FINAL SWMU I08 DECISION DOCUMENT

Solid Waste Management Unit (SWMU I08)
Building 70 Pit/Landfill

March 2012
Version 02

Hawthorne Army Depot
Hawthorne, Nevada

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

FINAL

DECISION DOCUMENT
SWMU I08: Building 70 Pit/Landfill
Hawthorne Army Depot, Nevada

Contract No. W91238-06-D-0019

March 2012

Prepared for:

US Army Environmental Command

Hawthorne Army Depot
Hawthorne, Nevada

Prepared by:

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ACRONYMS

API..... American Petroleum Institute
Army..... United States Army Environmental Command
bgs..... below ground surface
BTEX..... Benzene, Toluene, Ethylbenzene, and Xylene
COPC..... Chemicals of Potential Concern
HI..... Hazard Index
HSSM..... Hydrocarbon Spill Screening Model
HWAAP ..... Hawthorne Army Ammunition Plant
HWAD ..... Hawthorne Army Depot
LNAPL..... Light Non-Aqueous Phased Liquid
mg/kg..... milligrams per kilogram
NAC..... Nevada Administrative Code
NDEP ..... Nevada Division of Environmental Protection
NFA ..... No Further Action
PCB ..... Polychlorinated Biphenyls
PCG..... Proposed Closure Goal
RAI ..... Resource Application, Incorporated
RBCA ..... Risk Based Corrective Action
Secor..... Secor International, Inc.
SGPR ..... Surface Ground Penetrating Radar
SSTL ..... Site Specific Target Level
SVOC ..... Semi-volatile Organic Compound
SWMU..... Solid Waste Management Unit
Tetra Tech ..... Tetra Tech, Inc.
TPH ..... Total Petroleum Hydrocarbon
TPH-d..... TPH-diesel
TPH-e..... Extractable Total Petroleum Hydrocarbon
TPH-m..... TPH-motor oil
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) I08

1.2 STATEMENT OF BASIS AND PURPOSE

This Decision Document describes the rationale for the selected remedy of No Further Action (NFA) at SWMU I08 at Hawthorne Army Ammunition Plant (HWAAP) (hereafter referred to as SWMU I08), at Hawthorne Army Depot (HWAD), Hawthorne, Nevada (**Figure 1**).

This document is issued by the United States Army Environmental Command (Army) as the lead agency. The Army is managing remediation of contamination at SWMU I08 in accordance with Nevada Division of Environmental Protection (NDEP) guidance.

As the lead agency, the Army has selected the remedy. NDEP concurs with the selected remedy. The United States Environmental Protection Agency (USEPA) defers to NDEP for regulatory oversight of the Environmental Restoration Program at HWAD.

1.3 DESCRIPTION OF SELECTED REMEDY

It has been determined that no remedial action is necessary at SWMU I08. Based on investigative results, the Army, with concurrence from NDEP, has determined that no significant risks or threats to human health or the environment exist at this time.

1.4 REGULATORY SETTING

Remedial investigations of hazardous substances, pollutants, or contaminants at SWMU I08 have demonstrated that the:

- Total Petroleum Hydrocarbons, diesel and motor oil (TPH-d) and (TPH-m), were detected at concentrations above State Corrective Action Levels. The State corrective action level for TPH, at the time the investigation was completed at SWMU I08, was 100 milligrams per kilogram (mg/kg);
- Fate and Transport Modeling of residual TPH contamination indicates petroleum does not pose a significant risk to human health or the environment;
- Polychlorinated Biphenyls (PCB), benzene, toluene, ethylbenzene, and xylene (BTEX) organochlorine pesticide, and volatile organic compounds (VOC) ~~are~~ not detected or ~~are~~ were detected below their respective Proposed Closure Goal (PCGs); and
- Detected metals concentrations are statistically within HWAD-established background screening levels.

1.5 AUTHORIZING SIGNATURES

This signature sheet documents the Army approval and NDEP concurrence of the remedy selected in the Decision Document for SWMU I08 in 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.

20120410

Kirk L. Bausman
Deputy to the Commander
Hawthorne Army Depot

Date

5/8/12

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

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 I08 is an unlined open pit located adjacent to Building 70 in HWAD's central magazine area (**Figure 2**). The open pit was approximately 45 feet wide by 110 feet long and up to 15 feet deep in the center. Although SWMU I08 was named a pit/landfill, no debris was observed in the pit that would indicate landfill disposal activities.

The Building 70 area previously contained the HWAD auxiliary power unit which was powered by diesel fuel from two aboveground storage tanks. The power unit was destroyed by fire. The adjacent Building 70 area has an electrical substation and electrical maintenance area, which contains several electrical transformers as shown on the site map (**Attachment 1**). The electrical substation and electrical maintenance area is located approximately 160 ft east of the SWMU I08 site. (Secor, 2004).

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 location is shown in **Figure 2**. The site layout is shown in **Attachment 1** (Secor, 2004).

The predominant soil type at the site is sand with clay layers located at depths of approximately 20 feet and 75 feet. Groundwater in the vicinity of SWMU I08 is approximately 100 feet below ground surface (bgs) and regional groundwater flow direction is to the northwest (Secor, 2004).

2.3 INVESTIGATION HISTORY

A total of two inspections, one monitoring well installation, groundwater monitoring, and three investigations have been completed at SWMU I08. **Table 2-1** provides a brief summary of these activities.

2.4 NATURE AND EXTENT OF CONTAMINATION

2.4.1 Summary of Existing Data

Extractable Total Petroleum Hydrocarbons (TPH-e, quantified as TPH-diesel [TPH-d] and TPH-motor oil [TPH-m]) were not detected deeper than 60 ft below the bottom of the pit (73 feet bgs). Groundwater is estimated to be 100 feet bgs in the vicinity of SWMU I08. TPH-e does not appear to have impacted groundwater.

Table 2-1 Summary of Previous Actions at SWMU I08

Date	Area and Purpose of Investigation	Company	Area Assessed	Major Findings	Recommendations
1992	Site Screening Inspection	Resource Application, Incorporated (RAI)	SWMU I08	No evidence of chemical releases was reported. An unidentified substance was visible floating in a small amount of standing water in the pit.	Additional site assessment.
1993	Site Inspection	Tetra Tech, Inc. (Tetra Tech)	SWMU I08	Identified one open pit that was 15 feet deep near the center. Debris indicative of landfill disposal activities was not observed in the pit. Surface soil staining was not observed within or adjacent to the pit. Two settling tanks, which appeared to be connected by a drain line, were observed in the Building 70 area, north of SWMU I08. One tank was adjacent to the pit at SWMU I08. No drain lines connecting this settling tank to the pit at SWMU I08 were observed. The use of the settling tanks and drain line are unknown.	Additional site investigation.
1994	Monitoring Well Installation	Tetra Tech	Installed well Bldg70MW01 as part of diesel leak investigation at Building 70, SWMU J03.	Findings not noted.	
1997	Groundwater Monitoring	Tetra Tech	Groundwater in the vicinity of Building 70. Bldg70MW01 was sampled for metals, hexavalent chromium, organochlorine pesticides, Polychlorinated Biphenyls (PCBs), Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), and explosives.	Dissolved and total metals were the only target analytes detected in the groundwater near SWMU I08. Analytical results are included in **Attachment 1**.	
1994 and 1997	Remedial Investigation - Geophysical Survey, near-surface and subsurface soil investigation, and	Tetra Tech	Surface ground penetrating radar (SGPR) survey to search for drain lines that potentially released waste into the pit at SWMU I08. VOC field screening of subsurface headspace soil samples, petroleum	No drain lines connected to the open pit at SWMU I08 were found. Potential source pathways at SWMU I08 were determined to be surface runoff into the pit or releases directly into the pit by dumping. Concentrations of TPH exceeding the	Additional site investigation.

Table 2-1 Summary of Previous Actions at SWMU I08

Date	Area and Purpose of Investigation	Company	Area Assessed	Major Findings	Recommendations
	coolant oil analysis		hydrocarbon field screening (including Benzene, Toluene, Ethylbenzene, and Xylene [BTEX]), and PCB field screening for constituents of coolant oils from electrical transformers. Collected surface soil samples from five locations, four near-surface locations, and one subsurface location (at four depths: 5, 10, 15, and 20 ft below the bottom of the pit (18, 23, 28, and 33 ft bgs)). Soil samples were analyzed for PCBs, TPH, BTEX, organochlorine pesticide, and VOCs. Sample locations are shown in **Attachment 1**.	Proposed Closure Goal (PCG) of 100 milligrams per kilogram (mg/kg) were detected. TPH-diesel concentrations ranged from 150 to 1,200 mg/kg in surface and near-surface soil. TPH-d and TPH-m were detected at concentrations of 19,000 mg/kg and 1,600 mg/kg respectively, at 10 ft below the bottom of the pit (23 ft bgs). PCB, BTEX, organochlorine pesticide, and VOC detections were below their respective PCGs. Analytical results are included in **Attachment 1**.	
1999	Human Health Risk Evaluation	Tetra Tech	Evaluated potential carcinogenic and noncarcinogenic hazards associated with exposure to contaminants in the surface soil from 0 to 1.5 bgs for commercial/industrial scenario.	Estimated carcinogenic risk for a full-time, on-site worker was estimated as $1x10^{-10}$. The estimated carcinogenic risk is below the USEPA's acceptable risk threshold of $1x10^{-6}$. The estimated noncarcinogenic hazard index (HI) was estimated as $8x10^{-7}$. The HI is the risk threshold of 1.0.	
2003	Additional Soils Remedial Investigation	Secor	Three hollow-stem auger borings were drilled evenly spaced along the pit floor. Samples were generally collected at 5, 10, 15, 20, 40 and 60 ft below the bottom of the pit (18, 23, 28, 33, 53, 73 ft bgs). All samples were analyzed for TPH-e. Boring locations and boring logs are included in **Attachment 1**.	TPH-d and TPH-m concentrations exceeded the State of Nevada Corrective Action Level of 100 mg/kg in two soil borings at depths of 5 to 20 feet below the pit floor. Analytical results are included **Attachment 1**.	No further action.

2.4.2 Migration Modeling Data

As part of the *Final Remedial Investigation Report Additional Soils Remedial Investigation SWMU I08, Building 70 Pit/Landfill, April 2004*, Secor International, Inc. (Secor) evaluated the maximum soil retention capacity at SWMU I08 to determine if the diesel concentrations in the soil were high enough to continue vertical travel and eventually reach the groundwater. The maximum retention capacity was evaluated using two methodologies: the USEPA Hydrocarbon Spill Screening Model (HSSM) and a simple calculation performed by hand. Details of the maximum retention capacity evaluations from Secor's 2004 report are included in **Attachment 2**.

The maximum depth reached by the TPH-e after 100 years using the HSSM model for six different soil types was 55 feet bgs. The HSSM model does not predict any further vertical movement of TPH-e at SWMU I08.

Based on the hand calculation for soil retention capacity, TPH-e will not be mobile at SWMU I08 unless the concentration in the soil exceeds about 69,000 mg/kg. The highest concentration of TPH detected at the site, in 1997, was 19,000 mg/kg as TPH-d at 10 ft below the bottom of the pit (23 ft bgs). The highest detected concentration of TPH detected at the site in 2003 was 9,600 mg/kg as TPH-d at 10 ft below the bottom of the pit (23 ft bgs).

2.4.3 Tier II SSTL for TPH-Diesel

A Tier II Site Specific Target Level (SSTL) for TPH-d at Site I08 was developed to assist in evaluating the potential risk posed by TPH-d contaminated soils present at the site. A similar method for determining a SSTL for TPH-d was utilized at SWMUs K03 a, b, and d (Plexus, 2007). 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 TPH-d contains relatively little of the more mobile and more toxic volatile organic compounds, 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 inches. Therefore the TPH-d SSTL was developed based on the prevention of free product migration to groundwater.

2.4.3.1 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 phased 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.

2.4.3.2 Empirical Models

The API utilized three empirical models in developing a method for conservative screening levels. These included 1) a zero water method and a 2) field moisture capacity method (both methods 1 and 2 were 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 2-2**.

The zero water method is as follows:

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:

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 2-2 Summary of Empirical Residual Saturation Results (Diesel)

Average grain diameter (cm)	Residual Saturation (mg/kg)		
	0.05	0.01	Average
Zero Water	56,000	174,000	15,000
Field Moisture Capacity	32,000	55,000	43,000
Zytner	71,000		NA
Average of all	--		77,000

Notes:
Mg/kg milligrams per kilogram
cm centimeter

2.4.3.3 API Recommended Values

The API defined residual saturation to be as follows:

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 at 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 2-3**.

Table 2-3 Summary of API Residual Saturation Results

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

Notes:
% percent
Mg/kg milligrams per kilogram

2.4.3.4 Tier II SSTL 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 to 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.

Only one soil sample was found to exceed the 90% confidence level at a TPH-d concentration of 19,000 mg/kg but it was far below the median (50%) value for residual saturation. The sample was collected in 1997 from a depth of 23 ft bgs and groundwater is at a depth of approximately 100 ft bgs. Furthermore, in 2003 the highest TPH-d concentration detected was 9,200 mg/kg at 23 ft bgs, which is below the 90% confidence level.

Given the depth of the soil sample above groundwater, if mobile product exists at this depth, the concentration would continue to decrease with vertical migration until it was immobilized. The HSSM modeling performed indicates that TPH-d would be completely immobilized by a depth of 55 ft bgs. Therefore, the maximum TPH-d does not constitute a risk to groundwater.

2.5 DECOMMISSIONING ACTIVITIES

Soil borings completed at SWMU I08 were backfilled with bentonite and hydrated every 10 feet. The top four feet of the borings were backfilled with native soil (Secor, 2004). The former open pit at SWMU I08 was backfilled with fill material in September 2004 (CESPK, 2006). The methodology for backfilling the pit is not known. Photographs of the current site condition, collected in February 2012, are included in **Attachment 3**.

3.0 CONCLUSIONS

One sample, I08-SS02-1-S, collected outside of the pit bottom contained TPH-d at a concentration of 150 mg/kg. Broken asphalt was observed immediately adjacent to the sample collection point and may have contributed to the observed TPH concentration. All other detections of TPH-affected soils at SWMU I08 are contained within the open pit. In 2004, the pit was filled with clean soil reducing the risk to receptors through dermal contact or ingestion.

TPH-d and TPH-m concentrations within the pit exceeded the State of Nevada Corrective Action Level of 100 mg/kg from the bottom of the pit, or 13 ft bgs (1994 surface samples), to 20 ft from the bottom of the pit, or 33 ft bgs (two of three 2003 soil borings). In one of the three soil borings completed in 2003, TPH concentrations were detected from 40 and 60 ft below the bottom of the pit (53 and 73 ft bgs) exceeding the laboratory detection limit, however, TPH concentrations were below the State of Nevada Corrective Action Level of 100 mg/kg. Modeling of the maximum retention capacity predicted that no further migration of TPH-d will occur. Groundwater in the vicinity of SWMU I08 is approximately 100 feet bgs. The vertical extent of residual TPH contamination is predicted to remain at approximately 42 ft below the bottom of the pit (55 feet bgs), or 45 feet above groundwater.

Sampling, analysis and modeling indicate that no present or future receptors are likely to be adversely impacted by site contamination at SWMU I08. Closure is requested following NAC 445A.227 guidelines, under which the following issues were addressed (**Table 3-1**):

Table 3-1 Site Evaluation for SWMU I08

Assessment Criteria		Response
A	Depth of any groundwater	Estimated at 100 feet, approximately 45 feet deeper than TPH is anticipated to travel.
B	Distance to irrigation or drinking water wells	No irrigation or drinking water wells are located within three miles downgradient.
C	The type of soil that is contaminated	The predominant soil type at the site is sand. Clay layers are located at depths of approximately 20 feet and 75 feet.
D	The annual precipitation	Annual precipitation in Hawthorne, Nevada is 4.6 inches.
E	The type of waste or substance released	The release is TPH in the form of motor oil and diesel.
F	The extent of the contamination	It appears that the soil contamination is limited to the pit/landfill and is present from 13 to 73 feet below native ground surface (or 0 to 60 feet below bottom of the pit). The majority of the contamination appears to be from 23 to 33 ft bgs (or 10 to 20 feet below the bottom of the pit).
G	The present and potential use for the land	The site is presently used for industrial purposes. Future land use is also expected to be industrial.
H	The preferred routes of migration	Vertically, due to gravity.
I	The location of structures and impediments	There are no known subsurface structures or physical impediments to horizontal migration of contaminants.
J	The potential for a hazard related to fire, vapor, or explosion	There are no apparent hazards related to fire, vapor, or explosions.
K	Other site-specific factors	No other site-specific factors have been noted.

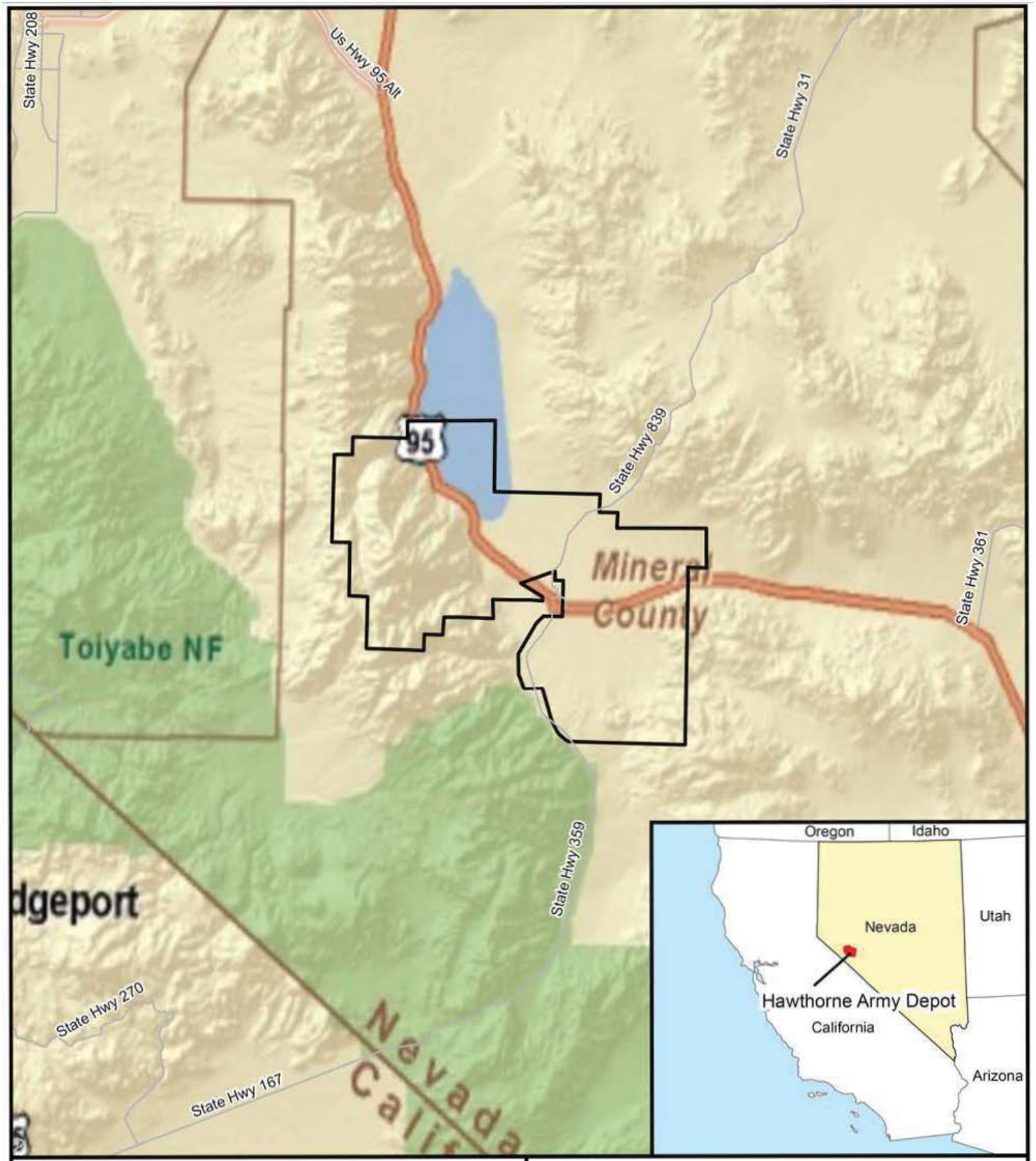
4.0 REFERENCES

CESPK , 2006. United States Army Corps of Engineers Sacramento District, 2006. *Draft Decision Document for I08.* June 2006.

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

Tetra Tech, 1999. *Final Remedial Investigation Report, SWMU I08, Building 70 Pit/Landfill*, *Hawthorne Army Depot, Hawthorne, Nevada*. January 1999.

Figures



Installation Boundary

Site Location Map

Bay West
Customer-Focused Environmental & Industrial Solutions

Figure 1

Hawthorne Army Depot, Hawthorne, Nevada

File: Hw_Fig1_RegionalMap.mxd Date: 11/1/2010

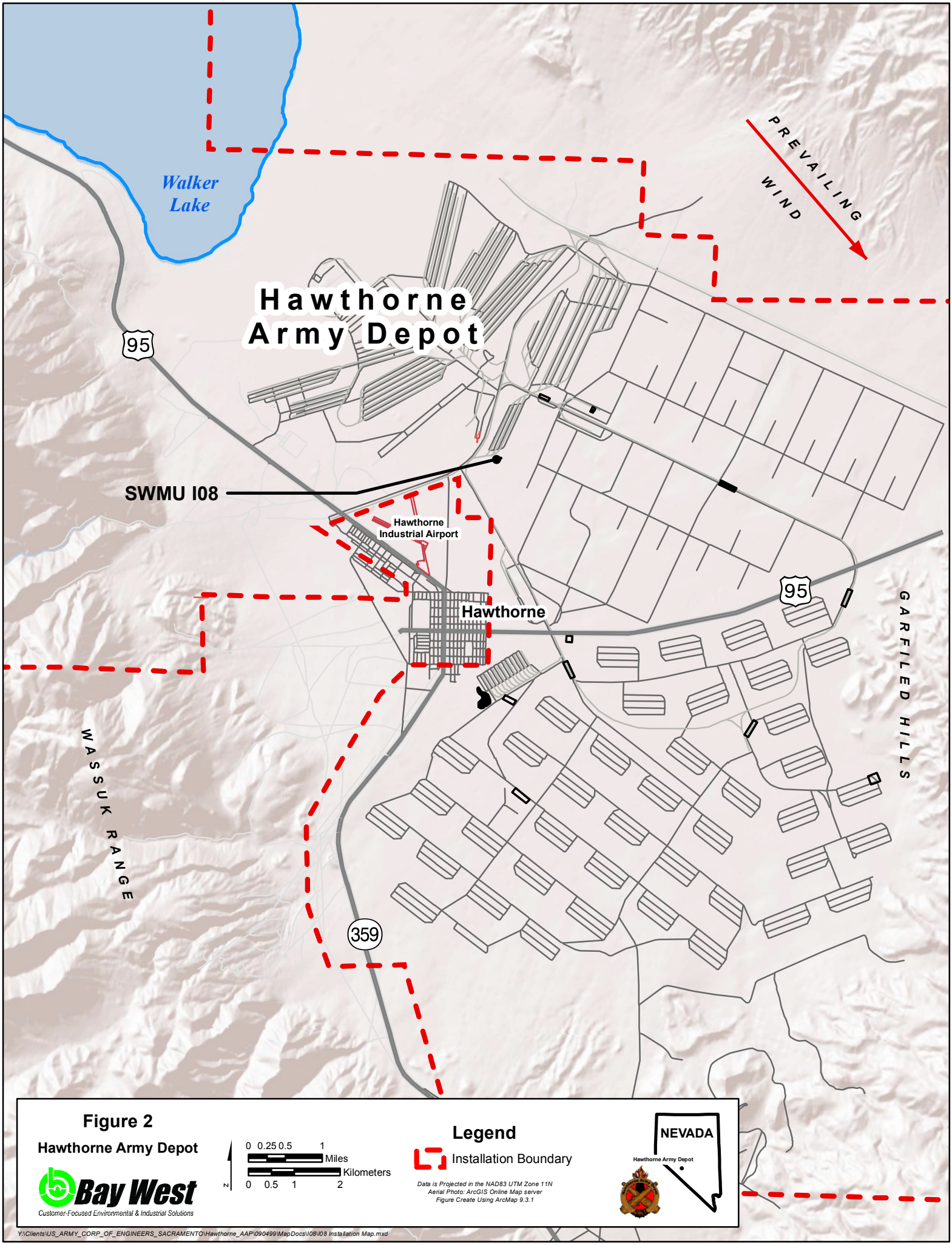


Figure 2

Hawthorne Army Depot

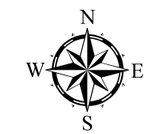
Attachment 1
Supporting Documentation

Site Map
1997 Groundwater Analytical Data
1993 and 1997 Remedial Investigation (RI) Boring Location Map
1994 and 1997 RI Analytical Data
2003 RI Boring Location Map
Test Pit Boring Logs
2003 RI Analytical Data

SWMU I-08

Site Map

Hawthorne Army Depot
Hawthorne, Nevada



Map Projection: NAD 1983 UTM Zone 11 North

Bing World Imagery Basemap

0 50 100 Feet

0 20 40 Meters

Photo Location

Fence

Remediation Area

Site Boundary

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: M.B. Date Drawn: 12/22/2011 Project No. J090499

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_SACRAMENTO\Hawthorne_AAP\090499\MapDocs\I08\I08_SiteMap.mxd

Table 4-2
Summary of Detected Analytical Results for Ground Water Samples
SWMU I08 – Building 70 Pit/Landfill

Sample ID	**BLDG70MW01-020297-W**								
Location ID	BLDG70MW01	Analyses	Detections	Minimum	Maximum	MCL	MCL Hits	PRG	PRG Hits
Sample Date	2/2/97								
Sample Depth (feet)	118								
Metals (μg/l)									
Methods 6000s/7000s									
Arsenic, Dissolved	4.9 [J]	1	1	4.9	4.9	50	0	0.045	1
Arsenic, Total	5.7	1	1	5.7	5.7	50	0	0.045	1
Chromium, Dissolved	2.6 [J]	1	1	2.6	2.6	100	0	NE	NE
Chromium, Total	5.5	1	1	5.5	5.5	100	0	NE	NE
Iron, Total	202	1	1	202	202	300	0	NE	NE
Lead, Dissolved	1.4 [J]	1	1	1.4	1.4	15	0	4	0
Lead, Total	4.9 [J]	1	1	4.9	4.9	15	0	4	1
Magnesium, Total	16100	1	1	16100	16100	NE	NE	NE	NE
Potassium, Total	12800	1	1	12800	12800	NE	NE	NE	NE
Selenium, Dissolved	4.3 [J]	1	1	4.3	4.3	50	0	180	0
Sodium, Total	186000	1	1	186000	186000	NE	NE	NE	NE

Workspace: HWAD.WOR

Legend:

- Boundary Corner Pin
- Hand Auger Location
- Soil Boring Location
- Surface Soil Sample
- Fence
- Railroad
- SGPR Anomaly
- SGPR Traverse
- SWMU Monument

0 45 90
Approximate Scale in feet

N

Tetra Tech, Inc.

Investigation Activity Map
SWMU I08
Building 70 Pit/Landfill

Hawthorne Army Depot
Hawthorne, Nevada

Figure 3-1

Table 4-1
Summary of Detected Analytical Results for Soil Samples
SWMU I08 – Building 70 Pit/Landfill

Sample ID	I08-SS01-1-S	I08-SS02-1-S	I08-DP034	I08-DP035	I08-DP036	I08-DP038	I08-DP039	I08-SS03-1-S	I08-SS04-0-S	I08-HA01-1-S
Location ID	SS01	SS02	SS02	SS02	SS02	SS02	SS02	SS03	SS04	HA01
Sample Date	7/10/94	7/10/94	7/10/94	7/10/94	7/10/94	7/10/94	7/10/94	7/10/94	7/10/94	7/25/94
Sample Depth (feet)	0	0	0	0	0	0	0	0	0	2
TPH (mg/kg)										
Method 8015M/8015ME										
C8-C10 (Gasoline)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C11-C22 (Diesel)	< 1000	150	NA	NA	240	NA	NA	< 10	1000	< 0.2
C23-C30 (Motor oil)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C31-C40 (Heavy oil)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH Test Kit (mg/kg)										
Method 4030										
TPH-d	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-d (Rerun)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VOCs (mg/kg)										
Method 8260										
Methylene chloride	NA	NA	NA	NA	NA	NA	0.0062	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	< 0.0004	NA	NA	NA
BTEX Test Kit (mg/kg)										
Method 4031										
BTEX	X> 50	10< X< 50	NA	NA	NA	10< X< 50	NA	2< X< 10	NA	< 2
PCBs (mg/kg)										
Method 8080										
Aroclor 1260	NA	NA	NA	< 0.2	NA	NA	NA	NA	NA	NA
PCB Test Kit (mg/kg)										
Method 4020										
Total PCBs	< 1	< 1	< 1	NA	NA	NA	NA	< 1	NA	< 1

Notes:
NA = Not analyzed.
NE = Not evaluated.
HWAD-PCG of 10 mg/kg for benzene applied as the action level for BTEX as a conservative comparison.
Soil samples I08-DP034, I08-DP035, I08-DP036, I08-DP038, and I08-DP039 are split duplicate samples of I08-SS02-1-S.
Soil sample I08-SB02-2-S is a collocated duplicate sample of I08-SB02-1-S.

Table 4-1 *(continued)*
Summary of Detected Analytical Results for Soil Samples
SWMU I08 – Building 70 Pit/Landfill

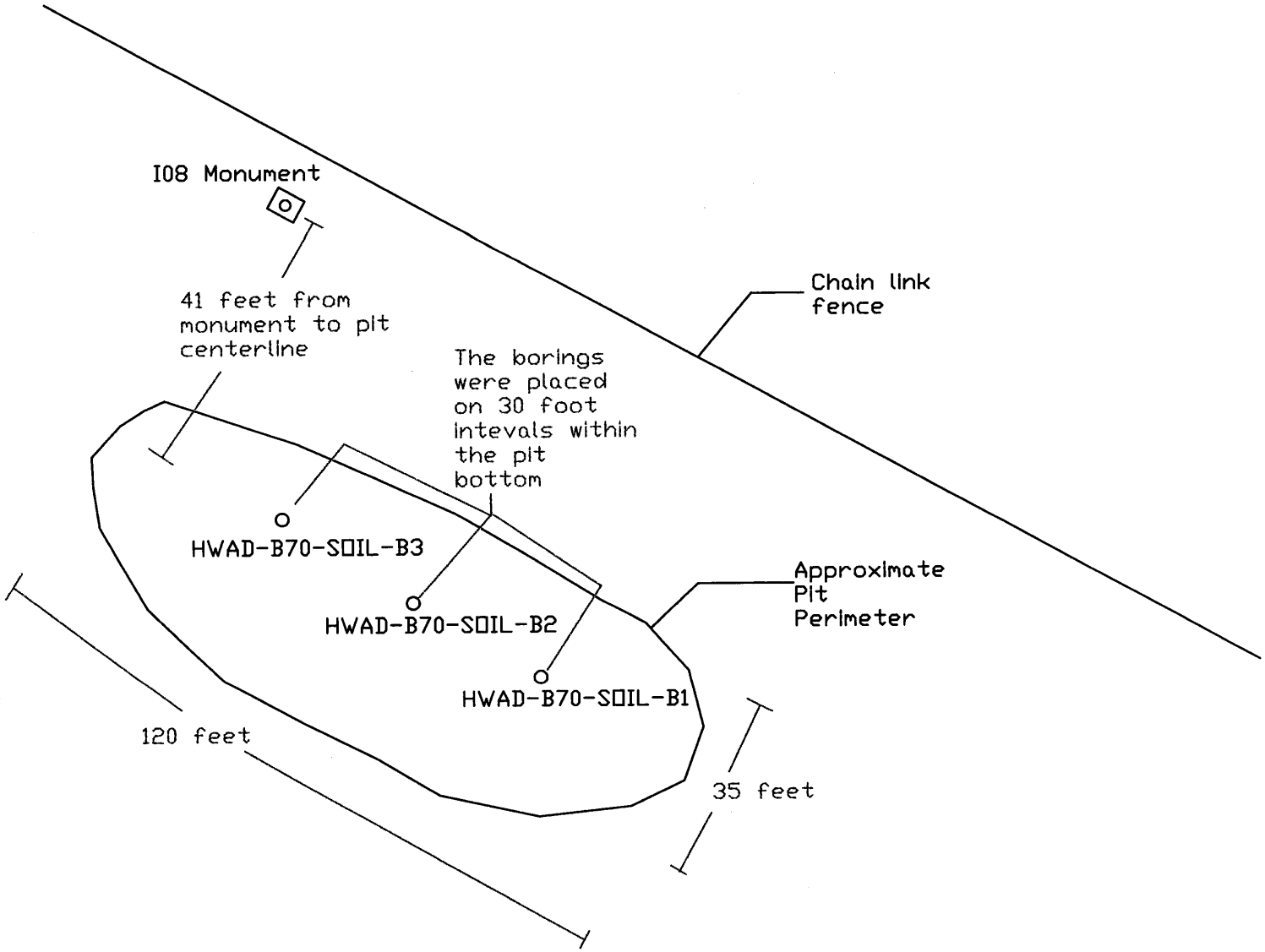
Sample ID	I08-HA02-1-S	I08-HA03-1-S	I08-HA04-0-S	I08-HA04-1-S	I08-SB02-1-S	I08-SB02-2-S	I08-SB02-3-S	I08-SB02-4-S	I08-SB02-5-S
Location ID	HA02	HA03	HA04	HA04	SB02	SB02	SB02	SB02	SB02
Sample Date	7/25/94	7/25/94	7/25/94	7/25/94	3/1/97	3/1/97	3/1/97	3/1/97	3/1/97
Sample Depth (feet)	1	1	0	2.5	5	5.25	10	15	20
TPH (mg/kg)									
Method 8015M/8015ME									
C8-C10 (Gasoline)	NA	NA	NA	NA	NA	NA	<17	NA	NA
C11-C22 (Diesel)	210	340	540	1200	NA	NA	19000	NA	NA
C23-C30 (Motor oil)	NA	NA	NA	NA	NA	NA	1600	NA	NA
C31-C40 (Heavy oil)	NA	NA	NA	NA	NA	NA	<31	NA	NA
TPH Test Kit (mg/kg)									
Method 4030									
TPH-d	NA	NA	NA	NA	100<X<500	100<X<500	100<X<500	100<X<500	100<X<500
TPH-d (Rerun)	NA	NA	NA	NA	NA	NA	4<X<20	NA	NA
VOCs (mg/kg)									
Method 8260									
Methylene chloride	NA	NA	NA	NA	<0.0007	<0.0007	<0.0008	<0.0007	<0.0007
Toluene	NA	NA	NA	NA	<0.0001	<0.0001	<0.0001	0.0004 UJ	<0.0001
BTEX Test Kit (mg/kg)									
Method 4031									
BTEX	2<X<10	2<X<10	10<X<50	<2	NA	NA	NA	NA	NA
PCBs (mg/kg)									
Method 8080									
Aroclor 1260	NA	NA	NA	NA	0.018 J	NA	NA	NA	NA
PCB Test Kit (mg/kg)									
Method 4020									
Total PCBs	<1	<1	1<X<5	<1	NA	NA	NA	NA	NA

Table 4-1 *(continued)*
Summary of Detected Analytical Results for Soil Samples
SWMU I08 – Building 70 Pit/Landfill

Sample ID Location ID Sample Date Sample Depth (feet)	Analyses	Detections	Minimum	Maximum	PCG	PCG Hits
TPH (mg/kg) **Method 8015M/8015ME**						
C8-C10 (Gasoline)	1	0	NE	NE	100	0
C11-C22 (Diesel)	11	8	150	19000	100	8
C23-C30 (Motor oil)	1	1	1600	1600	100	1
C31-C40 (Heavy oil)	1	0	NE	NE	100	0
TPH Test Kit (mg/kg) **Method 4030**						
TPH-d	5	5	100< X< 500	100< X< 500	100	5
TPH-d (Rerun)	1	1	4< X< 20	4< X< 20	100	0
VOCs (mg/kg) **Method 8260**						
Methylene chloride	6	1	0.0062	0.0062	4800	0
Toluene	6	1	0.0004	0.0004	16000	0
BTEX Test Kit (mg/kg) **Method 4031**						
BTEX	9	7	2< X< 10	X> 50	10	4
PCBs (mg/kg) **Method 8080**						
Aroclor 1260	2	1	0.018	0.018	25	0
PCB Test Kit (mg/kg) **Method 4020**						
Total PCBs	9	1	1< X< 5	1< X< 5	25	0

Table 4-2
Summary of Detected Analytical Results for Ground Water Samples
SWMU I08 – Building 70 Pit/Landfill

Sample ID	**BLDG70MW01-020297-W**								
Location ID	BLDG70MW01	Analyses	Detections	Minimum	Maximum	MCL	MCL Hits	PRG	PRG Hits
Sample Date	2/2/97								
Sample Depth (feet)	118								
Metals (μg/l)									
Methods 6000s/7000s									
Arsenic, Dissolved	4.9 [J]	1	1	4.9	4.9	50	0	0.045	1
Arsenic, Total	5.7	1	1	5.7	5.7	50	0	0.045	1
Chromium, Dissolved	2.6 [J]	1	1	2.6	2.6	100	0	NE	NE
Chromium, Total	5.5	1	1	5.5	5.5	100	0	NE	NE
Iron, Total	202	1	1	202	202	300	0	NE	NE
Lead, Dissolved	1.4 [J]	1	1	1.4	1.4	15	0	4	0
Lead, Total	4.9 [J]	1	1	4.9	4.9	15	0	4	1
Magnesium, Total	16100	1	1	16100	16100	NE	NE	NE	NE
Potassium, Total	12800	1	1	12800	12800	NE	NE	NE	NE
Selenium, Dissolved	4.3 [J]	1	1	4.3	4.3	50	0	180	0
Sodium, Total	186000	1	1	186000	186000	NE	NE	NE	NE



SECOR INTERNATIONAL INCORPORATED 1535 HOT SPRINGS ROAD, SUITE 3 CARSON CITY, NEVADA 89706	BORING LOCATIONS SWMU I08 Building 70 Pit/Landfill Hawthorne Army Depot Hawthorne, Nevada	FIGURE: 4 DATE: April 23, 2004 PROJECT NO: 930T.03192.00

SECOR

Logged By:	Date Drilled:	Drilling Contractor	Project Name:	Method/Equipment:	Boring Number:
Thomas	11/18/03	Westex	SWMU I08 Hawthorne Army Depot Building 70 Landfill/Pit	Hollow Stem Auger Mobile B-61	B-1

See "Legend to Logs" for sampling method, classifications and laboratory testing methods	Boring Diam.(in.):	Surface Elev.(ft. AMSL):	Groundwater Depth (ft.):	Total Depth (ft.):	Drive wt.(lbs.):	Drop Dist.(in.):
	8	N/A	No Groundwater Encountered	60.0	140	30

Soil Boring	Depth, (ft.)	Sample Interval	Blow Counts 6"	Description	PID Reading (ppm)	Time Sample Collected
Native Soil				SAND (SW), brown, dry, loose to medium dense, fine to coarse grained		
Bentonite Chips Hydrated in 10' Lifts	5	X	9 24 23		0.0	12:40
	10	X	9 32 17	SAND (SP), brown, slightly moist, loose to medium dense, fine to medium grained @ 10.75' gray, hydrocarbon odor	213	12:50
	15	X	25 50/5	Silty Sand (SP-SM), gray, slightly moist, dense; SAND (SW), brown, slightly moist, dense, fine to coarse grained	170	13:00
	20	X	50/5	Gravelly SAND (SW), brown, slightly moist, loose to dense (rock in shoe), fine to coarse grained with 15-20% gravel, 90% granitic, 10% volcanic, subangular to subrounded	22	13:10
	25					
	30					
	35					
	40	X	50/5	SAND (SW), brown, slightly moist, dense, fine to medium grained	0	13:40
	45			Gravelly SAND (SW), brown, slightly moist, loose to dense (rock in shoe), fine to coarse grained with 15% gravel, 90% granitic, 10% volcanic, subangular to subrounded		
	50					
	55					
	60	X	32 50/5	SILT (ML), brown, slightly moist, hard; SAND (SW), brown, slightly moist, dense, fine to coarse grained, trace gravel	0	14:20
	65			Silty CLAY (CL), brown, slightly moist		

Total Drilled Depth = 60 feet bgs

The substrata descriptions above are generalized representations and based upon visual/manual classification of cuttings and/or samples obtained during drilling. Predominant material types shown on the log may contain different materials and the change from one predominant material type to another could be different than indicated. Descriptions on this log apply only at the specific location the time of drilling and may not be representative of subsurface conditions at other locations or times.

Project No. 93OT.03207.00 Date November 2003

Log of Boring

C:\PROGRAM FILES\GINT\PROJECTS\B70 LANDFILL LOGS.GPJ
LOG OF BOREHOLE

Appendix

1 (sheet 1 of 1)

SECOR

Logged By:	Dates Drilled:	Drilling Contractor	Project Name:	Method/Equipment:	Boring Number:
Thomas	11/18/03 11/19/03	Westex	SWMU I08 Hawthorne Army Depot Building 70 Landfill/Pit	Hollow Stem Auger Mobile B-61	B-2

See "Legend to Logs" for sampling method, classifications and laboratory testing methods	Boring Diam.(in.):	Surface Elev.(ft. AMSL):	Groundwater Depth (ft.):	Total Depth (ft.):	Drive wt.(lbs.):	Drop Dist.(in.):
	8	N/A	No Groundwater Encountered	60.0	140	30

Soil Boring	Depth, (ft.)	Sample Interval	Blow Counts 6"	Description	PID Reading (ppm)	Time Sample Collected
Native Soil				SAND (SW), light brown, dry, loose to medium dense, fine to coarse grained		
Bentonite Chips Hydrated in 10' Lifts	5	☒	13 15 16	@ 6.5' moist	0.0	16:10
	10	☒	9 12 14	SILT (ML), medium brown, slightly moist, stiff, no odor	170	16:20
	15	☒	16 50/4	Silty SAND (SP-SM), medium brown, slightly moist, medium dense, fine grained, no odor	50.1	16:30
	20	☒	24 50/5	SAND (SW), red brown, slightly moist, medium dense, fine to coarse grained, no odor Gravelly SAND (SW), medium brown, slightly moist, medium dense, fine to coarse grained with 5 to 10% gravel, gravel is 90% granitic and 10% volcanic, subangular to subrounded	0	08:20
	25					
	30					
	35			SAND (SP), light brown, slightly moist, dense to very dense, fine grained, no odor		
	40	☒	32 50/6		0	08:45
	45					
	50					
	55					
	60	☒	16 30 30	Silty, clayey SAND (SM-SC), medium brown, moist, dense, fine grained with trace gravel SAND (SP), light brown, slightly moist, medium dense, fine grained, iron oxide mottling	0	09:15
	65			Total Drilled Depth = 60 feet bgs		

The substrata descriptions above are generalized representations and based upon visual/manual classification of cuttings and/or samples obtained during drilling. Predominant material types shown on the log may contain different materials and the change from one predominant material type to another could be different than indicated. Descriptions on this log apply only at the specific location the time of drilling and may not be representative of subsurface conditions at other locations or times.

Project No. **93OT.03207.00** Date **November 2003**

Log of Boring

C:\PROGRAM FILES\GINT\PROJECTS\B70 LANDFILL LOGS.GPJ
LOG OF BOREHOLE

Appendix

2 (sheet 1 of 1)

SECOR

Logged By:	Date Drilled:	Drilling Contractor	Project Name:	Method/Equipment:	Boring Number:
. Thomas	11/19/03	Westex	SWMU 108 Hawthorne Army Depot Building 70 Landfill/Pit	Hollow Stem Auger Mobile B-61	B-3

"Legend to Logs" for sampling method, classifications and laboratory testing methods	Boring Diam.(in.):	Surface Elev.(ft. AMSL):	Groundwater Depth (ft.):	Total Depth (ft.):	Drive wt.(lbs.):	Drop Dist.(in.):
	8	N/A	No Groundwater Encountered	60.0	140	30

Soil Boring	Depth, (ft.)	Sample Interval	Blow Counts 6"	Description	PID Reading (ppm)	Time Sample Collected
Native Soil				Gravelly SAND (SW), light brown, dry to slightly moist, dense to medium dense, fine to medium grained with 15% gravel, no odor		
Bentonite Chips Hydrated in 10' Lifts	5	X	25 16 10	Silty, Sandy CLAY (CL), grayish brown, slightly moist, stiff to very stiff	0	11:25
	10	X	16 24 34	SAND (SW), light brown, slightly moist, dense, fine to coarse grained, predominantly granitic, subangular to subrounded	0	11:35
	15	X	24 37 50/5		0	11:45
	20	X	45 50/5	Gravelly SAND (SW), reddish brown, slightly moist, very dense, fine to coarse grained with 15% gravel, granitic, subangular to subrounded	0	11:55
	25					
	30					
	35					
	40		70/0	No sample recovery, rock in shoe		
	45					
	50					
	55					
	60	X	25 50/4	Silty CLAY (CL), gray, slightly moist, very stiff, no odor	0	13:10
				SAND (SP), light brown, slightly moist, very dense, fine grained, no odor		
	65			Total Drilled Depth = 60 feet bgs		

The substrata descriptions above are generalized representations and based upon visual/manual classification of cuttings and/or samples obtained during drilling. Predominant material types shown on the log may contain different materials and the change from one predominant material type to another could be different than indicated. Descriptions on this log apply only at the specific location at the time of drilling and may not be representative of subsurface conditions at other locations or times.

Project No. 93OT.03207.00 Date November 2003

Log of Boring

C:\PROGRAM FILES\GINT\PROJECTS\B70 LANDFILL LOGS.GPJ
LOG OF BOREHOLE

Appendix

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Table 2: **SWMU I08 Analytical Results Summary and Comparison to Corrective Action Levels**

Date Collected	Sample Name	Location	Depth in Feet[a]	TPH-d in mg/kg[b]	TPH-m in mg/kg[b]
11/18/2003	HWAD-B70-SOIL-B1-5	B1	5	20 UJ	**610 J**
11/18/2003	HWAD-B70-SOIL-B1-10	B1	10	**9,600 J**	*550 UJ*
11/18/2003	HWAD-B70-SOIL-B1-15	B1	15	**3,900 J**	*1,000 UJ*
11/18/2003	HWAD-B70-SOIL-B1-15D	B1	15	**6,000**	*520 U*
11/18/2003	HWAD-B70-SOIL-B1-20	B1	20	**1,400 J**	*510 UJ*
11/18/2003	HWAD-B70-SOIL-B1-40	B1	40	79	*26 U*
11/18/2003	HWAD-B70-SOIL-B1-60	B1	60	1.3 U	14
11/19/2003	HWAD-B70-SOIL-B2-5	B2	5	10 UJ	**370 J**
11/19/2003	HWAD-B70-SOIL-B2-10	B2	10	**3,600 J**	*270 UJ*
11/19/2003	HWAD-B70-SOIL-B2-15	B2	15	**1,400 J**	*260 UJ*
11/19/2003	HWAD-B70-SOIL-B2-20	B2	20	**1,300 J**	51 UJ
11/19/2003	HWAD-B70-SOIL-B2-40	B2	40	1.0 U	5.1 U
11/19/2003	HWAD-B70-SOIL-B2-60	B2	60	1.0 U	5.2 U
11/19/2003	HWAD-B70-SOIL-B3-5	B3	5	1.1 U	5.5 U
11/19/2003	HWAD-B70-SOIL-B3-10	B3	10	1.0 U	5.1 U
11/19/2003	HWAD-B70-SOIL-B3-15	B3	15	1.0 U	5.1 U
11/19/2003	HWAD-B70-SOIL-B3-20	B3	20	1.0 U	5.2 U
11/19/2003	HWAD-B70-SOIL-B3-60	B3	60	1.1 U	5.5 U

NOTES:

BOLD indicates that the concentration exceeds Nevada State Correction Action Level

ITALIC indicates that the reporting limit exceeds Nevada State Corrective Action Level

(e.g., in Sample HWAD-B70-SOIL-B1-40, the sum of TPH-d and TPH-m reporting limit would exceed the limit.)

U indicates that the material was analyzed for but was not detected above the level of the associated value

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

UJ indicates that the material was analyzed for, but not detected. The associated value is an estimate and maybe inaccurate or imprecise.

a) Depth from the floor of the pit which is estimated at 13 feet from the ground surface.

b) The Nevada State Corrective Action Level for TPH 100 mg/kg.

Attachment 2

Transport Modeling Sensitivity Analysis and Results

Similarly, in boring HWAD-B70-SOIL-B2, the observed concentrations of TPH-d in the sampled soil decreased from 3,600 mg/kg at 10 feet from the pit floor to non-detect at 40 feet from the pit floor. TPH-m was detected only in one sample. At a depth of five feet below the pit floor TPH-m was observed at a concentration of 370 mg/kg. The detection limits were increased in the samples collected from 10, 15 and 20 feet from the pit floor due to the presence of TPH-d in these locations. The maximum detected total TPH in HWAD-B70-SOIL-B2 was 3,600 mg/kg of TPH-d and up to 270 mg/kg TPH-m, for a total of up to 3,870 mg/kg TPH.

No detections of TPH were observed in samples collected from boring HWAD-B70-SOIL-B3, nor were any detection limits increased.

4.4 POTENTIAL AREA OF IMPACT

The groundwater well nearest to SWMU I08 is Bldg70MW01, approximately 150 feet northwest and downgradient of the SWMU I08 Building Pit/Landfill (Figure 3). Groundwater at SWMU I08 is conservatively estimated to be present at a depth of approximately 100 feet bgs, based on the 104.06 feet depth to groundwater measurement collected from well Bldg70MW01 in May 2003 during the 2nd quarter 2003 Tt EMI Groundwater report. The location of this monitoring well from SWMU I08 should allow for significant groundwater impacts from this SWMU to be assessed. No irrigation or drinking water wells are located downgradient of SWMU I08.

The maximum depth at which TPH-e has been observed is less than 55 feet from ground surface (13 to 15 feet to the bottom of the open pit plus no observed detections at boring depths of 40 feet) and therefore has not impacted groundwater. To ensure that groundwater will not be impacted in the future, the maximum retention capacity was evaluated to determine if the diesel concentrations are high enough to continue vertical travel and reach the groundwater. The retention capacity has been evaluated using two methodologies: the United States EPA HSSM, which can be found at the following URL: http://www.epa.gov/ada/csmos/models/hssmwin.html, and a simple calculation performed by hand. Each is presented in subsequent sections herein.

TPH-e impacted soil containing TPH concentrations exceeding NAC cleanup levels of 100 mg/kg has been observed to begin at a depth of approximately 18 to 20 feet from the native ground surface (13 to 15 feet to the floor of the pit and five feet to the impact). Based on previous investigations conducted by Tt, the horizontal extent of the TPH-affected soils at SWMU I08 is contained within the open pit. One previously investigated location outside of the pit bottom was observed to contain TPH-d at a concentration of 150 mg/kg. Broken asphalt was observed immediately adjacent to the sample collection point, and may be attributable to the observed TPH. Simultaneously to horizontally delineation at SMWU I08, Tt conducted surface ground penetration radar and confirmed that no structures or impediments are present on the site.

4.4.1 HSSM Evaluation

The HSSM was developed by the EPA to serve as a simplified model for subsurface releases of fuel hydrocarbons. HSSM simulates flow of the LNAPL phase and transport of a chemical constituent of the LNAPL from the surface to the water table, radial spreading of the LNAPL phase at the water table, and dissolution and aquifer transport of the chemical constituent (each as applicable).

The HSSM model is one-dimensional in the vadose zone, radial in the capillary fringe, two-dimensional vertically averaged analytical solution of the advection-dispersion equation in the saturated zone. 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 underground storage tanks (USTs) 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 err on the conservative side.

HSSM is a screening model: it includes a number of chemical and hydraulic phenomena, assumes 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 included in 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.

The model is based on the KOPT, OILENS and TSGPLUME (a transient source Gaussian plume model) models. The first two modules of HSSM address the vadose zone flow and transport to the LNAPL. These two are the Kinematic Oily Pollutant Transport (KOPT) and OILENS (short for oil lense) modules. KOPT and OILENS are combined into one computer code, HSSM-KO, which provides a time-variable source condition for the aquifer model. In cases where the hydrocarbons do not reach groundwater, the OILENS portion of the code is not exercised; nonetheless, the quality control checks are conducted on OILENS input data, even if the data is not required or employed.

Within HSSM, the light non-aqueous phase liquids (LNAPL) follow 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 to interest.

The spill of the LNAPL phase may be simulated in three ways:

(1) The release of an LNAPL may occur at a known flux for a specified duration. This situation would occur if a known volume of LNAPL was released during a certain time period. The LNAPL volume divided by the duration and area of release determines the release rate, q_o. If the LNAPL flux exceeds the maximum effective LNPL conductivity, K_{eo}, some of the LNAPL will run off at the surface.

(2) A known volume of LNAPL may be placed over a specified depth interval, d_{pl}. When the simulation begins the LNAPL may begin to flow out of the specified zone, if the LNAPL retention capacity of the soil is exceeded.

(3) The last option is the specification of a constant depth of ponded LNAPL for a certain duration. His case represents a slowly leaking tank or a leaking tank within an embankment. In either of these situations, the pounded depth of NAPL is estimated or known. Tow options are available for this boundary condition. In the first, the ponding abruptly goes to zero at the

end of the ponding period. In the second, the ponded depth decreases gradually at the end of the ponding period.

For the impact at SWMU I08 only the approximate concentration of the LNAPL in the soil over a specified depth is known, from which the approximate volume has been calculated (see attachment to Table 3). There is no ponded hydrocarbon at a constant depth, nor is the flux or duration or release known; therefore, the second simulation input choice is the only option possible for SWMU I08.

The model was run for 100 years for six different soil types. The input parameters and associated output values are summarized in **Table 3**. The description of the input source and range are given as well, both in Table 3 and in the following description sheets. All input values that have relevance on the outcome of the simulation were varied over the entire reasonable range to ensure that the most conservative conditions were simulated. Breakthrough was not observed in any of the five runs. In all simulations after the 100 year simulation the TPH-e remained a maximum depth of the input starting point (at a depth of 12 meters or 40 feet from the pit floor, or approximately 53 feet from the ground surface) implying that the model does not predict any additional vertical movement of the observed TPH-e which could cause groundwater impact.

4.4.2 Hand Calculation for Soil Retention Capacity

A conservative method to determine if groundwater might be impacted is employed in this section. 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 (the most conservative value for the soil types represented at this site) 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 in which the highest observed level of TPH-e was 9,600 mg/kg as TPH-diesel, any residual diesel is unlikely to pose a threat to groundwater quality.

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Table 3 : Transport Modeling Sensitivity Analysis and Results

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	
General Data	High Porosity Sand	Low Porosity Sand	Loamy sand	Sandy loam	Loam	Silt Loam	Description of Source and Relevance
Module Switch							
Hydrologic Parameters							
Hydrologic Properties							
Water dynamic viscosity (cp)	1	1	1	1	1	1	HSSM default
Water density (g/cm3)	1	1	1	1	1	1	
Water surface tention (dyne/cm)	65	65	65	65	65	65	
Max. Krw during infiltration	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	Flint et al., 1996
Brooks & Corey's lambda	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	0.159	0.292	0.509	0.696	
Residual water saturation	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	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	Assume homogeneous
Porosity	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)	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 (the model requires >1.2)
Aquifer saturation thickness (m)	*10*	*10*	*10*	*10*	*10*	*10*	Irrelevant as the diesel is not being evaluated in gw
Depth to water table (m)	*26.5*	*26.5*	*26.5*	*26.5*	*26.5*	*26.5*	87 ft = 26.5 m from the bottom of the pit (100 ft - 13 ft = 87 ft)
Capillary thickness parameter (m)	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	Irrelevant if no diesel in gw, HSSM default
Groundwater gradient (m/m)	*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)	*1*	*1*	*1*	*1*	*1*	*1*	
Transverse dispersivity (m)	*1*	*1*	*1*	*1*	*1*	*1*	
Vertical dispersivity (m)	*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	Env. Canada Oil Properties Database
NAPL dynamic viscosity (cp)	2	2	2	2	2	2	
Hydrocarbon solubility (mg/L)	25	25	25	25	25	25	See sheet 2, average and most conservative run
Aquifer residual NAPL saturation	*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	Most conservative recommended by HSSM User's guide pg. 43
Soil/water partition coefficient (L/kg)	*100*	*100*	*100*	*100*	*100*	*100*	Irrelevant as the diesel is a single constituent
NAPL surface tension (dyne/cm)	32	32	32	32	32	32	Pg. 44, Table 11, HSSM user's guide (range 29-34)
Hydrocarbon Release (specified)							
NAPL Specific Volume/Area	0.246	0.246	0.246	0.246	0.246	0.246	Most conservative calculated on subsequent sheet.
Lower Depth of NAPL (m)	12	12	12	12	12	12	Assume 40 feet = 12 m
Model Simulation Data							
Model Simulation							
Radius of lens source (m)	*0.5642*	*0.5642*	*0.5642*	*0.5642*	*0.5642*	*0.5642*	No OILENs, 1 selected pg. 48 HSSM
Radius multiplicity factor	*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*	Irrelevant as the diesel is not being evaluated in groundwater
Simulation end time (d)	36500	36500	36500	36500	36500	36500	100 years
Max. Solution step time (d)	24	24	24	24	24	24	Recommended largest value on pg. 48 HSSM user's guide
Minimum time between printed time steps (d)	*1*	*1*	*1*	*1*	*1*	*1*	Irrelevant, only affects output, Pg. 48, HSSM user's guide
Oilens Simulation Ending Criterion							
User-specified time?	yes	yes	yes	yes	yes	yes	
HSSM-T Model Parameters							
Percent maximum contaminant radius (%)	*101*	*101*	*101*	*101*	*101*	*101*	Irrelevant as it is used for TSGPLUME, which implies constituent is in groundwater, recommended default HSSM user's guide, pg. 50
Minimum output concentration (mg/L)	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	
Beginning time (d)	*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*	
Time increment (d)	*100*	*100*	*100*	*100*	*100*	*100*	
DEPTH REACHED (m)	**12**	**12**	**12**	**12**	**12**	**12**	Depth reached from the bottom of the pit.

Not: Italics indicate that the value is irrelevant if diesel does not reach groundwater because it is a property of the groundwater. Yellow indicates differences for soil type.

Table 3, Sheet 2: **Solubility Data**

Diesel #2[a]			
C11-C22 Aromatics	60%		
C11-C22 Aliphatics	40%		
Compound	% expected	Solubiliy in mg/L[b]	Contribution
C10-12 aliphatics	8.00%	0.034	0.00272
C10-12 aromatics	9.00%	25[c]	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

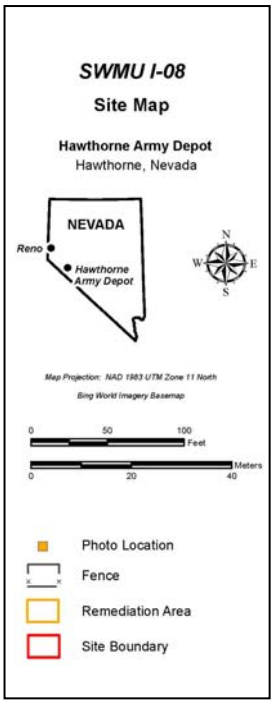
(a) Compositional Assumptions from NM Environmental Department TPH Screening Guidelines, June 24, 2003
(b) Water Solubility given by California Air Resources Board
(c) The most conservative value is 25

Table 3, Sheet 3: **Calculation for Volume-to-Area**

(1) Max concentration	10150	mg/kg	This is 9,600 mg/kg TPH-d + 550 mg/kg reporting limit TPH-m.
(2) Density soil	1.68	g/cm3	The most conservative density of the soil types evaluated.
	1680	kg/m3	
(3) Density TPH-d	0.85	g/cm3	
	8.5E+08	mg/m3	
(4) Volume of soil	35	ft wide	Based on field measurements.
	80	ft long	
	40	ft deep	
	112000	ft3	
	3173	m3	
(5) Max. Volume TPH	63.65	m3	This is equal to the result of (1) times (2) times (3) divided by (4).
(6) Area impacted	35	ft wide	
	80	ft long	
	2800	ft2	
	259.3	m2	
(7) Volume per Area	0.246		This is equal to the result of (5) divided by (6).

Attachment 3

SWMU I08 Photographic Log



SWMU I08 Photograph Location Figure

Hawthorne Army Depot

Image of:
Post Remedial Action Site Restoration

Notes: Purpose of the Photograph is to document that the area was backfilled.

Photograph View:
View to the east

SWMU I08 Photograph 01 (February 2012)

Hawthorne Army Depot

Image of:
Post Remedial Action Site Restoration

Notes: Purpose of the Photograph is to document that the area was backfilled.

Photograph View:
View to the North.

SWMU I08 Photograph 02 (February 2012)

Hawthorne Army Depot

Image of:
Post Remedial Action Site Restoration

Notes: Purpose of the Photograph is to document that the area was backfilled.

Photograph View:
View to the Northwest.

SWMU I08 Photograph 03 (February 2012)