Figure 3-1). The vapor sources, receptors, and migration for this OU are discussed below.

Vapor Sources. The table below shows the volatile chemicals of concern for the shallow soil, deep soil, and groundwater (USEPA, 2011). The LNAPL beneath the plant site consists primarily of benzene. Benzene is also the most prevalent contaminant in soil and groundwater at the Del Amo site.

Chemicals of Concern (Excerpted from Table 5-1, Del Amo OU-1 ROD, USEPA, 2011)

Chemical Name		Shallow Soil (0-15 feet bgs)	Deep Soil (>15 feet bgs)	Groundwater
VOCs	Benzene	x	x	x
	Ethylbenzene	x	x	x
	Toluene	x	x	x
	Xylene	x	x	x
	Styrene	x	x	x
	TPH (C6-C10)	x	x	x
	Trichloroethene (TCE)	x	--	--
	Tetrachloroethene (PCE)	x	--	--
	1,2,4-trimethylbenzene	x	--	--
	Cyclohexane	x	--	--
	Isopropylbenzene	x	--	--
	Isopropyltoluene	x	--	--

The areas with significant releases of VOCs considered by this OU are shown in Figure 3-3 and are summarized in Table 3-1.

TABLE 3-1

Operable Unit 1 Source Summary

Vapor Intrusion Assessment, Montrose and Del Amo Superfund Sites

Location	Release Area	VOCs	Type of Contamination
Former styrene plancor	Tank farm area	Benzene, toluene, ethylbenzene, styrene, trichloroethylene, tetrachloroethylene, acetone	Sorbed to Soil, Dissolved in Groundwater, LNAPL
	Styrene and ethylbenzene production facilities area	Benzene, toluene, ethylbenzene, and styrene	Sorbed to Soil, Dissolved in Groundwater
Former butadiene plancor	Laboratory area	Benzene, toluene, ethylbenzene, and styrene. Possibly xylenes	Sorbed to Soil, Dissolved in Groundwater, LNAPL
	Benzene pipeline area (middle)	Benzene	Sorbed to Soil, Dissolved in Groundwater, LNAPL

Soil impacts are localized near the release areas shown in Figure 3-3. LNAPL is present in deep soil and at the water table (approximately 30 feet to 60 feet below ground surface [bgs]), and in some locations is trapped in sediments below the water table (i.e., from 60 to 90 feet bgs). Figure 3-4 shows the approximate extent of LNAPL at the Del Amo site. The presence of LNAPL also resulted in a high-concentration dissolved plume in the water table and deeper aquifers. Because benzene is the most prevalent contaminant in groundwater beneath the Del Amo site and is encountered at the highest concentrations, dissolved groundwater contamination beneath the site is referred to as the benzene plume (see Section 3.4). Based on the above, all three types of vapor sources are present beneath the

Del Amo site, including contaminated vadose zone soil, LNAPL at and below the water table, and dissolved VOCs in groundwater.

Vapor Receptors. The former synthetic-rubber plant facilities have been dismantled and the Del Amo site has been redeveloped as a business park with buildings used predominantly for logistics (warehouse/freight), manufacturing, and office purposes. Approximately 68 commercial buildings are located on the Del Amo site, most of which are occupied. Many of these buildings overlie or are near the areas of historical VOC releases, including areas of LNAPL contamination. The nearest residential areas are located near the southern boundary of the Del Amo Site.

Vapor Migration. Soil gas (exterior and subslab) and indoor air data were collected to assess the completeness of the VI pathway (URS, 2007 and 2009). Risk assessment conducted using these data indicated that the VI/indoor air exposure pathway exceeded target risk levels in two buildings (URS, 2010). The OU-1 ROD for the Del Amo site (USEPA, 2011) specified remedial actions consisting of SVE beneath one of the buildings, and building engineering controls for the other building. In addition, soil vapor and/or indoor air monitoring activities will be required at both areas.

Background Concentrations. The indoor air cleanup goal established in the OU-1 ROD is, "...to reduce the indoor air concentrations of target VOC constituents to either the commercial USEPA Regional Screening Level (RSL)/California Human Health Screening Level (CHHSL) criteria for indoor air or background, whichever is higher (accounting for any contributions from other indoor air sources)." The need to account for background concentrations is important, especially for benzene, because the RSL and CHHSL are within or below the range of indoor-air and outdoor-air background concentrations reported in published studies (Battelle et al., 2011).

3.2.3 Historical Vapor Intrusion Assessment

A large number of shallow soil and soil vapor samples were collected at the Del Amo site during RI activities, between 1992 and 2003, as reported by URS in the Final RI Report (URS, 2007). An indoor air study was conducted from 1993 to 1995. The results were published by URS in the Workplace Air Monitoring Program Report (URS, 2001). The indoor air study included collecting indoor and outdoor air samples for USEPA Method TO-14 analysis at 13 buildings in 3 events between 1993 and 1995. Buildings were selected for inclusion in the Workplace Air Monitoring Program based on one or both of the following criteria: (1) the presence of former plant facilities/features that may pose a potential source of elevated VOCs in soils beneath the buildings in locations that cannot be accessed for investigation using perimeter shallow soil vapor surveys, and/or (2) the presence of elevated VOC concentrations in shallow soil vapor in proximity to the building perimeter.

A Baseline Risk Assessment (BRA) was published in 2006 (Geosyntec and URS, 2006). The BRA incorporated shallow soil and soil vapor data, indoor/outdoor air data, and groundwater data to estimate risk for the indoor air pathway. Potential exposures to chemicals detected in surface and shallow soils were evaluated in the BRA for inhalation of VOCs in indoor and outdoor air and fugitive dust. The potential for VOCs to migrate from the subsurface to indoor air was evaluated for deeper vadose zone soils and groundwater. The BRA determined that inhalation risks in outdoor or indoor air include several VOCs, but primarily benzene, PCE, and TCE.

Based on the results of the BRA, subslab samples were collected at five occupied parcels in 2009. The results of the subslab sampling confirmed that a remedy was necessary to address potential VI at two buildings (URS, 2009). The 2011 ROD includes provisions to mitigate potential VI at the two identified buildings and to manage the indoor air pathway for any areas that may be discovered in the future under existing buildings. The ROD selected building engineering controls to address indoor air at Area 16, and SVE beneath the building to address indoor air at Area 23.

3.2.4 Conclusions

VI has been adequately assessed at OU-1 for both existing and future development. The OU-1 ROD (USEPA, 2011) provides mitigation for identified buildings/areas that potentially pose a VI risk. The ROD also provides for assessment of new areas under existing buildings that could be identified in the future.

3.3 VI Assessment at Del Amo OU-2 – Waste Pits

3.3.1 Current Status

The RI/FS is complete for OU-2, and a ROD was signed in 1997. This OU is currently in the remedial action phase of the CERCLA process. The selected remedy consists of a Resource Conservation and Recovery Act (RCRA)-equivalent cap and SVE beneath the waste material. The SVE system utilizes enhanced bioremediation to minimize treatment of contaminated vapors at the surface. The second Five-Year Review of the Waste Pits remedy was completed in 2010 (USEPA, 2010).

3.3.2 Conceptual Site Model

Del Amo OU-2 includes the waste, soil, and soil gas contaminated by hazardous substances within the 4-acre Waste Pits area of the Del Amo site (see Figure 3-1). Aqueous, viscous, and semiviscous waste materials generated during operations at the former Del Amo synthetic rubber plant were deposited in a series of unlined pits at the southern end of the former rubber plant. Use of the Waste Pits ended with the closure of plant operations in 1972, at which point the open pits were covered with soil and surrounded by a chain-link fence. The vapor sources, receptors, and migration for this OU are discussed below.

Vapor Sources. Contaminants released from the Waste Pits operation include VOCs, with benzene being the most prevalent contaminant.

The Waste Pits consist of well-defined areas where historical releases of sludges and other liquid or semi-liquid waste were discharged from the manufacture of synthetic rubber. Benzene is the VOC detected at the highest frequency and concentration in the soil and groundwater beneath the former waste pits. Other petroleum-related VOCs including ethylbenzene and naphthalene also were found in soil and groundwater. LNAPL also could be present in the subsurface in this area based on high benzene and other VOC concentrations detected in groundwater (Figures 3-4 and 3-6). The lateral extent of soil contamination is roughly defined by the perimeter fence surrounding the pit area. A major petroleum pipeline corridor exists immediately south of the Del Amo Waste Pits, which could also contribute petroleum VOCs to soil and groundwater in the area. Groundwater beneath this area has high (up to 250,000 micrograms per liter ($\mu\text{g}/\text{L}$) concentrations of dissolved benzene and other contaminants. Based on the above, all three types of vapor sources are present beneath the Waste Pits, including contaminated vadose zone soil, LNAPL, and dissolved VOCs in groundwater. However, the contaminant concentrations in groundwater decrease significantly outside the southern boundary of the Waste Pits area because of intrinsic biodegradation of the benzene plume (see Section 3.4), and are generally low (i.e., less than 100 $\mu\text{g}/\text{L}$) to nondetect below residential and undeveloped properties south of the Del Amo site.

Vapor Receptors. There are no occupied structures at the Waste Pits area and/or within 30 feet of the benzene contamination at the Waste Pits. Occupied industrial buildings are located north of the Waste Pits, at the Del Amo Site. Occupied residences are located to the south of the Waste Pits. Both the industrial buildings and residences are located within a distance of more than 100 feet from the current perimeter fence surrounding the Waste Pits.

Vapor Migration. As noted above, separation distances between petroleum vapor sources and a structure of 30 feet or less are typically sufficient to reduce petroleum VOC concentrations (such as benzene) in soil vapors below risk-based concentrations. This suggests that the VI pathway is not

of concern for the Waste Pits, given a distance of more than 100 feet to the nearest buildings. Soil gas and indoor air testing conducted in 1995 in residential areas immediately south of the Waste Pits, and follow-up studies further confirmed the lack of significant VI resulting from petroleum VOC contamination in the Waste Pits (see Section 3.3.3). In addition, due to ongoing SVE treatment, only low concentrations of VOCs are detected in the perimeter monitoring wells. This further indicates that contaminated soil vapors are not likely migrating beyond the perimeter of the Waste Pits area (USEPA, 2010). Based on the above, the VI pathway associated with Waste Pits for nearby structures is not considered to be significant.

3.3.3 Historical Vapor Intrusion Assessment

In 1995, the Agency for Toxic Substances and Disease Registry (ATSDR) evaluated USEPA indoor air sampling conducted in 25 houses directly south of the Waste Pits. These houses were in the area of offered buyouts by the responsible parties and were subsequently torn down. The consultation concluded that contaminants were either below the Los Angeles County indoor air reference levels and/or below ATSDR's health comparison levels. It also concluded that the sources of contaminants could not easily be ascertained because the contaminant levels detected in the majority of air samples were comparable to levels detected in properties not impacted by the Montrose and Del Amo Superfund Sites (ATSDR, 1995).

In 2004, a Final Public Health Assessment prepared by the California Department of Health Services (CDHS) also concluded that the soil vapor and indoor samples collected in the nearby residential area do not suggest that an unacceptable VI risk exists (CDHS, 2004). The Final Public Health Assessment provides a summary of soil vapor sampling results collected south of the Del Amo Waste Pits and, based on these results, concludes that VOC vapor contamination is not migrating from the Waste Pits and pipelines that run across the southern border of the site.

These results and conclusions pre-date the installation and operation of remediation systems in 2006, and soil vapor monitoring that began in 2003 and is currently conducted monthly at perimeter wells located within the former 204th Street residential area. The remediation systems include a RCRA cap, gas collection and treatment system associated with the RCRA cap, and soil vapor extraction (SVE)/in situ biodegradation (IBT) remediation system to treat subsurface contamination. Associated with the SVE/IBT system is a network of perimeter vapor monitoring wells designed to detect fugitive vapor-phase contaminants that might be exiting the treatment area. These perimeter wells are monitored regularly. According to the Second 5-Year Review (USEPA, 2010), analytical samples collected in 2003 and 2006 at sentry vapor monitoring wells associated with the SVE/IBT system were well below conservative human health screening levels developed by the state of California for residential areas, which indicates that vapors are not migrating from the Waste Pits area.

3.3.4 Conclusions

Based on information from USEPA and CDHS, VI has been adequately assessed for both the unoccupied onsite area and the offsite residential area to the south. Ongoing source remediation and vapor monitoring is designed to detect any potential future vapor migration toward the offsite areas from the Waste Pits source.

3.4 VI Assessment at Montrose and Del Amo OU-3 – Dual Site Groundwater

3.4.1 Current Status

This OU includes dissolved groundwater contamination from both the Montrose and Del Amo Superfund Sites, as well as the TCE plume that is commingled with the groundwater contamination from the Montrose and Del Amo Superfund Sites. The RI/FS is complete for OU-3. The ROD for this OU was issued

in 1999 (USEPA, 1999). The ROD establishes the rationale for the selection of the cleanup plan and performance criteria for the groundwater remedy, and requires (1) containment of the principal threat (groundwater plumes) within the containment zone using hydraulic extraction and treatment (with aquifer injection), and intrinsic biodegradation (natural attenuation); (2) reduction of concentrations of dissolved contaminants outside the area of containment to cleanup goals; and (3) prevention of human exposure to contaminated groundwater. The containment zone is defined in the ROD as a portion of OU-3 that encompasses the areas of DNAPL and LNAPL occurrence (i.e., source areas) and extends to include a buffer outside those areas (Figure 3-5). This zone is also referred to as a technical impracticability (TI) waiver zone, because groundwater cleanup goals cannot be achieved within this zone due to the presence of LNAPL and DNAPL.

As mentioned above, the cleanup of source areas for the TCE plume, except Jones, is not included in the Montrose and Del Amo Superfund Sites. However, the groundwater remedy for this OU includes both (1) containment of these source areas to prevent further spreading of the TCE plume into the Montrose and Del Amo Superfund Sites, and (2) remediation of the TCE plume, to the extent that it extends into the benzene and chlorobenzene plumes and beyond.

USEPA recently approved the Final remedial design for the construction of a groundwater treatment system for this OU, which should soon be under construction. Once operational, the system will extract up to 700 gallons of water per minute, and inject the treated water back into the aquifer with a goal of containing dissolved contaminants within the containment zone and achieving cleanup standards outside this zone. Construction of the treatment system is expected to be completed in 18 months.

3.4.2 Conceptual Site Model

As discussed above, OU-3 Dual Site groundwater includes dissolved contamination in the groundwater aquifer system (multiple aquifers/aquitards affected) resulting from historical releases at the Montrose and Del Amo Superfund Sites and several nearby sources. The aquifer impacts from these sources are considered jointly because the plumes are partially commingled, making it impractical to consider them separately.

Note that while this OU addresses remedial actions for groundwater contamination at the source areas as well as outside source areas at the Montrose and Del Amo Superfund Sites, the only VI impacts discussed in this section are those attributed to dissolved plumes outside the source areas. Assessment of potential VI impacts at the source areas located at the Montrose and Del Amo Superfund Sites is discussed under Montrose OU-1, Del Amo OUs-1 and -2, and Montrose OU-7.

The vapor sources, receptors, and migration for this OU are discussed below.

Vapor Sources. Table 3-2 summarizes the information pertaining to the vapor sources for OU-3 – Dual Site Groundwater. OU-3 is typically discussed in terms of the benzene, chlorobenzene, and TCE plumes since these are the predominant contaminants present in groundwater and the extents of these plumes encompass the other dissolved VOCs (see Figure 3-5).

The dissolved VOCs in groundwater are present in several groundwater aquifers, including the water table aquifer also referred to as the Upper Bellflower Aquitard [UBA], and deeper units below the water table including the Middle Bellflower C Sand (MBFC), and the Gage aquifer. However, as discussed above, only the VOCs present at the water table are of concern for assessing VI from a groundwater vapor source.

The water table is present at depths of 40 to 60 feet bgs. The unsaturated (i.e., vadose) zone is heterogeneous and consists of interbedded layers of sands and low permeability silts/clays. The water table aquifer is also heterogeneous, and consists of interbedded layers of fine-grained sand, silty sand,

silt, and occasional clayey intervals. Groundwater flow in the water table aquifer is generally north to south and southwest, but deviates in some locations due to local groundwater mounding.

TABLE 3-2

Operable Unit 3 Source Summary*Vapor Intrusion Assessment, Montrose and Del Amo Superfund Sites*

Source of Release	Manufacturing Process	Primary VOCs Released to Groundwater	Type of Contamination
Former Montrose Plant Property	DDT pesticide manufacturing	Chlorobenzene	Dissolved in groundwater
Former Del Amo Plant Property	Synthetic rubber manufacturing	Benzene, Ethylbenzene, Naphthalene	Dissolved in groundwater
Jones	Chemical manufacturing	TCE, PCE, Dichloroethylene (DCE)	Dissolved in groundwater

The lateral extent of VOCs at the water table is substantially smaller than in the deeper aquifers. The highest concentrations of VOCs were detected in proximity to the source areas, beneath the Montrose and Del Amo sites as well as Jones and other upgradient source areas. The most recent data, including 2006 and 2012 groundwater monitoring data, indicate the following:

Benzene Plume. As discussed in Section 3.2, there are multiple benzene source areas at the Del Amo site and surrounding vicinity. Dissolved benzene and other contaminant distributions from these sources are commingled, forming a benzene plume. The most recent benzene distribution based on 2012 monitoring data (URS, 2012) is shown in Figure 3-6. Both historical and recent data indicate that most of the high-concentration benzene plume (above 1,000 µg/L) in the water table aquifer occurs near the source areas beneath the Del Amo site, near the southwestern corner of Jones (well MW-7), and near one source area located outside (south of) the Del Amo site (i.e., abandoned well XP-01). Benzene concentrations diminish to low (below 100 µg/L) to nondetect concentrations in the residential areas south of the Del Amo site boundary. The most recent monitoring results collected in 2012 indicate that the benzene distribution in 2012 is generally consistent with the historical distribution (URS, 2012).

TCE Plume. The high-concentration TCE plume also occurs primarily near source areas, including Jones, EPC, and PACCAR properties as well as the former Boeing facility. Elevated TCE concentrations were also encountered beneath the Del Amo site where the TCE plume is commingled with the benzene plume, and in the area south of Jones where TCE concentrations range from 530 µg/L (near the southern boundary of the Jones property) to 270 µg/L at a distance of about 1,100 feet south of Jones. Low concentrations of TCE (around 10 µg/L) were also detected south of the southeastern corner of the Del Amo site, where a landfill was formerly located. The most recent TCE distribution based on 2012 monitoring results (URS, 2012) is shown in Figure 3-7. These results indicate that the TCE distribution in 2012 is generally consistent with the historical distribution (URS, 2012).

Chlorobenzene Plume. Based on both historical and recent data, most of the chlorobenzene concentrations above in-situ groundwater standards of 70 µg/L in the water table aquifer occur beneath the Montrose plant property. However, monitoring data collected in 2012 indicated an increase in the chlorobenzene concentration for groundwater samples collected from one well located in the residential area (Figure 3-8) southeast of the Montrose plant property (AECOM, 2012c). Specifically, a chlorobenzene concentration of 2,900 µg/L was detected in well SWL0049, which is screened in the water table aquifer and located on 204th Street near the intersection with Kenwood Avenue. This concentration is above the historical range previously detected at this well (8 to 1,900 µg/L). Additional

investigations to further assess the chlorobenzene plume distribution in the water table aquifer in this area will be conducted in November 2012 as requested by USEPA.

In addition, concentrations of chlorobenzene up to 160 µg/L occur west of the Montrose plant property in a commercial and industrial business area, and are reportedly attributed to a 10-inch-diameter sewer line, which was used by Montrose for wastewater discharge prior to 1953.

Tertiary Butyl Alcohol (TBA). The 2012 groundwater monitoring results indicated that TBA is present at concentrations up to 73,000 µg/L beneath the southeastern corner of the Del Amo site (URS, 2012).

Vapor Receptors. Areas located within the footprint of the dissolved groundwater plumes described above include a mix of residential, commercial, and industrial uses, and occupied structures of various types. The residential areas are composed primarily of single-family detached houses with some multi-plex apartment buildings.

Vapor Migration. As discussed above, a distance of 100 feet for chlorinated solvents and 30 feet for petroleum hydrocarbons applied in both vertical and lateral directions is typically considered to be a threshold limit within which VI may require further evaluation (See Section 2, Vapor Migration). Absent preferential pathways, significant VI is unlikely at structures located outside this threshold distance. The following lines of evidence suggest a reduced potential for significant vapor migration from OU-3 groundwater to overlying structures outside source areas:

- As mentioned above, the depth to groundwater at the Montrose and Del Amo sites is about 40 to 60 feet bgs. Petroleum hydrocarbons such as benzene are unlikely to result in significant VI at distances greater than 30 feet, especially above a low-concentration (i.e., less than 100 µg/L) groundwater plume. Less degradable chemicals such as chlorobenzene and TCE will also substantially attenuate over this distance.
- The vadose zone above the water table generally consists of fine-grained materials. Fine-grained soils result in a zone of saturation that can extend several feet above the water table (the “capillary fringe”) and vapor concentrations typically diminish greatly across a thick capillary fringe.
- In addition, shallow groundwater contamination in the water table aquifer does not appear to migrate far from contaminant sources, and therefore only a few areas of elevated concentrations in groundwater outside source areas are located near commercial and residential buildings. Deeper aquifers have over 100 feet of separation distance from the potential VI receptors (i.e., occur at depths greater than 100 feet) and are separated from these receptors by the water table aquifer, which serves as a barrier to upward vertical migration of VOC vapors from deeper aquifers. Based on the above, the VI pathway associated with OU-3 groundwater outside source areas does not appear to be significant, with the potential exception of a few areas discussed below with elevated concentrations of TCE and chlorobenzene beneath the residential land use areas.

Concentrations of chlorobenzene (up to 160 µg/L) encountered west of the Montrose plant property are generally lower than USEPA’s groundwater-to-indoor-air screening level of 410 µg/L for a residential scenario (USEPA Vapor Intrusion Screening Level [VISL] tool, May 2012 RSLs). However, concentrations of chlorobenzene of 2,900 µg/L encountered beneath the residential areas southeast of the Montrose plant property exceed USEPA’s groundwater-to-indoor-air screening level of 410 µg/L. Please note that this screening level is very conservative, because it does not account for potential significant attenuation of chlorobenzene within 40 to 60 feet of the heterogeneous vadose zone separating the water table from the ground surface.

The site-specific attenuation factors for chlorobenzene can also be estimated based on the results of the soil vapor and VI studies performed at the Montrose plant site and adjacent GLJ Holdings property as

part of Montrose OU-1 (On- and Near-Property Soils) (Section 3.6). It should be noted that California EPA offers a similar vapor intrusion screening tool that does allow input for groundwater depth and vadose zone properties (http://www.dtsc.ca.gov/SiteCleanup/Vapor_Intrusion.cfm). Based on site-specific input parameters, and using the same toxicity value for chlorobenzene as that used in the EAP VISL tool, the California EPA tool estimates a groundwater-to-indoor air screening level of about 4,000 µg/L. Because the chlorobenzene concentration of 2,900 µg/L detected beneath the residential area is within the same order of magnitude of this screening level, to be conservative, EPA has requested further evaluation to assess potential VI for nearby residences based on the site-specific conditions and chlorobenzene attenuation factors.

TCE concentrations south of Jones (530 µg/L to 270 µg/L) also exceed USEPA's groundwater-to-indoor-air screening level for TCE of 1.1 µg/L and an estimated California EPA groundwater-to-indoor air screening level for TCE of 15 µg/L. Based on this exceedance and the fact that the separation distance between the elevated TCE concentrations and potential receptors may be less than the 100 feet required for chlorinated solvents, further evaluation of VI impacts from the dissolved TCE contamination is also warranted for this area. Similar to chlorobenzene, the site-specific attenuation factors for TCE should be considered, and can be estimated based on the results of the soil vapor studies performed at the Jones property as part of Montrose OU-7 (Section 3.7).

TBA detected at concentrations up to 73,000 µg/L beneath the southeastern corner of the Del Amo site appears to be below a generic VI screening level of 170,000 µg/L identified by the New Jersey Department of Environmental Protection (NJDEP) Master Table, Generic Vapor Intrusion Screening Levels, (http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_tables.pdf). NJDEP levels are referenced in this document because there are no California SLs for TBA at this time.

3.4.3 Historical Vapor Intrusion Assessment

As mentioned in Section 3.3.3, a health consultation performed by ATSDR in 1995 evaluated USEPA indoor air sampling conducted in 25 houses directly south of the Del Amo Waste Pits, in the area near the high-concentration benzene plume beneath the Waste Pits. These houses were in the area of offered buyouts by the responsible parties and were subsequently torn down. The consultation concluded that contaminants were either below the Los Angeles County indoor air reference levels and/or below ATSDR's health comparison levels. It also concluded that the sources of contaminants could not easily be ascertained because the majority of the levels were comparable to levels in properties not impacted by the Montrose and Del Amo Superfund Sites (ATSDR, 1995).

Also as mentioned in Section 3.3.3, the potential for VI into residential homes from contamination in the water table aquifer has been studied as part of the Final Public Health Assessment performed by CDHS (CDHS, 2004). Specifically, CDHS evaluated indoor air effects for two regions of the neighborhood south of the Del Amo site. The first region with high chlorobenzene and benzene concentrations in the water table is located near the northern end of Kenwood Avenue (western neighborhood). The second region that was evaluated is located in the area of Berendo Street (eastern neighborhood), and is relatively close to the area of elevated benzene concentrations in the water table. In addition, other organic chemicals were detected in the groundwater in this area, including vinyl chloride and naphthalene. According to the CDHS report, in that area there may be other sources (Gardena Landfill No. 4) that are contributing to the groundwater contamination. The CDHS assessment indicated that the cancer risk from the potential VI to the residents living in the western neighborhood is 4 in 10 million, and in the eastern neighborhood is 8 in 100 million. Based on these results, CDHS concluded that estimates of indoor air levels of several VOCs indicate that the groundwater does not pose a public health hazard to residents. The Final Public Health Assessment also stated that USEPA sampled the indoor air of a few

homes along West 204th Street and determined that no health threat exists from the groundwater vapors (CDHS, 2004).

The above conclusions appear to be consistent with the recent analysis of a database incorporating many sites with petroleum VOCs in groundwater³. This recent analysis demonstrates that 5 feet of clean soil is sufficient to attenuate benzene from groundwater plumes with benzene concentrations up to 1,000 µg/L. At least 40 feet of soil overlies the benzene plume at OU-3, suggesting a very low likelihood for significant VI of benzene or other petroleum hydrocarbons.

It is important to note, however, that the VI evaluations conducted to date at OU-3, as discussed above, have been focused primarily on the benzene plume. Evaluation of offsite VI impacts from the chlorobenzene, and TCE plumes has not yet been documented. Evaluation of VI impacts from chlorobenzene, TCE, and other VOCs at the GLJ Holdings and Jones Chemical properties are described in Sections 3.6 and 3.7.

3.4.4 Conclusions

Historical investigations performed by CDHS and ATSDR indicated no apparent increased VI risk to residents of homes south of the Del Amo Site and directly south of the Waste Pits Area. Based on these results, relatively low benzene concentrations near residential areas, and sufficient (over 30 feet) separation between sources and receptors, the benzene plume does not appear to pose an apparent increased VI risk to residential areas. An evaluation of potential VI impacts from the elevated TCE and chlorobenzene concentrations in groundwater in the areas discussed in Section 3.4.2 (vapor migration) is warranted. However, as further discussed below, indoor air sampling was conducted at the GLJ Holdings property located adjacent to the Montrose plant property in 2011. Based on multiple lines of evidence and pending the results of a comprehensive HHRA, vapor intrusion of soil gas contaminants does not appear to result in impacts to indoor air quality in excess of USEPA's acceptable health risk range (AECOM, 2012b). Indoor air sampling was also conducted at the Jones Chemical property in 2011 and 2012 (Arcadis, 2012). USEPA has requested additional indoor air sampling at the Jones property, but to date, none of the TCE concentrations in indoor air exceeded USEPA or California EPA indoor air screening levels. Attenuation factors from the above evaluations can be used to estimate the VI potential from groundwater in the residential neighborhood southeast of the Montrose plant property.

3.5 VI Assessment at Montrose OU-3 – DNAPL

3.5.1 Current Status

Montrose DNAPL. Montrose conducted DNAPL-related studies and developed several versions of the DNAPL FS, which evaluated remedial alternatives for DNAPL removal. The latest version of the revised Draft DNAPL FS submitted to USEPA is dated December 7, 2011. All active remedial alternatives considered in this document include SVE and institutional controls to prevent human exposure to DNAPL constituents (via ingestion, inhalation, or dermal contact) that would pose an unacceptable health risk. The National Remedy Review Board for this OU is scheduled for mid-November of 2012.

3.5.2 Conceptual Site Model

This OU addresses DNAPL at the Montrose Superfund Site. DNAPL was released primarily in the Central Process Area (CPA) at the former Montrose plant property (Figure 3-9). Based on recent and historic investigations, the area directly beneath the CPA has the most DNAPL in both the unsaturated zone and the saturated UBA. DNAPL has been definitively detected from a minimum of 7 feet bgs in the unsaturated zone to a maximum of 101.5 feet bgs in the saturated UBA. While DNAPL was not directly observed in the MBFC, its likely presence in this hydrostratigraphic unit could be inferred based on the

³ <https://iavi.rti.org/WorkshopsAndConferences.cfm?PageID=documentDetails&AttachID=547>

multiple lines of evidence. The amount of DNAPL in the BFS, however, is likely to be significantly less than that in the UBA. DNAPL occurs over an area of 160,000 square feet within the saturated zone, and over an area of 79,000 square feet within the unsaturated zone (AECOM, 2011). The area impacted by DNAPL is shown on Figure 3-10. The DNAPL is composed of approximately 50 percent chlorobenzene by weight (a VOC) and 50 percent DDT by weight (a non-volatile pesticide). Less than 1 percent of DNAPL by weight is composed of other VOCs, including methyl ethyl ketone, chloroform, 1,4-dichlorobenzene, and pCBA (AECOM, 2011).

Vapor Sources. Based on the DNAPL composition, chlorobenzene is the primary vapor source associated with the DNAPL. The vapor sources, however, also include to a lesser degree other VOCs present in the DNAPL and listed above.

Vapor Receptors. There are no occupied structures on the Montrose plant property, and there is no residential area in the immediate vicinity of this site. The buildings and facilities associated with historical DDT production were demolished years ago, and the contaminated portions of the property have been paved to prevent transport of DDT-contaminated soil as dust. There are three occupied commercial warehouse buildings (GLJ Holdings Property) immediately north of the property line and the former CPA.

Vapor Migration. As further discussed in Section 3.6 (Montrose OU-1 - On- and Near-Property Soils), soil vapor concentrations in excess of industrial screening levels were detected in the shallow subsurface along the northern Montrose plant property boundary and at the GLJ Holdings property located north of the plant property (AECOM, 2012a). The soil vapor samples suggested that VOCs in soil vapor exceeding conservative risk-based screening levels extended beneath the commercial structures adjacent to the northern boundary of the Montrose plant property. Subsequently, at the request of USEPA, indoor air sampling investigations were conducted as part of Montrose OU-1 to evaluate the VI pathway (AECOM, 2012b).

3.5.3 Historical Vapor Intrusion Assessment

The VI assessment for this OU is included as part of Montrose OU-1 (On- and Near-Property Soils) discussion (Section 3.6). While Montrose OU-1 is focused on the contamination of shallow soils, DNAPL and highly contaminated groundwater also occur within the footprint of this OU, and the VI impacts in this source area potentially can be attributed to all three types of vapor sources, including soil, DNAPL, and groundwater.

3.5.4 Conclusions

Conclusions pertaining to this OU are discussed in Section 3.6.4 below, as part of the Montrose OU-1 (On- and Near-Property Soils) discussion.

3.6 VI Assessment at Montrose OU-1 – On- and Near-Property Soils

3.6.1 Current Status

For Montrose OU-1, a human health risk assessment (HHRA) and FS are currently being prepared. Onsite soil vapor sampling was performed at the Montrose property. Indoor air sampling was conducted at the GLJ Holdings property located adjacent to the Montrose plant property in 2011. Based on multiple lines of evidence and pending the results of a comprehensive HHRA, vapor intrusion of soil gas contaminants does not appear to result in impacts to indoor air quality in excess of USEPA's acceptable health risk range (AECOM, 2012b).

3.6.2 Conceptual Site Model

Montrose OU-1 includes contamination in shallow soils and soil vapors that are present as a result of past activities at the Montrose plant (USEPA, 2010). The boundaries of OU-1 include the Montrose plant

property, as well as neighboring industrial properties located immediately to the north, east, and south. The soil vapor and VI assessments, conducted as part of OU1 work activities, entail relatively shallow measurements (less than 35 ft bgs) that record soil vapor concentrations resulting from shallow sources as well as deeper sources, including DNAPL and groundwater. The VI impacts from DNAPL, which occur in the subsurface primarily within the footprint of the Montrose plant property, have also been recorded by assessments performed for this OU. This is because VI impacts in the source areas potentially can be attributed to all three types of vapor sources, including contaminated vadose zone soil, DNAPL, and dissolved VOCs in groundwater. It is not possible to differentiate between these different sources of vapors. The vapor sources, receptors, and migration for this OU are discussed below.

Vapor Sources. As mentioned above, chlorobenzene is the predominant VOC released to soil and groundwater at the Montrose plant property both in terms of extent and concentration (USEPA, 2010). Chlorobenzene was released primarily in the CPA (Figure 3-9) through facility operations, and discharges to the water recycling pond. The highest concentrations of chlorobenzene in soil (up to 16,000 milligrams per kilogram [mg/kg]) were detected between 10 and 60 feet bgs. Chlorobenzene is also present in groundwater both in the dissolved phase and as DNAPL (Figures 3-8 and 3-10). DNAPL and residual soil contamination in the vadoze zone, as well as high chlorobenzene concentrations in the water table aquifer caused by the presence of DNAPL, constitute a primary subsurface vapor source. Several other VOCs including benzene, TCE, PCE, chloroform, and 1,4-dichlorobenzene were also detected on the Montrose plant property, but at lower concentrations and frequencies than chlorobenzene. These other VOCs constitute a secondary subsurface vapor source. Releases of PCE and TCE identified on and south of the Jones property are addressed in Section 3.7, Montrose OU-7 (Jones).

Vapor Receptors. There are no occupied structures on the Montrose plant property, and there is no residential area in the immediate vicinity (i.e., within several hundred feet radii) of this site. The buildings and facilities associated with historical DDT production were demolished years ago, and the contaminated portions of the property have been paved to prevent transport of DDT-contaminated soil as dust. Three occupied commercial warehouse buildings (GLJ Holdings Inc. Property) are located immediately north of the Montrose northern property boundary.

Vapor Migration. As further discussed below, soil vapor concentrations in excess of industrial screening levels were detected in the shallow subsurface along the northern Montrose plant property boundary and at the GLJ Holdings property located north of the plant property (AECOM, 2012a). The soil vapor samples suggested that VOCs in soil vapor exceeding conservative risk-based screening levels extended beneath the commercial structures adjacent to the northern boundary of the Montrose plant property. Subsequently, at the request of USEPA, indoor air sampling investigations was conducted for this OU to evaluate whether the VI pathway is complete and significant (AECOM, 2012b).

3.6.3 Historical Vapor Intrusion Assessment

Montrose conducted an onsite soil vapor survey between September 29 and October 20, 2003 (Earth Tech, 2004). The soil vapor investigation included a total of 86 samples from 34 locations, from depths of 5 to 35 feet bgs, throughout the Montrose plant property. Samples were analyzed by a mobile laboratory using USEPA Method 8260B. A total of 18 VOCs were detected. The most frequently detected VOCs were chlorobenzene, chloroform, and PCE. A comparison of these results against conservative risk-based screening levels (either California Human Health Screening Levels [CHHSLs] or RSLs, at a 10^{-6} target cancer risk or target noncancer hazard quotient of 1) indicated that the maximum concentrations of chlorobenzene, chloroform, and PCE at 5 feet bgs exceeded their respective screening levels.

In 2010, a shallow soil vapor survey was conducted along the northern Montrose property boundary and surrounding three existing commercial warehouse buildings offsite to the north of the Montrose plant

property to assess potential VI (AECOM, 2012a). A total of 142 samples were collected from 21 locations. Samples were collected from depths of 5 and 15 feet bgs and analyzed using a mobile laboratory by USEPA Method 8260B. A total of 18 VOCs were detected. Four VOCs (chloroform, PCE, carbon tetrachloride, and TCE) were detected at concentrations exceeding their screening levels (either CHHSLs or RSLs, at a 10^{-6} target risk) at 5 feet bgs. Chloroform and PCE were detected in all samples, with a majority of detections above screening levels. Note that chlorobenzene was not detected in soil vapors at this location at concentrations exceeding the screening level, although concentrations of dissolved chlorobenzene in the water table aquifer at the Montrose plant site are as high as 200,000 µg/L to 300,000 µg/L, and chlorobenzene DNAPL is also present in the subsurface.

Because soil vapor concentrations exceeding industrial soil gas screening levels were detected in the shallow subsurface at the GLJ Holdings property and along the northern Montrose plant property boundary, USEPA requested that Montrose conduct an indoor air sampling investigation to evaluate whether the VI pathway is complete and significant. In December 2010, Montrose conducted building evaluations (AECOM, 2010b), and followed up in 2011 with air sampling at the three warehouse buildings (AECOM, 2012b). Indoor air samples were collected in January and August 2011 over an 8-hour period, and analyzed using TO-15 selective ion monitoring (SIM). Results of the indoor air sampling were compared with CHHSLs, RSLs, and ATSDR Minimum Risk Levels (MRLs) (AECOM, 2012b). A review of available data (validated) suggests there are no impacts to indoor air quality in excess of USEPA's acceptable health risk range. The final assessment will depend on the results of a comprehensive HHRA, which is currently being prepared. The HHRA will include analysis of multiple constituents and calculations of actual risk values; and will address multiple exposure pathways, including VI.

3.6.4 Conclusions

Onsite soil vapor sampling was performed at the Montrose property. Soil vapor and VI have also been assessed at the adjacent commercial warehouse buildings located at GLJ Holdings Inc. Property. Shallow soil vapor samples suggested that VOCs in soil vapor exceeding conservative risk-based screening levels extended beneath the commercial structures adjacent to the northern boundary of the Montrose plant property. These elevated soil vapor sample results prompted USEPA to recommend an indoor air evaluation in three GLJ Holdings Inc. commercial warehouse buildings.

Subsequent indoor and outdoor air samples were collected in two events in 2011, and a final report was submitted to EPA in October 2012. Pending the results of the HHRA, the available data suggest that there are no impacts to indoor air quality in excess of USEPA's acceptable health risk range. USEPA plans to review the indoor air sampling results together with the HHRA to evaluate if further assessment is needed at that time.

3.7 VI Assessment at Montrose OU-7 – Jones Chemical

3.7.1 Current Status

This OU is in the RI stage of the Superfund process. The data are currently being collected to determine the extent of the contamination related to previous activities at Jones.

3.7.2 Conceptual Site Model

The primary releases on the Jones property are associated with the dry well main yard sump, former PCE storage tank/neutralization tank areas, former drum storage areas, and other unidentified processes or incidental releases. The vapor sources, receptors, and migration for this OU are discussed below.

Vapor Sources. Based on data presented in the Montrose RI Report, concentrations of PCE in soil as high as 6,700 mg/kg were detected at Jones (USEPA, 1998). Historical and recent soil and soil gas investigations have identified PCE and other VOCs at this site. Recent soil gas data collected during the

RI at the Jones property in 2010 and 2011 (Arcadis, 2012a) identified twelve VOCs at concentrations above applicable screening criteria, including PCE, TCE, 1,1,2-trichloroethane (1,1,2-TCA), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,4-dichlorobenzene, benzene, chlorobenzene, chloroform, ethylbenzene, vinyl chloride and carbon tetrachloride. PCE appears to be the most prevalent contaminant in soil-gas, with the highest concentrations detected within the vadose zone, at a depth of 35 ft bgs (See Figure 3-11). Dissolved VOCs also are present in groundwater beneath Jones, and appear to have migrated offsite. As discussed in Section 3.4 (OU-3 - Groundwater), elevated TCE concentrations detected south of Jones range from 530 µg/L (near the southern boundary of the Jones property) to 270 µg/L at a distance of about 1,100 feet south of Jones. Based on the above, vapor sources beneath Jones include contaminated vadose zone soil and dissolved VOCs in groundwater.

Vapor Receptors. There are several existing occupied buildings on the Jones property. The main offices and warehouse are located on the western side of the property. Manufacturing, distribution, and repackaging of chemicals occur on the southern end of the property near the railroad spur. The valve reconditioning shop and storage areas are located on the north end of the property. The areas to the west and east of Jones are zoned for industrial use, and are currently occupied by oil refineries and manufacturing facilities. The area south of Jones is zoned for a mixture of industrial, commercial, and residential uses. The nearest residences are located within a distance of several hundred feet from the Jones property.

Vapor Migration. Two rounds of indoor air sampling conducted by Jones in 2011 within buildings on the Jones property indicated that VOCs (benzene, carbon tetrachloride, chloroform and PCE) are present in indoor air samples at concentrations exceeding screening criteria (Arcadis, 2012b). Additional indoor air sampling is planned to confirm the initial indoor air sampling results. Soil gas sampling is also planned to be conducted at offsite areas adjacent to the Jones property to further define the extent of soil gas and evaluate the vapor migration pathways.

Background Concentrations. The indoor air sampling conducted at Jones in 2011 included collection of outdoor air samples to address the potential presence of outdoor background VOC sources. Of the four VOCs detected in indoor air samples above screening level criteria, two (benzene and carbon tetrachloride) were detected in background samples at similar concentrations as in indoor air samples, suggesting potential outdoor VOC sources for these chemicals. However, two of the VOCs (PCE and chloroform) were detected in indoor air at concentrations higher than background concentrations.

3.7.3 Historical Vapor Intrusion Assessment

Soil gas and soil sampling activities were performed between November 1994 and December 1995 as part of a Preliminary Endangerment Assessment (PEA) required under Consent Agreement and Order, Docket Number HWCA 88/89-009 dated October 1989. Jones RI activities performed in 2010 and 2011 include soil, soil-gas and indoor air sampling activities.

The 1995 PEA survey activities included 73 soil gas survey locations and 77 shallow soil boring locations focused on several study areas within Jones, including the evaporative cooling tower; elementary neutralization system (ENS) tanks; sodium hydroxide tanks; all railroad tracks within the boundaries of Jones; the acid container fill area sump; in, around, and underneath the containment channel; and in the containment channel itself. Results of the soil gas survey detected the presence of high levels of PCE and other VOCs, in the immediate vicinity of site features including the dry well, main yard sump, former PCE storage tank/neutralization tank areas, and southwest corner of the site.

A human health screening evaluation was performed to determine whether current or past chemical releases at Jones pose a potential risk to human health. Based on this evaluation, it was determined that

estimated risks exceeded target regulatory levels. However, this evaluation assumed that the potential future land use is residential. This overestimates actual risk, since the site use is currently industrial.

The RI activities completed at the Jones property in 2011 and 2012 included soil gas sampling (at 5, 15, and 35 feet bgs) at 44 locations across the property, deep soil and groundwater sampling at 6 locations, and two rounds of indoor air sampling at site buildings. Additional investigations are planned to include off-site soil-gas, groundwater and indoor air sampling to further assess potential VI migration from sources located at the Jones Property.

3.7.4 Conclusions

Historical and recent (i.e., 2010 and 2011) investigation results indicated that vapor sources beneath Jones include contaminated vadose zone soil and dissolved VOCs in groundwater. A human health screening evaluation performed as part of a 1995 PEA indicated that estimated VI risks at the Jones property exceeded target regulatory levels for residential land use. However, the Jones property currently has industrial land use. Recently, indoor air sampling conducted in 2011 within commercial buildings on the Jones property indicated that VOCs are present in indoor air samples at concentrations exceeding industrial screening criteria. Future investigations are planned to further assess the indoor air concentrations in the buildings located at the Jones property, and off-site soil gas concentrations. Please note that the soil-gas and indoor air sample data collected in 2010 and 2011 and discussed above are currently undergoing EPA review and validation.

4. References

General

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Montrose OU-1 – On- and Near-Property Soils

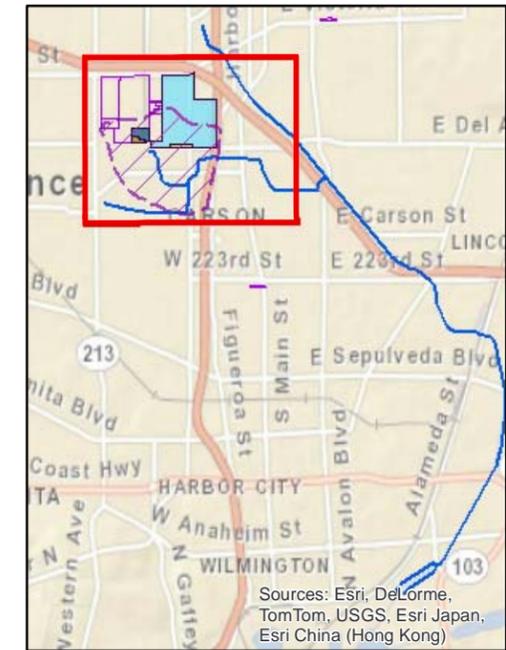
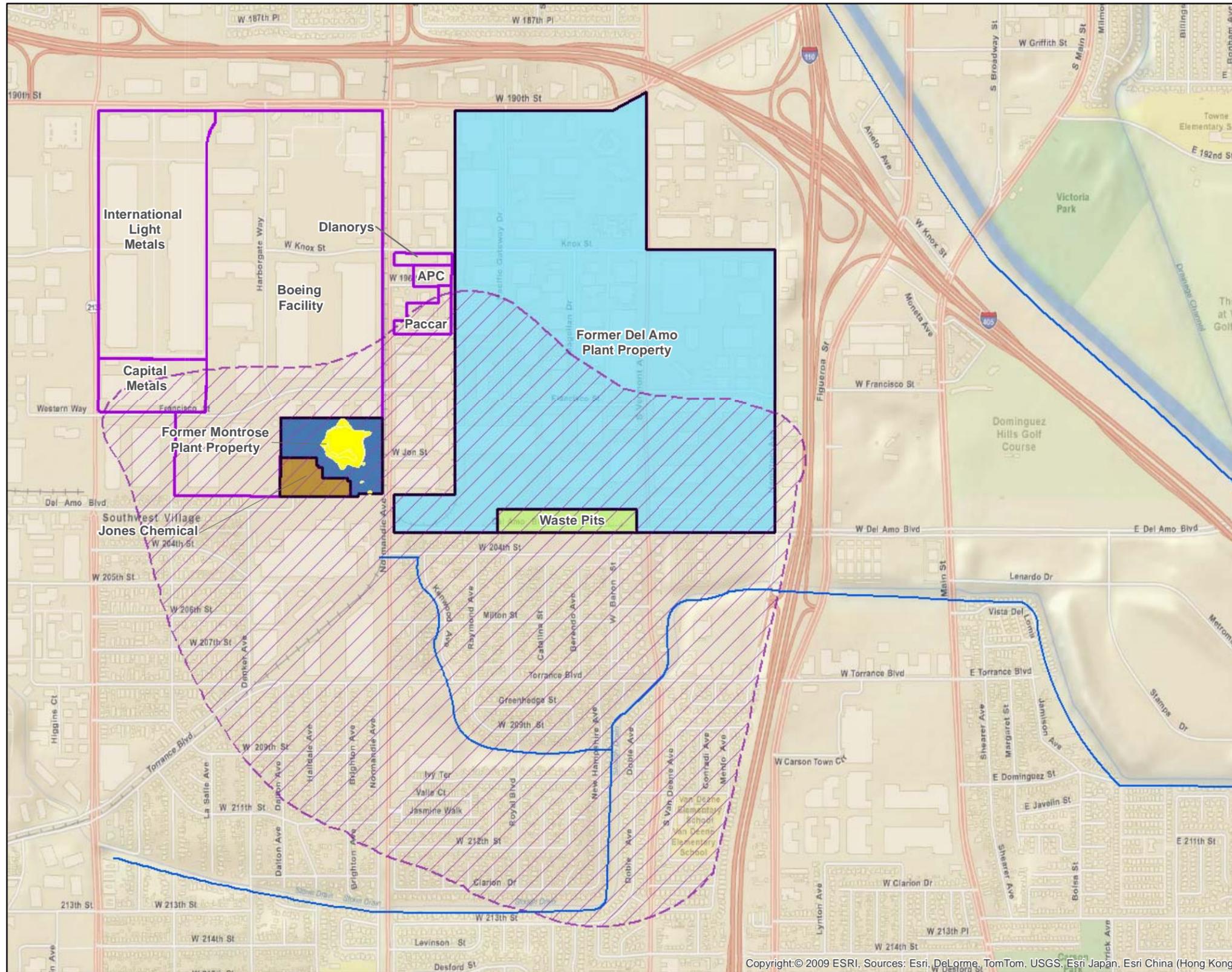
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Montrose OU-7 – Jones Chemical

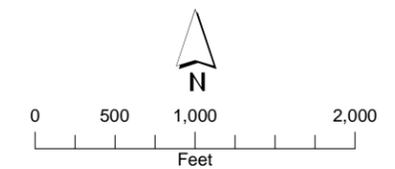
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Figures



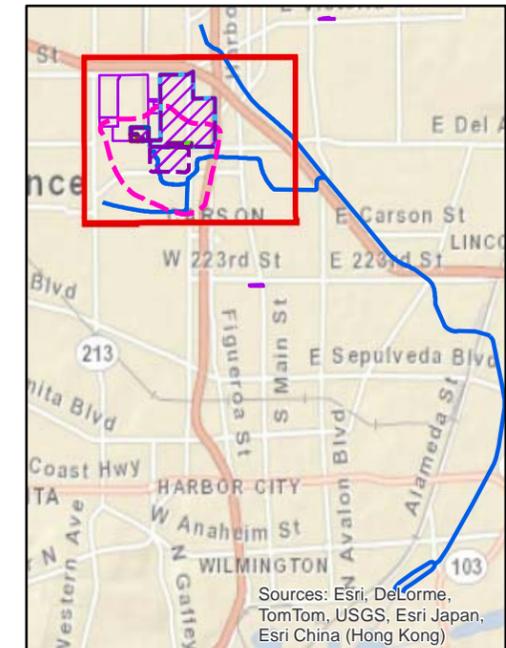
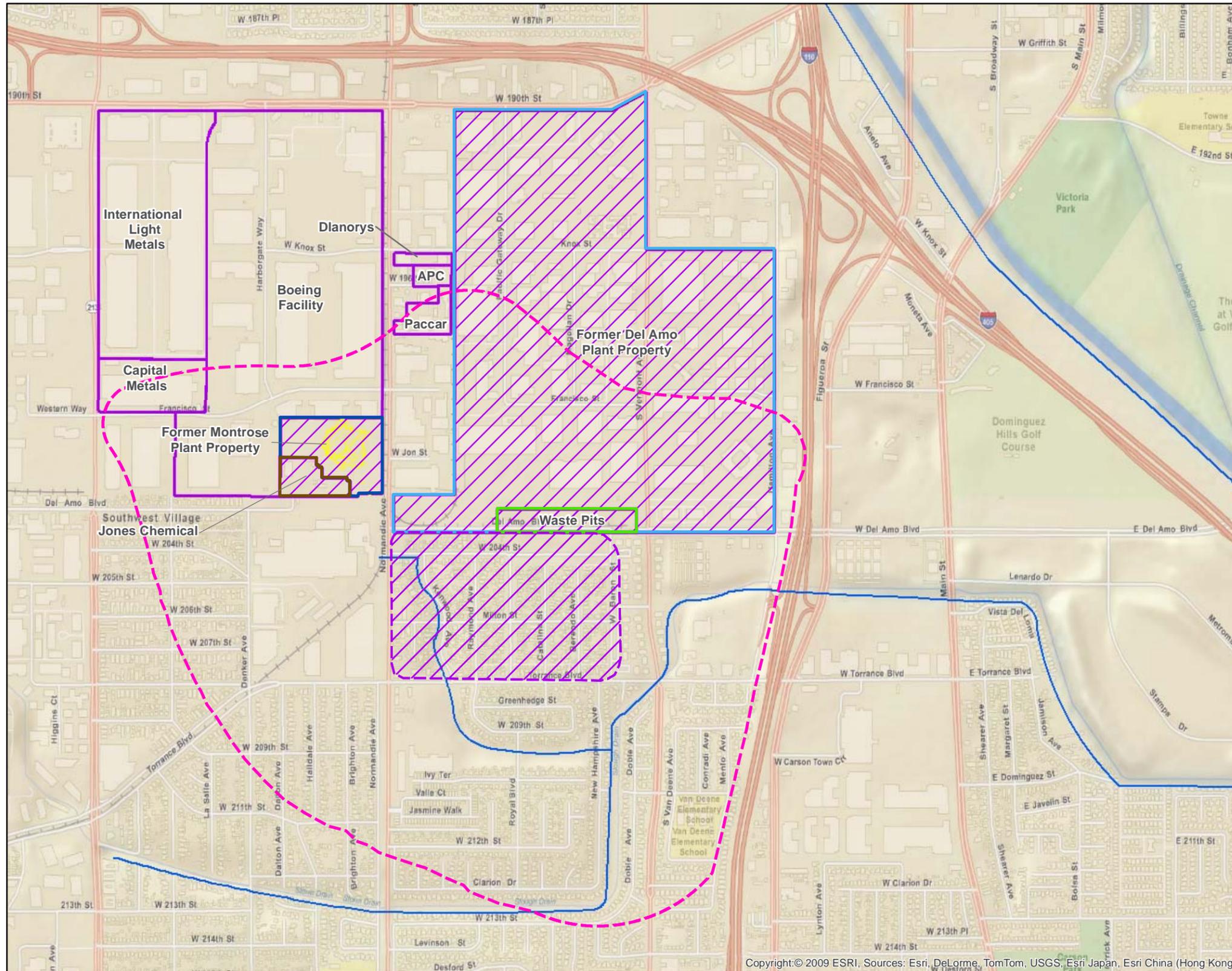
- Legend**
- Del Amo OU-1 (Soil and NAPL)
 - Del Amo OU-2 (Waste Pits)
 - Montrose OU-1 (On- and Near-Property Soils)
 - Montrose OU-7 (Jones Chemical)
 - Montrose OU-3 (Montrose DNAPL)
 - Montrose/Del Amo OU-3 (Dual Site Groundwater)
 - Approximate extent of Montrose/Del Amo Dual Site Groundwater (OU-3) Based on Groundwater Plumes and Well Field Configuration
 - Areas of TCE Sources
 - Drains

Note:
OU = Operable Unit



Copyright:© 2009 ESRI, Sources: Esri, DeLorme, TomTom, USGS, Esri Japan, Esri China (Hong Kong)

FIGURE 3-1
Montrose and Del Amo Superfund Sites Operable Units
Current Status of Vapor Intrusion Assessment,
Montrose and Del Amo Superfund Sites, Torrance, California



- Legend**
- Del Amo OU-1 (Soil and NAPL)
 - Del Amo OU-2 (Waste Pits)
 - Montrose OU-1 (On- and Near-Property Soils)
 - Montrose OU-3 (Montrose DNAPL)
 - Montrose/Del Amo OU-3 (Dual Site Groundwater)
Approximate extent of Montrose/Del Amo Dual Site Groundwater (OU-3) Based on Groundwater Plumes and Well Field Configuration
 - Montrose OU-7 (Jones Chemical)
 - Areas of TCE Source
 - Area Previously Assessed for Potential Vapor Intrusion
 - Drains
- Note:**
OU = Operable Unit

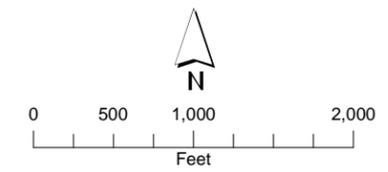
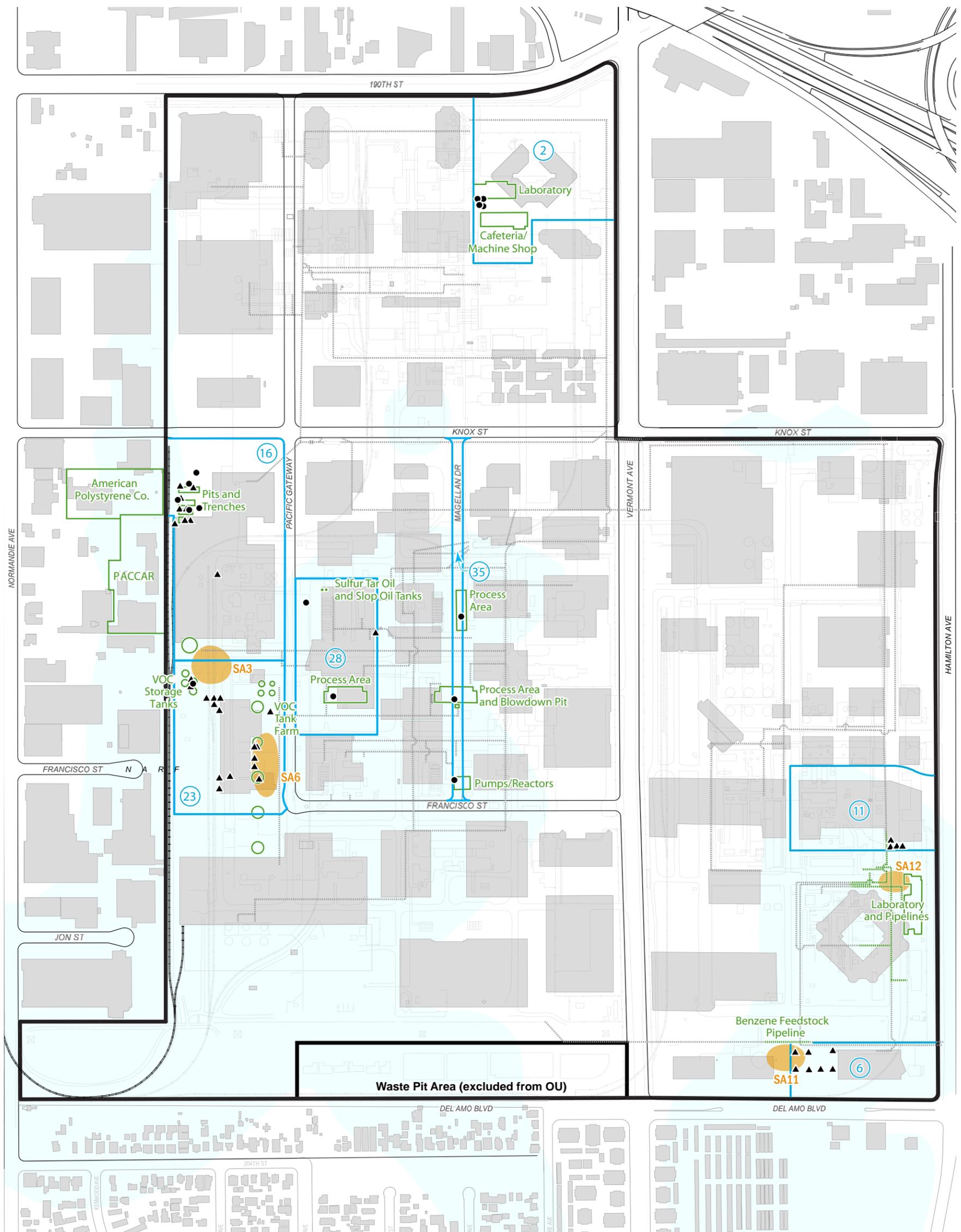


FIGURE 3-2
Areas of Previous Vapor Intrusion Assessment
Current Status of Vapor Intrusion Assessment,
Montrose and Del Amo Superfund Sites, Torrance, California



Legend

- Soil sampling location driving remedial action
- ▲ Soil gas sampling location driving remedial action
- SA11 ● Assumed LNAPL source area
- Historical rubber plant facilities
- Rubber plant facilities and offsite properties that may be associated with significant release
- Current building
- Dissolved water table benzene plume (exceeds 1 µg/l)
- ② Property with significant shallow soil release

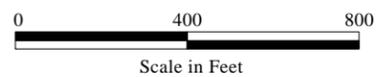
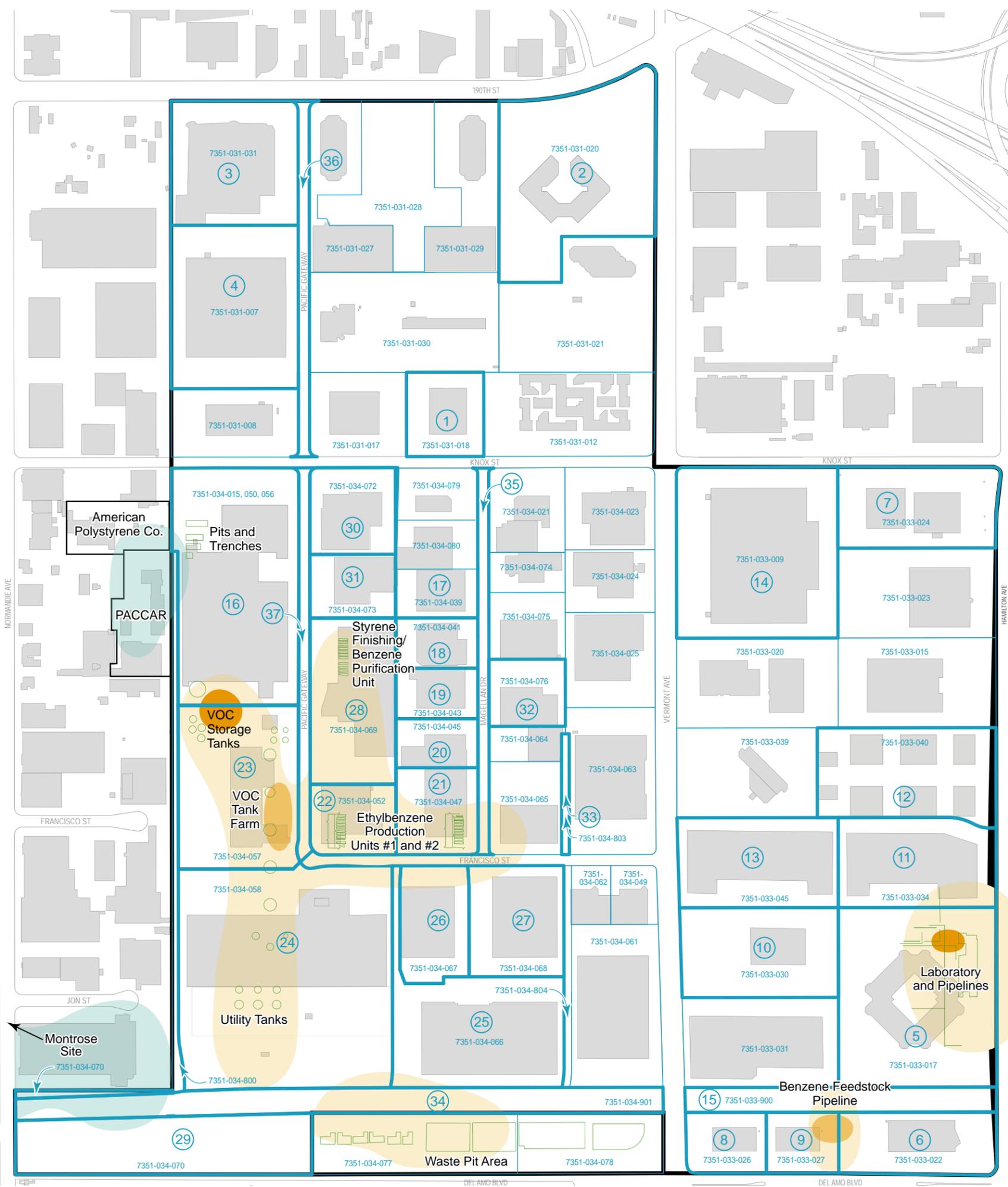


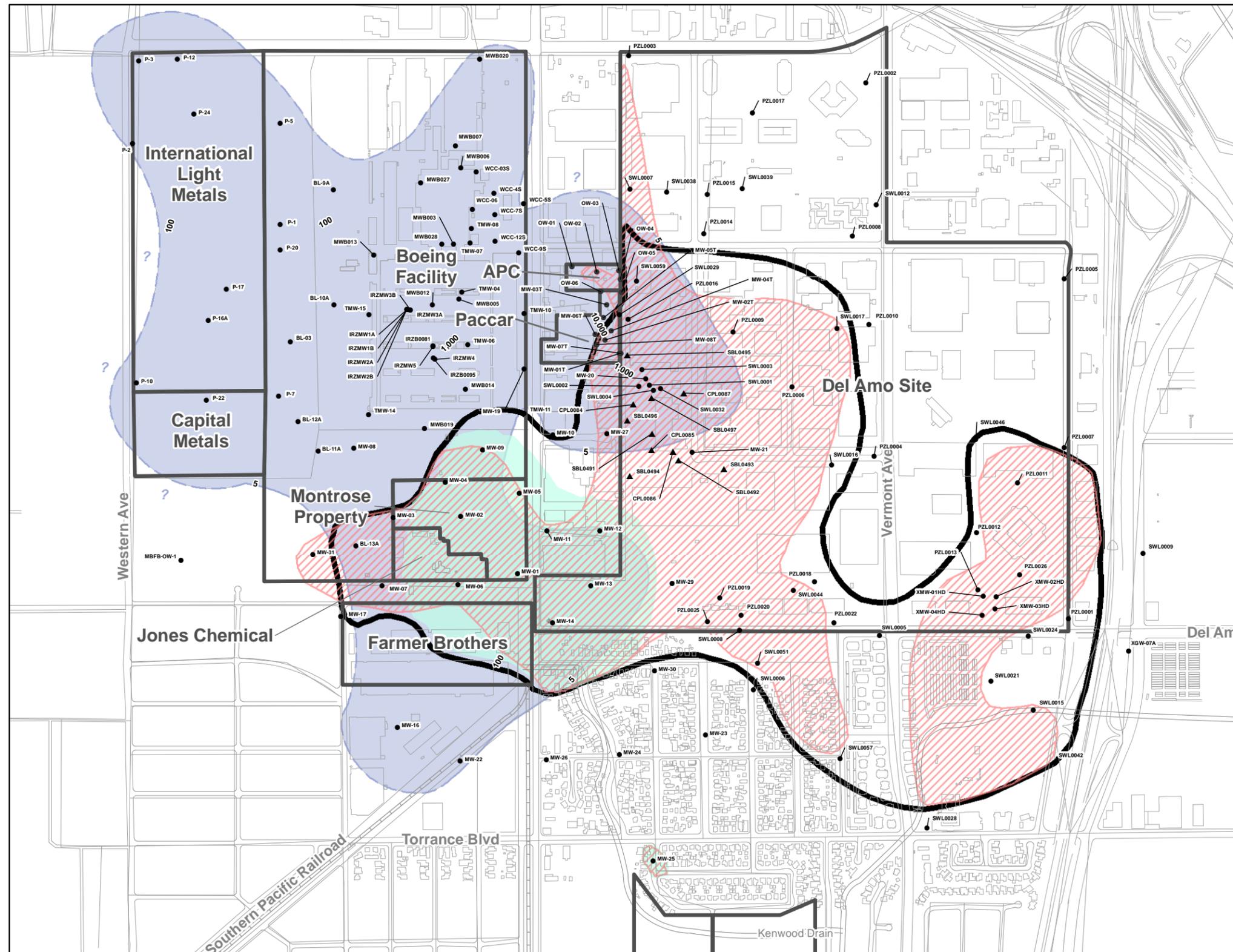
FIGURE 3-3
 Del Amo Significant Release Areas
 Current Status of Vapor Intrusion Assessment,
 Montrose and Del Amo Superfund Sites, Torrance, California



Legend

- Area where DNAPL is potentially present based on dissolved concentrations of TCE and/or PCE concentrations in excess of 1% of their respective solubilities within the water table zone
- Area where LNAPL has not been observed, but could potentially be present based on dissolved concentrations of benzene and/or ethylbenzene in excess of 5% of their respective solubilities within the water table zone
- Area where LNAPL has been observed at residual saturations, but has not accumulated within a water table monitoring well or temporary well point
- Area where visible LNAPL accumulations occur within one or more water table monitoring wells or temporary well points
- Historical rubber plant VOC facilities that may be associated with NAPL
- 29 Exposure area of potential concern with exposure area number
- 7351-034-070 Assessor parcel number

FIGURE 3-4
 Del Amo Potential and Known NAPL Areas
 Current Status of Vapor Intrusion Assessment,
 Montrose and Del Amo Superfund Sites, Torrance, California



- Legend**
- TI Waiver Zone
 - MW-10 Monitoring Well
 - ▲ Temporary Sampling Location
 - Schematic TCE Plume (above 5 µg/L)
 - ▨ Schematic Benzene Plume (above 1 µg/L)
 - Schematic Chlorobenzene Plume (above 70 µg/L)

Note:
* - Wells installed for pilot testing.

Prepared by CH2M Hill, April 2007

FIGURE 3-5
Groundwater Plumes within OU-3 Groundwater, Water Table Aquifer
*Current Status of Vapor Intrusion Assessment,
Montrose and Del Amo Superfund Sites, Torrance, California*

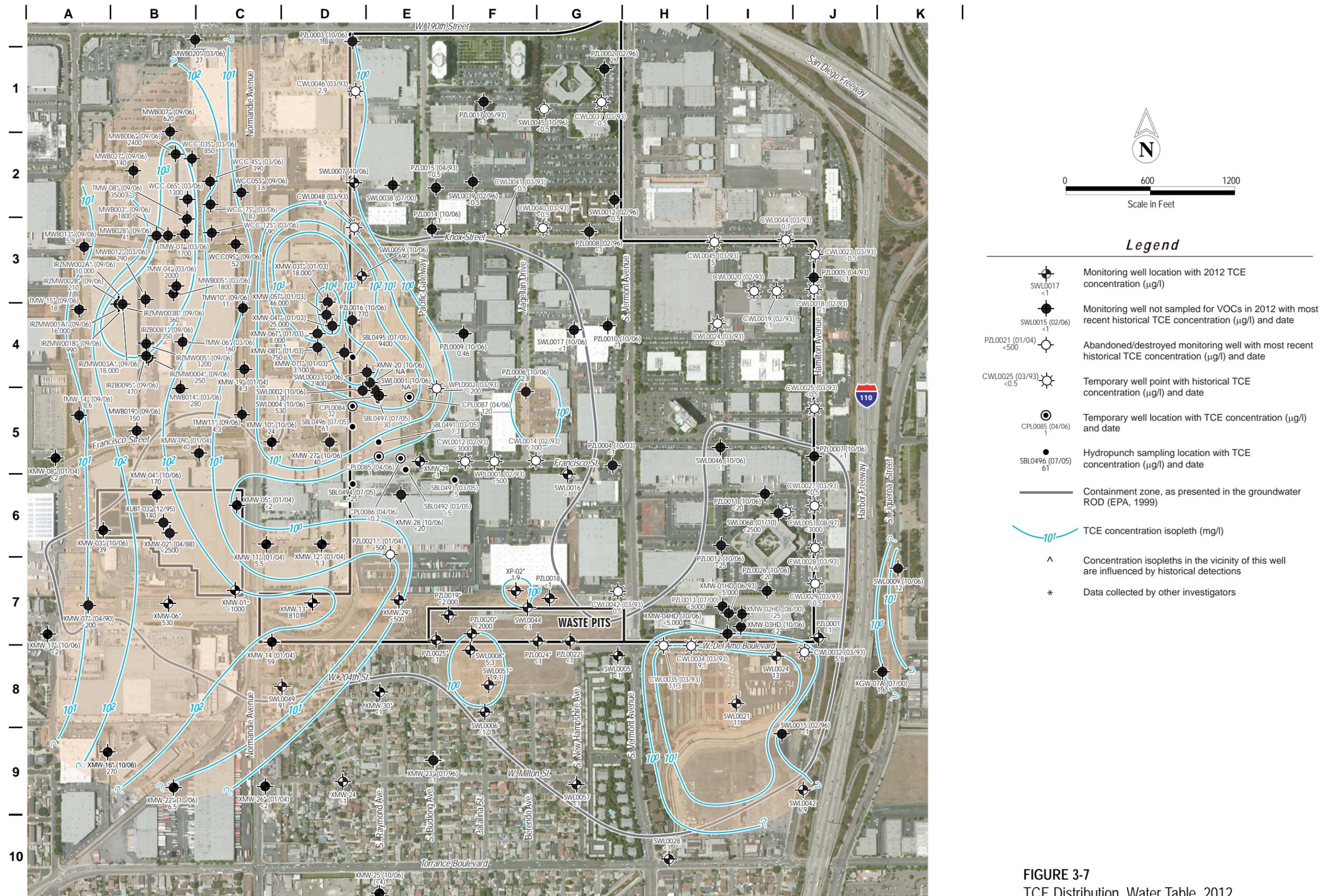
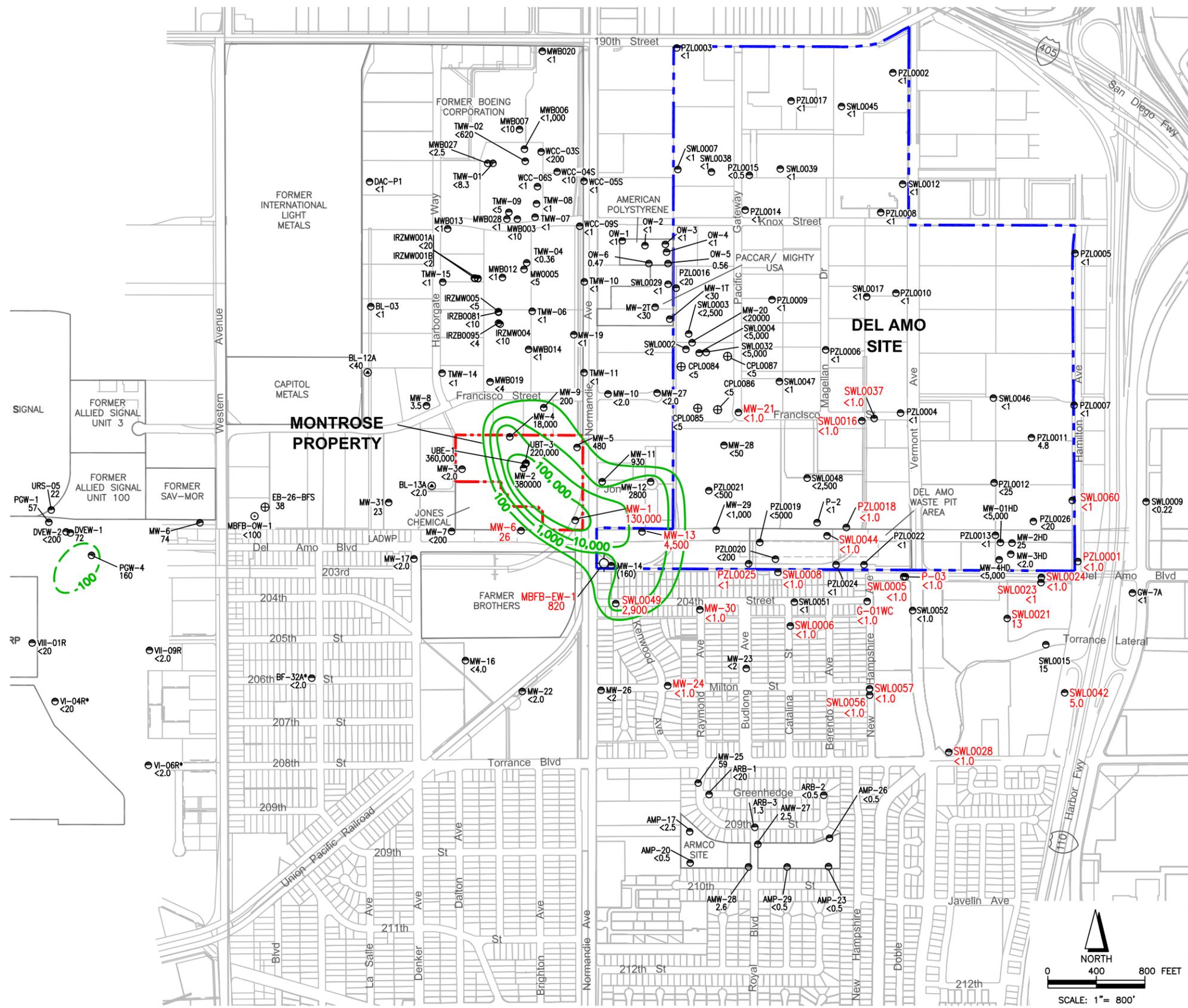


FIGURE 3-7
TCE Distribution, Water Table, 2012
Current Status of Vapor Intrusion Assessment,
Montrose and Del Amo Superfund Sites, Torrance, California

SOURCE: URS, 2012. Groundwater Monitoring Report, Dual Site Operable Unit, Figure 9. Original figure prepared by URS Corporation.
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Legend:

- Location of Montrose Property Boundary
- Location of Del Amo Superfund Site Boundary

Well Legend:

- SWL0012 Upper Belflower Aquitard (UBA) Groundwater Monitoring Well Location
 - ⊙ BL-12A Cluster Well
 - ⊕ EB-26-BFS Exploratory Boring and Temporary Upper Belflower Aquitard Observation Well
 - ⊖ MBFB-EW-1 Middle Belflower 'B' Extraction Well
 - MBFB-OW-1 Middle Belflower 'B' Observation Well
 - <1 Less than; Numerical value is the limit of detection for this analysis.
 - Well screened from the water table zone into the Middle Belflower 'C' sand.
 - MW-1 130,000 MCB concentration in micrograms per liter, Sampled December 2011 – March 2012
 - 0.1 MCB concentration in micrograms per liter, Sample Prior to 2012
 - MCB Monochlorobenzene
 - 100 Contour line of equal concentration of MCB in micrograms per liter dashed where approximate, dashed where inferred
- Well Identifier Notes:
- MW = Montrose Monitor Wells
 - G, GW, SWL, PZL, GW, P, = Del Amo Monitor Wells
 - MW-2T, MW-xHD OW = American Polystyrene Monitor Wells
 - AMW, AMP, ARB = Armco Monitor Wells
 - DAC, TMW, WCC, MWB = Boeing Monitor Wells
 - BL = International Light Metals Monitor Wells
 - IRZB, IRZMW = Boeing Bioremediation Wells

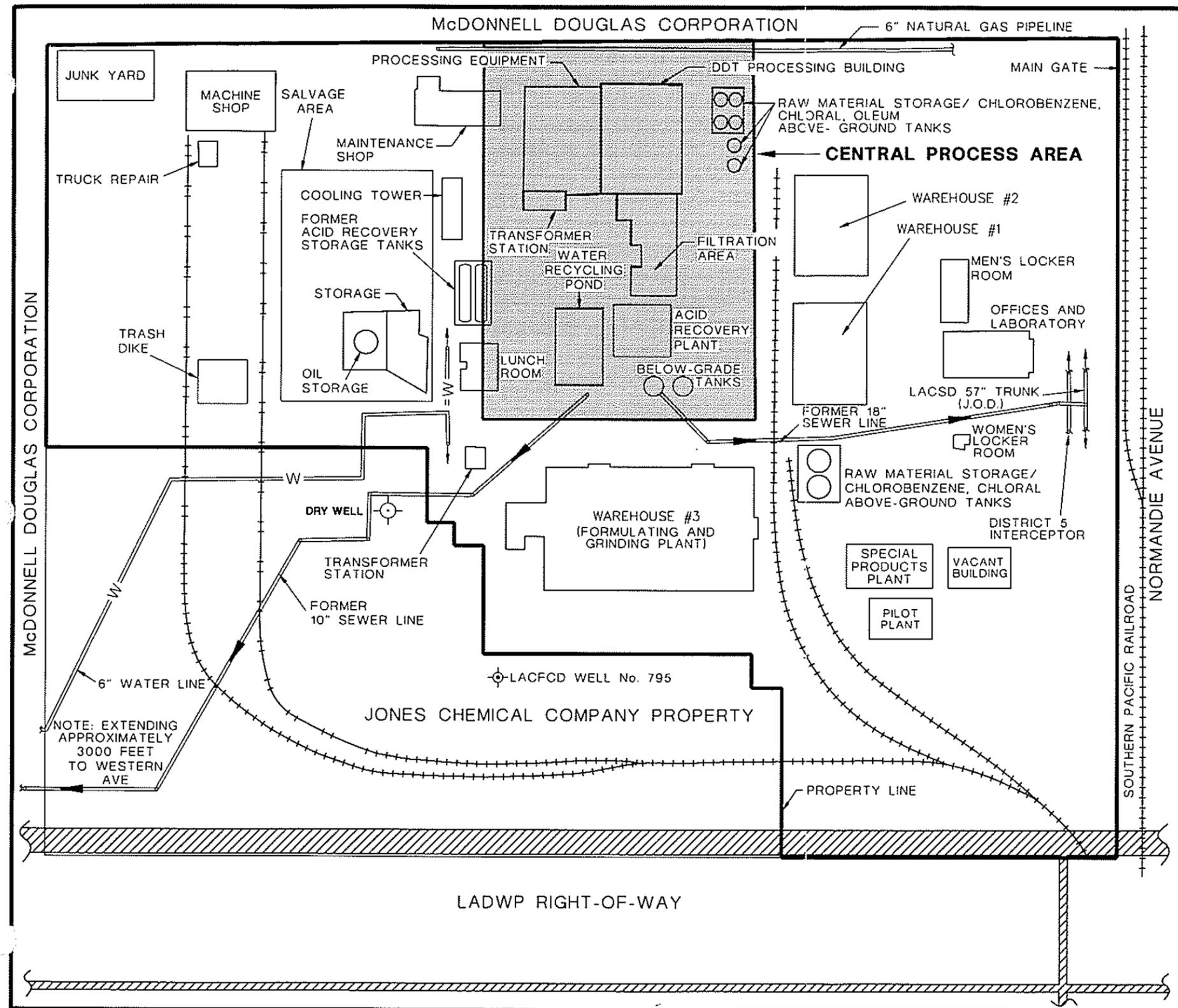
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2. H+A, 2009. Supplemental Groundwater Sampling and Analysis Results, April 2009, Montrose Superfund Site, Los Angeles, California. July 13.
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4. The Upper Belflower Aquitard is equivalent to the Water Table and Belflower 'B' Sand.

Notes:

1. In the area West of Western Avenue, not all historical data are shown. Details are provided in: H+A Technical Memorandum Results of West of Western Avenue Groundwater Assessment Montrose Site Torrance, California, April 24, 2009.
2. For MCB, the Federal Maximum Contaminant Level (MCL) is 100 µg/L, and the California MCL is 70 µg/L.

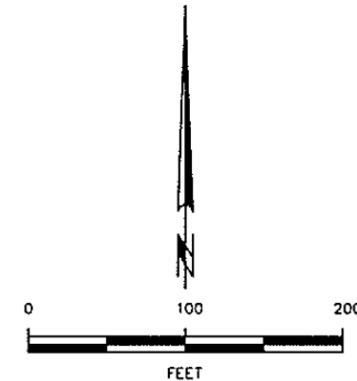
FIGURE 3-8
Chlorobenzene Distribution, Water Table, October 2012
Current Status of Vapor Intrusion Assessment,
Montrose and Del Amo Superfund Sites, Torrance, California



EXPLANATION

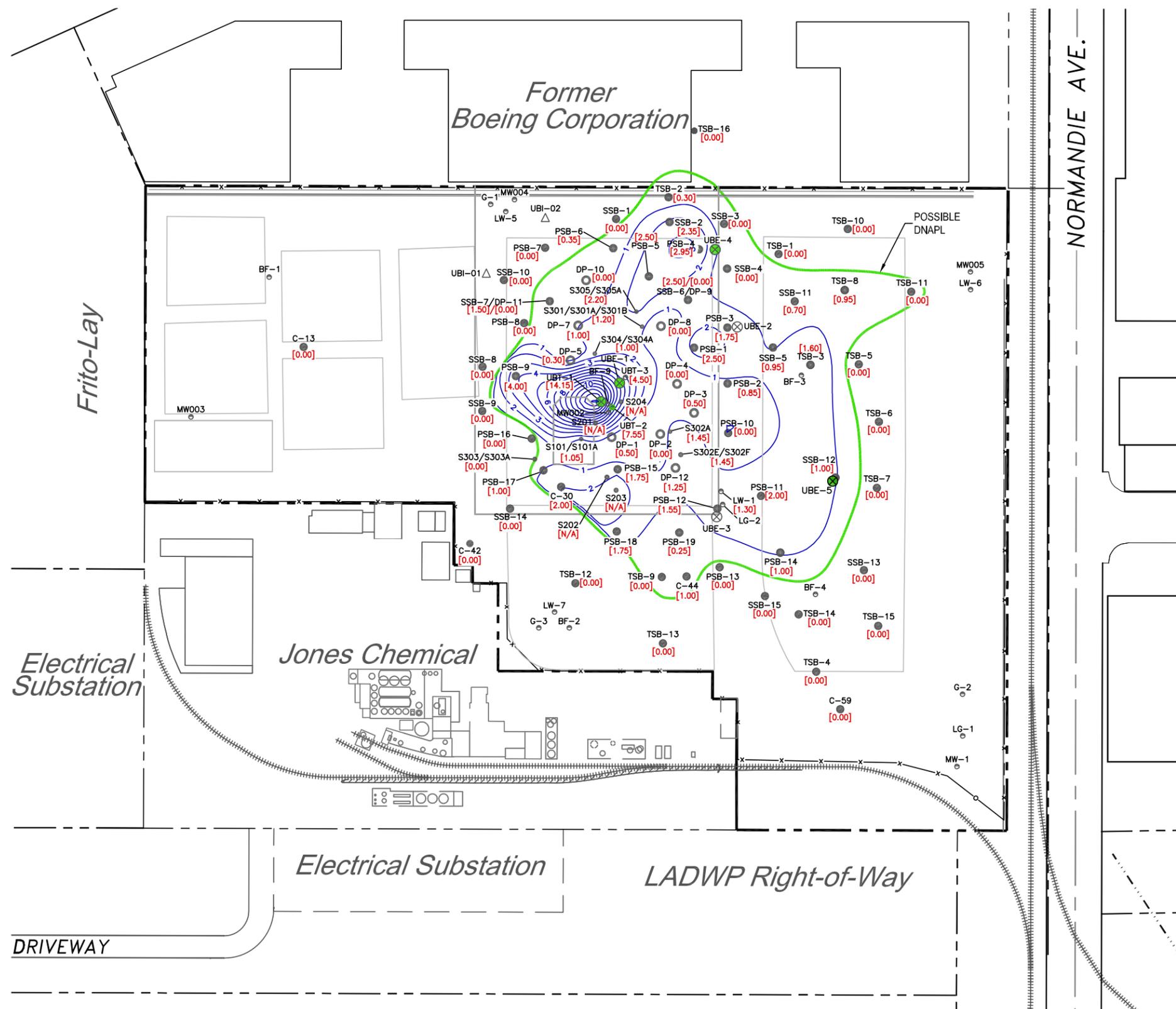
- MONTROSE PROPERTY BOUNDARY
- PROPERTY BOUNDARY
- RAILROAD TRACKS
- ABANDONED RAILROAD BED
- LADWP
- CENTRAL PROCESS AREA
- CHEMICAL AND PETROLEUM PRODUCT PIPELINE CORRIDORS
- DRY WELL

NOTES:
 ADAPTED FROM: METCALF & EDDY, INC., 1986
 BASED ON PLANT OPERATIONS IN 1982.
 ALL LOCATIONS ARE APPROXIMATE.
 LADWP LOS ANGELES DEPARTMENT OF WATER AND POWER
 LACSD LOS ANGELES COUNTY SANITATION DISTRICT



E:\PROJECTS\MONTROSE\HARGIS\410-1566.DWG 1/6/98

FIGURE 3-9
 Schematic of Montrose Plant and Surrounding Property
 Current Status of Vapor Intrusion Assessment,
 Montrose and Del Amo Superfund Sites, Torrance, California



- Legend:**
- Location of Current Montrose Property Boundary
 - Parcel Boundary / Right-of-Way
 - Surveyed Fence Line
 - Existing Railroad Tracks
 - Existing Building
 - LADWP
 - S204 Soil Boring Location
 - MW002 Monitoring Well Location
 - PSB-7 Sonic Boring Location
 - DP-10 Direct Push Boring Location
 - UBE-2 Extraction Well Location
 - Existing DNAPL Recovery Location
 - UBI-01 Injection Well Location
 - Entire Possible DNAPL Impacted Area
 - DNAPL Definite Thickness in Feet
 - [1.60] DNAPL Thickness in Feet

- References:**
1. Parcel Boundary Information from Los Angeles, CA, Department of Public Works, On-line ArcInfo GIS data set, 2004. Montrose Chemical Corporation Boundary Survey conducted August 13, 2001 by Dulin-Boynton Land Surveyors.
 2. Satellite/Aerial Photos Reference: Urban Areas Georeferenced Satellite Imagery, March 29, 2004.
 3. Source: H+A, 2008a

FIGURE 3-10
 Area of Observed DNAPL Occurrence at Montrose
*Current Status of Vapor Intrusion Assessment,
 Montrose and Del Amo Superfund Sites, Torrance, California*

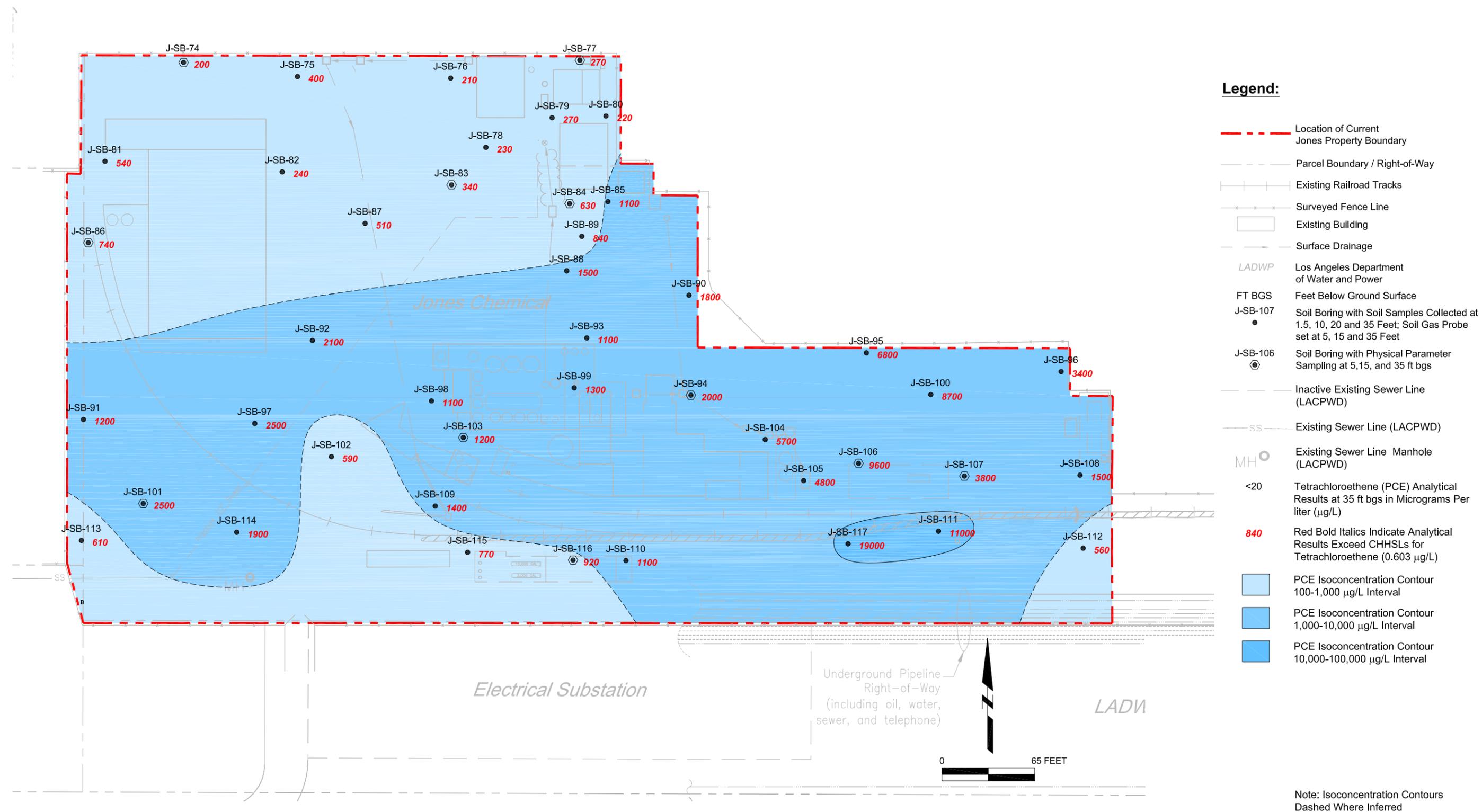


FIGURE 3-11
 Jones Property Site Plan Showing Recent Soil Gas Sampling Results for PCE at 35 feet Below Ground Surface
Current Status of Vapor Intrusion Assessment, Montrose and Del Amo Superfund Sites, Torrance, California

SOURCE: Soil and Soil-Gas Data Report, JCI Jones Chemicals, Arcadis 2012a
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