FINAL SWMU I07
DECISION DOCUMENT
SWMU I07: Building 101-44 Landfill

June 2012
Version 01

Hawthorne Army Depot
Hawthorne, Nevada

U.S. Army Corps of Engineers - Sacramento District
Contract W91238-06-D-0019
Task Order 0004

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Hawthorne Army Depot, Nevada

Contract No. W91238-06-D-0019

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Prepared for:

US Army Environmental Command

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Hawthorne, Nevada

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ACRONYMS

API ..... American Petroleum Institute
Army ..... United States Army Environmental Command
Bay West..... Bay West, Inc.
bgs ..... Below ground surface
BTEX ..... Benzene, toluene, ethylbenzene, and xylenes
COPC ..... Chemicals of potential concern
cy ..... Cubic yards
HMX..... Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HWAD ..... Hawthorne Army Depot
LNAPL..... Light non-aqueous phase liquid
mg/kg ..... Milligrams per kilogram
NAC ..... Nevada Administrative Code
NDEP ..... Nevada Division of Environmental Protection
NFA..... No Further Action
PCGs ..... Proposed Closure Goals
PRGs ..... Preliminary Remediation Goals
RA..... Remedial Action
RAI..... Resource Application Inc.
RCRA..... Resource Conservation & Recovery Act
RDX Hexahydro-1,3,5-trinitro-1,3,5-triazine
RSLs ..... Regional Screening Levels
SSTL..... Site-Specific Target Level
SWMU ..... Solid Waste Management Unit
TPH-d ..... Total petroleum hydrocarbons-diesel
USAEHA ..... United States Army Environmental Hygiene Agency
USACE ..... United States Army Corps of Engineers
USEPA..... United States Environmental Protection Agency
VOC ..... Volatile organic compound

1.0 INTRODUCTION

1.1 Site Name and Location

Facility Name: Hawthorne Army Depot

Site Location: Hawthorne, Nevada

Operable Unit/Site: Solid Waste Management Unit (SWMU) I07

1.2 Statement of Basis and Purpose

This Decision Document describes the rationale for the selected remedy of No Further Action (NFA), industrial scenario, at SWMU I07 at Hawthorne Army Depot (HWAD) (hereafter referred to as SWMU I07), Hawthorne, Nevada (**Figure 1** and **2**).

Remedial investigations of hazardous substances, pollutants, or contaminants at SWMU I07 have demonstrated that:

- Additional Remedial Action (RA) is not necessary. A previous SWMU I07 RA involved excavation and backfill which was selected in the June 2001 Decision Document (TetraTech, 2001).
- The vertical distribution of Total Petroleum Hydrocarbons-diesel (TPH-d) at SWMU I07 above the State of Nevada Screening Level (100 milligrams per kilogram [mg/kg]) is limited to approximately 8 to 24 feet below ground surface (bgs). Based on the analytical results and site contaminant modeling, unacceptable risks are not present and further site evaluation is not recommended unless residential land use is proposed.
- Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) was detected in soil sample I07-01-S-(05) at a concentration of 40 mg/kg at 5 feet bgs. This RDX concentration exceeds the 2011 United States Environmental Protection Agency (USEPA) Industrial Regional Screening Level (RSL) of 24 mg/kg; however, this result is significantly less than the Site-Specific Target Level (SSTL) of 363 mg/kg as developed for the SWMU B04 corrective action plan (Plexus, 2008) and adopted for this site. Therefore, the residual RDX soil contamination at SWMU I07 does not constitute a risk to human health or the environment.

1.3 Description of Selected Remedy

Based on investigative and remedial action results, the United States Army Environmental Command (Army), with concurrence from the Nevada Division of Environmental Protection (NDEP), has determined that no significant risks or threats to human health or the environment exist at this time and the selected remedy for SWMU I07 is NFA, industrial scenario.

1.4 Regulatory Setting

The USEPA provides regulatory oversight of contamination assessment and corrective measures at Resource Conservation and Recovery Act (RCRA) SWMUs under Section 3004 (u) of the 1984 Hazardous and Solid Waste Amendments to RCRA. Corrective action for releases of hazardous wastes or constituents is required under 40 CFR Part 264.101 (a), (b), and (c).

The HWAD also maintains RCRA Permit No. NEV HW0017 (renewed in August 2005), which requires corrective actions for any hazardous waste or hazardous constituents released from any SWMUs at the facility. Authority and responsibility for the implementation of RCRA has been delegated by the USEPA to the State of Nevada, making the NDEP the lead regulatory agency for all RCRA investigations and corrective actions at HWAD.

1.5 Authorizing Signatures

This signature sheet documents the Army approval and NDEP concurrence of the remedy selected in the Decision Document for SWMU I07 at the HWAD.

This remedy decision may be reviewed and modified in the future if information becomes available that indicates the presence of contamination may cause unacceptable risk to human health or the environment.

Kirk L. Bausman
Deputy to the Commander
Hawthorne Army Depot

20120627
Date

Greg Lovato
Chief, Bureau of Corrective Actions
Nevada Division of Environmental Protection

6/29/12
Date

2.0 DECISION SUMMARY

The Decision Summary identifies the selected remedy, explains how the remedy fulfills statutory and regulatory requirements, and provides a substantive summary of the Administrative Record file that supports the remedy selection decision.

2.1 Site Name, Location, and Description

SWMU I07 is located in the HWAD central magazine area, southeast of the main 101 production area (**Figure 2**) and approximately 500 feet southwest of SWMU B04. The SWMU is an inactive landfill that is 450 southwest of Building 101-44. The landfill consists of a pit that is estimated to be 150 feet long by 80 feet wide. The United States Army Corps of Engineers (USACE), HWAD, and the NDEP agreed to define the boundaries of SWMU I07 using annotated monuments and survey pins (Tetra Tech, 1998). Tetra Tech surveyed SWMU I07 and constructed a survey monument, designated as HWAAP-55-1996, which includes the SWMU number I07. Two corner pins were set and surveyed to define the SWMU boundary, using the monument as the northwest corner.

2.2 Physical Setting

HWAD is located on the southern shore of Walker Lake, 140 miles southeast of Reno, Nevada. It occupies approximately 150,000 acres of semi-arid land surrounding the Hawthorne community. The town has a resident population of about 5,000. The site layout of SWMU I07 is shown in **Figure 3**.

2.3 Investigation History Summary

Multiple investigations and one RA have been completed at SWMU I07. A summary of SWMU I07 site actions is included in **Table 2-1**.

Initial investigation activities completed in the 1990s identified explosives and TPH-d contamination in the landfill pit at SWMU I07. As documented in the 1988 United States Army Environmental Hygiene Agency (USAEHA) report and the 1998 Tetra Tech investigation report, large pieces of scrap metal, several empty 55-gallon drums, and one 55-gallon drum of “petroleum hydrocarbon liquid” were present in the landfill. Soils with concentrations of explosive constituents exceeding the Preliminary Remediation Goals (PRG) and TPH-d impacted soils exceeding actions levels were detected within the landfill.

Following the identification of contaminants of potential concern (COPCs) within the landfill pit at SWMU I07, a RA was completed in 2003 by Chung and Associates. The purpose of the RA was to remove RDX-impacted soil to below an established Preliminary Remediation Goal (PRGs) and to remove the highest concentrations of TPH-d impacted soils. A total of 880 cubic yards of impacted soil were removed, bio-remediated, and disposed of at the NDEP-Permitted Group 24 Industrial Solid Waste Disposal Cell.

Subsequent to the RA activities at SWMU I07, confirmation soil sampling was completed. However, the vertical distribution of COPCs was not clearly defined. In 2012 a supplemental investigation was completed by Bay West, Inc. (Bay West) to document the vertical distribution of TPH-d and explosives (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine [HMX] and RDX).

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
1988	Site Inspection	USAEHA	SWMU I07 site inspection.	Several empty 55-gallon drums and one full drum, which reportedly contained hydrocarbon contaminated water, were observed at the Site. No investigation or sampling occurred during the site inspection (USAEHA, 1988).	Additional site assessment.
1988	RCRA Facility Assessment	Jacobs Engineering	SWMU I07 site inspection.	Evidence of metal debris waste in landfill pit (Jacobs, 1988).	Additional site assessment.
1992	Site Screening Inspection	Resource Application Inc. (RAI)	SWMU I07 site inspection.	Evidence of metal waste debris noted in the disposal pit. No investigation or sampling occurred during the site inspection (RAI, 1992).	Additional site assessment.

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
1989, 1994, and 1997	Groundwater Monitoring	WaterWork (1989) Ecology and Environment (1994) Tetra Tech (1997)	As documented in the TetraTech Final Remedial Investigation Report (TetraTech, 1998), various groundwater sampling events occurred upgradient and downgradient from SWMU I07. The report references the following groundwater monitoring well groups: • Upgradient groundwater monitoring wells DZB101-44MW1, DZB101-44MW2, and DZB101-44MW3, which are located southeast of Building 101-44, within or near SWMU B04. • Upgradient groundwater monitoring wells IRPMW38 and IRPMW39 which are located approximately 5,080 feet southeast of SWMU I07. • Downgradient groundwater monitoring wells IRPMW36 and IRPMW37 which are located approximately 2,000 feet northwest of SWMU I07, within the boundary of SWMU B20. Groundwater monitoring well locations are illustrated on the TetraTech 1998 Figure 3-2, included in **Attachment 1**.	Groundwater samples collected in 1989, 1994, and 1997 were analyzed for various chemical constituents. However, the Groundwater contamination documented in the Tetra Tech Final Remedial Investigation Report (Tetra Tech, 1998) is based on analytical data collected from monitoring wells located within other active SWMU boundaries and/or are located a considerable distance from SWMU I07 and are not considered to be a result of activities associated with SWMU I07.	No recommendation.

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
1994	Remedial Investigation	Tetra Tech	Completion of a soil gas survey. The survey included the completion of 10 soil gas probes (SG01 through SG10) and the collection of 10 soil gas samples. Soil gas samples were analyzed for volatile organic compounds (VOCs). Soil gas sample locations are illustrated on the Tetra Tech 1998 Figure 3-1, included in **Attachment 1**.	No VOCs were detected above laboratory reporting limits in the soil gas samples. Analytical results are included on the Tetra Tech 1998 Table 1 in **Attachment 1**.	No recommendation.
			Completion of four hand auger borings (I07-HA01, I07-HA02, I07-HA03, and I07-HA04) and collection of eight soil samples. Soil samples were collected from two feet bgs and five feet bgs. Soils samples were analyzed for metals (aluminum, arsenic, barium, cadmium, chromium, and lead) and TPH-d. Soils samples were further field screened for benzene, toluene, ethyl benzene, and xylenes (BTEX). Soil boring locations are illustrated on the Tetra Tech 1998 Figure 3-1, included in **Attachment 1**.	Metals analyzed were detected below an established background screening level. TPH-d ranged from 1.2 mg/kg to 15,000 mg/kg. BTEX field screening ranged from non-detect to greater than 300 mg/kg. Analytical results and background screening levels are included on the Tetra Tech 1998 Table 4-1 in **Attachment 1**.	Bio-remediation of petroleum impacted soils (Tetra Tech, 1998).

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
1997	Remedial Investigation	Tetra Tech	Collection of surface soil sample I07-SS01-1-S and replicate sample I07-SS02-1-S from the yellow-brown ash-like material noted in the southeast area of the SWMU I07 landfill. Soil samples were analyzed for metals (aluminum, arsenic, barium, cadmium, chromium, and lead) and explosives (RDX and HMX). The surface soil sample location is illustrated on the Tetra Tech 1998 Figure 3-1, included in **Attachment 1**.	Aluminum, arsenic, barium, total chromium, and lead were below their respective Proposed Closure Goal (PCGs). Concentrations of HMX, at 5.97 mg/kg and 3.7 mg/kg, and concentrations of RDX, at 27.4 mg/kg and 20.7 mg/kg, were detected in both soil samples; however, they were below their respective PCGs. Analytical results and the 1997 PCGs are included on the Tetra Tech 1998 Table 4-1 in **Attachment 1**.	The yellow-brown ash-like material located within the landfill at SWMU I07 did not appear to be a significant environmental impact, however, the soil was recommended for removal (Tetra Tech, 1998).

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
1997	Remedial Investigation, cont.	Tetra Tech	Completion of three soil borings (SB01, SB02, and SB03). Soil borings SB01 and SB02 were completed to 25.5 feet bgs, and SB03 was completed to 50 feet bgs. A total of twelve soil samples were collected from fine-grained soil horizons from 4.5 to 50 feet bgs. All soil samples were analyzed for VOCs and field tested for TPH-d. Two soil samples (I07-SB03-3-S and I07-SB03-7-S) were analyzed by a fixed-based laboratory for TPH-d. Soil boring locations are illustrated on the Tetra Tech 1998 Figure 3-1, included in **Attachment 1**.	The field-based TPH-d testing produced inconsistent results. Field testing indicated that all soil samples analyzed had a TPH-d concentration greater than 100 mg/kg. Laboratory analytical data indicated TPH-d in soil boring SB03 at a concentration of 2,000 mg/kg at 15.5 feet bgs and 26 mg/kg at 50 feet bgs. With exception to soil sample I07-SB03-3-S all other soil samples analyzed for VOCs were below detection limits. Soil sample I07-SB03-3-S, collected at a depth of 15.5 feet bgs, was reported to contain 1,2,4-trimethylbenzene at 0.0008 mg/kg, 1,3,5-trimethylbenezene at 0.002 mg/kg, and 4-isopropyltoluene at 0.001 mg/kg. Analytical results and the 1997 PCGs are included on the Tetra Tech 1998 Table 4-1 in **Attachment 1**.	Remediation of petroleum impacted soils (Tetra Tech, 1998).
			Collection of sludge sample I07-SD01-1-SD from a 55-gallon drum. Sludge sample was analyzed for VOCs and TPH.	Based on the analytical result the drum contained oil. Drum was removed in May 1997 by Day and Zimmermann (Tetra Tech, 1998). Analytical results of the sludge samples are included on the Tetra Tech 1998 Table 4-1 in **Attachment 1**.	No recommendation.

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
2002	Remedial Action (Excavation)	Chung/Geofon	Completion of an RA at SWMU I07 to remove soil impacted by TPH-d and explosives. The removal action included the removal of 463 cubic yards (cy) of impacted soil and collection of confirmation samples.	Based on analytical results of confirmatory samples collected from the base of the excavation, RDX exceeded the USEPA PRGs. Analytical results of the initial confirmatory samples are not included in this Decision Document since a second removal was completed and excavation was re-sampled.	Continue remedial action.
2002	Remedial Action (Excavation)	Chung/Geofon	Completion of phase II of the RA at SWMU I07 to remove additional soil impacted by TPH-d and explosives. The removal action included the removal of 417 cy of impacted soil and collection of confirmation samples (Chung/Geofon, 2003). The final excavation contour and confirmation soil sample locations are included on the Chung/Geofon 2003 Figure 2.2 included in **Attachment 2**. Note – The last number in the sample name is included on Figure 2.2 as the sample location. Also, the highlighting and check marks on Figure 2.2 were added by an NDEP reviewer.	Based on analytical results of confirmatory samples collected from the base of the excavation RDX concentrations were below USEPA PRG (22 mg/kg), however, TPH-d was still present at concentrations ranging from below laboratory detection limits to 11,000 mg/kg at soil sample location I07-CF01-02-20 (or Figure 2.2 sample #20) from 6.9 feet bgs. The excavation depth ranged from approximately two feet bgs to 15 feet bgs. Analytical results and final excavation depths are included on the Chung/Geofon 2003 Table 2-2 in **Attachment 2**.	Remediation Complete. NDEP concurrence letter dated 06 October 2003 is included in **Attachment 3**.

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
2002/2003	Soil Bio-remediation	Chung/Geofon	Following the completion of a bio-remediation pilot study in 2000, and the finalization of a Decision Document in 2001 (Tetra Tech, 2001), bio-remediation of 880 cy of soil was completed by a soil compost method. Four windrows were created and staged in a treatment pad located south of building 101-44. Bio-remediation continued until analytical results indicated that RDX was below the USEPA PRG of 22 mg/kg and TPH-d was below the established disposal limit of 2,000 mg/kg.	Following remediation, bio-remediated soil was disposed of at the NDEP-Permitted Group 24 Industrial Solid Waste Disposal Cell. Subsequent to the soil disposal the top six to 18 inches of soil from the treatment pad (approximately 100 cy) were removed and disposed of at NDEP-Permitted Group 24 Industrial Solid Waste Disposal Cell. Following treatment pad removal soil samples were collected for TPH-d and explosives analysis. Based on the analytical data TPH-d and explosives were below laboratory detection limits (Chung/Geofon, 2004).	Remediation Complete. NDEP concurrence letter dated 25 February 2004 is included in **Attachment 3**.

Table 2-1 Summary of Actions at SWMU I07

Date	Action Purpose	Company	Site Actions	Major Findings	Recommendations
2012	Supplemental Investigation	Bay West Inc.	Completed three soil borings (I07-01, I07-02, and I07-03) to a depth of 75 feet bgs to evaluate the vertical distribution of TPH-d and explosives (RDX and HMX). Based on the analytical data obtained during the 2002 RA the supplemental investigation soil borings were placed in relation to known areas of TPH-d contamination. 27 Soil samples were collected from the three soil borings. The soil samples were collected from approximately 5, 10, 15, 25, 35, 45, 55, 65, and 75 feet bgs. Supplemental investigation soil boring locations and the 2002 RA former sample locations are included on the Bay West 2012 Figure 1-4 and 3-1, **Attachment 4**.	TPH-d was detected at concentrations exceeding the State of Nevada Screening Level of 100 mg/kg in five soil samples: I07-02-S-(015), I07-02-S-(21), I07-03-S-(010), I07-03-S-(15), and I07-03-S-(23). TPH-d concentrations ranged from 2,200 to 8,600 mg/kg. Based on the analytical data from the supplemental investigation TPH-d contamination is limited to approximately eight to 24 feet bgs. It should be noted that the 2002 RA excavation, within the area of the supplemental investigation soil borings, was completed to an approximate depth of eight to 10 feet bgs and backfilled with treated compost. One soil sample collected during the supplemental investigation contained explosives (RDX) above the 2011 USEPA RSL of 24 mg/kg. Soil sample I07-01-S-(05) had an RDX concentration of 40 mg/kg at a depth of five feet bgs. This detection is attributed to the backfill material since the area was remediated to a depth of approximately eight feet bgs. Analytical results are included on the Bay West 2012 Figure 3-1 and Table 3-1 in **Attachment 4**.	Based on fate and transport modeling and calculations of Tier II SSTLs for TPH-d and RDX, residual soil contamination present at SWMU I07 currently does not pose a risk to human health or the environment (Bay West, 2012). Site recommended for No Further Action, industrial scenario.

2.4 Nature and Extent of Contamination

Investigation activities completed in the 1990s identified RDX, HMX and TPH-d contamination in a 150-foot-long and 80-foot-wide landfill pit identified as SWMU I07. Field screening and laboratory analyses of the near-surface soils collected from within the landfill pit detected concentrations of petroleum hydrocarbon products as high as 15,000 mg/kg at depths of five feet bgs. The RDX and HMX were detected in yellow-brown ash-like material located on the surface within the landfill pit.

The explosives contamination was believed to be limited to near surface soil or the ash-like material. However, the TPH-d concentrations above 100 mg/kg were detected to a depth of 50 feet bgs. Based on the data obtained during the remedial investigations SWMU I07 was recommended for RA. The selected remedy was soil removal and soil bio-remediation.

In 2002, a RA was completed at SWMU I07 by Chung and Associates. The purpose of the RA was to remove RDX impacted soil and ash-like material to below an established RDX USEPA PRG of 22 mg/kg, and TPH-d impacted soils with the greatest concentration nearest the landfill pit surface. A total of 880 cubic yards of RDX and TPH-d impacted soil was removed, bio-remediated, and disposed of at the NDEP-Permitted Group 24 Industrial Solid Waste Disposal Cell. As documented in the Final Remediation Report Addendum A (Chung/Geofon 2003), the RA completed at SWMU I07 had successfully demonstrated the removal of RDX impacted soil. However, the vertical distribution of TPH-d beyond the base of the excavation was not determined. Furthermore, the total depth of TPH-d impacts beyond 50 feet bgs had not been investigated.

A supplemental investigation was completed in 2012 to evaluate the vertical distribution of TPH-d, HMX and RDX within the 2002 remediated area. The SWMU I07 2012 supplemental investigation included the completion of three soil borings within areas of known TPH-d contamination to a depth 75 feet bgs, and the collection of 27 soil samples. The soil samples were collected from approximately 5, 10, 15, 25, 35, 45, 55, 65, and 75 feet bgs. Based on data collected during the supplemental investigation, the vertical distribution of TPH-d at SWMU I07 above the State of Nevada Screening Level of 100 mg/kg is limited to approximately 8 to 24 feet bgs (Bay West, 2012).

As documented during the 2002 RA, RDX contamination above the established USEPA PRG (22 mg/kg) had been demonstrated to be removed from within the excavation footprint. With exception to soil sample I07-01-S-(05), RDX and HMX were detected below USEPA RSLs during the 2012 supplemental investigation. The RDX concentration in soil sample I07-01-S-(05) was 40 mg/kg which is above the 2011 USEPA Industrial RSL of 24 mg/kg. Soil sample I07-01-S-(05) was collected at a depth of five feet bgs. Soil sample I07-01-S-(05) was collected from with the RA backfill zone and is attributed to the backfill material and not residual contamination from the RA. Backfilling is further discussed in Section 2.8.

2.5 Fate and Transport

The site conceptual model for SWMU I07 is based on an unlined landfill pit with oil and petroleum waste products followed by transport or migration of contaminants to the soil. After petroleum waste leaks from the storage containers, gravitational forces act to draw

the fuel downward. While fuel is migrating downward, the fuel is either adsorbed to soil particles or trapped in soil pore space.

Based on data collected during the 2012 Supplemental Investigation, TPH-d contamination at SWMU I07 is limited vertically to a depth range of approximately 8 to 24 feet bgs.

The contaminant migration pathway at SWMU I07 is through dissolution of residual TPH-d in the soil by infiltration of water. Due to low rainfall in the Hawthorne area (<5 inches per year) it is unlikely that consequential amounts of water might move through the soil and leach contamination to groundwater. Fate and Transport modeling completed for SWMU I07 by Chung/Geofon in 2004 supports TPH-d's limited migration potential, as shown in **Table 2-2.** A more detailed discussion of the modeling is included as **Attachment 5**.

Table 2-2 SWMU I07 COPC Modeled Transport Depth

SWMU	Modeled COPC	Highest COPC Concentration Detected	COPC Depth (feet)	Modeled Vertical Transport Depth (feet)
I07*	TPH-d	11,000 mg/kg (1)	31-50 (2)	72

** Chung/Geofon, 2004. Final Remediation Report, Solid Waste Management Unit B29 and I07, Hawthorne Army Depot, Hawthorne, Nevada, February 2004.*

1-TPH-d contamination concentration data collected during the 2002 RA as documented in the Chung/Geofon 2003 Final Remediation Report Addendum A.

2-TPH-d contamination depth data collected during the 1997 Remedial Investigation as documented in the Tetra Tech 1998 Final Remedial Investigation Report.

2.6 Tier II SSTL for TPH-d

A Tier II SSTL for TPH-d at SWMU I07 was developed to assist in evaluating the potential risk posed by petroleum contaminated soils present at the site. Nevada Administrative Code (NAC) 445A.22705, allows for the application of the ASTM Standard E-1739-95 Risk Based Corrective Action (RBCA) to develop Tier II SSTLs in setting site-specific risk criteria. Because diesel contains relatively little of the more mobile and more toxic VOCs, the primary concern is on the prevention of free product on groundwater. NAC 445A.22735 requires that free product be reduced to less than 0.5 inch. Therefore the TPH-d SSTL was developed based on the prevention of free product migration to groundwater.

2.6.1 Tier II SSTL background

Soil has the ability to retain non-mobile liquids in smaller and discontinuous pore spaces. The amount of liquids that soil can hold is called its residual saturation. Once residual saturation has been exceeded, the liquid can migrate. Diesel exists as a light non-aqueous phase liquid (LNAPL) and is held in retention along with water. The American Petroleum Institute (API) published a summary of empirical models and compared the results with experimentally measured residual saturated values. The results of these comparisons were then used to develop screening level criteria for specific soils and products.

The API utilizes three empirical models in developing a method for conservative screening levels. These include: 1) a zero water method; 2) a field moisture capacity method (both developed by Hoag and Marley, 1986); and 3) a method developed by Zytner (1993). The Hoag and Marley methods are based on average soil particle

diameter and that residual retention is related to available surface area. In the zero water method, all the pore spaces are available for the LNAPL. In the field moisture capacity method some of the available pore space is occupied by water. Therefore, field conditions would be expected to range somewhere between the zero water and field moisture methods. The Zytner method is based on observed relationships of residual saturation and the ratio of product density over soil bulk density. A more detailed discussion of the SSTL is presented in **Attachment 6**.

2.6.2 Tier II SSTL Conclusion

Results of the empirical models for SWMU I07 indicated a petroleum residual saturated value of between 32,000 and 174,000 mg/kg. The average of the three methods is higher than the median API value. Therefore, applying the 90% confidence value of 11,000 mg/kg would provide an acceptable conservative margin. Groundwater contacting fine- to medium-grained soils with a TPH-d concentration less than 11,000 mg/kg would not likely result in free product (Bay West, 2012).

Based on the current analytical results TPH-d was detected above State of Nevada Screening Level of 100 mg/kg in five soil samples: I07-02-S-(015), I07-02-S-(21), I07-03-S-(010), I07-03-S-(15), and I07-03-S-(23). The TPH-d concentration range of the previously mentioned soil samples is 2,200 to 8,600 mg/kg which is below the 90% confidence level. Therefore the residual TPH-d contamination at SWMU I07 does not constitute a risk to groundwater.

2.7 Tier II SSTL for RDX

With NDEP concurrence, a Tier II SSTL for RDX, as documented in the Revised Final Corrective Action Plan for SWMU B04, (Plexus, 2008), was utilized to evaluate the health and environmental risks associated with RDX concentrations at SWMU I07. The RDX Tier II evaluation at SWMU B04 was performed to develop SSTLs for a range of protectiveness. As part of the evaluation, three exposure scenarios were developed: 1) current and future standard workers; 2) on-site workers; and, 3) potential future construction workers. Based on the exposure factor for each scenario, specific SSTLs were calculated. The range of SSTLs was evaluated for applicability and a single SSTL value was selected as a final RDX remediation/clean-up goal. The final RDX soil clean-up goal developed for SWMU B04, which is protective of human health and the environment, is 363 mg/kg. The SWMU B04 SSTL value was based on the construction work scenario with a target risk level of 1x10-6.

Based on the analytical data collected during the 2011 supplemental investigation, RDX was detected in I07-01-S-(05) at a concentration of 40 mg/kg. This RDX concentration exceeds the USEPA 2011 Industrial RSL of 24 mg/kg; however, this result is significantly less than the SSTL developed for SWMU B04 of 363 mg/kg. Therefore, the residual RDX soil contamination at SWMU I07 does not constitute a risk to human health or the environment.

2.8 Decommissioning Activities

The excavation pit was backfilled with satisfactorily treated compost that was located around the treatment pad, south of Building 101-44. Backfill material was transported by dump truck to the excavation area. The backfill material was placed in lifts at two feet or less, moisture-conditioned, and compacted. Native soil was placed in loose lifts over the

top two feet of the excavation foot print. The finished surface of the excavated area was smooth and free from irregular surface changes (Chung/Geofon, 2004).

Following bio-remediation activities the surface of the treatment pad was cleaned using a loader to scrape the top six to 12 inches of soil (100 cy). Following surface scraping the area was divided into grids and four soil samples were collected by using a five-point composite sampling method. Based on the analytical results, two of the four composite samples had TPH-d concentrations greater than 100 mg/kg, however explosives were below laboratory detection limits. Subsequently the treatment pad area was re-scraped and sampled using the same methodology. The soil samples collected after the second treatment pad scraping indicated TPH-d below laboratory detection limits (Chung/Geofon, 2004).

The following photograph was collected February 2012 during the 2012 Supplement Investigation. The photograph was taken after soil borings were completed.

Photograph of Former SWMU I07 Landfill Pit	
Photograph view to the northwest towards Walker Lake, NV. The former excavation/ landfill pit is located in the foreground of the photograph. The tire tracks in the photograph are from drilling equipment utilized during the 2012 Supplemental Investigation.	

3.0 CONCLUSIONS

Investigations, a RA, fate and transport modeling, and Tier II SSTL calculations indicate that no present or future receptors are likely to be adversely impacted by residual RDX and TPH-d soil contamination at SWMU I07. NFA, industrial scenario, is requested following NAC 445A.227 guidelines, under which issues were addressed as shown in **Table 3-1**.

Table 3-1 Site Evaluation for SWMU I07

Assessment Criteria		Response
A	Depth of any groundwater	Estimated to be 134 feet bgs.
B	Distance to irrigation or drinking water wells	No irrigation or drinking water wells are located within three miles down-gradient from SWMU I07.
C	The type of soil that is contaminated	The soil encountered during the 2012 supplemental investigation includes sand with varying amounts of silt.
D	The annual precipitation	Annual precipitation for Hawthorne, Nevada is 4.6 inches.
E	The type of waste or substance released	TPH-d is most likely from waste oil releases from drums found within the landfill pit and/or from dumping waste products in the pit. The explosive constituents that were detected at SWMU I07 in 2012 were most likely the result of disposal and burning of explosives within the landfill pit.
F	The extent of the contamination	Based on 2012 characterization results, it appears that the TPH-d soil contamination is present from 8 to 24 feet bgs. Fate and transport modeling completed by Chung/Geofon in 2004 indicated that the residual TPH-d contamination at the site is highly unlikely to impact groundwater. The RDX detection of 40 mg/kg noted in 2012 at five feet bgs is attributed to backfill material rather than residual SWMU I07 contamination.
G	The present and potential use for the land	SWMU I07 is currently considered industrial and future use of the site is expected to remain industrial.
H	The preferred routes of migration	Contaminant migration at SWMU I07 is vertical, due to gravity and capillary forces.
I	The location of structures and impediments	SWMU I07 is located 450 southwest of Building 101-44. There are no known subsurface structures or physical impediments to horizontal migration of contaminants at SWMU I07.
J	The potential for a hazard related to fire, vapor, or explosion	Based on field observations, there are no apparent hazards related to fire, vapor, or explosions at SWMU I07.
K	Other site-specific factors	No other SWMU-specific factors have been noted.

4.0 REFERENCES

Bay West Inc., June 2012. Final SWMU I07 Technical Memorandum, SWMU I07 Building 101-44 Former Landfill, Hawthorne Army Depot, Hawthorne, Nevada.

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USAEHA, 1988. Final Report. Ground Water Contamination Survey No. 38-26-0850-88. Evaluation of Solid Waste Management Units. HWAAP, Hawthorne, Nevada. May 12-19, 1987 and August 1-5.

Plexus, April 2007. Final Corrective Action Plan for K03a, b, d: Underground Storage Tank Sites, Hawthorne Army Depot, Hawthorne, Nevada.

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Tetra Tech, August 2000. “Draft Report 2000 Bioremediation Pilot Study for Explosives, Hawthorne Army Depot, Hawthorne. Nevada.

Tetra Tech, June 2001. Decision Document, Solid Waste Management Unit I07, Building 101-44 Landfill, Hawthorne Army Depot, Hawthorne, Nevada.

WaterWork, 1990. Hawthorne Army Ammunition Plant, Area 101 Surface Impoundments, Field Lab Data and Analysis, Attachment 1-8.

Figures

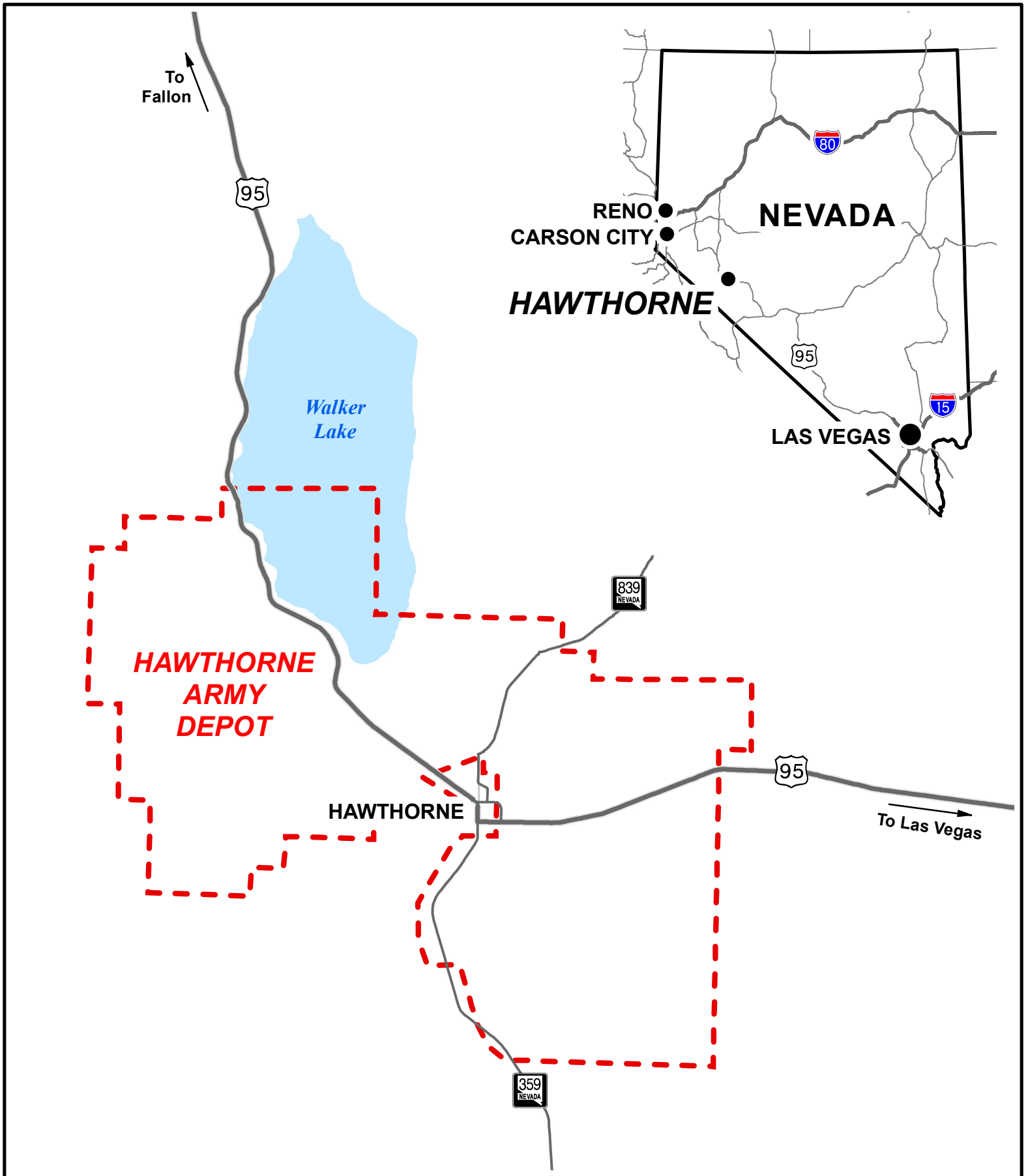


Figure 1

Hawthorne Army Depot

Bay West

Customer-Focused Environmental & Industrial Solutions

N

0 3 6 Miles

0 4 8 Kilometers

Legend

Installation Boundary

Data is Projected in the NAD83 UTM Zone 11N
Aerial Photo: ArcGIS Online Map server
Figure Create Using ArcMap 9.3.1

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_SACRAMENTO\Hawthorne_AAP\090499\MapDocs\I07\I07 Regional Map.mxd

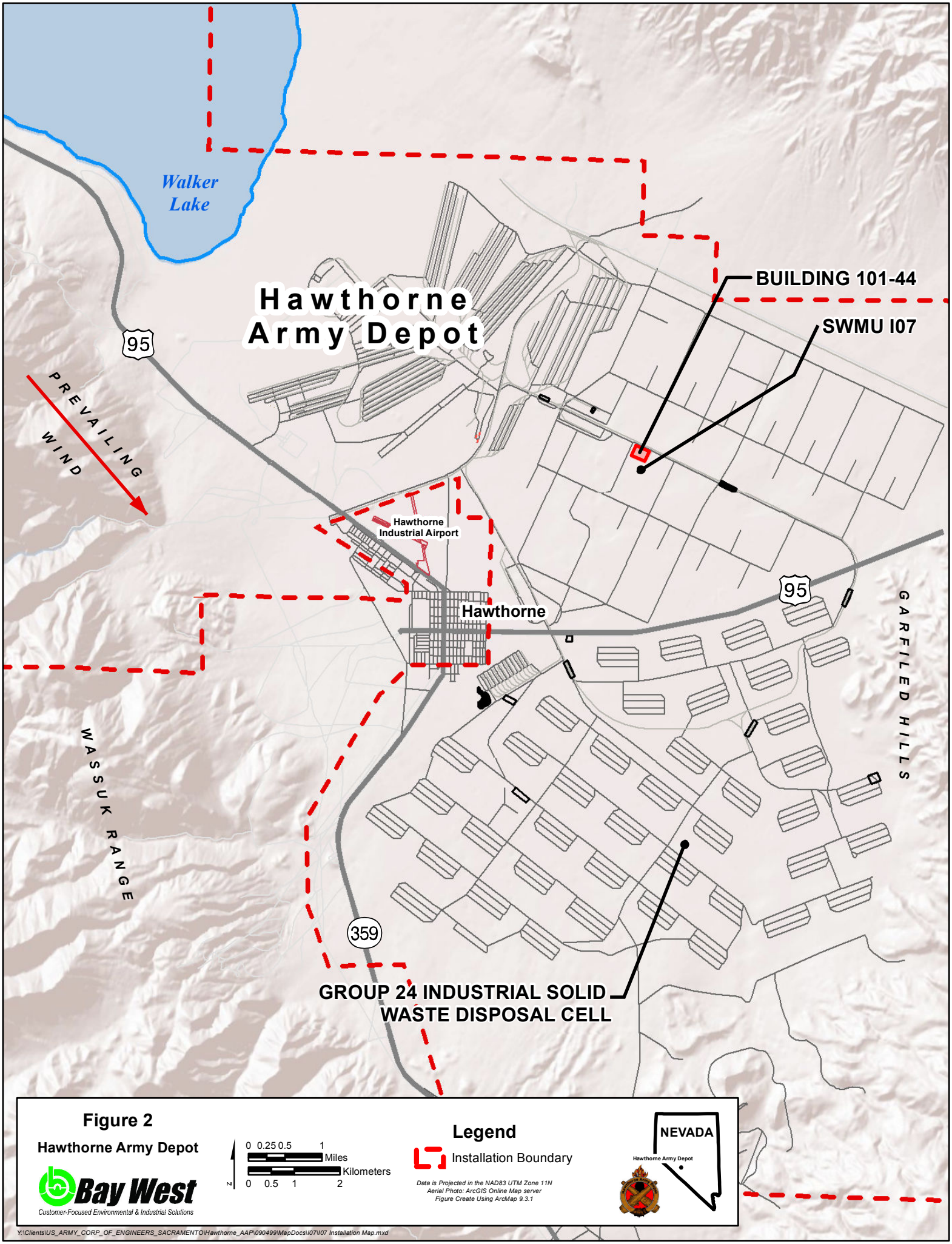
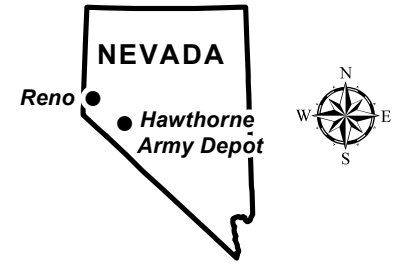


Figure 2

Hawthorne Army Depot

Figure 3
Site Map

Hawthorne Army Depot
Hawthorne, Nevada



Map Projection: NAD 1983 UTM Zone 11 North

Bing World Imagery Basemap

0 500 1,000 Feet

0 150 300 Meters

Sites of Interest

Installation Boundary

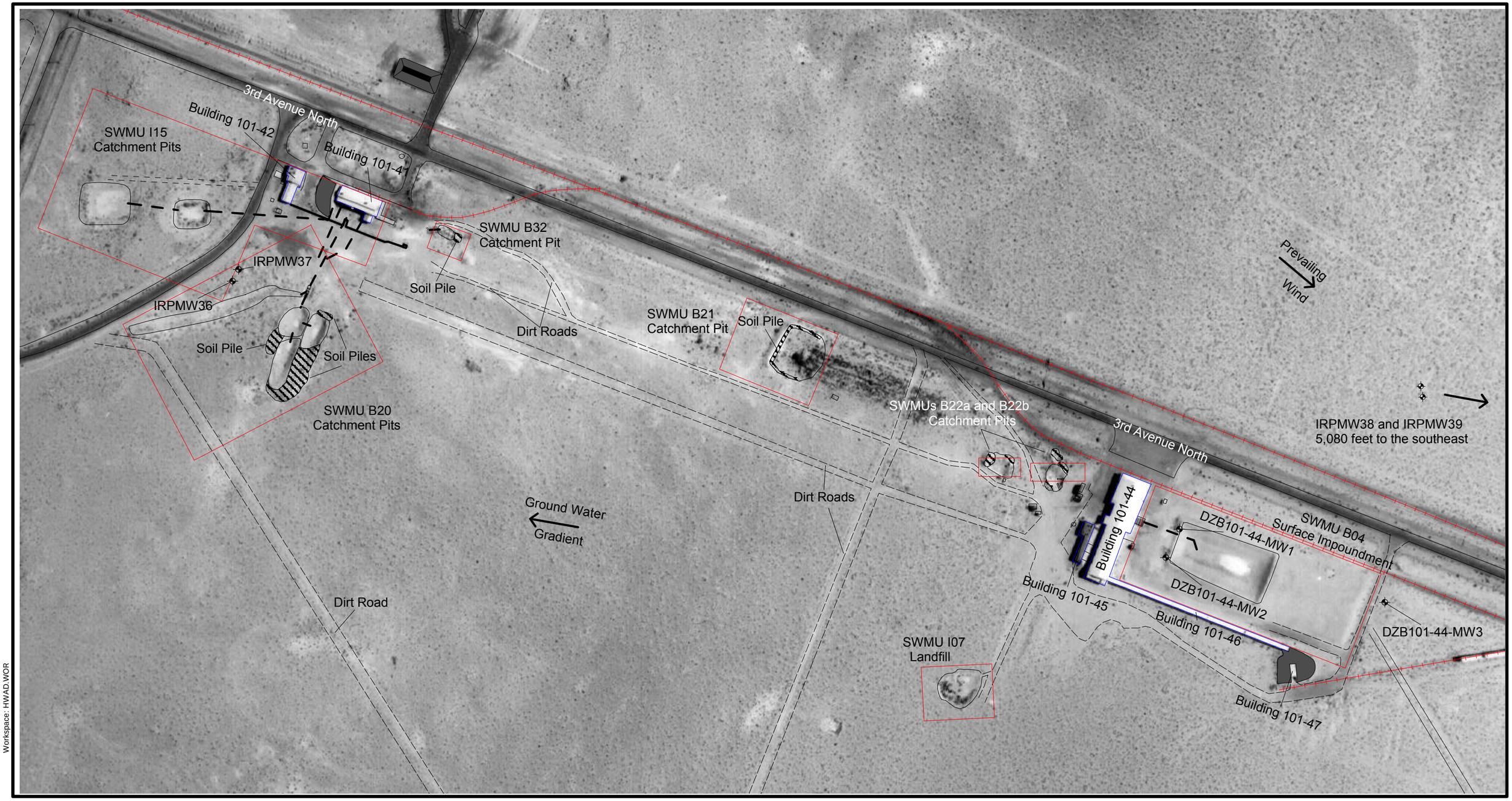
Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: M.B. Date Drawn:11/30/2011 Project # J090499

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_SACRAMENTO\Hawthorne_AAP\090499\MapDocs\I07\I07_Figure2_SiteMap.mxd

Attachment 1

Supporting Documentation from the 1998 Tetra Tech Final Remedial Investigation Report for Solid Waste Management Units, Hawthorne Army Depot, Hawthorne, Nevada.



Workspace: HWAD.WOR

Legend:

- Drain Line
- Explosion Barrier
- Fence
- Monitoring Well
- Railroad

N

0 115 230

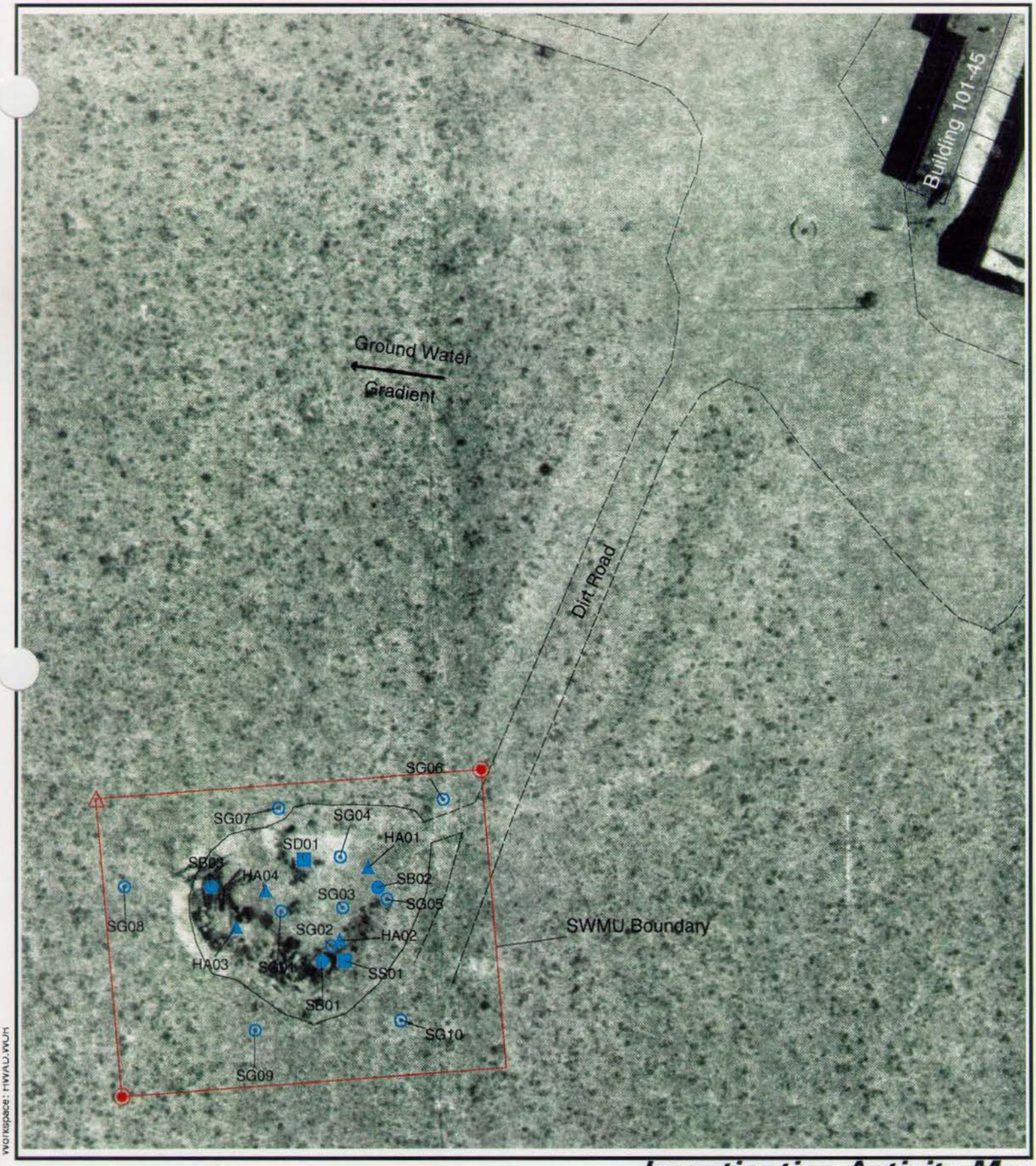
Approximate Scale in feet

Tetra Tech, Inc.

East 101 Production Area Map

Hawthorne Army Depot
Hawthorne, Nevada

Figure 3-2



Workspace: HWAU.WOR

Legend:

- Boundary Corner Pin
- Hand Auger Location
- Soil Boring Location
- Soil Gas Location
- Surface Soil/Sludge Sample
- SWMU Monument

0 30 60
Approximate Scale in Feet

N

Investigation Activity Map
SWMU I07
Building 101-44 Landfill

Hawthorne Army Depot
Hawthorne, Nevada

Tetra Tech, Inc.

Figure 3-1

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT	1.0	1.0	1.0	1.0	10
I3/4SG12	<1.0	<1.0	<1.0	<1.0	<10
I3/4SG13	<1.0	<1.0	<1.0	<1.0	<10
I3/4SG14	<1.0	<1.0	<1.0	<1.0	<10
I3/4SG15	<1.0	<1.0	<1.0	<1.0	<10
I3/4SG16	<1.0	<1.0	<1.0	<1.0	<10
I3/4SG17	<1.0	<1.0	<1.0	1.8	<10
I3/4SG18	<1.0	<1.0	<1.0	<1.0	<10
I3/4SG19	<1.0	<1.0	<1.0	<1.0	<10
I07SG01	<1.0	<1.0	<1.0	<1.0	<10
I07SG02	<1.0	<1.0	<1.0	<1.0	<10
I07SG03	<1.0	<1.0	<1.0	<1.0	<10
I07SG04	<1.0	<1.0	<1.0	<1.0	<10
I07SG05	<1.0	<1.0	<1.0	<1.0	<10
I07SG06	<1.0	<1.0	<1.0	<1.0	<10
I07SG07	<1.0	<1.0	<1.0	<1.0	<10
I07SG08	<1.0	<1.0	<1.0	<1.0	<10
I07SG09	<1.0	<1.0	<1.0	<1.0	<10
I07SG10	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG01	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG02	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG03	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG04	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG05	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG06	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG07	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG08	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG09	<1.0	<1.0	<1.0	<1.0	<10
I9/10SG10	<1.0	<1.0	<1.0	<1.0	<10
I11SG01	<1.0	<1.0	<1.0	<1.0	<10
I11SG02	<1.0	<1.0	<1.0	<1.0	<10
I11SG03	<1.0	<1.0	<1.0	<1.0	<10
I11SG04	<1.0	<1.0	<1.0	<1.0	<10
I11SG05	<1.0	<1.0	<1.0	3.1	670
I11SG06	<1.0	<1.0	<1.0	<1.0	<10
I11SG07	<1.0	<1.0	<1.0	<1.0	<10
I11SG08	<1.0	<1.0	<1.0	<1.0	<10
I11SG09	<1.0	<1.0	<1.0	<1.0	<10
I11SG10	<1.0	<1.0	<1.0	<1.0	<10

* *CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE*

Sample ID	I07-HA01-1-S	I07-HA01-2-S	I07-HA02-1-S	I07-HA02-2-S	I07-HA03-1-S	I07-HA03-2-S	I07-HA04-1-S	I07-HA04-2-S	I07-SB01-1-S
Location ID	HA01	HA01	HA02	HA02	HA03	HA03	HA04	HA04	SB01
Sample Date	7/20/94	7/20/94	7/21/94	7/21/94	7/21/94	7/21/94	7/21/94	7/21/94	2/26/97
Sample Depth (feet)	2	5	2	5	2	5	2	5	5
Metals (mg/kg)									
Methods 6000 to 7000									
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	5.2 J	<4	4.6 J	<4	<4	4.7 J	<4	<4	NA
Barium	34	99	46	64	63	70	74	150	NA
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	0.26 J	<0.2	<0.2	NA
Chromium	1.7 J	3.6 J	0.6	2 J	1 J	3.1 J	1 J	2.1 J	NA
Lead	<5	<5	<5	<5	<5	<6	<6	<5	NA
Explosives (mg/kg)									
Method 8330									
HMX	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX Test Kit (mg/kg)									
Method 8510									
RDX	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX-Dup	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX (Rerun)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organics (mg/kg)									
Method 8260A									
Tetrachloroethene	NA	NA	NA	NA	NA	NA	NA	NA	<0.0002
1,1-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001
1,3,5-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001
4-Isopropyltoluene	NA	NA	NA	NA	NA	NA	NA	NA	<0.0002
BTEX Test Kit (mg/kg)									
Method 4031									
BTEX	X>50	X>50	X<2	X<2	10<X<50	50<X<300	50	X>300	NA
TPH Test Kit (mg/kg)									
Method 4030									
TPH-d	NA	NA	NA	NA	NA	NA	NA	NA	100<X<500
TPH-d (Rerun)	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-d-Dup	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample ID	**I07-HA01-1-S**	**I07-HA01-2-S**	**I07-HA02-1-S**	**I07-HA02-2-S**	**I07-HA03-1-S**	**I07-HA03-2-S**	**I07-HA04-1-S**	**I07-HA04-2-S**	**I07-SB01-1-S**
Location ID	HA01	HA01	HA02	HA02	HA03	HA03	HA04	HA04	SB01
Sample Date	7/20/94	7/20/94	7/21/94	7/21/94	7/21/94	7/21/94	7/21/94	7/21/94	2/26/97
Sample Depth (feet)	2	5	2	5	2	5	2	5	5
Petroleum Hydrocarbons (mg/kg)									
Methods M8015E & 8015M									
C11-C22 (Diesel)	NA	NA	NA	NA	NA	NA	NA	NA	NA
C23-C30 (Motor oil)	NA	NA	NA	NA	NA	NA	NA	NA	NA
C31-C40 (Heavy oil)	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-d	1.2 [J]	1.3 [J]	<0.2	<0.2	1800 [J]	15000 [J]	14000 [J]	9170 [J]	NA

Sample ID	I07-SB01-2-S	I07-SB01-3-S	I07-SB01-4-S	I07-SB02-1-S	I07-SB02-2-S	I07-SB02-3-S	I07-SB02-4-S	I07-SB03-1-S	I07-SB03-2-S
Location ID	SB01	SB01	SB01	SB02	SB02	SB02	SB02	SB03	SB03
Sample Date	2/26/97	2/26/97	2/26/97	2/20/97	2/20/97	2/20/97	2/20/97	2/26/97	2/26/97
Sample Depth (feet)	5	18	25	4.5	4.5	14.5	25	7	7
Metals (mg/kg)									
Methods 6000 to 7000									
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (mg/kg)									
Method 8330									
HMX	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX Test Kit (mg/kg)									
Method 8510									
RDX	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX-Dup	NA	NA	NA	NA	NA	NA	NA	NA	NA
RDX (Rerun)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organics (mg/kg)									
Method 8260A									
Tetrachloroethene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0003
1,1-Dichloroethene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
1,2,4-Trimethylbenzene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
1,3,5-Trimethylbenzene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
4-Isopropyltoluene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0003
BTEX Test Kit (mg/kg)									
Method 4031									
BTEX	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH Test Kit (mg/kg)									
Method 4030									
TPH-d	100<X<500	100<X<500	100<X<500	100<X<500	100<X<500	100<X<500	100<X<500	X=500	100<X<500
TPH-d (Rerun)	NA	NA	NA	NA	NA	NA	0<X<20	100<X<500	NA
TPH-d-Dup	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample ID	**I07-SB01-2-S**	**I07-SB01-3-S**	**I07-SB01-4-S**	**I07-SB02-1-S**	**I07-SB02-2-S**	**I07-SB02-3-S**	**I07-SB02-4-S**	**I07-SB03-1-S**	**I07-SB03-2-S**
Location ID	SB01	SB01	SB01	SB02	SB02	SB02	SB02	SB03	SB03
Sample Date	2/26/97	2/26/97	2/26/97	2/20/97	2/20/97	2/20/97	2/20/97	2/26/97	2/26/97
Sample Depth (feet)	5	18	25	4.5	4.5	14.5	25	7	7
Petroleum Hydrocarbons (mg/kg)									
Methods M8015E & 8015M									
C11-C22 (Diesel)	NA	NA	NA	NA	NA	NA	NA	NA	NA
C23-C30 (Motor oil)	NA	NA	NA	NA	NA	NA	NA	NA	NA
C31-C40 (Heavy oil)	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-d	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample ID	I07-SB03-3-S	I07-SB03-4-S	I07-SB03-5-S	I07-SB03-6-S	I07-SB03-7-S	I07-SD01-1-SD	I07-SS01-1-S	I07-SS02-1-S
Location ID	SB03	SB03	SB03	SB03	SB03	SD01	SS01	SS01
Sample Date	2/26/97	2/26/97	2/26/97	2/26/97	2/26/97	2/16/97	2/16/97	2/16/97
Sample Depth (feet)	15.5	31	37	43	50	0	0.5	0.5
Metals (mg/kg)								
Methods 6000 to 7000								
Aluminum	NA	NA	NA	NA	NA	NA	4200	3010
Arsenic	NA	NA	NA	NA	NA	NA	4.4	4.7
Barium	NA	NA	NA	NA	NA	NA	39.3	31.7
Cadmium	NA	NA	NA	NA	NA	NA	<0.021	<0.021
Chromium	NA	NA	NA	NA	NA	NA	3.2	2.4
Lead	NA	NA	NA	NA	NA	NA	2.8	2.8
Explosives (mg/kg)								
Method 8330								
HMX	NA	NA	NA	NA	NA	NA	5.97	3.7
RDX	NA	NA	NA	NA	NA	NA	27.4	20.7
RDX Test Kit (mg/kg)								
Method 8510								
RDX	NA	NA	NA	NA	NA	NA	47.6	NA
RDX-Dup	NA	NA	NA	NA	NA	NA	NA	NA
RDX (Rerun)	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organics (mg/kg)								
Method 8260A								
Tetrachloroethene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.24 J	NA	NA
1,1-Dichloroethene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.11 J	NA	NA
1,2,4-Trimethylbenzene	0.0008 J	<0.0001	<0.0001	<0.0001	<0.0001	0.035 J-	NA	NA
1,3,5-Trimethylbenzene	0.002 J	<0.0001	<0.0001	<0.0001	<0.0001	0.06 J-	NA	NA
4-Isopropyltoluene	0.001 J	<0.0002	<0.0002	<0.0002	<0.0002	<0.02 UJ-	NA	NA
BTEX Test Kit (mg/kg)								
Method 4031								
BTEX	NA	NA	NA	NA	NA	NA	NA	NA
TPH Test Kit (mg/kg)								
Method 4030								
TPH-d	X<500	100<X<500	100<X<500	100<X<500	100<X<500	NA	NA	NA
TPH-d (Rerun)	100<X<500	NA	NA	NA	NA	NA	NA	NA
TPH-d-Dup	NA	NA	NA	NA	NA	NA	NA	NA

Sample ID	**I07-SB03-3-S**	**I07-SB03-4-S**	**I07-SB03-5-S**	**I07-SB03-6-S**	**I07-SB03-7-S**	**I07-SD01-1-SD**	**I07-SS01-1-S**	**I07-SS02-1-S**
Location ID	SB03	SB03	SB03	SB03	SB03	SD01	SS01	SS01
Sample Date	2/26/97	2/26/97	2/26/97	2/26/97	2/26/97	2/16/97	2/16/97	2/16/97
Sample Depth (feet)	15.5	31	37	43	50	0	0.5	0.5
Petroleum Hydrocarbons (mg/kg)								
Methods M8015E & 8015M								
C11-C22 (Diesel)	2000	NA	NA	NA	26	<8100	NA	NA
C23-C30 (Motor oil)	230	NA	NA	NA	<0.41	480000	NA	NA
C31-C40 (Heavy oil)	<3	NA	NA	NA	<0.31	500000 [J]	NA	NA
TPH-d	NA	NA	NA	NA	NA	NA	NA	NA

Sample ID Location ID Sample Date Sample Depth (feet)	Analyses	Detections	Minimum	Maximum	PCG	PCG Hits	Background	Background Hits
Metals (mg/kg) **Methods 6000 to 7000**								
Aluminum	2	2	3010	4200	80,000	0	12365	0
Arsenic	10	5	4.4	5.2	100	0	18.1	0
Barium	10	10	31.7	150	2,000	0	447	0
Cadmium	10	1	0.26	0.26	20	0	1.08	0
Chromium	10	10	0.6	3.6	20	0	13.76	0
Lead	10	2	2.8	2.8	100	0	16.7	0
Explosives (mg/kg) **Method 8330**								
HMX	2	2	3.7	5.97	4000	0	0	0
RDX	2	2	20.7	27.4	64	0	0	0
RDX Test Kit (mg/kg) **Method 8510**								
RDX	1	1	47.6	47.6	64	0	0	0
RDX-Dup	0	0	ND	ND	NE	NE	0	0
RDX (Rerun)	0	0	ND	ND	NE	NE	0	0
Volatile Organics (mg/kg) **Method 8260A**								
Tetrachloroethene	16	1	0.24	0.24	15	0	0	0
1,1-Dichloroethene	16	1	0.11	0.11	NE	NE	0	0
1,2,4-Trimethylbenzene	16	2	0.0008	0.035	NE	NE	0	0
1,3,5-Trimethylbenzene	16	2	0.002	0.06	NE	NE	0	0
4-Isopropyltoluene	16	1	0.001	0.001	NE	NE	0	0
BTEX Test Kit (mg/kg) **Method 4031**								
BTEX	8	1	50	50	NE	NE	0	0
TPH Test Kit (mg/kg) **Method 4030**								
TPH-d	15	0	ND	ND	NE	NE	0	0
TPH-d (Rerun)	3	0	ND	ND	NE	NE	0	0
TPH-d-Dup	0	0	ND	ND	NE	NE	0	0

Sample ID Location ID Sample Date Sample Depth (feet)	Analyses	Detections	Minimum	Maximum	PCG	PCG Hits	Background	Background Hits
Petroleum Hydrocarbons (mg/kg) **Methods M8015E & 8015M**								
C11-C22 (Diesel)	3	2	26	2000	100	1	0	0
C23-C30 (Motor oil)	3	2	230	480000	NE	NE	0	0
C31-C40 (Heavy oil)	3	1	500000	500000	NE	NE	0	0
TPH-d	8	6	1.2	15000	100	4	0	0

Attachment 2

Supporting Documentation from the (September) 2003 Chung/Geofon Final Remediation Report Addendum A, Solid Waste Management Unit I07, Building 101-44 Landfill, Hawthorne Army Depot, Hawthorne, Nevada.

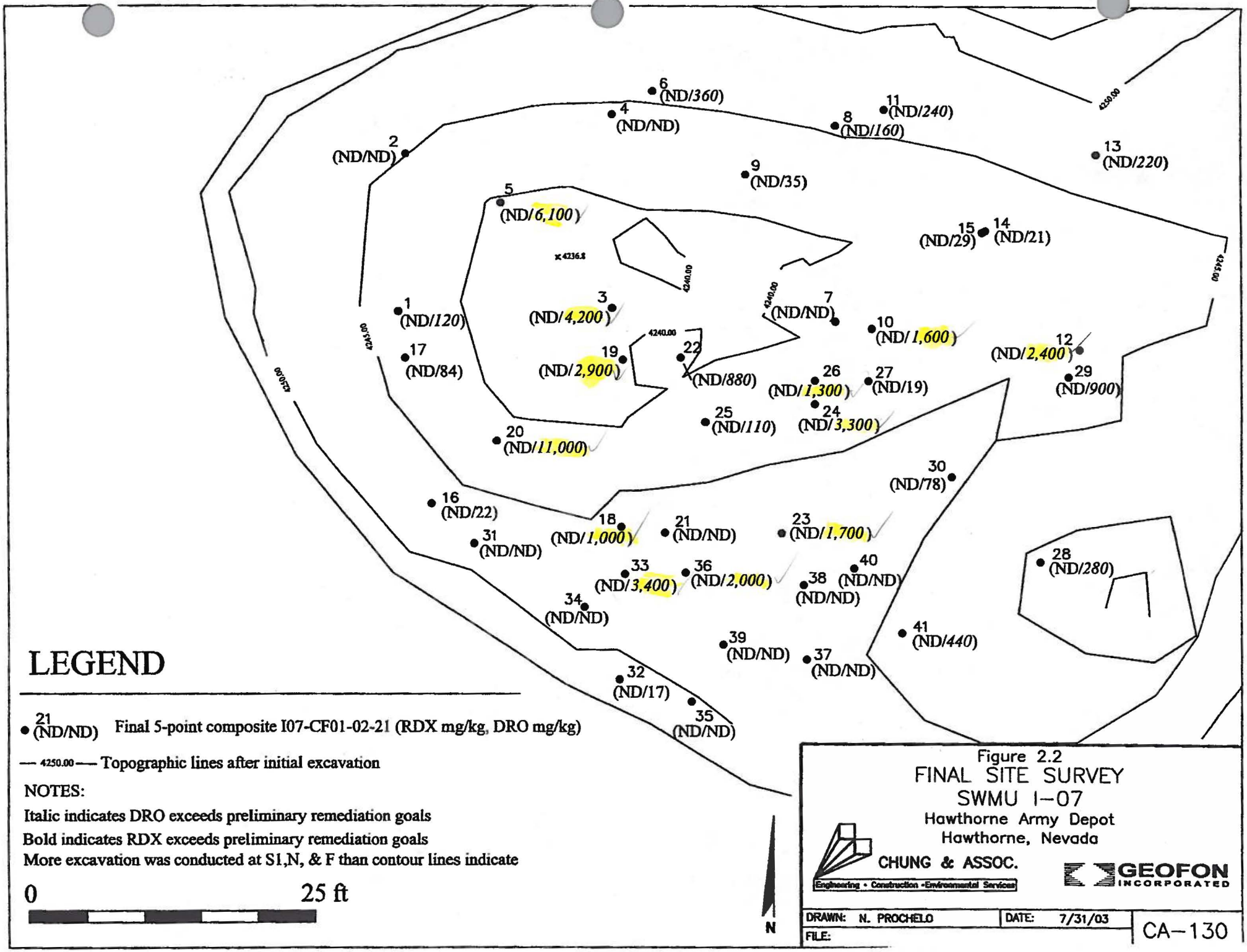

6 (ND/360)
4 (ND/ND)
11 (ND/240)
8 (ND/160)
2 (ND/ND)
13 (ND/220)
9 (ND/35)
5 (ND/6,100)
15 (ND/29)
14 (ND/21)
4236.8
4240.00
4250.00
4245.00
1 (ND/120)
3 (ND/4,200)
7 (ND/ND)
10 (ND/1,600)
12 (ND/2,400)
17 (ND/84)
19 (ND/2,900)
22 (ND/880)
26 (ND/1,300)
27 (ND/19)
29 (ND/900)
24 (ND/3,300)
25 (ND/110)
20 (ND/11,000)
30 (ND/78)
16 (ND/22)
18 (ND/1,000)
21 (ND/ND)
23 (ND/1,700)
31 (ND/ND)
28 (ND/280)
33 (ND/3,400)
36 (ND/2,000)
40 (ND/ND)
38 (ND/ND)
34 (ND/ND)
41 (ND/440)
39 (ND/ND)
37 (ND/ND)
32 (ND/17)
35 (ND/ND)
LEGEND
21 (ND/ND) Final 5-point composite I07-CF01-02-21 (RDX mg/kg, DRO mg/kg)
4250.00 Topographic lines after initial excavation
NOTES:
Italic indicates DRO exceeds preliminary remediation goals
Bold indicates RDX exceeds preliminary remediation goals
More excavation was conducted at S1,N, & F than contour lines indicate
0
25 ft
N
Figure 2.2
FINAL SITE SURVEY
SWMU I-07
Hawthorne Army Depot
Hawthorne, Nevada
CHUNG & ASSOC.
Engineering • Construction • Environmental Services
GEOFON INCORPORATED
DRAWN: N. PROCHELO
DATE: 7/31/03
FILE:
CA-130

TABLE 2.2 SWMU I07 Pit Final Sampling Results

Date Collected	Sample Name	Area	Location w/in area	Depth in feet	RDX in mg/kg	HMX in mg/kg	TPH-diesel in mg/kg
6/25/2003	I07-CF01-02-01	NW	SW	4.7	5.0 U	5.0 U	**120**
6/25/2003	I07-CF01-02-02	NW	NW	2.7	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-03	NW	SE	13.9	5.0 U	5.0 U	**4,200**
6/25/2003	I07-CF01-02-04	NW	NE	5.8	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-05	NW	Center	9.1	5.0 U	5.0 U	**6,100**
6/25/2003	I07-CF01-02-06	N	SW	3.6	5.0 U	5.0 U	**360**
6/25/2003	I07-CF01-02-07	N	NW	12.4	5.0 U	5.0 U	5.0 U
6/25/2003	I07-DUP43 (field duplicate of I07-CF-02-07	N	NW	12.4	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-08	N	SE	4.3	5.0 U	5.0 U	**160**
6/25/2003	I07-CF01-02-08-QA	N	SE	4.3			
6/25/2003	I07-CF01-02-09	N	NE	7.9	5.0 U	5.0 U	35
6/25/2003	I07-CF01-02-10	N	Center	11.5	5.0 U	5.0 U	**1,600**
6/25/2003	I07-CF01-02-11	NE	SW	2.7	5.0 U	5.0 U	**240**
6/25/2003	I07-CF01-02-12	NE	NW	6.9	5.0 U	5.0 U	**2,400**
6/25/2003	I07-CF01-02-13	NE	SE	3.4	5.0 U	5.0 U	**220**
6/25/2003	I07-CF01-02-14	NE	NE	9.3	5.0 U	5.0 U	21
6/25/2003	I07-CF01-02-15	NE	Center	9.3	5.0 U	5.0 U	29
6/25/2003	I07-CF01-02-16	W	SW	2.8	5.0 U	5.0 U	22
6/25/2003	I07-CF01-02-17	W	NW	4.3	5.0 U	5.0 U	84
6/25/2003	I07-CF01-02-18	W	SE	11.8	5.0 U	5.0 U	**1,000**
6/25/2003	I07-CF01-02-19	W	NE	15.2	5.0 U	5.0 U	**2,900**
6/25/2003	I07-CF01-02-20	W	Center	6.9	5.0 U	5.0 U	**11,000**
6/25/2003	I07-CF01-02-21	Center	SW	12.3	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-22	Center	NW	15.1	5.0 U	5.0 U	**880**
6/25/2003	I07-CF01-02-23	Center	SE	10.0	5.0 U	5.0 U	**1,700**
6/25/2003	I07-CF01-02-24	Center	NE	10.8	5.0 U	5.0 U	**3,300**
6/25/2003	I07-CF01-02-25	Center	Center	15.1	5.0 U	5.0 U	**110**
6/25/2003	I07-CF01-02-25-QA	Center	Center	15.1			
6/25/2003	I07-CF01-02-26	E	SW	9.4	5.0 U	5.0 U	**1,300**
6/25/2003	I07-CF01-02-27	E	NW	8.7	5.0 U	5.0 U	19
6/25/2003	IO7-DUP44 (field duplicate of IO7-CF-02-27	E	NW	8.7	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-28	E	SE	3.8	5.0 U	5.0 U	**280**
6/25/2003	I07-CF01-02-29	E	NE	6.9	5.0 U	5.0 U	**900**
6/25/2003	I07-CF01-02-30	E	Center	6.1	5.0 U	5.0 U	78
6/25/2003	I07-CF01-02-31	SW	NW	2.6	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-32	SW	SE	3.5	5.0 U	5.0 U	17
6/25/2003	I07-CF01-02-33	SW	NE	9.4	5.0 U	5.0 U	**3,400**
6/25/2003	I07-CF01-02-34	SW	Center	6.2	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-35	S	SW	2.5	5.0 U	5.0 U	5.0 U
6/25/2003	IO7-DUP45 (field duplicate of IO7-CF-02-35	S	SW	2.5	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-36	S	SE	9.8	5.0 U	5.0 U	**2,000**
6/25/2003	I07-CF01-02-37	S	NE	1.8	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-38	S	NE	6.1	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-39	S	Center	5.0	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-40	SE	NW	6.4	5.0 U	5.0 U	5.0 U
6/25/2003	I07-CF01-02-41	SE	Center	4.0	9.7	5.0 U	**440**

* **Bold** indicates exceeding preliminary remediation goals.

a = Preliminary remediation goal for RDX is 22 mg/kg.

b = Preliminary remediation goal for HMX is 44,000 mg/kg.

c = Preliminary remediation goal for TPH-diesel is 100 mg/kg. The level for the disposal cell is 2,000 mg/kg.

J = The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.

J+ = The compound was positively identified. The associated numerical value has a high bias and is the approximate concentration of the compound in the sample.

UJ = The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

U = The material was analyzed for, but was not detected above the level of the associated value.

TABLE 2.4 SWMU I07 Pit Table of Coordinates Location

Sample Name	Northing (feet)	Easting (feet)	Elevation (feet)	Depth from Average Pin Elevation (feet)
I07-CF01-01-N	1387089.71	501678.00	4247.34	4.0
I07-CF02-01-N	1387089.44	501692.44	4247.13	4.2
I07-CF03-01-N	1387085.84	501685.18	4244.72	6.6
I07-CF04-01-N	1387080.64	501678.90	4241.51	9.8
I07-CF05-01-N	1387079.11	501691.49	4241.47	9.9
I07-CF01-01-S	1387044.95	501682.70	4247.39	4.0
I07-CF02-01-S	1387049.82	501668.44	4246.95	4.4
I07-CF03-01-S	1387051.09	501677.32	4244.38	7.0
I07-CF04-01-S	1387055.56	501684.53	4241.49	9.9
I07-CF05-01-S	1387057.94	501674.60	4240.21	11.1
I07-CF01-01-E	1387075.45	501718.85	4242.39	9.0
I07-CF02-01-E	1387065.24	501717.77	4241.94	9.4
I07-CF03-01-E	1387070.00	501707.74	4240.44	10 9
I07-CF04-01-E	1387075.39	501696.36	4239.77	11.6
I07-CF05-01-E	1387064.26	501696.43	4240	11.3
I07-CF01-01-W	1387060.01	501663.27	4245.35	6.0
I07-CF02-01-W	1387078.81	501661.71	4245.25	6 1
I07-CF03-01-W	1387061.30	501664.94	4243.05	8 3
I07-CF04-01-W	1387061.30	501672.07	4240.07	11.3
I07-CF05-01-W	1387076.99	501673.07	4239.61	11.7
I07-CF01-01-F	1387063.03	501677.14	4237.32	14 0
I07-CF02-01-F	1387075.11	501678.00	4237.67	13 7
I07-CF03-01-F	1387068.09	501682.95	4239.36	12.0
I07-CF04-01-F	1387063.88	501688.99	4241.05	10 3
I07-CF05-01-F	1387075.01	501690.23	4240.35	11 0
I07-CF-02-01	1387067.95	501656.97	4246.64	4.7
I07-CF-02-02	1387084.73	501657.79	4248.69	2.7
I07-CF-02-03	1387068.29	504679.58	4237.41	13.9
I07-CF-02-04	1387089.03	501679.63	4245.57	5.8
I07-CF-02-05	1387079.43	501667.78	4242.21	9 1
I07-CF-02-06	1387091.57	501683.91	4247.72	3.6
I07-CF-02-07	1387066.92	501703.23	4238.98	12.4
I07-CF-02-08	1387087.81	501703.27	4247.03	4.3
I07-CF-02-09	1387082.47	501693.78	4243.49	7.9
I07-CF-02-10	1387066.17	501707.04	4239.86	11.5
I07-CF-02-11	1387089.56	501708.46	4248.63	2 7
I07-CF-02-12	1387064.03	501729.02	4244.44	6.9
I07-CF-02-13	1387084.71	501730.81	4247.92	3 4
I07-CF-02-14	1387076.45	501719.12	4242.01	9.3
I07-CF-02-15	1387076.27	501718.76	4242.01	9.3
I07-CF-02-16	1387047.51	501660.43	4248.54	2 8
I07-CF-02-17	1387063.09	501657.66	4247.08	4 3
I07-CF-02-18	1387045.01	501680.52	4239.54	11 8
I07-CF-02-19	1387062.88	501680.71	4237.17	14 2
I07-CF-02-20	1387054.27	501667.29	4244.46	6 9
I07-CF-02-21	1387044.39	501685.12	4239.08	12.3
I07-CF-02-22	1387063.09	501686.86	4236.21	15 1
I07-CF-02-23	1387044.36	501697.54	4241.35	10 0
I07-CF-02-24	1387058.22	501701.02	4240.52	10 8
I07-CF-02-25	1387056.27	501689.46	4236.26	15 1

TABLE 2.4 SWMU I07 Pit Table of Coordinates Location

Sample Name	Northing (feet)	Easting (feet)	Elevation (feet)	Depth from Average Pin Elevation (feet)
I07-CF-02-26	1387045.35	501701.03	4241.97	9.4
I07-CF-02-27	1387060.70	501706.66	4242.67	8 7
I07-CF-02-28	1387041.34	501724.83	4247.57	3.8
I07-CF-02-29	1387061.15	501727.40	4244.49	6.9
I07-CF-02-30	1387050.42	501715.52	4245.24	6.1
I07-CF-02-31	1387043.23	501664.85	4248.71	2.6
I07-CF-02-32	1387028.99	501680.35	4247.82	3 5
I07-CF-02-33	1387039.99	501680.94	4241.92	9.4
I07-CF-02-34	1387036.55	501676.69	4245.14	6.2
I07-CF-02-35	1387026.69	501687.99	4248.85	2.5
I07-CF-02-36	1387040.15	501687.34	4241.50	9.8
I07-CF-02-37	1387031.11	501700.21	4249.59	1 8
I07-CF-02-38	1387038.93	501699.88	4245.24	6.1
I07-CF-02-39	1387032.63	501691.30	4246.38	5.0
I07-CF-02-40	1387040.65	501705.16	4244.95	6 4
I07-CF-02-41	1387033.87	501710.28	4247.35	4 0
Monument 55 I07	1387124.72	501613.21	4249.89	1.5
TetraTech Pin 1	1387124.71	501787.23	4251.06	0.3
TetraTech Pin 2	1386991.77	501613.20	4251.63	-0.3

Note: Coordinates are based on an electronic map file, using the NAD 1983 datum. Depth from average pin elevation is the distance from the average of Tetra Tech Pin 1 and Tetra Tech Pin 2 to the sample location.

Attachment 3

NDEP Remedial Action Concurrence Letters

R. Michael Turnipseed, Director
Allen Biaggi, *Administrator*
(775) 687-4670
TDD 687-4678

Administration
Facsimile 687-5856

Mining Regulations and Reclamation
Facsimile 684-5259

STATE OF NEVADA
KENNY C. GUINN
Governor

Waste Management
Corrective Actions
Federal Facilities
Facsimile 687-6396

Air Quality
Water Quality Planning
Facsimile 687-6396

Department of Conservation and Natural Resources
Division of Environmental Protection

333 W. Nye Lane, Room 138
Carson City, Nevada 89706-0851

October 6, 2003

David W. Dornblaser
Lieutenant Colonel
Department of The Army
Hawthorne Army Depot
1 South Maine Street
Hawthorne, NV 89415-9404

Subject: September 2003 Final Remedial Investigation Report Addendum A, Solid Waste Management Unit I07, Building 101-44 Landfill, Hawthorne Army Depot, Hawthorne, Nevada

Dear Col. Dornblaser:

The Nevada Division of Environmental Protection (NDEP), Bureau of Federal Facilities staff, received and evaluated Hawthorne Army Depot's (HWAD) September 2003 subject report. The report provides a summary of additional work performed at Solid Waste Management Unit (SWMU) I07. SWMU I07 is an inactive disposal pit that is known to have received diesel fuel contaminated with explosives.

Based on this review, NDEP comments previously transmitted on June 20, 2003 have been incorporated and supplemental information was provided. This final document is therefore approved. Proceed with the recommendations as discussed in the subject report.

If you should have any questions, please contact our office at 775-687-9396.

Sincerely,

Ramon Naranjo
Environmental Hydrologist
Bureau of Federal Facilities

PJL/REN/RCN/cb

cc:
Herman Millsap, HWAD
Paul Zianno, USACE Sacramento District
Mineral County Commission, P.O. Box 1450, Hawthorne, NV
Hawthorne Fire Department, P.O. Box 1095, Hawthorne, NV
Mineral County Sheriffs Department, P.O. Box 2290, Hawthorne, NV
Walker River Paiute Tribe, P.O. Box 220, Schurz, NV 89427

ALLEN BIAGGI, *Administrator*

(775) 687-4670

TDD 687-4678

Administration
Facsimile 687-5856

Water Pollution Control
Facsimile 687-4684

Mining Regulation and
Reclamation
Facsimile 684-5259

STATE OF NEVADA
KENNY C. GUINN
Governor

R. MICHAEL TURNIPSEED, *Director*

Waste Management
Corrective Actions
Federal Facilities

Air Pollution Control
Air Quality Planning
Water Quality Planning

Facsimile 687-6396

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL PROTECTION

333 W. Nye Lane, Room 138

Carson City, Nevada 89706

February 25, 2004

David W. Dornblaser
Lieutenant Colonel
Department of The Army
Hawthorne Army Depot
1 South Maine Street
Hawthorne, NV 89415-9404

Subject: February 2004 Final Remedial Investigation Report Solid Waste Management Unit I07, Building 101-44 Landfill, Hawthorne Army Depot, Hawthorne, Nevada

Dear Col. Dornblaser:

The Nevada Division of Environmental Protection (NDEP), Bureau of Federal Facilities staff, received and evaluated Hawthorne Army Depot's (HWAD) February 2004 subject report. The report provides the results of excavation and remediation efforts conducted at Solid Waste Management Area I07. Soils were contaminated with explosives and total petroleum hydrocarbons (TPH-D) and were treated by composting in windrows. Confirmation samples were taken inside the excavation to insure explosives were removed. The results of the fate and transport modeling effort concluded that the total petroleum hydrocarbons left in place would not pose a risk to groundwater.

Based on this review, NDEP comments previously transmitted (October 6, 2003) have been incorporated and supplemental information was provided. This final document is therefore approved.

If you should have any questions, please contact our office at 775-687-9396.

Sincerely,

Ramon Naranjo
Environmental Hydrologist
Bureau of Federal Facilities

REN/RCN/[redacted]

Cc: Terre Maize, NDEP
Herman Millsap, HWAD
Rebecca Benecot, HWAD
Paul Zianno, USACE Sacramento District
Mineral County Commission, P.O. Box 1450, Hawthorne, NV
Hawthorne Fire Department, P.O. Box 1095, Hawthorne, NV
Mineral County Sheriffs Department, P.O. Box 2290, Hawthorne, NV
Richard Black, Fallon Paiute-Shoshone Tribe Environmental Director, 1011 Rio Vista Drive, Fallon, NV 89406
Tad Williams, Walker River Paiute Tribe Environmental Director, P.O. Box 220 Shurz NV 89427
Duane Masters Sr. Yerington Paiute Tribe Environmental Director, 603 W. Bridge Street, Yerington, NV 89447
Tansey Smith, Tribal-State Liaison, Inter-Tribal Council of Nevada Inc., 333 W. Nye Lane, Carson City NV 89706

Attachment 4

Supporting Documentation from the 2012 Bay West Inc. Final SWMU I07 Technical Memorandum, SWMU I07 Building 101-44 Former Landfill, Hawthorne Army Depot, Hawthorne, Nevada.

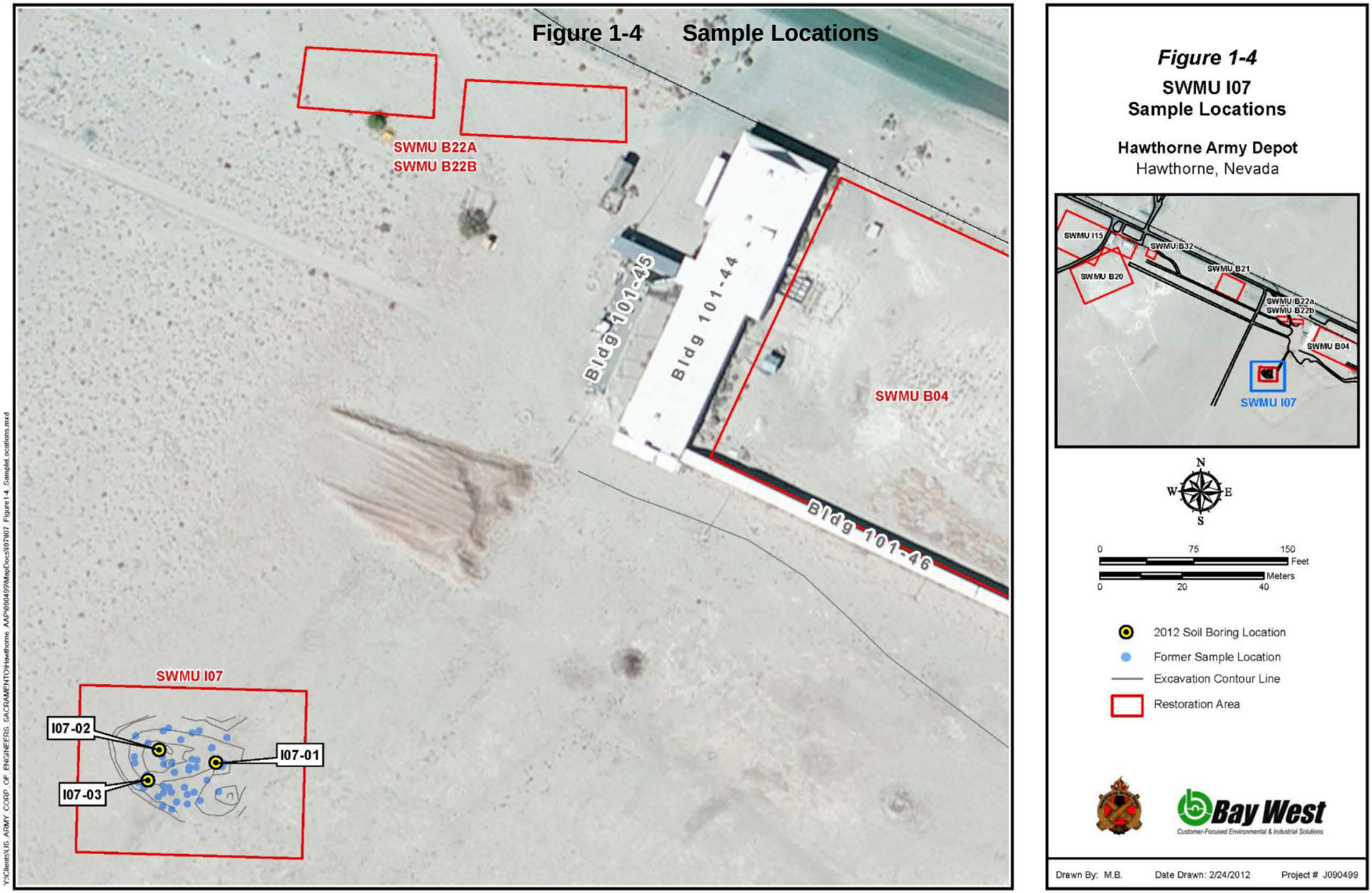


Figure 1-4 Sample Locations
SWMU B22A
SWMU B22B
Bldg 101-45
Bldg 101-44
SWMU B04
Bldg 101-46
SWMU I07
I07-02
I07-01
I07-03
Y:\Clients\US ARMY CORP OF ENGINEERS SACRAMENTO\Hawthorne AAP\090499\Map\Doc\I07\I07 Figure 1-4 Sample Locations.mxd
Figure 1-4
SWMU I07
Sample Locations
Hawthorne Army Depot
Hawthorne, Nevada
SWMU I15
SWMU B32
SWMU B20
SWMU B21
SWMU B22a
SWMU B22b
SWMU B04
SWMU I07
N
W
E
S
0
75
150
Feet
Meters
0
20
40
2012 Soil Boring Location
Former Sample Location
Excavation Contour Line
Restoration Area
Bay West
Customer-Focused Environmental & Industrial Solutions
Drawn By: M.B.
Date Drawn: 2/24/2012
Project # J090499

Figure 3-1 Sample

Soil Boring I07-02			
Sample ID	RDX	HMX	TPH-D
Screening Level	24 (1)	49,000 (1)	100 (2)
I07-02-S-(05)	0.41	0.16	37
I07-02-S-(07)	0.1 JJ	0.066 J	38
I07-02-S-(15)	0.079 U	0.038 JJ	**8,600** D Q
I07-02-S-(21)	0.074 U	0.037 U	**2,200** D Q
I07-02-S-(31)	0.076 U	0.038 U	93
I07-02-S-(37)	0.077 U	0.039 U	2.1 J
I07-02-S-(55)	0.078 U	0.039 U	2 J
I07-02-S-(65)	0.078 U	0.039 U	2.1 J
I07-02-S-(75)	0.077 U	0.038 U	2.6 J M

Soil Boring I07-01			
Sample ID	RDX	HMX	TPH-D
Screening Level	24 (1)	49,000 (1)	100 (2)
I07-01-S-(05)	**40** J	4.8	54
I07-01-S-(10)	0.097 J	0.039 U	2.9 J
I07-01-S-(10)-Z	0.12 J	0.04 U	4 J
I07-01-S-(15)	0.08 U M	0.04 U	1.9 J
I07-01-S-(25)	0.079 U	0.04 U	1.5 J
I07-01-S-(35)	0.08 U M	0.04 U	1.5 J
I07-01-S-(45)	0.078 U M	0.039 U	2.2 J
I07-01-S-(55)	0.077 U	0.038 U	1.9 J
I07-01-S-(65)	0.08 U M	0.04 U	1.2 J
I07-01-S-(75)	0.08 U	0.04 U	1.1 J

Soil Boring I07-03			
Sample ID	RDX	HMX	TPH-D
Screening Level	24 (1)	49,000 (1)	100 (2)
I07-03-S-(03)	0.21	0.082 J	89
I07-03-S-(10)	3.7	0.39	**7,100** D Q
I07-03-S-(15)	0.073 U Q	0.036 U Q	**7,200** D Q
I07-03-S-(15)-Z	0.079 U Q	0.04 U Q	**7,700** D Q
I07-03-S-(23)	0.84	0.038 U Q	**4,100** D Q
I07-03-S-(33)	0.079 U	0.039 U	2.5 J
I07-03-S-(45)	0.076 U	0.038 U	2.8 J
I07-03-S-(51)	0.078 U	0.039 U	2.1 J
I07-03-S-(65)	0.078 U M	0.039 U	0.94 J M
I07-03-S-(75)	0.074 U M	0.037 U	1.6 J

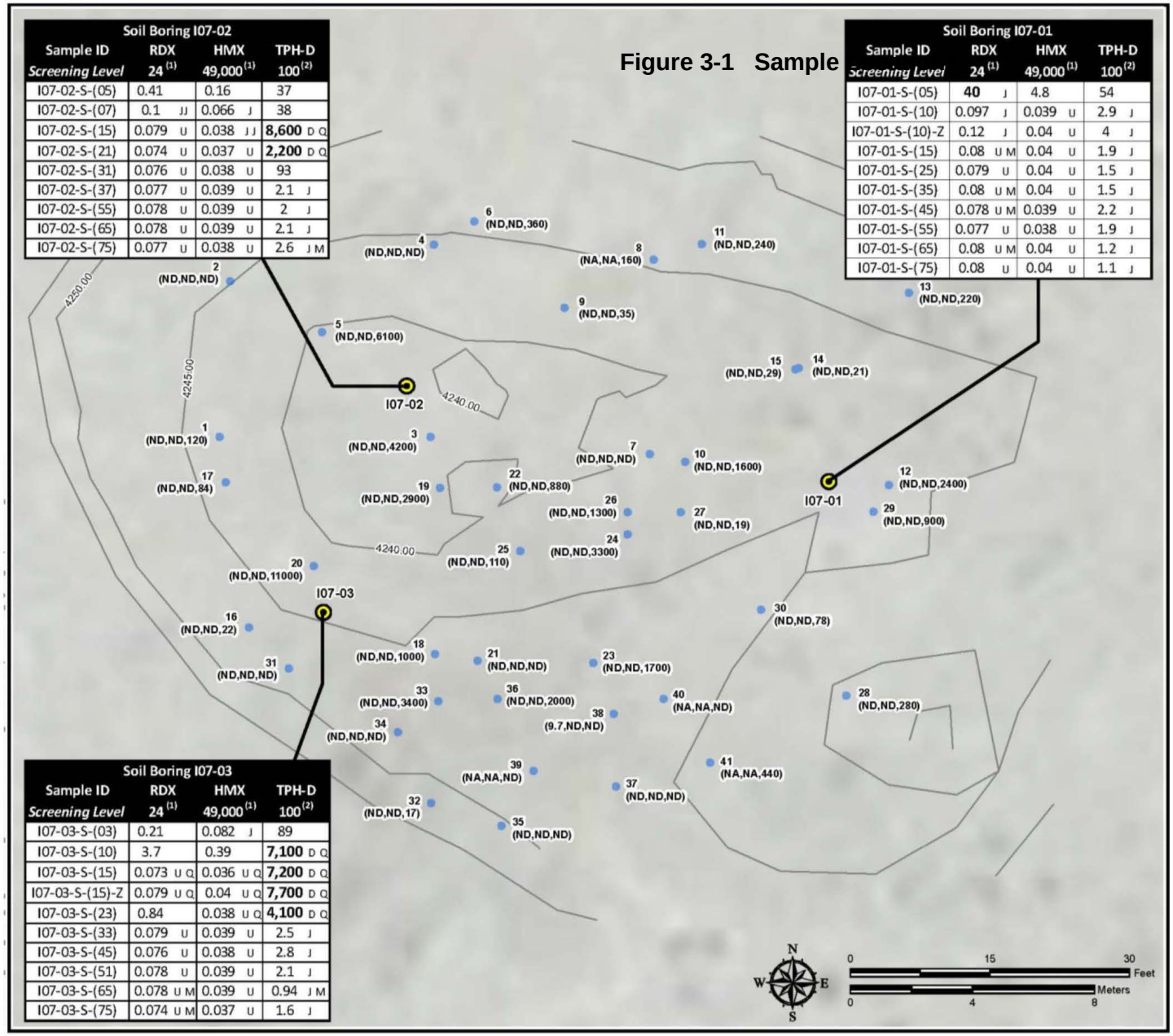
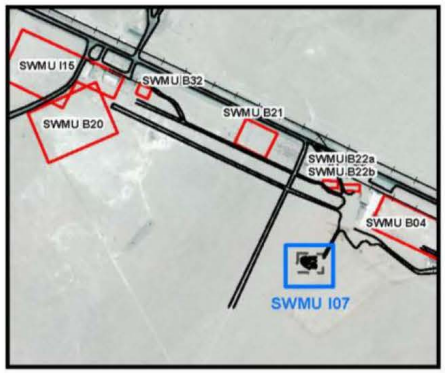


Figure 3-1

SWMU I07 Sample Locations and Analytical Results

Hawthorne Army Depot
Hawthorne, Nevada



2012 Soil Boring Location

Former Sample Location

(ND,ND,ND) Sample Results (RDX, HMX, TPH-D)

Excavation Contour Line

ND - Not Detected above laboratory detection limits

NA - Not Analyzed / Not Available

RDX, HMX, and TPH-D (TPH-Diesel) reported in mg/kg

Bold - Results above screening criteria

(1) - United States Environmental Protection Agency (USEPA) Industrial Regional Screening Levels (RSLs), June 2011

(2) - State of Nevada Screening Level

J - Estimated: The analyze was positively identified; the quantitation is an estimation

JJ - Estimated: The quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria

D - Sample result required a dilution

Q - One or more quality control criteria failed.

U - Undetected at the Limit of Detection.

M - Manual integrated compound.

Drawn By: M.B. Date Drawn: 5/24/2012 Project # J090499

Table 3-1 SWMU I07 Analytical Results

Analyte	CAS Number	Method	Units	EPA RSLs (2011) Industrial	EPA RSLs (2011) residential	I07-01																										
						I07-01-S-(05)			I07-01-S-(10)			I07-01-S-(10)-Z			I07-01-S-(15)			I07-01-S-(25)			I07-01-S-(35)			I07-01-S-(45)			I07-01-S-(55)			I07-01-S-(65)			I07-01-S-(75)		
						2/8/2012			2/8/2012			2/8/2012			2/8/2012			2/8/2012			2/8/2012			2/8/2012			2/8/2012			2/8/2012			2/8/2012		
						04-06 ft bgs			08-10 ft bgs			Duplicate			14-16 ft bgs			24-26 ft bgs			34-36 ft bgs			44-46 ft bgs			44-56 ft bgs			64-66 ft bgs			74-75 ft bgs		
						Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America		
						Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
Total Petroleum Hydrocarbon - Diesel (TPH-Diesel)																																			
TPH-Diesel	N/A	8015B	mg/Kg	100(1)	100(1)	**54**		0.73	**2.9**	J	0.7	**4**	J	0.7	**1.9**	J	0.66	**1.5**	J	0.72	**1.5**	J	0.77	**2.2**	J	0.69	**1.9**	J	0.69	**1.2**	J	0.79	**1.1**	J	0.74
Explosives																																			
2-Amino-4,6-dinitrotoluene	35572-78-2	8330B	mg/Kg	2000	150	0.039	U	0.032	0.039	U	0.032	0.04	U	0.033	0.04	U	0.033	0.04	U	0.033	0.04	U	0.033	0.039	U	0.032	0.038	U	0.032	0.04	U	0.033	0.04	U	0.033
4-Amino-2,6-dinitrotoluene	19406-51-0	8330B	mg/Kg	1900	150	0.039	U	0.029	0.039	U	0.029	0.04	U	0.03	0.04	U	0.03	0.04	U	0.03	0.04	U	0.03	0.039	U	0.029	0.038	U	0.029	0.04	U	0.03	0.04	U	0.03
1,3-Dinitrobenzene	99-65-0	8330B	mg/Kg	62	6.1	0.039	U	0.016	0.039	U	0.016	0.04	U	0.016	0.04	U	0.017	0.04	U	0.016	0.04	U	0.017	0.039	U	0.016	0.038	U	0.016	0.04	U	0.017	0.04	U	0.017
2,4-Dinitrotoluene	121-14-2	8330B	mg/Kg	5.5	1.6	0.039	U	0.014	0.039	U	0.014	0.04	U	0.015	0.04	U	0.015	0.04	U	0.015	0.04	U	0.015	0.039	U	0.014	0.038	U	0.014	0.04	U	0.015	0.04	U	0.015
2,6-Dinitrotoluene	606-20-2	8330B	mg/Kg	620	61	0.039	U	0.019	0.039	U	0.019	0.04	U	0.019	0.04	U	0.019	0.04	U	0.019	0.04	U	0.019	0.039	U	0.019	0.038	U	0.018	0.04	U	0.019	0.04	U	0.019
HMX	2691-41-0	8330B	mg/Kg	49000	3800	**4.8**		0.022	0.039	U	0.022	0.04	U	0.023	0.04	U	0.023	0.04	U	0.023	0.04	U	0.023	0.039	U	0.022	0.038	U	0.022	0.04	U	0.023	0.04	U	0.023
Nitrobenzene	98-95-3	8330B	mg/Kg	24	4.8	0.098	U	0.084	0.097	U	0.082	0.099	U	0.084	0.1	U	0.085	0.099	U	0.084	0.1	U	0.085	0.098	U	0.083	0.096	U	0.082	0.1	U	0.085	0.1	U	0.085
2-Nitrotoluene	88-72-2	8330B	mg/Kg	13	2.9	0.079	U	0.046	0.078	U	0.046	0.079	U	0.047	0.08	U	0.047	0.079	U	0.047	0.08	U	0.047	0.078	U	0.046	0.077	U	0.045	0.08	U	0.047	0.08	U	0.047
3-Nitrotoluene	99-08-1	8330B	mg/Kg	62	6.1	0.079	U	0.063	0.078	U	0.062	0.079	U	0.063	0.08	U	0.064	0.079	U	0.063	0.08	U	0.064	0.078	U	0.063	0.077	U	0.062	0.08	U	0.064	0.08	U	0.064
4-Nitrotoluene	99-99-0	8330B	mg/Kg	110	30	0.098	U	0.036	0.097	U	0.035	0.099	U	0.036	0.1	U	0.036	0.099	U	0.036	0.1	U	0.036	0.098	U	0.036	0.096	U	0.035	0.1	U	0.036	0.1	U	0.036
RDX	121-82-4	8330B	mg/Kg	24	5.6	**40**	J	0.042	**0.097**	J	0.042	**0.12**	J	0.043	0.08	U M	0.043	0.079	U	0.043	0.08	U M	0.043	0.078	U M	0.042	0.077	U	0.041	0.08	U M	0.043	0.08	U	0.043
Tetryl	479-45-8	8330B	mg/Kg	2500	240	0.079	U	0.043	0.078	U	0.043	0.079	U	0.044	0.08	U	0.044	0.079	U	0.044	0.08	U	0.044	0.078	U	0.043	0.077	U	0.042	0.08	U	0.044	0.08	U	0.044
1,3,5-Trinitrobenzene	99-35-4	8330B	mg/Kg	27000	2200	0.039	U	0.014	0.039	U	0.013	0.04	U	0.014	0.04	U	0.014	0.04	U	0.014	0.04	U	0.014	0.039	U	0.013	0.038	U	0.013	0.04	U	0.014	0.04	U	0.014
2,4,6-Trinitrotoluene	118-96-7	8330B	mg/Kg	79	19	0.039	U	0.03	0.039	U	0.03	0.04	U	0.03	0.04	U	0.031	0.04	U	0.03	0.04	U	0.031	0.039	U	0.03	0.038	U	0.03	0.04	U	0.031	0.04	U	0.031

Notes
RSLs - Regional Screening Levels
HWAD - Hawthorne Army Depot
MDL - Method Detection Limit
BGS - Below Ground Surface
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
N/A- Not Applicable or Not Established
Bold - results above method detection limit
Highlighted in yellow - above EPA Industrial RSL

Laboratory Qualifiers
J - Estimated: The analyte was positively identified; the quantitation is an estimation
JJ - Estimated: The quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria
D - Sample result required a dilution
Q - One or more quality control criteria failed.
U - Undetected at the Limit of Detection.
(1) - State of Nevada Screening Level
M - Manual integrated compound.
B - Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.

Table 3-1 SWMU I07 Analytical Results (Continued)

Analyte	CAS Number	Method	Units	EPA RSLs (2011) Industrial	EPA RSLs (2011) residential	I07-02																							
						I07-02-S-(05)			I07-02-S-(07)			I07-02-S-(015)			I07-02-S-(21)			I07-02-S-(31)			I07-02-S-(37)			I07-02-S-(55)			I07-02-S-(65)			I07-02-S-(75)		
						2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012		
						04-06 ft bgs			06-08 ft bgs			14-16 ft bgs			20-22 ft bgs			30-32 ft bgs			36-38 ft bgs			54-56 ft bgs			64-66 ft bgs			74-75 ft bgs		
						Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America		
Analyte	CAS Number	Method	Units	EPA RSLs (2011) Industrial	EPA RSLs (2011) residential	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
Total Petroleum Hydrocarbon - Diesel (TPH-Diesel)																																
TPH-Diesel	N/A	8015B	mg/Kg	100(1)	100(1)	**37**		0.68	**38**		0.71	**8600**	D Q	15	**2200**	D Q	7.3	**93**		0.72	**2.1**	J	0.64	**2**	J	0.73	**2.1**	J	0.77	**2.6**	J M	0.72
Explosives																																
2-Amino-4,6-dinitrotoluene	35572-78-2	8330B	mg/Kg	2000	150	**0.034**	J	0.032	0.039	U	0.032	0.039	U	0.032	0.037	U	0.03	0.038	U	0.031	0.039	U	0.032	0.039	U	0.032	0.039	U	0.032	0.038	U	0.031
4-Amino-2,6-dinitrotoluene	19406-51-0	8330B	mg/Kg	1900	150	0.039	U	0.029	0.039	U	0.029	0.039	U	0.03	0.037	U	0.028	0.038	U	0.028	0.039	U	0.029	0.039	U	0.029	0.039	U	0.029	0.038	U	0.029
1,3-Dinitrobenzene	99-65-0	8330B	mg/Kg	62	6.1	0.039	U	0.016	0.039	U	0.016	0.039	U	0.016	0.037	U	0.015	0.038	U	0.016	0.039	U	0.016	0.039	U	0.016	0.039	U	0.016	0.038	U	0.016
2,4-Dinitrotoluene	121-14-2	8330B	mg/Kg	5.5	1.6	0.039	U	0.014	0.039	U	0.014	0.039	U	0.015	0.037	U	0.014	0.038	U	0.014	0.039	U	0.014	0.039	U	0.014	0.039	U	0.014	0.038	U	0.014
2,6-Dinitrotoluene	606-20-2	8330B	mg/Kg	620	61	0.039	U	0.019	0.039	U	0.019	0.039	U	0.019	0.037	U	0.018	0.038	U	0.018	0.039	U	0.018	0.039	U	0.019	0.039	U	0.019	0.038	U	0.018
HMX	2691-41-0	8330B	mg/Kg	49000	3800	**0.16**		0.022	**0.066**	J	0.022	**0.038**	J J	0.022	0.037	U	0.021	0.038	U	0.021	0.039	U	0.022	0.039	U	0.022	0.039	U	0.022	0.038	U	0.022
Nitrobenzene	98-95-3	8330B	mg/Kg	24	4.8	0.097	U	0.083	0.097	U	0.082	0.099	U	0.084	0.092	U	0.078	0.094	U	0.08	0.097	U	0.082	0.097	U	0.082	0.097	U	0.083	0.096	U	0.081
2-Nitrotoluene	88-72-2	8330B	mg/Kg	13	2.9	0.078	U	0.046	0.078	U	0.046	0.079	U	0.047	0.074	U	0.044	0.076	U	0.045	0.077	U	0.046	0.078	U	0.046	0.078	U	0.046	0.077	U	0.045
3-Nitrotoluene	99-08-1	8330B	mg/Kg	62	6.1	0.078	U	0.062	0.078	U	0.062	0.079	U	0.063	0.074	U	0.059	0.076	U	0.06	0.077	U	0.062	0.078	U	0.062	0.078	U	0.062	0.077	U	0.061
4-Nitrotoluene	99-99-0	8330B	mg/Kg	110	30	0.097	U	0.036	0.097	U	0.035	0.099	U	0.036	0.092	U	0.034	0.094	U	0.034	0.097	U	0.035	0.097	U	0.035	0.097	U	0.036	0.096	U	0.035
RDX	121-82-4	8330B	mg/Kg	24	5.6	**0.41**		0.042	**0.1**	J J	0.042	0.079	U	0.042	0.074	U	0.04	0.076	U	0.041	0.077	U	0.042	0.078	U	0.042	0.078	U	0.042	0.077	U	0.041
Tetryl	479-45-8	8330B	mg/Kg	2500	240	0.078	U	0.043	0.078	U	0.043	0.079	U	0.043	0.074	U	0.04	0.076	U	0.041	0.077	U	0.042	0.078	U	0.043	0.078	U	0.043	0.077	U	0.042
1,3,5-Trinitrobenzene	99-35-4	8330B	mg/Kg	27000	2200	**0.059**	J	0.013	**0.016**	J J	0.013	0.039	U	0.014	0.037	U	0.013	0.038	U	0.013	0.039	U	0.013	0.039	U	0.013	0.039	U	0.013	0.038	U	0.013
2,4,6-Trinitrotoluene	118-96-7	8330B	mg/Kg	79	19	0.039	U	0.03	0.039	U	0.03	0.039	U	0.03	0.037	U	0.028	0.038	U	0.029	0.039	U	0.03	0.039	U	0.03	0.039	U	0.03	0.038	U	0.029

Notes:
RSLs - Regional Screening Levels
HWAD - Hawthorne Army Depot
MDL - Method Detection Limit
BGS - Below Ground Surface
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
N/A- Not Applicable or Not Established
Bold - results above method detection limit
Highlighted in yellow - above EPA Industrial RSL

Laboratory Qualifiers
J - Estimated: The analyze was positively identified; the quantitation is an estimation
JJ - Estimated: The quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria
D - Sample result required a dilution
Q - One or more quality control criteria failed.
U - Undetected at the Limit of Detection.
(1) - State of Nevada Screening Level
M - Manual integrated compound.
B - Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.

Table 3-1 SWMU I07 Analytical Results (Continued)

Analyte	CAS Number	Method	Units	EPA RSLs (2011) Industrial	EPA RSLs (2011) residential	I07-03																										
						I07-03-S-(03)			I07-03-S-(010)			I07-03-S-(15)			I07-03-S-(15)-Z			I07-03-S-(23)			I07-03-S-(33)			I07-03-S-(45)			I07-03-S-(51)			I07-03-S-(65)			I07-03-S-(75)		
						2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/9/2012			2/10/2012			2/10/2012			2/10/2012		
						02-04 ft bgs			08-10 ft bgs			14-16 ft bgs			Duplicate			22-24 ft bgs			32-34 ft bgs			44-46 ft bgs			50-52 ft bgs			64-66 ft bgs			74-75 ft bgs		
						Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America			Test America		
						Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
otal Petroleum Hydrocarbon - Diesel (TPH-Diesel)																																			
TPH-Diesel	N/A	8015B	mg/Kg	100(1)	100(1)	**89**		0.69	**7100**	D Q	13	**7200**	D Q	14	**7700**	D Q	14	**4100**	D Q	6.7	**2.5**	J	0.7	**2.8**	J	0.66	**2.1**	J	0.69	**0.94**	J M	0.77	**1.6**	J	0.71
Explosives																																			
2-Amino-4,6-dinitrotoluene	35572-78-2	8330B	mg/Kg	2000	150	0.038	U	0.031	0.039	U	0.032	0.036	U Q	0.03	0.04	U Q	0.033	0.038	U	0.032	0.039	U	0.032	0.038	U	0.031	0.039	U	0.032	0.039	U	0.032	0.037	U	0.03
4-Amino-2,6-dinitrotoluene	19406-51-0	8330B	mg/Kg	1900	150	0.038	U	0.028	0.039	U	0.029	0.036	U Q	0.027	0.04	U Q	0.03	0.038	U	0.029	0.039	U	0.029	0.038	U	0.029	0.039	U	0.029	0.039	U	0.029	0.037	U	0.028
1,3-Dinitrobenzene	99-65-0	8330B	mg/Kg	62	6.1	0.038	U	0.016	0.039	U	0.016	0.036	U Q	0.015	0.04	U Q	0.016	0.038	U	0.016	0.039	U	0.016	0.038	U	0.016	0.039	U	0.016	0.039	U	0.016	0.037	U	0.015
2,4-Dinitrotoluene	121-14-2	8330B	mg/Kg	5.5	1.6	0.038	U	0.014	0.039	U	0.014	0.036	U Q	0.013	0.04	U Q	0.015	0.038	U Q	0.014	0.039	U	0.014	0.038	U	0.014	0.039	U	0.014	0.039	U	0.014	0.037	U	0.014
2,6-Dinitrotoluene	606-20-2	8330B	mg/Kg	620	61	0.038	U	0.018	0.039	U	0.018	0.036	U Q	0.017	0.04	U Q	0.019	0.038	U	0.018	0.039	U	0.018	0.038	U	0.018	0.039	U	0.019	0.039	U	0.019	0.037	U	0.018
HMX	2691-41-0	8330B	mg/Kg	49000	3800	**0.082**	J	0.021	**0.39**		0.022	0.036	U Q	0.021	0.04	U Q	0.023	0.038	U Q	0.022	0.039	U	0.022	0.038	U	0.022	0.039	U	0.022	0.039	U	0.022	0.037	U	0.021
Nitrobenzene	98-95-3	8330B	mg/Kg	24	4.8	0.094	U	0.08	0.096	U	0.082	0.091	U Q	0.077	0.099	U M Q	0.084	0.096	U Q	0.082	0.099	U	0.084	0.095	U	0.081	0.097	U	0.083	0.098	U	0.083	0.092	U	0.078
2-Nitrotoluene	88-72-2	8330B	mg/Kg	13	2.9	0.075	U	0.044	0.077	U	0.045	0.073	U Q	0.043	**0.54**	Q M J	0.047	**0.34**	J Q	0.045	0.079	U	0.047	0.076	U	0.045	0.078	U	0.046	0.078	U	0.046	0.074	U	0.044
3-Nitrotoluene	99-08-1	8330B	mg/Kg	62	6.1	0.075	U	0.06	0.077	U	0.062	0.073	U Q	0.058	0.079	U Q	0.064	0.077	U	0.061	0.079	U	0.063	0.076	U	0.061	0.078	U	0.062	0.078	U	0.063	0.074	U	0.059
4-Nitrotoluene	99-99-0	8330B	mg/Kg	110	30	0.094	U	0.034	0.096	U	0.035	0.091	U Q	0.033	0.099	U Q	0.036	0.096	U	0.035	0.099	U	0.036	0.095	U	0.035	0.097	U	0.036	0.098	U	0.036	0.092	U	0.034
RDX	121-82-4	8330B	mg/Kg	24	5.6	**0.21**		0.04	**3.7**		0.041	0.073	U Q	0.039	0.079	U Q	0.043	**0.84**		0.041	0.079	U	0.042	0.076	U	0.041	0.078	U	0.042	0.078	U M	0.042	0.074	U M	0.04
Tetryl	479-45-8	8330B	mg/Kg	2500	240	0.075	U	0.041	0.077	U	0.042	0.073	U Q	0.04	0.079	U Q	0.044	0.077	U	0.042	0.079	U	0.043	0.076	U	0.042	0.078	U	0.043	0.078	U	0.043	0.074	U	0.041
1,3,5-Trinitrobenzene	99-35-4	8330B	mg/Kg	27000	2200	**0.05**	J	0.013	0.039	U	0.013	0.036	U Q	0.013	0.04	U Q	0.014	0.038	U Q	0.013	0.039	U	0.014	0.038	U	0.013	0.039	U	0.013	0.039	U	0.014	0.037	U	0.013
2,4,6-Trinitrotoluene	118-96-7	8330B	mg/Kg	79	19	0.038	U	0.029	0.039	U	0.03	0.036	U Q	0.028	0.04	U Q	0.03	0.038	U Q	0.029	0.039	U	0.03	0.038	U	0.029	0.039	U	0.03	0.039	U	0.03	0.037	U	0.028

Notes:
RSLs - Regional Screening Levels
HWAD - Hawthorne Army Depot
MDL - Method Detection Limit
BGS - Below Ground Surface
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
N/A - Not Applicable or Not Established
Bold - results above method detection limit
Highlighted in yellow - above EPA Industrial RSL

Laboratory Qualifiers
J - Estimated: The analyze was positively identified; the quantitation is an estimation
JJ - Estimated: The quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria
D - Sample result required a dilution
Q - One or more quality control criteria failed.
U - Undetected at the Limit of Detection.
(1) - State of Nevada Screening Level
M - Manual integrated compound.
B - Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.

Attachment 5

Fate and Transport Model Supporting Documentation from the 2004 Chung/Geofon Final Remediation Report, Solid Waste Management Unit B29 and I07, Hawthorne Army Depot, Hawthorne, Nevada.

HSSM HYDROCARBON SPILL SCREENING MODEL FOR HWAD F&T RELEASE SITES

Introduction

Hydrocarbon Spill Screening Mode (HSSM) is an EPA model that simulates releases of light nonaqueous phase liquids (LNAPLs). The model includes separate modules for LNAPL flow through the vadose zone, spreading in the capillary fringe, and transport to chemical constituents of the LNAPL in a water table aquifer. These modules are based on simplified conceptualizations of the flow and transport phenomena, which were used to that the resulting model would be a practical, though approximate tool. For select HWAD release sites, HSSM is used only to model petroleum hydrocarbon fate and transport to groundwater. A model's predictive ability is only as good as the assumptions, data inputs, and professional judgment that constitute the model. For HWAD, using HSSM is appropriate for estimating impact to groundwater from leaking UST and surface releases. Wherever possible, site-specific data is utilized, and if not available, then appropriate parameter values are used from the HSSM documentation or literature. Representative and conservative inputs are used so that model output will be realistic; yet eerr on the conservative side.

HSSM is a screening model; it includes a number of chemical and hydraulic phenomena, assume subsurface homogeneity, executes rapidly, and excludes some phenomena. For example, if gasoline is spilled, HSSM< may be used to give a rough estimate of groundwater concentrations of constituents of gasoline. Also, one would not expect to calibrate the model by adjusting the spatial distinctions of the parameters, as heterogeneity is not include din the model.

If simulation of complex, heterogeneous sites is needed or other approximations made in HSSM are unacceptable (using another model with the available data is not likely to yield a "better" prediction), then additional soil boring sand samples would be need to be collected.

This vadose zone fate and transport report present the model description, model results and conclusions, model inputs, input screens, model output, for both the calibrated and reported (estimated) scenarios, and sensitivity analysis, parameter input value table and the user guide and theoretical background (EPA manuals).

Model Description

HSSM simulates the impacts of water-immiscible contaminants (LNAPLs) on water table aquifers. The model is based on approximate treatments of flow through the vadose zone, LNAPL spreading along the water table, and miscible transport of a single chemical constituent of the LNAPL through a water table aquifer to various receptor points. Surface and underground storage tank releases are potential areas for use of HSSM.

In HSSM, the LNAPL (or hydrocarbon) is assumed to be composed of two components. The first component is the LNAPL itself, which is a liquid that is separate from and does not mix with the subsurface water. The model contains a set of equations for tracking the motion of the LNAPL phase. Several of the results and graphs produced by the model depict the distribution of the LNAPL phase. The second component is referred to as a chemical constituent of the LNAPL, because typical LNAPLs are composed of many individual chemicals. HSSM tracks the

transport of one of these chemicals. Since the chemical constituent may dissolve into the subsurface water, it can be transported by the groundwater and contaminate downgradient receptor points. For example, HSSM may be used to simulate a gasoline release. Benzene could be the chemical constituent of interest. All of the rest of the chemicals composing the gasoline would be treated as being part of the LNAPL. When the impact of another constituent of gasoline, say toluene, needed to be determined, the chemical constituent would be the toluene. In this way, HSSM could be run for several of the important chemical constituents of the LNAPL. The model user could develop a feel for the behavior of the different chemicals by comparing the results.

HSSM is designed for LNAPLs, and is not suitable for denser-than-water NAPLs (DNAPLs) as the NAPL is assumed to "float" on the water table. The vadose zone module ofHSSM could, however, be used for a DNAPL, as that module is not affected by fluid density.

Model Components

A typical release of a LNAPL pollutant at the ground surface is shown below. The LNAPL flows downward through the vadose zone due to gravity and capillary forces. The LNAPL is deflected from its downward path by geologic heterogeneities it encounters on its way toward the water table. Infiltrating rainwater may push the LNAPL down faster than it would move on its own. Once in the vicinity of the water table, the LNAPL floats in the capillary fringe since it is a nonwetting phase that is less dense than water. Fluctuation of the water table due to natural causes or wells may create a smear zone containing trapped LNAPL. Contact with the ground water or infiltrating recharge water causes the chemical constituents of the LNAPL to dissolve, resulting in aquifer contamination. The constituents may be leached at different rates due to their diverse properties. Depending on their volatility, the constituents also partition into the vadose zone air.

Once in the aquifer, limited mixing leaves the constituents in a relatively narrow band near the top of the aquifer. These constituents are transported by advection and dispersion through the aquifer. The aquifer, like the vadose zone, is heterogeneous and flow may follow preferential pathways.

HSSM is based on a simple conceptualization of an LNAPL release. Within HSSM, the LNAPL follows a one-dimensional path from the surface to the water table. Properties of the subsurface are taken as being uniform. The LNAPL is composed of two components: one is the LNAPL phase and the other is the chemical constituent of interest. At the water table, the LNAPL spreads radially, which implies that the regional gradient has no effect on the flow of the LNAPL. Dissolution of the chemical constituent obeys local equilibrium partitioning, but is driven by the flowing ground water and recharge water reaching the water table. The chemical constituent is transported by advection and dispersion to multiple receptor points in the uniform aquifer.

The model is composed of three modules, based on the simplified conceptualization presented above. All of the modules are in the form of semi-analytical solutions of the governing equations, so the modules of HSSM do not use discretization of the flow domain nor iterative solution techniques. These approximations are designed to execute rapidly. The conceptual basis of the modules is discussed in the following paragraphs. The mathematical details of the modules are presented in the HSSM documentation. The model is intended to address the problem of LNAPL flow and transport from the ground surface to a water table aquifer.

Assuming that the principle interest lies with water quality, an emphasis of the model is the determination of the NAPL lens size and the mass flux of contaminants into the aquifer. These quantities define the source condition for aquifer contamination and must be based upon multiphase flow phenomena in the vadose zone. The first two modules of HSSM address the vadose zone flow and transport of the LNAPL. These two are the Kinematic Oily Pollutant Transport (KOPT) and OILENS modules. KOPT and OILENS are combined into one computer code, HSSM-KO, which provides a time- variable source condition for the aquifer model.

A chemical constituent dissolved in both the LNAPL and water phases is tracked by KOPT and OILENS. Once that chemical constituent reaches the water table, it contaminates the aquifer by contact with the recharge water and by dissolution from the LNAPL lens. Thus, the third part of the model is transported through the aquifer of one chemical constituent of the LNAPL. Notably, the mass flux from OILENS is time varying so that the aquifer model must be capable of simulating a time-varying source condition. In keeping with the level of approximation used in KOPT and OILENS, one suitable choice is the Transient Source Gaussian Plume (TSGPLUME) model, which uses an analytical solution of the advection-dispersion equation. TSGPLUME uses different numerical techniques than KOPT and OILENS so it is not incorporated within HSSMKO, but rather is implemented in the computer code HSSM- T. The TSGPLUME model takes the dissolution mass flux from the OILENS module of HSSM-KO and calculates the expected concentrations at a number of downgradient receptor points.

Windows interfaces are provided to create input data sets, run the model, and graph the results.

Rationale

The EPA HSSM was used to model the movement of diesel contamination (TPH-d) through the unsaturated zone to determine potential impact to groundwater at SWMU I07. This model was designed to simulate the behavior of water-immiscible contaminants, such as diesel fuel. The HSSM model is appropriate for use at HWAD to evaluate potential TPH-d impact to groundwater.

HSSM Model application to HWAD SWMU I07

The HSSM model was calibrated by changing the most sensitive parameter, flux. This simulation assumes a specific flux (volume released) over a specified duration (release time). The flux is varied to indicate that the hydrocarbon contamination would reach the lowest depth with detected TPH-d. In the case of SWMU I07, sample I07-SB03-7-S indicated hydrocarbon contamination had reached a maximum depth of 50 feet bgs, at a concentration of 26 mg/kg, well below the action level of 100 mg/kg. None of the LNAPL simulations have an input parameter for the actual measured concentration. The highest concentrations of TPH-d occurred near the surface. Therefore, by choosing the maximum depth at which TPH-d was detected and assuming that no lateral migration has occurred (HSSM assumption), the most conservative calibration is achieved. If the maximum detected concentration occurred at depth, other assumptions would have to be made regarding calibration of the HSSM model (e.g., assume that the vertical extent of contamination is deeper than the maximum depth of detected TPH-d, or perhaps looking at BTEX compounds).

Maximum concentration observed at the site is not a sufficient input parameter for the HSSM Model; therefore, an addition calculation can be performed as secondary assurance that based

on the maximum concentration observed groundwater will not be impacted. This calculation is presented below.

Additionally, a range of the necessity for each input was evaluated and is presented in Table G1.

Additional Modeling

As demonstrated in a Tetra Tech report in March 2002 diesel will not be mobile until the concentration in the soil exceeds 69,000 mg/kg or seven percent by weight. This was determined by employing a conservative method to determine if groundwater might be impacted. This method to estimate the volume of fuel necessary to overcome the effects of adsorption and to reach the water table is presented in the USEPA document Underground Technology Update, Volume 4, Number 4, August 1994: "Soil porosity and bulk hydrocarbon physical characteristics will determine the soil volume (Vs) necessary to immobilize a release (through adsorption)." The formula is

$Vs = 0.2 \times Vhc / P \times Rs$

Where Vs = soil volume, Vhc = volume in barrels of discharged hydrocarbons (one barrel = 44 gallons), P = effective porosity, and RS = residual saturation capacity (RS of soils is generally about 33% of the soil's water holding capacity). For this site, an RS value of 0.15 for diesel is appropriate. This equation can be rearranged to solve for the fuel concentration at which no further migration would occur because this is any concentration that results in a residual porosity (porosity unfilled by diesel) greater than the residual saturation capacity of the soil. The equation indicates that one cubic yard of soil with a porosity of 0.25 percent can absorb/adsorb approximately 0.19 barrels of diesel. A barrel of diesel weighs about 144 kg. Therefore, one cubic yard of soil can absorb 27 kg of diesel. Assuming that the dry bulk density of soils is about 500 kg/cubic meter, each cubic yard of soil weighs about 400 kg. This means that 400 kg of soil can absorb 27 kg of diesel, or in other words, the diesel will not be mobile until the concentration in the soil exceeds about 69,000 mg/kg, or about seven percent by weight. Thus based upon site conditions (final pit sampling result I07-CF01-02-20 had the highest concentration of 11,000 mg/kg TPH-diesel) any residual diesel is unlikely to pose a threat to groundwater quality.

Figure 1 – Calibrated model using a flux of 0.00165 meters per day.

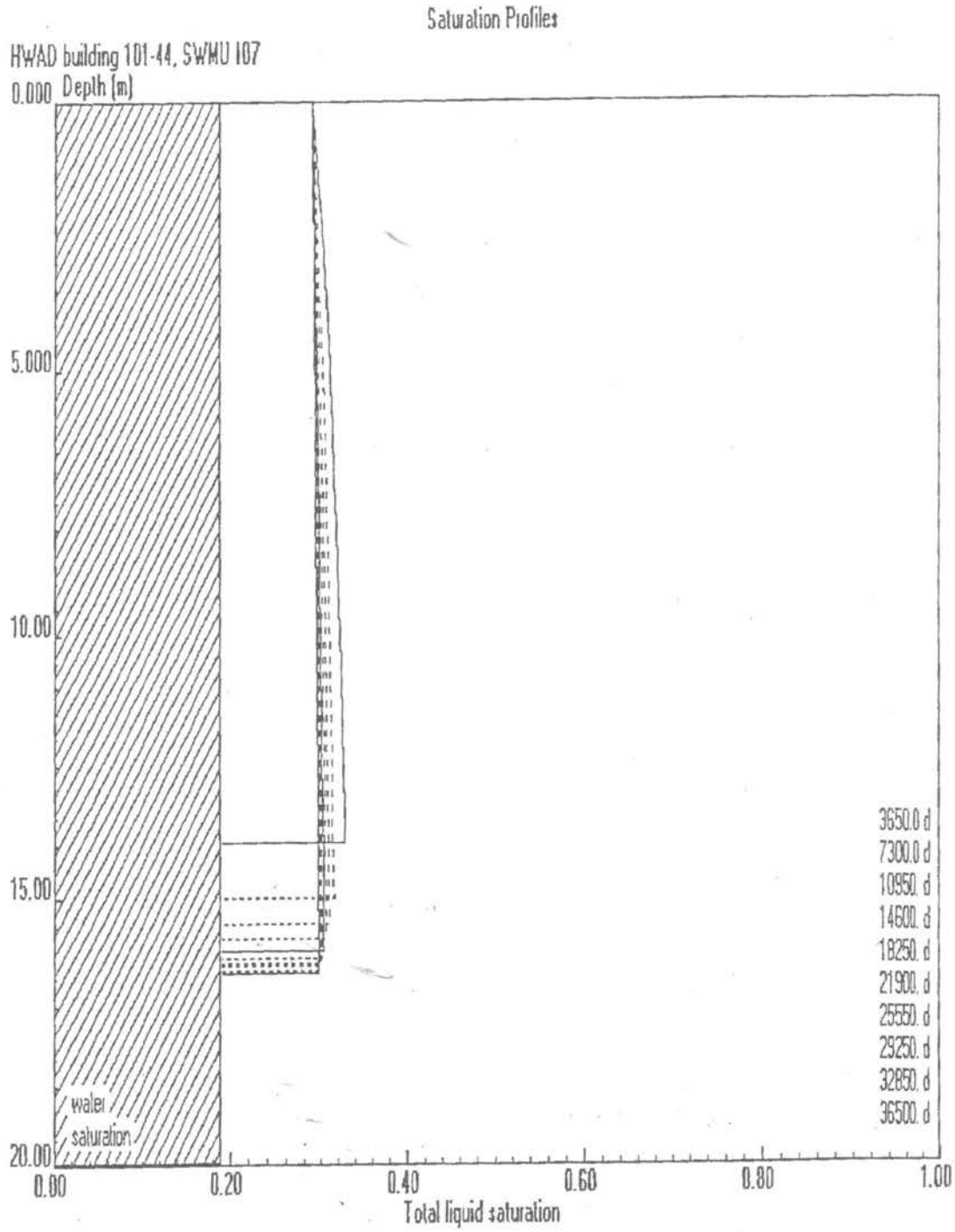
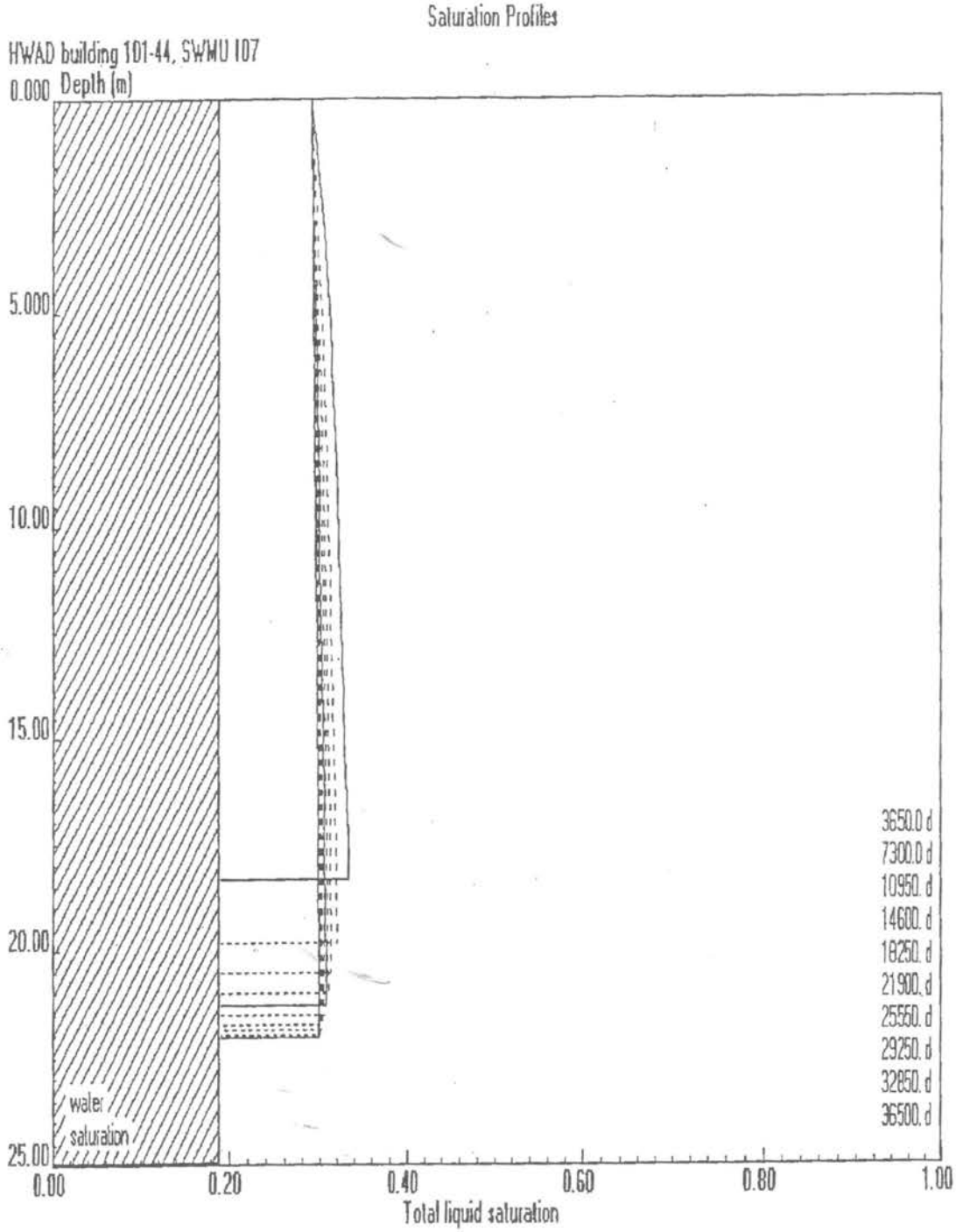


Figure 2 – Estimated model using a flux of 0.00224 meters per day.



HSSM INPUT PARAMETERS FOR SWMU I-07, HAWTHORNE ARMY DEPOT

HYDOLOGIC INPUT PARAMETERS	Value	Source	Expected Range at HWAD
Water Dynamic Viscosity (cp)	1	Standard value	NA
Water Density (g/cm^3)	1	Standard value	NA
Water Sufrace Tension (dyne/cm)	65	HSSM default assumption	NA
Maximum k_{rw} during infiltration	0.5	HSSM default assumption	NA
Recharge/Saturation			
Saturation	0.19	Flint et al., 1996	NA
Capillary Pressure Curve Model (sand)			
Brooks and Corey's Lambda	0.573	Page 166, Table 92, HSSM User's Guide	0.216 to 0.573 (silt loam to sand)
Air Entry Head (h_{ce})	0.353	Page 166, Table 92, HSSM User's Guide	0.353 to 0.693 (sand to silt loam)
Residual Water Saturation	0.045	Page 167, Table 94, HSSM User's Guide	0.045 to 0.067 (sand to silt loam)
Porous Medium Properties (sand)			
Saturated Vertical Hydraulic Conductivity (k)	7.1	Page 169, Table 96, HSSM User's Guide	0.060 to 7.1 (silt to sand)
Porosity (n)	0.349	Page 166, Table 92, HSSM User's Guide	0.349 to 0.484 (sand to silt loam)
HYDROCARBON PHASE PARAMETERS (Diesel)	**Value**	**Source**	**Expected Range at HWAD**
NAPL Density (g/cm3)	0.85	Env. Canada Oil Properties Database	0.85 to 0.87 (diesel to fuel oil)
NAPL Dynamic Viscosity (cp)	2	Env. Canada Oil Properties Database	2 to 4 (diesel to fuel oil)
Vadose Zone Residual NAPL Saturations	0.1	HSSM Default Value	NA
NAPL Surface Tension (dyne/cm)	25	Env. Canada Oil Properties Database	25-28 (diesel to fuel oil)
NAPL Flux (m/d)	variable (0.00224 for SWMU I-07)		site specific
Beginning Time (d)	0		NA
Ending Time (d)	365		site specific

NOTE: The values chosen as imput parameters were the most conservative based on a predominant sand soil type.

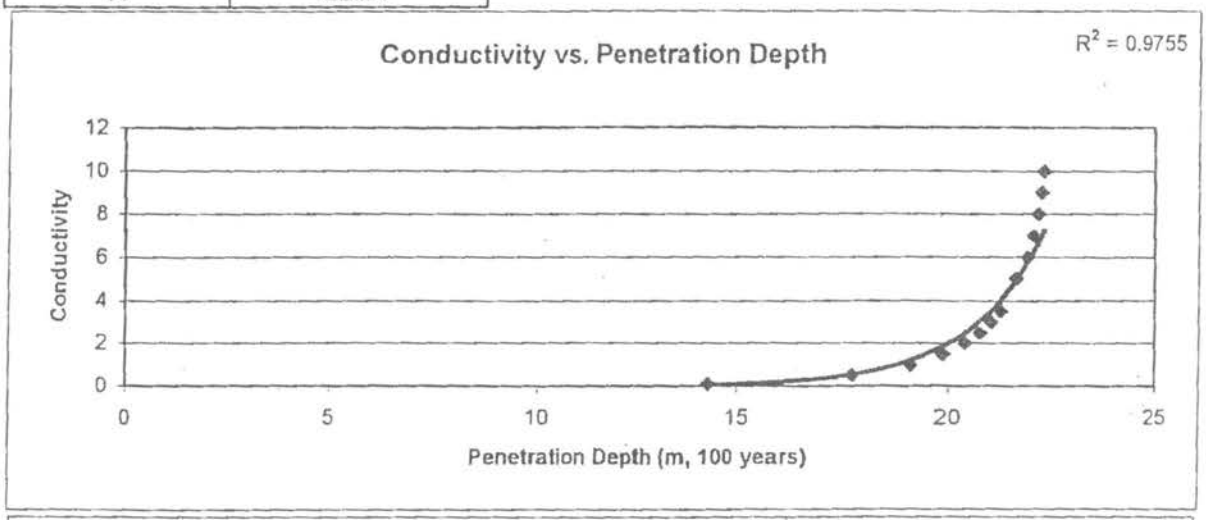
Modeling Impact to Groundwater using the Hydrocarbon Spill Screening Model (HSSM), SWMU I-07, Hawthorne Army Depot, Hawthorne, Nevada

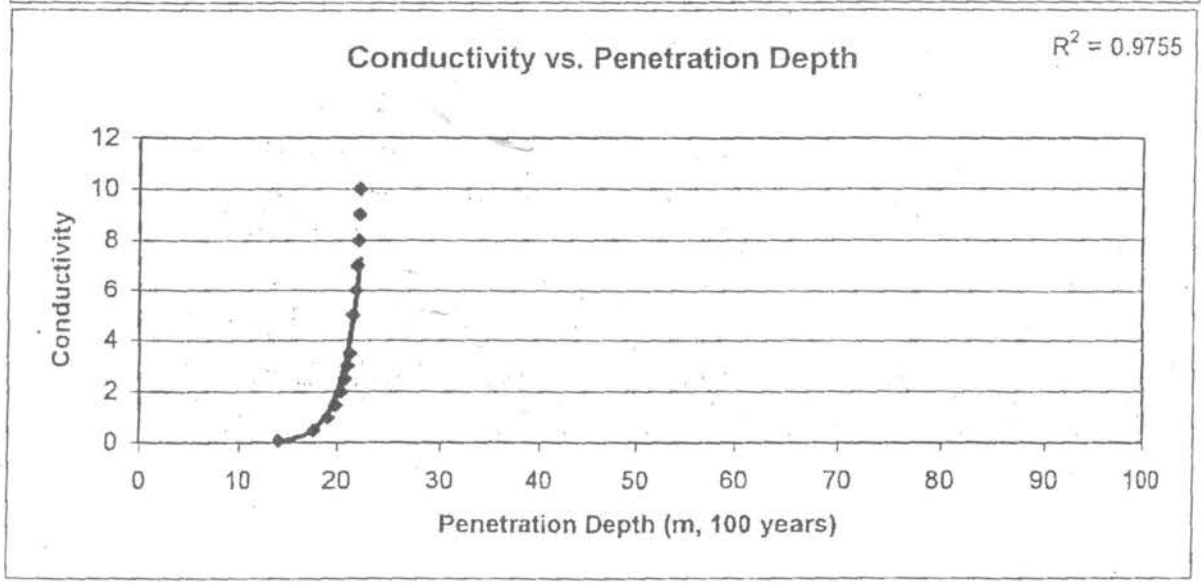
Sensitivity Analysis

A sensitivity analysis was conducted to determine which HSSM input parameters had the most impact on hydrocarbon (diesel) penetration depth. The following graphs indicate that flux had the most impact, while viscosity had little impact on penetration depth. Both conductivity and porosity have possible significant impacts over the range of extreme values (up to 15 meters for porosity), but the conditions expected at Hawthorne Army Depot indicate that flux will be the most sensitive parameter.

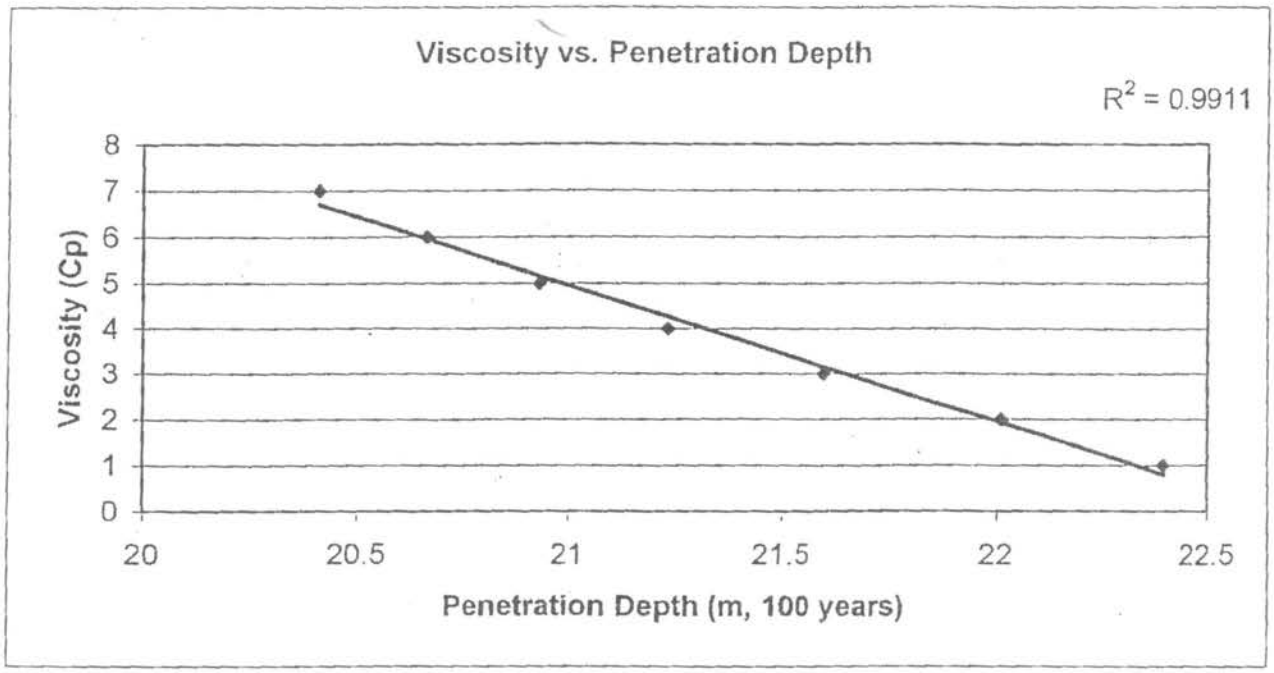
X

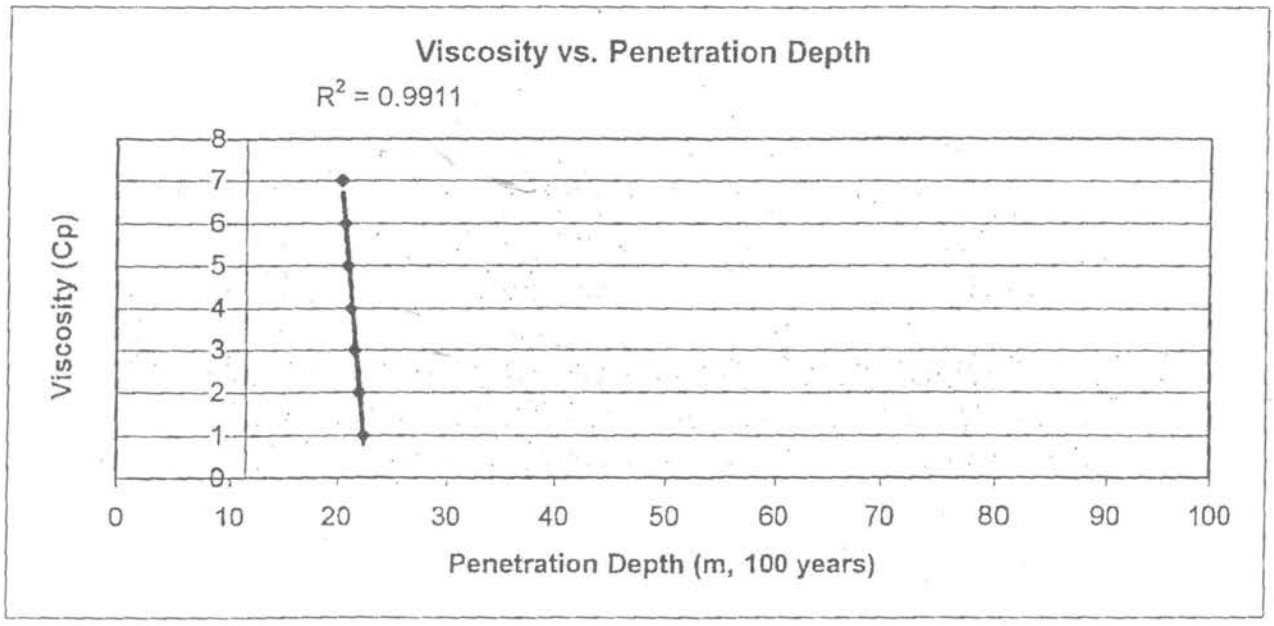
SWMU I-07 HSSM MODEL SENSITIVITY ANALYSIS - CONDUCTIVITY					
Sat Hyd Cond. (k)	Penetration Depth (100 years)	Porosity	Viscosity	Surface Tension	Flux
0.1	14.3	0.349	2	65	0.00224
0.5	17.74				
1	19.14				
1.5	19.89				
2	20.39				
2.5	20.74				
3	21				
3.5	21.22				
5	21.58				
6	21.85				
7	22				
8	22.1				
9	22.18				
10	22.24				



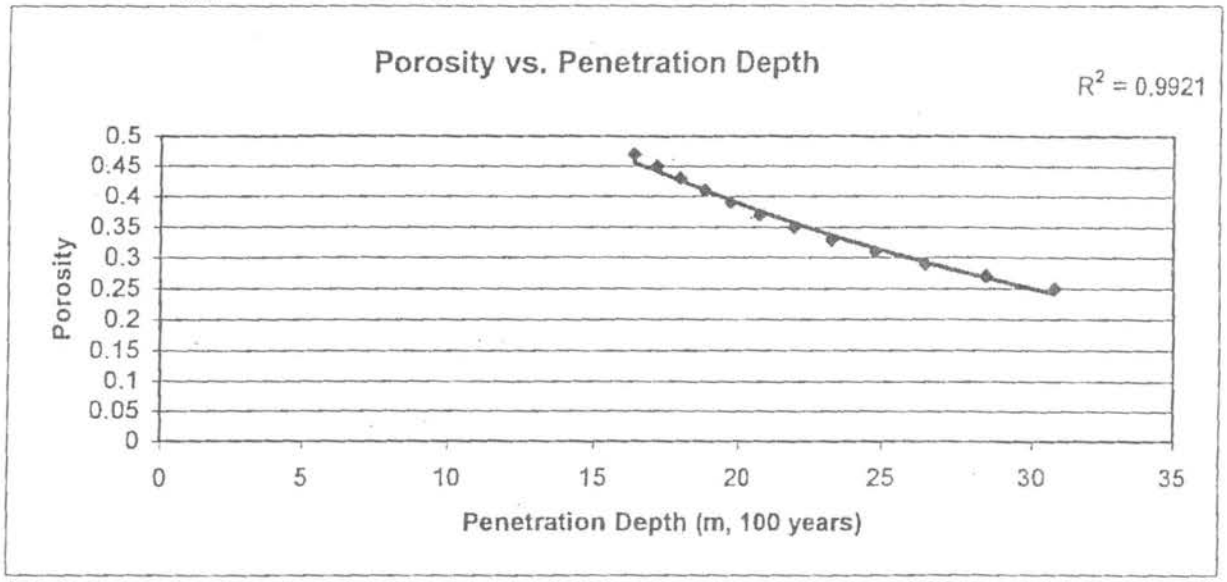


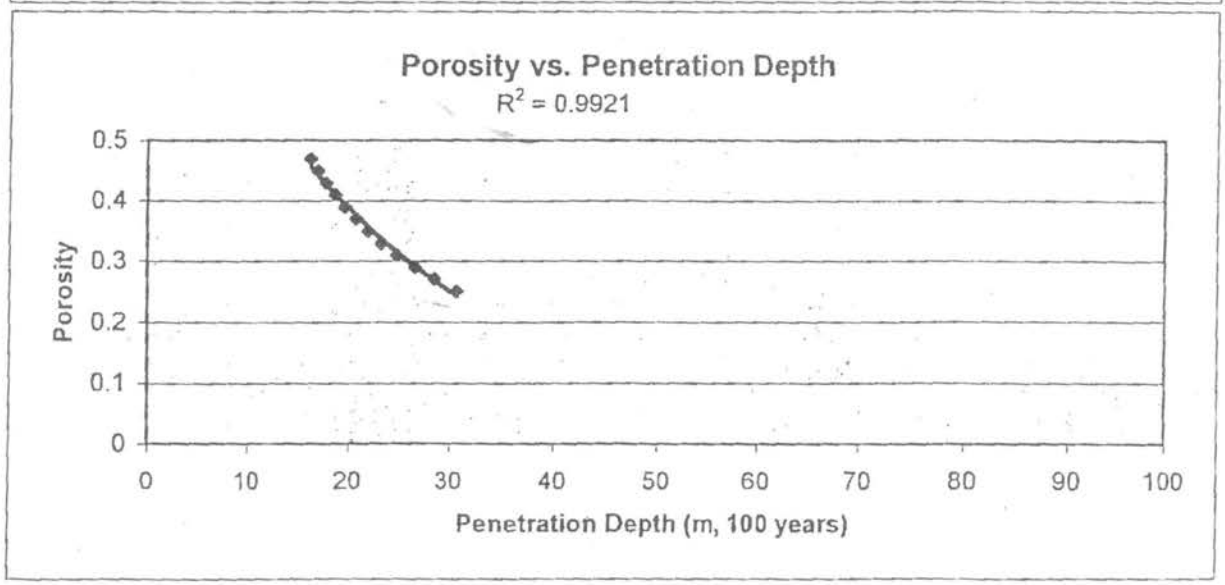
SWMU I-07 HSSM MODEL SENSITIVITY ANALYSIS - POROSITY					
VISCOSITY	Penetration Depth (100 years)	Conductivity	Porosity	Surface Tension	Flux
1	22.39	7.1	0.349	65	0.00224
2	22.01				
3	21.6				
4	21.23				
5	20.93				
6	20.66				
7	20.41				



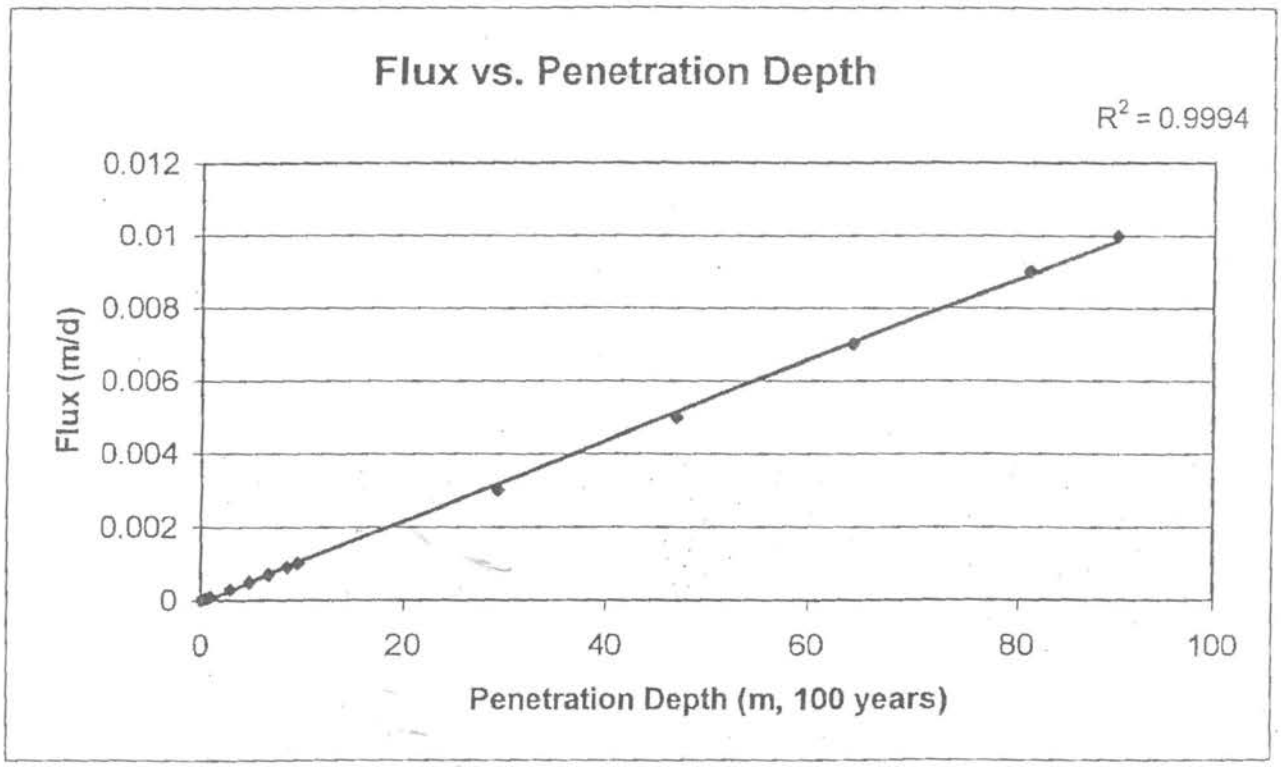


SWMU I-07 HSSM MODEL SENSITIVITY ANALYSIS - POROSITY					
Porosity	Penetration Depth (100 years)	Conductivity	Viscosity	Surface Tension	Flux
0.25	30.73	7.1	2	65	0.00224
0.27	28.45				
0.29	26.49				
0.31	24.78				
0.33	23.28				
0.35	21.94				
0.37	20.73				
0.39	19.68				
0.41	18.74				
0.43	17.87				
0.45	17.07				
0.47	16.34				





SWMU I-07 HSSM MODEL SENSITIVITY ANALYSIS - FLUX					
Flux	Penetration Depth (100 years)	Conductivity	Porosity	Viscosity	Surface Tension
0.00001	0.1	7.1	0.349	2	65
0.00003	0.31				
0.00005	0.51				
0.00007	0.71				
0.00009	0.91				
0.0001	1.02				
0.0003	3.04				
0.0005	5.05				
0.0007	7.05				
0.0009	9.03				
0.001	10.02				
0.003	29.12				
0.005	47.08				
0.007	64.33				
0.009	81.06				
0.01	89.72				



Run Titles:

HWAD building 101-44, SWMU 107

Diesel Arrival Time at Groundwater flux 0.00165

OK

Cancel

Printing switches

- [x] Create output files
- ( ) Echo print data only
- (•) Run models

Module switches

- [x] Run KOPT
- [ ] Run OILENS
- [ ] Write HSSM-T input file

File names

NOTE: These filenames will be used if the data file is saved under a new name with the "SaveAs" option.

C:\HSSM\HWAD107.DAT	HSSM-KO input file
C:\HSSM\HWAD107.HSS	HSSM-KO output file
C:\HSSM\HWAD107.PL1	HSSM-KO plot file 1
C:\HSSM\HWAD107.PL2	HSSM-KO plot file 2
C:\HSSM\HWAD107.PL3	HSSM-KO plot file 3
C:\HSSM\HWAD107.PMI	HSSM-T input file
C:\HSSM\HWAD107.TSG	HSSM-T output file
C:\HSSM\HWAD107.PMP	HSSM-T plot file

HYDROLOGIC PROPERTIES

Data file:
C:\HSSM\HWAD107.DAT

OK

Cancel

☐ Enable range checking

Water dynamic viscosity (cp)	1
Water density (g/cm³)	1
Water surf. tension (dyne/cm) . . .	65
Maximum krw during infiltration . . .	0.5

Recharge

○ Average recharge rate (m/d)

◉ Saturation — value: .19

Capillary pressure curve model

◉ Brooks and Corey

○ van Genuchten

Brooks and Corey's lambda	0.573
Air entry head (m)	0.353
Residual water saturation	0.045
van Genuchten's alpha (1/m) . . .	0
van Genuchten's n	0

POROUS MEDIUM PROPERTIES

Sat'd vert. hydraulic cond. (m/d) . .	7.1
Ratio of horz/vert hyd. cond.	1
Porosity	0.349
Bulk density (g/cm³)	0
Aquifer saturated thickness (m) . . .	.0
Depth to water table (m)	0
Capillary thickness parameter (m) .	0
Groundwater gradient (m/m)	.0
Longitudinal dispersivity (m)	.0
Transverse dispersivity (m)	.0
Vertical dispersivity (m)	.0

HYDROCARBON PHASE PROPERTIES

NAPL density (g/cm³)	0.85
NAPL dynamic viscosity (cp)	2
Hydrocarbon solubility (mg/L)	0
Aquifer residual NAPL saturation	0
Vadose zone residual NAPL sat'n	0.1
Soil/water partition coeff. (L/kg)	0
NAPL surface tension (dyne/cm)	25

DISSOLVED CONSTITUENT PROPERTIES

☐ Dissolved constituent exists

Initial constit. conc. in NAPL	0
NAPL/water partition coefficient	0
Soil/water partition coeff. (L/kg)	0
Constituent solubility (mg/L)	0
☐ Constit. ½-life in aquifer (d)	0.0

Data file:
C:\HSSM\HWAD107.DAT

OK

☐ Enable range checking

Cancel

HYDROCARBON RELEASE

- ◉ Specified flux
- ○ Specified volume/area
- ○ Constant head ponding
- ○ Variable ponding after const head period

NAPL flux (m/d)	.00165
Beginning time (d)	0
Ending time (d)	365
Ponding depth (m)	0
NAPL volume/area (m)	0
Lower depth of NAPL zone (m)	0

SIMULATION CONTROL PARAMETERS

Radius of NAPL lens source (m). . .	1.2
Radius multiplication factor	0
Max NAPL saturation in NAPL lens	0
Simulation ending time (d)	36500
Maximum solution time step (d) . . .	100
Minimum time between printed time steps (d)	10

OILENS Simulation ending criterion

- (•) User-specified time
- ( ) NAPL lens spreading stops
- ( ) Max contaminant mass flux into aquifer
- ( ) Contaminant leached from lens

Fraction of mass remaining 0

HSSM-T MODEL PARAMETERS

Percent max. contam't radius (%) . .	0
Minimum output conc'n (mg/L)	0
Beginning time (d)	0
Ending time (d)	0
Time increment (d)	0

Data file:
C:\HSSM\HWAD107.DAT

☐ Enable range checking

OK

Cancel

NAPL LENS PROFILES

Enter time (d) for each of up to 10 profiles

Number of profiles: 10

1	3650
2	7300
3	10950
4	14600
5	18250
6	21900
7	25550
8	29250
9	32850
10	36500

RECEPTOR WELL LOCATIONS

Enter coordinates for each of up to 6 wells

Number of wells: 1

	X (m)	Y (m)
1	0	0
2		
3		
4		
5		
6		

TETRA TECH, INC.
180 Howard Street, Suite 250
San Francisco, CA 94105-1661
Telephone (415) 974-1221
FAX (415) 974-5914

Log of Well No. IRPMW36

Hawthorne Army Depot
Hawthorne, Nevada

Date Started: 11/19/96	Completed: 11/20/96	Water Level During Drilling: 185.0 ft	Stabilized: 131.8 ft
Logged By: K. Bronson	Checked By: R. Brunner	Casing: PVC schedule 40	Diameter: 4 inches
Drilling Co: Water Dev. Corp.	Driller: R. Anderson	Perforation: 0.01 inch circumslot	from 185.4 ft to 190.4 ft
Drilling Method: ARCH		Pack: 30-50 Sand	from 180.0 ft to 191.0 ft
Drilling Equipment: CME95		Seal: Bentonite Seal	from 176.0 ft to 180.0 ft
Ground Surface Elevation: 4233.93 ft	Total Depth: 191.0 ft	Grout	from 0 ft to 176.0 ft

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
	SAND, silty, fine to coarse sand and gravel, subangular to angular, very loose, rootlets present <1 ft. fines with depth to a fines with depth to a silty fine to vfine sand. Color: 2.5Y-7/4 (Pale Yellow) Fines with depth to silty very fine to fine sand.	SM			1530 1535	95 100		Lithology from pilot boring SB1-1-101/42 logged by E&E 9/10/96 & 9/12/96.
5	SAND, well sorted v.fine to fine, micaceous, v.loose to loose and slightly silty from 9' to 10'. 2.5Y-7/4	SW			1545 1550	100 100		
10	SAND, well sorted, v.fine sand, micaceous loose to med. dense, tr silt. 2.5Y-7/4	SW			1600	90		Sample 2-101/42-SB1-1-010 (Analytical)
	SILTY SAND, silty v.fine sand, loose to med. dense, micaceous and sl. moist. 2.5Y-6/4 (lt Yllw-Brn)	SM			1603	100		
15					1606	40		
	SAND, well sorted, fine to med. sand, micaceous, v.loose. 2.5Y-6/4	SW			1615	100		
	SAND, poorly sorted, fine to coarse, v.loose. 2.5Y-6/2 (lt Brn-Gry)	SP						
20	SAND, poorly sorted, fine to coarse, v.loose, sub-angular to sub-round, little gravel 20' to 21', finer 21'-22'. 2.5Y-6/2	SP			1625	98		
	SAND, well sorted, fine to med., v.loose, micaceous, little coarse sand. 2.5Y-6/2	SC			1630	100		
25	SAND, poorly sorted, fine to coarse, layered, little gravel. 2.5Y-6/2	SP			1635	100		
	SAND, well sorted, fine sand, v.loose, micaceous, tr coarse sand. 2.5Y-6/2 (lt gray)	SW			1643	100		
30					1647	100		
	SAND, poorly sorted, fine to coarse sand and, 1/4" to 1/2" subrounded fine gravel, coarsens with depth to med. to	SP						

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Log of Well No. **IRPMW36**

Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
	coarse sand. 5Y-6/3 (Pale Olive)				1655	100		
35	SAND, poorly sorted, fine to coarse, gravelly 35' to 36', micaceous, fines with depth. 3.5Y-6/6 (Olive-Yllw)	SP			1700	90		Sample 2-101/42-SB1-1-035 (Analytical) Sample 2-101/42-SB2-1-035 (Duplicate) Sample 2-101/42-SB3-1-035 (Split)
	SANDY GRAVEL, fine to coarse, sub-round to sub-angular gravel, mostly >3". 5Y-7/3 (Pale Yllw)	GW			1703			
40	SILTY SAND, silty fine sand, low to med. cementation in 1/2" to 1" layers, loose to med. dense. 5Y-7/3	SM			1708	90		
	SAND, silty fine sand, mod. cementation throughout, 1.5" varved silty layer (lt gry) at 43'. 5Y-7/3	SM			1716	100		
45					1725	100		
	SAND, well sorted, white (non-quartz) sand, low to mod. cementation. 5Y-7/3	SW			1730	100		
	SAND, well sorted, fine to med. sand, loose, coarsens w/ depth, turning from white sand to qtz. sand. 2.5Y-8/2	SW						
50	SAND, well sorted, v.fine to fine sand, sl. micaceous, loose to v.loose. 5Y-6/3	SW			1738	100		Sample 2-101/42-SB1-1-050 (Analytical)
	SILTY SAND, silty to clayey, hard, blocky. 5Y-6/3	SM						
	SAND, well sorted, v.fine to fine sand, sl. micaceous, loose to v.loose, sl. varved layering to 55', dry to moist. 5Y-6/3 changes to 5Y-7/3 (Pale Yllw) at 60'	SC SW			1742	100		
55					1746	100		
					1752	100		
60					1756	100		
					0700	100		
	SAND, silty, v.fine to fine sand, dense, dry, blocky. 5Y-7/3	SM						
65	SAND, well sorted, v.fine to fine, loose, dry, sl. micaceous, dry, sl. silty 69' to 70'. 5Y-7/3	SW			0704	100		
					0712	100		
70					0716	100		
	SAND, POORLY SORTED, FINE TO COARSE SAND and, 1/4" to 1.25" sub-rounded to sub-angular gravel.	SP SW			0722	100		

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Log of Well No. **IRPMW36**

Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
	5Y-6/3	SP						
	SAND, well sorted, v.fine to fine sand, loose, dry. 5Y-6/3							
75	SAND, poorly sorted, med. to coarse sand and sub-angular gravel, tr fine sand and silt. 5Y-6/3				0730	90		
	SAND, silty to clayey, fine sand, tr med. sand, v.dense. 2.5Y-6/4	SC			0737	100		
	SAND, poorly sorted med. to coarse sand and 1/4" to >3" gravel. 2.5Y-6/4	SP GP SC						
80	SAND, silty to clayey, fine sand, dry, brittle, dense, hard. 2.5Y-6/2	SM SM			0745	100		
	LAYERED, silty fine sand, silty fine to med. sand, well sorted med. sand, silty fine to med. sand, clayey fine sand, dry. 2.5Y-6/2	SW SM SC ML			0750	100		
	SANDY SILT, med. dense, dry to moist. 2.5Y-6/4	SW						
85	SAND, well sorted, fine, micaceous, v.loose to loose, dry sl. moist. 5Y-6/3	SM			0755	100		
	SILTY SAND, fine to med. sand, 25% silt, med. dense, dry, brittle. 5Y-6/3	SP						
	SAND, poorly sorted, med. with some coarse, v.loose, dry, sub-round. 5Y-6/3	SM			0800	100		
	SILTY SAND, silty fine sand, tr. clayey sand. 5Y-7/3							
	SAND, well sorted, fine, dry, loose. 5Y-7/3	SW						
90	SILTY SAND, silty fine sand, med. dense to hard, minor layers of mod. cemented, fine to v.fine sand. Caliche layers appx. 1" with broken pieces throughout. 5Y-6/3	SM			0806	100		
	SAND, silty, fine to coarse sand (mostly fine to med.), little fine, sub-angular, 1/4" to 3/8" gravel. 5Y-6/3	SM			0820	100		
95	CALICHE, >3" rock and broken gravel size pieces. 5Y-6/3				0835	100		
	SILTY CALICHE, caliche rock, gravel and coarse sand in silty matrix, med. dense, hard. 5Y-6/3	SM SC						
	SILTY SANDY CLAY, fine sand, blocky, brittle, v.stiff, hard, moist at 97.5'. 5Y-7/3				0850	100		
	SILT, white, varved, hard, dry. 2.5Y-8/0 (white)	MH						
	SILTY SAND, med. dense, dry to moist. 5Y-6/3	SM						
100	SANDY CLAY, fine sand, v.stiff to hard. 5Y-6/2	CL			0930	100		Sample 2-101/42-SB1-1-100 (Analytical)
	SANDY SILT, fine sandy silt to sandy clay, moist, stiff. 5Y-6/2	ML CL						
	SILT, gray-white, varved.	ML						
	SANDY CLAY, fine sandy clay, stiff, sl. moist. 5Y-6/2	CL CL			0955	100		
	SANDY CLAY, fine sand, silty, dense, stiff, dry to moist. 5Y-6/2	SP CL						
105	SAND, poorly sorted, fine to coarse sand and fine gravel, loose. 5Y-5/3 (Olive)	ML			1000	100		
	SANDY CLAY, fine sand, v.stiff, dry to moist. 5Y-6/3							
	SANDY SILT, fine sand, minor clay, moist, soft, crumbly. 5Y-6/3				1012	100		
110					1025	100		
	SILTY SAND, fine sand, loose, stiff, dry to moist. 5Y-5/3	SM						
	SANDY CLAY, some silt, fine to coarse sand, fines w/ depth, stiff. 2.5Y-5/4 (lt Olive-Brn)	CL			1035	100		

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Log of Well No. **IRPMW36**

Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
115	CLAYEY SAND, fine to coarse sand and fine sub-angular gravel, dense. 2.5Y-5/4	SC						
	SANDY GRAVEL, fine to med. gravel, med. to coarse sand and minor silt, sub-angular, moist. 5Y-5/3	GM			1043	100		
	SANDY CLAY, fine sand, v.stiff, moist. 5Y-5/3	CL						
	SILTY SAND, fine to med. sand, loose, med. dense, moist. 2.5Y-6/4 (lt Yllw-Brn)	SM			1050	100		
120	SILTY SAND, fine sand, loose, med. dense, sl. micaceous, silt decreases w/ depth. 2.5Y-5/4	SM			1100	100		
					1106	100		
125	fine to med. sand, trace coarse sand, sl. more moist.				1115	100		
	silt content increases.				1125	100		
130	SAND, fine to med. sand, loose, well sorted, micaceous, wet. 2.5Y-5/2 (Gry-Brn)	SW			1135	90		
	GRAVEL, poorly graded gravel with med. to coarse sand, v. loose, sub-angular (Qtz, Olivine, Volcanics). 2.5Y-4/4 (Olive-Brn)	GP			1143	5		
135	SAND, poorly sorted, med. to coarse, minor fines. 2.5Y-4/4	SP			1200	60		Sample SB1-101/42-134 (Grain size)
	SANDY CLAY, some fine sand, stiff. 2.5Y-6/2	CL						
	GRAVEL, sub-round to sub-angular. 5Y-6/2	GP						
	CLAY, some fine sand, stiff. 5Y-6/2	CL			1300	85		
	CLAYEY SAND, fine to coarse sand, dense. 5Y-6/2	SC						
140	GRAVEL, silty, sandy, 3/4" to 1.25" sub-rounded gravel, v.loose. 2.5Y-5/4	GM			1330	100		
	SANDY CLAY, fine sand, stiff, mottled gray w/ red iron streaks. 5Y-7/1 (lt Gry)	CL						
	SAND, clayey, silty, fine sand, med. dense to dense. 5Y-6/2	SC SM			1400	100		
	GRAVEL, silty, clayey, minor sand. 2.5Y-6/4	GM						
145	SAND, silty, clayey, fine sand, little med. sand, dense. 2.5Y-6/4	SM SC			1415	100		
	SANDY CLAY, fine sand, sub-round gravel 3/4" to 1.5" at 148', less sand w/ depth, low plasticity from 149' ti 150'. 5Y-5/3	CH			1440	100		
150	SANDY CLAY, fine sand, tr coarse sand, dense. 5Y-5/3	CL			1500	90		Sample 2-101/42-SB1-1-150 (Analytical)
	SAND & GRAVEL, clayey, silty, coarse sand, sub-round, loose. 2.5Y-5/4	SM GM			1520	100		
	SAND, clayey, fine to med. sand, dense. 2.5Y-5/4	SM						
	CLAY, some fine sand, v.stiff, moist. 2.5Y-5/4	CL						
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Log of Well No. **IRPMW36**

Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
					1620	100		
					1645	100		
160	SILTY SAND, fine to med. sand, dense, minor clay, moist to wet. 10YR-5/3 (Brn)	SM			1710	90		
	SAND, silty, fine sand, hard, v.dense. 10YR-5/3	SM			1735	100		
165	SAND, silty, fine sand, loose to med. dense, appx. 3" to 5" layers with more or less silt. 10YR-5/3	SM			1755	100		
	SANDY CLAY, fine sand, hard, moist. 2.5Y-5/4	CL			1825	100		
170					1845	100		
	SANDY CLAY, fine to coarse sand, v.hard, moist to dry. 10YR-5/3	CL			0710	100		
175	SILTY SAND, silty, fine sand, med. dense, tr med. sand, silt decreases w/ depth, moist to wet. 10YR-5/3	SM			0730	100		
	wet.				0830	100		
	CLAY, silty, tr fine sand, brittle, moist to dry. 2.5Y-5/2	CL						
180	SILTY SAND, silty, fine to med. sand, loose to med. dense, increasing density and silt w/ depth, tr sub-round to sub-angular coarse sand, wet. 10YR-5/3	SM			0850	100		
					0910	70		
185					0940			Sample SB1-101/42-184 (Grain size)
	Notes: Pilot boring SB1-1-101/42 drilled by hollow stem auger to a total depth of 185 feet. Lithology logged from pilot boring by E&E 9/10/96 & 9/12/96. Soil types classified in accordance the Unified Soil Classification System. Well Construction: Well drilling method ARCH (Air rotary casing hammer). Well construction depths measured from ground surface. Well boring completed to 191 ft bgs. Well installed to 190.9 ft bgs. 30-50 Filter pack sand placed from 191 ft to 183 ft. 30-50 Transition sand placed from 183 ft to 180 ft. Centralizers placed at depths of 190 ft, 185 ft, 165 ft, 125 ft, 85 ft, 45 ft, and 10 ft. Well completed aboveground with a steel stovepipe set in a							
190								
195								

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Log of Well No. IRPMW36

Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
	concrete apron with a survey pin. Survey pin elevation 4234.46 ft above msl. Top of well casing notch surveyed at 4236.93 ft above msl.							
200								
205								
210								
215								
220								
225								
230								
235								

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Log of Well No. **IRPMW37**

Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
	coarse sand. 5Y-6/3 (Pale Olive)				1655	100		
35	SAND, poorly sorted, fine to coarse, gravelly 35' to 36', micaceous, fines with depth. 3.5Y-6/6 (Olive-Yllw)	SP			1700	90		Sample 2-101/42-SB1-1-035 (Analytical) Sample 2-101/42-SB2-1-035 (Duplicate) Sample 2-101/42-SB3-1-035 (Split)
	SANDY GRAVEL, fine to coarse, sub-round to sub-angular gravel, mostly >3". 5Y-7/3 (Pale Yllw)	GW			1703			
40	SILTY SAND, silty fine sand, low to med. cementation in 1/2" to 1" layers, loose to med. dense. 5Y-7/3	SM			1708	90		
	SAND, silty fine sand, mod. cementation throughout, 1.5" varved silty layer (lt gry) at 43'. 5Y-7/3	SM			1716	100		
45					1725	100		
	SAND, well sorted, white (non-quartz) sand, low to mod. cementation. 5Y-7/3	SW			1730	100		
	SAND, well sorted, fine to med. sand, loose, coarsens w/ depth, turning from white sand to qtz. sand. 2.5Y-8/2	SW						
50	SAND, well sorted, v.fine to fine sand, sl. micaceous, loose to v.loose. 5Y-6/3	SW			1738	100		Sample 2-101/42-SB1-1-050 (Analytical)
	SILTY SAND, silty to clayey, hard, blocky. 5Y-6/3	SM						
	SAND, well sorted, v.fine to fine sand, sl. micaceous, loose to v.loose, sl. varved layering to 55', dry to moist. 5Y-6/3 changes to 5Y-7/3 (Pale Yllw) at 60'	SC SW			1742	100		
55					1746	100		
					1752	100		
60					1756	100		
					0700	100		
	SAND, silty, v.fine to fine sand, dense, dry, blocky. 5Y-7/3	SM						
65	SAND, well sorted, v.fine to fine, loose, dry, sl. micaceous, dry, sl. silty 69' to 70'. 5Y-7/3	SW			0704	100		
					0712	100		
70					0716	100		
	SAND, POORLY SORTED, FINE TO COARSE SAND AND, 1/4" TO 1.25" sub-rounded to sub-angular gravel.	SP SW			0722	100		

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Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
	5Y-6/3	SP						
	SAND, well sorted, v.fine to fine sand, loose, dry. 5Y-6/3							
75	SAND, poorly sorted, med. to coarse sand and sub-angular gravel, tr fine sand and silt. 5Y-6/3				0730	90		
	SAND, silty to clayey, fine sand, tr med. sand, v.dense. 2.5Y-6/4	SC			0737	100		
	SAND, poorly sorted med. to coarse sand and 1/4" to >3" gravel. 2.5Y-6/4	SP GP SC						
80	SAND, silty to clayey, fine sand, dry, brittle, dense, hard. 2.5Y-6/2	SM SM			0745	100		
	LAYERED, silty fine sand, silty fine to med. sand, well sorted med. sand, silty fine to med. sand, clayey fine sand, dry. 2.5Y-6/2	SW SM SC ML			0750	100		
	SANDY SILT, med. dense, dry to moist. 2.5Y-6/4	SW						
85	SAND, well sorted, fine, micaceous, v.loose to loose, dry sl. moist. 5Y-6/3	SM			0755	100		
	SILTY SAND, fine to med. sand, 25% silt, med. dense, dry, brittle. 5Y-6/3	SP						
	SAND, poorly sorted, med. with some coarse, v.loose, dry, sub-round. 5Y-6/3	SM			0800	100		
	SILTY SAND, silty fine sand, tr. clayey sand. 5Y-7/3							
	SAND, well sorted, fine, dry, loose. 5Y-7/3	SW						
90	SILTY SAND, silty fine sand, med. dense to hard, minor layers of mod. cemented, fine to v.fine sand. Caliche layers appx. 1" with broken pieces throughout. 5Y-6/3	SM			0806	100		
	SAND, silty, fine to coarse sand (mostly fine to med.), little fine, sub-angular, 1/4" to 3/8" gravel. 5Y-6/3	SM			0820	100		
	CALICHE, >3" rock and broken gravel size pieces. 5Y-6/3							
95	SILTY CALICHE, caliche rock, gravel and coarse sand in silty matrix, med. dense, hard. 5Y-6/3	SM SC			0835	100		
	SILTY SANDY CLAY, fine sand, blocky, brittle, v.stiff, hard, moist at 97.5'. 5Y-7/3				0850	100		
	SILT, white, varved, hard, dry. 2.5Y-8/0 (white)	MH						
	SILTY SAND, med. dense, dry to moist. 5Y-6/3	SM						
100	SANDY CLAY, fine sand, v.stiff to hard. 5Y-6/2	CL			0930	100		Sample 2-101/42-SB1-1-100 (Analytical)
	SANDY SILT, fine sandy silt to sandy clay, moist, stiff. 5Y-6/2	ML CL						
	SILT, gray-white, varved.	ML						
	SANDY CLAY, fine sandy clay, stiff, sl. moist. 5Y-6/2	CL CL			0955	100		
	SANDY CLAY, fine sand, silty, dense, stiff, dry to moist. 5Y-6/2	SP CL						
105	SAND, poorly sorted, fine to coarse sand and fine gravel, loose. 5Y-5/3 (Olive)	ML			1000	100		
	SANDY CLAY, fine sand, v.stiff, dry to moist. 5Y-6/3							
	SANDY SILT, fine sand, minor clay, moist, soft, crumbly. 5Y-6/3				1012	100		
110					1025	100		
	SILTY SAND, fine sand, loose, stiff, dry to moist. 5Y-5/3	SM						
	SANDY CLAY, some silt, fine to coarse sand, fines w/ depth, stiff. 2.5Y-5/4 (lt Olive-Brn)	CL			1035	100		

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Log of Well No. **IRPMW37**

Hawthorne Army Depot
Hawthorne, Nevada

Depth (feet)	LITHOLOGIC DESCRIPTION	Lithology	Monitoring Well Construction	Sample	Time	Recovery	PID/FID (ppm)	REMARKS
	CLAYEY SAND, fine to coarse sand and fine sub-angular gravel, dense. 2.5Y-5/4	SC						
115	SANDY GRAVEL, fine to med. gravel, med. to coarse sand and minor silt, sub-angular, moist. 5Y-5/3	GM			1043	100		
	SANDY CLAY, fine sand, v.stiff, moist. 5Y-5/3	CL						
	SILTY SAND, fine to med. sand, loose, med. dense, moist. 2.5Y-6/4 (lt Yllw-Brn)	SM			1050	100		
120	SILTY SAND, fine sand, loose, med. dense, sl. micaceous, silt decreases w/ depth. 2.5Y-5/4	SM			1100	100		
					1106	100		
125	fine to med. sand, trace coarse sand, sl. more moist.				1115	100		
	silt content increases.				1125	100		
	SAND, fine to med. sand, loose, well sorted, micaceous, wet. 2.5Y-5/2 (Gry-Brn)	SW						
130	GRAVEL, poorly graded gravel with med. to coarse sand, v. loose, sub-angular (Qtz, Olivine, Volcanics). 2.5Y-4/4 (Olive-Brn)	GP			1135	90		
					1143	5		Sample IRPMW37-133 collected during well construction (Grain size)
135	SAND, poorly sorted, med. to coarse, minor fines. 2.5Y-4/4	SP			1200	60		Sample SB1-101/42-134 (Grain size)
	SANDY CLAY, some fine sand, stiff. 2.5Y-6/2	CL						
	GRAVEL, sub-round to sub-angular. 5Y-6/2	GP						
	CLAY, some fine sand, stiff. 5Y-6/2	CL			1300			
	CLAYEY SAND, fine to coarse sand, dense. 5Y-6/2	SC						

140 Notes:
Pilot boring SB1-1-101/42 drilled by hollow stem auger to a total depth of 185 feet (see IRPMW36 log).
Lithology logged from pilot boring by E&E on 9/10/96 & 9/12/96.
Soil types classified in accordance with the Unified Soil Classification System.

Well Construction:
145 Well drilling method ARCH (Air rotary casing hammer).
Well construction depths measured from ground surface.
Well boring completed to 138 ft bgs.
Well installed to 137.5 ft bgs.
20-40 Filter pack sand placed from 138 ft to 125.5 ft.
20-40 Transition sand placed from 125.5 ft to 123.5 ft.
Centralizers placed at depths of 7 ft, 57 ft, 97 ft, 127 ft, and 137 ft.
150 Well completed aboveground with a steel stovepipe set in a concrete apron with a survey pin.
Survey pin elevation 4234.83 ft above msl.
Top of well casing notch surveyed at 4237.34 ft above msl.

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**************************************************
HSSM          HYDROCARBON SPILL SIMULATION MODEL
**************************************************
KOPT          KINEMATIC OILY POLLUTANT TRANSPORT
OILENS        RADIAL OIL LENS MOTION
TSGPLUME      TRANSIENT SOURCE GAUSSIAN PLUME
**************************************************
HWAD building 101-44, SWMU I07
Diesel Arrival Time at Groundwater


INPUT DATA
==========

DATA FILES:
 HSSM-KO INPUT:    C:\HSSM\HWADI07.DAT
 HSSM-KO OUTPUT:   C:\HSSM\HWADI07.HSS
 HSSM-KO PLOT 1:   C:\HSSM\HWADI07.PL1
 HSSM-KO PLOT 2:   C:\HSSM\HWADI07.PL2
 HSSM-KO PLOT 3:   C:\HSSM\HWADI07.PL3
 HSSM-T INPUT:     C:\HSSM\HWADI07.PMI
 HSSM-T OUTPUT:    C:\HSSM\HWADI07.TSG
 HSSM-T PLOT:      C:\HSSM\HWADI07.PMP
INTERFACE FLAG            = W
WRITING CRITERIA          =      1
KOPT RUN FLAG             =      1
DISSOLVED CONSTITUENT FLAG =      0
OILENS RUN FLAG           =      0
TSGPLUME RUN FLAG         =      0

CONSTANTS & MATRIX PROPERTIES...........
SAT. VERT. HYD.CONDUCTIVITY = 7.100    (M/D)
RATIO OF HORZIZONTAL TO
VERTICAL CONDUCTIVITY     = 1.000    (*)
RELATIVE PERMEABILITY INDEX =      1 (*)
POROSITY                  = .3490    (*)
RESIDUAL WATER SATURATION  = .4900E-01 (*)
BROOKS AND COREY'S LAMBDA  = .5730    (*)

WATER EVENT CHARACTERISTICS.............
DYNAMIC VISCOSITY         = 1.000    (CP)
DENSITY                   = 1.000    (G/CC)
RAIN TYPE : 1-FLUX 2-SAT.  =      2 (*)
WATER FLUX OR SATURATION   = .1900    (M/D)  OR (*)
MAX KRW DURING INFILTRATION = .5000    (*)
DEPTH TO WATER TABLE       = .0000    (M)
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POLLUTANT EVENT CHARACTERISTICS.....
DYNAMIC VISCOSITY = 2.000 (CP)
DENSITY = .8500 (G/CC)
RESIDUAL NAPL SATURATION = .1000 (*)
OIL LOADING TYPE = 1 (*)

CAPILLARY SUCTION PARAMETERS.....
AIR ENTRY HEAD = .3530 (M)
WATER SURFACE TENSION = 65.00 (DYNE/CM)
OIL SURFACE TENSION = 25.00 (DYNE/CM)

FLUX LOADING RATE = .2240E-02 (M/D)
BEGINNING TIME = .0000 (D)
ENDING TIME = 365.0 (D)

DISSOLVED CONSTITUENT PARAMETERS.....
INITIAL CONC. IN NAPL = .0000 (MG/L)
NAPL/WATER PARTITION COEF. = .0000 (*)
SOIL/WATER PARTITION COEF. = .0000 (L/KG)
SOIL/WATER (HYDROCARBON) = .0000 (L/KG)
BULK DENSITY = .0000 (G/CC)

OILENS SUBMODEL PARAMETERS.....
RADIUS OF POLLUTANT SOURCE = 1.000 (M)
RADIUS MULTIPLYING FACTOR = .0000 (*)
THICKNESS OF CAP. FRINGE = .0000 (M)
AQUIFER'S VERT DISPERSIVITY = .0000 (M)
GROUNDWATER GRADIENT = .0000 (*)
NAPL RESIDUAL IN AQUIFER = .0000 (*)
MAX NAPL SATURATION IN LENS = .0000 (*)
WATER SOLUBILITY CONTAMINANT= .0000 (MG/L)
WATER SOLUBILITY OF OIL = .0000 (MG/L)

SIMULATION PARAMETERS.....
SIMULATION ENDING TIME = .3650E+05 (D)
MAXIMUM RKF TIME STEP = 100.0 (D)
MIN. TIME BETWEEN PRINTING = 10.00 (D)
ENDING CRITERIA = 1 (*)
FACTOR FOR ENDING CRITERIA 4= .0000 (*)

PROFILES.....
NUMBER OF PROFILES = 5 (*)
AT TIMES: (D)
3650.0000 7300.0000 10550.0000
14400.0000 36500.0000

TSGPLUME MODEL PARAMETERS.....
LONGITUDINAL DISPERSIVITY .0000 (M)

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TRANSVERSE DISPERSIVITY        .0000    (M)
PERCENT MAX. RADIUS            .0000    (*)
MINIMUM OUTPUT CONC.           .0000    (MG/L)
CONSTITUENT HALF LIFE          .0000    (D)
NUMBER OF RECEPTOR LOCATIONS          1 (*)
BEGINNING TIME (D)             .0000    (D)
ENDING TIME (D)                .0000    (D)
TIME INCREMENT (D)             .0000    (D)
AQUIFER THICKNESS (M)          .0000    (M)

RECEPTOR LOCATIONS
          X        Y
    .0000    .0000


LEGEND
======
(*)      DIMENSIONLESS OR NOT APPLICABLE
(M)      METERS
(M^2)    SQUARE METERS
(D)      DAYS
(M/D)    METERS PER DAY
(CP)     CENTIPOISE  1.0 CP = 0.01 GR/CM/SEC
(DYNE/CM) DYNE PER CENTIMETER
(MG/L)   MILLIGRAMS PER LITER
(L/KG)   LITERS PER KILOGRAM SOIL
(G/CC)   GRAMS PER CUBIC CENTIMETER


***END OF INPUT DATA***

CALCULATED PARAMETERS.................
SAT VERT NAPL  CONDUCTIVITY =  3.018     (M/D)
AREA OF THE SOURCE          =  3.142     (M^2)
TRAPPED AIR SATURATION      =  .9633E-01 (*)
DARCY VELOCITY              =  .0000     (M/D)
SEEPAGE VELOCITY            =  .0000     (M/D)
RETARDATION FACTOR          =  1.000     (*)
WATER SATURATION            =  .1900     (*)
WATER FLUX                  =  .2958E-04 (M/D)
MAX. OIL CONDUCTIVITY       =  .8682     (M/D)
POLLUANT VOLUME FLUX        =  .2240E-02 (M/D)
TOTAL OIL LOADING, VOL/AREA =  .8176     (M)
TOTAL OIL MASS              =  2183.     (KG)
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1

WATER-AIR, NAPL-AIR CAPILLARY PRESSURE CURVE
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WATER or NAPL SATURATION	CAPILLARY HEAD (M) WATER	CAPILLARY HEAD (M) NAPL
.0690	298.3588	135.0040
.0890	88.9982	40.2707
.1090	43.8598	19.8461
.1290	26.5475	12.0124
.1490	17.9844	8.1377
.1690	13.0830	5.9199
.1890	9.9971	4.5236
.2090	7.9189	3.5832
.2290	6.4475	2.9174
.2490	5.3646	2.4274
.2690	4.5426	2.0555
.2890	3.9026	1.7659
.3090	3.3938	1.5356
.3290	2.9821	1.3493
.3490	2.6438	1.1963
.3690	2.3622	1.0688
.3890	2.1250	.9615
.4090	1.9233	.8703
.4290	1.7501	.7919
.4490	1.6002	.7241
.4690	1.4696	.6650
.4890	1.3550	.6131
.5090	1.2539	.5674
.5290	1.1641	.5267
.5490	1.0841	.4905
.5690	1.0123	.4581
.5890	.9478	.4289
.6090	.8895	.4025
.6290	.8367	.3786
.6490	.7886	.3568
.6690	.7448	.3370
.6890	.7046	.3188
.7090	.6678	.3022
.7290	.6339	.2868
.7490	.6026	.2727
.7690	.5737	.2596
.7890	.5469	.2475
.8090	.5220	.2362
.8290	.4989	.2257
.8490	.4773	.2160

.8690	.4572	.2069
.8890	.4384	.1984
.9090	.4207	.1904
.9290	.4042	.1829
.9490	.3886	.1759
.9690	.3740	.1692
1.0000	.3530	.1597

1

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LOCATION OF THE NAPL FRONT

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HWAD building 101-44, SWMU I07
Diesel Arrival Time at Groundwater

STEP	TIME (D)	DEPTH (M)	NAPL SATURATION (*)	FLUX (M/D)	RUNOFF (KG)	MASS (KG)	PONDING (M)	UCHAR SPD. (M/D)	FRONT SPD. (M/D)	DCHAR SPD. (M/D)
1	.0000	.0000	.2658	.0022	.0000	.0000				
3	100.0001	2.4149	.2658	.0022	.0000	598.2	.0000			
4	200.0001	4.8298	.2658	.0022	.0000	1196.	.0000			
5	300.0001	7.2448	.2658	.0022	.0000	1794.	.0000			
6	350.0001	8.4522	.2658	.0022	.0000	2094.	.0000			
7	365.0000	8.8145	.2658	.0022	.0000	2183.	.0000			
10	415.0011	10.0221	.2658	.0022	.0000	2183.	.0000			
11	435.6458	10.5208	.2658	.0022	.0000	2183.	.0000			
13	448.1458	10.8015	.2586	.0019	.0000	2183.	.0000			
14	459.2470	11.0216	.2532	.0017	.0000	2183.	.0000			
15	470.4673	11.2222	.2485	.0015	.0000	2183.	.0000			
16	482.4541	11.4169	.2441	.0013	.0000	2183.	.0000			
17	495.5410	11.6105	.2398	.0012	.0000	2183.	.0000			
18	509.9270	11.8044	.2357	.0011	.0000	2182.	.0000			
19	525.8499	12.0002	.2317	.0010	.0000	2182.	.0000			
20	543.5164	12.1983	.2277	.0009	.0000	2182.	.0000			
21	563.0671	12.3979	.2238	.0008	.0000	2182.	.0000			
22	584.7380	12.5996	.2200	.0007	.0000	2182.	.0000			
23	608.8083	12.8038	.2163	.0006	.0000	2182.	.0000			

24	635.5538	13.0103	.2126	.0005	.0000	2182.	.0000
25	665.1304	13.2180	.2090	.0005	.0000	2182.	.0000
26	697.9465	13.4276	.2055	.0004	.0000	2182.	.0000
27	734.4182	13.6396	.2021	.0004	.0000	2182.	.0000
28	774.9642	13.8537	.1986	.0003	.0000	2182.	.0000
29	819.8107	14.0686	.1953	.0003	.0000	2181.	.0000
30	869.5591	14.2850	.1921	.0003	.0000	2181.	.0000
31	924.8699	14.5034	.1889	.0002	.0000	2181.	.0000
32	986.4032	14.7238	.1858	.0002	.0000	2181.	.0000
33	1054.6630	14.9449	.1827	.0002	.0000	2181.	.0000
34	1130.2290	15.1663	.1797	.0002	.0000	2181.	.0000
35	1214.2280	15.3890	.1768	.0002	.0000	2181.	.0000
36	1307.7500	15.6132	.1739	.0001	.0000	2180.	.0000
37	1407.7500	15.8303	.1712	.0001	.0000	2180.	.0000
38	1507.7500	16.0275	.1687	.0001	.0000	2180.	.0000
39	1607.7500	16.2080	.1666	.0001	.0000	2180.	.0000
40	1707.7500	16.3745	.1646	.0001	.0000	2180.	.0000
41	1807.7500	16.5290	.1628	.0001	.0000	2180.	.0000
42	1907.7500	16.6730	.1612	.0001	.0000	2180.	.0000
43	2007.7500	16.8079	.1597	.0001	.0000	2179.	.0000
44	2107.7500	16.9348	.1583	.0001	.0000	2179.	.0000
45	2207.7500	17.0544	.1570	.0001	.0000	2179.	.0000
46	2307.7500	17.1672	.1557	.0001	.0000	2179.	.0000
47	2407.7500	17.2741	.1545	.0001	.0000	2179.	.0000
48	2507.7500	17.3755	.1534	.0001	.0000	2179.	.0000
49	2607.7500	17.4720	.1524	.0001	.0000	2179.	.0000
50	2707.7500	17.5641	.1514	.0000	.0000	2178.	.0000
51	2807.7500	17.6520	.1505	.0000	.0000	2178.	.0000
52	2907.7500	17.7362	.1496	.0000	.0000	2178.	.0000
53	3007.7500	17.8169	.1488	.0000	.0000	2178.	.0000
54	3107.7500	17.8944	.1480	.0000	.0000	2178.	.0000
55	3207.7500	17.9690	.1473	.0000	.0000	2178.	.0000
56	3307.7500	18.0407	.1466	.0000	.0000	2178.	.0000
57	3407.7500	18.1099	.1459	.0000	.0000	2178.	.0000
58	3507.7500	18.1767	.1452	.0000	.0000	2178.	.0000
59	3607.7500	18.2412	.1446	.0000	.0000	2178.	.0000
60	3650.0000	18.2679	.1443	.0000	.0000	2178.	.0000
61	3750.0000	18.3294	.1438	.0000	.0000	2177.	.0000
62	3850.0000	18.3890	.1432	.0000	.0000	2177.	.0000
63	3950.0000	18.4467	.1426	.0000	.0000	2177.	.0000
64	4050.0000	18.5026	.1420	.0000	.0000	2177.	.0000
65	4150.0000	18.5567	.1415	.0000	.0000	2177.	.0000
66	4250.0000	18.6092	.1410	.0000	.0000	2177.	.0000
67	4350.0000	18.6602	.1405	.0000	.0000	2177.	.0000
68	4450.0000	18.7097	.1400	.0000	.0000	2176.	.0000
69	4550.0000	18.7578	.1395	.0000	.0000	2176.	.0000
70	4650.0000	18.8046	.1391	.0000	.0000	2176.	.0000
71	4750.0000	18.8502	.1386	.0000	.0000	2176.	.0000

72	4850.0000	18.8946	.1382	.0000	.0000	2176.	.0000
73	4950.0000	18.9378	.1378	.0000	.0000	2176.	.0000
74	5050.0000	18.9800	.1374	.0000	.0000	2176.	.0000
75	5150.0000	19.0211	.1370	.0000	.0000	2176.	.0000
76	5250.0000	19.0613	.1366	.0000	.0000	2176.	.0000
77	5350.0000	19.1005	.1363	.0000	.0000	2176.	.0000
78	5450.0000	19.1388	.1359	.0000	.0000	2176.	.0000
79	5550.0000	19.1762	.1356	.0000	.0000	2175.	.0000
80	5650.0000	19.2128	.1352	.0000	.0000	2175.	.0000
81	5750.0000	19.2486	.1349	.0000	.0000	2175.	.0000
82	5850.0000	19.2837	.1346	.0000	.0000	2175.	.0000
83	5950.0000	19.3179	.1343	.0000	.0000	2175.	.0000
84	6050.0000	19.3515	.1340	.0000	.0000	2175.	.0000
85	6150.0000	19.3844	.1337	.0000	.0000	2175.	.0000
86	6250.0000	19.4166	.1334	.0000	.0000	2175.	.0000
87	6350.0000	19.4482	.1331	.0000	.0000	2175.	.0000
88	6450.0000	19.4792	.1328	.0000	.0000	2175.	.0000
89	6550.0000	19.5096	.1326	.0000	.0000	2175.	.0000
90	6650.0000	19.5394	.1323	.0000	.0000	2174.	.0000
91	6750.0000	19.5687	.1320	.0000	.0000	2174.	.0000
92	6850.0000	19.5974	.1318	.0000	.0000	2174.	.0000
93	6950.0000	19.6256	.1315	.0000	.0000	2174.	.0000
94	7050.0000	19.6533	.1313	.0000	.0000	2174.	.0000
95	7150.0000	19.6805	.1310	.0000	.0000	2174.	.0000
96	7250.0000	19.7072	.1308	.0000	.0000	2174.	.0000
97	7300.0000	19.7204	.1307	.0000	.0000	2174.	.0000
98	7400.0000	19.7465	.1305	.0000	.0000	2174.	.0000
99	7500.0000	19.7721	.1302	.0000	.0000	2174.	.0000
100	7600.0000	19.7973	.1300	.0000	.0000	2174.	.0000
101	7700.0000	19.8221	.1298	.0000	.0000	2173.	.0000
102	7800.0000	19.8465	.1296	.0000	.0000	2173.	.0000
103	7900.0000	19.8704	.1294	.0000	.0000	2173.	.0000
104	8000.0000	19.8941	.1292	.0000	.0000	2173.	.0000
105	8100.0000	19.9173	.1290	.0000	.0000	2173.	.0000
106	8200.0000	19.9402	.1288	.0000	.0000	2173.	.0000
107	8300.0000	19.9627	.1286	.0000	.0000	2173.	.0000
108	8400.0000	19.9848	.1284	.0000	.0000	2173.	.0000
109	8500.0000	20.0066	.1282	.0000	.0000	2173.	.0000
110	8600.0000	20.0280	.1280	.0000	.0000	2173.	.0000
111	8700.0000	20.0491	.1278	.0000	.0000	2173.	.0000
112	8800.0000	20.0699	.1276	.0000	.0000	2173.	.0000
113	8900.0000	20.0904	.1274	.0000	.0000	2172.	.0000
114	9000.0000	20.1105	.1272	.0000	.0000	2172.	.0000
115	9100.0000	20.1303	.1271	.0000	.0000	2172.	.0000
116	9200.0000	20.1499	.1269	.0000	.0000	2172.	.0000
117	9300.0000	20.1692	.1267	.0000	.0000	2172.	.0000
118	9400.0000	20.1881	.1265	.0000	.0000	2172.	.0000
119	9500.0000	20.2069	.1264	.0000	.0000	2172.	.0000

120	9600.0000	20.2253	.1262	.0000	.0000	2172.	.0000
121	9700.0000	20.2435	.1260	.0000	.0000	2172.	.0000
122	9800.0000	20.2614	.1259	.0000	.0000	2172.	.0000
123	9900.0000	20.2791	.1257	.0000	.0000	2172.	.0000
124	10000.0000	20.2966	.1256	.0000	.0000	2171.	.0000
125	10100.0000	20.3138	.1254	.0000	.0000	2171.	.0000
126	10200.0000	20.3308	.1253	.0000	.0000	2171.	.0000
127	10300.0000	20.3475	.1251	.0000	.0000	2171.	.0000
128	10400.0000	20.3641	.1250	.0000	.0000	2171.	.0000
129	10500.0000	20.3804	.1248	.0000	.0000	2171.	.0000
130	10550.0000	20.3885	.1248	.0000	.0000	2171.	.0000
131	10650.0000	20.4045	.1246	.0000	.0000	2171.	.0000
132	10750.0000	20.4203	.1245	.0000	.0000	2171.	.0000
133	10850.0000	20.4359	.1243	.0000	.0000	2171.	.0000
134	10950.0000	20.4513	.1242	.0000	.0000	2171.	.0000
135	11050.0000	20.4665	.1241	.0000	.0000	2171.	.0000
136	11150.0000	20.4816	.1239	.0000	.0000	2170.	.0000
137	11250.0000	20.4964	.1238	.0000	.0000	2170.	.0000
138	11350.0000	20.5111	.1237	.0000	.0000	2170.	.0000
139	11450.0000	20.5256	.1235	.0000	.0000	2170.	.0000
140	11550.0000	20.5399	.1234	.0000	.0000	2170.	.0000
141	11650.0000	20.5540	.1233	.0000	.0000	2170.	.0000
142	11750.0000	20.5680	.1232	.0000	.0000	2170.	.0000
143	11850.0000	20.5819	.1231	.0000	.0000	2170.	.0000
144	11950.0000	20.5955	.1229	.0000	.0000	2170.	.0000
145	12050.0000	20.6090	.1228	.0000	.0000	2170.	.0000
146	12150.0000	20.6224	.1227	.0000	.0000	2170.	.0000
147	12250.0000	20.6356	.1226	.0000	.0000	2170.	.0000
148	12350.0000	20.6487	.1225	.0000	.0000	2169.	.0000
149	12450.0000	20.6616	.1224	.0000	.0000	2169.	.0000
150	12550.0000	20.6744	.1223	.0000	.0000	2169.	.0000
151	12650.0000	20.6870	.1221	.0000	.0000	2169.	.0000
152	12750.0000	20.6995	.1220	.0000	.0000	2169.	.0000
153	12850.0000	20.7119	.1219	.0000	.0000	2169.	.0000
154	12950.0000	20.7241	.1218	.0000	.0000	2169.	.0000
155	13050.0000	20.7362	.1217	.0000	.0000	2169.	.0000
156	13150.0000	20.7482	.1216	.0000	.0000	2169.	.0000
157	13250.0000	20.7601	.1215	.0000	.0000	2169.	.0000
158	13350.0000	20.7718	.1214	.0000	.0000	2169.	.0000
159	13450.0000	20.7834	.1213	.0000	.0000	2169.	.0000
160	13550.0000	20.7949	.1212	.0000	.0000	2169.	.0000
161	13650.0000	20.8063	.1211	.0000	.0000	2168.	.0000
162	13750.0000	20.8176	.1210	.0000	.0000	2168.	.0000
163	13850.0000	20.8287	.1209	.0000	.0000	2168.	.0000
164	13950.0000	20.8398	.1208	.0000	.0000	2168.	.0000
165	14050.0000	20.8507	.1208	.0000	.0000	2168.	.0000
166	14150.0000	20.8615	.1207	.0000	.0000	2168.	.0000
167	14250.0000	20.8723	.1206	.0000	.0000	2168.	.0000

16814350.0000	20.8829	.1205	.0000	.0000	2168.	.0000
16914400.0000	20.8882	.1204	.0000	.0000	2168.	.0000
17014500.0000	20.8986	.1203	.0000	.0000	2168.	.0000
17114600.0000	20.9090	.1203	.0000	.0000	2168.	.0000
17214700.0000	20.9193	.1202	.0000	.0000	2168.	.0000
17314800.0000	20.9294	.1201	.0000	.0000	2168.	.0000
17414900.0000	20.9395	.1200	.0000	.0000	2167.	.0000
17515000.0000	20.9495	.1199	.0000	.0000	2167.	.0000
17615100.0000	20.9594	.1198	.0000	.0000	2167.	.0000
17715200.0000	20.9692	.1198	.0000	.0000	2167.	.0000
17815300.0000	20.9789	.1197	.0000	.0000	2167.	.0000
17915400.0000	20.9886	.1196	.0000	.0000	2167.	.0000
18015500.0000	20.9981	.1195	.0000	.0000	2167.	.0000
18115600.0000	21.0076	.1194	.0000	.0000	2167.	.0000
18215700.0000	21.0169	.1194	.0000	.0000	2167.	.0000
18315800.0000	21.0262	.1193	.0000	.0000	2167.	.0000
18415900.0000	21.0354	.1192	.0000	.0000	2167.	.0000
18516000.0000	21.0446	.1191	.0000	.0000	2167.	.0000
18616100.0000	21.0536	.1190	.0000	.0000	2167.	.0000
18716200.0000	21.0626	.1190	.0000	.0000	2166.	.0000
18816300.0000	21.0715	.1189	.0000	.0000	2166.	.0000
18916400.0000	21.0803	.1188	.0000	.0000	2166.	.0000
19016500.0000	21.0891	.1188	.0000	.0000	2166.	.0000
19116600.0000	21.0977	.1187	.0000	.0000	2166.	.0000
19216700.0000	21.1063	.1186	.0000	.0000	2166.	.0000
19316800.0000	21.1149	.1185	.0000	.0000	2166.	.0000
19416900.0000	21.1233	.1185	.0000	.0000	2166.	.0000
19517000.0000	21.1317	.1184	.0000	.0000	2166.	.0000
19617100.0000	21.1400	.1183	.0000	.0000	2166.	.0000
19717200.0000	21.1483	.1183	.0000	.0000	2166.	.0000
19817300.0000	21.1565	.1182	.0000	.0000	2166.	.0000
19917400.0000	21.1646	.1181	.0000	.0000	2166.	.0000
20017500.0000	21.1726	.1181	.0000	.0000	2166.	.0000
20117600.0000	21.1806	.1180	.0000	.0000	2165.	.0000
20217700.0000	21.1886	.1179	.0000	.0000	2165.	.0000
20317800.0000	21.1964	.1179	.0000	.0000	2165.	.0000
20417900.0000	21.2042	.1178	.0000	.0000	2165.	.0000
20518000.0000	21.2120	.1177	.0000	.0000	2165.	.0000
20618100.0000	21.2197	.1177	.0000	.0000	2165.	.0000
20718200.0000	21.2273	.1176	.0000	.0000	2165.	.0000
20818300.0000	21.2349	.1176	.0000	.0000	2165.	.0000
20918400.0000	21.2424	.1175	.0000	.0000	2165.	.0000
21018500.0000	21.2498	.1174	.0000	.0000	2165.	.0000
21118600.0000	21.2572	.1174	.0000	.0000	2165.	.0000
21218700.0000	21.2646	.1173	.0000	.0000	2165.	.0000
21318800.0000	21.2718	.1172	.0000	.0000	2165.	.0000
21418900.0000	21.2791	.1172	.0000	.0000	2164.	.0000
21519000.0000	21.2863	.1171	.0000	.0000	2164.	.0000

21619100.0000	21.2934	.1171	.0000	.0000	2164.	.0000
21719200.0000	21.3004	.1170	.0000	.0000	2164.	.0000
21819300.0000	21.3075	.1170	.0000	.0000	2164.	.0000
21919400.0000	21.3144	.1169	.0000	.0000	2164.	.0000
22019500.0000	21.3214	.1168	.0000	.0000	2164.	.0000
22119600.0000	21.3282	.1168	.0000	.0000	2164.	.0000
22219700.0000	21.3351	.1167	.0000	.0000	2164.	.0000
22319800.0000	21.3418	.1167	.0000	.0000	2164.	.0000
22419900.0000	21.3485	.1166	.0000	.0000	2164.	.0000
22520000.0000	21.3552	.1166	.0000	.0000	2164.	.0000
22620100.0000	21.3619	.1165	.0000	.0000	2164.	.0000
22720200.0000	21.3684	.1165	.0000	.0000	2164.	.0000
22820300.0000	21.3750	.1164	.0000	.0000	2163.	.0000
22920400.0000	21.3815	.1164	.0000	.0000	2163.	.0000
23020500.0000	21.3879	.1163	.0000	.0000	2163.	.0000
23120600.0000	21.3943	.1163	.0000	.0000	2163.	.0000
23220700.0000	21.4007	.1162	.0000	.0000	2163.	.0000
23320800.0000	21.4070	.1162	.0000	.0000	2163.	.0000
23420900.0000	21.4133	.1161	.0000	.0000	2163.	.0000
23521000.0000	21.4195	.1161	.0000	.0000	2163.	.0000
23621100.0000	21.4257	.1160	.0000	.0000	2163.	.0000
23721200.0000	21.4318	.1160	.0000	.0000	2163.	.0000
23821300.0000	21.4379	.1159	.0000	.0000	2163.	.0000
23921400.0000	21.4440	.1159	.0000	.0000	2163.	.0000
24021500.0000	21.4500	.1158	.0000	.0000	2163.	.0000
24121600.0000	21.4560	.1158	.0000	.0000	2162.	.0000
24221700.0000	21.4620	.1157	.0000	.0000	2162.	.0000
24321800.0000	21.4679	.1157	.0000	.0000	2162.	.0000
24421900.0000	21.4738	.1156	.0000	.0000	2162.	.0000
24522000.0000	21.4796	.1156	.0000	.0000	2162.	.0000
24622100.0000	21.4854	.1155	.0000	.0000	2162.	.0000
24722200.0000	21.4911	.1155	.0000	.0000	2162.	.0000
24822300.0000	21.4969	.1154	.0000	.0000	2162.	.0000
24922400.0000	21.5025	.1154	.0000	.0000	2162.	.0000
25022500.0000	21.5082	.1153	.0000	.0000	2162.	.0000
25122600.0000	21.5138	.1153	.0000	.0000	2162.	.0000
25222700.0000	21.5194	.1153	.0000	.0000	2162.	.0000
25322800.0000	21.5249	.1152	.0000	.0000	2162.	.0000
25422900.0000	21.5304	.1152	.0000	.0000	2162.	.0000
25523000.0000	21.5359	.1151	.0000	.0000	2161.	.0000
25623100.0000	21.5414	.1151	.0000	.0000	2161.	.0000
25723200.0000	21.5468	.1150	.0000	.0000	2161.	.0000
25823300.0000	21.5521	.1150	.0000	.0000	2161.	.0000
25923400.0000	21.5575	.1149	.0000	.0000	2161.	.0000
26023500.0000	21.5628	.1149	.0000	.0000	2161.	.0000
26123600.0000	21.5681	.1149	.0000	.0000	2161.	.0000
26223700.0000	21.5733	.1148	.0000	.0000	2161.	.0000
26323800.0000	21.5785	.1148	.0000	.0000	2161.	.0000

36033500.0000	21.9399	.1107	.0000	.0000	2154.	.0000
36133600.0000	21.9425	.1107	.0000	.0000	2154.	.0000
36233700.0000	21.9451	.1107	.0000	.0000	2154.	.0000
36333800.0000	21.9477	.1106	.0000	.0000	2154.	.0000
36433900.0000	21.9503	.1106	.0000	.0000	2154.	.0000
36534000.0000	21.9528	.1106	.0000	.0000	2154.	.0000
36634100.0000	21.9554	.1105	.0000	.0000	2154.	.0000
36734200.0000	21.9579	.1105	.0000	.0000	2154.	.0000
36834300.0000	21.9604	.1105	.0000	.0000	2154.	.0000
36934400.0000	21.9629	.1104	.0000	.0000	2154.	.0000
37034500.0000	21.9654	.1104	.0000	.0000	2154.	.0000
37134600.0000	21.9678	.1104	.0000	.0000	2154.	.0000
37234700.0000	21.9703	.1104	.0000	.0000	2154.	.0000
37334800.0000	21.9727	.1103	.0000	.0000	2154.	.0000
37434900.0000	21.9751	.1103	.0000	.0000	2153.	.0000
37535000.0000	21.9775	.1103	.0000	.0000	2153.	.0000
37635100.0000	21.9799	.1102	.0000	.0000	2153.	.0000
37735200.0000	21.9823	.1102	.0000	.0000	2153.	.0000
37835300.0000	21.9847	.1102	.0000	.0000	2153.	.0000
37935400.0000	21.9870	.1102	.0000	.0000	2153.	.0000
38035500.0000	21.9894	.1101	.0000	.0000	2153.	.0000
38135600.0000	21.9917	.1101	.0000	.0000	2153.	.0000
38235700.0000	21.9940	.1101	.0000	.0000	2153.	.0000
38335800.0000	21.9963	.1101	.0000	.0000	2153.	.0000
38435900.0000	21.9986	.1100	.0000	.0000	2153.	.0000
38536000.0000	22.0008	.1100	.0000	.0000	2153.	.0000
38636100.0000	22.0031	.1100	.0000	.0000	2153.	.0000
38736200.0000	22.0053	.1099	.0000	.0000	2153.	.0000
38836300.0000	22.0076	.1099	.0000	.0000	2153.	.0000
38936400.0000	22.0098	.1099	.0000	.0000	2153.	.0000

39036500.0000 22.01

Diesel #2[a]

C11-C22 Aromatics	60%
C11-C22 Aliphatics	40%

Compound	% expected	solubility in mg/L[b]	Contribution
C10-12 aliphatics	8.00%	0.034	0.00272
C10-12 aromatics	9.00%	25	2.25
C12-16 aliphatics	16.00%	0.00076	0.0001216
C12-16 aromatics	24.00%	5.8	1.392
C16-C21 aromatics	24.00%	0.65	0.156
C16-C35 aliphatics	16.00%	0.000003	0.00000048
C21-C68 aromatics	3.00%	0.0066	0.000198
Total	100.00%		3.80104008

a) Compositional Assumptions from New Mexico Environmental Department TPH Screening Guidelines, June 24, 2003
b) Water Solubilities given by California Air Resources Board

Most conservative value is 25

The only relevant items in the model that were altered in an attempt to understand sensitivity and make the model more conservative were:

1) Porosity - varied between 0.25 and 0.5 (Cherry & Freeze)
2) Bulk density - used at the highest calculated of 1.26 and lowest allowed, 1.21.
3) Hydrocarbon solubility - may or may not be relevant, depends on how used (i.e. is if used with infiltration, not if in aquifer). Used a value of 25 mg/L as the most conservative (see Diesel sol sheet)
4) NAPL surface tension (increased to 29 as per recommendation on pg. 44, Table 11).

5) Radius of lens source was decreased to 1, as OILENs is not being run and this is the rec Did not see a depth of greater than 30 m in the most conservative scenario after 100 year simulation.

HSSM Parameters and Associated Results

	Report value	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	
General Data	USACE sand	Sand upper	Sand lower	Loamy sand	Sandy loam	Loam	Silt Loam	Description of Source and Relevance
Module Switch	Run KOPT only							
Hydrologic Parameters								
Hydrologic Properties								
Water dynamic viscosity (cp)	1	1	1	1	1	1	1	HSSM default
Water density (g/cm3)	1	1	1	1	1	1	1	
Water surface tention (dyne/cm)	65	65	65	65	65	65	65	
Max. Krw during infiltration	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Recharge Saturation	0.19	0.19	0.19	0.19	0.19	0.19	0.19	Flint et al., 1996
Brooks & Corey's lambda	0.573	0.573	0.573	0.46	0.398	0.258	0.216	pg. 166, Table 92, HSSM user's guide
Air entry head (m)	0.353	0.353	0.353	0.159	0.292	0.509	0.696	
Residual water saturation	0.045	0.045	0.045	0.057	0.065	0.095	0.067	pg. 167, Table 94, HSSM user's guide
Porous Media								
Sat'd vertical hydraulic conductivity (m/d)	7.1	7.1	7.1	3.5	1.1	0.25	0.11	pg. 169, Table 96, HSSM user's guide
Ratio of horizontal/vertical conductivity	1	1	1	1	1	1	1	Assume homogeneous
Porosity	0.349	0.25	0.5	0.41	0.423	0.452	0.484	pg. 166, Table 92, HSSM user's guide = 0.349
Bulk density (g/cm3)	0	1.26	0.72 /1.21	0.85 / 1.21	0.83 / 1.21	0.79 / 1.21	0.74 / 1.21	= solids density * (1-porosity) density ranges 1.44-1.68 g/cm3 (must be >1.2)
Aquifer saturation thickness (m)	*0*	*10*	*10*	*10*	*10*	*10*	*10*	Irrelevant as the diesel is not being evaluated in gw
Depth to water table (m)	*0*	*40.8*	*40.8*	*40.8*	*40.8*	*40.8*	*40.8*	134 ft = 40.8 m, from the surface, irrelevant if it does not reach
Capillary thickness parameter (m)	*0*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	Irrelevant as the diesel is not being evaluated in the gw, HSSM default
Groundwater gradient (m/m)	*0*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	irrelevant as the diesel is not being evaluated in the gw
Longitudinal dispersivity (m)	*0*	*1*	*1*	*1*	*1*	*1*	*1*	
Transverse dispersitivity (m)	*0*	*1*	*1*	*1*	*1*	*1*	*1*	
Vertical dispersivity (m)	*0*	*1*	*1*	*1*	*1*	*1*	*1*	
Hydrocarbon Phase Data								
Hydrocarbon Phase Properties								
NAPL density (g/cm3)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	Env. Canada Oil Properties Database
NAPL dynamic viscosity (cp)	2	2	2	2	2	2	2	
Hydrocarbon solubility (mg/L)	0	25	25	25	25	25	25	see sheet 2, average and most conservative run
Aquifer residual NAPL saturation	*0*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	irrelevant, diesel is not being evaluated in the gw, HSSM user's guide, pg.43
Vadose Zone residual NAPL saturation	0.1	0.1	0.1	0.1	0.1	0.1	0.1	most conservative recommended by HSSM User's guide pg. 43
Soil/water partition coefficient (L/kg)	*0*	*100*	*100*	*100*	*100*	*100*	*100*	irrelevant as the diesel is a single constituent
NAPL surface tension (dyne/cm)	25	29	29	29	29	29	29	pg. 44, Table 11, HSSM user's guide
Hydrocarbon Release (specified flux)								
NAPL Flux (m/d)	0.00224	0.0022	0.00224	0.00224	0.00224	0.00224	0.00224	most conservative calculated from 500 gallon release
Beginning time (d)	0	0	0	0	0	0	0	
Ending time (d)	365	365	365	365	365	365	365	Released over 1 year.
Model Simulation Data								
Model Simulation								
Radius of lens source (m)	1.2	1	1	1	1	1	1	25 ft by 25 ft area = 4.3 m radius, however, no OILENs, 1 selected pg. 48 HSSM
Radius multiplicity factor	*0*	*1.001*	*1.001*	*1.001*	*1.001*	*1.001*	*1.001*	pg. 48 HSSM default value, not relevant without OILENs
Max. NAPL saturation in NAPL lense	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	Irrelevant as the diesel is not being evaluated in groundwater
Simulation end time (d)	36500	36500	36500	36500	36500	36500	36500	100 years
Max. Solution step time (d)	100	25	25	25	25	25	25	Recommended largest value on pg. 48 HSSM user's guide
Minimum time between printed time steps (d)	*10*	*10*	*10*	*10*	*10*	*10*	*10*	Irrelevant, only affects the output as per pg. 48, HSSM user's guide
Oilens Simulation Ending Criterion								
User-specified time?	yes	yes	yes	yes	yes	yes	yes	
HSSM-T Model Parameters								
Percent maximum contaminant radius (%)	*101*	*101*	*101*	*101*	*101*	*101*	*101*	Irrelevant as it is used for TSGPLUME, which implies constituent is in groundwater,
Minimum output concentration (mg/L)	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	recommended default HSSM user's guide, pg. 50
Beginning time (d)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	Irrelevant as it is used for TSGPLUME, which implies constituent is in groundwater
Ending time (d)	*36500*	*36500*	*36500*	*36500*	*36500*	*36500*	*36500*	
Time increment (d)	*100*	*100*	*100*	*100*	*100*	*100*	*100*	
DEPTH REACHED (m)	**22**	**~30**	**~17**	**~16**	**~14**	**~7.5**	**~6**	Depth from the ground surface.

Note Italics indicate that the value is irrelevant if diesel does not reach groundwater because it is a property of the groundwater.

Yellow indicates relevant differences between the most conservative model and the original model.

Attachment 6

Tier II SSTL Calculation for TPH-d Supporting Documentation from the 2012 Bay West Inc. Final SWMU I07 Technical Memorandum, SWMU I07 Building 101-44 Former Landfill, Hawthorne Army Depot, Hawthorne, Nevada.

4.0 FATE AND TRANSPORT

The site conceptual model for SWMU I07 is based on an unlined landfill pit with oil and petroleum waste products followed by transport or migration of contaminants to the soil. When petroleum waste leaks from the storage containers, gravitational forces act to draw the fuel downward. While fuel is migrating downward, the fuel is either adsorbed to soil particles or trapped in soil pore space.

Based on data collected during the limited site investigation, TPH-d contamination at SWMU I07 is limited vertically (I07-03) to a depth of approximately 24 feet bgs.

The contaminant migration pathway at I07 is through dissolution of residual TPH-d in the soil by infiltration of water. Due to low rainfall in the Hawthorne area (<5 inches per year) it is unlikely that consequential amounts of water might move through the soil and leach contamination to groundwater. Fate and Transportation modeling completed at SWMU I07 and SWMU I08 supports TPH-d's limited migration potential at SWMU I07, as shown in **Table 4-1**.

Table 4-1 COPC Modeled Transport Depth Comparison

SWMU	Modeled COPC	Highest COPC Concentration	COPC Depth (feet)	Modeled Transport Depth (feet)
I07*	TPH-d	11,000 mg/kg	31-50	72
I08**	TPH-e	19,000 mg/kg	53	55

** Chung/Geofon, 2004. Final Remediation Report, Solid Waste Management Unit B29 and I07, Hawthorne Army Depot, Hawthorne, Nevada, February 2004.*

***Secor, 2004. Final Remedial Investigation Report Additional Soils Remedial Investigation SWMU I08, Building 70 Pit/Landfill Hawthorne Army Depot, Hawthorne, Nevada. April 2004.*

4.1 Tier II Site-Specific Target Level for TPH-d

A Tier II Site-Specific Target Level (SSTL) for TPH-d at Site I07 was developed to assist in evaluating the potential risk posed by petroleum-contaminated soils present at the site. A similar method for determining a SSTL for TPH-d was utilized at SWMU K03a, b, and d (Plexus, 2007). NAC 445A.22705 allows for the application of the American Society for Testing and Materials (ASTM) Standard E-1739-95 Risk Based Corrective Action (RBCA) to develop Tier II SSTLs in setting site-specific risk criteria. Because diesel contains relatively little of the more mobile and more toxic VOCs, the primary concern is on the prevention of free product on groundwater. NAC 445A.22735 requires that free product be reduced to less than 0.5 inch. Therefore, the TPH-d SSTL was developed based on the prevention of free product migration to groundwater.

4.1.1 Background

Soil has the ability to retain non-mobile liquids in smaller and discontinuous pore spaces. The amount that a soil can hold is called its residual saturation. Once residual saturation has been exceeded, the liquid can migrate. Diesel exists as a light non-aqueous phase liquid (LNAPL) and is held in retention along with water. The American Petroleum Institute (API) published a summary of empirical models and compared the results with experimentally measured residual saturated values (API, 2000). The results of these comparisons were used to develop screening level criteria for specific soils and products. The evaluation of the TPH-d SSTL will consider both the empirical results and the recommended values provided by the API.

4.1.2 Empirical Models

The API utilized three empirical models in developing a method for conservative screening levels. These included 1) a zero water method; 2) a field moisture capacity method (both developed by Hoag and Marley, 1986); and 3) a method developed by Zytner (1993). The Hoag and Marley methods are both based on average soil particle diameter and that residual retention is related to available surface area. In the zero water method, all the pore spaces are available for the LNAPL. In the field moisture capacity method, some of the available pore space is occupied by water. Therefore, field conditions would be expected to range somewhere between the two methods. The Zytner method is based on observed relationships of residual saturation and the ratio of product density over soil bulk density. Equations are shown below and the results empirical models are summarized in **Table 4-2**.

The zero water method is as follows:

$$\text{EQ1)}\ Cres = (0.01154 \times dp + 0.000652) \times \frac{6}{2.65 \times dp} \times 10^6\ mg/kg$$

Where: dp = average grain diameter (in cm). Site soils are fine to medium sands. Average grain size is assumed to be 0.01 to 0.05 cm (recommended by API)

The field moisture capacity method is as follows:

$$\text{EQ2)}\ Cres = (0.01136 \times dp + 0.000131) \times \frac{6}{2.65 \times dp} \times 10^6\ mg/kg$$

The Zytner method is as follows:

$$EQ3)\ Cres = \left(1.05 \times {}^{\rho o}/_{\rho s} \times \theta t - 0.15\right) \times 10^6\ mg/kg$$

Where: θt= total porosity, use 0.41, this is the average of fine to medium sand by Todd (1980). It is also the value recommended by API.

ρo= product density, use 0.8, this is the value recommended by API for diesel fuel (middle distillate).

ρs= soil dry bulk density (1.56 calculated from porosity).

Table 4-2 Summary of Empirical Residual Saturation Results (Gasoline)

Average grain diameter (cm)	Residual Saturation (mg/kg)		
	0.05	0.01	Average
Zero Water	56,000	174,000	115,000
Field Moisture Capacity	32,000	55,000	43,000
Zytner	71,000		NA
Average of all	--		77,000

Notes:
cm - centimeter

API Recommended Values

The API defined residual saturation to be as follows:

$$\text{EQ4)}\ Cres = Sr \times \theta t \times {}^{\rho o}/_{\rho s} \times 10^6\ mg/kg$$

Where:

Sr= soil retention fraction (see text below)

θt= total porosity, use 0.41, this is the average of fine to medium sand by Todd (1980). It is also the value recommended by API.

ρo= product density, use 0.8, this is the value recommended by API for diesel fuel (middle distillate)

ρs= soil dry bulk density (1.56 calculated from porosity)

The value for Sr was determined by the API by statistical evaluation of the above methods (plus the Zytner method) against measured residual saturation concentrations. This evaluation found that the median trend (50% confidence) was for diesel in fine- to medium-grained sand to have a Sr value of 0.19. The evaluation also found that the value of Sr was 0.05 for diesel in fine- to medium-grained sands at confidence level of 90%. At a 90% confidence there is only a 10% probability of a measured value exceeding the calculated value. Results of the API values used in equation 4 are provided in **Table 4-3**.

Table 4-3 Summary of API Residual Saturation Results

Confidence level	Residual Saturation (mg/kg)
50%	40,000
90%	11,000

Notes
% - percent

4.1.3 Summary

Results of the empirical models indicated a residual saturated value of between 32,000 and 174,000 mg/kg. The average of the three methods is higher than the median API value. Therefore, applying the 90% confidence value of 11,000 mg/kg would provide an acceptable conservative margin. Groundwater contacting fine- to medium-grained soils with a TPH-d concentration less than 11,000 mg/kg would not likely result in free product.

Based on the current analytical results, TPH-d was detected above State of Nevada Screening Level of 100 mg/kg in five soil samples: I07-02-S-(015), I07-02-S-(21), I07-03-S-(010), I07-03-S-(15), and I07-03-S-(23). TPH-d concentration range of the previously mentioned soil samples is 2,200 to 8,600 mg/kg which is below the 90% confidence level. Therefore, the residual TPH-d contamination at SWMU I07 does not constitute a risk to groundwater.

4.2 Tier II SSTL for RDX

As documented in the Revised Final Corrective Action Plan for SWMU B04, (Plexus, 2008), a RDX Tier II evaluation was performed to develop site-specific target levels for a range of protectiveness. As part of the evaluation, three exposure scenarios were developed: current and future standard workers, on-site workers, and potential future construction workers. Based on the exposure factor for each scenario, specific SSTLs were calculated. The range of SSTLs was evaluated for applicability and a single SSTL value was selected as a final RDX remediation/clean-up goal. The final RDX soil clean-