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FINAL FOLLOW-UP REPORT/TECHNICAL GUIDANCE DOCUMENT 15 PROPOSAL FOR  
SITE CLOSURE TANK SYSTEM 106 AND 107MILLINGTON SUPPACT TN  
1/8/1999  
ENSAFE/ALLEN & HOSHALL

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**FINAL FOLLOW-UP REPORT/  
TECHNICAL GUIDANCE DOCUMENT 15  
PROPOSAL FOR SITE CLOSURE**

**TANK SYSTEMS 106 AND 107  
NAVAL HOSPITAL, BUILDING 100  
NAVAL SUPPORT ACTIVITY MID-SOUTH  
MILLINGTON, TENNESSEE  
FACILITY ID #0-791707**



**CTO-082**

**Prepared for:**

**Department of the Navy  
Southern Division  
Naval Facilities Engineering Command  
North Charleston, South Carolina**



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**January 8, 1999**

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## 1.0 INTRODUCTION

The following report proposes site closure and discontinuing of further groundwater monitoring of underground storage tank (UST) systems 106 and 107 at the Naval Hospital, Building H-100 of the Naval Support Activity Mid-South (NSAM) in Millington, Tennessee (Site). The report was prepared following *Technical Guidance Document (TGD) — 015, Procedure to Obtain Closure for Sites in the Monitoring Only Program*, State of Tennessee, Department of Underground Storage Tanks, August 1, 1996.

### Site History

A release of No. 2 fuel oil was reported on June 7, 1991 to the Tennessee Department of Environment and Conservation (TDEC) after fuel oil was seen seeping from an expansion joint near the area where the tank system piping intersected Building H-100. Following notification of the release, a limited investigation was completed by NSAM personnel to determine the point of release. The USTs and all pipe fittings were unearthed for visual inspection.

Results of a tank tightness test, completed on June 13, 1991, by CTC Industrial Services, Inc. of Memphis, Tennessee, indicated the tanks were within acceptable tightness limits. The tightness of the system piping, however, was outside acceptable limits, indicating a leak. The supply and return lines were replaced with above-ground lines. No further releases have been reported.

An Environmental Assessment Plan (EAP) was developed by EnSafe/Allen & Hoshall (E/A&H) and implemented to produce data of technical quality to assess current site conditions. Results are in the *Environmental Assessment Report, Tank Systems 106 and 107, Naval Hospital, Building 100, Naval Air Station, Memphis, Tennessee*, E/A&H, September 18, 1992. A Corrective Action Plan (CAP) (reference: *Corrective Action Plan, Naval Hospital, Building H-100, NAS Memphis*, October 30, 1992) was prepared following completion of the

EAR. In the CAP, monitoring only was chosen as the remedial alternative for impacted groundwater and no-action for contamination in soil.

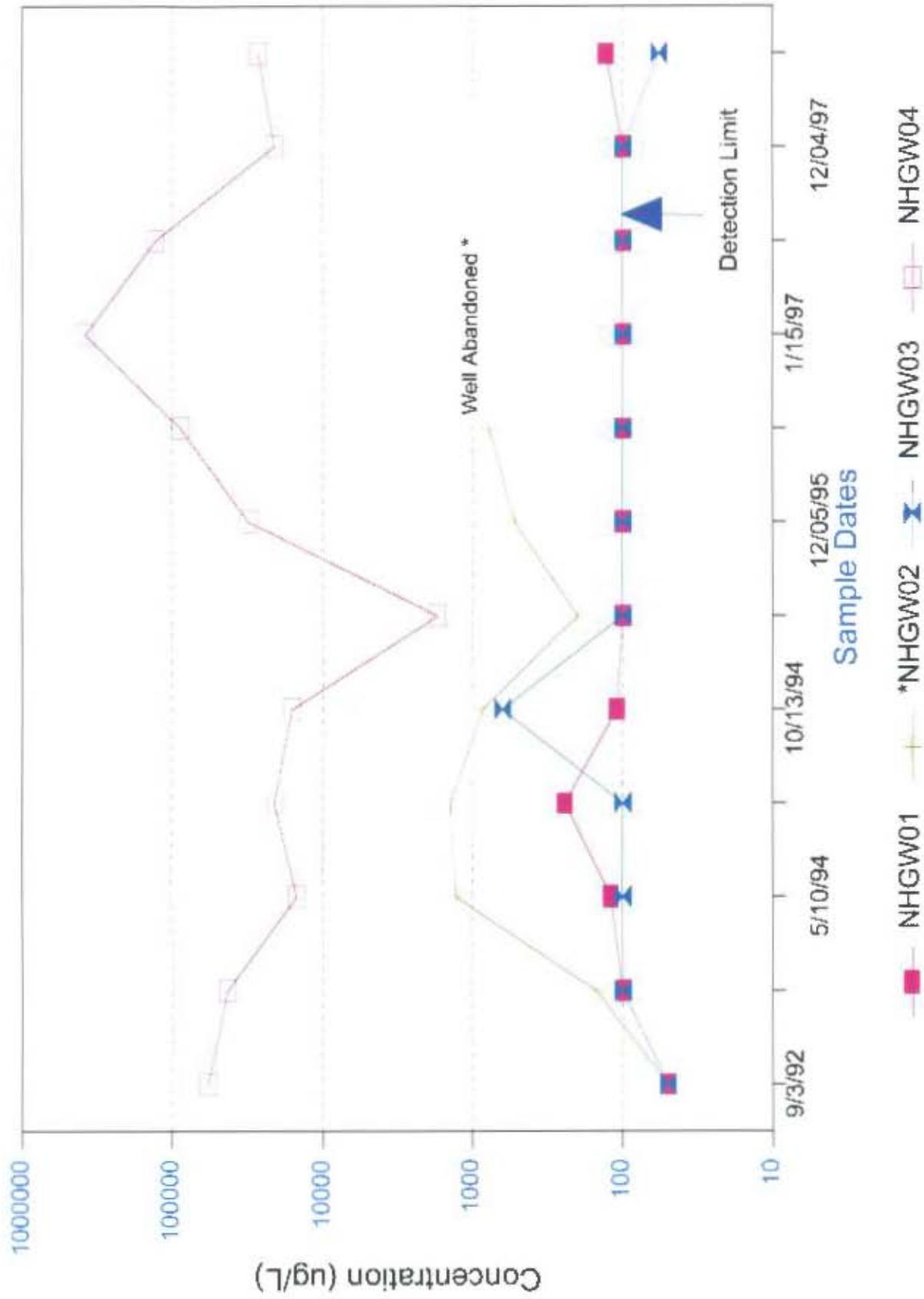
During 11 groundwater monitoring events from December 1993 to June 1998, petroleum hydrocarbons exceeded the TDEC action level of 1,000 micrograms per liter ( $\mu\text{g/L}$ ) in two wells. Monitoring well NHGW04, adjacent to the naval hospital's boiler room and the former fuel-line leak, contained petroleum concentrations from 1,700  $\mu\text{g/L}$  and 380,000  $\mu\text{g/L}$ . A slight sheen of product ranging from one-sixteenth to one-eighth inch has been measured on groundwater in this well. In an effort to recover this product and minimize further groundwater impacts, the Navy performed six mobile enhanced multiphase extractions (MEMEs) at the site between March and December 1998. Results of the MEMEs are provided in corresponding reports titled *Enhanced Fluid Recovery Results*, all of which have been submitted to the TDEC by the Navy.

Monitoring well NHGW02, adjacent to the former tank pit, contained petroleum at concentrations from nondetect to 1,400  $\mu\text{g/L}$ . During monitoring, petroleum hydrocarbon concentrations exceeded the 1,000  $\mu\text{g/L}$  action level in two of eight sampling events. This well was closed in August 1996 when the naval hospital's USTs (Tanks 106 and 107) were replaced with aboveground tanks. A site plan showing well locations and the groundwater flow direction from June 1998 groundwater elevations is provided in Figure 1. Petroleum hydrocarbons measured since the EAR are shown in Figure 2.

This report has been prepared at the request of the TDEC Division of UST to discontinue monitoring and to close the site through TGD-15, *Procedure to Obtain Closure for Sites in the Monitoring Only Program*.

Figure 2

# Petroleum Hydrocarbons in Groundwater



## **2.0 PROCEDURE TO OBTAIN CLOSURE**

TGD-015 provides the owner and/or operator with the minimum requirements to obtain closure at a UST site currently in the monitoring only program. The UST site may be eligible for closure after at least two years of monitoring, if the groundwater concentrations at the point of compliance are at or below the established cleanup levels of 0.070 parts per million (ppm) benzene and 1.0 ppm total petroleum hydrocarbons (TPH). At the site, only No. 2 fuel oil was stored in the USTs, therefore, TPH was the only parameter sampled for during implementation of the CAP.

### **2.1 Distance to the Point of Compliance**

The point of compliance is defined in TGD-15 as the offsite building nearest the monitoring well with the highest contaminant concentrations. The building can be either residential or commercial, as long as it is occupied and within the specified area. The specified area is found as outlined below:

- A line to show the dominant groundwater flow direction starts at the upgradient property line and passes through the monitoring well with the highest level of contamination and extends downgradient to the edge of the map's edge.
- Two additional lines are drawn, each 45 degrees downgradient off the groundwater flow direction line. These lines begin at the upgradient property line and extend to the edge of the map. The point of compliance is between these two lines.
- The distance from the MW with the highest level of contamination to the point of compliance is measured.

The point of compliance is approximately 750 feet downgradient of monitoring well NHGW04. Figure 3 depicts the point of compliance using the methods described above.

## **2.2 Closure Report for Monitoring Only Sites**

The following pages are the closure report for the Site. The format of the report is prepared in accordance with TGD-015. Calculations were prepared in a spreadsheet and are presented in Appendix A.

Since TPH is the contaminant of concern at the site, it was the only parameter analyzed for during the groundwater monitoring, and only parameters for TPH are used in the calculations. Also, soil has not been monitored at the site, except soil sampled during for the Environmental Assessment Report, therefore, the soil concentration used in the calculations is the average of all soil samples from all borings in which TPH was detected. This includes soil borings completed as monitoring wells and soil samples collected beneath the basement floor of Building H-100. Soil samples collected in the drainage ditch approximately 250 feet southeast of Tanks 106 and 107 are not included in the average soil contamination since they were collected at the surface and are not directly downgradient of the tanks.

**STATE OF TENNESSEE  
 DEPARTMENT OF ENVIRONMENT AND CONSERVATION  
 DIVISION OF UNDERGROUND STORAGE TANKS  
 CLOSURE REPORT FOR MONITORING ONLY SITES**

1. Facility ID #: 0-791707
2. Facility Name: *Tank Systems 106 and 107, Naval Hospital, Building H-100*
3. Date the site was approved for monitoring only: *December 1993*
4. Provide a description of the point of compliance (i.e. residence, business). Attach a vicinity map showing its location and the distance to the monitoring well with the highest level of contamination.
5. List the following parameters used in the calculations:

Parameter	Value	Units
$\rho_s$ , soil bulk density	1.7	g-soil/cm <sup>3</sup> -soil
$\theta_w$ , volumetric water content in vadose zone soils	0.12	cm <sup>3</sup> -H <sub>2</sub> O/cm <sup>3</sup> -soil
$f_o$ , fractional organic carbon	0.01	percent
$\theta_a$ , volumetric air content in vadose zone soils	0.26	cm <sup>3</sup> -air/cm <sup>3</sup> -soil
$U_{gw}$ , groundwater darcy velocity	3.05	cm/yr
$S_w$ , width of source area parallel to groundwater flow direction	1500	cm
$L_{imp}$ , percent of soil plume covered by impermeable surface	90	percent
$x$ , distance to point of compliance	23,000	cm

6. List the benzene groundwater concentrations, in ppm, from the three most recent sampling events. *Benzene is not a contaminant of concern at the Site, and is not used in any of the calculations.*

7. List the TPH groundwater concentrations, in ppm, from the three most recent sampling events.

	Event 1	Event 2	Event 3
Date of Sampling Event →			
Well Number ↓	June 12, 1997	December 4, 1997	June 2, 1998
NHGW01	0.1U	0.1U	0.13U
NHGW02	NA	NA	NA
NHGW03	0.1U	0.1U	0.058U
NHGW04	130	21	27

*Notes:*

NA — Not applicable, well closed.

U — Compound not detected. Value indicates method reporting limit.

8. Provide  $C_{\text{soil,ave}}$  for benzene, and DRO, in ppm. Include document, date, and page number where information can be verified. Soil was only sampled during the EAR and samples were only analyzed for diesel range organics (DRO).

Location	DRO (ppm)	Date	Document
B2 at 0-4 ft	10	05/19/92	EAR, page no. 28
B4 at 0-4 ft	740	06/01/92	EAR, page no. 28
B4 at 4-8 ft	50	06/01/92	EAR, page no. 28
B5 at 0-4 ft	10	05/19/92	EAR, page no. 28
B6 at 0-4 ft	210	05/19/92	EAR, page no. 28
B8 at 4-8 ft	35	05/26/92	EAR, page no. 28
SA2 at 0-1 ft	11,000	05/21/92	EAR, page no. 28
SA7 at 0-0.8 ft	5,540	07/14/92	EAR, page no. 28
SA7 at 2.3-2.8 ft	23	07/14/92	EAR, page no. 28
SA8 at 0-0.6 ft	58	07/14/92	EAR, page no. 28
SA10 at 6-6.5 ft	4,210	07/14/92	EAR, page no. 28

Location	DRO (ppm)	Date	Document
SA10 at 8-8.5 ft	610	07/14/92	EAR, page no. 28
Average		1,874 ppm	

**Notes:**

- SB — soil boring
- SA — soil sample beneath floor in Building H-100
- EAR — Environmental Assessment Report, September 18, 1992

9. Worksheets for calculations are located in Appendix A.
10. Provide the results of the calculations in the following table.

Parameter	Value	Units
$I_{le}$ , infiltration rate of water through soil	30	cm/yr
$\alpha$ , leachate to gw dilution factor	1.14	unitless
$k_{s, benzene}$ , soil-water sorption coefficient	NA	g-H <sub>2</sub> O/g-soil
$k_{s, GRO}$ , soil-water sorption coefficient	NA	g-H <sub>2</sub> O/g-soil
$k_{s, DRO}$ , soil-water sorption coefficient	12.9	g-H <sub>2</sub> O/g-soil
$K_{sw, benzene}$ , soil to leachate partition	NA	unitless
$K_{sw, GRO}$ , soil to leachate partition	NA	unitless
$K_{sw, DRO}$ , soil to leachate partition	0.08	unitless
$LF_{sw, benzene}$ , soil to groundwater leaching	NA	(mg/L-H <sub>2</sub> O)/(mg/kg-soil)
$LF_{sw, GRO}$ , soil to groundwater leaching	NA	(mg/L-H <sub>2</sub> O)/(mg/kg-soil)
$LF_{sw, DRO}$ , soil to groundwater leaching	0.07	(mg/L-H <sub>2</sub> O)/(mg/kg-soil)
$C_{soil, avg, benzene}$ , avg. benzene contamination in soil	NA	ppm
$C_{soil, avg, GRO}$ , avg. GRO contamination in soil	NA	ppm
$C_{soil, avg, DRO}$ , avg. DRO contamination in soil	1,874	ppm
$C_{leaching, benzene}$ , contamination in gw contributed by leaching	NA	ppm
$C_{leaching, GRO}$ , contamination in gw contributed by leaching	NA	ppm
$C_{leaching, DRO}$ , contamination in gw contributed by leaching	127.17	ppm

Parameter	Value	Units
$C_{gw, avg, benzene}$ , avg. benzene contamination in gw	NA	ppm
$C_{gw, avg, TPH}$ , avg. TPH contamination in gw	59.33	ppm
$C_{source, benzene}$ , benzene concentration at source	NA	ppm
$C_{source, TPH}$ , TPH concentration at source	186.5	ppm
$\alpha_x$ , longitudinal dispersivity	2,300	cm
$\alpha_y$ , transverse dispersivity	767	cm
$\alpha_z$ , vertical dispersivity	230	cm
$C_{x, benzene}$ , concentration of benzene at compliance point	NA	ppm
$C_{x, TPH}$ , concentration of TPH at compliance point	0.237	ppm

11. Determine if the site is eligible for closure:

	Benzene	TPH
Calculated concentrations at the point of compliance	NA	0.237 ppm
Applicable cleanup levels	NA	1.0 ppm
Is the calculated concentration below the applicable cleanup level?	NA	YES

12. Determine target site cleanup goal(s) for benzene and TPH, if applicable:

Benzene target site cleanup goal (ppm)	Not applicable
TPH target site cleanup goal (ppm)	Not applicable

### **3.0 CONCLUSIONS**

As shown in Section 2.0, the point of compliance is approximately 750 feet downgradient of monitoring well NHGW04. The calculated petroleum hydrocarbon concentration at that point is 0.237 ppm, which is well below the site cleanup level of 1.0 ppm. On the Navy's behalf, EnSafe recommends site closure.

**4.0 SIGNATURE PAGE**

We, the undersigned, certify under penalty of law, including but not limited to penalties for perjury, that the information contained in this report and on any attachments is true, accurate, and complete to the best of our knowledge, information, and belief. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for intentional violations.

\_\_\_\_\_  
Owner/Operator (Print)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

STATE OF \_\_\_\_\_ COUNTY OF \_\_\_\_\_

Sworn to and subscribed before me by \_\_\_\_\_ on this date

\_\_\_\_\_. My commission expires \_\_\_\_\_.

\_\_\_\_\_  
Notary Public (print name)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Stamp/Seal

Ben Brantley (P.G.)  
P.E. or P.G. (Print)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Tennessee License/Registration #

STATE OF \_\_\_\_\_ COUNTY OF \_\_\_\_\_

Sworn to and subscribed before me by \_\_\_\_\_ on this date

\_\_\_\_\_. My commission expires \_\_\_\_\_.

\_\_\_\_\_  
Notary Public (print name)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Stamp/Seal

**Appendix A**

**Calculations**

**Tank Systems 106 & 107, Naval Hospital, Building 100, NSA Memphis**  
**Procedure to Obtain Closure for Site in the Monitoring Only Program - TSD-016**  
**Tank Systems 106 & 107, Naval Hospital, Building 100, NSA Memphis**  
**Procedure to Obtain Closure for Site in the Monitoring Only Program - TSD-016**

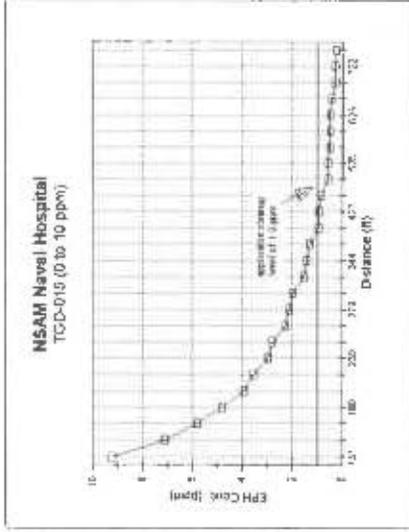
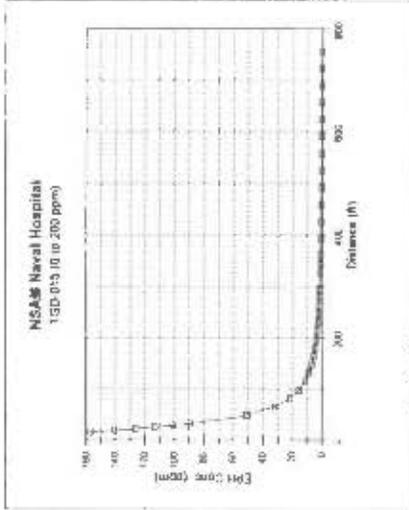
**Site Groundwater Concentrations**

<b>Petroleum Hydrocarbons (EPH or TPH)</b>	
A	soil bulk density: 1.70 g soil/cubic cm soil (default value)
B	voluimetric water content in vadose zone soils 0.12 cubic cm water/cubic cm soil (default value)
C	carbon-water sorption coefficient: 1200.00 square cm water/g carbon (published value)
D	fractional organic carbon: 0.01 fraction (default value)
E	soil-water sorption coefficient: 12.00 g water/g soil (calculated)
F	Henry's law constant: 0.06 unitless (published value)
G	voluimetric air content in vadose zone soils: 0.25 cubic cm air/cubic cm soil (default value)
H	soil to leachate partition (Ksw): $[A \cdot (B+E \cdot A) + (F \cdot C)]$ 0.06 ppm water/ppm soil (calculated)
I	groundwaterarcy velocity: 3.05 cm/yr (calculated)
J	groundwater mixing zone thickness: 200.00 cm (default value)
K	infiltration rate of water through soil (I): 30.00 cm/yr (default value)
L	width of source area parallel to gw flow direction (Sw): 1500.00 cm (default value)
M	leachate to groundwater dilution factor: $[(I \cdot J) \cdot (I \cdot L)]$ 1.14 unitless (calculated)
N	leaching factor (LFsw), soil to groundwater: (I/M) 0.07 ppm/ppm (calculated)
O	percent of soil plume which is covered (cover): 0.80 (calculated)
P	site specific infiltration rate (Iste): $[K \cdot (1-C)]$ 3.00 cm/yr (calculated)
R	avg soil contamination (Csoil ave): 1874.00 ppm (calculated)
S	cont. in gw contributed by leaching (Cleaching): $[R \cdot N]$ 127.17 ppm (calculated)
<b>T</b>	
Avg site gw contamination (Cgw ave):	NHGW01 NHGW02 NHGW03 NHGW04
3rd most recent event:	0.1U N/A 0.1U 0.1U
2nd most recent event:	0.1U N/A 0.1U 0.1U
1st most recent event:	0.13U N/A 0.058U 0.27
Cgw ave:	0 0 0 89.33
U	Concentration at the source (Csource): $(S + T)$ 188.50 ppm (calculated)
V	Source depth, 5d 200.00 cm (default value)

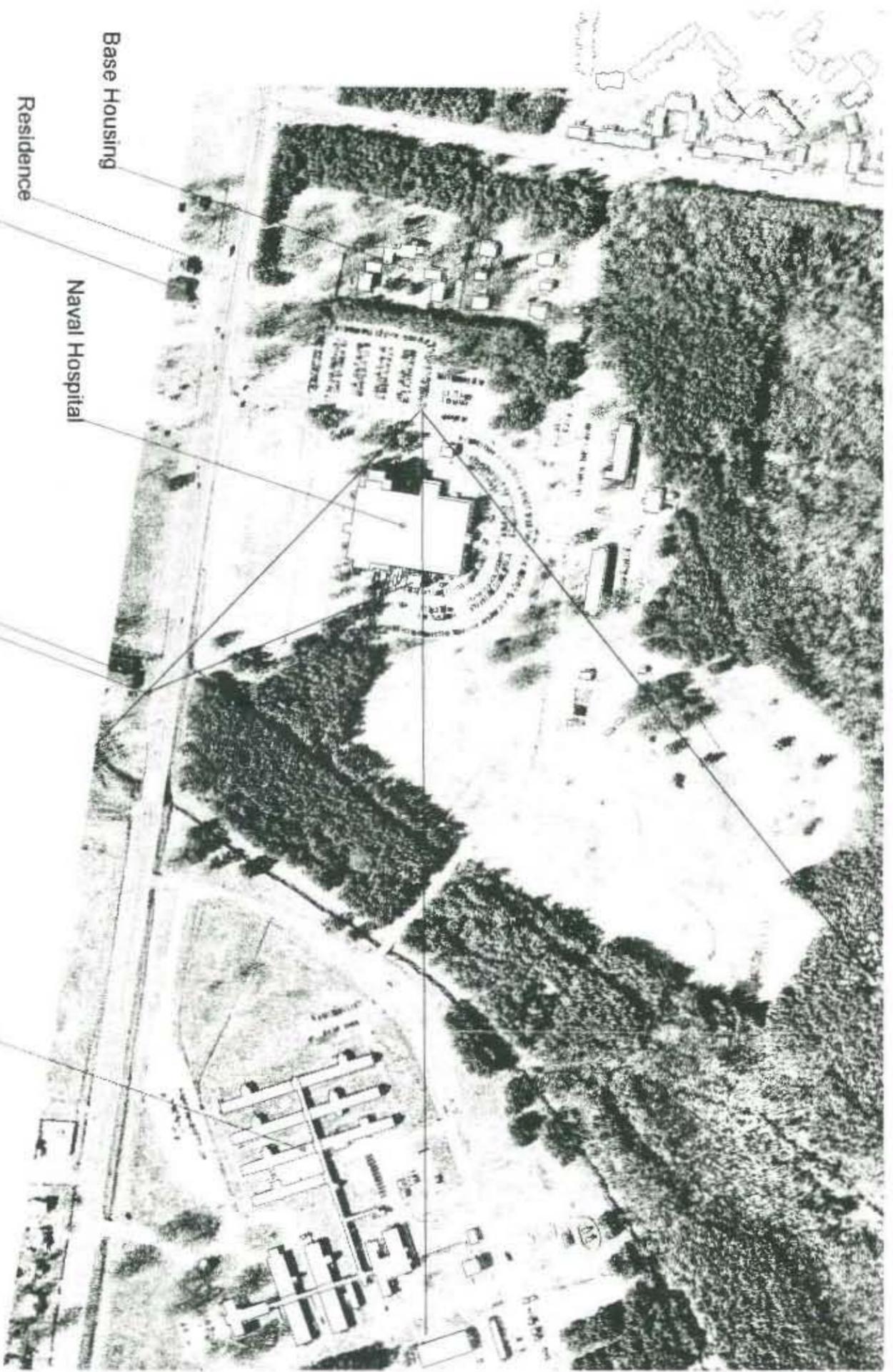
**Tank Systems 106 & 107, Naval Hospital, Building 100, NSA, Memphis**  
 Procedure to Obtain Closure for Site in the Monitoring Only Program - TSD-015

x (cm)	x (ft)	longitudinal dispersivity (cm)	y transverse dispersivity (cm)	z vertical dispersivity (cm)	Beta1	erf	Beta2	erf	EPH (ppm)
100	3	10.00	3.33	1.00	20.54	5.00	5.00	0.000	
200	7	20.00	6.67	2.00	10.27	2.50	2.50	0.000	
300	10	30.00	10.00	3.00	6.85	1.67	1.67	0.000	
400	13	40.00	13.33	4.00	5.13	1.25	1.25	0.000	
500	14	50.00	16.67	5.00	4.11	1.00	0.842701	157.103	
600	20	60.00	20.00	6.00	3.42	0.866850	0.93	141.155	
700	23	70.00	23.33	7.00	2.89	0.868560	0.71	128.198	
800	28	80.00	26.67	8.00	2.57	0.872250	0.63	113.649	
900	30	90.00	30.00	9.00	2.28	0.870480	0.56	101.294	
1000	33	100.00	33.33	10.00	2.05	0.821180	0.50	89.519	
1500	49	150.00	50.00	15.00	1.37	0.759240	0.33	50.846	
2000	66	200.00	66.67	20.00	1.03	0.628760	0.25	32.301	
2500	82	250.00	83.33	25.00	0.82	0.520500	0.20	21.818	
3000	98	300.00	100.00	30.00	0.68	0.447230	0.17	15.838	
3500	115	350.00	118.87	35.00	0.59	0.369180	0.14	11.566	
4000	131	400.00	133.33	40.00	0.51	0.338760	0.13	9.211	
4500	148	450.00	150.00	45.00	0.48	0.307710	0.11	7.092	
5000	164	500.00	166.67	50.00	0.41	0.276328	0.10	5.786	
5500	180	550.00	183.33	55.00	0.37	0.254890	0.08	4.813	
6000	197	600.00	200.00	60.00	0.34	0.233430	0.08	3.919	
6500	213	650.00	216.67	65.00	0.32	0.211760	0.08	3.566	
7000	230	700.00	233.33	70.00	0.29	0.200620	0.07	2.952	
7500	246	750.00	250.00	75.00	0.27	0.189890	0.07	2.78*	
8000	262	800.00	266.67	80.00	0.26	0.178940	0.06	2.256	
8500	279	850.00	283.33	85.00	0.24	0.167898	0.06	2.118	
9000	295	900.00	300.00	90.00	0.23	0.156890	0.06	1.978	
10000	325	1000.00	333.33	100.00	0.21	0.145760	0.05	1.533	
10500	344	1050.00	350.00	105.00	0.20	0.134890	0.05	0.85372	
11000	361	1100.00	366.67	110.00	0.19	0.123570	0.05	0.65372	
12000	384	1200.00	400.00	120.00	0.17	0.112463	0.04	1.298	
13000	427	1300.00	433.33	130.00	0.16	0.112463	0.04	0.948	
14000	459	1400.00	466.67	140.00	0.15	0.101240	0.04	0.852	
15000	482	1500.00	500.00	150.00	0.14	0.260030	0.03	0.588	
16000	525	1600.00	533.33	160.00	0.13	0.260030	0.03	0.568	
17000	558	1700.00	566.67	170.00	0.12	0.278810	0.03	0.33920	
18000	591	1800.00	600.00	180.00	0.11	0.278810	0.03	0.487	
19000	623	1900.00	633.33	190.00	0.11	0.278810	0.03	0.487	
20000	656	2000.00	666.67	200.00	0.10	0.267590	0.03	0.429	
22000	727	2200.00	700.00	210.00	0.10	0.267590	0.02	0.284	
23000	755	2300.00	766.67	230.00	0.09	0.067590	0.02	0.264	
					0.09	0.056372	0.02	0.237	

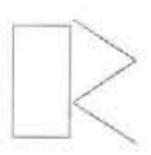
extrapolation  
 enter high x 0.05  
 enter low x 0  
 enter high f(x) 0.056372  
 enter low f(x) 0  
 enter x 0.02  
 x = 0.022548







**Legend**



**Point of Compliance Building**



**Point of Compliance**

**Federal Prison Camp  
(Federal Bureau of Prisons)**

**Big Creek Animal Hospital**

**Naval Hospital**

**Residence**

**Base Housing**

**Shelby Co  
Fire Station**

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**NSA Mid-South  
Millington,  
Tennessee**

**Figure 3  
Vicinity Map &  
Point of Compliance**

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