SECTION 2

Description of Site Conditions

The following section discusses the results of previous investigations and the recent remedial investigation conducted at the POL Hill AST-2 Area. This information forms the baseline from which the corrective action alternatives were developed and evaluated in subsequent sections of the text. This section provides descriptions of conditions and physical characteristics of the POL Hill AST-2 Area, including:

- HAAF background and history
- POL Hill AST-2 Area description
- Geology and hydrogeology
- Field investigations and environmental studies prior to the RI
- Remedial investigations and actions
- Nature and extent of contamination
- Data comparability

2.1 HAAF Background and History

HAAF was a 1,600-acre military installation located approximately 22 miles north of San Francisco on San Pablo Bay in Marin County, California (see Figure 1-1). The military installation was bounded on the north by the North Antenna Field (a formerly-used defense site), private agricultural lands, and a private residential community (Bel Marin Keys); on the east by state-owned land and San Pablo Bay; on the south by private agricultural fields; and on the west by Nave Drive, which parallels State Highway 101.

HAAF was constructed on reclaimed tidal mud flats by the Army Air Corps in 1932. The site, previously known as Marin Meadows, had been used as ranch and farm land since the Mexican Land Grant (USACE, undated). Military operations began in December 1932, first as a Base for bombers, and later as a Base for transport and fighter aircraft. The Base played a major role during World War II as a training field and staging area for Pacific operations. During the war (i.e., early- and mid-1940s), the Base hospital served as an acute-care and rehabilitation facility for thousands of war casualties per month.

The Base was renamed Hamilton Air Force Base in 1947 when it was transferred to the newly created U.S. Air Force (USAF). The USAF used the Base primarily as a training and fighter installation until 1975. In 1976, the USAF ended military operations at the Base and the U.S. Department of the Army (Army) began aircraft operations at the airfield and supporting facilities with permission from the USAF (Hamilton Field Association, Inc., 1988). In 1984, the airfield property was officially transferred back to the Army and renamed Hamilton Army Airfield. The Base was declared surplus under the Base Realignment and Closure Act of 1988. The Army continued to use the airfield primarily for Army Reserve aircraft operations until March 1994. The BRAC Property is currently managed by the Department of the Army, I Corps, at Fort Lewis, Washington.

The Main BRAC Property encompasses approximately 644 acres located primarily within the northeastern portion of the HAAF. The Main BRAC Property is bounded on the southwest by the GSA Phase II Sale Area and U.S. Coast Guard-administered military housing, both of which are located within the current Base limits. The 7.84-acre POL Hill Outparcel has been addressed by the Army together with other BRAC sites; however, the outparcel is separate from the contiguous Main BRAC Property (see Figure 1-2). The POL Hill Outparcel is located on the north side of a ridge known as Reservoir Hill, and the adjacent lowlands southwest of West Boundary Road. The Outparcel is bounded by the GSA Phase II Sale Area (see Figure 1-3). The POL Hill AST-2 is located in the south-central portion of the POL Hill Outparcel.

2.2 POL Hill AST-2 Area Description

The POL Hill Outparcel lies within the upland portion of HAAF, on the north side of a ridge known as Reservoir Hill and southwest of West Boundary Road (see Figure 1-3). The POL Hill Outparcel operated as the Base fuel-storage center from 1942 until prior to May 1986, when the storage tanks were removed. AST-2 stood on the hillside bench and supplied JP-4 for aircraft operations to the former tank-farm area by gravity feed through a pipeline. Discharges of jet fuel have impacted the soil and groundwater beneath the former AST-2. Since AST-2 was removed in 1986, the following wells have been used to assess environmental conditions in this area: PL-MW-101 (D) and MW-POLA-121(S) in the source area and PL-MW-103, PL-MW-104, PL-MW-114, PL-MW-115, PL-MW-116, and MW-POLA-120 in downgradient areas around former AST-2 (see Figure 1-3). Another well, PL-MW-106, was used to assess conditions associated with the AST-2 in the March 1994 sample round but was non-detect for petroleum hydrocarbons and so was not included in subsequent sample rounds. Monitoring well PL-MW-107 was sampled for BTEX and TPH between February 1997 and September 1998 and for TPH between September 2001 and August 2002. All of the above-listed wells were also sampled for geochemical parameters to support the natural attenuation study between September 2001 and August 2002 (SOTA, 2002).

The POL Hill Outparcel formerly contained a variety of fuel-storage facilities, including several ASTs, underground storage tanks (USTs), and associated fuel lines and pumping systems which were removed between 1986 and 1990. In 1986, AST-2 and the twenty USTs, associated with the former underground tank-farm area, were removed. At this time, the soils containing petroleum hydrocarbons in excess of 1,000 mg/kg were excavated and replaced with clean backfill including the soil from the AST-2 hillside bench area. In 1990, the pipeline that supplied the lower tank farm was removed, along with additional items from the lower tank farm. At this time, there was further removal of soils with concentrations above 100 mg/kg and the excavated soils were replaced with clean fill.

2.3 Geology and Hydrogeology

Reservoir Hill lies within the San Francisco-Marin structural block of the Northern Coast Range geomorphic province of California. The higher-relief areas to the west and south of HAAF are generally underlain by serpentine and sandstone bedrock from the Franciscan Complex of Jurassic to Cretaceous age. The bedrock is locally overlain by Tertiary alluvium and colluvium deposits.

Five distinct geologic units were identified in the POL Hill Area from well-boring logs: two bedrock units, Bay Mud, and two artificial-fill units (ESI, 1993). The lower bedrock unit is a gray, highly indurated, fractured Franciscan sandstone that was encountered to the total depth of the borings. The upper bedrock unit is described as friable, yellow-to-buff colored, interbedded sandstone, siltstone, and shale. In areas not disturbed by excavation and fill activities, a thin layer of Bay Mud overlies the upper-bedrock unit along the northeastern perimeter of the site. An older fill unit of pebbly, sandy clay is present to a depth of approximately 7 ft below ground surface (bgs) along the northern boundary of the POL Hill Area (WCC, 1987). A younger fill, typically less than 10 ft thick, consisting of clayey, sandy gravel is present in the former tank-farm area and at the bench where AST-2 was located.

Groundwater occurs in the weathered bedrock along the flanks of Reservoir Hill. Recharge occurs from rainfall on the top and slopes of the hill, with groundwater percolating into the weathered material and fractures in the bedrock. Flow within the bedrock is controlled by fractures and also follows topography. A representative groundwater-elevation contour map is provided in Figure A-7 of the POL Hill Outparcel RI (IT, 1999), included in Appendix A of this CAP.

Groundwater in the vicinity of the former AST-2 occurs in the bedrock at approximately 15 to 25 ft bgs and in the fill material at increasingly shallower depths away from the hill (Figure 2-2). Groundwater data near the drainage ditch suggest that an upward hydraulic gradient exists between the shallow and deeper units of the area (ESI, 1993).

Groundwater at the POL Hill Outparcel and GSA Properties was determined to occur in a low-flow fractured-bedrock layer and to have low aquifer production rates. The RWQCB is responsible for enforcement of State Water Resource Control Board Policy 88-63 (RWQCB, 1992), which specifies several criteria for determining whether groundwater is suitable for municipal or domestic water supply (i.e., drinking water). One of the criteria for suitability is recovery rate. During the investigation, the groundwater within the POL Hill Outparcel was recovered at an average of approximately 5 gal per day, which is below the minimum recovery rate for beneficial-use designation for drinking water of 200 gal per day.

Given the low groundwater yield based on testing (see Appendix F), the primary use of the groundwater (i.e., recharge to San Francisco Bay) from the POL Hill Outparcel is the same as the GSA properties, and suggests that GSA Phase I residential cleanup goals (RCGs) for groundwater also apply at the POL Hill AST-2 Area.

The only perennial surface-water feature in the area is a drainage ditch that lies outside the northern boundary of the POL Hill Outparcel (Figure 2-1). It originates east of the POL Hill AST-2 Area and drains westward under Aberdeen Road.

2.4 Field Investigations and Environmental Studies Prior to the RI

The Army conducted several field investigations and environmental studies for the POL Hill Outparcel between 1986 and 1994, prior to the RI that was initiated in 1996 and completed in February 1999 (IT, 1999). Earlier remedial activities conducted during the investigations and studies included AST and UST decommissioning and removal, contaminated-soil removal, contaminated-soil aeration, and investigations of soil and groundwater to identify the nature and extent of contamination resulting from site activities. Most of the previous studies evaluated both the AST-2 and Tank Farm areas of the POL Hill Outparcel.

NOTE:

1. BASED ON PROCESS KNOWLEDGE, JP-4 WAS STORED IN THE TANKS, HOWEVER, BASED ON CHEMICAL INTERFERENCES AND DEGRADATION RESULTING IN THE QUANTIFICATION OF JP-4 AGAINST DIESEL AND GASOLINE STANDARDS, THE REPORTED VALUES FOR TPH-DIESEL AND TPH-GASOLINE WERE TOTALLED AT EACH LOCATION TO CONSERVATIVELY ESTIMATE THE EXTENT AND MAGNITUDE OF JP-4 GROUNDWATER CONTAMINATION.
2. WELLS NOT LABELED AND SHOWN IN GRAY WERE NOT SAMPLED IN THIS ROUND.

LEGEND:

- FENCE
- EXISTING MONITORING WELL
- ABANDONED MONITORING WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- CONTOURS REPRESENT COMBINED TPH-DIESEL, TPH-GASOLINE, AND TPH-JP4 DETECTIONS. CONCENTRATIONS ARE IN µG/L
- ND — NOT DETECTED (DETECTION LIMIT=50µG/L FOR TPH COMPOUNDS AND 1µG/L FOR BTEX)
- (S) — SHALLOW MONITORING WELL
- (D) — DEEPER MONITORING WELL
- FORMER STRUCTURES
- APPROXIMATE LIMITS OF USACE EXCAVATION
- NHP LEVEE AND EASEMENT
- POL OUTPARCEL BRAC PROPERTY BOUNDARY
- GSA PHASE 1 TRANSFERED PROPERTY BOUNDARY
- LANDFILL 26 BOUNDARY

FORMER ABERDEEN ROAD
DRAINAGE DITCH
WEST BOUNDARY ROAD
LIMIT OF 1993 USACE INVESTIGATION
FORMER BUILDING 737
LANDFILL 26 GROUNDWATER TREATMENT FACILITY
LIMIT OF 1991 USACE INVESTIGATION
LANDFILL 26
HYDRANT
FORMER BUILDING 738
RAMP
PL-MW-106 | TPH | ND
FORMER BUILDING 735
PL-MW-116 | TPH | ND
SLOPE
ABERDEEN ROAD
DRAINAGE
LEVEE CONSTRUCTION HAUL ROAD
FORMER JP-4 PUMPS
PL-MW-104 | TPH | 464 µg/L
FORMER TANK FARM
PL-MW-103 | TPH | 417 µg/L
STAIRWAY
PL-MW-114 | TPH | 355 µg/L
LEVELED AREA ON BENCHED SLOPE
FORMER AST 2 EL. 52'
LEVELED AREA
PL-MW-101(D) | TPH | 5350 µg/L
MW-POLA-120
PL-MW-115 | TPH | 803 µg/L
RESERVOIR HILL

N

SCALE
0 80 160 FEET

Source: International Technology Corporation (IT) Drawing 762538-B512

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER POL HILL AST-2 AREA MARCH 1994

HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA

CH2MHILL

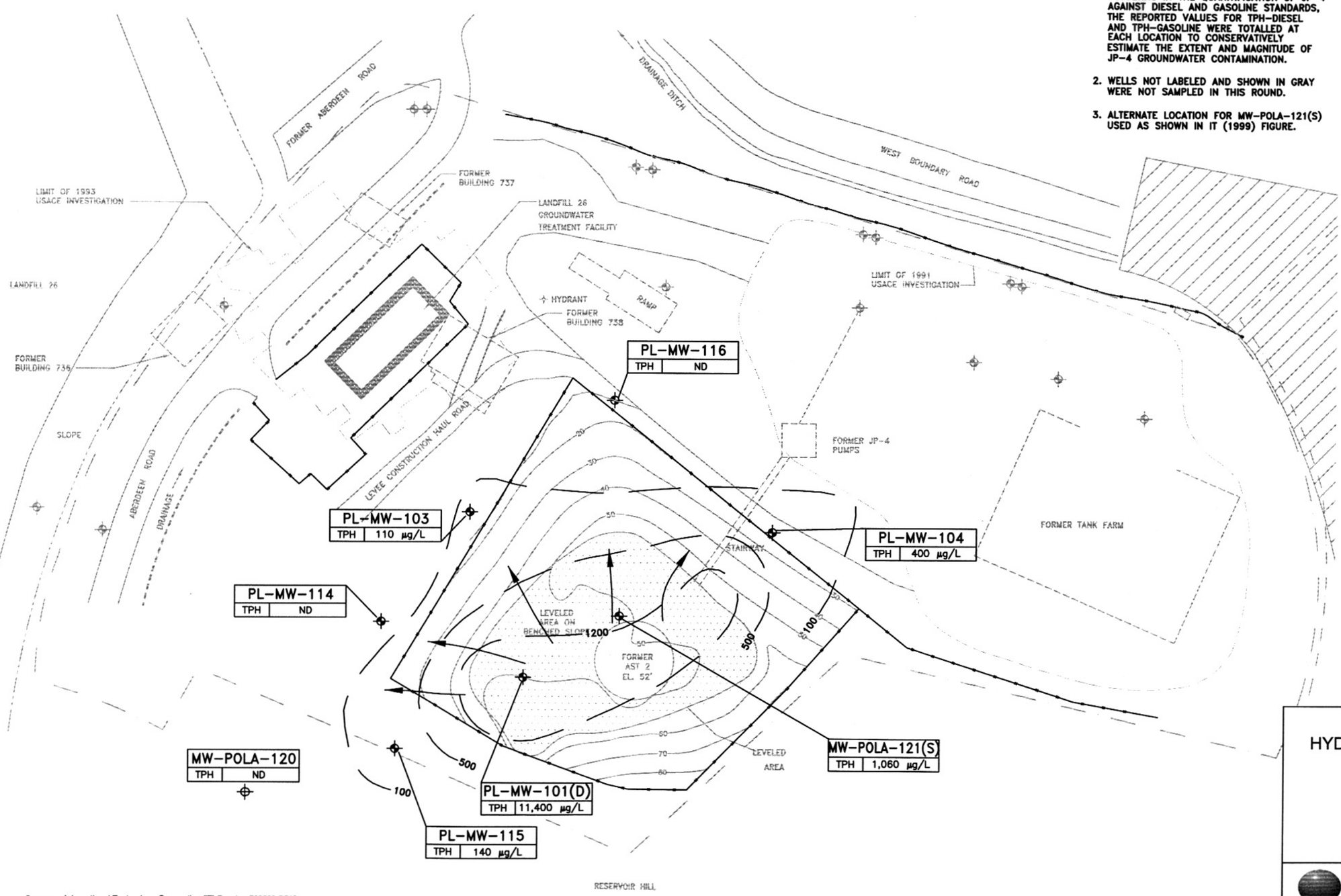
FIGURE 2-1
159892.08.PL.CR
SEPTEMBER 2002

NOTE:

1. BASED ON PROCESS KNOWLEDGE, JP-4 WAS STORED IN THE TANKS, HOWEVER, BASED ON CHEMICAL INTERFERENCES AND DEGRADATION RESULTING IN THE QUANTIFICATION OF JP-4 AGAINST DIESEL AND GASOLINE STANDARDS, THE REPORTED VALUES FOR TPH-DIESEL AND TPH-GASOLINE WERE TOTALLED AT EACH LOCATION TO CONSERVATIVELY ESTIMATE THE EXTENT AND MAGNITUDE OF JP-4 GROUNDWATER CONTAMINATION.
2. WELLS NOT LABELED AND SHOWN IN GRAY WERE NOT SAMPLED IN THIS ROUND.
3. ALTERNATE LOCATION FOR MW-POLA-121(S) USED AS SHOWN IN IT (1999) FIGURE.

LEGEND:

- FENCE
- EXISTING MONITORING WELL
- ABANDONED MONITORING WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- 100 — CONTOURS REPRESENT COMBINED TPH-DIESEL, TPH-GASOLINE, AND TPH-JP4 DETECTIONS. CONCENTRATIONS ARE IN µG/L
- ND — NOT DETECTED (DETECTION LIMIT=50 µG/L FOR TPH COMPOUNDS AND 1 µG/L FOR BTEX)
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL
- FORMER STRUCTURES
- APPROXIMATE LIMITS OF USACE EXCAVATION
- NHP LEVEE AND EASEMENT
- POL OUTPARCEL BRAC PROPERTY BOUNDARY
- GSA PHASE 1 TRANSFERED PROPERTY BOUNDARY
- LANDFILL 26 BOUNDARY



N

SCALE

0 80 160 FEET

Source: International Technology Corporation (IT) Drawing 762538-B513

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER POL HILL AST-2 AREA FEBRUARY 1997

HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA

CH2MHILL

FIGURE 2-2

159892.08.PL.CR

SEPTEMBER 2002

Descriptions of site histories, test boring logs, subsurface characterizations, and analytical results from previous investigations for the POL Hill AST-2 Area were used to provide background information for this CAP and are listed below:

- In 1986, IT removed and disposed of fuel-storage tanks and associated equipment at HAAF, including AST-2 and the tank farm at the POL Hill Outparcel. Sampling and analysis of soil and water were performed beneath and around the former tank locations as documented in their Hamilton Air Force Base-Storage Tank Removal Project report (IT, 1987).
- An enhanced Preliminary Assessment of the BRAC Property was conducted by Roy F. Weston, Inc. (Weston) in 1990. This investigation included reconnaissance-level site assessments. The investigation identified locations of known and suspected USTs (Weston, 1990).
- A Remedial Action Plan prepared by IT in 1990 provided information regarding remediation of contaminated soil at three sites at HAAF, including the POL Hill Outparcel within the BRAC Property. The plan outlined proposed cleanup levels and remedial options (IT, 1990). The remedial work, which included removal of fuel pipelines and excavation and treatment of contaminated soils, was performed the following year (IT, 1991).
- Engineering-Science, Inc. (ESI) conducted an environmental investigation (EI) for the BRAC Property at HAAF in 1993. The investigation defined the distribution, type, and concentrations of contaminants at the base, and provided a risk assessment of those contaminants (ESI, 1993).
- In 1994, a supplementary environmental report by the Army provided additional information in preparation for remedial activities at HAAF. The scope of the investigation included the collection and analysis of soil, sediment, and groundwater samples from six areas within the BRAC Property, including the POL Hill Outparcel that required additional investigation (USACE, 1994).

The summary provided below focuses on the portions of investigation and results for the POL Hill AST-2 Area. Results of the previous investigations confirmed or suggested the presence of petroleum hydrocarbons in the soil and groundwater at the POL Hill AST-2 Area. This information was used to scope the remedial investigation activities summarized in Section 3.0 and detailed in Appendix A. Details of the individual work efforts and investigations that were conducted at the POL Hill AST-2 Area prior to the RI (IT, 1999) and the results of each are summarized in Table 2-1.

2.4.1 Excavation and Sampling

The 850,000-gal AST-2 and associated piping was removed by IT in 1986 (IT, 1987). Prior to excavation activities, the valves and equipment associated with the tanks were demolished and removed. Following the tank removal, IT excavated the soil beneath the tank until the level of the original grade was reached. Additionally, soils samples were collected from beneath the removed tank and from trenches in and around the tank-removal area. Groundwater samples were collected from 11 monitoring wells, which were previously installed by Woodward Clyde in 1985, located downgradient of the investigative area. Both soil- and groundwater-sample analytical results indicated elevated levels of volatile-fuel

TABLE 2-1
Previous Field Investigations and Engineering Studies Related to POL Hill AST-2

Source	Soil Investigation and Significant Analytical Results	Groundwater Investigation and Significant Analytical Results	Remedial Activities	References
Hamiliton AFB[a] Storage Tank Removal Project—IT Corporation	None	None	Removed one 850,000-gallon AST[b] (AST-2) and associated fuel lines and pumping systems. Excavated soil with TPH[c] concentrations greater than 1,000 milligrams per kilogram (mg/kg) from the area around the removed tank and piping system.	IT, 1987[d]
Final Engineering Report, Miscellaneous Contaminated Sites—IT Corporation	None	None	Additional investigation of soil from the tank/piping system area resulted in the removal of contaminated soil exceeding TPH concentrations of 100 mg/kg.	IT, 1991[e]
Final Investigation Report—Engineering Science, Inc.	Phase I: Thirteen composite soil samples were collected from the drill cuttings during construction of 13 of 15 monitoring wells. Concentrations of contaminants detected include: bis(2-ethylhexyl)phthalate (7 detects ranging from 0.82-3.02 mg/kg) 2-methylnaphthalene (1 detect at 0.3 mg/kg) lead (13 detects ranging 5.94-15.2 mg/kg)	Phase I: Fifteen groundwater samples and 3 duplicates were collected from 15 monitoring wells. Monitoring well PL-MW-101 was the only well with consistent contaminant detections: benzene (9.69 μg/L), ethylbenzene (210 μg/L), xylene (371 μg/L), 1,3-dimethylbenzene (479 μg/L), bis(2-ethylhexyl)phthalate (14.7 μg/L), and 2-methylnapthalene (89 μg/L). Bis(2-ethylhexyl)phthalate was also detected in well PL-MW-103 at 29.3 μg/L.	None	ESI, 1993[g]

TABLE 2-1
Previous Field Investigations and Engineering Studies Related to POL Hill AST-2

Source	Soil Investigation and Significant Analytical Results	Groundwater Investigation and Significant Analytical Results	Remedial Activities	References
Final Investigation Report—Engineering Science, Inc.	Phase II: Two composite soil samples were collected from the drill cuttings of two additional monitoring wells. Lead was detected at 8.7 and 16 mg/kg. BTEX[f] was analyzed for but not detected. Thirty soil borings and 1 duplicate were collected from 16 shallow auger borings. No contaminants were detected.	Phase II: Seventeen groundwater samples were collected from 17 monitoring wells during 2 sampling rounds. Monitoring well PL-MW-101 was the only well with consistent contaminant detection during both rounds with maximum detections: benzene (6.05 μg/L), toluene (10.0 μg/L), ethylbenzene (110 μg/L), xylenes (290 μg/L), and 1,3-dimethylbenzene (280 μg/L). During Round 1, no other wells detected contaminants. However, lead was detected in Round 2 in two wells (6.4 μg/L in PL-MW-114 and 6.13 μg/L in PL-MW-115).	None	ESI, 1993[g]
Supplement to the Final Environmental Investigation Report—USACE	Two soil samples were collected during drilling of monitoring well PL-MW-116 to determine if the contaminants had migrated downgradient of former AST-2. No contaminants were detected.	Investigations included installation of monitoring well PL-MW-116 and collection of groundwater samples from the new well in addition to wells PL-MW-101, -103, -104, -114, and -115. Detections in wells included PL-MW-101 (TPH measured as diesel 5,350 μg/L, ethylbenzene 129 μg/L, and xylenes 405 μg/L), while TPH measured as diesel was the only contaminant detected in PL-MW-103 (417 μg/L), PL-MW-104 (464 μg/L), PL-MW-114 (355 μg/L), and PL-MW-115 (803 μg/L).	None	USACE, 1994[h]

Source: IT, 1997c.

[a] Air Force Base
[b] Aboveground storage tank.
[c] Total petroleum hydrocarbons
[d] IT Corporation (IT), 1987. Hamilton AFB Storage Tank Removal Project, Martinez, CA.
[e] IT, 1991. Final Engineering Report, Miscellaneous Contaminated Sites, Hamilton Army Airfield, Novato, CA, Martinez, CA.
[f] Benzene, toluene, ethylbenzene, and xylenes
[g] Engineering Science, Inc. (ESI), 1993. Final Environmental Investigation Report, Hamilton Army Airfield, Volumes I and II, Alameda, CA.
[h] USACE, 1994. Supplement to the Final Environmental Investigation Report, Hamilton Army Airfield, CA, Sacramento, CA.

hydrocarbon. Soil with TPH concentrations greater than 1,000 mg/kg were removed from the area around the tank. Excavation activities were conducted by IT in 1990 to further remove the impacted soils with TPH concentrations greater than 100 mg/kg. Following removal of impacted soil, the excavations were backfilled with clean fill. As a result of the 1986 activities, over 13,000 cubic yards of impacted soil from the POL Hill Outparcel was disposed off-site at a Class I landfill (IT, 1987), while approximately 4,000 cubic yards of material was aerated and reused as non-contaminated backfill. This amount includes soils from the former UST areas as well as the AST-2 Area.

2.4.2 Phase I and II Environmental Investigations

From 1990 to 1992, ESI conducted a Phase I and Phase II EI (ESI, 1993). The investigation included the installation and sampling of 14 shallow (PL-MW-101, PL-MW-103 through -110, -111 A, -112A, -113A, -114, and -115) and 3 deeper (PL-MW-101, -112B, and -113C) groundwater-monitoring wells and the sampling of 16 shallow-soil borings. Results of the investigation indicated that groundwater in the former location of AST-2 had TPH concentrations up to 14,000 µg/L and benzene concentrations up to 9.7 µg/L. Additionally, concentrations greater than 100 mg/kg were detected in the soil and rock in the vicinity of former AST-2 and its associated piping. However, all soil and groundwater samples in these investigations were analyzed for TPH by EPA Method 418. 1. The documentation of validation has not been found for ESI data and the data are of unknown quality.

2.4.3 Supplemental Investigation

In 1994, the Army conducted a supplemental investigation to determine whether groundwater contaminants had migrated downgradient from the hillside bench where AST-2 was located (USACE, 1994). The investigation included the installation of a new monitoring well (PL-MW-116), and the collection of groundwater samples from the new well and six existing wells (PL-MW-101, -103, -104, -106, -114, and -115). Groundwater samples were analyzed for both TPH measured as gasoline/diesel/JP-4 by modified EPA Method 8015 and total recoverable petroleum hydrocarbons (TRPH) by EPA Method 418. 1. The results of the USACE investigation are summarized as follows:

- Potential hydrocarbon contamination was detected in soil samples from PL-MW-116 (2.5 and 7.5 feet bgs) at concentrations of 24 and 33 mg/kg, respectively. No hydrocarbon contamination was detected in groundwater from this well.
- TPH measured as JP-4, ethylbenzene, and xylenes were detected in well PL-MW-101 at concentrations of 5,350 µg/L, 129 µg/L, and 405 µg/L, respectively.
- TPH measured as diesel was detected in wells PL-MW-103, -104, -114, and -115 at concentrations ranging from 355 to 803 µg/L.

In summary, the results of the investigations prior to the RI indicated that residual petroleum hydrocarbons were present in the unsaturated rock and groundwater in the vicinity of the former location of AST-2. The extent of impact appeared to be limited to the vicinity of former AST-2. There was no evidence of contamination along the former AST-2 fuel-supply lines. The highest concentrations in groundwater (TPH measured as diesel at 6,600 µg/L) were reported in samples collected from monitoring well PL-MW-101, located immediately adjacent to the former location of AST-2. This well also exhibited the highest

benzene (9.7 µg/L) detection in the former AST-2 Area. The detection of JP-4 is consistent with the expected nature of the petroleum hydrocarbon chemical constituents in this area, given that AST-2 was known to be a JP-4 storage tank. The source of the diesel detections reported in wells downgradient of PL-MW-101 is not known; however, it may represent weathered JP-4.

2.5 Remedial Investigations and Actions

The following subsections describe and summarize the results of the remedial investigation activities conducted at the POL Hill Outparcel. For detailed results of these activities, refer to the Remedial Investigation Report for the POL Hill Outparcel, which is included as Appendix A of this document. The following summary focuses on investigation activities and results related to AST-2.

On behalf of the USACE, IT conducted remedial investigation activities at the POL Hill Outparcel commencing in the winter of 1996. The activities were conducted per the Remedial Investigation/Feasibility Study Work Plan (IT, 1997a) and the CQC/SAP (IT, 1997b). The objectives of the investigative activities related to AST-2 included:

- Improve groundwater-monitoring coverage
- Perform groundwater monitoring, sampling, and slug or specific capacity testing to evaluate stability of groundwater contaminants in the bedrock fissures and the potential for migration
- Perform groundwater sampling to evaluate evidence of natural attenuation
- Determine the extent of TPH impact at the rock outcrop located on Reservoir Hill.

In order to achieve the objectives, the following tasks for AST-2 were completed during the field activities:

- Drilling two new borings and installing monitoring wells at MW-POLA-120 and -121
- Identifying the extent of Potential Contaminants of Concern (PCOCs)
- Collecting groundwater samples from the newly installed and existing wells to evaluate the extent of PCOCs
- Collecting groundwater samples from the newly installed and existing wells to evaluate if natural attenuation is occurring
- Measuring water levels in the monitoring wells to evaluate groundwater-flow patterns and rates
- Collecting samples of the rock outcrop surrounding the AST-2 Area to evaluate the absence or presence of petroleum-hydrocarbon contamination

A summary of the results of the remedial investigation activities pertaining to AST-2 is presented below. Details regarding the investigation activities and analytical results used to identify the PCOCs are presented in Appendix A**.** Additional discussions and summaries of groundwater monitoring and natural attenuation sampling are presented in Appendix H.

During the RI (IT, 1999), a composite-rock sample was collected from the area of visible staining of the rock outcrop near the former location of AST-2. The sample was analyzed for TPH, polynuclear aromatic hydrocarbons (PNAs), and polychlorinated biphenyls (PCBs). Only chrysene (960 µg/kg) and TPH measured as diesel (1,800 mg/kg) were detected. Additionally, the rock outcrop was visually inspected to evaluate the extent of TPH-impacted rock, the extent of impact was mapped, and a rough volume of TPH-impacted rock was estimated at 65 cubic yards.

Two additional monitoring wells (MW-POLA-120 and -121) were installed in the POL Hill AST-2 Area and six rounds of groundwater sampling were conducted (February 1997, March 1997, March/April 1998, June/July 1988, September/October 1998, and January 1999). Wells PL-MW-101 and MW-POLA-121 (both located near former AST-2) were the only wells with consistent contaminant detections during all rounds. Additionally, groundwater samples were collected in March/April 1998 and September/October 1998 and analyzed for hydrogeologic chemical indicators of biodegradation of petroleum hydrocarbons. A summary of the results of the groundwater chemical and natural attenuation monitoring program are presented in Appendix H.

Slug tests were performed in wells MW-POLA-121 and PL-MW-101, -103, -104, -106 to provide estimates of hydraulic conductivity and a better understanding of the hydrogeologic system for the POL Hill AST-2 Area. Specific capacity and single-well pumping tests were performed in well MW-POLA-120. Hydraulic conductivity at the site was estimated at $7.4x\ 10^{-4}$ ft/day in MW-POLA-121. The highest estimate of hydraulic conductivity in the POL Hill Outparcel was 5.3 ft/day in well PL-MW-108. Details of aquifer test results are presented in Appendix F.

After the May 2, 2001 meeting, an additional three rounds of groundwater sampling and analysis were completed by SOTA as documented in their report (SOTA, 2002) included in Appendix I. Groundwater samples were collected from AST-2 area wells in September 2001, February 2002, and August 2002 and were analyzed for TPH-purgeable and TPH-extractable. In addition, various geochemical parameters were also quantified for the groundwater by analytical testing or field measurements to develop additional information about the site's ability to support the MNA remedial alternative. The geochemical parameters for MNA included dissolved oxygen, redox, ferrous iron, methane, sulfate, total sulfide, nitrate, total alkalinity as $CaCO_3$, pH, turbidity, and temperature.

The SOTA (2002) report concluded that the decreases of extractable and purgeable TPH concentrations in groundwater correlated directly with the decrease in groundwater elevations at the site and with the indicators of natural attenuation. Their results suggest that a decrease in residual soil contamination dissolution near the capillary fringe resulting from the drop in the water table and/or the degrading of dissolved TPH in groundwater through natural attenuation processes is occurring during the dry season. SOTA also concluded that the TPH-contaminated groundwater appears to be relatively stable within bedrock fractures in the area of the former AST-2.

2.6 Nature and Extent of Contamination

The following subsections describe the PCOCs associated with POL Hill AST-2 area and their extent at the site.

2.6.1 Evaluation of Potential Chemicals of Concern

Because TPH measured as diesel and gasoline was the only PCOC suspected to be present at elevated levels at the POL Hill AST-2 Area, the following discussion focuses on the derivation of the RCGs for TPH. In 1995, Woodward-Clyde Federal Services established cleanup goals for TPH contaminants in soil and groundwater at HAAF GSA Phase I Sale Property (WCFS, 1995a). The GSA Phase I RCGs for each medium (i.e., soil and groundwater) were developed based upon site conditions and suspected analytes to be encountered in the comprehensive remedial investigation. The POL Hill AST 2 Area is planned to be used for recreational open space in the future. The use of the GSA Phase I RCGs (see Table 2-2) is conservative for the site because these goals are based on residential reuse.

Typically, cleanup levels are derived from an appropriate risk-based method. However, contaminant cleanup levels were already identified for unrestricted land use within the GSA Phase I Sale Area (WCFS, 1995b). Because these cleanup criteria (i.e., GSA RCGs) were previously developed and used for evaluation of other nearby portions of the HAAF with similar site conditions, these levels are being used as the basis for all closure evaluations and the POL Hill AST-2 Area.

TABLE 2-2
GSA Phase I Residential Cleanup Goals for Analytes Detected in Groundwater beneath AST-2 Area

Analyte	Maximum Contaminant Concentration (μg/L)	GSA Phase I Residential Cleanup Goal(μg/L)
Benzene	9.69[a]	350
Toluene	10.0[a]	835,000
Ethylbenzene	210[a]	1,924,000
Xylenes	405[b]	20,299,000
Lead (total)	6.4[a]	2,300
Bis (2-ethylhexyl) phthalate	14.7[a]	not available
2-methylnaphthalene	89[a]	not available
TPH as gasoline (purgeable)	4,800[c]	600
TPH as diesel (extractable)	6,600[c]	1,200

Notes:
All the maximum detected concentrations (except for lead) reported in this table were collected from well PL-MW-101. The reported maximum value for lead was collected from PL-MW-114.

[a] Source: ESI, 1993.
[b] Source: USACE, 1994.
[c] Source: IT, 1999.

The GSA Phase I Sale Area RCGs were developed using a series of risk-based assessments and risk-management evaluations (WCFS, 1995b). The RCG selection process included the following steps:

- Quantitative human-health-risk assessments and ecological risk assessments were performed in which uncertainty in each step of the evaluation process (i.e., selection of PCOCs, exposure assumptions, toxicity assessment, and risk characterization) was addressed by assuming the most conservative "worst case" situation.
- Results of the human-health-risk assessments and ecological-risk assessments were used to generate risk-based remedial action objectives (RAOs) for both the residential and commercial land-use scenarios. Assuming that the conservative assumptions made during the risk assessments were valid, the RAO was the concentration of a chemical that could be present at a site and not pose an unacceptable risk to receptors.
- Unless an RAO was greater than a chemical's background concentration, or significantly different from a benchmark, the background concentration was adopted as the RCG since it would be impractical to remediate a site to below background concentrations.
- Analyte background concentrations, analytical method practical quantification limits, and other benchmarks were compared to each RAO to assess the viability of the RAO. A benchmark is a promulgated regulatory standard, such as acceptable TPH concentration based on Marin County UST regulations, or a toxicity-based screening value, such as EPA Region IX Preliminary Remediation Goals.

The remainder of this discussion focuses on the derivation of the RCG for TPH measured as diesel and gasoline because they were the only PCOCs suspected to be present at elevated levels at the former AST-2 site. In 1995, Woodward-Clyde Federal Services reviewed the established limits for diesel constituents to determine applicable TPH cleanup levels for the GSA Property. The results of this study are presented in *Groundwater TPH Cleanup Levels for GSA Sale Property* (WCFS, 1995c). This study established cleanup levels for TPH in the groundwater for the GSA Phase I Sale Property.

As part of this study, each of the diesel constituents was evaluated with respect to chemical risk and percent of diesel composition. PNAs were determined to be the primary risk drivers for diesel fuel. Typical diesel fuel contains between 0.7- and 2-percent total PNAs. Using the conservative estimate of 2-percent total PNAs in diesel and an aquatic maximum-contaminant level of 50 µg/L, a cleanup level for diesel of 2,500 µg/L was established for groundwater. However, during GSA RCG negotiations with the regulatory agencies, an additional degree of conservatism was introduced by reducing the RCG for TPH measured as diesel from the calculated value of 2,500 µg/L to 1,200 µg/L. The GSA RCG of 1,200 µg/L will be used in evaluation of the groundwater results in this CAP to determine if remedial action needs to be implemented.

While gasoline was not stored in AST-2 (or other POL Hill Outparcel storage facilities), this parameter was measured in groundwater samples to assess potential volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylenes (collectively referred to as BTEX compounds) that could be present in JP-4. The GSA RCG for TPH measured as gasoline in groundwater is 600 µg/L (WCFS, 1995c).

The soil GSA RCG is 200 mg/kg for TPH measured as diesel and is 100 mg/kg for TPH measured as gasoline. Previous soil remedial activities have already removed the soils beneath AST-2 that were above 100 mg/kg and were feasible to remove, therefore the RCGs for soil have been met for the POL Hill AST-2 Area. All excavated soils beneath AST-2 were replaced with clean fill.

2.6.2 Extent of Contamination

The results of the historical investigations indicate that petroleum-hydrocarbon contaminants in the groundwater within bedrock fractures beneath the location of former AST-2 but that the extent of impact appears to be limited to the vicinity of former AST-2 (see Figures 2-1 through 2-4). The highest concentration of TPH measured as diesel (9,800 µg/L) and TPH measured as gasoline at (6,200 µg/L) was detected in groundwater samples from monitoring well PL-MW-101 during the February 2002 sample round. This well is located immediately adjacent (east) of the former AST-2 location. This well also exhibited the only benzene concentrations in the former AST-2 Area; however, benzene was not detected in any samples collected after August 1992. The detections of TPH measured as diesel and gasoline are consistent with the expected nature of the petroleum-hydrocarbon chemical constituents in this area since AST-2 was known to be a JP-4 storage tank.

The contamination identified in the soil and groundwater at the POL AST-2 Area consists of light- and medium-weight hydrocarbons found in JP-4 and gasoline and their decomposition products; however, the contaminated soil was removed to the bedrock surface and replaced with clean-fill material during previous remedial activities. A composite sample of the rock outcrop indicated that elevated concentrations of TPH measured as diesel were detected. However, remediation of the rock outcrop is not proposed, since the asphaltic material which covers the outcrop is bound within the bedrock fractures, is not mobile, and is bound in such a manner that removal by hand is virtually impossible.

The extent of TPH contamination in groundwater associated with JP-4 releases from AST-2 was evaluated during ten separate sampling events between March 1994 and August 2002. The contaminant isopleths indicating the location, concentration, and extent of the groundwater contamination were completed for the March 1994, February 1997, March/April 1998, and January 1999 sampling events and are presented along with analytical results in Figures 2-1 through 2-4. The TPH values reported on these figures are actually the sum of TPH as diesel and TPH as gasoline analytical results at each location. The TPH values were reported in this way because of chemical interferences.

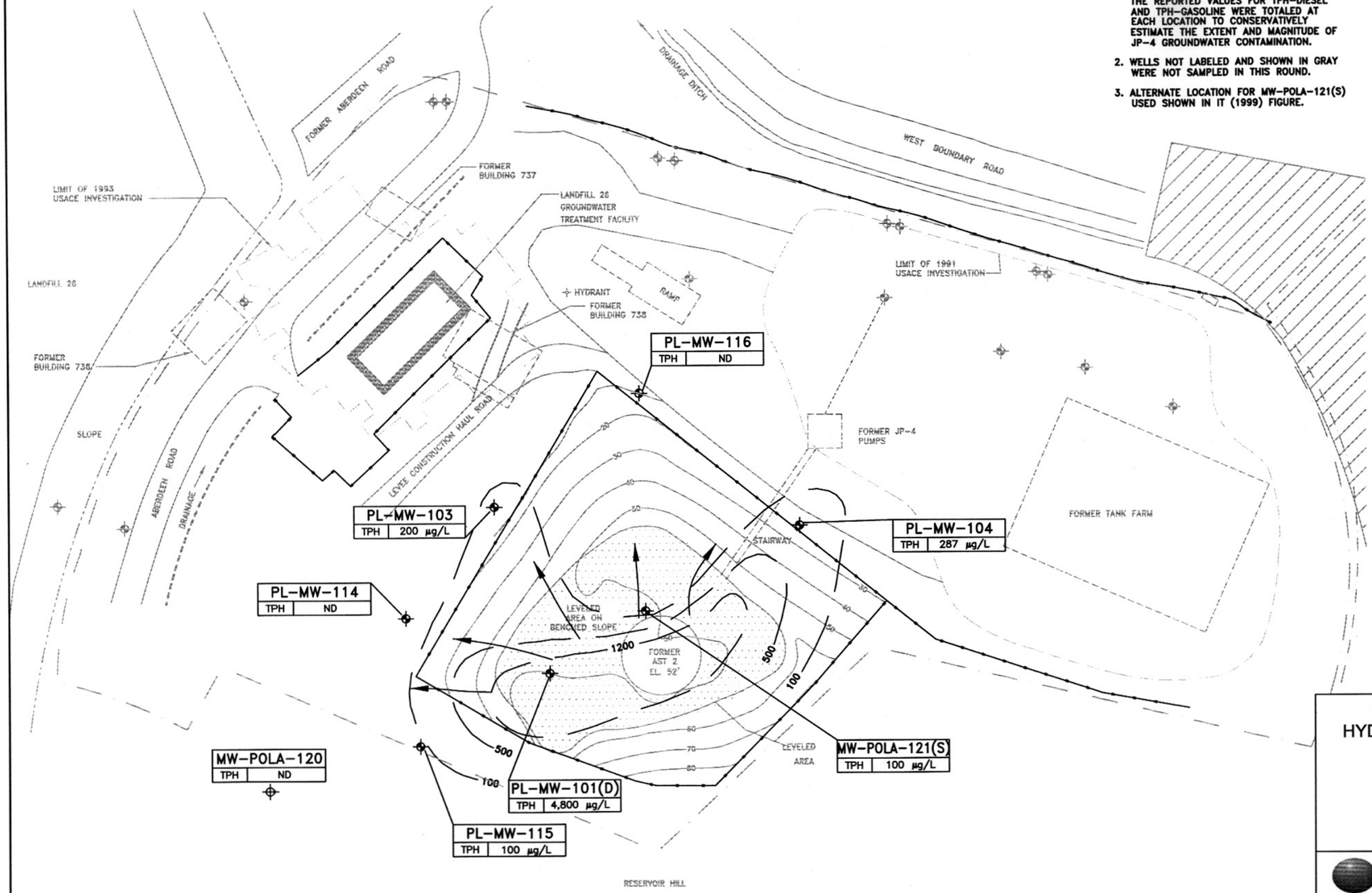
Additional testing of AST-2 area groundwater samples collected by SOTA in September 2001, February 2002, and August 2002 supports the conclusion that the TPH-contaminated groundwater is relatively stable and that natural attenuation of the contaminants is occurring. Data and graphical representations of the contaminant isopleths from these more recent sampling rounds are included in Appendix I.

NOTE:

1. BASED ON PROCESS KNOWLEDGE, JP-4 WAS STORED IN THE TANKS, HOWEVER, BASED ON CHEMICAL INTERFERENCES AND DEGRADATION RESULTING IN THE QUANTIFICATION OF JP-4 AGAINST DIESEL AND GASOLINE STANDARDS, THE REPORTED VALUES FOR TPH-DIESEL AND TPH-GASOLINE WERE TOTALED AT EACH LOCATION TO CONSERVATIVELY ESTIMATE THE EXTENT AND MAGNITUDE OF JP-4 GROUNDWATER CONTAMINATION.
2. WELLS NOT LABELED AND SHOWN IN GRAY WERE NOT SAMPLED IN THIS ROUND.
3. ALTERNATE LOCATION FOR MW-POLA-121(S) USED SHOWN IN IT (1999) FIGURE.

LEGEND:

- FENCE
- EXISTING MONITORING WELL
- ABANDONED MONITORING WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- 100 — CONTOURS REPRESENT COMBINED TPH-DIESEL, TPH-GASOLINE, AND TPH-JP4 DETECTIONS. CONCENTRATIONS ARE IN µG/L
- ND — NOT DETECTED (DETECTION LIMIT=50 µG/L FOR TPH COMPOUNDS AND 1 µG/L FOR BTEX)
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL
- FORMER STRUCTURES
- APPROXIMATE LIMITS OF USACE EXCAVATION
- NHP LEVEE AND EASEMENT
- POL OUTPARCEL BRAC PROPERTY BOUNDARY
- GSA PHASE 1 TRANSFERRED PROPERTY BOUNDARY
- LANDFILL 26 BOUNDARY



N

SCALE

0 80 160 FEET

Source: International Technology Corporation (IT) Drawing 762538-B514

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER POL HILL AST-2 AREA MARCH/APRIL 1998 HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA

CH2MHILL

FIGURE 2-3

159892.08.PL.CR

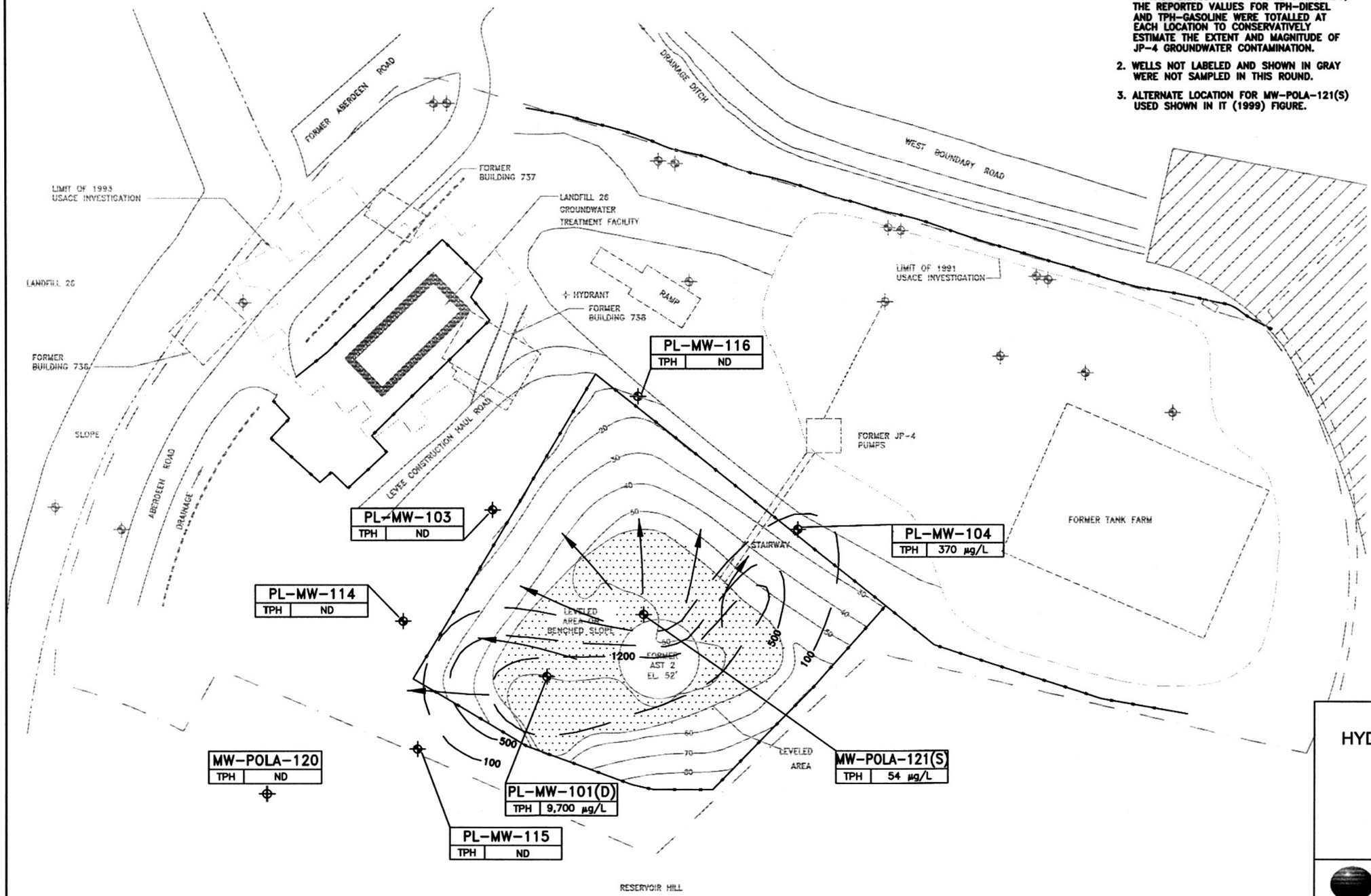
SEPTEMBER 2002

NOTE:

1. BASED ON PROCESS KNOWLEDGE, JP-4 WAS STORED IN THE TANKS, HOWEVER, BASED ON CHEMICAL INTERFERENCES AND DEGRADATION RESULTING IN THE QUANITIFICATION OF JP-4 AGAINST DIESEL AND GASOLINE STANDARDS, THE REPORTED VALUES FOR TPH-DIESEL AND TPH-GASOLINE WERE TOTALLED AT EACH LOCATION TO CONSERVATIVELY ESTIMATE THE EXTENT AND MAGNITUDE OF JP-4 GROUNDWATER CONTAMINATION.
2. WELLS NOT LABELED AND SHOWN IN GRAY WERE NOT SAMPLED IN THIS ROUND.
3. ALTERNATE LOCATION FOR MW-POLA-121(S) USED SHOWN IN IT (1999) FIGURE.

LEGEND:

- FENCE
- EXISTING MONITORING WELL
- ABANDONED MONITORING WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- 100 — CONTOURS REPRESENT COMBINED TPH-DIESEL, TPH-GASOLINE, AND TPH-JP4 DETECTIONS. CONCENTRATIONS ARE IN µG/L
- ND — NOT DETECTED (DETECTION LIMIT=50µG/L FOR TPH COMPOUNDS AND 1µG/L FOR BTEX)
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL
- FORMER STRUCTURES
- APPROXIMATE LIMITS OF USACE EXCAVATION
- NHP LEVEE AND EASEMENT
- POL OUTPARCEL BRAC PROPERTY BOUNDARY
- GSA PHASE 1 TRANSFERED PROPERTY BOUNDARY
- LANDFILL 26 BOUNDARY



Source: International Technology Corporation (IT) Drawing 762538-B515

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER POL HILL AST-2 AREA JANUARY 1999

HAMILTON ARMY AIRFIELD
NOVATO, CALIFORNIA

CH2MHILL

FIGURE 2-4

159892.08.PL.CR

SEPTEMBER 2002

2.7 Data Comparability

Environmental investigations at HAAF have included both non-specific TPH analyses that utilize infrared spectroscopy (IR), and partially-specific TPH analysis methods that utilize gas chromatography (GC). Infrared Spectroscopy methods are subject to interference from naturally-occurring organic matter (i.e., Bay Muds). EPA Method 418.1 (1995) is an IR method that was used at the HAAF during the 1992 investigation to quantify TRPH. Because of the problems with interferences, there is an uncertainty for using the TRPH data as an indicator of "true" hydrocarbon contamination. For this reason, TRPH data will not be used or referenced in this document.

On the other hand, GC methods (modified EPA Method 8015) can be used to distinguish between naturally occurring hydrocarbons and refined petroleum hydrocarbons, products of contaminants. Two versions of modified EPA Method 8015, purgeable and extractable TPH fractions, have been used to analyze samples collected at HAAF. In this document, GC results are reported as specific TPH fractions (i.e., TPH measured as diesel, TPH measured as JP-4, TPH measured as motor oil, and TPH measured as gasoline).

Although speciation of gasoline, diesel, and JP-4 is possible analytically, end users of the data must recognize that chemical interferences and degradation phenomena will influence quantities reported for each species. For example, higher levels of heavier petroleum products such as diesel and JP-4 may contain some volatile components that produce a response when measuring TPH as gasoline. Similarly, the heavy ends of gasoline and JP-4 chains may also produce a response when measuring TPH as diesel. Furthermore, petroleum constituents may undergo varying degrees of weathering and degradation during the period between release and sample collection. Consequently, chromatogram signatures from investigative samples often do not match those associated with calibration standards. When the sample chromatogram does not match that of the fuel standard used for calibration, the contaminant is reported by the laboratory as "unknown hydrocarbon." When the unknown falls in the gasoline range (C_7 to C_{12}), the result will be quantitated against the gasoline standard. When the unknown falls in the diesel (C_{10} to C_{24}), JP-4 (C_8 to C_{13}), or motor oil (C_{24} to C_{36}) range, the result will be quantitated against the diesel standard.

Given data limitations associated with historic methods (EPA 418. 1) and speciation uncertainties, this report presents the type and likely range of contaminant levels derived from correlating the investigative results with process knowledge. For example, soil and groundwater contamination attributed to releases from AST-2 and its appurtenances will be evaluated as JP-4 (see Section 2.1), even though contaminant concentrations may have been reported as TRPH or gasoline/diesel.