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NWS YORKTOWN
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FINAL SITE CHARACTERIZATION REPORT AT BUILDING 1958 NWS YORKTOWN VA
2/2/1993
ROY F. WESTON

FINAL

SITE CHARACTERIZATION REPORT
AT BUILDING 1958

NAVAL WEAPONS STATION
YORKTOWN, VIRGINIA

CONTRACT TASK ORDER 0143

Prepared For:

NAVAL FACILITIES
ENGINEERING COMMAND
ATLANTIC DIVISION
NORFOLK, VIRGINIA

Under:

Contract N62470-89-D-4814

Prepared By:

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Virginia Beach, Virginia

Under the Direction of:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

2 FEBRUARY 1993

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Based on investigation results and regulatory requirements, remediation of the free-phase hydrocarbons in the vicinity of Building 1958 is recommended. The installation of an interceptor trench and/or a large-diameter recovery well with a product recovery system are applicable options for free product recovery. As part of the remediation process, excavated soils would be transported for thermal reclamation. As a preventative measure for soil contaminant leaching, soil stabilization utilizing an asphalt patch over the soil contaminated area is also an applicable option.

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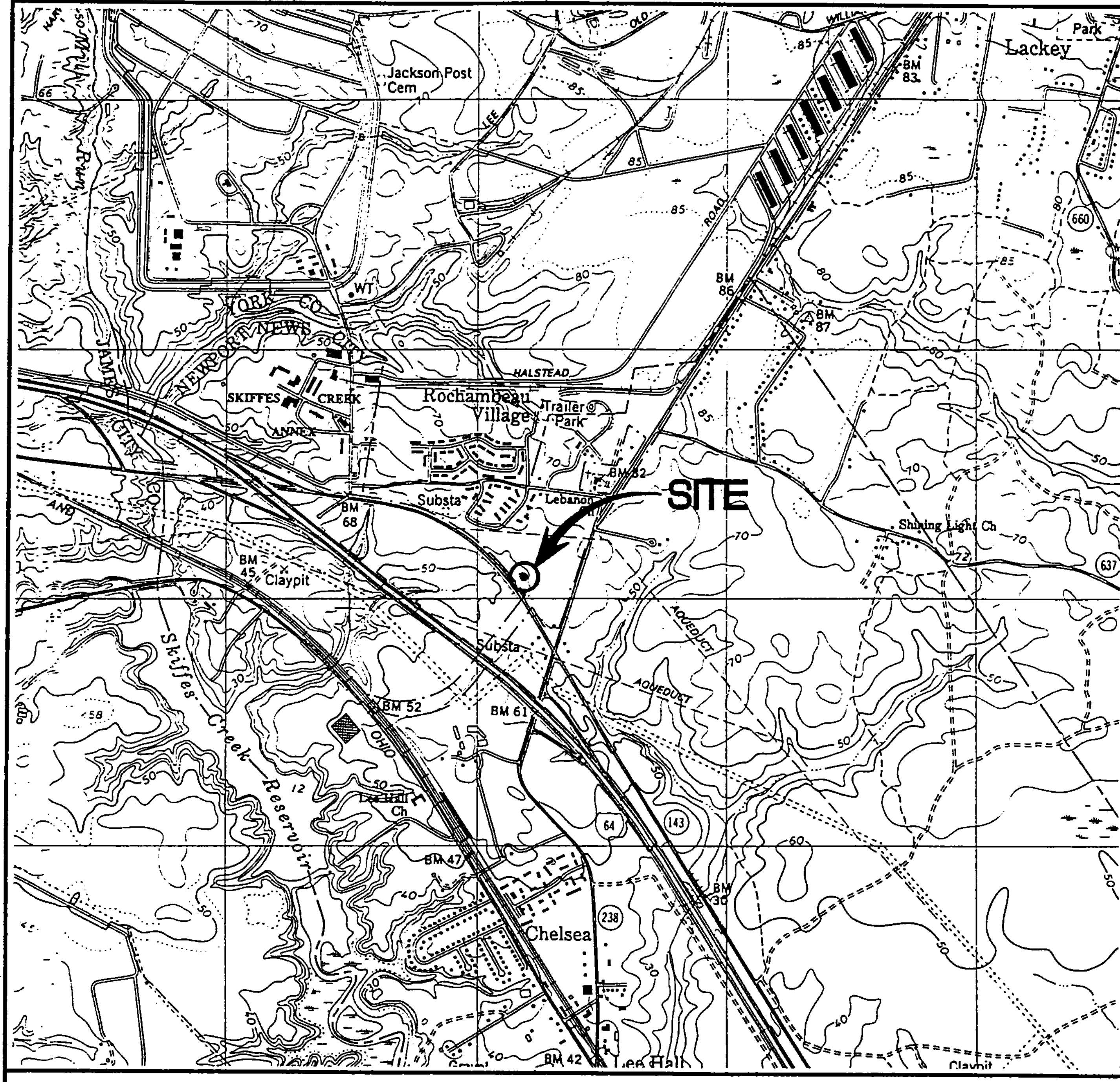

1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

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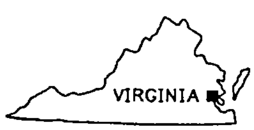

QUADRANGLE LOCATION

SOURCE: YORKTOWN, VA
7.5' QUADRANGLE
37076-B5-TF-024
1984

PROJECT TITLE: SITE CHARACTERIZATION REPORT EMERGENCY FUEL GENERATOR - BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA	CLIENT DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND NORFOLK, VIRGINIA
DWG. TITLE REGIONAL SITE LOCATION MAP	FIGURE NO. 1-1

WESTON

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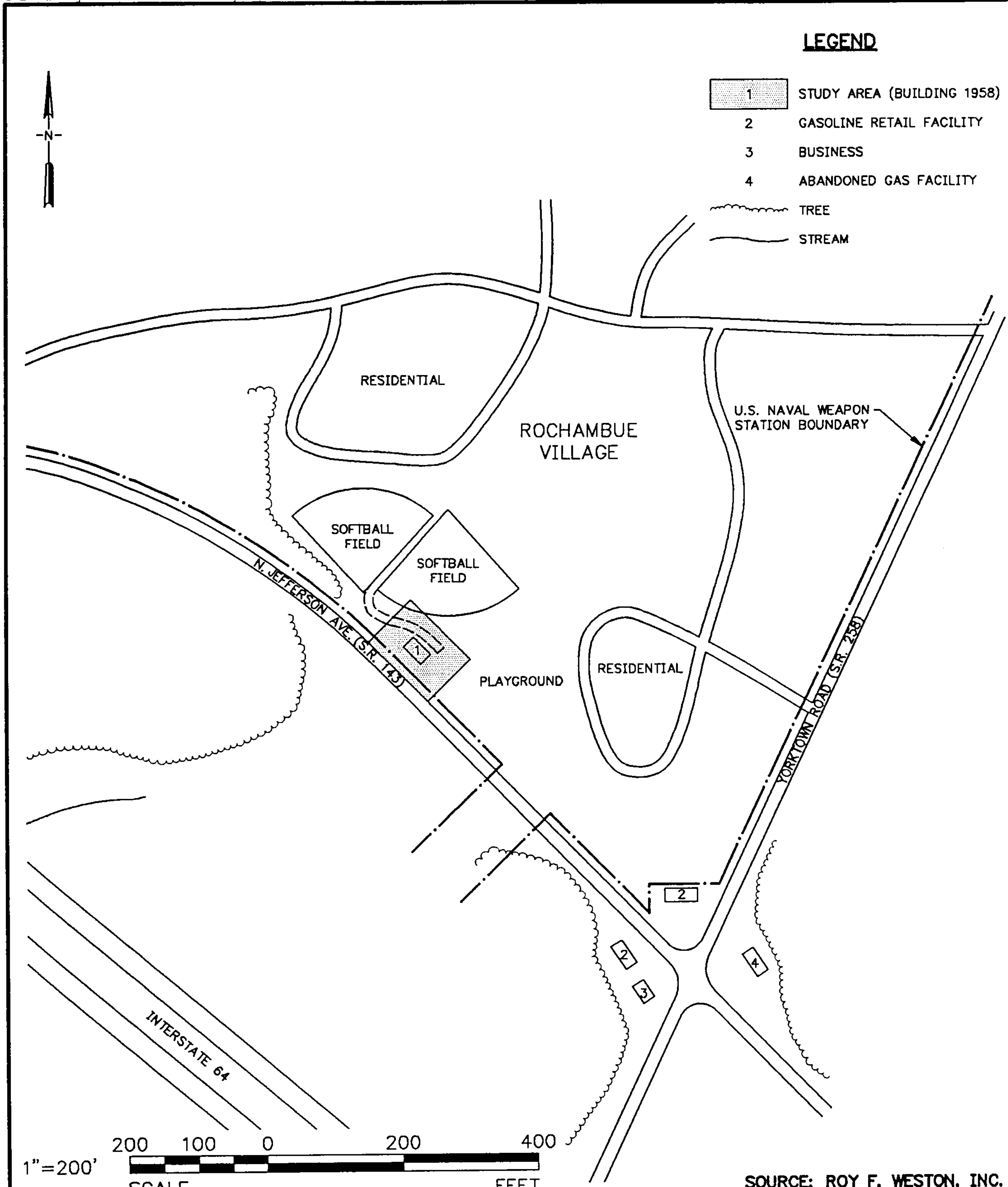

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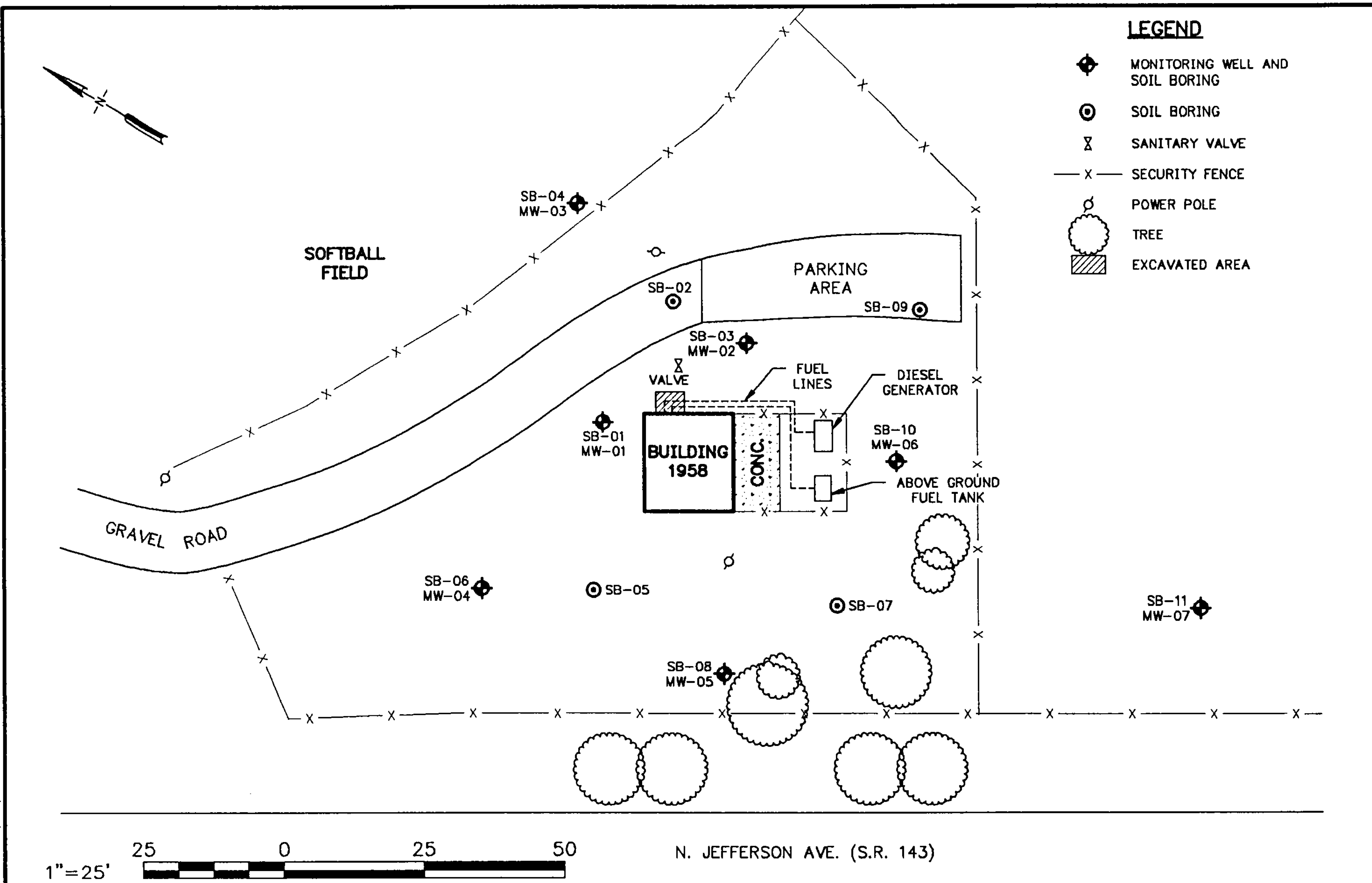
DWG. TITLE AREA MAP	FIGURE NO. 1–2	



SOURCE: ROY F. WESTON, INC.

PROJECT TITLE: SITE CHARACTERIZATION REPORT EMERGENCY FUEL GENERATOR – BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA	CLIENT: DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND NORFOLK, VIRGINIA	WESTON
DWG. TITLE: SITE MAP	FIGURE NO. 1–3	

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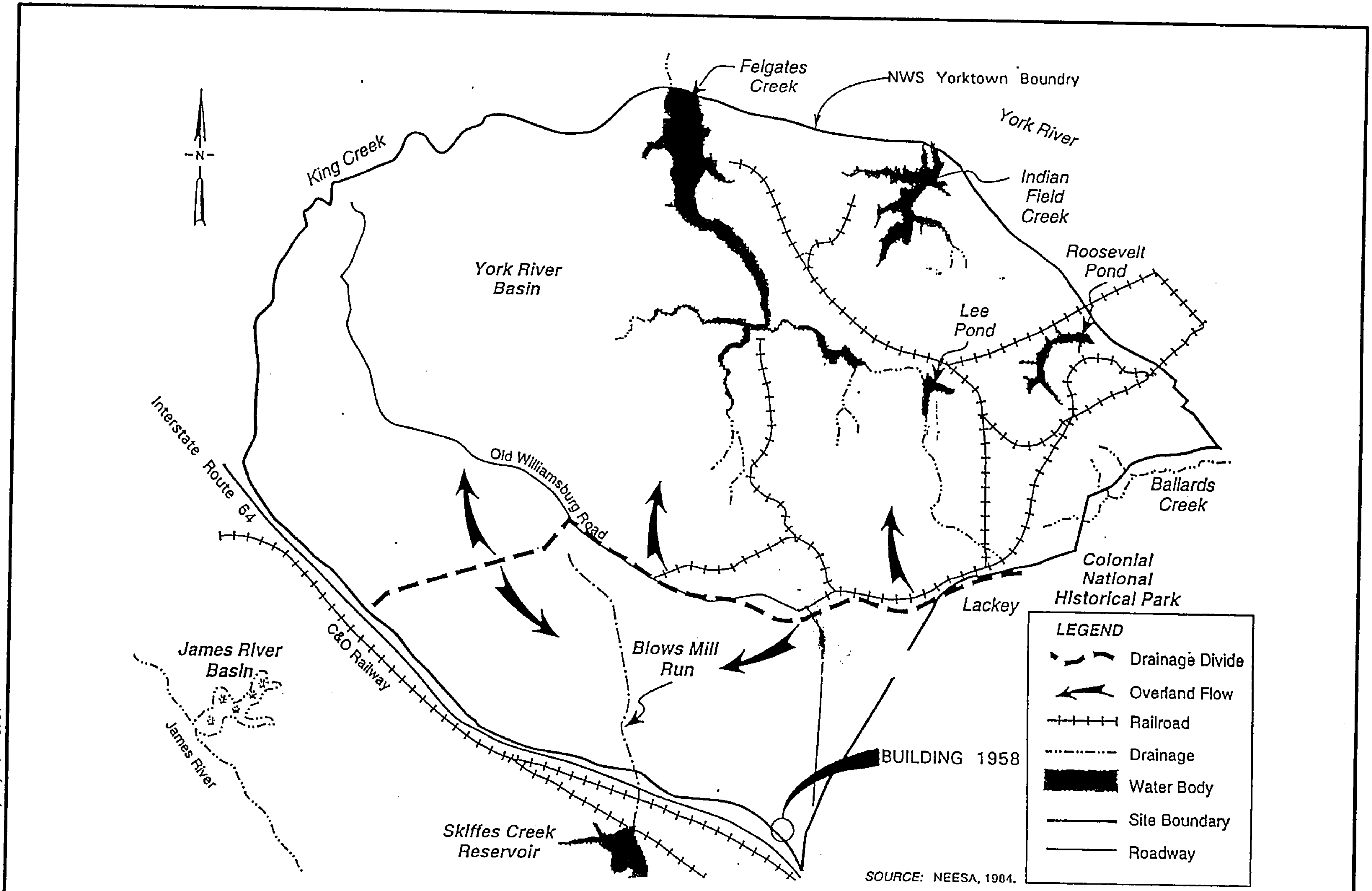
The upper artesian aquifer underlies the water table aquifer and consists of the Calvert, Chickahominy, and Nanjemoy Formations. The bluish clayey St. Mary's Formation, which is approximately 100 feet thick, functions as an aquitard between the upper artesian aquifer and the water table aquifer. The upper artesian aquifer is generally 50 to 80 feet thick and consists of medium-grained sand, moderately to poorly sorted with glauconite, usually called green sand or black sand. The depth to the upper artesian aquifer is approximately 250 feet below mean seal level (MSL) in the vicinity of NWS Yorktown. The aquifer is a reliable source of domestic water supply. Much of the recharge to the aquifer is probably derived from silts and clays of the St. Mary's Formation. Specific capacities of wells completed in this system range from 1 to 10 gallon/minute/foot (gpm/ft) (Johnson, 1972).

The principal artesian aquifer (the deepest of the three aquifers) consists of deposits of the Mattaponi (lower) and Potomac Group Formations of the Lower Cretaceous Series and several discontinuous sand bodies interbedded with silt and clay. The top of the aquifer is approximately 450 feet below MSL in the vicinity of NWS Yorktown. Recharge to the aquifer occurs through the outcrop in Henrico, Hanover, and western King William Counties. However, substantial recharge also occurs east of these areas from vertical leakage between the adjacent aquifers through the confining layers; it has been estimated at 30,500 gallons/day/square mile (gpd/mi^2) of area. Transmissivities in the central an eastern parts of the aquifer (including NWS Yorktown) vary from 15,000 to 50,000 gallons/day/foot (gpd/ft). Flow direction is generally eastward toward the Chesapeake Bay (Hamilton et al., 1983). The most extensive development of the aquifer has occurred in the Richmond metropolitan area, near West Point, Virginia, and in Franklin, Virginia. Dissolved solids in the water increase with depth in an easterly direction and result in limited use of the aquifer east of Williamsburg, where total dissolved solids range from 1,500 to 9,000 parts per million (ppm) and chlorides may exceed 1,000 ppm (Johnson, 1972). The deep aquifer is unusable as a potable water source at NWS Yorktown because of its naturally poor quality (high hardness, elevated amounts of both total dissolved solids and fluorides).

1.2.3.2 <u>Surface Water</u>

NWS Yorktown is situated within two major drainage basins, the York River Basin to the north and the James River Basin to the south (see Figure 1-4). Approximately 80% of the station lies in the York River Basin. This basin, in the central and eastern sections of Virginia, is located between the Rappahannock River Basin to the north and the James River Basin to the south. The headwaters rise in Orange County and flow approximately 120 miles in a southeasterly direction to the Chesapeake Bay. At NWS Yorktown, the basin is approximately 5 miles wide.

The main tributaries of the York River at NWS Yorktown are King Creek on the northwestern boundary of the station, Ballards Creek on the eastern boundary of the station, and Felgates and Indian Field Creeks in the northeastern region of the station (see Figure 1-4). Felgates Creek, which traverses the north-central section of NWS Yorktown, is the main drainage feature of the station.



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DWG. TITLE: SURFACE DRAINAGE MAP	FIGURE NO. 1–4	

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Extensive wetlands are found along the creeks that drain the station and also along some shoreline areas of the York River. The tidal reaches of the York River extend across much of NWS Yorktown. The tributary creeks draining NWS Yorktown are also tidal up to 1 mile inland from the riverbank. The tidal reaches of the York River, including in the vicinity of NWS Yorktown, are classified as shellfish waters.

The southernmost portion of NWS Yorktown, located south of the York County/James City County boundary and Old Williamsburg Road, is situated in the James River Basin. Blows Mill Run, the main drainage feature in this area, discharges off-station into Skiffes Creek Reservoir, which drains southward through Skiffes Creek to the James River. The Skiffes Creek Reservoir is one of the water impoundments of the City of Newport News that provides potable water supplies to NWS Yorktown. Building 1958, located in the extreme southern portion of NWS Yorktown, is located within the James River Basin (see Figure 1-4). Stormwater in the vicinity of Building 1958 is directed by gravity drains from the north to the south towards Highway 143, is then routed to the east, eventually outfalling into the Skiffs Creek Reservoir. Building 1958 is about 600 feet upgradient from a stream that drains into Skiffs Creek Reservoir and about 3,000 feet upgradient of Skiffes Creek Reservoir.

1.2.3.3 Floodplain

Building 1958 is located approximately 2.6 miles east-northeast of the James River. At the closest point of the James River to the study area, the river is at an elevation of approximately 5 feet above MSL. In this location, the 100-year high water mark is approximately 10 feet above MSL. The 100-year high water mark approximates the maximum lateral extent of the James River floodplain. Building 1958 is approximately 60 feet above MSL. Thus, based on location and elevation, the study area is not located within the James River or any other floodplain.

1.2.4 Climate

The climate of the Virginia Peninsula is moderate continental with mild winters and long, warm summers. The average monthly temperatures in the area range from 40°F in January to 78.4°F in July. Precipitation is well distributed throughout the year, with the heaviest rains occurring in July and August. The average annual precipitation is 45.22 inches.

1.2.5 Local Land Use

Land use in the study area is considered to be mixed residential (see Figure 1-2). The site is bordered on the north and east by recreational softball fields and further to the north and east by base residential housing. The site is cornered to the west and south by Highway 143 and a large corn field on the opposite side of Highway 143.

1.2.6 Well Survey

Four water supply wells at NWS Yorktown were completed in the principal artesian aquifer at depths of 445, 470, 480, and 538 feet bgs. They are located at Buildings 120, 352, 304, and 28, respectively. The rated capacity of two of the wells is reportedly 300 gallons per minute (gpm). The wells were originally intended as emergency sources of potable water supplies if the off-station supplies were inadequate (C.C. Johnson, 1972)); however, based on water quality analysis, water from the wells was not certified as potable by the Virginia State Health Department due to high hardness and elevated amounts of both total dissolved solids and fluorides. This resulted in the abandonment of three of the wells (in Buildings 120, 352, and 304) and the continued use of the fourth (in Building 28) for boiler feed and processing water supplies (C.C. Johnson, 1972). This well is located approximately 2 miles north-northeast of the study area within the groundwater flow regime of the York River Basin.

Several additional wells were identified within 1 mile of Building 1958 using SWCB records. Figure 1-5 illustrates the locations of these wells. Well 216-9 is an in use water supply well completed in the water table aquifer with an estimated yield of about 35 gpm. Wells 216-18 through -23 are a series of 6 nested observation wells completed at varying depths from 60 (216-18) to about 1,500 feet (216-23). These wells are being used by state and federal agencies to monitor groundwater quality in the area.

1.3 INVESTIGATIVE METHODS

Field activities by WESTON personnel were conducted from 10 August 1992 through 1 September 1992. These activities included soil borings, monitoring well installation, and aquifer testing.

1.3.1 Soil Boring Activities

Eleven borings were advanced in the vicinity of Building 1958 located at NWS Yorktown, as shown in Figure 1-3. The boreholes were advanced using 4.25-inch (inner diameter) hollow-stem augers. Each boring was advanced to a depth ranging between 14 to 22 feet bgs. Soil cuttings obtained during drilling activities were placed on polyethylene and subsequently moved to an open-top dumpster for disposal by Envirotech Mid-Atlantic, Inc.

Split-spoon samples were collected at continuous 2-foot intervals in the initial boring. In all other soil borings, soil samples were collected via split-spoon at 5-foot intervals or intervals designated by the site geologist based on geologic variability and field screening for organic hydrocarbon concentrations. All soil samples were visually classified by the site geologist and recorded in a field log. The classification included characterization of soil type, color, moisture content, relative density (blow counts), plasticity, grain size, and other pertinent information

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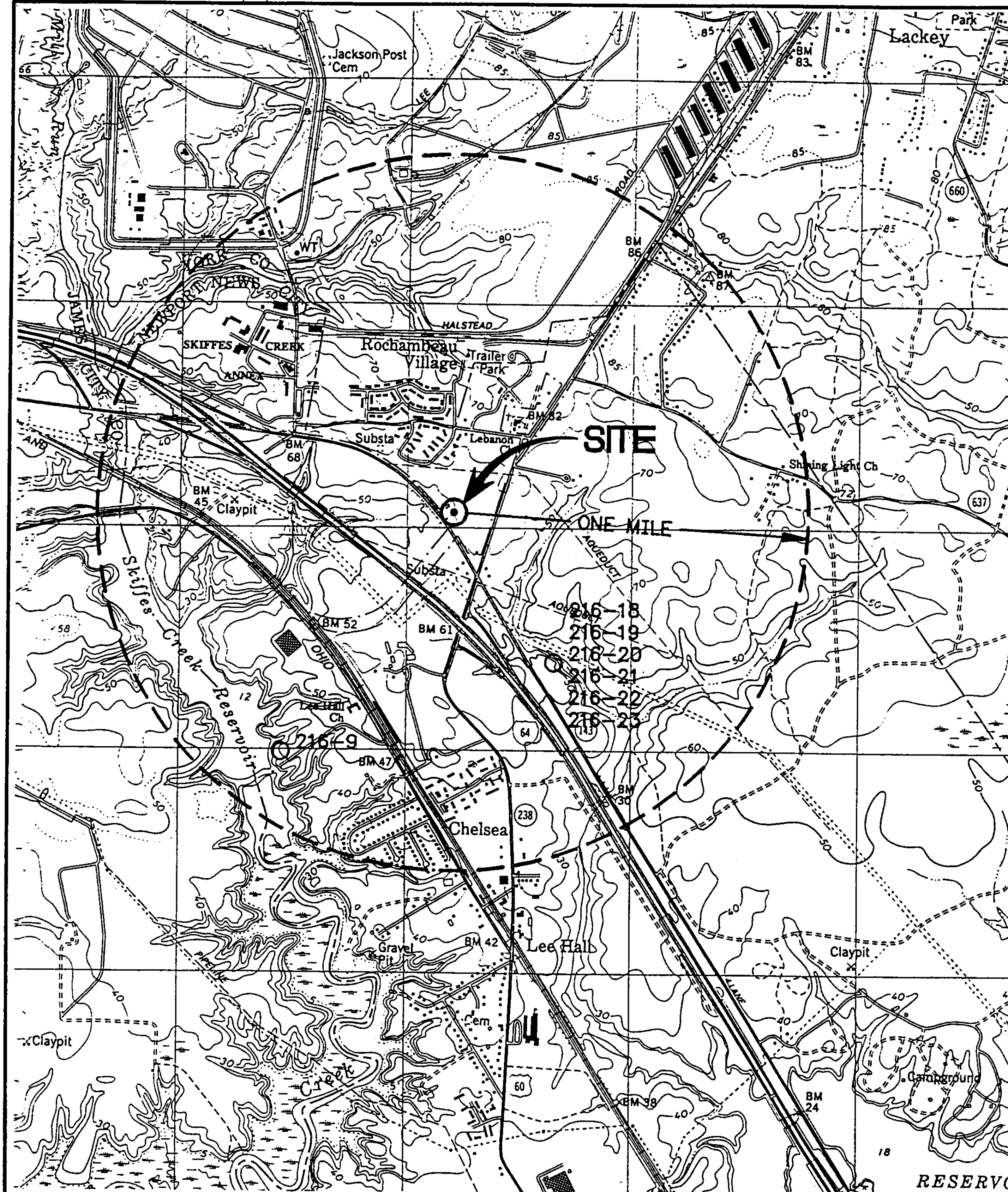

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DWG. TITLE WELL LOCATION MAP	FIGURE NO. 1-5	

such as petroleum odors. Standard penetration tests (SPT) were conducted following ASTM D-1586 Guidelines. Copies of the boring records are provided in Appendix C.

In addition to soil classification, each soil sample was screened with an HNU photoionization detector (PID) to check for the presence of total volatile organic vapors. The measurements were used to assist in determining the locations of soil samples and groundwater monitoring wells.

Drilling equipment, including hollow-stem augers, drill rods, and split-spoon samplers, were decontaminated to minimize the potential for cross-contamination between boring locations. The hollow-stem augers and drill rods were decontaminated using high-pressure steam. Split-spoon samplers were decontaminated between samples by washing in a nonphosphate soap solution and rinsing in distilled water. Decontamination fluids were contained within a temporary decontamination pad/area located at the scrap metal area at NWS Yorktown. The scrap metal area was selected due to the secure nature of the area and its potable water source. These fluids were transferred into 55-gallon steel drums, labeled, and stored at the scrap metal area prior to collection and disposal by C&M Distributors, Inc.

1.3.2 Soil Sampling and Analysis

Two soil samples were collected from each boring and submitted for chemical analysis. Each of the selected soil samples as well as two duplicate soil samples were analyzed for total petroleum hydrocarbons (TPH). In addition, two soil samples were collected from separate borings and submitted for several additional analyses including 8 metals by toxicity characteristic leachate procedure (TCLP), flash point, grain size, and benzene, toluene, ethylbenzene, xylenes (BTEX).

The samples were collected via 1.5-inch-diameter split-spoons, as discussed in Subsection 1.3.1. Each soil sample collected for chemical analyses was transferred into a laboratory-prepared bottle, properly labeled, and placed in an ice chest cooled to approximately 4°C. The samples were transported to T.C. Analytics, Inc. in Norfolk, Virginia, for analysis. The samples were analyzed for TPH (EPA SW846, modified method 8015), 8 TCLP metals (EPA SW846), Flash point (EPA SW846, method 1010), grain size (EPA SW846), and BTEX (EPA SW846, method 8020). Appropriate chain-of-custody documentation accompanied the samples to the laboratory.

1.3.3 Monitoring Well Installation

Shallow groundwater monitoring wells were constructed in 7 of the 11 soil borings. The locations of these wells are shown in Figure 1-3. Monitoring well locations were selected to assess relative contaminant concentrations and to establish outer limits for free product and dissolved phase contaminant plumes. In addition, the monitoring wells provided information on the groundwater flow patterns in the area. The depths of the monitoring wells ranged between 14 and 18 feet bgs. Table 1-2 provides a summary of well construction details.

Prior to well construction, boreholes were reamed using a 4.25-inch (inner diameter) hollow-stem auger to the selected depth for screen placement. Due to the dense nature of the soils, wells were constructed immediately after the augers were extracted from the ground. The monitoring wells were constructed of 2-inch nominal diameter, schedule 40, flush-joint and threaded polyvinyl chloride (PVC) casing, with a 10-foot long 0.010-inch slotted screen. A coarse-grain (No. 2 filter sand) sand pack extending 2 feet above the top of the screen was placed in the annulus between the screen and the borehole wall. A 1-foot bentonite pellet seal was constructed above the sand pack and hydrated with potable water. The remaining annular space was backfilled with a cement/bentonite mixture to ground surface. A flush-to-grade manhole cover and PVC locking cap were fitted at the top of 143-SB-03 (MW-02) and 143-SB-04 (MW-03). The remaining wells were stick-up mounts for non-traffic areas. The monitoring well construction design for non-traffic areas (typical for this site) is illustrated in Figure 1-6. Well construction diagrams for the monitoring wells are presented in Appendix D.

Following the construction activities, each monitoring well was developed until the groundwater was essentially sediment-free. The wells were developed by pumping using a diaphragm pump. Approximately 35 gallons (about 22 well volumes) of water was removed from each well. The water recovered from each well was containerized in 55-gallon steel drums, labeled, and stored at the scrap metal area on base. Monitoring well 143-SB-03 (MW-02) contained measurable free product (approximately 0.31 feet).

1.3.4 Well Elevation Survey and Fluid Level Measurements

Each of the newly installed monitoring wells were surveyed by the firm of Hoggard-Eure Associates, of Norfolk, Virginia on 25 August 1992. A temporary benchmark was set with a railroad spike on a power pole located adjacent to Building 1958. The benchmark was set relative to MSL. The top of well casings and ground surface elevations were measured for each well location to the nearest 0.01-foot relative to MSL. This type of survey facilitates the determination of the groundwater flow direction after the wells have been gauged. The well elevation survey is presented in Appendix E. The top of casing and ground surface elevations for each monitor well are also summarized in Table 1-2.

TABLE 1-2

SUMMARY OF WELL CONSTRUCTION DETAILS

Well No.	Date Installed	Top of Casing Elevation (feet, above MSL)	Ground Surface Elevation (feet, above MSL)	Boring Depth (feet bgs)	Well Depth (feet bgs)	Screen Interval Depth (feet bgs)	Depth to Sandpack (feet bgs)	Depth to Bentonite (feet bgs)
SB-01 (MW-01)	11 AUGUST 92	62.14	59.20	22.0	15.7	15-5.0	3.0	2.0
SB-03 (MW-02)	12 AUGUST 92	59.29	59.0	22.0	15.5	15-5.0	3.0	2.0
SB-04 (MW-03)	12 AUGUST 92	60.84	60.90	17.0	15.1	15-5.0	3.0	2.0
SB-06 (MW-04)	13 AUGUST 92	61.71	58.80	17.0	15.1	15-5.0	3.0	2.0
SB-08 (MW-05)	17 AUGUST 92	62.39	58.70	15.0	14.5	14-4.0	2.0	1.0
SB-10 (MW-06)	18 AUGUST 92	62.64	59.70	16.0	15.2	15-5.0	3.0	2.0
SB-11 (MW-07)	18 AUGUST 92	61.15	58.0	15.0	15.1	15-5.0	3.0	2.0

MSL - Mean sea level.
bgs - Below ground surface.

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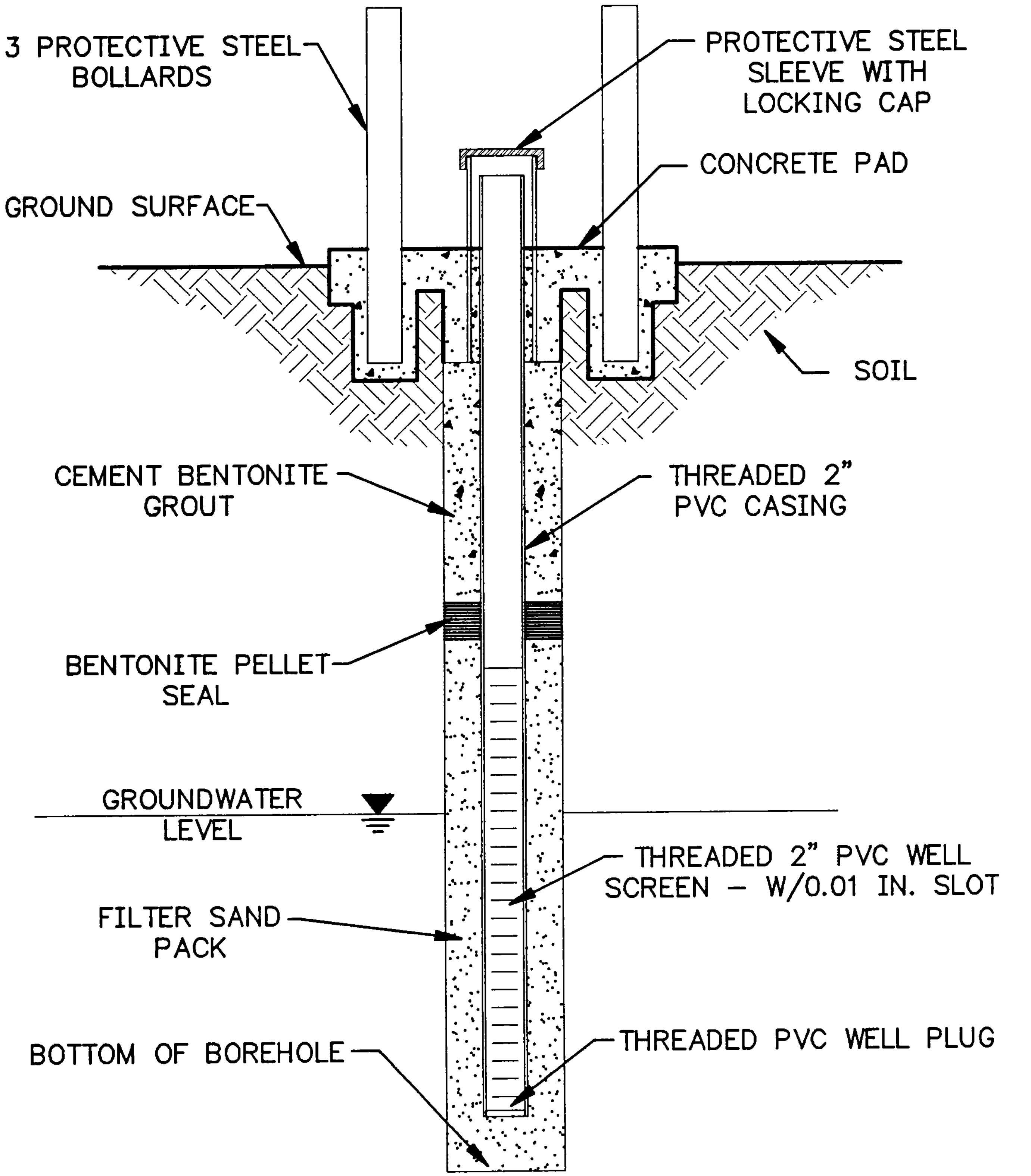

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SOURCE: ROY F. WESTON, INC.

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DWG. TITLE TYPICAL MONITORING WELL CONSTRUCTION	FIGURE NO. 1-6	

Fluid level measurements for each well were taken periodically during the field investigation. The depth to water was measured using an oil/water interface probe capable of detecting product layers as thin as 0.01 foot. Depths were measured to the nearest 0.01-foot. The interface probe was decontaminated between readings by washing with a non-phosphate soap solution and rinsing with distilled water. The fluid level measurements are provided in Appendix F and discussed in Section 1.4.2.

1.3.5 Groundwater Sampling and Analyses

Groundwater samples were collected from 6 of the 7 monitoring wells on 24 August 1992. Monitoring well MW-02 was not sampled due to the presence of free-phase hydrocarbons. The groundwater samples were analyzed for purgable aromatics (EPA 600, method 602), TPH (EPA 600, method 418.1), and total lead (EPA 600, method 239.2). Additionally, one duplicate groundwater sample was collected (for QA/QC purposes) and analyzed for purgable aromatics, TPH, and total lead. While disposable bailers were used in the sampling process, a rinsate sample was also taken as an additional QA/QC confirmation step and analyzed for all parameters indicated above.

The disposable polyethylene bailers were used to purge a minimum 3 well volumes prior to sampling the monitoring wells. Purge water was containerized in 55-gallon steel drums, labeled, and stored at the scrap metal area. Water characteristics such as turbidity, color, odor, amount bailed, and the presence/absence of free-phase hydrocarbons were recorded in the site log. Groundwater samples were then collected from the wells using the disposable polyethylene bailers. The samples were transferred into laboratory-prepared sample containers and placed in an ice chest cooled with ice to approximately 4°C. Groundwater samples were collected by slowly pouring water from the bailer into the appropriate sample container to minimize volatilization. The samples were sent to T.C. Analytics, Inc. in Norfolk, Virginia, for analysis. Appropriate chain-of-custody documentation and a trip blank sample accompanied the samples to the laboratory.

1.3.6 Hydraulic Conductivity Tests

Hydraulic conductivity tests (also commonly referred to as slug tests) were conducted in 2 monitoring wells. The tests were performed by rapidly inserting an object of known volume (slug) within a monitoring well and allowing the groundwater level in the well to re-equilibrate to its former static level prior to removing the submersed slug. The slug displaces a volume of groundwater within the monitoring well resulting in a rise and fall of the groundwater level that is measured with respect to time. The slug insertion portion of the test is also referred to as a falling-head conductivity test; slug removal is referred to as a rising-head conductivity test.

Monitoring wells at the site where the hydraulic conductivity tests were performed were designed to monitor for floating product and constructed to take into account the natural rise and fall in depth to groundwater. As such, the entire length of the screen has the potential to not be completely located within the saturated portion of the aquifer. Where a portion of the screened interval is located in the vadose zone, a falling-head test is not an appropriate method for estimating the hydraulic conductivity since it is based on an evaluation of the saturated portion of the aquifer. Therefore, while both rising and falling-head tests were performed, to avoid any false hydraulic conductivity values, only rising- head (slug removal) test data were used for estimating the site-specific aquifer characteristics.

For the hydraulic conductivity tests performed at monitoring wells, a solid Teflon® slug, 5 feet in length and 1.5 inches in diameter was used. The change in groundwater levels observed during the test was measured using an electric pressure transducer and recorded with an In Situ® SE1000C Environmental Data Logger. The slug and pressure transducer were cleaned between wells using non-phosphate soap solution and were rinsed with distilled water. The test data were evaluated and hydraulic conductivity was calculated for confined and unconfined conditions by means of a computer program using the Bouwer and Rice (1976) equation for a partially penetrated unconfined aquifer and the Cooper et al. (1967) equation for confined conditions. The field data and program output are presented in Appendix G.

1.4 INVESTIGATION RESULTS

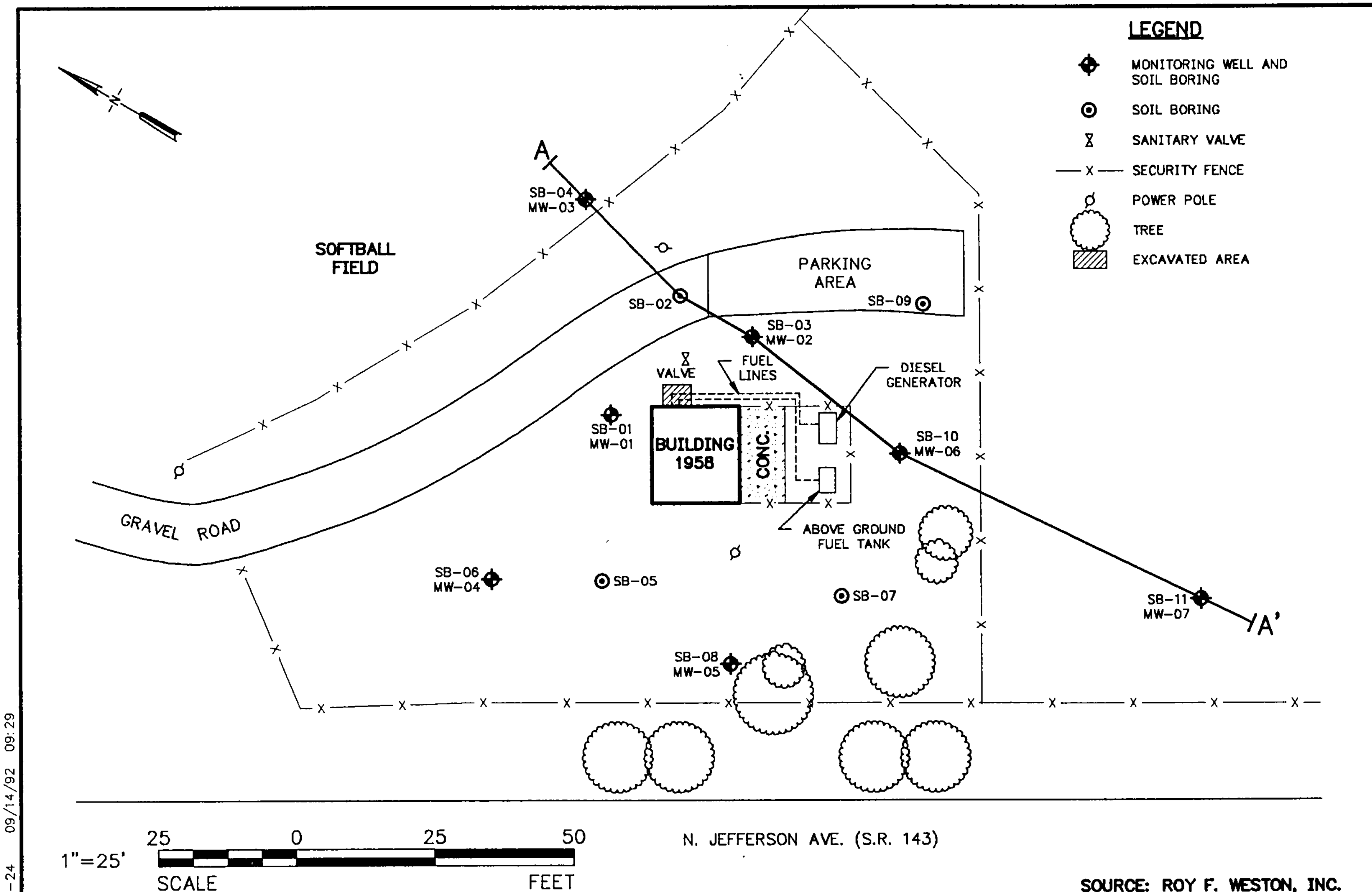
This section presents the results of the site assessment activities. Site subsurface conditions are discussed and are followed by a description of the nature and extent of petroleum hydrocarbon contamination as indicated by the available analytical data.

1.4.1 Site Soils and Geology

Soil samples were obtained from each of the 11 borings to characterize subsurface soil conditions. In general, the Building 1958 area is underlain by 6 to 10 feet of a yellow to gray fine-grained sandy clay, followed by layers of dense sandy clays. The remaining strata are various colors of sandy/silty clays. A layer with broken shell fragments was encountered at 22 feet in SB-01. Copies of the boring logs describing the soils encountered are provided in Appendix C.

The surficial geologic unit in the study area is the Pliestocene Age Windsor Formation. The Windsor in this area is a fining upward sequence of silty and sandy clays that are interbedded with stiff clay lenses and small, medium-grained sand lenses. The thickness of the Windsor ranges from 0 to 40 feet. In one soil boring (SB-01), the sandy clays grade into a shelly sandy silt characteristic of the Yorktown Formation. Together, the Windsor and Yorktown Formations form the uppermost water table aquifer.

A geologic cross section has been prepared using the soil boring logs for SB-04, SB-02, SB-03, SB-10, SB-11, and the well elevation survey (Figure 1-7). Cross section A-A′ is illustrated in Figure 1-8 and shows an overview of



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SITE CHARACTERIZATION REPORT EMERGENCY FUEL GENERATOR – BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA	DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND NORFOLK, VIRGINIA	WESTON
DWG. TITLE: GEOLOGIC CROSS SECTION LOCATION	FIGURE NO. 1-7	

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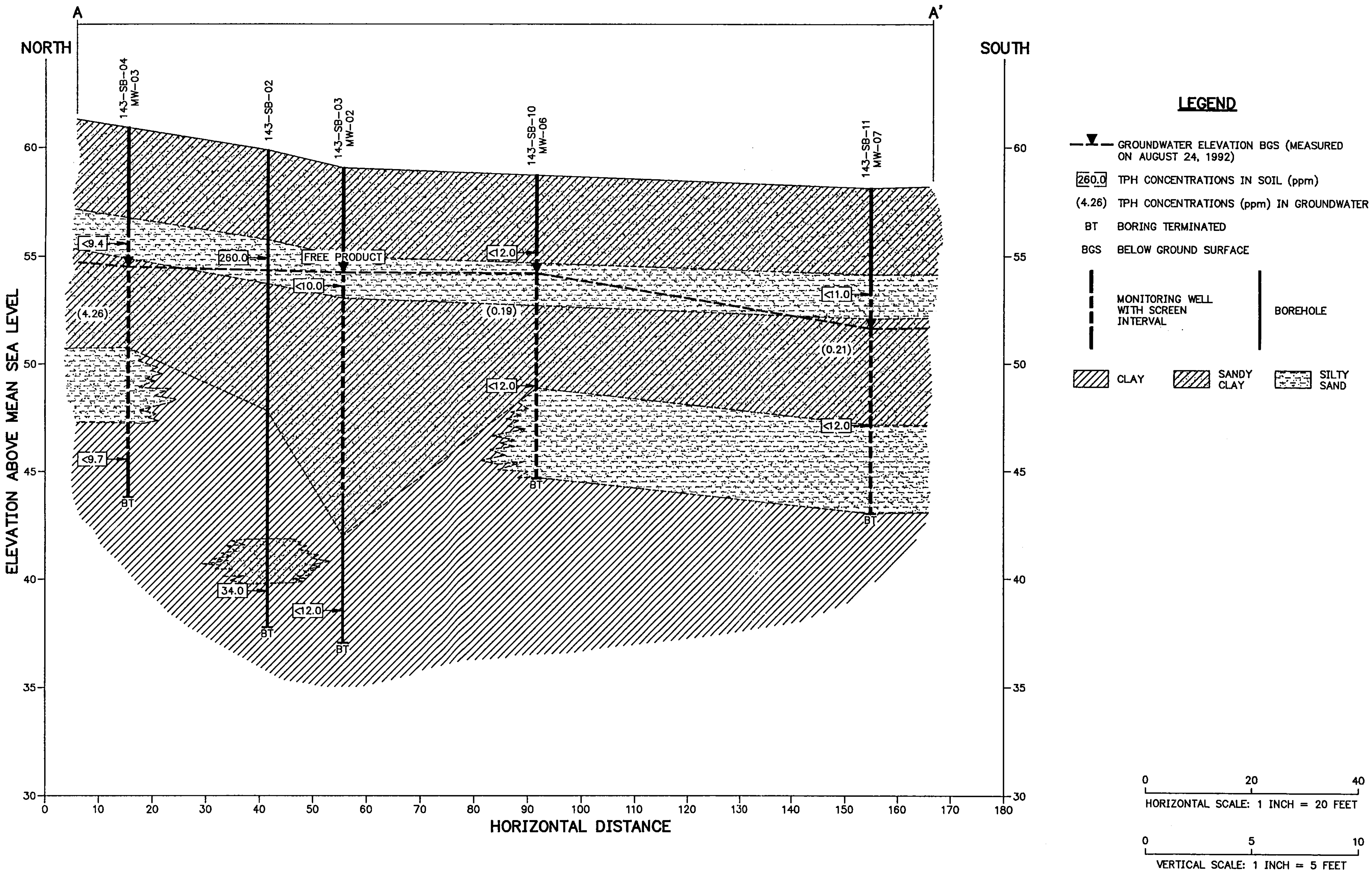

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WESTON MANAGERS DESIGNERS/CONSULTANTS

CLIENT
DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
NORFOLK, VIRGINIA

PROJECT TITLE
SITE CHARACTERIZATION REPORT
EMERGENCY FUEL GENERATOR – BUILDING 1958
NAVAL WEPONS STATION
YORKTOWN, VIRGINIA

DWG TITLE
SITE GEOLOGIC CROSS SECTION A–A'

DWG. NO.
FIGURE 1–8

SHEET OF

the site geology (Figure 1-8). A sandy clay with a 2 foot thick silty sand layer was observed throughout the site. The sandy clay overlays a discontinuous silty sand and illustrates the heterogeneity of the subsurface stratigraphy. A clay layer was observed throughout the area at a depth ranging from 11 to 18 feet bgs.

1.4.2 Site Hydrogeology

The appearance of saturated soils were not encountered during soil boring activities until depths ranging from 15 to 20 feet bgs. After the monitoring wells were constructed, groundwater rose in the wells to a level of approximately 2 to 8 feet bgs.

The hydrogeologic characteristics of the water table aquifer are coincident with surface topography. Since topographic relief across the site is slight, surface water not intercepted by storm drains or ditches would flow south to southwest, and would follow surface topography. The clay layers allow slow vertical movement of groundwater and may act as a confining layer. Most of the groundwater in the study area migrates laterally towards natural and developed discharge areas through the surficial aquifer.

Groundwater levels in the wells installed at the site were measured periodically during field activities (see Appendix F). While all fluid level measurements show a similar potentiometric surface, the 24 August 1992 data appear most representative of subsurface conditions. Groundwater levels varied from between 2 and 11 feet bgs during field activities and is likely to be related to the unseasonably high quantities of rain during August 1992 (about 13 inches of rain).

Depth to groundwater at the site on 24 August 1992 ranged between approximately 4.3 and 6.7 feet bgs. Table 1-3 summarizes fluid level measurements and elevations on 24 August 1992. Based on the 24 August 1992 groundwater elevation data, groundwater appears to be flowing across the site in both westerly and southerly directions (see Figure 1-9). As illustrated in Figure 1-9, a potentiometric surface high is located beneath Building 1958 and is in effect acting as a groundwater divide. This water table mounding effect may be due to fluid leakage from the lift station sump area (see concrete pad, Figure 1-3).

1.4.2.1 Aquifer Testing

Site-specific aquifer characteristics were determined by evaluating the rising-head test data from the 1 September 1992 slug tests in monitoring wells MW-04 and MW-06. The field data (Appendix G) were evaluated using both the Bower and Rice (1976) equation for a partially penetrated unconfined aquifer and the Cooper et al. (1967) equation for confined aquifers. The computer program output is also included in Appendix G. Based on the present site conditions, assumptions for both tests, and (Fetter, 1980) test results, it was determined that the

TABLE 1-3

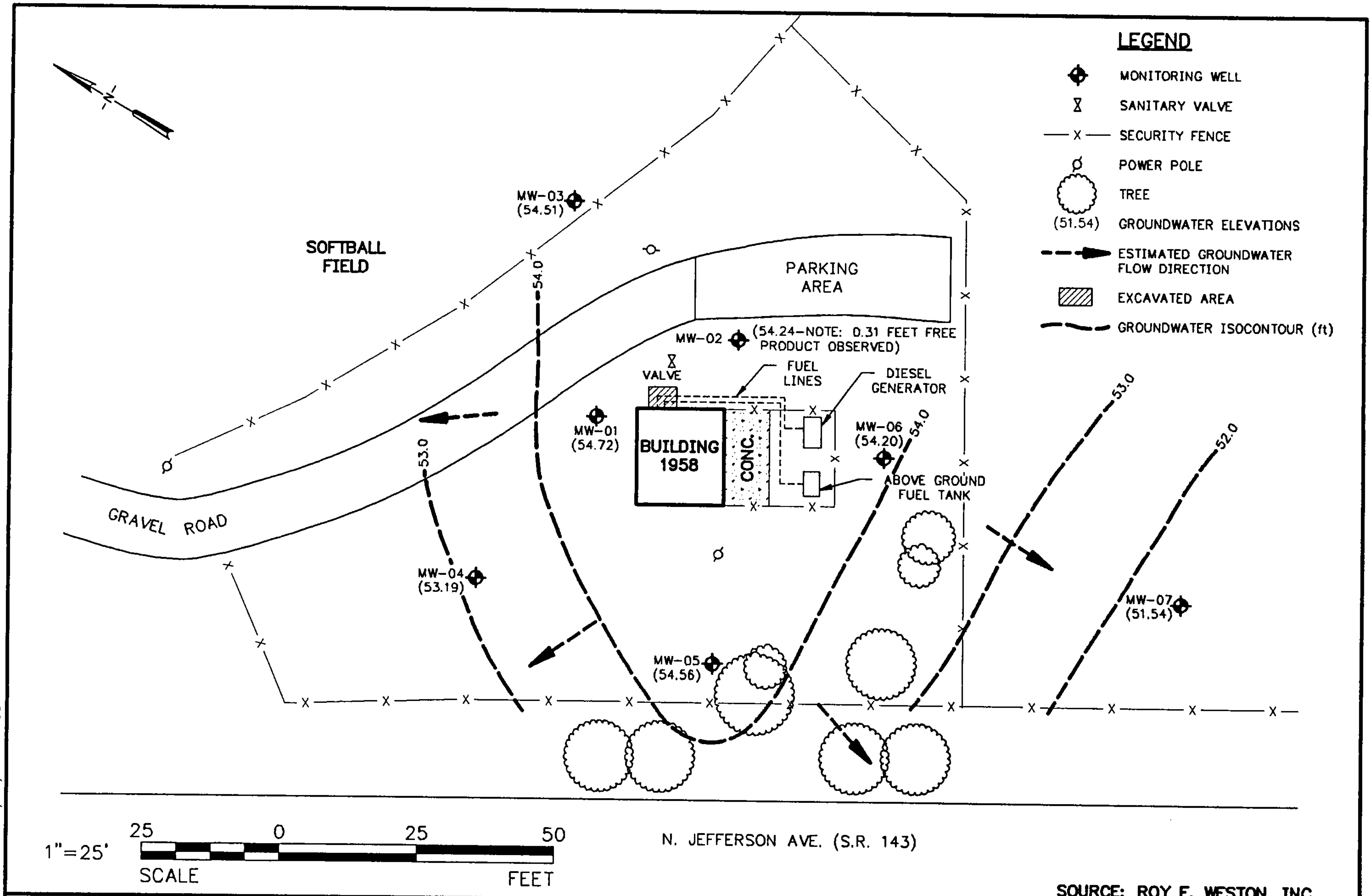
FLUID LEVEL MEASUREMENTS
BUILDING 1958

24 AUGUST 1992

Well No.	Top of Casing Elevation (feet, above MSL)	Depth to Product (feet, below top of casing)	Depth to Groundwater (feet, below top of casing)	Product Thickness (feet)	Groundwater Elevation (feet, above MSL)	Corrected Groundwater Elevation (feet, above MSL)
143-SB-01 (MW-01)	62.14	ND	7.42	ND	54.72	--
143-SB-03 (MW-02)	59.29	4.99	5.30	0.31	53.99	54.24
143-SB-04 (MW-03)	60.84	ND	6.33	ND	54.51	--
143-SB-06 (MW-04)	61.71	ND	8.52	ND	53.19	--
143-SB-08 (MW-05)	62.39	ND	7.83	ND	54.56	--
143-SB-10 (MW-06)	62.64	ND	8.44	ND	54.30	--
143-SB-11 (MW-07)	61.15	ND	9.61	ND	51.54	--

Notes: MSL - Mean sea level.
ND - Not detected.
-- = Not applicable.

1. Where product was detected, groundwater elevation has been corrected by a factor of 0.81 (Diesel).



PROJECT TITLE: SITE CHARACTERIZATION REPORT EMERGENCY FUEL GENERATOR – BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA	CLIENT: DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND NORFOLK, VIRGINIA
DWG. TITLE: GROUNDWATER ISOCONTOUR MAP	FIGURE NO. 1–9

WESTON

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conductivity, transmissivity, and storativity values based on partially penetrated unconfined conditions were more representative of the site.

Hydraulic conductivity (K) is defined as the rate of flow of water in feet per day (ft/day) through a cross-sectional area of one square foot of the saturated zone (Fetter, 1980). Hydraulic conductivity was determined to be 6.1 and 1.6 ft/day for MW-04 and MW-06, respectively.

Transmissivity, the capacity of a water-bearing zone to transmit groundwater, is defined as the rate at which water flows (ft^2/day) through a unit width (1-foot) of the saturated thickness of the saturated zone under a unit hydraulic gradient (Fetter, 1980). Transmissivity is equal to the hydraulic conductivity multiplied by the saturated thickness of the water-bearing zone. The water column in the wells was assumed to be the saturated thickness of the water-bearing zone. Transmissivity was calculated to be 47.6 and 15.8 ft^2/day for MW-04 and MW-06, respectively.

The results of the aquifer testing are summarized below in Table 1-4.

TABLE 1-4

SUMMARY OF AQUIFER PARAMETERS

Well No.	Hydraulic Conductivity		Transmissivity	
	ft/day	cm/sec	ft^2/day	cm^2/day
MW-04	6.1	2.4×10^{-3}	47.6	4.4×10^4
MW-06	1.6	5.6×10^{-4}	15.8	1.5×10^4

Using a gradient for the site at each well location and the hydraulic conductivity values determined for the site, the groundwater flow velocity beneath the site can be estimated using the following equation:

$$V = Ki/n_e$$

Where: V = estimated groundwater flow velocity

K = hydraulic conductivity

i = groundwater gradient

n_e = effective porosity, as a decimal fraction.

Using the values calculated for K of 6.1 (MW-04) and 1.6 ft/day (MW-06) calculated from the aquifer tests, a groundwater gradient of 0.017 in the northwest portion of the site and 0.044 in the southern portion of the site, and an estimated effective porosity of 35% (Fetter, 1980), the range of groundwater flow velocities is calculated as 0.3 ft/day to 0.2 ft/day (105 to 73 ft/yr).

1.4.3 Field Screening of Soils

Split-spoon samples collected during the soil borings were screened with a PID to check for the presence of volatile organic vapors. Results of the field screening are shown in Table 1-5. Volatile organic vapor concentrations ranged from 0 to 225 units in the samples screened. Samples monitored from borings 143-SB-01, 143-SB-04, and 143-SB-05 exhibited readings greater than 100 units. PID readings were typically highest in samples collected at the 10 to 12 foot interval. However, PID readings for 143-SB-04 were unusually high and may have reflected an equipment divergence from calibration due to high ambient humidity conditions.

1.4.4 Soil Sampling

A total of 26 subsurface soil samples were collected from the 11 boring locations. All samples were analyzed for TPH. In addition, two soil samples were also analyzed for TCLP metals, flash point, grain size, and BTEX. The 2 samples collected for the additional analyses were taken from 143-SB-01 and 143-SB-06. Laboratory results are summarized in Tables 1-6 and 1-7. Laboratory analyses are provided in Appendix H, and chain-of-custody records are provided in Appendix I.

Laboratory results indicate that TPH concentrations in soil samples ranged from <9.4 ppm in soil boring 143-SB-04-01 (4 to 6 feet bgs) to 2,500 ppm in soil boring 143-SB-01-01 (4 to 6 feet bgs). Of the 24 soil samples analyzed for TPH (two from each boring and two duplicates), 5 samples contained TPH concentrations that exceed the SWCB "action level" of 100 ppm. Soil borings that exhibited TPH concentrations greater than 100 ppm include 143-SB-01, 143-SB-02, and 143-SB-09. None of the remaining 19 soil samples analyzed exceeded a TPH concentration of 34 ppm. The analytical data indicate that the TPH detected from these soil samples appears to be representative of the diesel group of fuels.

Analytical results for BTEX in the 2 soil samples analyzed indicate no BTEX compounds were detected in soil sample 143-SB-06-02 and a concentration of 6.2 ppb total xylenes detected in soil sample 143-SB-01-02 (see Table 1-6). Analytical results for the 8 TCLP metals in the soil samples showed that no metals were present above practical quantitation limits for the analyses (see Table 1-7). Neither of these samples exhibited the characteristics of ignitability since both showed a flashpoint of greater than 140°F (60°C).

TABLE 1-5

SUMMARY OF PID FIELD SCREENING OF SOILS

Boring No.	Sample Depth (feet)/PID Readings (units ppm)										
	0.0-2.0	2.0-4.0	4.0-6.0	6.0-8.0	8.0-10.0	10.0-12.0	12.0-14.0	14.0-16.0	16.0-18.0	18.0-20.0	20.0-22.0
143-SB-01	0	0	50	12	15	40	75	75	120	80	45*
143-SB-02	0	2	25			0	0		0		5*
143-SB-03		0	10			10		5			10*
143-SB-04	75	150	225			120		180*			
143-SB-05	7	8	5			65		110*			
143-SB-06	0	50	19			10		5*			
143-SB-07	0	0	7			0	30*				
143-SB-08	0	0	2			20		*			
143-SB-09	1	1	2			1	1	5*			
143-SB-10	1	1	3			3*					
143-SB-11	0	0	2			0	0	*			

SB - WESTON soil boring.
* Borehole terminated.
ND - Not detected.
Blank Cell - No PID reading recorded.
Note: 143-SB-04 had high PID readings and may have reflected equipment divergence from calibration due to high ambient air moisture.

TABLE 1-6
SUMMARY OF TPH AND BTEX ANALYSIS FOR SOIL SAMPLES
BUILDING 1958

Soil Boring Number	Field Sample Number	Sample Interval[a]	PARAMETER (ppm)					
			TPH	Benzene	Toluene	Ethylbenzene	Total Xylenes	Total BTEX
143-SB-01	143-SB-01-01	4.0-6.0	**2500**					
143-SB-01	143-SB-01-01A	4.0-6.0	**1400**					
143-SB-01	143-SB-01-02	10.0-12.0	**120**	BDL	BDL	BDL	6.2	.0062
143-SB-02	143-SB-02-01	4.0-6.0	**260**					
143-SB-02	143-SB-02-01A	4.0-6.0	**15**					
143-SB-02	143-SB-02-02	20.0-22.0	**34**					
143-SB-03	143-SB-03-01	4.0-6.0	<PQL					
143-SB-03	143-SB-03-02	20.0-22.0	<PQL					
143-SB-04	143-SB-04-01	4.0-6.0	<PQL					
143-SB-04	143-SB-04-02	15.0-17.0	<PQL					
143-SB-05	143-SB-05-01	4.0-6.0	<PQL					
143-SB-05	143-SB-05-02	15.0-17.0	<PQL					
143-SB-06	143-SB-06-01	4.0-6.0	<PQL					
143-SB-06	143-SB-06-02	15.0-17.0	<PQL	BDL	BDL	BDL	BDL	ND
143-SB-07	143-SB-07-01	4.0-6.0	<PQL					
143-SB-07	143-SB-07-02	12.0-14.0	<PQL					
143-SB-08	143-SB-08-01	4.0-6.0	<PQL					
143-SB-08	143-SB-08-02	10.0-12.0	**26**					
143-SB-09	143-SB-09-01	4.0-6.0	<PQL					
143-SB-09	143-SB-09-02	14.0-16.0	**1300**					
143-SB-10	143-SB-10-01	4.0-6.0	<PQL					
143-SB-10	143-SB-10-02	10.0-12.0	<PQL					
143-SB-11	143-SB-11-01	4.0-6.0	<PQL					
143-SB-11	143-SB-11-02	10.0-12.0	<PQL					
143-SB-01	143-SB-01-03E	NA	NA	BDL	BDL	BDL	BDL	ND

a - Feet below ground surface.
A - Duplicate sample.
E - Trip blank.

ND - None detected.
<PQL - Less than practical quantitation limits.
NA - Not applicable.

BDL - Below detection limits.

TABLE 1-7
SUMMARY OF 8 TCLP METALS ANALYSIS FOR SOIL SAMPLES
BUILDING 1958

Soil Boring Number	Field Sample Number	Sample[a] Interval	PARAMETER (ppm)							
			Ag	As	Ba	Cd	Cr	Hg	Pb	Se
143-SB-01	20-SB-01-02	10.0-12.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
143-SB-06	20-SB-06-02	15.0-17.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

a - Feet below ground surface.
ppm - parts per million.
<PQL - Less than practical quantitation limits.

Grain size analysis conducted for the 2 soil samples for SB-01 and SB-06 both showed a silty clay with sand composition for the soils encountered. Soil analyzed for grain size samples from boring SB-01 and SB-06 were collected at the 10 to 12 foot interval and 15 -17 foot interval, respectively.

1.4.5 Groundwater Sampling

Groundwater samples were collected on 24 August 1992 from 6 of the 7 newly installed monitoring wells. Monitoring well MW-02 was not sampled due to the presence of liquid-phase hydrocarbons. The samples were analyzed for purgable aromatics (EPA method 602), TPH (EPA method 418.1), and lead (EPA method 239.2). Results of the laboratory analyses are presented in Table 1-8. In addition, field parameters, including pH, temperature, and specific conductance, were measured at the time of sampling. All field parameters showed a variance of less than 10% indicating that both development and purging activities were sufficient to obtain a representative groundwater sample. These field parameter measurements are reported in well development logs in Appendix D and summarized in Table 1-9.

Purgable aromatics were detected in all of the existing monitoring wells and ranged from .0131 ppm in MW-06 to 0.597 ppm in MW-01. The purgable aromatics that were detected included benzene, toluene, ethylbenzene, total xylenes, (BTEX), chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. Chlorinated hydrocarbon compounds are not normally a constituent of diesel. Dissolved total BTEX compounds in groundwater ranged from 0.0056 ppm in well MW-10 to 0.506 ppm in MW-01. The duplicate groundwater sample taken from MW-10 showed a close correlation in total BTEX concentrations. Analytical results detected 0.0056 ppm total xylenes in MW-10. No BTE concentrations were detected. No BTEX compounds were present in the duplicate sample. However, a total xylenes concentration of 0.0073 ppm was detected in the rinsate sample (143-12-01).

Total petroleum hydrocarbons dissolved in groundwater was detected in all samples, and ranged from 0.21 ppm in MW-06 and MW-07 to 4.26 ppm in MW-04. The groundwater sample (MW-06) showed 0.19 ppm TPH compared to the duplicate sample of 0.21 ppm; therefore, the duplicate sample was utilized for the range of TPH values.

Total lead in groundwater was detected in 6 of the 7 groundwater samples collected. Total lead in groundwater ranged from less than PQL in MW-01 to 0.078 ppm in MW-03. The duplicate groundwater sample (taken from MW-10) showed a close correlation of 0.010 ppm lead to 0.0110 in the original sample.

The rinsate sample collected detected 0.08 ppm TPH, 0.0123 ppm total BTEX, a total of 0.0392 ppm purgable aromatics (including BTEX), and <0.005 ppm total lead.

TABLE 1-8
SUMMARY OF TPH AND PURGABLE AROMATIC ANALYSES FOR GROUNDWATER SAMPLES

Sample Location	Sample No.	Parameter (ppm)											
		TPH	Benzene	Toluene	Xylene (Total)	Ethyl-benzene	Total BTEX	1,3-Dichloro-benzene	1,4-Dichloro-benzene	1,2-Dichloro-benzene	Chloro-benzene	Total Purg. Arom.	Total Lead
143-GW-01 (MW-01)	143-GW-01-01	1.52	0.037	0.039	0.340	0.090	0.506	<PQL	0.091	<PQL	<PQL	0.597	<PQL
143-GW-04 (MW-03)	143-GW-04-01	0.46	<PQL	<PQL	0.033	<PQL	0.033	0.017	0.014	0.016	<PQL	0.080	0.0780
143-GW-06 (MW-04)	143-GW-06-01	4.26	<PQL	0.013	0.180	0.044	0.237	<PQL	0.100	<PQL	<PQL	0.337	0.0260
143-GW-08 (MW-05)	143-GW-08-01	3.13	<PQL	<PQL	0.060	0.016	0.076	0.010	0.041	0.019	0.014	0.160	0.0320
143-GW-10 (MW-06)	143-GW-10-01	0.19	<PQL	<PQL	0.0056	<PQL	0.0056	0.0083	0.010	0.009	<PQL	0.0273	0.0110
143-GW-10 (MW-06)	143-GW-10-01A	0.21	<PQL	<PQL	<PQL	<PQL	ND	<PQL	0.007	0.0061	<PQL	0.0131	0.0100
143-GW-11 (MW-07)	143-GW-11-01	0.21	<PQL	<PQL	0.006	<PQL	0.006	0.0087	0.0096	0.012	<PQL	0.0363	0.068
143-GW-12[a]	143-GW-12-01	0.08	<PQL	<PQL	0.0073	<PQL	0.0073	0.0076	0.0094	0.0099	<PQL	0.0342	<PQL
143-GW-13[b]	143-GW-13-01	NA	<PQL	<PQL	<PQL	<PQL	ND	<PQL	<PQL	<PQL	<PQL	ND	NA

<PQL - Less than practical quantitative limits.
NA - Not applicable. Trip blank was only analyzed for purgable aromatics.
A - Duplicate sample.
a - Rinsate Sample.
b - Trip blank.
ND - Not detected.

TABLE 1-9

SUMMARY OF GROUNDWATER FIELD PARAMETERS BUILDING 1958

Well No.	pH[a]	Specific Conductance[b] (cm/μmhos)	Temperature[b] (C°)
143-SB-01 (MW-01)	5.80	140	22.0
143-SB-04 (MW-03)	5.20	58	22.0
143-SB-06 (MW-04)	5.40	60	22.0
143-SB-08 (MW-05)	5.40	65	22.0
143-SB-10 (MW-06)	5.20	115	24.0
143-SB-11 (MW-07)	4.80	105	23.0

a - pH values measured in the field using an American Scientific pH meter.

b - Specific conductivity and temperature measured in the field using a YSI conductivity meter.

1.5 NATURE AND EXTENT OF CONTAMINATION

1.5.1 Nature of Contamination

Historical information, field interpretations, and analytical results confirm that subsurface soils in the vicinity of the emergency generator fuel supply lines near Building 1958 are contaminated with petroleum compounds related to diesel fuels. Most of the chemical compounds in petroleum-type fuels are either aliphatic or aromatic compounds. Aliphatic compounds are organic compounds with either straight or branched carbon chains. An example of aliphatic compounds found in gasoline are hexane, pentane, and octane. Aromatic compounds are organic compounds with a carbon ring structure.

Diesel fuel belongs to the group of petroleum products called middle distillates. This group includes diesel fuel, jet fuel, and lighter fuel oils. Products in this group tend to be denser, less volatile, less mobile, and less water soluble than gasoline. In addition, this group usually contains a lower percentage of the aromatic hydrocarbons, such as benzene, toluene, ethylbenzene, and total xylenes, than gasoline. The physical/chemical characteristics of diesel and related compounds are shown in Table 1-10.

Petroleum hydrocarbons can be present in the subsurface as liquid-phase hydrocarbons (LPH), dissolved-phase hydrocarbons (DPH), adsorbed-phase hydrocarbons (APH) and vapor-phase hydrocarbons (VPH). The migration process of petroleum products in the subsurface is unique for each phase. Released LPH tend to move downward through the unsaturated zone in response to gravity. The vertical migration is generally limited to the vicinity of the release until the hydrocarbon comes in contact with groundwater. Since petroleum hydrocarbons are less dense than water and relatively insoluble in water, LPH that reach the water table form a distinct layer (free product) that can float on and travel under the influence of the natural groundwater flow regime.

The DPH migrate in the subsurface by advection and hydrodynamic dispersion. Advection is the transportation of chemical constituents by groundwater flow. Hydrodynamic dispersion is a process by which the chemical constituents are mechanically mixed by the motion of the groundwater. Dispersion is responsible for diluting the concentrations of the dissolved hydrocarbon plume as the distance from the source is increased.

The VPH are a result of the volatilization of the constituents in the LPH and DPH. Vapor migration is controlled by many parameters such as soil permeability, temperature, and moisture. In general, however, VPH tend to follow more conductive pathways such as in the vadose zone.

TABLE 1-10

PHYSICAL/CHEMICAL CHARACTERISTICS OF DIESEL AND RELATED COMPOUNDS

CHEMICAL COMPOSITION:	Approximate Composition: Alkanes 61.0% Cycloalkanes 29.0% Alkylbenzenes 8.0% Indans/tetralins 1.1% Naphthalenes 0.0% <1%
PHYSICOCHEMICAL DATA:	Physical State: Liquid Color: Clear translucent golden brown to brown Odor: Diesel; threshold: 1 ppm Specific Gravity: 0.80 - 0.85 (@ 15-25 deg C) Freeze/Melt Point: -72.00° Boiling Point: 340 to 675°F (171 to 358°C) Flash Point: 125°F (52°C) Flammable Limits: 1.30 to 8.00% by volume Autoignition Temp.: <40.0 to 242.0°C Vapor Pressure: 9.10E+01 mm Hg at 20°C Satd. Conc. in Air: 600E+05 mg/m^3 (at 20°C) Solubility in Water: 300 mg/l (at 20°C) Viscosity: 1.3 to 4.1 cp (at 104°F (40°C)) Surface Tension: est 2.5E+01 dyne/cm Log (Octanol-Water Partions Coeff.): 3.0 to 7.0 Soil Adsorp. Coeff.: 2.4E+02 to 5.0E+06 Henry's Law Const.: 1.0E+4 to 1.0E+1 atn. m^3/mol Bioconc. Factor: 5.0E+1 to 5.0E+5

Groundwater samples collected from monitoring well locations indicate the presence of purgable aromatics. Several purgable aromatics were detected: BTEX, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. Although these purgable aromatic components were detected, all concentrations (with the exception of benzene in 1 sample) were small and below the federal allowable groundwater standards.

1.5.2 Extent of Contamination

Concentrations of TPH contamination in soils in the vicinity of the Building 1958 are depicted in Figure 1-10. The distribution pattern of TPH concentrations in soil indicates that the highest area of soil contamination is located in the vicinity 143-SB-01, 143-SB-02, and 143-SB-09. This is supported by PID screening and analytical results.

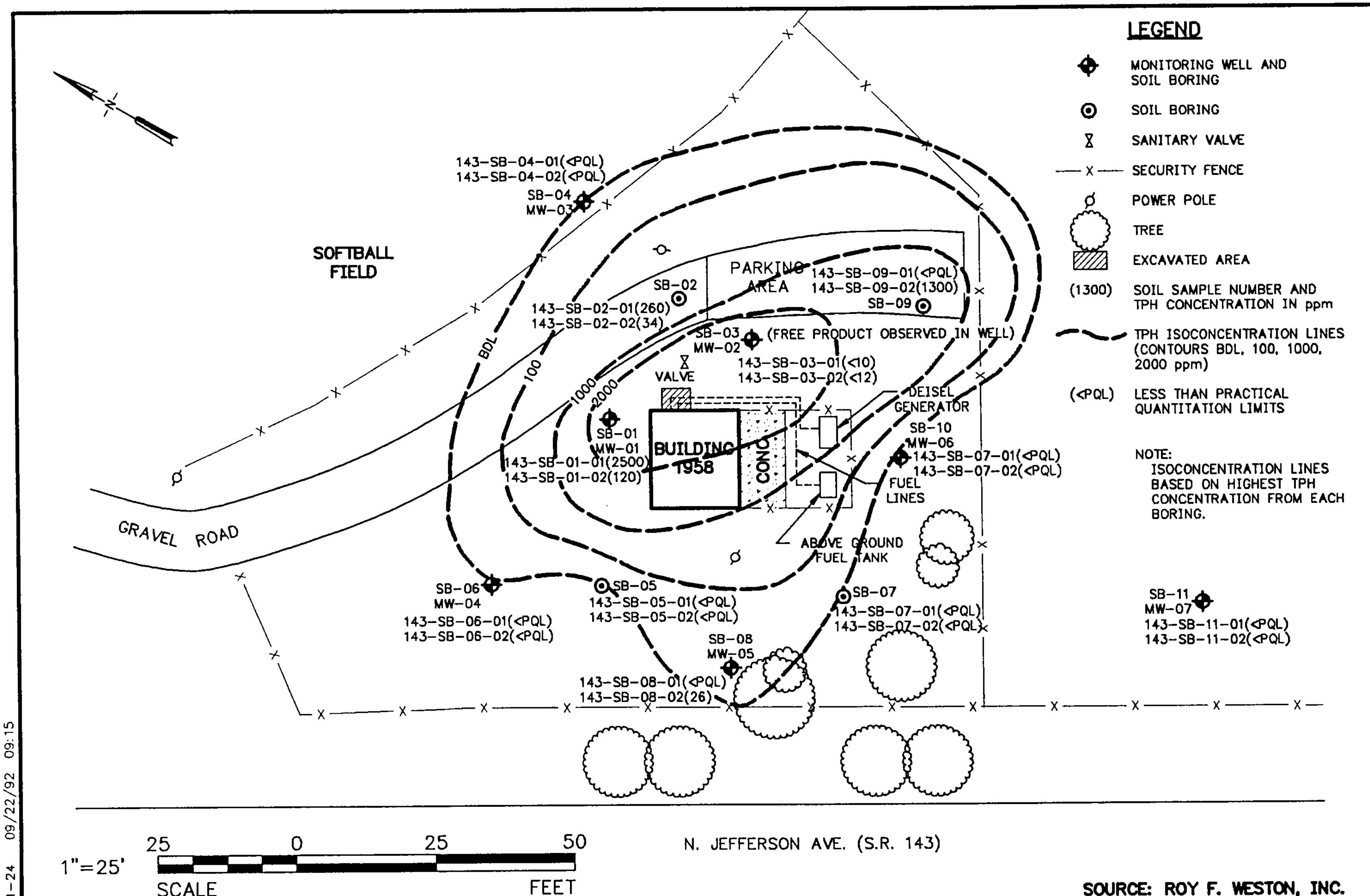
Contours plotted for TPH concentrations in soils (Figure 1-10) indicate high concentrations of TPH present in the vicinity of the north corner of Building 1958. These concentrations of TPH are likely related to the confirmed release of petroleum hydrocarbons from the fuel lines. Although BTEX was analyzed for, all concentrations were below the detection limit, with the exception of xylene (0.0062 ppm) in 143-SB-01.

Free petroleum product was detected in only one monitoring well 143-SB-03 (MW-02). This well is in the vicinity of the sanitary bypass valve at Building 1958 (Figure 1-3) where LPH was initially observed. The product is clear in appearance, suggesting that the release is relatively recent.

Groundwater chemical compounds found in the vicinity of the Building 1958 are depicted in Figure 1-11 for TPH. The contaminant distribution pattern for TPH appears to be occurring as a single contaminant plume located at the north and west corners of Building 1958. The highest levels of TPH were detected in 143-SD-06 (MW-04), which had a TPH value of 4.26 ppm, and appear to be migrating in a westerly direction.

BTEX compounds and chlorinated hydrocarbons were detected in all groundwater samples and ranged from 13.1 ppb in MW-06 to 597 in MW-01. Several purgable aromatics were detected: benzene, toluene, ethylbenzene, total xylenes, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. 1,4-dichlorobenzene was detected in all groundwater samples and ranged for 0.0096 ppm to 0.10 ppm. Dissolved total BTEX in groundwater ranged from BDL to 0.506 ppm in MW-01.

Groundwater samples detected several purgable organics not normally constituents of diesel fuel; chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. Two groundwater samples contained concentrations of 1,4-dichlorobenzene above state and federal drinking water standards. Lead, also not usually a constituent of diesel fuel, was detected in all groundwater samples (Figure 1-12).



SOURCE: ROY F. WESTON, INC.

PROJECT TITLE:	CLIENT	
SITE CHARACTERIZATION REPORT EMERGENCY FUEL GENERATOR – BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA	DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND NORFOLK, VIRGINIA	WESTON
DWG. TITLE: SOIL TPH ISOCONCENTRATION MAP	FIGURE NO. 1–10	

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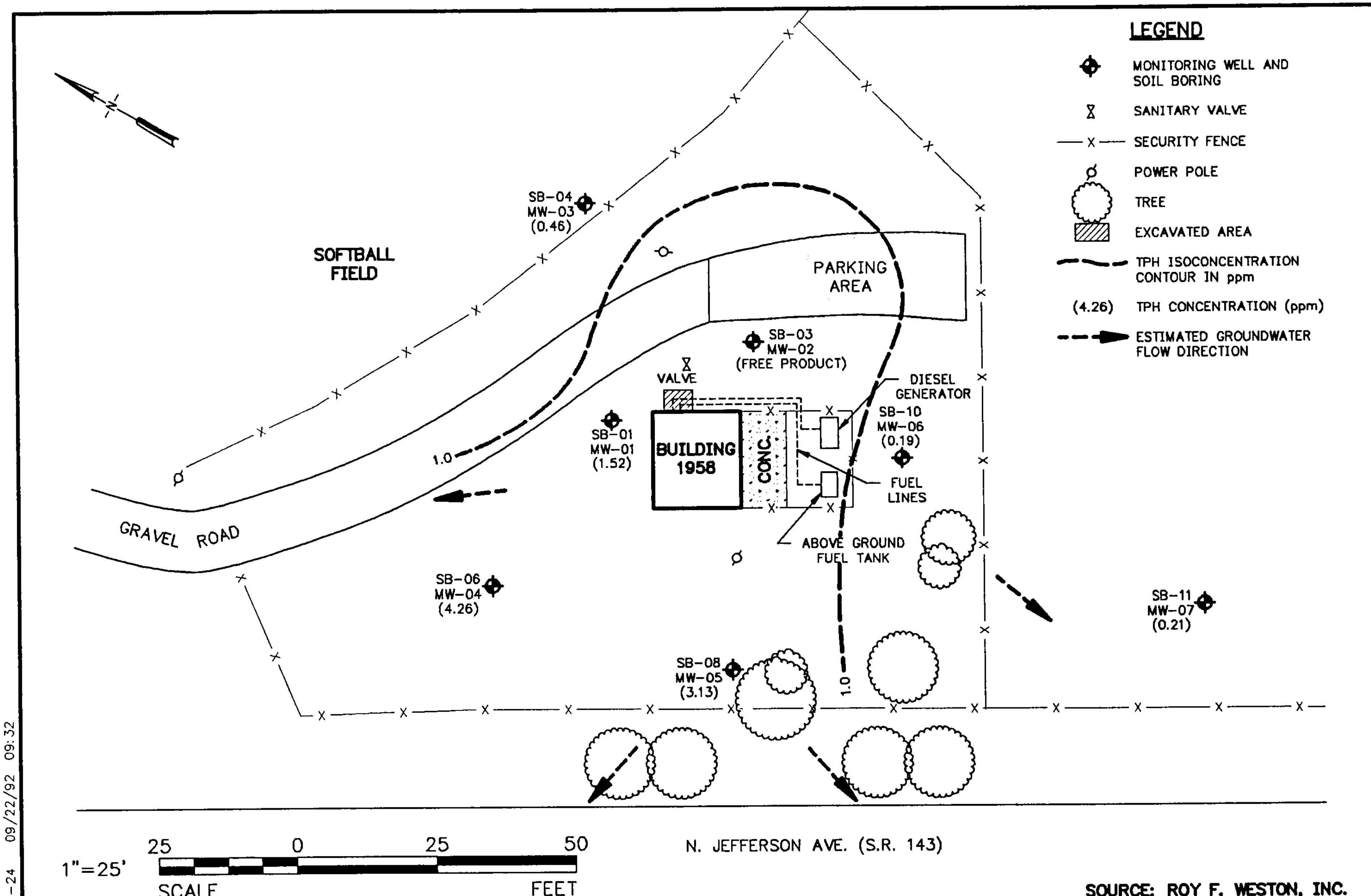

PROJECT TITLE:
SITE CHARACTERIZATION REPORT
EMERGENCY FUEL GENERATOR – BUILDING 1958
NAVAL WEAPONS STATION
YORKTOWN, VIRGINIA

CLIENT
DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
NORFOLK, VIRGINIA

WESTON

DWG. TITLE
TPH IN GROUNDWATER ISOCONCENTRATION MAP

FIGURE NO.
1-11

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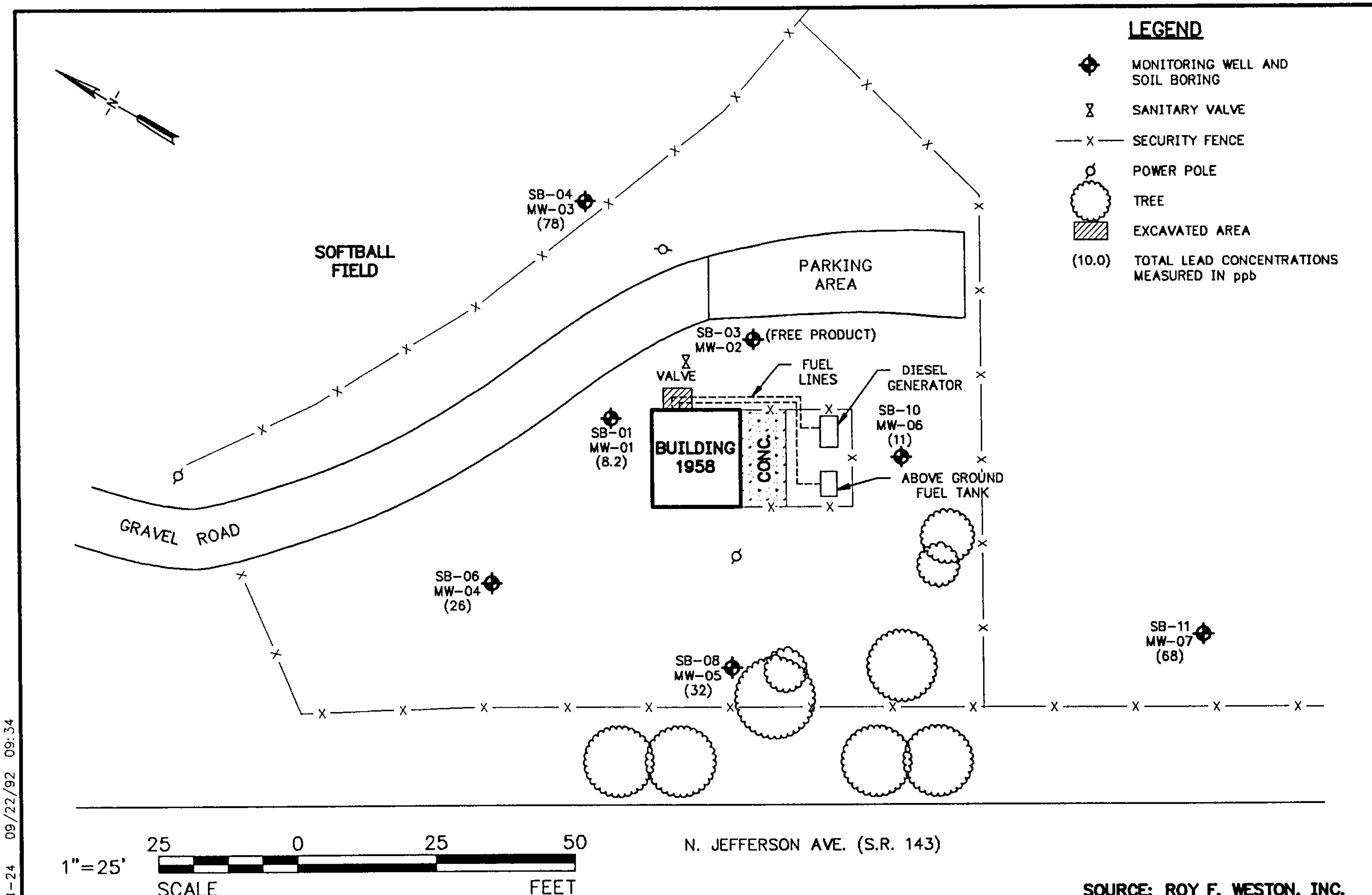

SOURCE: ROY F. WESTON, INC.

PROJECT TITLE:	CLIENT
SITE CHARACTERIZATION REPORT EMERGENCY FUEL GENERATOR – BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA	DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND NORFOLK, VIRGINIA
DWG. TITLE: TOTAL LEAD IN GROUNDWATER	FIGURE NO. 1–12

WESTON

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Groundwater samples were also analyzed for total lead (see Figure 1-12). With the exception of the rinsate sample (143-GW-01R), all groundwater samples analyzed contained lead. The highest levels of lead were detected in 143-SB-04 (MW-03) at 0.078 ppm and 143-SB-11 (MW-07) at 0.068 ppm. Concentration of lead in four of the seven groundwater samples analyzed are greater than the federal allowable levels for drinking water of 0.015 ppm (see Table 2-1); two are greater than the state allowable levels (0.05 ppm).

1.5.3 Conclusions

The following conclusions are based on the results of the Site Characterization Study:

- Free-phase petroleum product was encountered in 143-SB-03 (MW-02). The maximum free product thickness in MW-02 measured during this investigation was approximately 0.31 feet.

- Soils with elevated levels of TPH (>100 ppm) was detected in the vicinity of Building 1958 (Figure 1-10). The source of the soil contamination is likely due to a release resulting from the failure of the underground fuel supply lines for the emergency generator.

- Groundwater sampling revealed levels of TPH and total lead above SWCB standards.

- Groundwater in the investigation site generally flows to the west and south with the predominant groundwater flow in a westerly direction at about 105 ft/yr. A plot of groundwater contours (Figure 1-9) indicates significant local influence, and suggests that the strata directly under Building 1958 may be a local groundwater recharge point.

2.0 RISK ASSESSMENT

The objective of the Risk Assessment portion of the Site Characterization Report is to: 1) identify the actual and/or potential receptors (human or environmental) to any contamination attributable to the site; 2) identify the actual and/or potential pathways of exposure; 3) quantify the exposure levels; and 4) evaluate the actual and/or potential human and/or environmental risk.

The Risk Assessment section consists of five subsections. The first subsection identifies the demographics and land and water uses in the area. The second subsection identifies any actual or potential human or environmental receptors that might be affected by contamination at the site. The third subsection identifies the actual or potential exposure pathways. The fourth subsection quantifies the exposure levels, and the fifth subsection evaluates the potential risk.

2.1 SITE DEMOGRAPHICS

NWS Yorktown is located in a mixed urban area that includes commercial and residential activities. The Building 1958 area is bounded on the north and east by a softball field and base housing, and on the south and west by Highway 143. Building 1958 is surrounded by lowland grassed area. A small playground is located directly upgradient, approximately 100 feet from the site.

2.2 IDENTIFICATION OF RECEPTORS

There are limited actual or potential human or nonhuman receptors to contamination at this site. For the most part, the soil contamination detected in the area occurs several feet below the ground surface. The surrounding surface area is either paved or grassed; therefore, there is little potential for dispersion due to fugitive dust except during intrusive activities such as construction or landscaping. Even though groundwater monitoring wells installed in the area indicate free product and levels of lead above the Commonwealth of Virginia groundwater standards and federal MCLs, present and future use of the groundwater is considered unlikely. Since drinking water is supplied to NWS Yorktown by municipal pipeline from off-site sources, no human receptors of contaminated drinking water are expected.

The distance downgradient to the nearest surface water body is approximately 600 feet to a stream that drains southeast to Skiffes Creek Reservoir, about 3,000 feet downgradient of the site. The potential for impact to human receptors appears to be low since the dense clays prohibit any horizontal and vertical movement of fluids. While these clays exert a control on floating petroleum product, the strata does not remove dissolved petroleum compounds. These dissolved compounds could potentially affect aquatic organisms that may come into contact with them in the downgradient surface ditches and surface water bodies. In addition, humans and wildlife in the area may be affected by ingestion of these aquatic organisms.

Subsurface utilities may act as a preferred migration routes and are also potential receptors. The subsurface utilities include storm drains, gas lines, and sanitary sewer lines. Physical information regarding type and location of the utility lines was obtained from NWS Yorktown personnel (see Figure 2-1).

One possible drinking water well was located within a 1-mile radius of Building 1958 (see Figure 1-5). However, since it does not appear to be within the same groundwater flow regime no tap water samples were collected.

2.3 IDENTIFICATION OF EXPOSURE PATHWAYS

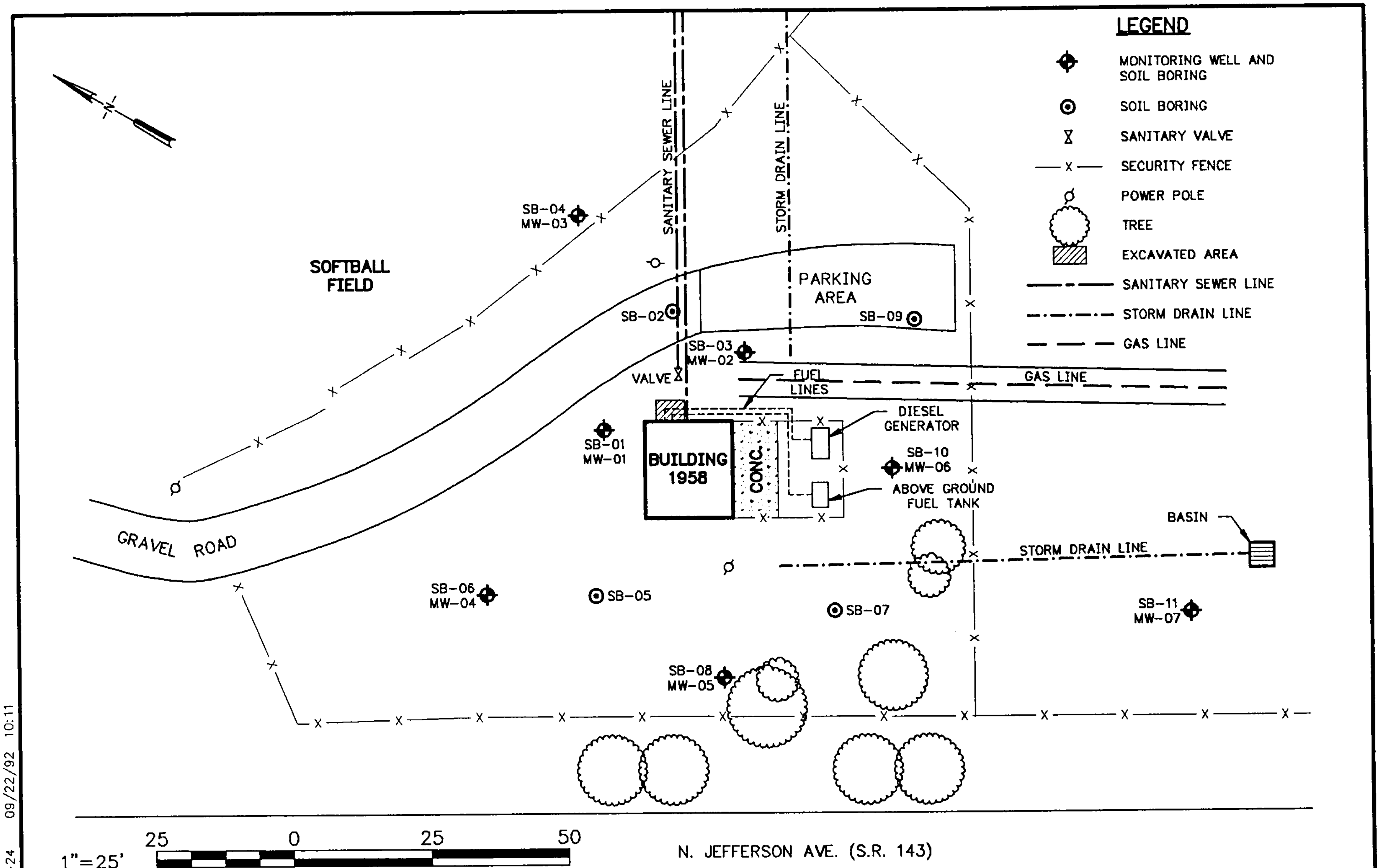
The possible exposure pathways of concern for human exposure may include: ingestion, inhalation (of volatile organics from groundwater, surface water, and particulates), and dermal contact of contaminated groundwater and surface waters. Contaminated surface waters and sediments would be the likely environmental exposure pathways to aquatic organisms.

Soil contamination was detected at depth in soil; however, as stated previously, human exposure to soils at this depth is not likely unless construction activities are conducted in the affected area. No surficial soil samples were collected, but since the surrounding area is either grassed or paved, no potential for dispersion due to fugitive emissions from soil are expected.

Groundwater transportation of leached TPH and/or BTEX constituents into a surface water receiver is an exposure pathway. This pathway is highly restricted by the distance to the nearest stream 600 feet. However, Skiffes Creek Reservior, a drinking water supply surface impoundment located 3,000 feet downgradient of the site, is where the stream outfalls. Surface water samples were not collected.

2.4 QUANTIFICATION OF EXPOSURE LEVELS

National Primary Drinking Water Regulations (NPDWRs), Maximum Contaminant Levels (MCLs) currently exist for BTEX, chlorinated hydrocarbons, and lead. The Commonwealth of Virginia also has groundwater quality standards however, has set no standards for TPH in soil. Federal and Commonwealth of Virginia Ambient Water Quality Criteria (AWQC) have been established for the protection of human and aquatic life. These criteria are guidelines used to establish health standards such as MCLs and can be enforcable based on the health risk to human, animals, plants, or aquatic life. The estimated surface water concentrations were compared to the federal and Commonwealth criteria on Table 2-1. The analytical data for soils and groundwater are presented in Appendix H. The following discussion summarizes water contamination at this site.



SOURCE: ROY F. WESTON, INC.

PROJECT TITLE: SITE CHARACTERIZATION REPORT EMERGENCY FUEL GENERATOR – BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA	CLIENT: DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND NORFOLK, VIRGINIA
DWG. TITLE: SUBSURFACE UTILITIES MAP	FIGURE NO. 2-1

WESTON

0124-2-1.dwg 6629-01-24 09/22/92 10:11

TABLE 2-1

FREQUENCY SUMMARY FOR VOLATILES IN GROUNDWATER (ppm)

Parameter	State Standards[1]	Federal MCLs[1]	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detected Values (%)	Number of Detects Greater Than Standards	
						State	Federal
Benzene	0.710	0.005	0.037	0.037	16	0	1
Chlorobenzene	N/A	0.100	0.014	0.014	33	0	0
1,2-Dichlorobenzene	17.000	0.600	0.0061	0.019	66	0	0
1,3-Dichlorobenzene	2.600	0.600	0.0083	0.017	66	0	0
1,4-Dichlorobenzene	2.600	0.075	0.0094	0.100	100	0	2
Ethylbenzene	29.000	0.700	0.016	0.090	50	0	0
Toluene	200.000	1.000	0.013	0.039	29	0	0
Xylenes, total	N/A	10.000	0.0060	0.340	86	0	0
Lead[2]	0.05	0.015	0.010	0.078	100	2	4

NA - Not applicable, no standards have been set.

Note: 1) Federal MCLs are based on the federal Drinking Water Standard, and state MCLs are based on the water standards with general, statewide Application.
2) Groundwater standards by the state are used.

The soils data show that concentrations of TPH were detected in the vicinity of Building 1958. Of the 8 detected TPH levels, the concentrations ranged from 15 to 2,500 ppm. TPH concentrations were not detected in 16 out of the 24 samples analyzed.

BTEX was detected in 1 of the 2 soil samples analyzed with total xylenes being the only compound detected at .0062 ppm.

- Benzene was detected in 1 out of the 6 groundwater samples collected. The concentration was 0.037 ppm, which is above the federal Drinking Water Standard MCL of 0.005 ppm, but below the SWCB's MCL of 0.710 ppm for benzene.

- Toluene was detected in 2 out of the 6 groundwater samples collected. The range of concentrations for detected levels was 0.013 to 0.039 ppm, which does not exceed the SWCB groundwater or federal Drinking Water Standard MCLs (20.0 ppm and 1.0 ppm, respectively).

- Total xylenes were identified in 4 out of the 6 groundwater samples collected. The concentration detected ranged from 0.006 to 0.34 ppm. These concentrations did not exceed the federal Drinking Water Standard MCL of 10.0 ppm.

- Ethylbenzene was detected in 3 of the 6 groundwater samples collected. The concentrations ranged from 0.016 to 0.090 ppm. These concentrations do not exceed current SWCB and federal MCLs.

The following compounds have also been identified in the groundwater samples collected, however are not typically constituents of diesel:

- Chlorobenzene was identified in 1 out of the 6 groundwater samples at a concentration of 0.014 ppm. This concentration does not exceed the federal Drinking Water Standard MCL of 0.100 ppm.

- 1,2-dichlorobenzene was detected in 4 out of the 6 groundwater samples collected. The concentration ranged from .0061 to 0.019 ppm. The detected levels do not exceed the federal Drinking Water Standard MCL of 0.60 ppm.

- 1,3-dichlorobenzene was detected in 4 of the 6 groundwater samples collected. The concentration ranged from .007 to .017 ppm, and does not exceed the federal Drinking Water Standard MCL of 0.60 ppm or the SWCB's MCL of 2.60 ppm.

- 1,4-dichlorobenzene was detected in all groundwater samples collected. The concentration was ranged from .0070 to 0.100 ppm. This does not exceed the SWCB groundwater MCL (2.6 ppm) but exceeds the federal Drinking Water Standard MCL (.075 ppm) in two samples.

- Total lead was detected in all groundwater samples collected. The concentrations ranged from .010 to .078 ppm. Four of the samples exceeded federal MCLs. Two of the samples exceeded SWCB groundwater standards.

2.5 POTENTIAL RISKS TO RECEPTORS

Several subsurface utilities were identified in the vicinity of Building 1958 (Figure 2-1). The depths to the subsurface utilities identified are one to four feet beneath the surface; the depth to water beneath the site varies from 2 to 11 feet. However, the city of Newport News water supply system functions under its own positive pressure, thus inhibiting potential incursion by dissolved hydrocarbons in groundwater. Based on the information provided above, man-made sensitive receptors appear unlikely to be impacted by the subsurface hydrocarbons.

The potential risk to human receptors is also estimated to be low. The one potable water well identified within a one mile radius of the site does not appear to be in the same groundwater flow regime. Contaminated soils in the immediate vicinity of Building 1958 were for the most part detected at depth. Thus, human exposure is not considered likely unless construction conditions exist. Organic vapors have not been detected in the atmosphere above the ground surface at the site and only at depth in the soil; thus, due to the tight nature of the soils, organic vapors appear to present no risk to human or other natural receptors.

Risk to the nearest potential downgradient receptor from the groundwater contaminants present was quantified using a three-dimensional computer model. The model used is entitled; Analytical Transient One-, Two-, and Three Dimensional Simulation of Waste Transport in the Aquifer System (AT123D) (Yeh, 1981). The model was used to assess the potential level to which the elevated levels of total lead could impact the nearest potential sensitive receptors. The nearest downgradient natural sensitive receptor is the intermittent stream located approximately 600 feet from the site.

Based on computer modeling results, subsurface hydrocarbon impact on sensitive receptors appears unlikely. Using current information, the model predicts that total lead will not migrate a distance of 600 feet from the site. The model predicts that a lead concentration of 1 ppb would not reach a distance of 200 feet after 25 years. A narrative discussion identifying the assumptions and parameters used and the results of the model are contained in Appendix J.

2.6 RISK SUMMARY

As stated in Subsection 2.5, no human or nonhuman receptors are anticipated to be impacted by contamination at this site. The contaminants identified do not represent or pose a public health risk as there are limited opportunities for exposure to contaminants.

3.0 REMEDIATION ASSESSMENT

The Remediation Assessment portion of the Site Characterization Report is presented in four subsections. The first subsection (Subsection 3.1) discusses the objectives of the Remediation Assessment. Subsection 3.2 presents a discussion of the rationale for remediation at the site. Subsection 3.2 also presents the projected remediation endpoints based on the results of the Site and Risk Assessments. Subsection 3.3 presents a description and evaluation of applicable technologies for the site. The evaluations are based on effectiveness, implementability, and costs. Subsection 3.4 presents the recommended technologies for the site.

3.1 OBJECTIVES

The objectives of this Remediation Assessment are to: (1) evaluate whether the site requires remediation with respect to free product, contaminated groundwater, and/or contaminated soils; (2) evaluate potential areas of requiring remediation; and (3) evaluate and identify potential technologies for site remediation.

3.2 REMEDIATION RATIONALE

3.2.1 Impacted Areas Potentially Requiring Remediation

Groundwater and soil in the vicinity of Building 1958 have been impacted by petroleum hydrocarbons. This was confirmed by analytical results of soil and groundwater samples collected during the Site Assessment (Section 1.4). Free-phased hydrocarbons were detected in monitoring well MW-02 (0.31 feet) and in the vicinity of the sanitary bypass valve. This contamination in the northeast corner of the building appears to be associated with the emergency generator fuel lines.

An area of TPH contamination in the soils exceeding the SWCB TPH action level of 100 ppm was identified at the site. The area of contaminated soils is located in the immediate vicinity of the fuel lines and to the north of Building 1958. The estimated extent of TPH contamination in the soils at the site exceeding 100 ppm is shown in Figure 1-10.

With respect to the impacted groundwater, the analytical results from the site assessment (Subsection 1.4) indicated that elevated levels of total TPH exist in the immediate vicinity and to the northwest of Building 1958 (see Figure 1-11). Elevated levels of total lead were also identified. The downgradient lateral extent of impacted groundwater has yet to be identified.

The results of the Risk Assessment conducted for this site identified that the potential human or environmental receptors will not be impacted by the contamination at the site. Therefore, based on the results of the Site and

Risk Assessments and state guidelines, remediation is recommended to recover the free-phase product. Based on the risk assessment however, soils and groundwater at the site will not require remediation. Contaminated soils from any excavations that may be necessary should be remediated.

3.2.2 Projected Remediation Endpoints

The estimated extent of the TPH plume at the site is shown in Figure 1-11. The plume may have migrated off Navy property to the west underneath N. Jefferson Avenue. However, the results of the Risk Assessment indicated the likelihood of contamination from the site affecting human receptors is minimal. Based on this information, free phased product should be removed until a significant layer (1/8-inch or greater) is not identified in the monitoring wells at the site. The rationale for using 1/8-inch as an endpoint for remediation is based on the minimum feasible thickness that free product can be generally reduced using current recovery techniques.

Due to the apparent low risk to both human and environmental receptors, active soil and groundwater remediation is not recommended. Natural processes, such as biodegradation will in time reduce the concentration of the contaminant. Endpoints for soil and groundwater at the site are the existing site conditions.

By addressing the free-phase product and soil contamination within the limits of excavations, groundwater contamination levels will gradually decrease over time.

Due to the nature of the contaminant present, i.e., diesel fuel, remediation of vapors is not required. Diesel fuel has a low percentage of volatile compounds present; therefore, remediation or monitoring of the vapor phase would not be appropriate or effective.

3.3 IDENTIFICATION AND ELALUATION OF POTENTIAL REMEDIATION TECHNOLOGIES

3.3.1 Soil Remediation Technologies

The objective for the remediation of soils is to reduce or eliminate the effects that excessively contaminated soils have on the groundwater. Table 3-1 presents demonstrated technologies for soil remediation. Table 3-1 also summarizes the evaluation of each technology based on applicability to the site, implementability, and costs.

The soil remediation technologies that are applicable to this site are briefly discussed and evaluated below:

TABLE 3-1

SOIL REMEDIATION OPTIONS
BUILDING 1958

OPTION	PROCESS	ESTIMATED COSTS(1)	PRACTICAL CONSTRAINTS	REMARKS	APPLICABLE TO SITE (Y/N)
Excavation and disposal as hazardous waste	Excavate and haul to Class I landfill; emplace and compact clean fill	$\$300/yd^3$	Cradle-to-grave liability as waste generator	High cost	N
Excavation and disposal as solid waste (nonhazardous)	Excavate and haul to Class III landfill; backfill with clean fill	$\$60/yd^3$	Location of a suitable landfill	Economical on small projects	Y
Excavation, aeration, and disposal off-site	Excavate and spread on-site; turn repeatedly to aerate; haul to clean fill disposal site; emplace and compact new clean fill		Emission considerations; space considerations	Technically feasible; permitting very difficult under current legislation; requires numerous analytical tests	N
Excavation, landfarming, and replacement	Excavate and spread on-site; aerate and add nutrients and water; re-emplace and compact	$\$50/yd^3$	Emission considerations; space considerations; leaves excavation open during treatment	Technically feasible, permitting may be difficult; requires numerous analytical tests	N
Mechanically enhanced volatilization	Excavate; pass through crusher; aerator; and re-emplace	$\$250/yd^3$	Requires dust control and vapor treatment	High cost, but suitable for specific locations	N
In situ venting (vacuum extraction)	Investigate extent of contamination and soil conditions; design and install venting system; permit system; operate system; reinvestigate to monitor effectiveness	$\$20\text{-}50/yd^3$	Fine-grained soils and low volatility of hydrocarbon in soils limit the effectiveness of this method	Not a technically viable option for sites with clayey soils; requires disposal of air filtration medium	N
Excavation and low-temperature thermal reduction (LTTR)	Contamination in soil reduced through volatilization by the application of heat	$50/ton + trans-portation	Emissions considerations	Moderate cost, suitable for small projects	Y
In situ bioremediation or chemical degradation	Investigate extent of contamination and soil and groundwater conditions; conduct feasibility study; design and install pumping and injection system; permit system; operate system; reinvestigate to monitor effectiveness	$\$75/yd^3$	Fine-grained soils limit ability to inject and pump fluids through soils. System could be engineered to be installed and operated around existing facilities; requires ongoing operation and maintenance (O&M) and monitoring. Requires periodic soil sampling and final investigation	Overall effectiveness cannot be assured; pending results of pilot study; requires on-site monitoring	N

(1) Estimated costs reflect 1990 dollars.
Source: Testa, Stephen M. and Duane L. Winegardner. Restoration of Petroleum-Contaminated Aquifers. Lewis Publishers, Inc., Chelsea, Michigan. 1991.

TABLE 3-1 (Cont'd)

SOIL REMEDIATION OPTIONS
BUILDING 1958

OPTION	PROCESS	ESTIMATED COSTS(1)	PRACTICAL CONSTRAINTS	REMARKS	APPLICABLE TO SITE (Y/N)
Stream injection and stripping	Investigate extent of contamination and soil and groundwater conditions; conduct feasibility study; design and install steam injection and recovery system; permit system; operate system; monitor effectiveness on an ongoing basis	$100-200/yd³	Fine-grained soils limit ability to inject steam and recover fluids from soils	Overall effectiveness cannot be assured, pending pilot study results; O&M cost	N
Asphalt incorporation	Excavate and transport	$125/ton	Soil must pass flash-test before acceptance	Moderate costs, good option for low-volatile hydrocarbons affected soils	Y
No action	No action		No risk to public health, safety, and welfare. No risk to surface water or groundwater; considered of beneficial use	Site-specific	Y
Soil washing/extraction	Excavate; crush; mix with wash fluid; separate; replace; treat wash water		Limited to granular soils; wash fluid treatment may be difficult	Technically feasible; high cost; limited applications	N
In situ leaching	Construct infiltration and recovery systems; irrigate washing fluid; retrieve fluid; treat fluid	$150 to $200/yd³	Limited to permeable soil, and higher solubility hydrocarbons	Often used in conjunction with biotreatment practices, permit approval may be difficult	N
Aboveground leaching/replacement	Excavate; crush; place over collector bed; flush with wash fluid; replace; treat fluid		Total washing fluid collection, temperature, and odor control; requires fairly large open area	May be used in association with biotreatment, often effective; permitting not as difficult	N

(1) Estimated costs reflect 1990 dollars.
Source: Testa, Stephen M. and Duane L. Winegardner. Restoration of Petroleum-Contaminated Aquifers. Lewis Publishers, inc., Chelsea, Michigan. 1991.

3.3.1.1 Excavation

Any contaminated soils that are excavated from the site could be handled in the following ways:

- Excavation And Disposal as Solid Waste: this option is applicable due to it being economical on small projects. However, disposal of the soils in a permitted landfill may not remove the Navy from future liabilities.

- Excavation and Either Low Temperature Thermal Treatment or Asphalt Incorporation: These options may be useful if small trenches or sumps are constructed. These options would also be applicable for the total site due to the small extent of soil contamination at the site. These options may be useful for limited areas to reduce contaminants in the areas with the highest TPH concentrations.

3.3.1.2 Asphalt Stabilization

Stabilization of contaminated soils is an option where excavation is not warranted. However conducted as a preventative measure for soil contaminant leaching, soil stabilization utilizing an asphalt patch over the contaminated area can decrease the rate of soil contamination leaching into groundwater.

3.3.1.3 No Action

The no action alternative may be applicable when no threat to the environment from the contamination exists.

3.3.2 Product Recovery Technologies

The free-phase product observed at the site must be recovered as discussed in Subsection 3.2.1. Several technologies that may be applicable for the remediation of free-phased product are shown on Table 3-2. These technologies will be evaluated (with respect to advantages and disadvantages) in the following subsections. Please note that generic recovery technologies and not specific variations on each type of technology have been included in the following discussions.

3.3.2.1 Well Points

Well point technology consists of the installation of a number of small-diameter recovery wells on the perimeter of the free phase product plume. Each well point would be equipped with independent recovery equipment. Due to the low permeability of the soils and the nature of the contaminant, it would be necessary for the well points to be spaced close together. A considerable quantity of groundwater would be generated by this process.

This option will require considerable additional expense and may not be the best alternative for this site.

3.3.2.2 Recovery Wells

Recovery wells are a conventional, demonstrated technology, that are useful with sandy aquifers. The wells would be larger in diameter than a well point, and would be spaced further apart than within a well point system. Due to soil conditions present at the site, one or more recovery wells may be necessary to adequately remediate the site. A considerable quantity of groundwater would also be generated by this process.

Because of the soil conditions and type of contaminant present at the site, the concept of a recovery well system is not suitable for this site. However, free product recovery from MW-02 should be performed to accelerate the overall free product recovery operations. To enhance free product recovery from MW-02, the well should be utilized in conjunction with an excavated sump. The sump would be constructed to allow product to collect in the vicinity of MW-02, from where it can be skimmed out of the aquifer.

TABLE 3-2

SCREENING OF POTENTIAL PRODUCT RECOVERY ALTERNATIVES
BUILDING 1958

ALTERNATIVE	DESCRIPTION	CAPABILITY	LIMITATION	EVALUATION	APPLICABLE TO SITE (Y/N)
1. Passive Remediation	Take no action - continue groundwater monitoring to determine if product plume is migrating off-site.	Simplest, least costly option	Does not facilitate containment, control, or recovery of product.	The option does not actively improve site groundwater quality.	N
2. Subsurface Flow Controls (barriers)	Install slurry, membrane or structural walls around plume to isolate it and preclude further migration.	A conventional, demonstrated technology	This option is usually very expensive. Many slurry wall mixtures or membranes may not provide long-term durability.	This option does not actively improve site groundwater quality. It may not provide long-term benefits.	N
3. Well Points	Install several closely spaced small-diameter wells around the plume.	A conventional, demonstrated technology	Requires a large number of well points to be effective. Large quantities of water would be generated. Requires frequent maintenance.	Effective for sites with low permeability and shallow water table.	Y
4. Recovery Wells	Install groundwater/free product recovery wells at selected locations.	A conventional, demonstrated technology	Several wells required to renovate the aquifer. Usually suited for use in sandy aquifers.	Effective for sites with groundwater levels more than 25 feet deep.	N
5. Large-Diameter Sumps	Install a few large-diameter sumps at selected locations.	A conventional, demonstrated technology	Only effective in shallow aquifers with low permeabilities.	May be effective in shallow conditions where low permeabilities exist.	Y
6. Interceptor Trenches	Construct trenches with sumps at right angles to existing groundwater flow patterns.	A conventional, demonstrated technology	Only effective in shallow aquifers with low permeabilities. Construction may disrupt facility operations. Installation may not be possible for areas.	May be effective in shallow conditions where low permeabilities exist. Construction is limited to open areas.	Y
7. In Situ Biotreatment	Utilize recovery and injection wells along with a fixed-film biotreatment unit to biodegrade contaminants.	A conventional, demonstrated technology	Requires large capital costs. Maintenance is usually extensive. Biotreatment is slow as compared to other remediation methods.	Presence of lead makes this option less effective.	N

Note: Estimated costs for remediation alternatives are not possible due to variables such as volume of groundwater to be removed, number of pumps required, etc.

3.3.2.3 Interceptor Trenches

An interceptor trench is excavated downgradient of a plume for the purpose of intercepting and preventing further migration of free-phased product. The trench is dug to a depth several feet below the water table, and should be long enough to intercept the full lateral extent of the plume. The trench must also be perpendicular to local groundwater flow direction. As the product plume migrates, free product accumulates in the trench and can be recovered manually or with pumps. An impermeable liner can be placed on the downstream side of the trench to eliminate free product from moving past the trench. Pumps may also be installed within sumps or wells located within the trench to increase the rate of recovery.

This option can inhibit the migration of the product plume. Because of the low permeabilities of the soils, the interceptor trench is evaluated as being an efficient method to contain the contaminant plume and recover free product.

3.4 RECOMMENDATIONS

A discussion of the various options for the remediation of soil and groundwater at Building 1958 is provided in Subsections 3.3.1 and 3.3.2. The remediation endpoints and recommended technologies are summarized in Table 3-3. Based on the information provided by the Site and Risk Assessments the following actions are recommended:

- Soil at the site should be directly remediated only in areas where excavation is necessary. Soil stabilization in an applicable option with the use of an asphalt patch.

- The recommended option for the remediation of soils that are excavated is low-temperature thermal reduction.

- Free-phase product will be recovered until a significant layer (1/8-inch or greater) is not identified in the monitoring wells at the site.

- Applicable product recovery methods would include the construction of an interceptor trench and/or an excavated sump area with a large diameter well to inhibit product migration. The large diameter well(s), installed within the trench and/or sump area, would be placed in the vicinity of Building 1958.

TABLE 3-3

SUMMARY OF RECOMMENDED REMEDIATION ALTERNATIVES
BUILDING 1958

CONTAINMENT PHASE	PROPOSED ENDPOINT	ENDPOINT EVALUATION	RECOMMENDED REMEDIATION ALTERNATIVE
Vapor	Not applicable	The nature of the contamination is primarily comprised of semivolatile compounds. Vapor monitoring and remediation is not practical for this contaminant.	Not applicable
Soil	Present site conditions.	Soil contaminants appear to be spread by product migration with the groundwater. Excavation of the entire site is not practical or necessary based on low risk.	Soils recovered during excavation activities should be transproted off-site for disposal/treatment. The recommended method of disposal/treatment is low-temperature thermal treatment. Soil may also be stabilized by use of an asphalt patch.
Groundwater	Present site conditions.	Based on the nature of the contaminant and the site hydrogeologic conditions (soil type, groundwater flow direction, and rate), and low risk to health, no groundwater remediation is recommended.	Any groundwater recovered by free product removal activities will be transported off-site, with the free product, and disposed of by a permitted facility.
Product	<1/8-inch	State guidelines request that free product be removed from the environment.	Product recovery pumps installed within final recovery system. An interceptor trench or a large diameter well in a sump would be the recommended recovery system. These systems will produce a suitable barrier to contain the free product.

APPENDIX A

SWCB SITE CHARACTERIZATION REPORT CHECKLIST

SITE CHARACTERIZATION REPORT CHECKLIST

Site: Building 1958, NWS Yorktown, VA PC# 92-2002 Region Tidewater

The following checklist must be filled out by the Responsible Party (RP) and/or the RP's Consultant and included in the Site Characterization Report. **Indicated on the checklist the page and section number where each item is addressed in the attached report.** Also indicate on the checklist the section and page number where justification is given for items omitted from the attached report. The contents of the report should reflect and be commensurate with the nature of the release, degree of contamination and complexity of the site investigation.

A copy of the Initial Abatement Measures Report must be attached to or included in the Site Characterization Report.

Items marked with an * are required as part of the CAP Permit Application.

1. SITE ASSESSMENT

PAGE / SECTION

29 / 1.5.1 Nature and quantity of release
32 / 1.5.1 *Physical and chemical properties of released product
NA / NA Free Product Removal Report
5 / 1.1.1 Tank information (capacity, location, contents)
18 / 1.4 Geologic/hydrogeologic site information
- 18 / 1.4.1 Site geology
- 1 / 1.4.2 Subsurface conditions (fractures, solution cavities, lenses, depth to groundwater)
- 10 / 1.2.3.2 Pumping/injection wells
- App. C / App. C Drillers/geologic logs and construction details for all wells and boreholes
- 21 / 1.4.2 Aquifer characteristics
  - 21 / 1.4.2 Name
  - 18 / 1.4.1 Thickness
  - 24 / 1.4.2.1 Conductivity
  - 24 / 1.4.2.1 Transmissivity
  - 25 / 1.4.2.1 Hydraulic gradient
  - 25 / 1.4.2.1 Flow velocity/direction
  - 20 / 1.4.1 Hydrogeologic cross section

9 & 11 / 1.2 Information as to water resources within 1000 ft of site (wells, springs, surface water)
5 / 1.2.1 Information as to adjacent property owners and potentially affected ground and surface water users (names, addresses, telephone numbers)
5 / 1.1.1 Information on historical releases at the site as well as historical releases from USTs located on adjacent property
NA / NA Construction information on potentially affected wells
7 / 1.2.3.1 Current and projected groundwater/land use
32 / 1.5.2 Description of vertical and lateral extent of contamination
- 34 / 1.5.2 Free product phase
- 34 / 1.5.2 Dissolved phase
- 32 / 1.5.2 Residual phase
- 32 / 1.5.2 Vapor phase

25 / 1.4.2 Plume migration direction and rate
25-29 / 1.4 *Sampling /monitoring results

NOTE: All lab sheets and tables submitted in the SCR must have sample media, analytical method used, detection limit method, unit of measure, sample depths, and sample locations. Sampling results from BTEX analysis must be reported individually and totaled.

Site maps/sketches (combine when appropriate and to scale when possible)

2 / 1.0 *Locus map on 7.5 min. quad. or county highway map
4 / 1.0 *Base map with property lines and physical features (buildings, roads, etc.)
4 / 1.0 *Location of source(s) of contamination at site
4 / 1.0 Sample locations (water, vapor, and/or soil)
- 4 / 1.0 Excavation pits
- 20 / 1.4.1 Surficial soils
- 2-3 / 1.0 Surface waters
- 41 / 2.2 Basements/conduits (and/or soil vapor surveys)
- 4 / 1.0 Monitoring wells
- 12 / 1.2.6 Domestic wells
- 12 / 1.2.6 Public supply wells
- NA / NA Springs

4 / 1.0 Boring locations
4 / 1.0 Observation well locations
23 / 1.4.2.1 Groundwater flow direction map
41 / 2.2 Subsurface conduits (telephone, water, sewer, power, dispenser piping)
10 / 1.2.3.2 *Potentially affected wells/streams/springs
10 / 1.2.3.3 *Flood plain designation
32 / 1.5.2 Isoconcentration or plume delineation map for each affected aquifer and/or soil zone for all phases present (cross-sectional and map view)
- 35 / 1.5.2 Free product
- 36 / 1.5.2 Dissolved
- 35 / 1.5.2 Residual
- NA / NA Vapor

FOR OFFICE USE ONLY

COMMENTS: ____________________

DEFICIENCIES: ____________________

2. RISK ASSESSMENT

39 / 2.1 Description of demographics (population)
39 / 2.2 Impacted and potentially impacted receptors (human/wildlife/forestry, etc.)
40 / 2.3 Exposure pathways for receptors
- 40 / 2.3 Ingestion
- 40 / 2.3 Dermal contact
- 40 / 2.3 Inhalation
- NA / NA Other

40 / 2.4 Exposure levels for receptors
- 43 / 2.4 Exposure level determination
  - NA / NA Tap water sample
  - 43 / 2.5 Direct well sample (monitoring wells)
  - NA / NA Surface water sample
  - NA / NA OVA and location of measurement
  - 44 / 2.5 Extrapolation
  - NA / NA Other

44 / 2.5 Evaluation of existing/potential risk to receptors (based on contaminant levels, exposure levels, frequency of exposure)
44 / 2.5 Evaluation of existing/potential risk to environment (based on contaminant levels, fate and transport, etc.)
NA / NA Evaluation/provision of alternate water supply

FOR OFFICE USE ONLY

COMMENTS:

DEFICIENCIES:

3. REMEDIATION ASSESSMENT

__46__/_3.0__ Remediation feasibility
__47__/_3.2.2_ Projected remediation endpoints based on site, risk, and remediation assessments
  __47__/_3.2.2_ Free product
  __47__/_3.2.2_ Dissolved
  __47__/_3.2.2_ Residual
  __47__/_3.2.2_ Vapor
__47__/_3.3__ Description & evaluation of applicable technologies
  __47__/_3.3__ Design for each applicable technology
  __47__/_3.3__ Timeframe for implementation and duration for each applicable technology to achieve projected remediation endpoints
  __48__/_3.3__ Projected costs for each applicable technology to achieve projected remediation endpoints
  __54__/_3.4__ Achievable endpoints for each applicable technology
    __54__/_3.4__ Free product
    __54__/_3.4__ Dissolved
    __54__/_3.4__ Residual
    __54__/_3.4__ Vapor
  __54__/_3.4__ Estimated timeframe for achieving endpoints for each applicable technology
    __54__/_3.4__ Free product
    __54__/_3.4__ Dissolved
    __54__/_3.4__ Residual
    __54__/_3.4__ Vapor
  __54__/_3.4__ Immediate/future beneficial results for each applicable technology
__53__/_3.4__ Recommendation of most appropriate technologies with costs
__1__/_1.1.1_ Site Characterization Report submitted within 45 days of release confirmation or extension granted

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COMMENTS:____

DEFICIENCIES:____

REVIEWEDBY:________________________ DATE:____________

APPENDIX B

INITIAL ABATEMENT MEASURES REPORT

DEPARTMENT OF THE NAVY
NAVAL WEAPONS STATION
YORKTOWN, VIRGINIA 23691 -5000

5090.22A
177
15 May 92

Mr. David Borton
State Water Control Board
Tidewater Regional Office
287 Pembroke Office Park
Suite 310 Pembroke Two
Va. Beach, Va. 23462-2955

Dear Mr. Borton:

This letter concerns the Diesel fuel release from the emergency generator fuel system at building 1958 on the Naval Weapons Station, Yorktown, Va. (SWCB PC#92-2002). As you requested in your letter dated May 5, 1992, two copies of our Initial Abatement Measures Report are attached.

As discussed with Ms. Erin Tisdell on April 28, 1992, a Site Characterization Report will be required for this release. Due to the contracting regulations, we will not meet your June 12, 1992 deadline. We therefore request a written sixty (60) day extension to the deadline as soon as possible so that we may avoid any Notices of Violation.

Due to our limited in-house capability, we would appreciate any assistance that you may be able to give us in properly assessing this situation. If you have any questions please contact Mr. Jim Reeve at (804) 887-4881.

Sincerely,

Monica R. Shephard

MONICA R. SHEPHARD
By direction

Site: Naval Weapons Station, Bldg. 1958 PC# 92-2002 Region ________

The following checklist must be filled out by the Responsible Party (RP) and/or the RP's Consultant and included in the Initial Abatement Report. **Indicate on the checklist the page and section number where each item is addressed in the attached report.** Also indicate on the checklist the section and page number where justification is given for items omitted from the attached report. The contents of the report should reflect and be commensurate with the nature of the release, degree of contamination and complexity of the site investigation.

1. RELEASE INVESTIGATION AND CONFIRMATION STEPS

Page	/Section	
1	/ 1.0	Evidence for suspecting a release has occurred
1	/ 1.0	Monitoring results from release detection used
1	/ 1.0	Results of tank/line tightness test
1	/ 1.0	Actions taken to repair, replace, upgrade UST

2. SITE CHECK

1	/ 2.0	Measures taken to identify the source of release
1	/ 2.0	Depth to ground water
1	/ 2.0	Description and justification of sampling
	/	types (ground water, soil)
	/	locations (include site map)
	/	parameters, EPA methods, units, and detection limits

3. INITIAL ABATEMENT MEASURES

1	/ 3.0	Release inspection results and measures taken to prevent further migration of contaminates into soils and ground water
1	/ 3.0	Regulated substance removed from UST system
1	/ 3.0	Efforts to mitigate fire and safety hazards
1	/ 3.0	Efforts to measure for the presence of free product
1	/ 3.0	Efforts to remove free product
1	/ 3.0	Measures taken, as part of Initial Abatement, to address contaminated ground water and soils, tank water and sludges, and debris (i.e. tanks, piping, concrete) Include permits
1	/ 3.0	Initial Abatement Measures Report submitted within 20 days of release confirmation or extension granted

FOR OFFICE USE ONLY

COMMENTS: ____________________

DEFICIENCIES: ____________________

REVIEWED BY: ____________________ DATE: ____________

INITIAL ABATEMENT MEASURES REPORT

1.0 RELEASE INVESTIGATION AND CONFIRMATION STEPS

This release was the result of corroded supply and return fuel lines (four total) for an emergency generator system located at the sewage lift station. The lines connected an aboveground outdoor tank to an aboveground day tank inside the building, which was connected to an outdoor generator. The lines were about two feet below ground and were about twenty-five feet in length. The integrity of the tanks were not compromised. The release was detected when the utilities personnel noticed fuel buildup in a bypass valve box located just outside the building. Upon investigation, we found that the lines were severly pitted and had multiple pin-sized holes in them, only about six feet of piping was exposed and at least five holes were noticed. This system was installed about ten years ago, and there seems to be no way to determine how long the pipes have been leaking or how much has been released. We feel it is extensive due to the extent of corrosion, the amount of holes noticed in such a short lenght of pipe, and the fact that fuel was contantly in the lines. We also performed some initial borings using a hand auger and found lateral contamination twelve feet away from the excavated area, at a depth of about four feet below ground level. Enclosure (1) shows an overview of the area. The system will be put back in operation by running aboveground copper fuel lines directly from the outdoor tank to the generator. We do not plan to request Interim Authorization to perform any excavation because of the severity of the leak.

2.0 SITE CHECK

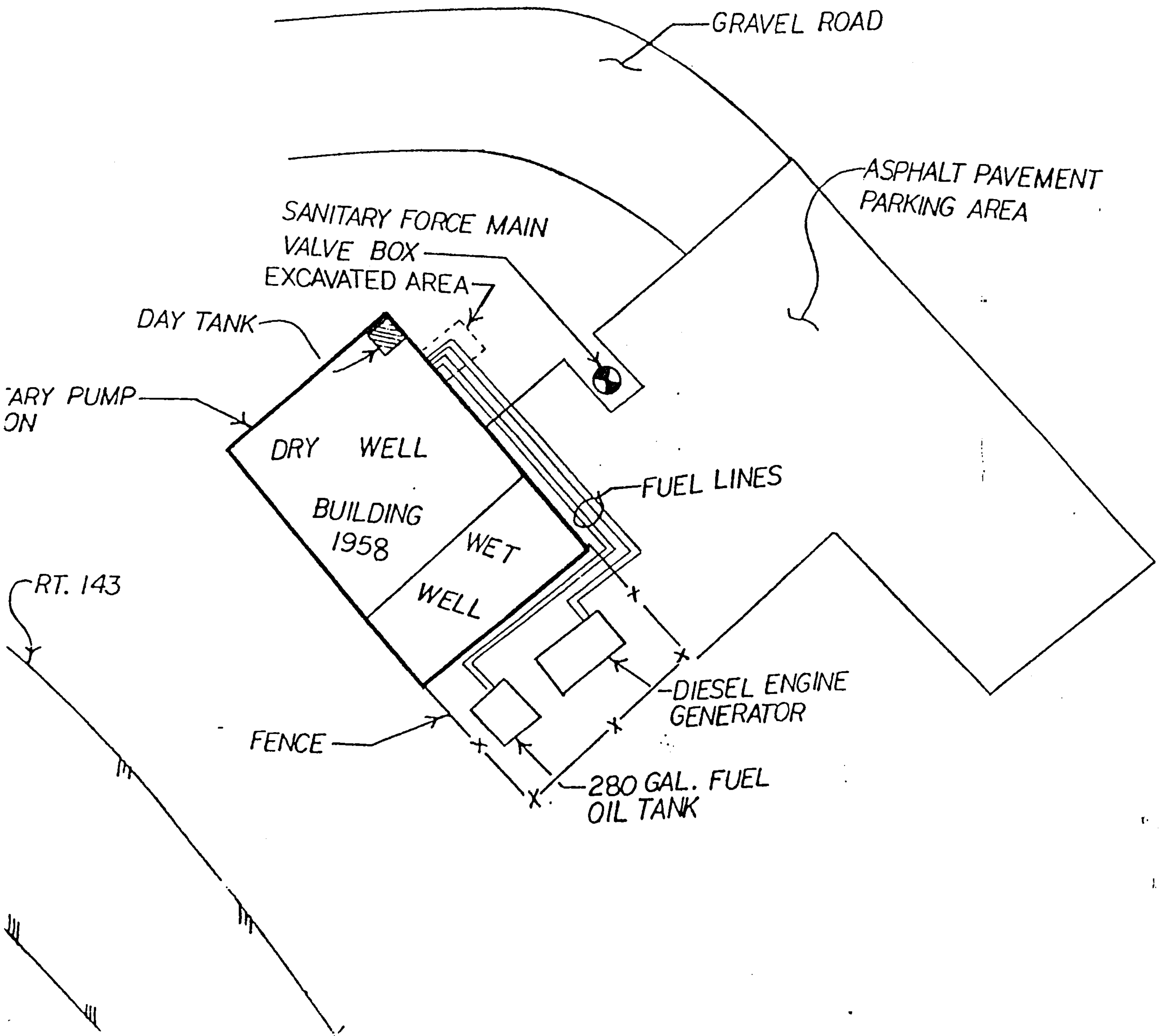
Due to the physical circumstances of the release, we were confident of the source of the release and did not investigate other possibilities. The groundwater table in the area is about 23 feet below grade and the nearest surface body of water is 3000 feet away (Skiffes Creek). There are no reasons why the groundwater table would change substantially over time. Due to the amount of contamiantion, we plan to initiate sampling when the Site Characterization begins.

3.0 INITIAL ABATEMENT REPORT

The lines have been disconnected, drained of all fuel, and pose no risk to the environmnet or station personnel. The immediate area has been covered with plastic to prevent further migration due to rainwater. There was no free product visible, so none was recovered. Fire hazard is minimal because the fuel is Diesel, all contamination is below ground level, and the area surrounding the tank is well ventilated. The safety hazard was also minimized because no "Hot Work" took place, and there was no confined space entry.

Prepared by [illegible] 5.15.92

Approved by [illegible] 15 May 1992


GRAVEL ROAD
ASPHALT PAVEMENT PARKING AREA
SANITARY FORCE MAIN VALVE BOX
EXCAVATED AREA
DAY TANK
ARY PUMP
ON
DRY WELL
BUILDING 1958
WET WELL
FUEL LINES
RT. 143
DIESEL ENGINE GENERATOR
FENCE
280 GAL. FUEL OIL TANK

ENCL.1

APPENDIX C

BOREHOLE LOGS

WESTON

BOREHOLE LOG

PROJECT ID - PHASE: CTO-143

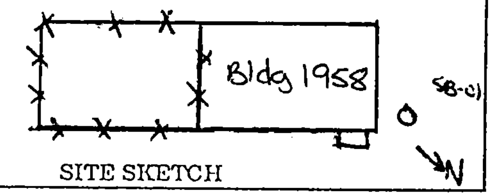
FACILITY ID Yorktown (NWS)

LOCATION ID 143-SB-01 (MW-01)

DATE ESTABLISHED 8-11-92 (DD-MMM-YY)

ESTABLISHING COMPANY HHI

LOCATION DESCRIPTION Bldg. 1958



SITE SKETCH

BOREHOLE DIAMETER (IN) 8

TOTAL DEPTH (FT) 22

WATER ENCOUNTERED (FT) 12

TOP OF BEDROCK (FT) N/A

DRILLING/EXCAVATING METHOD B-61 mobile

DRILLING/EXCAVATING COMPANY HHI

TIME (HHMM)	SAMPLE ID	BEGIN DEPTH (FT)	END DEPTH (FT)	ppm SOIL/ROCK TYPE HNu	GEOL MAT TYPE	RECOV (FT) %	BLOW COUNT	DESCRIPTION
1300		0	2	0	SC	75	2-1-2-2	18" yellow gray sandy clay, organics, no odor, plastic, med. density, damp.
1302		2	4	0	SC	50	2-2-1-2	12" yellow gray sandy clay, no odor, plastic, med. density, dry
1305	143-SB-01-01 & 01A	4	6	50	SS	50	1-2-2-2	12" yellow silty sand, fine grained, dense, med. plasticity, strong odor, damp
1310		6	8	12	SC	100	3-4-7-8	24" light gray, fine grained sandy clay, dense, NP, strong odor, dry
1315		8	10	15	SC	100	4-5-10-9	SAME
1320	143-SB-01-02	10	12	40	SC	100	6-7-9-7	12" SAME 12" ORANGE MED. grained sandy clay, dense, NP, strong odor, saturated
1325		12	14	75	SC/SS	50	2-4-7-9	6" fine grained, white sandy clay, dense, plastic, strong odor, saturated 6" orange, coarse grained silty sand, slight odor, NP, saturated
1330		14	16	75	SC/SC	100	2-4-2-2	12" TAN, fine grained, sandy clay, strong odor, dense, plastic, damp 12" yellow orange med. grained SANDY CLAY, dense, plastic, strong odor, damp
1335		16	18	120	C	100	4-2-2-2	24" orange clay, stiff, plastic, strong odor, damp
1340		18	20	80	C	100	2-1-2-2	SAME
1345		20	22	45	C/F	100	2-1-2-2	12" SAME 12" Fossiliferous sediments, loose, NP, strong odor, saturated.

Figure 3. Borehole Log

WESTON

BOREHOLE LOG

PROJECT ID - PHASE: CTO-143

FACILITY ID Yorktown (NWS)

LOCATION ID 143-SB-02

DATE ESTABLISHED 8-12-92 (DD-MMM-YY)

ESTABLISHING COMPANY HHI

LOCATION DESCRIPTION Bldg. 1958

BOREHOLE DIAMETER (IN) 8

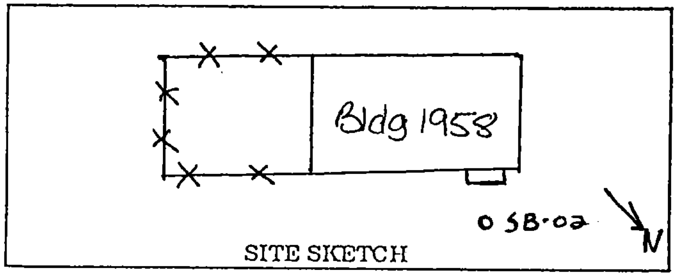
TOTAL DEPTH (FT) 22

WATER ENCOUNTERED (FT) 21

TOP OF BEDROCK (FT) N/A

DRILLING/EXCAVATING METHOD B-61 Mobile

DRILLING/EXCAVATING COMPANY HHI



SITE SKETCH

TIME (HHMM)	SAMPLE ID	BEGIN DEPTH (FT)	END DEPTH (FT)	SOIL ROCK TYPE (ppm HNU)	GEOL MAT TYPE	RECOV (FT) %	BLOW COUNT	DESCRIPTION
0745		0	2	0	SC	50	8-10-7-9	12" yellow-gray sandy clay, damp, no odor, dense, plastic
0750		2	4	2	SC	100	4-6-11-10	24" Same
0755	143-SB-02-01 / 01A	4	6	25	SS/SS	100	2-1-3-2	12" gray, fine grained silty sand, dense, NP, slight odor, damp 12" yellow, fine grained silty sand, dense, NP, slight odor, damp
0800		10	12	0	SC/SC	100	6-8-11-13	12" light gray, fine grained, sandy clay, dense, no odor, damp, NP 12" orange, med. grained, sandy clay, dense, no odor, damp, NP
0805		12	14	0	C	100	5-8-10-12	24" gray mottled clay, dense, plastic, no odor, damp
0810		15	17	0	C/C	100	3-6-8-8	12" Same 12" orange-gray mottled clay, dense, plastic, no odor, damp
0830	143-SB-02-02	20	22	5	SC/C	100	1-2-3-2	6" tan-yellow sandy clay, dense, plastic, slight odor, saturated 18" orange clay, plastic, dense, slight odor, damp

Figure 3. Borehole Log

WESTON

BOREHOLE LOG

PROJECT ID - PHASE: CTO-143

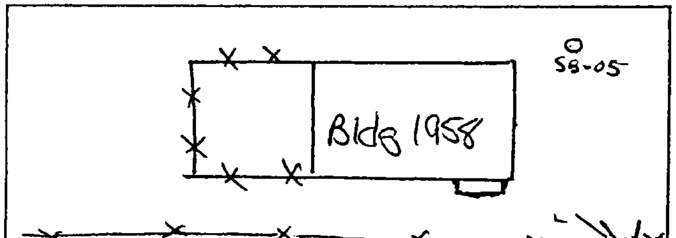
FACILITY ID Yorktown (NWS)

LOCATION ID 143-SB-05

DATE ESTABLISHED 8-12-92 (DD-MMM-YY)

ESTABLISHING COMPANY HHI

LOCATION DESCRIPTION Bldg. 1958



SITE SKETCH

BOREHOLE DIAMETER (IN) 8

TOTAL DEPTH (FT) 17'

WATER ENCOUNTERED (FT) 16'

TOP OF BEDROCK (FT) N/A

DRILLING/EXCAVATING METHOD B-61 Mobile

DRILLING/EXCAVATING COMPANY HHI

TIME (HHMM)	SAMPLE ID	BEGIN DEPTH (FT)	END DEPTH (FT)	~~SOIL ROCK TYPE~~ PPM HNU	GEOL MAT TYPE	RECOV (FT)	BLOW COUNT	DESCRIPTION
1650		0	2	7	SC	100	2-2-5-7	Yellow-gray sandy clay, organics, fine grained; dense, no odor, damp, plastic
1655		2	4	8	SC	100	5-6-7-9	Same
1700	143 SB-05-01	4	6	5	SC	100	4-7-9-12	SAME
1710		10	12	65	C	100	7-9-9-16	GRAY-ORANGE CLAY, ~~STIFF~~, dense, PLASTIC, NO odor, dry
1715	143 SB-05-02	15	17	110	C / SS	100	4-6-8-8	18" SAME 6" ORANGE, coarse grained, silty sand, med. density, slight odor, NP, Saturated

Figure 3. Borehole Log

Revised 01-MAY-91

APPENDIX D

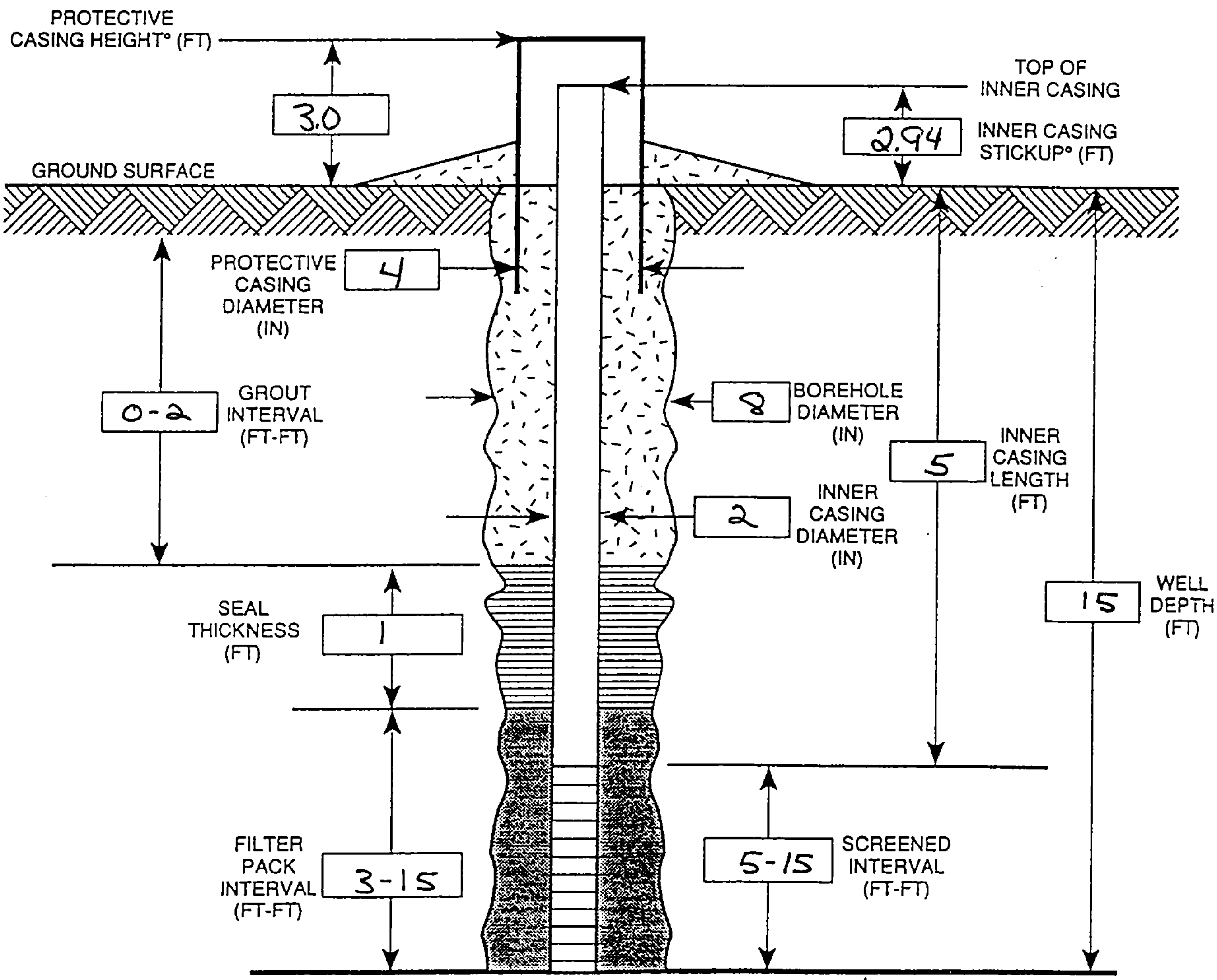
WELL CONSTRUCTION DIAGRAMS

WELL COMPLETION INFORMATION

(SINGLE CASED, SCREENED)

PROJECT ID - PHASE: TE-CTO-143
FACILITY ID Yorktown (NWS)
WELL LOCATION ID 143 SB-01 (MW-01)
SCREENED LENGTH (FT) 10
INNER CASING LENGTH (FT) 5
INNER CASING MATERIAL SCH40 PVC
SCREEN SLOT SIZE (IN) 0.01
REMARKS

WELL COMPLETION METHOD S S
INSTALLATION DATE * 8-11-92
INSTALLING COMPANY HHI (___)
PURGE PUMP TYPE (___)
SAMPLE PUMP TYPE (___)
PURGE PUMP DEPTH (FT)
SAMPLE PUMP DEPTH (FT)
WELL YIELD BEGINNING (GPM)



G34-240a

*DATE: DD-MMM-YY
°ESTIMATED

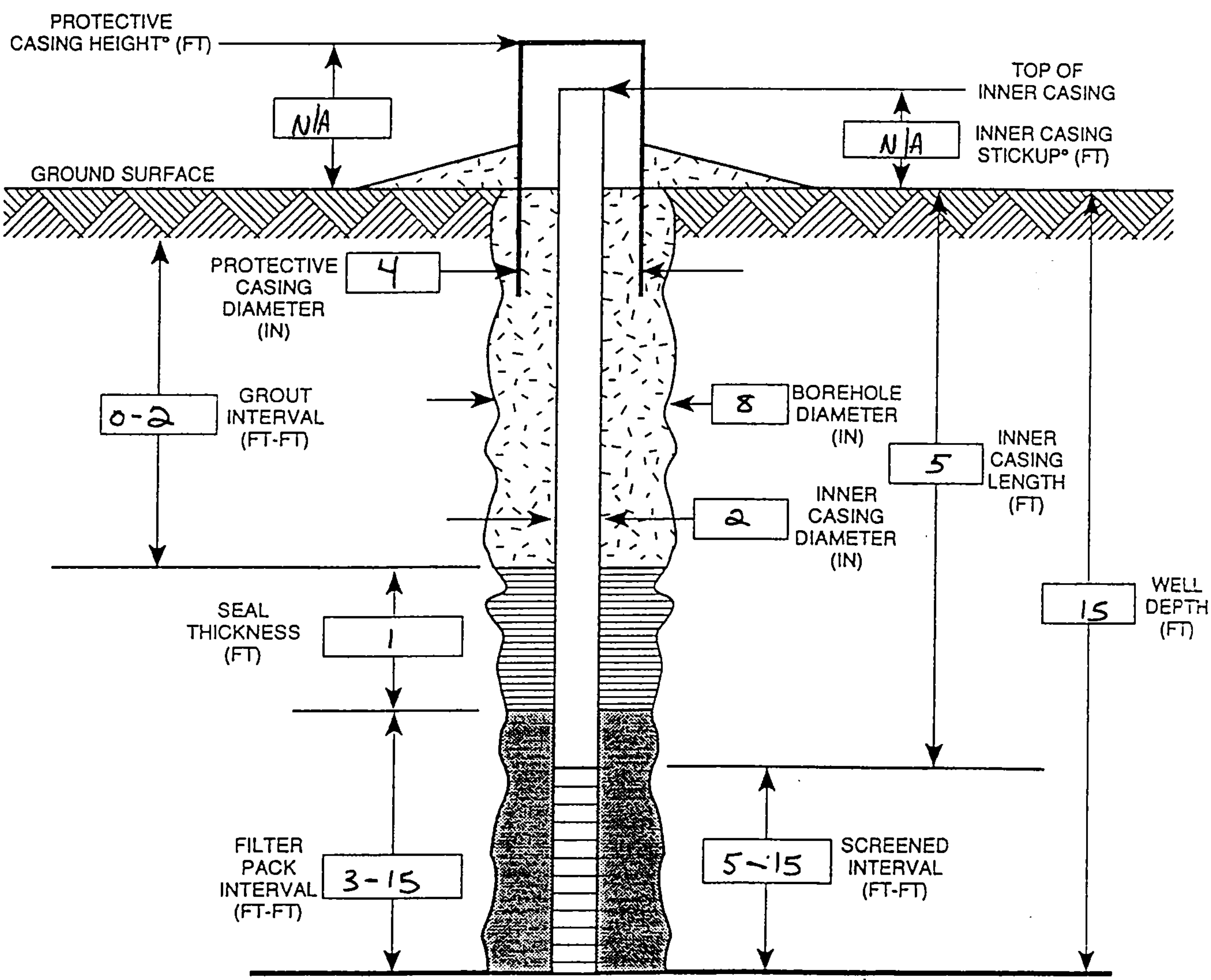
Figure 4. Well Completion Form

Revised 12-19-89

WELL COMPLETION INFORMATION
(SINGLE CASED, SCREENED)

PROJECT ID - PHASE: TE-CTO-143
FACILITY ID Yorktown (NWS)
WELL LOCATION ID 1435B-04 (mw03)
SCREENED LENGTH (FT) 10
INNER CASING LENGTH (FT) 5
INNER CASING MATERIAL SCH40 (PVC)
SCREEN SLOT SIZE (IN) 0.01
REMARKS

WELL COMPLETION METHOD S S
INSTALLATION DATE* 8-12-92
INSTALLING COMPANY HHI (___)
PURGE PUMP TYPE (___)
SAMPLE PUMP TYPE (___)
PURGE PUMP DEPTH (FT)
SAMPLE PUMP DEPTH (FT)
WELL YIELD BEGINNING (GPM)



G34-240a

*DATE: DD-MMM-YY
°ESTIMATED

Figure 4. Well Completion Form

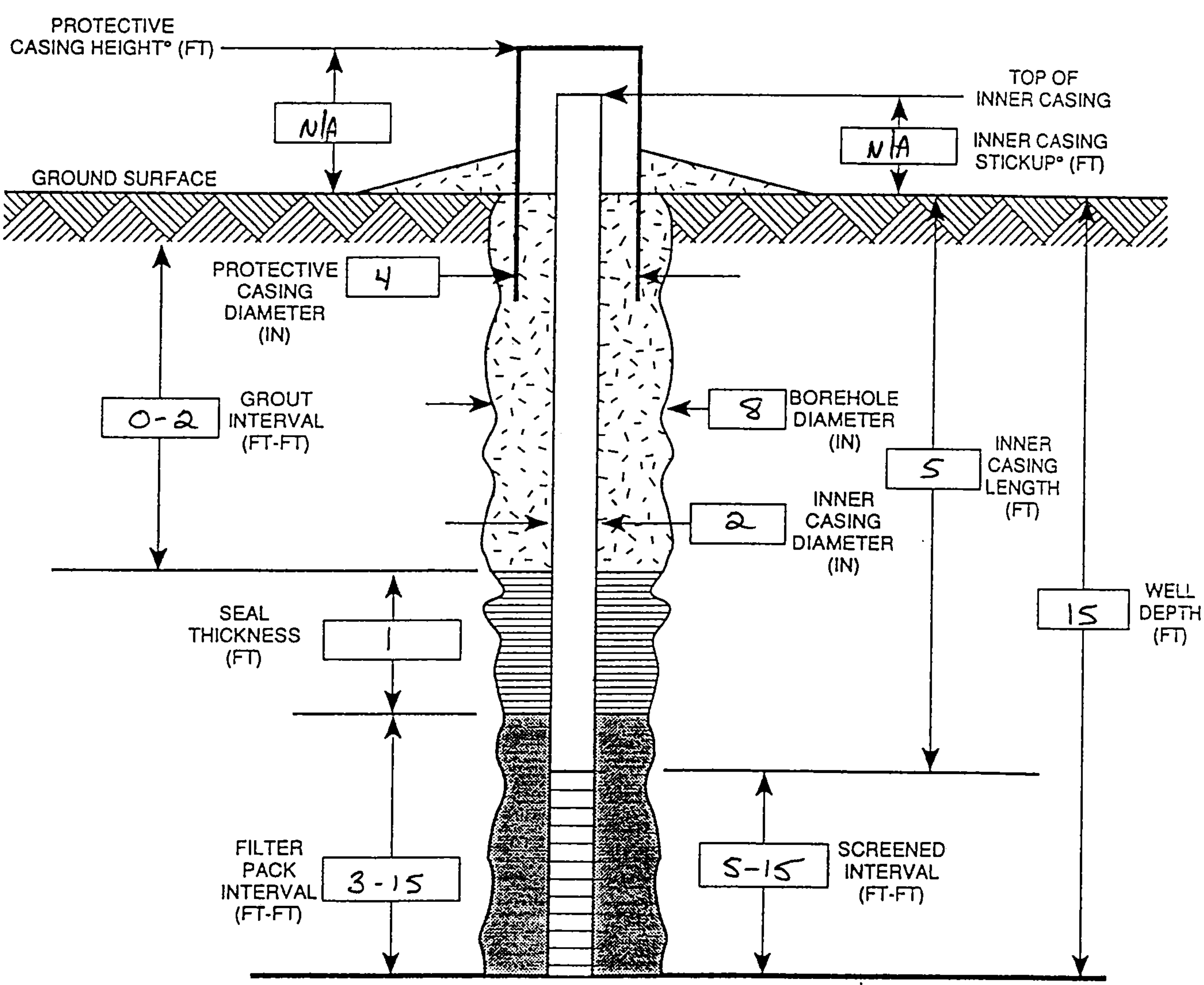
Revised 12-19-89

WELL COMPLETION INFORMATION

(SINGLE CASED, SCREENED)

PROJECT ID - PHASE: TE-CTO-143
FACILITY ID Yorktown(NWS)
WELL LOCATION ID 143-SB-03 (MW-02)
SCREENED LENGTH (FT) 10
INNER CASING LENGTH (FT) 5
INNER CASING MATERIAL SCH40 PVC)
SCREEN SLOT SIZE (IN) 0.01
REMARKS

WELL COMPLETION METHOD S S
INSTALLATION DATE * 8-12-92
INSTALLING COMPANY HHI (___)
PURGE PUMP TYPE (___)
SAMPLE PUMP TYPE (___)
PURGE PUMP DEPTH (FT)
SAMPLE PUMP DEPTH (FT)
WELL YIELD BEGINNING (GPM)



G34-240a

*DATE: DD-MMM-YY
°ESTIMATED

Figure 4. Well Completion Form

Revised 12-19-89

WESTON

WELL COMPLETION INFORMATION

(SINGLE CASED, SCREENED)

PROJECT ID - PHASE: TE-CTO-143

FACILITY ID Yorktown(NWS)

WELL LOCATION ID 143-SB-06 (MW-04)

SCREENED LENGTH (FT) 10

INNER CASING LENGTH (FT) 5

INNER CASING MATERIAL SCH40 PVC)

SCREEN SLOT SIZE (IN) 0.01

REMARKS

WELL COMPLETION METHOD S S

INSTALLATION DATE * 8-14-92

INSTALLING COMPANY HHI (___)

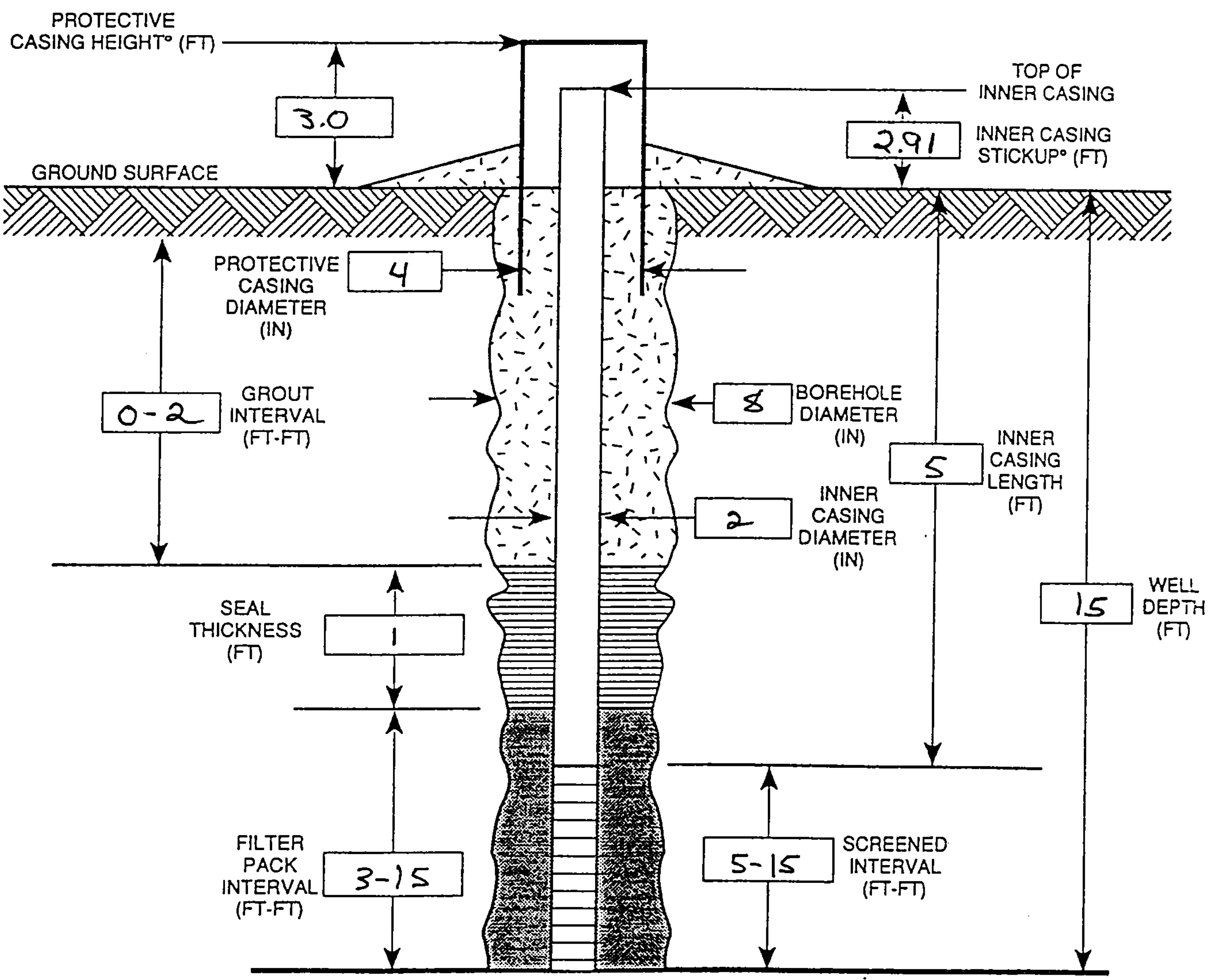
PURGE PUMP TYPE (___)

SAMPLE PUMP TYPE (___)

PURGE PUMP DEPTH (FT)

SAMPLE PUMP DEPTH (FT)

WELL YIELD BEGINNING (GPM)



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*DATE: DD-MMM-YY
°ESTIMATED

Figure 4. Well Completion Form

Revised 12-19-89

WESTON

WELL COMPLETION INFORMATION

(SINGLE CASED, SCREENED)

PROJECT ID - PHASE: TE-CTO-143

FACILITY ID Yorktown (NWS)

WELL LOCATION ID 113-SB-08 (mw-05)

SCREENED LENGTH (FT) 10

INNER CASING LENGTH (FT) 4

INNER CASING MATERIAL SCH40 PVC)

SCREEN SLOT SIZE (IN) 0.01

REMARKS

WELL COMPLETION METHOD S S

INSTALLATION DATE * 8-17-92

INSTALLING COMPANY HHI (___)

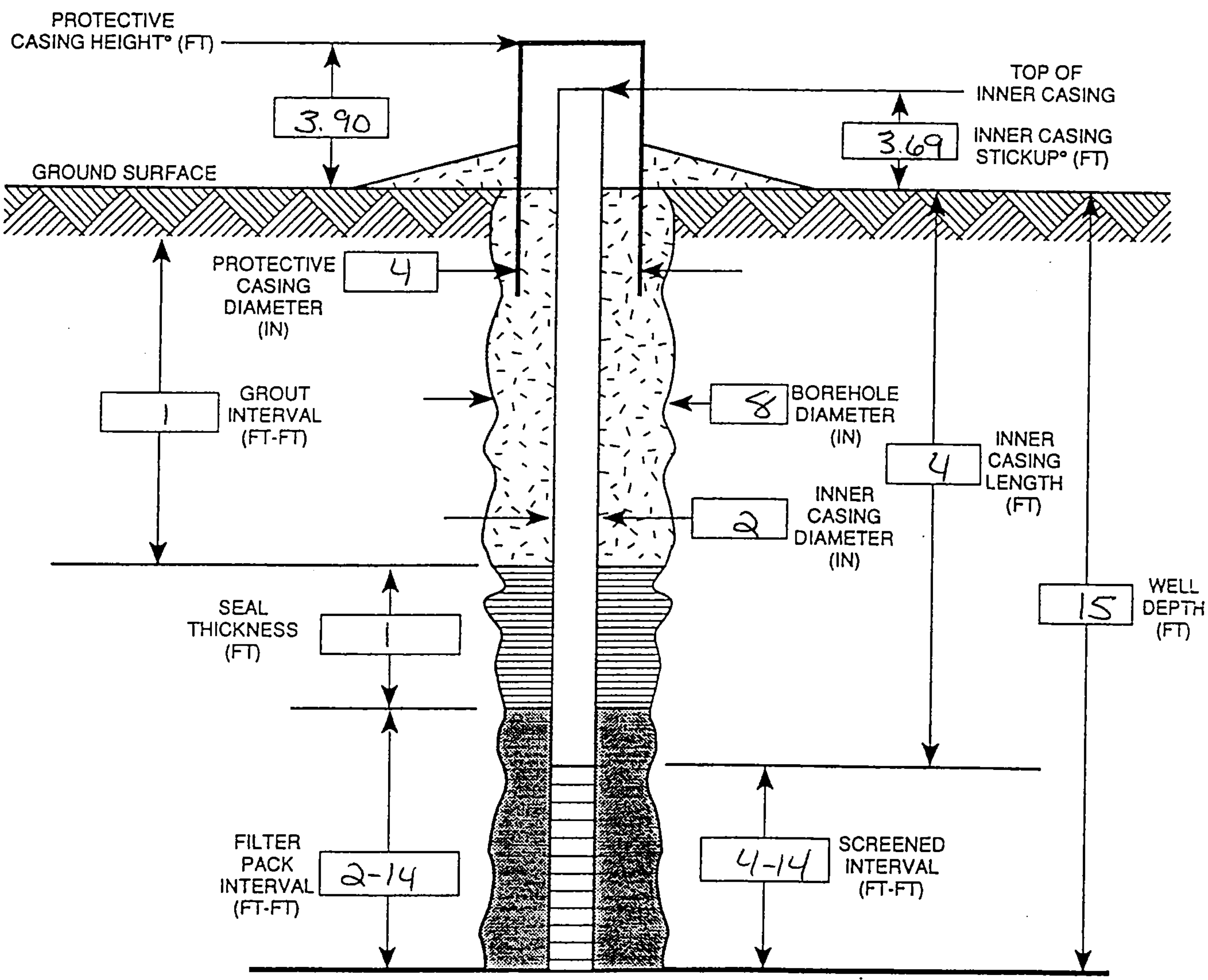
PURGE PUMP TYPE (___)

SAMPLE PUMP TYPE (___)

PURGE PUMP DEPTH (FT)

SAMPLE PUMP DEPTH (FT)

WELL YIELD BEGINNING (GPM)



G34-240a

*DATE: DD-MMM-YY
°ESTIMATED

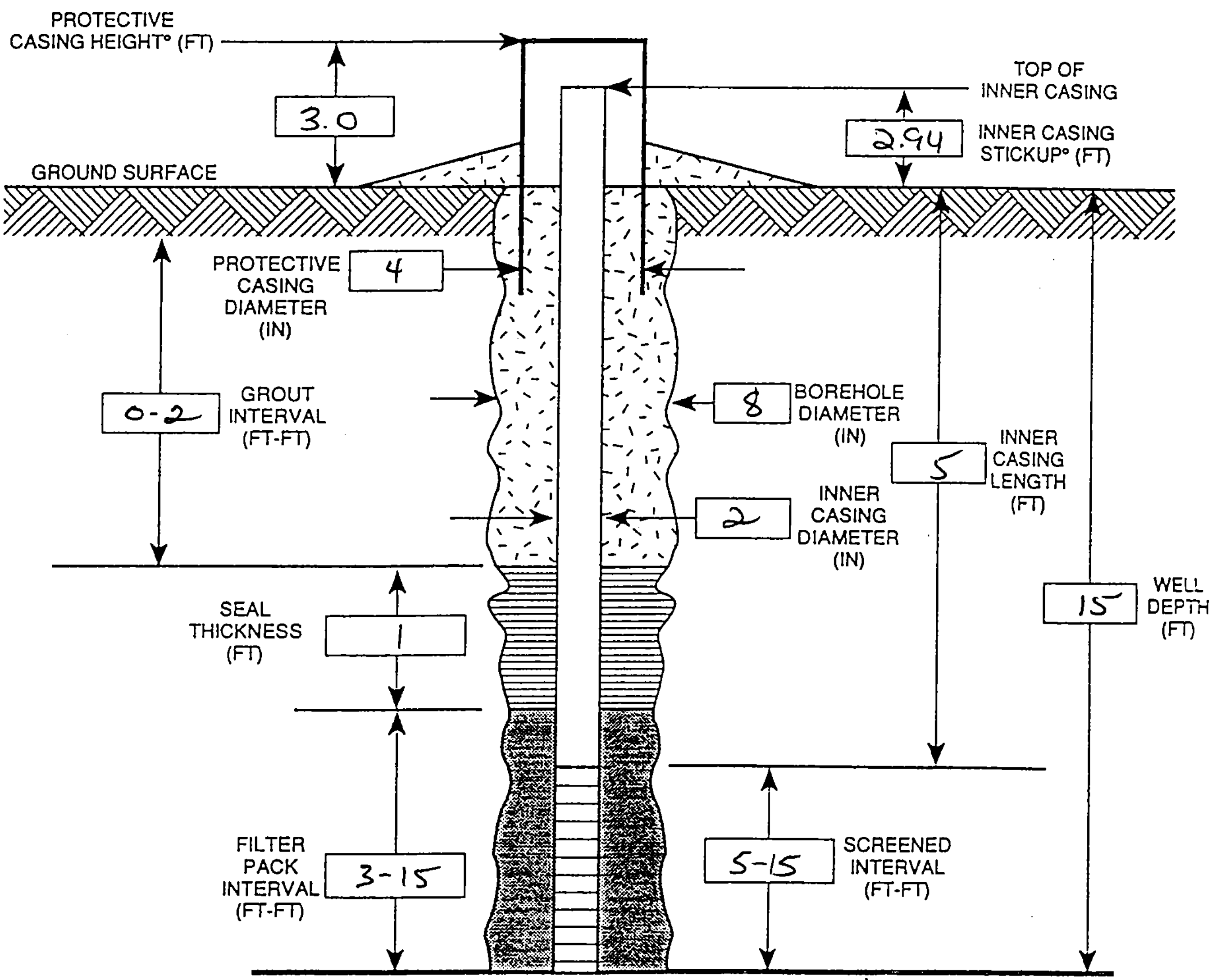
Figure 4. Well Completion Form

Revised 12-19-89

WELL COMPLETION INFORMATION
(SINGLE CASED, SCREENED)

PROJECT ID - PHASE: TE-CTO-143
FACILITY ID Yorktown (NWS)
WELL LOCATION ID 143-SB-09 (mw-06)
SCREENED LENGTH (FT) 10
INNER CASING LENGTH (FT) 5
INNER CASING MATERIAL SCH40 PVC)
SCREEN SLOT SIZE (IN) 0.01
REMARKS

WELL COMPLETION METHOD S S
INSTALLATION DATE * 8-18-92
INSTALLING COMPANY HHI (___)
PURGE PUMP TYPE (___)
SAMPLE PUMP TYPE (___)
PURGE PUMP DEPTH (FT)
SAMPLE PUMP DEPTH (FT)
WELL YIELD BEGINNING (GPM)



G34-240a

*DATE: DD-MMM-YY
°ESTIMATED

Figure 4. Well Completion Form

Revised 12-19-89

WESTON

WELL COMPLETION INFORMATION

(SINGLE CASED, SCREENED)

PROJECT ID - PHASE: TE-CTO-143

FACILITY ID Yorktown (NWS)

WELL LOCATION ID 143-SB-11

SCREENED LENGTH (FT) 10

INNER CASING LENGTH (FT) 5

INNER CASING MATERIAL SCH40 (PVC)

SCREEN SLOT SIZE (IN) 0.01

REMARKS

WELL COMPLETION METHOD S S

INSTALLATION DATE * 8-18-92

INSTALLING COMPANY HHI (___)

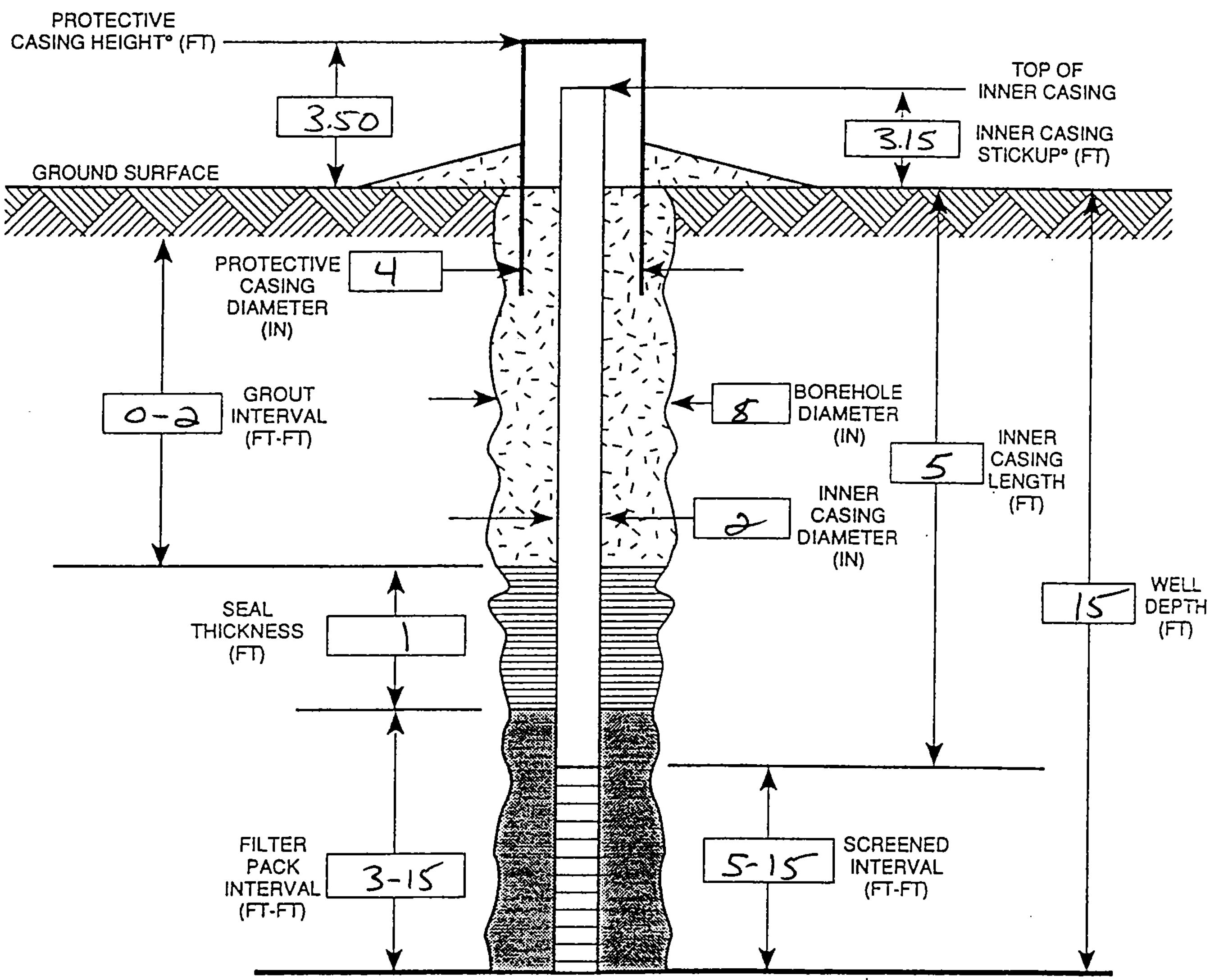
PURGE PUMP TYPE (___)

SAMPLE PUMP TYPE (___)

PURGE PUMP DEPTH (FT)

SAMPLE PUMP DEPTH (FT)

WELL YIELD BEGINNING (GPM)



G34-240a

*DATE: DD-MMM-YY
°ESTIMATED

Figure 4. Well Completion Form

Revised 12-19-89

GEOLIS Well Development Form

COMPANY: ROY F. WESTON
CLIENT: BAKER
PROJECT: CTO-143
SITE: YORKTOWN N.W.S.

WELL NO.: (MW01) 143-SB-01
DATE: 8-24-92
LOGGER: James E. Davis
SIGNATURE: James E. Davis

ONE WELL VOLUME: 1.83 gallons WELL TD: 18.61 ft TOC

Well Volume (gallons/foot): 2-inch = 0.16, 4-inch = 0.65, 6-inch = 1.47, 8-inch = 2.61

TIME	ACTIVITY CODE	DEPTH TO WATER (ft)	PURGE RATE (gpm)	PURGE VOLUME (gal)	FIELD MEASUREMENTS MTP (°C)	MSC	MPH		TURBIDITY	COMMENTS
1015	DBB	7.42		0	24	112	5.60		N	Salinity=0
1020				5	22	140	5.78		L	
1025	DBE			10	22	140	5.80		L	
										Depth to water measured from top of casing.
	FINAL									

DEVELOPMENT ACTIVITY CODES

DBB - Begin Bailing / DBE - End Bailing
DOB - Begin Overpumping / DOE - End Overpumping
DRB - Begin Rawhiding / DRE - End Rawhiding
DCB - Begin Recirculation / DCE - End Recirculation
DHB - Begin Hydraulic Jetting / DHE - End Hydraulic Jetting
DAB - Begin Air Surging / DAE - End Air Surging
DSB - Begin Surge Blocking / DSE - End Surge Blocking
DXB - Begin Other / DXE - End Other
Specify other method:
FME - Field Measurements (select from codes at right)

FIELD MEASUREMENT CODES

MTP - Temperature
MSC - Specific Conductance
MPD - Photoionizer (e.g., HNu)
MFD - Flame Ionizer (e.g., OVA)
MDO - Dissolved Oxygen
MPH - pH
MEH - Eh
MMC - Imhoff Cone
MO1 - Other:
MO2 - Other:

TURBIDITY

Enter Turbidity Meter Reading (Final should be < 5 NTU)
OR
Enter Qualitative Observations

H - High: Opaque/Muddy/Silty
M - Medium: Translucent/Cloudy
L - Low: Transparent/Some Silt
N - None: Clear/No Visible Silt

Figure 5. Well Development Form

G061291T

GEOLIS Well Development Form

COMPANY: ROY F. WESTON
CLIENT: BAKER
PROJECT: CTO-143
SITE: YORKTOWN N.W.S.

WELL NO.: MW-02
DATE: 8-24-92
LOGGER: James E. Davis
SIGNATURE:

ONE WELL VOLUME: ______ gallons WELL TD: 15.72 ft TOC

Well Volume (gallons/foot): 2-inch = 0.16, 4-inch = 0.65, 6-inch = 1.47, 8-inch = 2.61

TIME	ACTIVITY CODE	DEPTH TO WATER (ft)	PURGE RATE (gpm)	PURGE VOLUME (gal)	FIELD MEASUREMENTS MTP	MSC	MPH		TURBIDITY	COMMENTS
1045	—	5.30	—	—	—	—	—		N	NO sampling due To Free product
	FINAL									

DEVELOPMENT ACTIVITY CODES		FIELD MEASUREMENT CODES	TURBIDITY
DBB - Begin Bailing	DBE - End Bailing	MTP - Temperature	Enter Turbidity Meter Reading (Final should be <5 NTU)
DOB - Begin Overpumping	DOE - End Overpumping	MSC - Specific Conductance	OR
DRB - Begin Rawhiding	DRE - End Rawhiding	MPD - Photoionizer (e.g., HNu)	Enter Qualitative Observations
DCB - Begin Recirculation	DCE - End Recirculation	MFD - Flame Ionizer (e.g., OVA)	H - High: Opaque/Muddy/Silty
DHB - Begin Hydraulic Jetting	DHE - End Hydraulic Jetting	MDO - Dissolved Oxygen	M - Medium: Translucent/Cloudy
DAB - Begin Air Surging	DAE - End Air Surging	MPH - pH	L - Low: Transparent/Some Silt
DSB - Begin Surge Blocking	DSE - End Surge Blocking	MEH - Eh	N - None: Clear/No Visible Silt
DXB - Begin Other	DXE - End Other	MMC - Imhoff Cone	
Specify other method:		MO1 - Other:	
FM1 - Field Measurements (select from codes at right)		MO2 - Other:	

Figure 5. Well Development Form

G061291T

GEOLIS Well Development Form

COMPANY:	ROY F WESTON	WELL NO.:	(MW-03) 143-SB-04
CLIENT:	BAKER	DATE:	8-24-92
PROJECT:	CTO-143	LOGGER:	James E. Davis
SITE:	YORKTOWN N.W.S.	SIGNATURE:	James E. Davis

ONE WELL VOLUME: 1.44 gallons WELL TD: 15.15 ft TOC

Well Volume (gallons/foot): 2-inch = 0.16, 4-inch = 0.65, 6-inch = 1.47, 8-inch = 2.61

TIME	ACTIVITY CODE	DEPTH TO WATER (ft)	PURGE RATE (gpm)	PURGE VOLUME (gal)	FIELD MEASUREMENTS °C MTP	MSC	MPH		TURBIDITY	COMMENTS
1115	DBB	6.33		0	24	90	5.60		N	SALINITY = 0
1125				5	22	60	5.20		H	
1130	DBE			10	22	58	5.20		H	
										DEPTH TO WATER MEASURED FROM TOP OF CASING
	FINAL									

DEVELOPMENT ACTIVITY CODES

DBB - Begin Bailing; DBE - End Bailing
DOB - Begin Overpumping; DOE - End Overpumping
DRB - Begin Rawhiding; DRE - End Rawhiding
DCB - Begin Recirculation; DCE - End Recirculation
DHB - Begin Hydraulic Jetting; DHE - End Hydraulic Jetting
DAB - Begin Air Surging; DAE - End Air Surging
DSB - Begin Surge Blocking; DSE - End Surge Blocking
DXB - Begin Other; DXE - End Other
Specify other method:
FM1 - Field Measurements (select from codes at right)

FIELD MEASUREMENT CODES

MTP - Temperature
MSC - Specific Conductance
MPD - Photoionizer (e.g., HNu)
MFD - Flame Ionizer (e.g., OVA)
MDO - Dissolved Oxygen
MPH - pH
MEH - Eh
MMC - Imhoff Cone
MO1 - Other:
MO2 - Other:

TURBIDITY

Enter Turbidity Meter Reading (Final should be < 5 NTU)
OR
Enter Qualitative Observations
H - High: Opaque/Muddy/Silty
M - Medium: Translucent/Cloudy
L - Low: Transparent/Some Silt
N - None: Clear/No Visible Silt

Figure 5. Well Development Form

G061291T

GEOLIS Well Development Form

COMPANY: ROY F WESTON
CLIENT: BAKER
PROJECT: CTO-143
SITE: YORKTOWN N.W.S.

WELL NO.: (MW-04) 143-SB-06
DATE: 8-24-92
LOGGER: James E. Davis
SIGNATURE: James E. Davis

ONE WELL VOLUME: 1.55 gallons WELL TD: 17.98 ft TOC

Well Volume (gallons/foot): 2-inch = 0.16, 4-inch = 0.65, 6-inch = 1.47, 8-inch = 2.61

TIME	ACTIVITY CODE	DEPTH TO WATER (ft)	PURGE RATE (gpm)	PURGE VOLUME (gal)	FIELD MEASUREMENTS °C MTP	MSC	MPH		TURBIDITY	COMMENTS
1230	DBB	8.52		0	24	70	5.60		N	Salinity = 0
1240				5	22	60	5.40		L	
1250	DBE			10	22	60	5.40		L	
										DEPTH To WATER measured from Top of casing
	FINAL									

DEVELOPMENT ACTIVITY CODES		FIELD MEASUREMENT CODES	TURBIDITY
DBB - Begin Bailing	DBE - End Bailing	MTP - Temperature	Enter Turbidity Meter Reading (Final should be < 5 NTU)
DOB - Begin Overpumping	DOE - End Overpumping	MSC - Specific Conductance	OR
DRB - Begin Rawhiding	DRE - End Rawhiding	MPD - Photoionizer (e.g., HNu)	Enter Qualitative Observations
DCB - Begin Recirculation	DCE - End Recirculation	MFD - Flame Ionizer (e.g., OVA)	H - High: Opaque/Muddy/Silty
DHB - Begin Hydraulic Jetting	DHE - End Hydraulic Jetting	MDO - Dissolved Oxygen	M - Medium: Translucent/Cloudy
DAB - Begin Air Surging	DAE - End Air Surging	MPH - pH	L - Low: Transparent/Some Silt
DSB - Begin Surge Blocking	DSE - End Surge Blocking	MEH - Eh	N - None: Clear/No Visible Silt
DXB - Begin Other	DXE - End Other	MMC - Imhoff Cone	
Specify other method:		MO1 - Other:	
FM1 - Field Measurements (select from codes at right)		MO2 - Other:	

Figure 5. Well Development Form

G061291T

GEOLIS Well Development Form

COMPANY: ROY F WESTON
CLIENT: BAKER
PROJECT: CTO-143
SITE: YORKTOWN N.W.S.

WELL NO.: (MW-05) 143-SB-08
DATE: 8-24-92
LOGGER: James E. Davis
SIGNATURE: James E. Davis

ONE WELL VOLUME: 1.69 gallons WELL TD: 18.17 ft TOC

Well Volume (gallons/foot): 2-inch = 0.16, 4-inch = 0.65, 6-inch = 1.47, 8-inch = 2.61

TIME	ACTIVITY CODE	DEPTH TO WATER (ft)	PURGE RATE (gpm)	PURGE VOLUME (gal)	FIELD MEASUREMENTS °C MTP	MSC	MPH		TURBIDITY	COMMENTS
1315	DBB	7.83		0	26	65	5.20			SALINITY = 0
1325				5	22	65	5.40			
1330	DBE			16	22	65	5.40			
										DEPTH TO WATER measured from Top of Casing.
	FINAL									

DEVELOPMENT ACTIVITY CODES

DBB - Begin Bailing; DBE - End Bailing
DOB - Begin Overpumping; DOE - End Overpumping
DRB - Begin Rawhiding; DRE - End Rawhiding
DCB - Begin Recirculation; DCE - End Recirculation
DHB - Begin Hydraulic Jetting; DHE - End Hydraulic Jetting
DAB - Begin Air Surging; DAE - End Air Surging
DSB - Begin Surge Blocking; DSE - End Surge Blocking
DXB - Begin Other; DXE - End Other
Specify other method:
FM1 - Field Measurements (select from codes at right)

FIELD MEASUREMENT CODES

MTP - Temperature
MSC - Specific Conductance
MPD - Photoionizer (e.g., HNu)
MFD - Flame Ionizer (e.g., OVA)
MDO - Dissolved Oxygen
MPH - pH
MEH - Eh
MMC - Imhoff Cone
MO1 - Other:
MO2 - Other:

TURBIDITY

Enter Turbidity Meter Reading (Final should be <5 NTU)
OR
Enter Qualitative Observations
H - High: Opaque/Muddy/Silty
M - Medium: Translucent/Cloudy
L - Low: Transparent/Some Silt
N - None: Clear/No Visible Silt

Figure 5. Well Development Form

G061291T

GEOLIS Well Development Form

COMPANY: ROY F WESTON
CLIENT: BAKER
PROJECT: CTO-143
SITE: YORKTOWN N.W.S.

WELL NO.: (MW-06) 143-SB-10
DATE: 8-24-92
LOGGER: James E. Davis
SIGNATURE: James E. Davis

ONE WELL VOLUME: 1.58 gallons WELL TD: 18.13 ft TOC

Well Volume (gallons/foot): 2-inch = 0.16, 4-inch = 0.65, 6-inch = 1.47, 8-inch = 2.61

TIME	ACTIVITY CODE	DEPTH TO WATER (ft)	PURGE RATE (gpm)	PURGE VOLUME (gal)	FIELD MEASUREMENTS °C MTP	MSC	MPH		TURBIDITY	COMMENTS
1350	DBB	8.44		0	25	115	5.40		L	Salinity = 0
1355				5	24	115	5.20		L	
1405	DBE			10	24	115	5.20		L	
										DEPTH TO WATER measured from Top of casing.
	FINAL									

DEVELOPMENT ACTIVITY CODES

DBB - Begin Bailing; DBE - End Bailing
DOB - Begin Overpumping; DOE - End Overpumping
DRB - Begin Rawhiding; DRE - End Rawhiding
DCB - Begin Recirculation; DCE - End Recirculation
DHB - Begin Hydraulic Jetting; DHE - End Hydraulic Jetting
DAB - Begin Air Surging; DAE - End Air Surging
DSB - Begin Surge Blocking; DSE - End Surge Blocking
DXB - Begin Other; DXE - End Other
Specify other method:
FM1 - Field Measurements (select from codes at right)

FIELD MEASUREMENT CODES

MTP - Temperature
MSC - Specific Conductance
MPD - Photoionizer (e.g., HNu)
MFD - Flame Ionizer (e.g., OVA)
MDO - Dissolved Oxygen
MPH - pH
MEH - Eh
MMC - Imhoff Cone
MO1 - Other:
MO2 - Other:

TURBIDITY

Enter Turbidity Meter Reading (Final should be < 5 NTU)
OR
Enter Qualitative Observations
H - High: Opaque/Muddy/Silty
M - Medium: Translucent/Cloudy
L - Low: Transparent/Some Silt
N - None: Clear/No Visible Silt

Figure 5. Well Development Form

G061291T

GEOLIS Well Development Form

COMPANY:	ROY F. WESTON	WELL NO.:	(MW-07) 143-SB-11
CLIENT:	BAKER	DATE:	8-24-92
PROJECT:	CTO-143	LOGGER:	James E. Davis
SITE:	YORKTOWN N.W.S.	SIGNATURE:	[signature]

ONE WELL VOLUME: 1.40 gallons WELL TD: 18.20 ft TOC

Well Volume (gallons/foot): 2-inch = 0.16, 4-inch = 0.65, 6-inch = 1.47, 8-inch = 2.61

TIME	ACTIVITY CODE	DEPTH TO WATER (ft)	PURGE RATE (gpm)	PURGE VOLUME (gal)	FIELD MEASUREMENTS °C MTP	MSC	MPH		TURBIDITY	COMMENTS
1425	DBB	9.61		0	24	112	5.0		N	SALINITY = 0
1430				5	23	105	4.8		L	
1435	DBE			10	23	105	4.8		L	
										DEPTH TO WATER MEASURED FROM TOP OF CASING
	FINAL									

DEVELOPMENT ACTIVITY CODES

- DBB - Begin Bailing / DBE - End Bailing
- DOB - Begin Overpumping / DOE - End Overpumping
- DRB - Begin Rawhiding / DRE - End Rawhiding
- DCB - Begin Recirculation / DCE - End Recirculation
- DHB - Begin Hydraulic Jetting / DHE - End Hydraulic Jetting
- DAB - Begin Air Surging / DAE - End Air Surging
- DSB - Begin Surge Blocking / DSE - End Surge Blocking
- DXB - Begin Other / DXE - End Other
- Specify other method:
- FM - Field Measurements (select from codes at right)

FIELD MEASUREMENT CODES

- MTP - Temperature
- MSC - Specific Conductance
- MPD - Photoionizer (e.g., HNu)
- MFD - Flame Ionizer (e.g., OVA)
- MDO - Dissolved Oxygen
- MPH - pH
- MEH - Eh
- MMC - Imhoff Cone
- MO1 - Other
- MO2 - Other

TURBIDITY

Enter Turbidity Meter Reading (Final should be <5 NTU)

OR

Enter Qualitative Observations

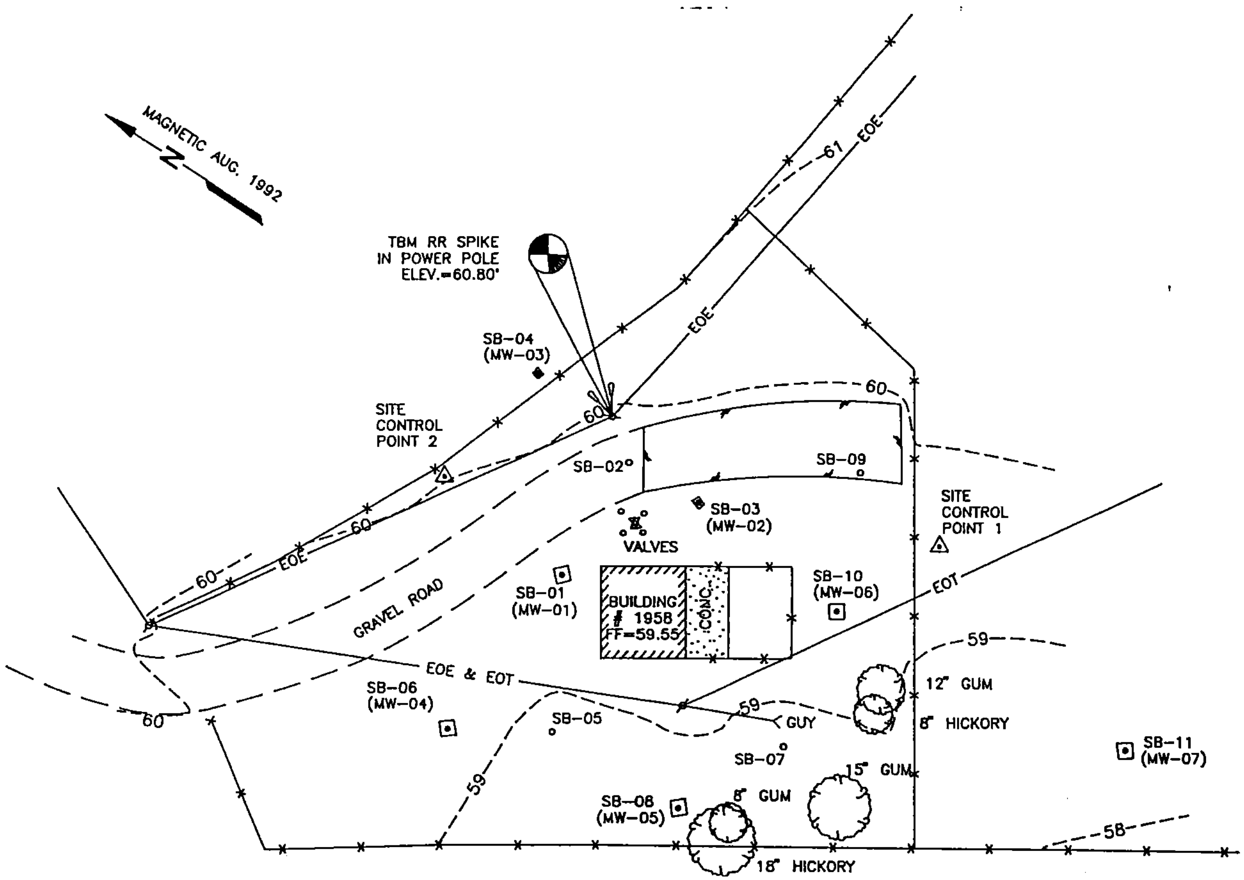
- H - High: Opaque/Muddy/Silty
- M - Medium: Translucent/Cloudy
- L - Low: Transparent/Some Silt
- N - None: Clear/No Visible Silt

Figure 5. Well Development Form

G061291T

APPENDIX E

WELL ELEVATION SURVEY



STATION I.D.	ELEVATIONS		
	TOP PVC	CONCRETE	GROUND
SB-01 (MW-01)	62.14'	59.71'	59.2'
SB-02	---	---	59.6'
SB-03 (MW-02)	59.29'	59.42'	59.0'
SB-04 (MW-03)	60.84'	60.99'	60.9'
SB-05	---	---	58.7'
SB-06 (MW-04)	61.71'	59.42'	58.8'
SB-07	---	---	58.6'
SB-08 (MW-05)	62.39'	59.21'	58.7'
SB-09	---	---	59.3'
SB-10 (MW-06)	62.64'	60.12'	59.7'
SB-11 (MW-07)	61.15'	58.52'	58.0'

LEGEND

SB-01 ▣	SOIL BORING (MONITORING WELL)
△	SITE CONTROL POINT
—x—	SECURITY FENCE
58- - -	CONTOUR (1' INTERVAL)
	POWER POLE
	POWER POLE -W- LIGHT
— EOE —	OVERHEAD ELECTRIC
— EOT —	OVERHEAD COMMUNICATIONS
	SANITARY VALVE
SB-02 ∘	SOIL BORING

SOIL BORINGS and MONITORING WELLS in the VICINITY of BUILDING 1958 NAVAL WEAPONS STATION YORKTOWN, VIRGINIA

HOGGARD/EURE ASSOCIATES
Surveyors/Planners/Engineers
6006 CHURCHLAND BLVD/PO BOX 6398/(804)484-9670
Portsmouth, Virginia 23703

DRAWN BY: RCS

DATE: 01 SEPT. 1992

SCALE: 1 INCH = 25 FEET

SHEET NO. 1 OF 1

798.09-92\PUMP.DWG

PROJECT No. 798.09-92

APPENDIX F

FLUID LEVEL DATA

WESTON MANAGERS DESIGNERS/CONSULTANTS

Fluid Level Measurements
Building 1958, NWS Yorktown
Yorktown, VA
20 August 1992

Date Recorded By: J. Davis

Monitoring Wells

No.	DTW	DTP	PT	ELEV[1]	ELEV W	CORRECTED ELEV W	COMMENTS
1	2.65	--	--	62.14	59.49	--	
2	3.36	3.26	0.10	59.29	55.93	56.01	
3	4.55	--	--	60.84	56.29	--	
4	2.00	--	--	61.71	59.71	--	
5	2.05	--	--	62.39	60.34	--	
6	1.10	--	--	62.64	61.52	--	
7	5.50	--	--	61.15	55.65	--	

[1] - Elevation from temporary benchmark set with spike in power pole relative to mean sea level.
PTW - Depth to water, as measured relative to mark at top of PVC casing.
DTP - Depth to product.
PT - Product Thickness.
Elev - Elevation of marked top of PVC casing.
Elev - Elevation of Groundwater.
Corrected Elev W - Where product detected, groundwater elevation has been corrected by a factor of 0.81 (diesel).
-- Not detected.

Fluid Level Measurements
Building 1958, NWS Yorktown
Yorktown, VA
24 August 1992

Date Recorded By: J. Davis

Monitoring Wells

No.	DTW	DTP	PT	ELEV[1]	ELEV W	CORRECTED ELEV W	COMMENTS
1	7.42	--	--	62.14	54.72	--	
2	5.30	4.99	0.31	59.29	53.99	54.24	
3	6.33	--	--	60.84	54.51	--	
4	8.52	--	--	61.71	53.19	--	
5	7.83	--	--	62.39	54.56	--	
6	8.44	--	--	62.64	54.20	--	
7	9.61	--	--	61.15	51.54	--	

[1] - Elevation from temporary benchmark set with spike in power pole relative to mean sea level.
PTW - Depth to water, as measured relative to mark at top of PVC casing.
DTP - Depth to product.
PT - Product Thickness.
Elev - Elevation of marked top of PVC casing.
Elev - Elevation of Groundwater.
Corrected Elev W - Where product detected, groundwater elevation has been corrected by a factor of 0.81 (diesel).
-- Not detected.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Fluid Level Measurements
Building 1958, NWS Yorktown
Yorktown, VA
1 September 1992

Date Recorded By: Ed Dullaghan

Monitoring Wells

No.	DTW	DTP	PT	ELEV[1]	ELEV W	CORRECTED ELEV W	COMMENTS
1	10.18	--	--	62.14	51.96	--	
2	7.72	7.59	0.13	59.29	51.57	51.67	
3	8.87	--	--	60.84	51.97	--	
4	9.76	--	--	61.71	51.95	--	
5	10.79	--	--	62.39	51.60	--	
6	10.81	--	--	62.64	51.83	--	
7	11.17	--	--	61.15	49.98	--	

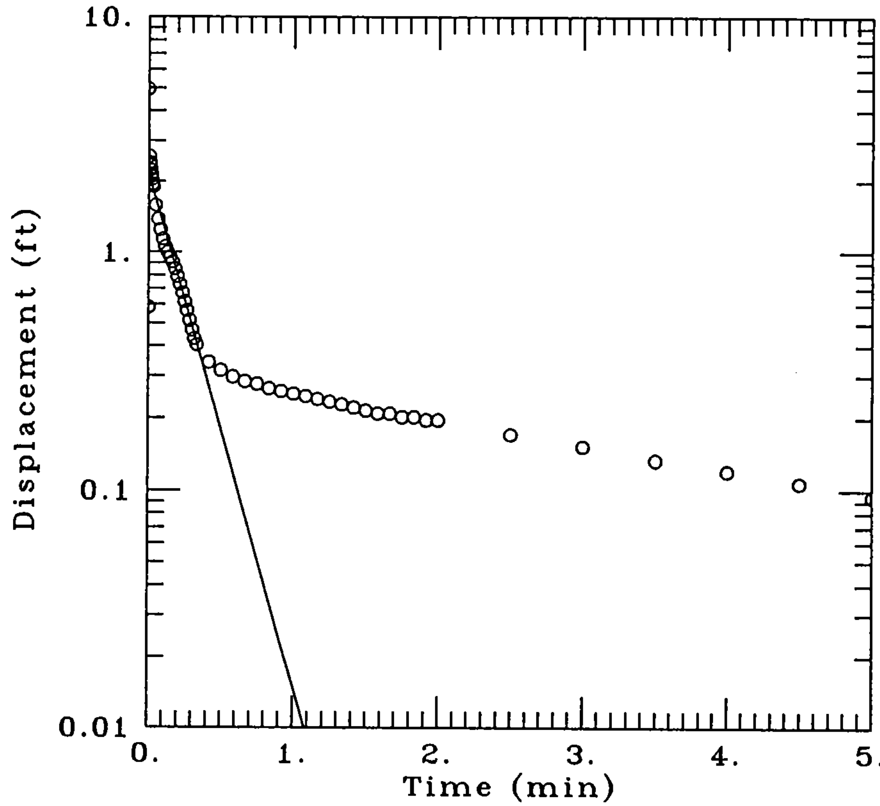
[1] - Elevation from temporary benchmark set with spike in power pole relative to mean sea level.
PTW - Depth to water, as measured relative to mark at top of PVC casing.
DTP - Depth to product.
PT - Product Thickness.
Elev - Elevation of marked top of PVC casing.
Elev - Elevation of Groundwater.
Corrected Elev W - Where product detected, groundwater elevation has been corrected by a factor of 0.81 (diesel).
-- Not detected.

APPENDIX G

HYDRAULIC CONDUCTIVITY DATA

Roy F. Weston, Inc.	Client: NWS-Yorktown
Project No.: 06629-001-024	Location: Yorktown, Virigina

MW-4 Rising-Head Test (CTO-143)



DATA SET:
mw04r.dat
09/08/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
September 1, 1992

OBS. WELL:
mw-4

ESTIMATED PARAMETERS:
K = 0.004162 ft/min
y0 = 2.138 ft

TEST DATA:
H0 = 4.95 ft
rc = 0.0833 ft
rw = 0.333 ft
L = 10. ft
b = 7.88 ft
H = 7.88 ft

NWS YORKTOWN, BLDG. 1958
RISING-HEAD MW-4

SE1000C
Environmental Logger
09/02 15:41

Unit# 00862 Test 0

INPUT 1: Level (F) TOC

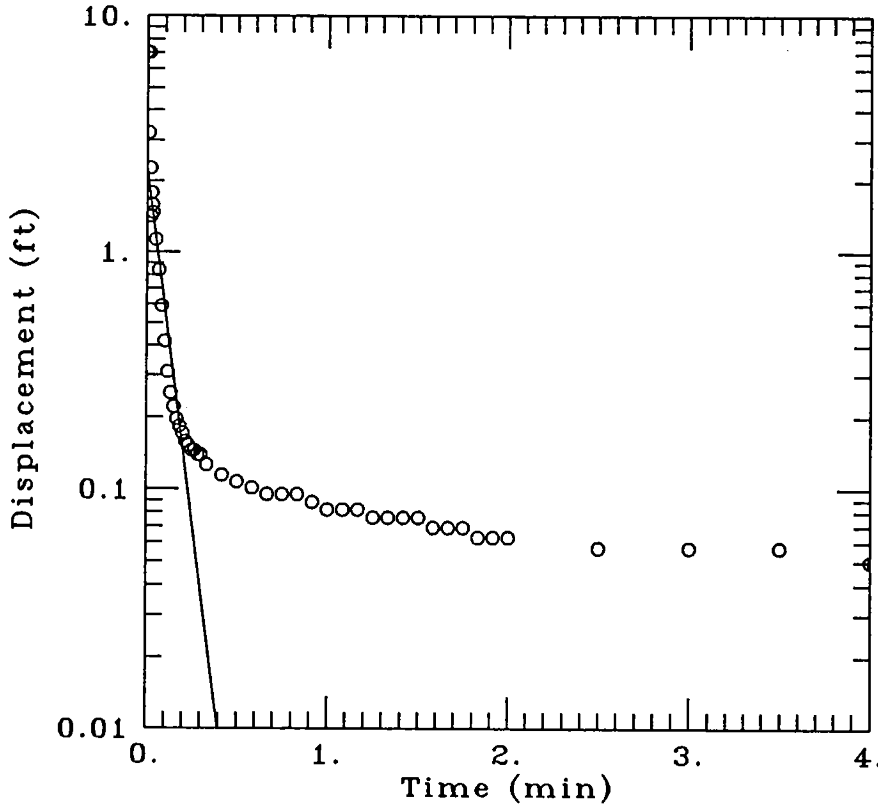
Reference 0.000
Linearity -0.040
Scale factor 20.070
Offset -0.020
Delay mSEC 50.000

Step 1 09/02 09:13:18

Elapsed Time	INPUT 1
0.0000	4.954
0.0033	0.582
0.0066	2.559
0.0100	2.413
0.0133	2.344
0.0166	2.236
0.0200	2.147
0.0233	2.096
0.0266	2.039
0.0300	1.944
0.0333	1.894
0.0500	1.577
0.0666	1.374
0.0833	1.241
0.1000	1.133
0.1166	1.051
0.1333	0.994
0.1500	0.950
0.1666	0.905
0.1833	0.848
0.2000	0.785
0.2166	0.728
0.2333	0.671
0.2500	0.614
0.2666	0.563
0.2833	0.513
0.3000	0.468
0.3166	0.430
0.3333	0.405
0.4166	0.342
0.5000	0.316
0.5833	0.297
0.6666	0.285
0.7500	0.278
0.8333	0.266
0.9166	0.259
1.0000	0.253
1.0833	0.247
1.1666	0.240
1.2500	0.234
1.3333	0.228
1.4166	0.221
1.5000	0.215
1.5833	0.209
1.6666	0.209
1.7500	0.202
1.8333	0.202
1.9166	0.196
2.0000	0.196
2.5000	0.171
3.0000	0.152
3.5000	0.133
4.0000	0.120
4.5000	0.107
5.0000	0.094
5.5000	0.088
6.0000	0.082
6.5000	0.075
7.0000	0.069
7.5000	0.057
8.0000	0.050
8.5000	0.050
9.0000	0.044
9.5000	0.044
10.0000	0.037
12.0000	0.019
14.0000	0.012
16.0000	0.006

Roy F. Weston, Inc.	Client: NWS-Yorktown
Project No.: 06629-001-024	Location: Yorktown, VA

MW-06 Rising



DATA SET:
mw06r.dat
09/09/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATE:
September 1, 1992

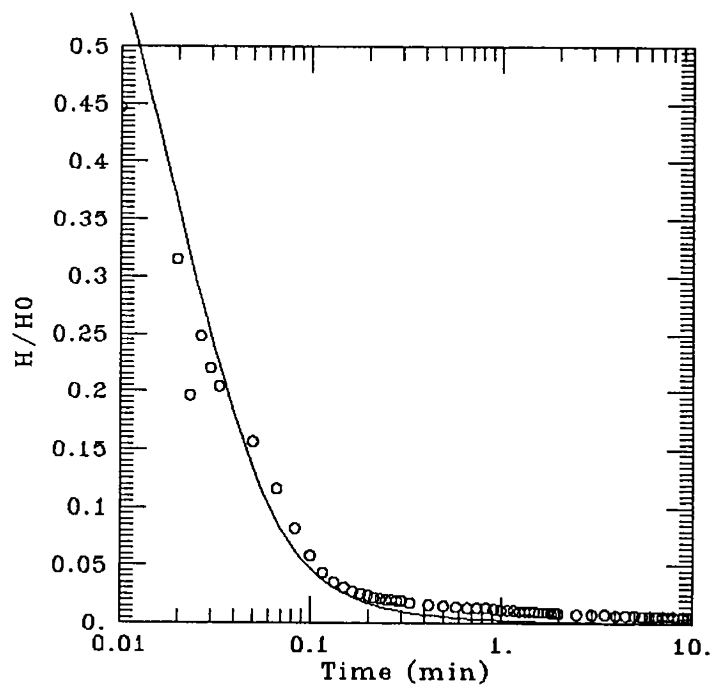
OBS. WELL:
MW-06

ESTIMATED PARAMETERS:
K = 0.01111 ft/min
y0 = 2.249 ft

TEST DATA:
H0 = 7.021 ft
rc = 0.0833 ft
rw = 0.333 ft
L = 10. ft
b = 7.24 ft
H = 7.24 ft

Roy F. Weston, Inc.	Client: NWS Yorktown
Project No.: 06629-001-024	Location: Yorktown, VA

MW06 Rising-Head Test (CTO-143)



DATA SET:
Mw06r.dat
09/14/92

AQUIFER TYPE:
Confined
SOLUTION METHOD:
Cooper et al.
TEST DATE:
September 1, 1992
OBS. WELL:
MW-06

ESTIMATED PARAMETERS:
T = 0.6804 ft^2/min
S = 0.0001

TEST DATA:
H0 = 7.2 ft
rc = 0.0833 ft
rw = 0.333 ft

NWS YORKTOWN, BLDG. 1958
RISING-HEAD MW-6

SE1000C
Environmental Logger
09/02 15:45

Unit# 00862 Test 1

INPUT 1: Level (F) TOC

Reference 0.000
Linearity -0.040
Scale factor 20.070
Offset -0.020
Delay mSEC 50.000

Step 1 09/02 10:17:31

Elapsed Time	INPUT 1
0.0000	-0.323
0.0033	-0.323
0.0066	-0.323
0.0100	3.218
0.0133	7.021
0.0166	-1.355
0.0200	2.268
0.0233	1.412
0.0266	1.786
0.0300	1.583
0.0333	1.469
0.0500	1.127
0.0666	0.836
0.0833	0.589
0.1000	0.418
0.1166	0.310
0.1333	0.253
0.1500	0.221
0.1666	0.196
0.1833	0.183
0.2000	0.171
0.2166	0.158
0.2333	0.152
0.2500	0.145
0.2666	0.145
0.2833	0.139
0.3000	0.139
0.3166	0.133
0.3333	0.126
0.4166	0.114
0.5000	0.107
0.5833	0.101
0.6666	0.095
0.7500	0.095
0.8333	0.095
0.9166	0.088
1.0000	0.082
1.0833	0.082
1.1666	0.082
1.2500	0.076
1.3333	0.076
1.4166	0.076
1.5000	0.076
1.5833	0.069
1.6666	0.069
1.7500	0.069
1.8333	0.063
1.9166	0.063
2.0000	0.063
2.5000	0.057
3.0000	0.057
3.5000	0.057
4.0000	0.050
4.5000	0.050
5.0000	0.050
5.5000	0.044
6.0000	0.044
6.5000	0.044
7.0000	0.044
7.5000	0.044
8.0000	0.044
8.5000	0.038
9.0000	0.038
9.5000	0.038
10.0000	0.038
12.0000	0.038
14.0000	0.038
16.0000	0.031
18.0000	0.044
20.0000	0.031

NWS YORKTOWN, BLDG. 1958
FALLING-HEAD MW-4

SE1000C
Environmental Logger
09/02 15:30

Unit# 0862 Test 0

INPUT 1: Level (F) TOC

Reference 0.000
Linearity -0.040
Scale factor 20.070
Offset -0.020
Delay mSEC 50.000

Step 1 09/02 08:53:33

Elapsed Time	INPUT 1
0.0000	-0.031
0.0033	-0.025
0.0066	-0.025
0.0100	-0.025
0.0133	-0.247
0.0166	-0.557
0.0200	-1.279
0.0233	-1.450
0.0266	-0.766
0.0300	-0.785
0.0333	-0.304
0.0500	-0.291
0.0666	-0.278
0.0833	-0.278
0.1000	-0.278
0.1166	-0.272
0.1333	-0.272
0.1500	-0.272
0.1666	-0.266
0.1833	-1.336
0.2000	-0.196
0.2166	-0.177
0.2333	-0.728
0.2500	-0.101
0.2666	0.924
0.2833	-0.557
0.3000	-0.373
0.3166	-0.329
0.4166	-0.506
0.5000	-0.557
0.5833	-0.513
0.6666	-0.494
0.7500	-0.481
0.8333	-0.462
0.9166	-0.449
1.0000	-0.437
1.0833	-0.424
1.1666	-0.411
1.2500	-0.405
1.3333	-0.399
1.4166	-0.392
1.5000	-0.386
1.5833	-0.380
1.6666	-0.367
1.7500	-0.367
1.8333	-0.361
1.9166	-0.354
2.0000	-0.348
2.5000	-0.329
3.0000	-0.304
3.5000	-0.285
4.0000	-0.272
4.5000	-0.253
5.0000	-0.240
5.5000	-0.228
6.0000	-0.215
6.5000	-0.209
7.0000	-0.196
7.5000	-0.190
8.0000	-0.177
8.5000	-0.164
9.0000	-0.164
9.5000	-0.158
10.0000	-0.152
12.0000	-0.126
14.0000	-0.107
16.0000	-0.101
18.0000	-0.088

NWS YORKTOWN, BLDG. 1958
FALLING-HEAD MW-6

SE1000C
Environmental Logger
09/02 15:33

Unit# 00862 Test 1

INPUT 1: Level (F) TOC

Reference	0.000
Linearity	-0.040
Scale factor	20.070
Offset	-0.020
Delay mSEC	50.000

Step 0 09/02 09:46:06

Elapsed Time	INPUT 1
0.0000	0.006
0.0033	-0.006
0.0066	-0.019
0.0100	-3.775
0.0133	-4.946
0.0166	-4.047
0.0200	-3.211
0.0233	-1.837
0.0266	1.140
0.0300	0.557
0.0333	-0.196
0.0500	-0.538
0.0666	-0.456
0.0833	-0.462
0.1000	-0.468
0.1166	-0.468
0.1333	-0.475
0.1500	-0.475
0.1666	-0.475
0.1833	-0.475
0.2000	-0.475
0.2166	-0.475
0.2333	-0.475
0.2500	-0.475
0.2666	-0.468
0.2833	-0.475
0.3000	-0.468
0.3166	-0.475
0.3333	-0.468
0.4166	-0.468
0.5000	-0.468
0.5833	-0.468
0.6666	-0.462
0.7500	-0.462
0.8333	-0.462
0.9166	-0.462
1.0000	-0.462
1.0833	-0.456
1.1666	-0.456
1.2500	-0.456
1.3333	-0.456
1.4166	-0.456
1.5000	-0.456
1.5833	-0.456
1.6666	-0.456
1.7500	-0.456
1.8333	-0.456
1.9166	-0.456
2.0000	-0.449
2.5000	-0.449
3.0000	-0.443
3.5000	-0.443
4.0000	-0.437
4.5000	-0.424
5.0000	-0.424
5.5000	-0.424
6.0000	-0.418
6.5000	-0.418
7.0000	-0.411
7.5000	-0.405
8.0000	-0.411
8.5000	-0.411
9.0000	-0.405
9.5000	-0.405
10.0000	-0.405
12.0000	-0.386
14.0000	-0.380
16.0000	-0.367
18.0000	-0.361
20.0000	-0.361
22.0000	-0.342
24.0000	-0.342
26.0000	-0.335
28.0000	-0.335
30.0000	-0.329

APPENDIX H

LABORATORY ANALYSES

TC ANALYTICS, INC.

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

RECEIVED SEP 0 8 1992

Sampling Site: CTO-143 BLDG 1958

Sampling Date: 08/11/92-08/24/92

Date Received: 08/14/92-08/24/92

Date Reported: 09/01/92

Released By: S. Long

Account Info: W.O. #6629-01-024

Roy F. Weston, Inc.
Pembroke Two, Suite 113
287 Independence Blvd.
Virginia Beach, VA 23462
Attn: Marving Farmer

Data:

Table of Contents

Reviewed By:____________________
Steven J.E. Long
Laboratory Supervisor

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

W.O. # 6629-01-024
SITE: CTO-143
BLDG 1958

1. LAB NUMBER/FIELD NUMBER

CROSS REFERENCE

2. CHAIN OF CUSTODY:

COPIES OF ORIGINALS

TC ANALYTICS, INCORPORATED
1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

CROSS REFERENCE OF LAB NUMBERS TO FIELD NUMBERS
W.O. #6629-01-024
SITE: CTO-143, BLDG 1958

Sample Date: 08/11/92

LAB #	FIELD #
92-3859	143-SB-01-01
92-3860	143-SB-01-01A
92-3861	143-SB-01-02
92-3862	143-SB-01-03

Sample Date: 08/12/92

LAB #	FIELD #
92-3863	143-SB-02-01
92-3864	143-SB-02-01A
92-3865	143-SB-02-02
92-3866	143-SB-03-01
92-3867	143-SB-03-02
92-3868	143-SB-04-01
92-3869	143-SB-04-02
92-3870	143-SB-05-01
92-3871	143-SB-05-02

Sample Date: 08/13/92

LAB #	FIELD #
92-3872	143-SB-06-01

Sample Date: 08/14/92

LAB #	FIELD #
92-3873	143-SB-06-02

Sample Date: 08/17/92

LAB #	FIELD #
92-3931	143-SB-07-01
92-3932	143-SB-07-02
92-3933	143-SB-08-01
92-3934	143-SB-08-02

Sample Date: 08/18/92

LAB #	FIELD #
92-3935	143-SB-09-01
92-3936	143-SB-09-02
92-3937	143-SB-10-01
92-3938	143-SB-10-02
92-3939	143-SB-11-01
92-3940	143-SB-11-02

Sample Date: 08/24/92

LAB #	FIELD #
92-3969	143-GW-01-01
92-3970	143-GW-04-01
92-3971	143-GW-06-01
92-3972	143-GW-08-01
92-3973	143-GW-10-01
92-3974	143-GW-10-01A
92-3975	143-GW-11-01
92-3976	143-GW-12-01
92-3977	143-GW-13-01

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

SAMPLE RESULTS

W.O.# 6629-01-024
SITE: CTO-143
BLDG 1958

Sample results include:

Site
Sampling Dates
Field Numbers
Lab Received Dates
Lab Numbers
Extraction Dates
Analyses Dates

PARAMETERS TESTED:

TPH (modified 8015)
BTEX (8020)
PURGEABLE AROMATICS (602)
TCLP METALS
FLASH POINT
GRAIN SIZE
TOTAL LEAD (EPA 239.2)
TRPH (418.1)

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

W.O. #6629-01-024

TPH (modified 8015)

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/11/92	08/11/92	08/11/92	08/12/92	08/12/92	08/12/92
FIELD #:	143-SB-01-01	143-SB-01-01A	143-SB-01-02	143-SB-02-01	143-SB-02-01A	143-SB-02-02
LAB RCVD DATE:	08/14/92	08/14/92	08/14/92	08/14/92	08/14/92	08/14/92
LAB #:	92-3859	92-3860	92-3861	92-3863	92-3864	92-3865
EXTRACT DATE:	08/20/92	08/20/92	08/24/92	08/20/92	08/20/92	08/20/92
ANALYSIS DTE:	08/22/92	08/24/92	08/24/92	08/24/92	08/20/92	08/20/92
ANALYSIS: (ppm) TPH(mod 8015) Stnd: #2 Heating Fuel	2500.	1400.	120.	260.	15.	34.

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/12/92	08/12/92	08/12/92	08/12/92	08/12/92	08/12/92
FIELD #:	143-SB-03-01	143-SB-03-02	143-SB-04-01	143-SB-04-02	143-SB-05-01	143-SB-05-02
LAB RCVD DATE:	08/14/92	08/14/92	08/14/92	08/14/92	08/14/92	08/14/92
LAB #:	92-3866	92-3867	92-3868	92-3869	92-3870	92-3871
EXTRACT DATE:	08/20/92	08/20/92	08/20/92	08/20/92	08/20/92	08/20/92
ANALYSIS DTE:	08/20/92	08/20/92	08/20/92	08/20/92	08/20/92	08/20/92
ANALYSIS: (ppm) TPH(mod 8015) Stnd: #2 Heating Fuel	<10.	<12.	<9.4	<9.7	<9.5	<10.

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/13/92	08/14/92	08/17/92	08/17/92	08/17/92	08/17/92
FIELD #:	143-SB-06-01	143-SB-06-02	143-SB-07-01	143-SB-07-02	143-SB-08-01	143-SB-08-02
LAB RCVD DATE:	08/14/92	08/14/92	08/19/92	08/19/92	08/19/92	08/19/92
LAB #:	92-3872	92-3873	92-3931	92-3932	92-3933	92-3934
EXTRACT DATE:	08/20/92	08/20/92	08/21/92	08/20/92	08/20/92	08/20/92
ANALYSIS DTE:	08/20/92	08/20/92	08/21/92	08/20/92	08/20/92	08/20/92
ANALYSIS: (ppm) TPH(mod 8015) Stnd: #2 Heating Fuel	<9.6	<11.	<12.	<13.	<10.	26.

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/18/92	08/18/92	08/18/92	08/18/92	08/18/92	08/18/92
FIELD #:	143-SB-09-01	143-SB-09-02	143-SB-10-01	143-SB-10-02	143-SB-11-01	143-SB-11-02
LAB RCVD DATE:	08/19/92	08/19/92	08/19/92	08/19/92	08/19/92	08/19/92
LAB #:	92-3935	92-3936	92-3937	92-3938	92-3939	92-3940
EXTRACT DATE:	08/20/92	08/20/92	08/20/92	08/20/92	08/20/92	08/20/92
ANALYSIS DTE:	08/20/92	08/21/92	08/20/92	08/20/92	08/20/92	08/20/92
ANALYSIS: (ppm) TPH(mod 8015) Stnd: #2 Heating Fuel	<11.	1300.	<12.	<12.	<11.	<12.

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

BTEX 8020

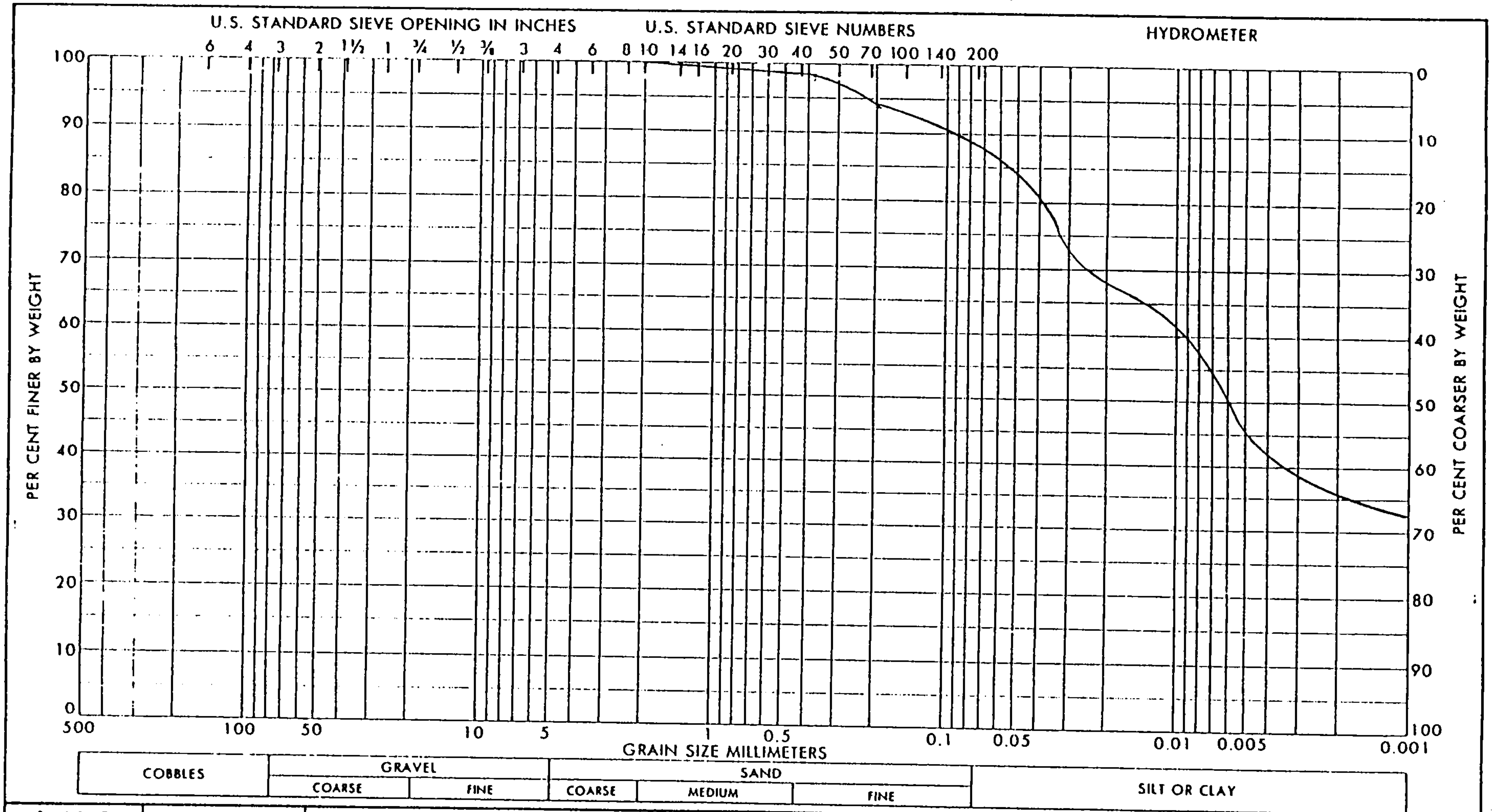
SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/11/92	08/11/92	08/14/92
FIELD #:	143-SB-01-02	143-SB-01-03	143-SB-06-02
LAB RCVD DATE:	08/14/92	08/14/92	08/14/92
LAB #:	92-3861	92-3862	92-3873
EXTRACT DATE:	08/21/92	08/21/92	08/21/92
ANALYSIS DTE:	08/21/92	08/21/92	08/21/92
ANALYSIS: (ppb)			
Benzene	<5.4	<2.3	<2.8
Toluene	<5.4	<2.3	<2.8
Ethylbenzene	<5.4	<2.3	<2.8
Xylenes	6.2	<4.6	<5.6

BTEX (8020)

TCLP METALS

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/11/92	08/14/92
FIELD #:	143-SB-01-02	143-SB-06-02
LAB RCVD DATE:	08/14/92	08/14/92
LAB #:	92-3861	92-3873
EXTRACT DATE:	08/17/92	08/17/92
ANALYSIS DTE:	08/20/92	08/20/92
ANALYSIS: (ppm)		
Ag	<0.25	<0.25
As	<0.25	<0.25
Ba	<0.25	<0.25
Cd	<0.25	<0.25
Cr	<0.25	<0.25
Hg	<0.02	<0.02
Pb	<0.25	<0.25
Se	<0.25	<0.25

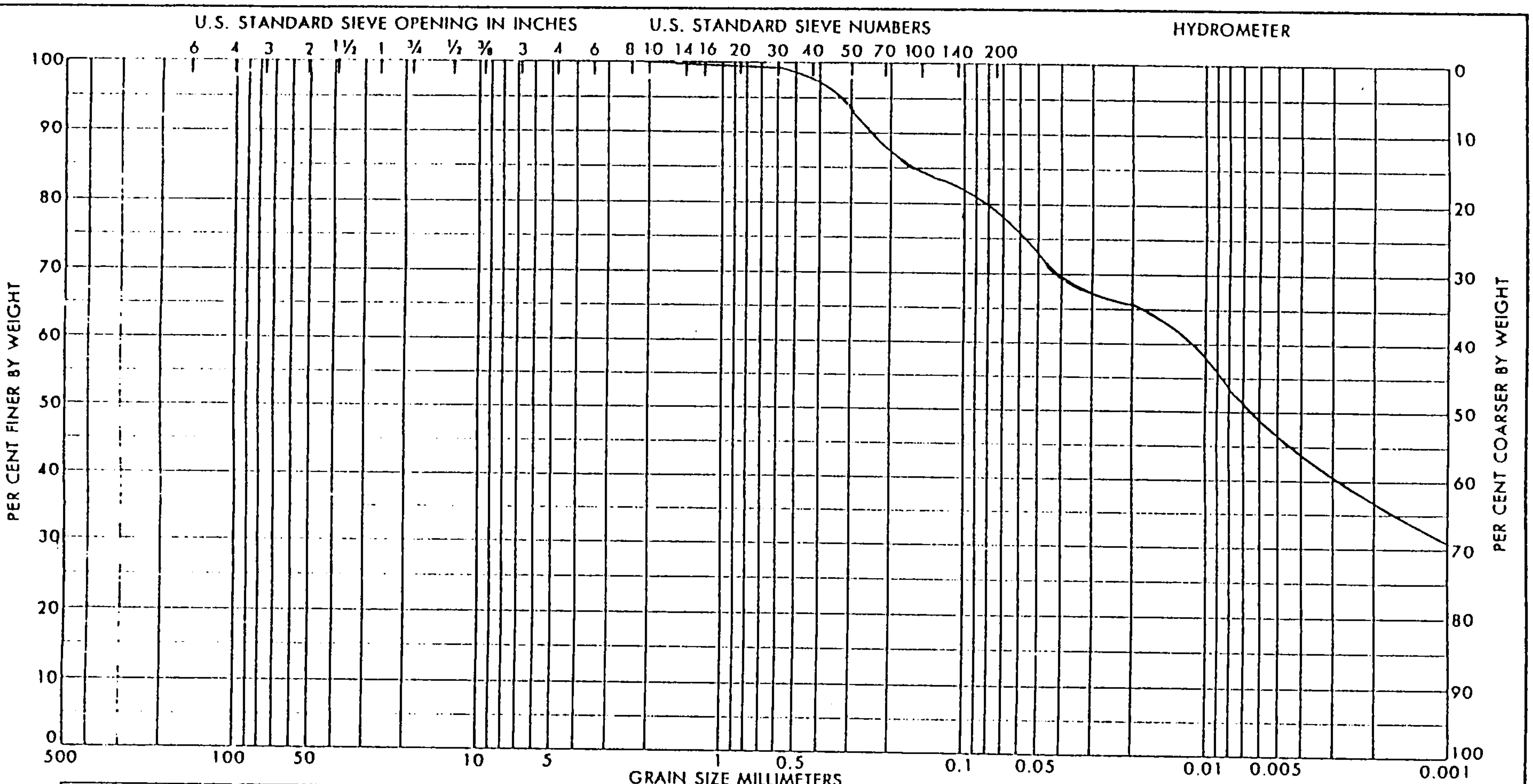
TCLP (1311, 6010, 7470)



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1	NA	Gray, Clayey SILT, little fine Sand	NA	NA	NA	NA
		43.5% Silt - 33% Colloids				
		12.% Clay - 11.5% Sand				
		Figure 1				

GRADATION CURVES

PROJECT	TCA #1
	26-02-92-00225
AREA	
BORING NO.	923861
DATE	8/21/92



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1	NA	Gray CLAY, some Silt, little fine Sand 33% Silt - 31% Colloids 20% Sand - 16% Clay				
		Figure 2				

PROJECT	TCA #1
	26-02-92-00225
AREA	
BORING NO.	923873
DATE	8/21/92

GRADATION CURVES

FORM 105

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

Grain Size ASTM D422

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/11/92	08/14/92
FIELD #:	143-SB-01-02	143-SB-06-02
LAB RCVD DATE:	08/14/92	08/14/92
LAB #:	92-3861	92-3873
ANALYSIS DTE:	08/21/92	08/21/92
ANALYSIS:		
GRAIN SIZE (%)		

SEIVE NUMBER		
NO. 10	100.	100.
NO. 16	99.9	99.9
NO. 30	99.6	99.7
NO. 40	99.3	99.0
NO. 50	98.2	94.7
NO. 80	94.1	85.0
NO. 100	92.6	82.6
NO. 200	88.5	80.0

MATERIAL%	#92-3861	#92-3973
Sand Content	11.5	20.
Silt Content	43.5	33.
Clay Content	12.0	16.
Colloids Content	33.0	31.

See following pages for graphical representation of the above results.

Flash Point

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/11/92	08/14/92
FIELD #:	143-SB-01-02	143-SB-06-02
LAB RCVD DATE:	08/14/92	08/14/92
LAB #:	92-3861	92-3873
ANALYSIS DTE:	08/28/92	08/28/92
ANALYSIS:		
FLASH POINT	>60 Degree C	>60 Degree C

Samples do not exhibit the characteristics of ignitability.

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

PURGEABLE AROMATICS (602)

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92
FIELD #:	143-GW-01-01	143-GW-04-01	143-GW-06-01	143-GW-08-01	143-GW-10-01	143-GW-10-01A
LAB RCVD DATE:	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92
LAB #:	92-3969	92-3970	92-3971	92-3972	92-3973	92-3974
EXTRACT DATE:	08/27/92	08/27/92	08/26/92	08/26/92	08/26/92	08/26/92
ANALYSIS DTE:	08/27/92	08/27/92	08/26/92	08/26/92	08/26/92	08/26/92
ANALYSIS: (ppb)						
Benzene	37.	<5.0	<13.	<5.0	<5.0	<5.0
Toluene	39.	<5.0	13.	<5.0	<5.0	<5.0
Chlorobenzene	<25.	<5.0	<13.	14.	<5.0	<5.0
Ethylbenzene	90.	<5.0	44.	16.	<5.0	<5.0
Xylenes	340.	33.	180.	60.	5.6	<10.
1, 3-Dichlorobenzene	<25.	17.	<13.	10.	8.3	<5.0
1, 4-Dichlorobenzene	91.	14.	100.	41.	10.	7.0
1, 2-Dichlorobenzene	<25.	16.	<13.	19.	9.0	6.1

PURGEABLE AROMATICS (602)

PURGEABLE AROMATICS (602)

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/24/92	08/24/92	08/24/92
FIELD #:	143-GW-11-01	143-GW-12-01	143-GW-13-01
LAB RCVD DATE:	08/24/92	08/24/92	08/24/92
LAB #:	92-3975	92-3976	92-3977
EXTRACT DATE:	08/26/92	08/26/92	08/26/92
ANALYSIS DTE:	08/26/92	08/26/92	08/26/92
ANALYSIS: (ppb)			
Benzene	<5.0	<5.0	<2.5
Toluene	<5.0	<5.0	<2.5
Ethylbenzene	<5.0	<5.0	<2.5
Chlorobenzene	<5.0	<5.0	<2.5
Xylenes	6.0	7.3	<5.0
1, 3-Dichlorobenzene	8.7	7.6	<2.5
1, 4-Dichlorobenzene	9.6	9.4	<2.5
1, 2-Dichlorobenzene	12.	9.9	<2.5

PURGEABLE AROMATICS (602)

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

Total Pb (239.2)

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92
FIELD #:	143-GW-01-01	143-GW-04-01	143-GW-06-01	143-GW-08-01	143-GW-10-01	143-GW-10-01A
LAB RCVD DATE:	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92
LAB #:	92-3969	92-3970	92-3971	92-3972	92-3973	92-3974
EXTRACT DATE:	08/27/92	08/27/92	08/27/92	08/27/92	08/27/92	08/27/92
ANALYSIS DTE:	08/28/92	08/28/92	08/28/92	08/28/92	08/28/92	08/28/92
ANALYSIS: (ppb) Total Pb (239.2)	8.2	78.	26.	32.	11.	10.

Total Pb (239.2)

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/24/92	08/24/92
FIELD #:	143-GW-11-01	143-GW-12-01
LAB RCVD DATE:	08/24/92	08/24/92
LAB #:	92-3975	92-3976
EXTRACT DATE:	08/27/92	08/27/92
ANALYSIS DTE:	08/28/92	08/28/92
ANALYSIS: (ppb) Total Pb (239.2)	68.	<5.0

TRPH (418.1)

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92
FIELD #:	143-GW-01-01	143-GW-04-01	143-GW-06-01	143-GW-08-01	143-GW-10-01	143-GW-10-01A
LAB RCVD DATE:	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92	08/24/92
LAB #:	92-3969	92-3970	92-3971	92-3972	92-3973	92-3974
EXTRACT DATE:	08/31/92	08/31/92	08/31/92	08/31/92	08/31/92	08/31/92
ANALYSIS DTE:	08/31/92	08/31/92	08/31/92	08/31/92	08/31/92	08/31/92
ANALYSIS: (ppm) TRPH (418.1)	1.52	0.46	4.26	3.13	0.19	0.21

TRPH (418.1)

SITE:	CTO-143 BLDG 1958	CTO-143 BLDG 1958
SAMPLE DATE:	08/24/92	08/24/92
FIELD #:	143-GW-11-01	143-GW-12-01
LAB RCVD DATE:	08/24/92	08/24/92
LAB #:	92-3975	92-3976
EXTRACT DATE:	08/31/92	08/31/92
ANALYSIS DTE:	08/31/92	08/31/92
ANALYSIS: (ppm) TRPH (418.1)	0.21	0.08

TC ANALYTICS, INCORPORATED
1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

W.O. # 6629-01-024
SITE: CTO-143
BLDG 1958

QA/QC DATA

The following pages contain the QA/QC Data to support the parameters tested. The data has been divided into the following sections:

ACCURACY FOR KNOWN SPIKE RECOVERIES

ACCURACY FOR MATRIX SPIKES/STANDARD ADDITION RECOVERIES

PRECISION BY REPLICATE MEASUREMENTS AND PERCENT RELATIVE DEVIATION

QA/QC RANGES

DATA PRESENTED FOR:

TPH (modified 8015)
BTEX (8020)
PURGEABLE AROMATICS (602)
TCLP METALS
TOTAL LEAD (EPA 239.2)
TRPH (418.1)

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

TPH (modified 8015)

Date Analyzed: 8/20/92, 21, 22, 8/24/92

Lab #	Field #
92-3859	143-SB-01-01
92-3860	143-SB-01-01A
92-3861	143-SB-01-02
92-3863	143-SB-02-01
92-3864	143-SB-02-01A
92-3865	143-SB-02-02
92-3866	143-SB-03-01
92-3867	143-SB-03-02
92-3868	143-SB-04-01
92-3869	143-SB-04-02
92-3870	143-SB-05-01
92-3871	143-SB-05-02
92-3872	143-SB-06-01
92-3873	143-SB-06-02
92-3931	143-SB-07-01
92-3932	143-SB-07-02
92-3933	143-SB-08-01
92-3934	143-SB-08-02
92-3935	143-SB-09-01
92-3936	143-SB-09-02
92-3937	143-SB-10-01
92-3938	143-SB-10-02
92-3939	143-SB-11-01
92-3940	143-SB-11-02

ACCURACY

KNOWN SPIKE RECOVERIES
(in percent)
107 93 112 100

MATRIX SPIKE/STANDARD ADDITIONS
(in percent)
Matrix Spikes were performed on:

92-3863/143-SB-02-01	103
92-3969/143-SB-04-02	109
92-3932/143-SB-07-02	112

PRECISION
Replicates were performed on:

92-3861/143-SB-01-02	12% RD
92-3868/143-SB-04-01	<PQL
92-3931/143-SB-07-01	<PQL

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Data:

BTEX (8020)

Date Analyzed: 08/21/92

Lab #	Field #
92-3861	143-SB-01-02
92-3862	143-SB-01-03
92-3873	143-SB-06-02

ACCURACY

KNOWN SPIKE RECOVERIES
(in percent)

Benzene	98	89
Toluene	83	79
Ethylbenzene	96	94
Xylenes	91	86

MATRIX SPIKE/STANDARD ADDITIONS
(in percent)

Matrix Spike was performed on:
92-3873/143-SB-06-02

Benzene	93
Toluene	89
Ethylbenzene	96
Xylenes	93

PRECISION
Replicate performed on:
92-3873/143-SB-06-02
All values less than PQL, with the exception of Xylenes which had Percent Relative Difference of 13.

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Data:

TCLP METALS

Mercury Analysis (Method 7471)

Date Analyzed: 08/24/92

Lab #	Field #
92-3861	143-SB-01-02
92-3873	143-SB-06-02

ACCURACY

KNOWN SPIKE RECOVERIES
(in percent)
93 88

MATRIX SPIKE/STANDARD ADDITIONS
Matrix Spike performed on:
92-3861/143-SB-01-02
90%

PRECISION
Replicate performed on:
92-3861/143-SB-01-02
Both values less than PQL.

Ag, As, Ba, Cd, Cr, Pb, Se, (Method 6010)

Date Analyzed: 08/20/92

Lab #	Field #
92-3861	143-SB-01-02
92-3873	143-SB-06-02

ACCURACY

KNOWN SPIKE RECOVERIES
(in percent)

Ag	As	Ba	Cd	Cr	Pb	Se
100	101	100	102	101	102	101
98	96	99	99	100	103	101
100	102	96	99	101	102	100
94	101	90	101	96	94	100
104	93	100	102	104	105	101

MATRIX SPIKES/STANDARD ADDITIONS
(in percent)

Matrix spikes were performed on:
92-3873/143-SB-06-02

Ag	As	Ba	Cd	Cr	Pb	Se
98	102	92	103	97	98	103

PRECISION
Replicate performed on:
92-3861/143-SB-01-02
All values less than PQL.

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

PURGEABLE AROMATICS (602)

Date Analyzed: 08/25/92-08/28/92

Lab #	Field #
92-3969	143-GW-01-01
92-3970	143-GW-04-01
92-3971	143-GW-06-01
92-3972	143-GW-08-01
92-3973	143-GW-10-01
92-3974	143-GW-10-01A
92-3975	143-GW-11-01
92-3976	143-GW-12-01
92-3977	143-GW-13-01

ACCURACY

KNOWN SPIKE RECOVERIES
(in percent)

BENZENE	108	107	108	88	80
TOLUENE	109	104	100	89	87
CHLOROBENZENE	105	111	99	96	89
ETHYLBENZENE	107	108	103	86	86
XYLENES	105	101	103	91	92
1,3-DCB	105	138	117	83	102
1,4-DCB	109	139	131	83	122
1,2-DCB	109	124	131	84	88

MATRIX SPIKE/STANDARD ADDITIONS
(in percent)
Matrix Spike was performed on: 92-3970

BENZENE	92
TOLUENE	94
CHLOROBENZENE	95
ETHYLBENZENE	89
XYLENES	97
1,3-DCB	56
1,4-DCB	100
1,2-DCB	62

PRECISION
Replicate performed on: 92-3969
Percent Relative Deviation

BENZENE	2.1
TOLUENE	9.7
CHLOROBENZENE	<PQL
ETHYLBENZENE	5.2
XYLENES	6.8
1,3-DCB	<PQL
1,4-DCB	17
1,2-DCB	<PQL

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

TOTAL Pb (239.2)

Date Analyzed: 8/28/92

Lab #	Field #
92-3969	143-GW-01-01
92-3970	143-GW-04-01
92-3971	143-GW-06-01
92-3972	143-GW-08-01
92-3973	143-GW-10-01
92-3974	143-GW-10-01A
92-3975	143-GW-11-01
92-3976	143-GW-12-01

ACCURACY

KNOWN SPIKE RECOVERIES
(in percent)
97 90 88

MATRIX SPIKE/STANDARD ADDITIONS
(in percent)

Matrix Spike was performed on:
92-3974/143-GW-10-01A
99

PRECISION
Replicate was performed on:
92-3976/143-GW-12-01
Both values less than PQL.

TRPH (418.1)

Date Analyzed: 8/31/92

Lab #	Field #
92-3969	143-GW-01-01
92-3970	143-GW-04-01
92-3971	143-GW-06-01
92-3972	143-GW-08-01
92-3973	143-GW-10-01
92-3974	143-GW-10-01A
92-3975	143-GW-11-01
92-3976	143-GW-12-01

ACCURACY
(in percent)
104

TC ANALYTICS, INCORPORATED
1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

QA/QC RANGES

TPH (Modified 8015)

STANDARD: #2 Heating Fuel
ACCURACY: Soil 73 - 126%

PRECISION
< or = 20% Relative Difference

BTEX (8020)

ACCURACY	%		
Benzene	39	-	150
Toluene	46	-	148
Ethylbenzene	32	-	160
Xylenes	60	-	140

PRECISION
< or = 20% Relative Difference

PURGEABLE AROMATICS (602)

ACCURACY	%		
Benzene	39	-	150
Chlorobenzene	55	-	135
1,2-DCB	37	-	154
1,3-DCB	50	-	141
1,4-DCB	42	-	143
Ethybenze	32	-	160
Toluene	46	-	148
Xylenes	60	-	140

PRECISION
< or = 20% Relative Difference

TCLP METALS

	ACCURACY		PRECISION
	Known Spikes	Matrix Spikes	Percent Rel. Difference
Ag	87 - 111	70 - 111	8.15
As	87 - 111	75 - 118	17.64
Ba	81 - 110	76 - 108	14.18
Cd	86 - 109	63 - 132	12.19
Cr	90 - 109	68 - 118	18.59
Hg	81 - 105	85 - 108	8.48
Pb	69 - 126	69 - 113	15.97
Se	82 - 111	69 - 125	15.66

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Data:

TRPH (418.1)

ACCURACY
75% - 125%

TOTAL LEAD (239.2)

ACCURACY
85 - 115%

PRECISION
< or = 20% Relative Difference

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

W.O. # 6629-01-024
SITE: CTO-143
BLDG 1958

DETECTION AND QUANTIFICATION LIMITS

PARAMETERS REPORTED FOR:

TPH (modified 8015)
BTEX (8020)
PURGEABLE AROMATICS (602)
TCLP METALS
TOTAL LEAD (EPA 239.2)
TRPH (418.1)

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

TPH (Modified 8015)

		TPH (ppm)	
STANDARD:	#2 Heating Fuel	IDL	3.50
MATRIX:	Soil	MDL	0.7 mg/Kg
AMOUNT EXTRACTED:	5 g (nominal)	PQL	9.47
EXTRACTION VOLUME:	1 ml		

BTEX (8020)

		BETX	
MATRIX:	Soil	IDL	9.0 ng
AMOUNT PURGED:	5 g (nominal)	MDL	1.8 ug/kg
FOR ALL PARAMETERS		PQL	5.0 ug/kg

PURGEABLE AROMATICS (602)

		602 (ppb)	
MATRIX:	Water	IDL	2.0
ALL LISTED PARAMETERS		MDL	2.0
		PLQ	5.0

TCLP METALS

(All Values in PPM)

		IDL	MDL	PQL
SILVER	(Ag)	0.002	0.002	0.25
ARSENIC	(As)	0.015	0.015	0.25
BARIUM	(Ba)	0.001	0.001	0.25
CADMIUM	(Cd)	0.002	0.002	0.25
CHROMIUM	(Cr)	0.001	0.001	0.25
MERCURY	(Hg)	0.05 ppb	0.05 ppb	0.02 ppm
LEAD	(Pb)	0.025	0.025	0.25
SELENIUM	(Se)	0.015	0.015	0.25

TC ANALYTICS, INCORPORATED
1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

TRPH (418.1)

		TPH (ppm)	
MATRIX:	Water	IDL	0.10
AMOUNT EXTRACTED:	1L (Nominal)	MDL	0.10
FINAL EXTRACTION VOLUME:	100 ml	PQL	0.10

TOTAL LEAD (239.2)

		Pb (ppb)	
MATRIX:	Water	IDL	0.61
		MDL	0.61
		PQL	5.0

TC ANALYTICS, INCORPORATED

1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

Data:

GLOSSARY OF TERMS

IDL

Instrument Detection Limit

Minimum concentration of analyte that can be measured with 99% confidence that the analyte concentration is greater than zero.

MDL

Method Detection Limit

Minimum concentration of analyte that can be measured with 99% confidence that the analyte concentration is greater than zero. Sample amounts extraction volumes and final volumes are considered in determining MDL.

PQL

Practical Quantification Limit

Concentration of analyte that can be determined precisely and accurately. Sample amounts extraction volumes and final volumes are considered in determining MDL.

TPH

Total Petroleum Hydrocarbons

ppm

Parts Per Million

Equivalent units mg/L, ug/ml and mg/Kg.

ppb

Parts Per Billion

Equivalent units ug/L ng/ml and ug/Kg.

TCLP METALS

SILVER	(Ag)
ARSENIC	(As)
BARIUM	(Ba)
CADMIUM	(Cd)
CHROMIUM	(Cr)
MERCURY	(Hg)
LEAD	(Pb)
SELENIUM	(Se)

APPENDIX I

CHAIN-OF-CUSTODY RECORDS

TC ANALYTICS, INC

Tel. (80 ... 27-0 ... FAX ... 62 ... 18

CHAIN OF CUSTODY RECORD

Project Name: CTO 143 (Bldg 1958)

Sampler: JAMES E. DAVIS

Project Number: 6629-01-024

Lab Destination: T.C. ANALYTICS

Sample No.	Sample Location	Description	Date & Time Collected	Sample Type	Container Type	Condition on Receipt (Name & Date)
43-SB-05-01	@ WEST Corner of Bldg. 4'-6'	TPH	8-12-92 / [redacted]	GRAB/Soil	4 oz. GLASS	
43-SB-05-02	SAME - 15'-17'	TPH	8-12-92 / 1715	GRAB/Soil	4 oz. GLASS	
[redacted]	In grassy Area @ end of Bldg - 4'-6'	TPH	8-13-92 / 0755	GRAB/Soil	4 oz. Glass	
[redacted]	SAME - 15'-17'	8 TCLP METALS TPH	8-14-92 / 0815	GRAB/Soil	16 oz. glass	
[redacted]	SAME - 15'-17'	GRAIN SIZE	8-14-92 / 0815	GRAB/Soil	16 oz. glass	
[redacted]	SAME - 15'-17'	VOA ([redacted])	8-14-92 / 0815	GRAB/Soil	4 oz. glass	

Special Instructions: ([redacted] SW 846 METHOD 8015 Modified; (8 TCLP METALS) EPA [redacted] (Grain Size) EPA SW846; [redacted] SW846 METHOD 1010; (Volatile Aromatic Organics) [redacted] SW 846 [redacted] 8020

Possible Lab Hazards:

Signatures: (Name, Company, Date & Time)

1. Relinquished By: [signature] 8-14-92 / 1340
   Received By: [signature] 8-14-92 1340

2. Relinquished By:
   Received By:

3. Relinquished By:
   Received By:

4. Relinquished By:
   Received By:

Authorization For Disposal:

Disposed By:

TC ANALYTICS INC
Tel. (80‑ ‑27‑C‑ FAX ‑) 62 18

CHAIN OF CUSTODY RECORD

Project Name CTO 143 (Bldg 1958) Sampler JAMES E. DAVIS

Project Number 6629-01-024 Lab Destination TC ANALYTICS

Sample No.	Sample Location	Description	Date & Time Collected	Sample Type	Container Type	Condition on Receipt (Name & Date)
43-SB-01-01	NE Corner Bldg. 1958 (MW-01) - 4'-6'	TPH	8-11-92 / 1305	GRAB/Soil	4oz. GLASS	
[redacted] -01A	SAME - 4'-6'	TPH	8-11-92 / 1305	GRAB/Soil	4oz. GLASS	
[redacted]	[redacted]E - 10'-12'	8TCLP METALS, TPH, FP, GRAIN SIZE	8-11-92 / 1320	GRAB/Soil	2x16oz GLASS	
[redacted]	[redacted] 10'-12'	VOA (BETX)	8-11-92 / 1330	GRAB/Soil	4oz. GLASS	
43-[redacted]	[redacted] - 10'-12'	VOA (BETX)	8-11-92 / 1320	GRAB/Soil	4oz. GLASS	
43-SB-02-01	[redacted]	TPH	8-12-92 / 0755	GRAB/Soil	4oz. GLASS	
43-SB-02-01A	SAME - 4'-6'	TPH	8-12-92 / 0755	GRAB/Soil	4oz. GLASS	
43-SB-02-02	SAME 20'-22'	TPH	8-12-92 / 0830	GRAB/Soil	4oz. GLASS	
43-SB-03-01	@ Bldg. ENTRANCE (MW-02) - 4'-6'	[redacted]	8-12-92 / 0905	GRAB/Soil	4oz. GLASS	
43-SB-03-02	SAME - 20'-2[redacted]	[redacted]	8-12-92 / 0935	GRAB/Soil	4oz. GLASS	
43-SB-04-01	[redacted]	[redacted]	8-12-92 / 1520	GRAB/Soil	4oz. GLASS	
43-SB-04-02	SAME - 15'-17'	[redacted]	8-12-92 / 1545	GRAB/Soil	4oz. GLASS	

[redacted] EPA SW846; METHOD 8015 Modified (TPH); EPA SW 846 METHOD 1010 (Flash point)

Special Instructions: [redacted] (GRAIN SIZE); (VOLATILE AROMATIC ORGANICS) EPA SW 846 [redacted] 8020

Possible Lab Hazards: [redacted] High Concentrations in Samples of TPH & Constituents of Fuel oil.

Signatures: (Name, Company, Date & Time)

1. Relinquished By [illegible] 8-14-92 / 1340
   Received By [illegible] 8/14/92 1840
2. Relinquished By ______
   Received By ______
3. Relinquished By ______
   Received By ______
4. Relinquished By ______
   Received By ______

Authorization For Disposal ______ Disposed By ______

TC ANALYTICS, INC.

1200 Boissevain Avenue ... Tel. (8..., 327-... FAX ...

CHAIN OF CUSTODY RECORD

Project Name CTO-143 (Bldg 1958) Sampler JAMES E. DAVIS

Project Number 6629-01-024 Lab Destination T.C. ANALYTICS

Sample No.	Sample Location	Description	Date & Time Collected	Sample Type	Container Type	Condition on Receipt (Name & Date)
143-SB-07-01	4-6' @ South corner of Bldg.	TPH	8-17-92 / 1035	GRAB/soil	4oz. GLASS	
143-SB-07-02	Same 12'-14'	TPH	8-17-92 / 1046	GRAB/soil	4oz. GLASS	
143-SB-08-01	West side of Bldg @ oak tree 4'-6'	TPH	8-17-92 / 1155	GRAB/soil	4oz. GLASS	
143-SB-08-02	Same. 10'-12'	TPH	8-17-92 / 1330	GRAB/soil	4oz. Glass	
143-SB-09-01	South side @ above ground tank	TPH	8-18-92 / 0835	GRAB/soil	4oz. GLASS	
143-SB-09-02	Same. 14'-16'	TPH	8-18-92 / 0850	GRAB/soil	4oz. GLASS	
143-SB 10-01	@ EAST corner in pavement.	TPH	8-18-92 / 1000	GRAB/SOIL	4oz. Glass	
143-SB 10-02	Same. 10'-12'	TPH	8-18-92 / 1015	GRAB/SOIL	4oz. GLASS	
143-SB-11-01	South of playground @ 4'-6'	TPH	8-18-92 / 1210	GRAB/soil	4oz. GLASS	
143-SB-11-02	Same. 10'-12'	TPH	8-18-92 / 1220	GRAB/soil	4oz. GLASS	

Special Instructions: (TPH) EPA SW846 METHOD 8015 Modified; (8 RCRA METALS) EPA SW 846; (Flashpoint) EPA SW 846 METHOD 1010; (GRAIN SIZE) EPA SW 846; (Volatile Aromatic Organics) EPA SW 846 METHOD 8020

Possible Lab Hazards: ____________________

Signatures: (Name, Company, Date & Time)

1. Relinquished By James E. Davis 8-19-92 1330
   Received By [signature] 8/19/92 1330

2. Relinquished By ____________________
   Received By ____________________

3. Relinquished By ____________________
   Received By ____________________

4. Relinquished By ____________________
   Received By ____________________

Authorization For Disposal ____________________

Disposed By ____________________

TC ANALYTICS, INC.
1200 Boissevain Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

CHAIN OF CUSTODY RECORD

Project Name CTO 143 ; Bldg 1958 Sampler JAMES E. DAVIS

Project Number 6629-01-024 Lab Destination T.C. ANALYTICS

Sample No.	Sample Location	Description	Date & Time Collected	Sample Type	Container Type	Condition on Receipt (Name & Date).
43-GW-01-01	MW-01	Purgeable Aromatics	8-24-92/1015	Water GRAB	2x40mL. VOA	
43-GW-01-01	MW-01	TPH	8-24-92/1015	Water GRAB	1 L. Amber	
43-GW-01-01	MW-01	Pb	8-24-92/1015	WATER GRAB	500 mL. PLASTIC	
43-GW-04-01	MW-03	Purgeable Aromatics	8-24-92/1130	WATER GRAB	2x40ml. VOA	
43-GW-04-01	MW-03	TPH	8-24-92/1130	WATER GRAB	1L. Amber	
143-GW-04-01	MW-03	Pb	8-24-92/1130	WATER GRAB	500mL. PLASTIC	
143-GW-06-01	MW-04	Purgeable Aromatics	8-24-92/1250	WATER GRAB	2x40 mL. VOA	
43-GW-06-01	MW-04	TPH	8-24-92/1250	WATER GRAB	1L. Amber	
143-GW-06-01	MW-04	Pb	8-24-92/1250	WATER GRAB	500 mL. PLASTIC	
143-GW-08-01	MW-05	Purgeable Aromatics	8-24-92/1330	WATER GRAB	2x40 mL. VOA	
143 GW-08-01	MW-05	TPH	8-24-92/1330	WATER GRAB	1L Amber	
143-GW-08-01	MW-05	Pb	8-24-92/1330	WATER GRAB	500mL PLASTIC	

Special Instructions: TOTAL PETROLEUM Hydrocarbons (TPH) EPA 600 METHOD 418.1 ; Purgeable Aromatics EPA 600 METHOD 602 ; LEAD (Pb) EPA 600 METHOD 239.2

Possible Lab Hazards: Preservatives: Purgeable Aromatics - ICE ; TPH - H_2SO_4 TO pH OF 2 ; Pb - HNO_3 To pH of 2

Signatures: (Name, Company, Date & Time)

1. Relinquished By [signature] RFW, 8-24-92, 1800
Received By [signature] TCA 8/24/92 1800

2. Relinquished By
Received By

3. Relinquished By
Received By

4. Relinquished By
Received By

Authorization For Disposal

Disposed By

TC ANALYTICS, INC.

200 [illegible] Avenue Norfolk, Virginia 23507
Tel. (804) 627-0400 FAX (804) 627-1118

CHAIN OF CUSTODY RECORD

Project Name CTO 143; Bldg 1958 Sampler JAMES E. DAVIS

Project Number 6629-01-024 Lab Destination T.C. ANALYTICS

Sample No.	Sample Location	Description	Date & Time Collected	Sample Type	Container Type	Condition on Receipt (Name & Date)
143-GW-10-01/01A	MW-06	Purgeable Aromatics	8-24-92 / 1405	WATER GRAB	2x40ml. VOA	
143-GW-10-01/01A	MW-06	TPH	8-24-92 / 1405	WATER GRAB	1L. Amber	
143-GW-10-01/01A	MW-06	Pb	8-24-92 / 1405	WATER GRAB	500ml. PLASTIC	
143-GW-11-01	MW-07	Purgeable Aromatics	8-24-92 / 1435	WATER GRAB	2x40ml VOA	
143-GW-11-01	MW-07	TPH	8-24-92 / 1435	WATER GRAB	1L Amber	
143-GW-11-01	MW-07	Pb	8-24-92 / 1435	WATER GRAB	500ml. PLASTIC	
143-GW-12-01	Rinse	Purgeable Aromatics	8-24-92 / 1100	WATER GRAB	2x40mL VOA	
143-GW-12-01	RINSE	TPH	8-24-92 / 1100	WATER GRAB	1L Amber	
143-GW-12-01	RINSE	Pb	8-24-92 / 1100	WATER GRAB	500ml. PLASTIC	
143-GW-13-01	—	Purgeable Aromatics	8-24-92 / 1500	WATER GRAB	2x400ml. VOA	

Special Instructions: TOTAL PETROLEUM Hydrocarbons (TPH) EPA 600 METHOD 418.1; Purgeable AROMATICS EPA 600 METHOD 602; LEAD (Pb) EPA 600 METHOD 239.2

Possible Lab Hazards: Preservatives: Purgeable Aromatics - ICE; TPH - H_2SO_4 to pH of 2; Pb - HNO_3 To pH of 2

Signatures: (Name, Company, Date & Time)

1. Relinquished By [signature], RFW, 8-24-92, 1800
   Received By [signature], TCA 8/24/92 1800
2. Relinquished By
   Received By
3. Relinquished By
   Received By
4. Relinquished By
   Received By

Authorization For Disposal

Disposed By

APPENDIX J

AT123D MODEL

AT123D MODEL

Introduction

This section of the report is based on the generalized analytical transient, one-, two-, and three dimensional model (AT123D) by G. T. Yeh (1981) adopted to compute the three dimensional distribution of lead in an aquifer system through time. The model is used in this case as an aid in evaluating the potential risk to a downgradient receptor from lead in groundwater in the vicinity of Building 1958, Naval Weapons Station Yorktown (NWS Yorktown), Yorktown, Virginia.

The AT123D model code provides for a variety of initial conditions including source areal extent, type of release, areal extent of the aquifer, and site-specific aquifer characteristics such as permeability, porosity, dispersivity, and hydraulic gradient. The model also takes into account solute-specific geochemical behavior such as adsorption. Analytical simulation of the fate and transport problem is based on Green's Function, as outlined in Yeh (1981). Several assumptions of the model for all initial conditions include:

- Steady and uniform flow in the saturated zone.
- The saturated zone is homogeneous and isotropic.
- Sorption is in a state of linear isothermal equilibrium
- No expansion or compression of the fluid media

Since several site and solute-specific parameters require estimation, this model therefore provides an order-of-magnitude estimate of how the solute concentrations vary with time and distance.

Site Specific Conditions

WESTON personnel conducted a site assessment at Building 1958, NWS Yorktown, Virginia. The assessment was conducted in response to an initial assessment that identified liquid-phase hydrocarbons (LPH) at a flush-to-grade valve box near the building. The source of the LPH (diesel) was determined to be the subsurface emergency generator fuel lines. When the lines were uncovered for inspection, corrosion, pitting, and small holes were observed. WESTON's assessment detected LPH (approximately 0.31 feet in MW-02), and concentrations of TPH in soil and groundwater. Also detected in groundwater were chlorinated hydrocarbons and total lead, not typically related to diesel.

Total lead in groundwater was determined to be the analyte of most concern and was therefore selected to be modeled. Total lead was identified in four of six groundwater samples at levels greater than state and federal MCL's. As previously mentioned, the lead in groundwater is not typically a constituent of diesel, therefore an unknown source in the vicinity of Building 1958 has been modeled. This scenario assumes a constant source with a continuous release into the saturated zone (worst case) as both source configuration, time and duration of release are unknown.

Model Parameters

Model parameters specifications include the geometry of the aquifer system and the source area, information regarding the type and rate of release, site-specific aquifer characteristics and solute-specific chemical characteristics.

Aquifer Geometry

A 600 feet by 600 feet grid was overlain on the site normal to groundwater flow direction (600 feet is the distance to the stream). The origin located at point 0,0,0 (x,y,z) is Building 1958. The width of the grid is an estimate of the width of the local groundwater flow regime in the vicinity of the study area. The length of aquifer depth is estimated to be 40 feet based on regional geologic evidence of typical depth to the St. Mary's formation, the uppermost portion of which is an aquatard.

Length of Model and Rate of Release

Building 1958 has been in operation for about 10 years. Since the source of lead in the study is assumed to be from a possible release from the lift station sump area, the duration of release is conservatively estimated as 5 years. This duration time from release and concentration in MW-04, 50 feet away, was used to calibrate the model. The model was then used to calculate the concentration of lead and the distance from source over time for a period of 25 years.

The rate of release (Kg/Hr) is continuous from a constant (same) source over the length of the model (worst case) and varies based on site and solute-specific aquifer characteristics.

Site-Specific Aquifer Characteristics

Porosity (Ne), 35%: based on boring logs and grain size analysis.

Hydraulic Conductivity (k), 0.83 M/Hr: based on rising-head permeability test conducted on MW-04.

Hydraulic Gradient (i), 0.017: based on Figure 1-9 in the vicinity of MW-09, with the predominant groundwater flow direction to the west.

Dispersivity (D): generally estimated as 1/10 of horizontal distance; 5 feet (1.5 meters) for the calibration run and 60 feet (18.3 meters) to the stream. The dispersivity value was adjusted during calibration runs. Lateral and vertical dispersivity is estimated as 1/10 of horizontal dispersivity (Eagleson, 1970, Bredehoeft and Pinder, 1973, Robertson, 1974).

Bulk Density (Pb), 1900 Kg/M^3: estimated value typical for sandy, silty clay.

Solute-Specific Characteristics

Decay Constant (λ), *0.0:* based on the estimated inorganic nature of lead (worst case)

Distribution Coefficient (k_d), *0.34* m^3/kg: estimated value based on lead adsorption by Cecil clay loam; adsorption isotherm as described by linear Freundlich equation (Roy et al., 1991).

Model Runs and Calibration

Using the estimated parameters, an initial set of calibration runs were conducted. Sensitivity test showed k_d, D, and waste release rates to be the most sensitive parameters affecting concentration change over time. With the exception of dispersivity (D), site-specific parameters were not modified during calibration of the model.

Parameters were selected using solute-specific information and waste release rates to calibrate the model using present site conditions. Calibration of the model to represent present site conditions are based on the assumption the present values of total lead in MW-04 (26 ppb) are the result of a constant source approximately 50 feet away (Building 1958). After the model was calibrated it was used to predict lead concentrations over time at the nearest downgradient sensitive receptor; a stream located 600 feet away that drains into the Skiffes Creek Reservoir. Skiffes Creek Reservoir is a potable water supply surface impoundment for the city of Newport News.

Results

Program input information and results are included in this appendix for two distances (50 feet and 600 feet). Applying the model a distance of 50 feet predicts a total lead in groundwater concentration of 3.9 ppb after 5 years, and approximates present site conditions. Using the current information the model was applied to a distance of 600 feet with a 100 foot grid. The model was run at one-half year time intervals for a period of 200 years. Steady state conditions were not reached before the final simulating time. The model predicts that total lead will not reach the 600 feet distance to the stream at a concentration of 1 ppb after 200 years. Results show a decrease in concentrations of total lead at the source with higher concentrations migrating as a "slug" downgradient. It should be emphasized that in view of the very high initial estimate of total lead ($.5 \times 10^4$ ppm) calculated by the program, and additional parameters selected conservatively, these model results reflect a worst case scenario.

Conclusions

The model adequately demonstrates the high absorptive capacity for lead in a sandy clay environment and that there is a very low probability the concentrations of lead observed at the site will ever reach the stream, 600 feet downgradient. Further delineation of lead concentrations in groundwater and its relation to potential risk to receptors would include a batch-equilibrium or column soil tests for a more accurate distribution coefficient (K_d) and sampling source area and groundwater for dissolved lead.

SIMULATION WITH AT123D IGWMC VERSION 1.1.

INPUT INFORMATION

TOTAL LEAD, CONSTANT RELEASE, CONSTANT SOURCE, BLDG. 1958, NWS YORKTOWN. **INITIAL CALIBRATION RUN**, SOURCE IS 50 FEET UPGRADIENT OF MW-04, PRESENT SITE CONDITIONS FOR MW-04 IS 7.8×10^{-3} PPM

NO. OF POINTS IN X-DIRECTION 2
NO. OF POINTS IN Y-DIRECTION 4
NO. OF POINTS IN Z-DIRECTION 2
NO. OF ROOTS: NO. OF SERIES TERMS 1000
NO. OF BEGINNING TIME STEPS 5
NO. OF ENDING TIME STEP 5
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION 1
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE 1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE 0
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT 1
CASE CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD 2

AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ... .1220E+02
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ... .9146E+02
BEGIN POINT OF X-SOURCE LOCATION (METERS) .... .0000E+00
END POINT OF X-SOURCE LOCATION (METERS) .... .0000E+00
BEGIN POINT OF Y-SOURCE LOCATION (METERS) .... .0000E+00
END POINT OF Y-SOURCE LOCATION (METERS) .... .0000E+00
BEGIN POINT OF Z-SOURCE LOCATION (METERS) .... .0000E+00
END POINT OF Z-SOURCE LOCATION (METERS) .... .0000E+00

POROSITY .... .3500E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR) .... .8300E+00
HYDRAULIC GRADIENT .... .1700E-01
LONGITUDINAL DISPERSIVITY (METER) .... .5000E+01
LATERAL DISPERSIVITY (METER) .... .5000E+00
VERTICAL DISPERSIVITY (METER) .... .5000E+00
DISTRIBUTION COEFFICIENT, KD (M**3/KG) .... .3400E+00
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C).. .0000E+00

MOLECULAR DIFFUSION MULTIPLY BY POROSITY (M**2/HR) .0000E+00
DECAY CONSTANT (PER HOUR) .... .0000E+00
BULK DENSITY OF THE SOIL (KG/M**3) .... .1900E+04

ACCURACY TOLERANCE FOR REACHING STEADY STATE ...... .1000E-02
DENSITY OF WATER (KG/M**3) .... .1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) .. .8760E+04
DISCHARGE TIME (HR) .... .4380E+05
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) . .1000E+01

RETARDATION FACTOR .... .1847E+04
RETARDED DARCY VELOCITY (M/HR) .... .2183E-04
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) .. .1092E-03
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR).. .1092E-04
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR). .1092E-04

COMPUTIONAL RESULTS

STEADY STATE SOLUTION HAS NOT BEEN
REACHED BEFORE FINAL SIMULATING TIME

DISTRIBUTION OF CHEMICAL IN PPM
AT .3504E+05 HRS

Z = .00

Y \ X	0.	15.
0.	.239E+05	.635E-03
30.	.396E-02	.290E-09
61.	.000E+00	.000E+00
91.	.471E-11	.185E-17

Z = 12.19

Y \ X	0.	15.
0.	.186E-03	.876E-10
30.	.288E-10	.411E-16
61.	.000E+00	.000E+00
91.	.351E-18	.260E-24

SIMULATION WITH AT123D IGWMC VERSION 1.1.

INPUT INFORMATION

TOTAL LEAD, CONSTANT RELEASE AND SOURCE, BLDG. 1958, NWS YORKTOWN.

MODEL RUN FOR TWO HUNDRED YEARS AT ONE-HALF YEAR TIME INTERVALS TO A DISTANCE OF 600 FEET DOWNGRADIENT (STREAM).

NO. OF POINTS IN X-DIRECTION 7
NO. OF POINTS IN Y-DIRECTION 4
NO. OF POINTS IN Z-DIRECTION 2
NO. OF ROOTS: NO. OF SERIES TERMS 1000
NO. OF BEGINNING TIME STEPS 395
NO. OF ENDING TIME STEP 401
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION 1
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE 1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE 0
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT 1
CASE CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD 2

AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ... .1220E+02
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ... .9146E+02
BEGIN POINT OF X-SOURCE LOCATION (METERS) .... .0000E+00
END POINT OF X-SOURCE LOCATION (METERS) .... .0000E+00
BEGIN POINT OF Y-SOURCE LOCATION (METERS) .... .0000E+00
END POINT OF Y-SOURCE LOCATION (METERS) .... .0000E+00
BEGIN POINT OF Z-SOURCE LOCATION (METERS) .... .0000E+00
END POINT OF Z-SOURCE LOCATION (METERS) .... .0000E+00

POROSITY .... .3500E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR) .... .8300E+00
HYDRAULIC GRADIENT .... .1700E-01
LONGITUDINAL DISPERSIVITY (METER) .... .3000E+01
LATERAL DISPERSIVITY (METER) .... .3000E+00
VERTICAL DISPERSIVITY (METER) .... .3000E+00
DISTRIBUTION COEFFICIENT, KD (M**3/KG) .... .2000E+00
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C).. .0000E+00

MOLECULAR DIFFUSION MULTIPLY BY POROSITY (M**2/HR) .0000E+00
DECAY CONSTANT (PER HOUR) .... .0000E+00
BULK DENSITY OF THE SOIL (KG/M**3) .... .1900E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE ...... .1000E-02
DENSITY OF WATER (KG/M**3) .... .1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) .. .4380E+04
DISCHARGE TIME (HR) .... .4380E+05
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) . .1000E+01

RETARDATION FACTOR .... .1087E+04
RETARDED DARCY VELOCITY (M/HR) .... .3710E-04
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) .. .1113E-03
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR).. .1113E-04
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR). .1113E-04

0NE HUNRED FEET EQUALS 30.48 METERS

COMPUTATIONAL RESULTS

DISTRIBUTION OF CHEMICAL IN PPM AT .1726E+07 HRS

Z = .00

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.254E+02	.119E+04	.477E+04	.163E+04	.477E+02	.120E+00	.258E-04
30.	.231E-05	.109E-03	.435E-03	.149E-03	.435E-05	.109E-07	.237E-11
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.148E-13	.708E-12	.297E-11	.110E-11	.359E-13	.103E-15	.263E-19

Z = 12.19

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.159E-06	.758E-05	.315E-04	.115E-04	.367E-06	.103E-08	.252E-12
30.	.393E-13	.187E-11	.786E-11	.290E-11	.940E-13	.268E-15	.673E-19
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.432E-21	.206E-19	.866E-19	.321E-19	.105E-20	.301E-23	.763E-27

DISTRIBUTION OF CHEMICAL IN PPM AT .1730E+07 HRS

Z = .00

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.250E+02	.118E+04	.476E+04	.165E+04	.494E+02	.127E+00	.285E-04
30.	.228E-05	.107E-03	.434E-03	.151E-03	.451E-05	.117E-07	.261E-11
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.146E-13	.700E-12	.297E-11	.111E-11	.372E-13	.110E-15	.289E-19

Z = 12.19

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.157E-06	.749E-05	.315E-04	.116E-04	.380E-06	.109E-08	.278E-12
30.	.387E-13	.185E-11	.784E-11	.294E-11	.973E-13	.286E-15	.741E-19
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.426E-21	.204E-19	.864E-19	.325E-19	.108E-20	.320E-23	.840E-27

DISTRIBUTION OF CHEMICAL IN PPM AT .1734E+07 HRS

Z = .00

Y	X: 0.	30.	61.	91.	122.	152.	183.
0.	.247E+02	.116E+04	.475E+04	.168E+04	.512E+02	.136E+00	.315E-04
30.	.225E-05	.106E-03	.433E-03	.153E-03	.467E-05	.124E-07	.288E-11
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.144E-13	.691E-12	.296E-11	.113E-11	.385E-13	.117E-15	.318E-19

Z = 12.19

Y	X: 0.	30.	61.	91.	122.	152.	183.
0.	.155E-06	.741E-05	.314E-04	.118E-04	.393E-06	.116E-08	.306E-12
30.	.382E-13	.183E-11	.782E-11	.297E-11	.101E-12	.304E-15	.816E-19
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.419E-21	.201E-19	.862E-19	.329E-19	.112E-20	.341E-23	.924E-27

DISTRIBUTION OF CHEMICAL IN PPM AT .1739E+07 HRS

Z = .00

Y	X: 0.	30.	61.	91.	122.	152.	183.
0.	.243E+02	.115E+04	.474E+04	.170E+04	.530E+02	.145E+00	.347E-04
30.	.221E-05	.105E-03	.432E-03	.155E-03	.484E-05	.132E-07	.318E-11
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.142E-13	.683E-12	.295E-11	.114E-11	.398E-13	.124E-15	.350E-19

Z = 12.19

Y	X: 0.	30.	61.	91.	122.	152.	183.
0.	.153E-06	.732E-05	.313E-04	.119E-04	.407E-06	.124E-08	.337E-12
30.	.376E-13	.181E-11	.780E-11	.301E-11	.104E-12	.323E-15	.898E-19
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.413E-21	.199E-19	.860E-19	.333E-19	.116E-20	.362E-23	.102E-26

DISTRIBUTION OF CHEMICAL IN PPM AT .1743E+07 HRS

Z = .00

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.239E+02	.114E+04	.473E+04	.172E+04	.549E+02	.154E+00	.382E-04
30.	.218E-05	.104E-03	.431E-03	.157E-03	.502E-05	.141E-07	.351E-11
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.140E-13	.675E-12	.294E-11	.116E-11	.412E-13	.132E-15	.385E-19

Z = 12.19

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.150E-06	.723E-05	.312E-04	.121E-04	.421E-06	.132E-08	.370E-12
30.	.370E-13	.179E-11	.778E-11	.305E-11	.108E-12	.344E-15	.987E-19
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.407E-21	.197E-19	.857E-19	.337E-19	.120E-20	.385E-23	.112E-26

DISTRIBUTION OF CHEMICAL IN PPM AT .1748E+07 HRS

Z = .00

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.236E+02	.112E+04	.472E+04	.174E+04	.569E+02	.164E+00	.421E-04
30.	.215E-05	.102E-03	.430E-03	.159E-03	.519E-05	.150E-07	.386E-11
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.138E-13	.667E-12	.294E-11	.117E-11	.426E-13	.141E-15	.423E-19

Z = 12.19

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.148E-06	.715E-05	.312E-04	.123E-04	.436E-06	.140E-08	.407E-12
30.	.365E-13	.177E-11	.776E-11	.309E-11	.112E-12	.365E-15	.108E-18
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.401E-21	.194E-19	.855E-19	.342E-19	.124E-20	.409E-23	.123E-26

STEADY STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME

DISTRIBUTION OF CHEMICAL IN PPM AT .1752E+07 HRS

Z = .00

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.232E+02	.111E+04	.471E+04	.177E+04	.589E+02	.175E+00	.464E-04
30.	.212E-05	.101E-03	.429E-03	.161E-03	.538E-05	.160E-07	.425E-11
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.136E-13	.660E-12	.293E-11	.119E-11	.440E-13	.149E-15	.464E-19

Z = 12.19

Y \ X	0.	30.	61.	91.	122.	152.	183.
0.	.146E-06	.707E-05	.311E-04	.124E-04	.450E-06	.149E-08	.447E-12
30.	.360E-13	.175E-11	.774E-11	.313E-11	.115E-12	.388E-15	.119E-18
61.	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
91.	.395E-21	.192E-19	.853E-19	.346E-19	.128E-20	.435E-23	.135E-26

APPENDIX K
REFERENCES

REFERENCES

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