

PUMPHOUSE #1 OVERVIEW

EPD Facility No. 9025085

CAP-Part A investigation (submitted to EPD May 14, 1997):

No. of Gore Sorbers	No. of Soil Borings	No. of Monitoring Wells	No. of Surface Water/ Sediment Samples
257	14	5	4

Results:

Gore Sorber

- Gore sorber results indicated BTEX contamination in two distinct areas at approximately the same magnitude (refer to Gore maps).
- The BTEX and PAH maps show significant differences in plume geometry.
- The C11, C13, and C15 plume map is presented to show possible impacts from JP-type products.

Soil

Compound	Criteria*	# of Samples > Criteria	Detection Range	Notes
Benzene	0.017 mg/kg	10 of 38	0.16 to 5.6 mg/kg	7 of 38 had detection limits > than criteria
Toluene	115 mg/kg	1 of 38	160 J	MW-3
Ethylbenzene	18 mg/kg	4 of 38	19 to 96 mg/kg	MW-1, 3, 11, SB20
PAH	0.660 mg/kg (individual compounds)	6 of 38	0.8 to 5.4 mg/kg	SB2, 6, 7, 8, 24, MW11

* Table B, Column 1 STLs are used as criteria for soil sample analytical results based on the short distance to the storm water drainage ditch. No private wells are located within a 0.5-mile radius. The closest public well is located 4,300 feet upgradient of Pump House #1 and the nearest downgradient well is 6,300 feet southeast of the site. Both wells draw water from the Floridan Aquifer which is separated from the shallow aquifer by two confining units.

Groundwater

Compound	Criteria*	# of Samples > Criteria	Detection Range	Notes
Benzene	71.28 µg/L	2 of 5	740 to 1100 µg/L	MW2, MW3. Detection limit > IWQS at MW1 (110µg/L).
PAH	0.0311 µg/L (individual compounds)	1 of 5	0.21 to 9.2 µg/L	Trace conc. at MW03

* In-stream water quality standards (IWQS) outlined in Chapter 391-3-6 are used as screening criteria for groundwater instead of MCLs based on the short distance to the storm water drainage ditch. No private wells are located within a 0.5-mile radius. The closest public well is located 4,300 feet upgradient of Pump House #1 and the nearest downgradient well is 6,300 feet southeast of the site. Both wells draw water from the Floridan Aquifer which is separated from the shallow aquifer by two confining units.

Surface Water

Compound	Criteria	# of Samples > Criteria	Detection Range	Notes
Benzene	71.28 µg/L	0 of 4	1 to 19J µg/L	

Sediment

Compound	Criteria	# of Samples > Criteria	Detection Range	Notes
PAH	0.660 mg/kg	2 of 4	0.8 to 3.6 mg/kg	SE09, 10. Detections not apparently associated with PH#1 (i.e., far downgradient).

CAP-Part B investigation:

(Sampled in June 1997)

No. of Soil Borings	No. of Monitoring Wells
17	12 (1 deep)

Results:

Soil (see Figure 5)

Compound	Criteria*	# of Samples > Criteria	Detection Range	Notes
Benzene	0.017 mg/kg	0 of 58	N/A	18 of 58 had detection limits > than criteria
Toluene	115 mg/kg	1 of 58	0.01 to 180 mg/kg	SB40
Ethylbenzene	18 mg/kg	4 of 58	0.008 to 82 mg/kg	SB25, SB27, SB30, and SB40
PAH	0.660 mg/kg (individual compounds)	2 of 58	0.42 to 10J mg/kg	SB25, SB38

* Table B, Column 1 STLs are used as criteria for soil sample analytical results based on the short distance to the storm water drainage ditch. No private wells are located within a 0.5-mile radius. The closest public well is located 4,300 feet upgradient of Pump House #1 and the nearest downgradient well is 6,300 feet southeast of the site. Both wells draw water from the Floridan Aquifer which is separated from the shallow aquifer by two confining units.

Groundwater (see Figure 6)

Compound	Criteria*	# of Samples > Criteria	Detection Range	Notes
Benzene	71.28 µg/L	4 of 12	100 to 630 µg/L	MW19, 21, 22, 23
PAH	0.0311 µg/L (individual compounds)	5 of 12	all < 1 µg/L	MW15, MW17, MW20, MW21, MW23

* In-stream water quality standards (IWQS) outlined in Chapter 391-3-6 are used as screening criteria for groundwater instead of MCLs based on the short distance to the storm water drainage ditch. No private wells are located within a 0.5-mile radius. The closest public well is located 4,300 feet upgradient of Pump House #1 and the nearest downgradient well is 6,300 feet southeast of the site. Both wells draw water from the Floridan Aquifer which is separated from the shallow aquifer by two confining units.

Generalized Geology:

The lithology encountered is predominantly a dark gray to dark brown, **very fine to medium-grained sand**, with variable silt and clay content. At a depth of about 29.5 feet, lithology increased to fine to coarse-grained sand. Generally, the samples with higher silt and clay content were within a few feet of the surface. Lower silt and clay content was noted with depth.

Documented Calculations of Relevant Aquifer Parameters

A total of five Shelby tube samples were collected during the CAP-Part B investigation. The Shelby tube samples were collected from borings MW15 (7-9 ft), MW16 (7-9 ft), MW21 (10-12 ft), MW22 (8-10 ft), and SB33 (8-10 ft). The Shelby tube samples were analyzed for grain size distribution, moisture content, and permeability. **The Shelby tube samples averaged 91.4 percent sand, 21.5 percent moisture, and 2.9×10^{-3} cm/s permeability.** Permeability tests using kerosene were performed on SB33 (8-10 ft) and MW22 (8-10 ft) with results of 1.1×10^{-3} cm/s and 2.6×10^{-3} cm/s, respectively. A permeability test using high octane unleaded gasoline was performed on MW21 (10-12 ft) with the result of 5.3×10^{-3} cm/s. **An average seepage velocity of 9.7×10^{-5} cm/s (0.27 ft/day)** was calculated using a hydraulic gradient of 0.006 ft/ft, the permeability of 2.9×10^{-3} cm/s and average effective porosity of 0.18 from another investigation at HAAF (Former Building 728; M&E, 1997) which has the same general lithology. **Figure 10** provides an illustration of the potentiometric surface near Pump House #1.

Fate and Transport Modeling Summary

A computer modeling program (Solute v.4.04) was utilized to estimate contaminant transport at the Pump House #1 site. The model simulates the one-dimensional transport of a solute having a pulse (release) of limited duration with a concentration-dependent flux as the inlet boundary (source). The model accounts for the effects of advection, longitudinal dispersion, retardation, and first-order decay. Four modeling scenarios simulating contaminant transport near Pump House #1 were evaluated.

- Contaminant transport simulation between MW2 and the ditch

- Contaminant transport simulation between MW19 and the ditch
- A third model scenario matched concentrations observed at MW2 and MW19 using a hypothetical contaminant source located 100 feet north of MW2 and then simulated contaminant transport using standard input parameters.
- The fourth model used the benzene half-life obtained from the calibration model (MW2-MW19 matching model) and a site-specific area as the suspected to be the source of contamination (the pipeline area). The suspected area source area was approximately 80 feet north of MW3 and was based on historical Gore Sorber™ data (passive soil vapor monitoring device) and elevated concentrations from soil and groundwater analytical data. The suspected source area was previously identified during the DAACG investigation where DAACG monitoring well MW5 contained 4,100 ug/L benzene. Each monitoring point associated with the DAACG investigation is located within the stippled area illustrated on **Figure 5** and **Figure 6**.

The modeling is based on analytical data collected during this investigation and predicts the movement of contaminants in the future. It does not attempt to model the original leak/spill because no information concerning concentration or spill duration is known. The fuel system was taken out of service approximately 20 years ago and any original contaminant slug would have most likely migrated away from the site or degraded away. **The modeling study assumes that steady state conditions exist** and that no additional sources or contaminant influx other than the Pump House #1 area are responsible for the contaminant plume.

Scenario #3 most closely matched conditions observed in the field. The model scenario #3 suggests that benzene concentrations above IWQS (579 ug/L predicted) will reach the ditch. This appears likely because the benzene concentration in MW19, located 45 feet upgradient of the ditch, is 630 ug/L. Benzene concentrations in groundwater are illustrated in **Figure 6**. The actual concentration of benzene in surface water is much lower than the modeled seepage concentration of 579 ug/L. The benzene likely volatilizes at the seepage front on the ditch slope or degrades

more rapidly in the surface water. Benzene is also diluted by surface water which might explain why higher benzene concentrations were not detected downstream.

Fate and transport of benzene associated with the DAACG area was also simulated using a one-dimensional computer model. Model input parameters were similar to those used for the MW2-MW19 matching model. Area specific parameters (groundwater seepage velocity, initial aquifer concentration, etc.) were entered in accordance with observed conditions in the DAACG area. The results of this modeling effort indicate that contamination will reach the nearest down-gradient surface water receptor at concentrations greater than IWQS. However, the pulse duration (1500 days-- the same as was used in the MW2-MW19 matching model) had a significant impact on downgradient contaminant concentrations. The pulse duration was shown to greatly influence model outcome in the Pump House #1 models previously discussed. Review of analytical data presented on **Figure 6** indicate that benzene concentrations decrease from 700 ug/l to 100 ug/l between DAACG wells MW2 and MW1, respectively. Well MW1 (located within the stippled area associated with the DAACG investigation) is directly down-gradient of MW2. Review of the contour data indicate that benzene concentrations down-gradient of MW1 should decrease below the IWQS (71.28 ug/l) over a short distance, perhaps 100 feet, beyond MW1. This leads to a conclusion that modeling using a 1500 day pulse from a location just upgradient of MW2 does not reflect what has been confirmed with actual water samples and is inappropriate under this scenario. **Consequently, the determination that the downgradient surface water will not be impacted by benzene at concentrations that exceed IWQS in this area was based upon the analytical data rather than the groundwater model.**

Remedial Alternatives Evaluation

SUMMARY OF GROUNDWATER CONTAMINATION

The IWQS for benzene (see **Figure 6**) was exceeded at seven groundwater monitoring well locations near Pump House #1 and seven wells under the tarmac (near the DAACG complex). Trace concentrations of PAH compounds (see **Figure 7**) were also identified in groundwater at five locations above the IWQS. However, no BTEX contaminants were identified in surface

water samples from the nearby drainage ditch above IWQS. A risk of exposure assessment, discussed in preceding paragraphs, identified no contaminant receptors downgradient of the study area. The data suggest that natural processes are reducing contaminant levels in the groundwater/surface water system to well below IWQS directly adjacent to the site. However, no data has been collected over an extended time period to verify that future concentrations of contaminants in the surface water will remain within IWQS.

The Pump House #1 investigation defined the southern boundary of the groundwater contamination identified in the DAACG investigation (north of fuel pits 1-A and 1-B). The contour map of groundwater analytical data (Figure 6) indicated that no IWQS would be violated in the nearest surface water receptors. Therefore, passive remediation is recommended for the area northwest of Pump House #1. However, a sentinel monitoring well is proposed to be installed between the contaminant plume and the nearest receptor to monitor potential contaminant migration.

SUMMARY OF SOIL CONTAMINATION

Soil containing elevated concentrations of hydrocarbons may be a continuing source of groundwater contamination at Pump House #1. Rainwater, leaching through shallow unconfined soils, mobilizes hydrocarbon contaminants that eventually contribute to the groundwater contamination plume. None of the soil samples collected during the CAP-Part B investigation exceeded the benzene criteria established in Table B of 391-3-15.09 (although the laboratory detection limit for 18 of 58 soil borings was above the benzene STL due to interferences). This makes accurate quantification of benzene in the samples difficult. The extent of contamination in soil was estimated using the data and two general areas of soil contamination were defined and are shown in Figure 5.

SOURCE AREA STATUS

The fuel system that is the reported source of soil contamination near Pump House #1 has been removed. In March 1995, eight 25,000 gallon underground storage tanks (USTs) were removed by Anderson Columbia Environmental, Inc. Two 25,000 gallon tanks remained in place, partially under the Pump House structure, until June 1998 when the tanks were removed. The pipeline servicing the former Pump House #1 and the de-fuel tank were abandoned in place using a grout slurry. No separate phase hydrocarbons (SPH) have been identified at the Pump House #1 area. The impacted soil in the DAACG area is nearly completely covered with concrete pavement and percolation through the soil column would be minimal. In addition, soil contamination in this area is not anticipated to present a significant human health threat because exposure pathways are incomplete.

PROPOSAL TO COLLECT ADDITIONAL DATA FOR REMEDIAL EVALUATION

A review of contaminant and hydrogeologic data collected during the investigation indicates that several data gaps exist primarily in the understanding of the hydraulic and geologic nature of the shallow aquifer. Although the data collected during the investigation covered an extensive area, detailed hydrogeologic testing was not performed. Collecting additional data as outlined below will support a more accurate evaluation of treatment alternatives and will allow for the proper design of any remediation components.

- Changes in groundwater contaminant concentrations over time are not well understood. An extended sampling program should be initiated to establish upper and lower bounds of contaminant concentrations across the site. Groundwater samples will be collected from Pump House #1 area wells (the proposed aquifer testing well, MW01, MW02, MW03, MW18, MW-19, MW-20, MW-21, and MW-24) on a quarterly basis for the first year and semi-annual for the second year of the monitoring period for analysis. Two wells that were installed upgradient of Pump House #1 during the DAACG investigation, MW5 and MW6, will also be sampled for field and laboratory analyses. Laboratory analytical parameters include: VOCs (by EPA Method 8021B), SVOCs (by EPA Method 8310), total organic

carbon (TOC), nitrate (NO₃), nitrite (NO₂), sulfate (SO₄), dissolved methane (CH₄), and dissolved ferrous iron (Fe²⁺). In addition, field analysis of dissolved oxygen (DO), pH, and eH will be conducted. Table 1 provides a complete list of proposed sample analytical parameters. Several wells located near the DAACG facility (beneath the concrete tarmac) will also be sampled and analyzed to document natural attenuative processes. These wells include: MW1, MW2, MW11, MW13, MW17, MW19, and the proposed sentinel well. These samples will be collected at the same frequency as the Pump House #1 samples and will be analyzed for the parameters listed in Table 1.

- Verification of soil contamination over time will also be performed. Approximately ten soil samples will be collected from areas known to contain elevated concentrations of hydrocarbons (see Figure 11). These samples will be collected annually for a two year period from the soil horizon that exhibits the most elevated organic vapor analyzer (OVA) reading. Soil sample results will then be used to evaluate appropriate treatment alternatives and the efficiency of biological processes.
- Aquifer tests will be conducted to gain information on groundwater flow direction and velocity. The installation of a 4-inch diameter, approximately 35 foot deep PVC groundwater well is proposed for use in aquifer withdrawal tests. A continuously sampled pilot hole should be advanced prior to the test well installation so that verification can be made that the well screen contacts at least 80 percent of the complete thickness of the shallow aquifer. The well should be installed approximately 60 feet east of MW03 (see Figure 6). The proposed suite of aquifer tests include: slug testing all wells included in the quarterly/semiannual sampling program, a step drawdown test in the pumping well, a 48-hour aquifer withdrawal test, and several infiltration (percolation) tests. Weather monitoring/research will also be conducted during the testing period. Testing the drainage canal sediment permeability (leakance rate) will also be performed and head levels in the stream will be monitored during aquifer testing.
- Measurement of surface water flow rates within the ditch will be performed during each sampling period. Water level elevations in the ditch will also be measured during sampling events.

- Direct push groundwater sampling and field VOC analysis to define the extent of the soluble hydrocarbon plume is proposed. Selected geochemical parameters will also be monitored during vertical profiling to evaluate efficacy of naturally occurring biodegradation processes. This data will be collected for use in plume delineation and 3-dimensional groundwater modeling (if required) during the remedial evaluation stage. The primary purpose of the vertical profiling will be to determine what type of biodegradation (aerobic or anaerobic) is taking place throughout the groundwater plume. A illustration of the area where direct push vertical profiling will be performed is provided in: **Figure 12**. Approximately 20 sampling points each having ³ ~~five~~ sampling intervals (~10, 20, and 30 feet below land surface) will be used to assess the extent of contamination and gain an understanding of the geochemical processes taking place in the shallow aquifer.

If warranted by the data, a 3-dimensional modeling study which includes contaminant transport and fate analysis will be performed. The model will account for biological decay if groundwater analyses indicate that biodegradation is occurring. A review of the first year of quarterly monitoring will be conducted to determine if additional testing is required. Following two years of monitoring, alternate concentration levels (ACLs) for groundwater contaminants may be calculated based on data collected during the monitoring period. In addition, achievable soil treatment goals may be calculated based on available treatment technology.

Data collected during the two year monitoring program will be used to evaluate appropriate treatment alternatives at the site. Emphasis will be placed on maintaining the surface water quality in the nearby drainage ditch with respect to State regulations. The potential for further impact to the ditch and any surrounding populations will be reviewed and incorporated into the final remedial design. Contaminant distribution and aquifer hydraulic data collected during the monitoring period will allow Fort Stewart to efficiently design any remedial system components required to meet State standards.

Table 1. Additional parameters to be measures to assess natural attenuation

Parameter	Description
Alkalinity	Provides an indication of the buffering capacity of the water and the amount of carbon dioxide dissolved in the water. Increases due to biodegradation of organic compounds.
pH	Microbial activity tends to be reduced outside of a pH range of 5 to 9, and many anaerobic bacteria are particularly sensitive to pH extremes.
Temperature	Affects rates of microbial metabolism. Slower biodegradation of occurs at lower temperatures.
Dissolved oxygen	Highest energy-yielding electron acceptor for biodegradation of organic constituents. <10 ppm.
Redox potential	A measure of the oxidation-reduction potential of the environment. Ranges from +500 mV for aerobic conditions to -300 mV for methanogenic conditions.
Sulfate	Used as an electron acceptor in biodegradation of organic constituents. Reduced to form sulfide.
Sulfide	Microbially reduced form of sulfate. Indicates reduced conditions.
Methane	Indicator of anaerobic conditions and methanogenic bacteria. Produced by the microbial reduction of carbon dioxide. Solubility limit 25 to 40 ppm.
Ethane/ethene	Metabolic end product of reductive dehalogenation of halogenated ethenes and ethanes.
Total organic carbon (TOC)	A measure of the total concentration of organic material in water that may be available for biological degradation.
Chloride	May be useful as an indication of biological dechlorination and as a conservative tracer.
VOC/daughter products	Provides a measure of the type and quantity of parent and biogenic daughter products.
SVOC/ daughter products	Provides a measure of the type and quantity of parent and biogenic daughter products.
Nitrogen	An essential nutrient of microbial growth and biodegradation.
Nitrate	Used as an electron acceptor. Consumed next after oxygen.
Nitrite	Product of nitrate reduction. Produced only under anaerobic conditions. Rarely observed.
Phosphorous	Essential nutrient for microbial growth and biodegradation.
Iron(total, dissolved)	A product of bacterial iron reduction. Only the reduced form (ferrous) is soluble. The oxidized form (ferric) is used as an electron acceptor.

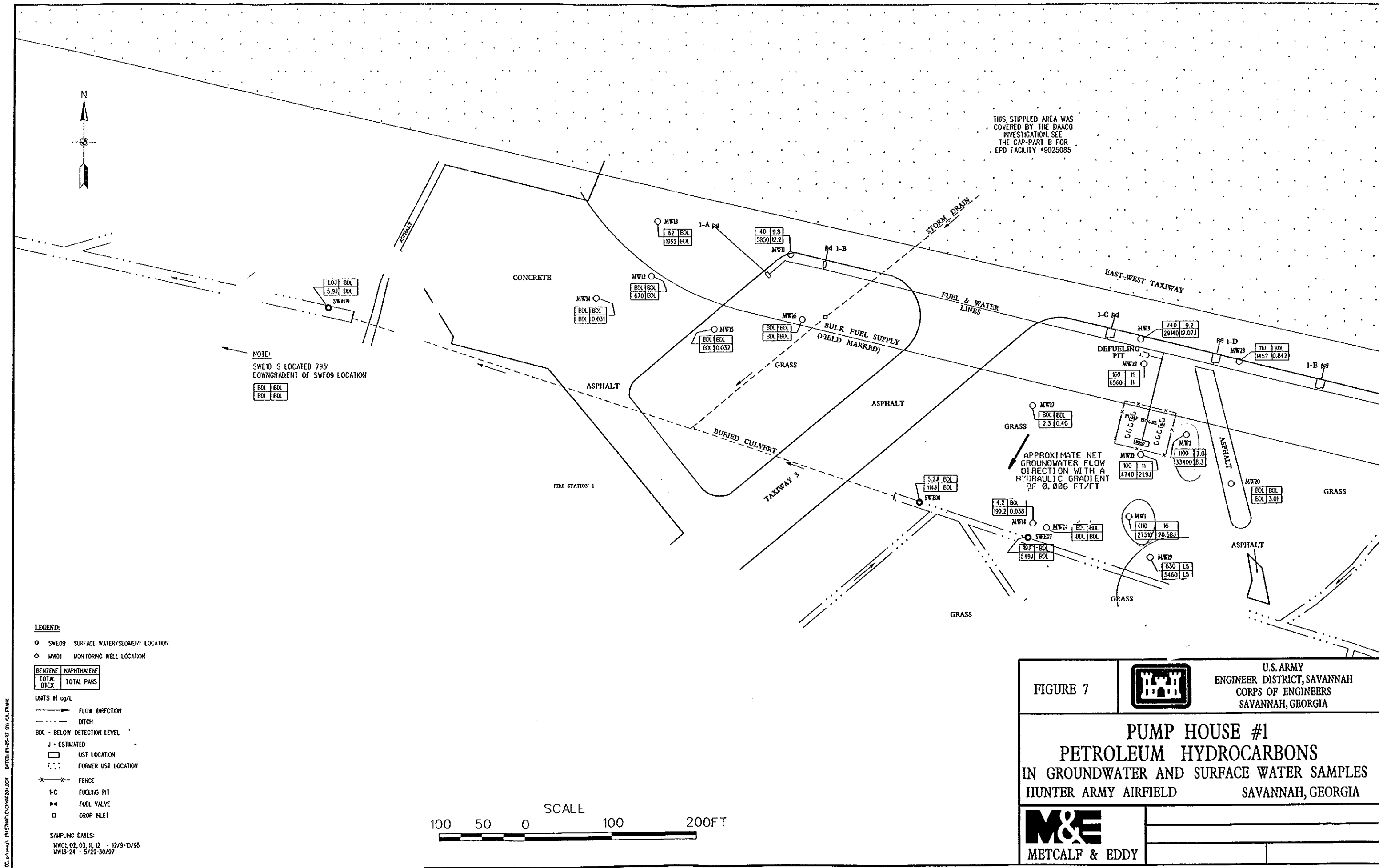


FIGURE 7



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

PUMP HOUSE #1 PETROLEUM HYDROCARBONS IN GROUNDWATER AND SURFACE WATER SAMPLES HUNTER ARMY AIRFIELD SAVANNAH, GEORGIA



METCALF & EDDY

LOC: ps\proj\ 19457HAF\CHAF012.DGN DATED: 09-05-97 BY: M.A. FRANK

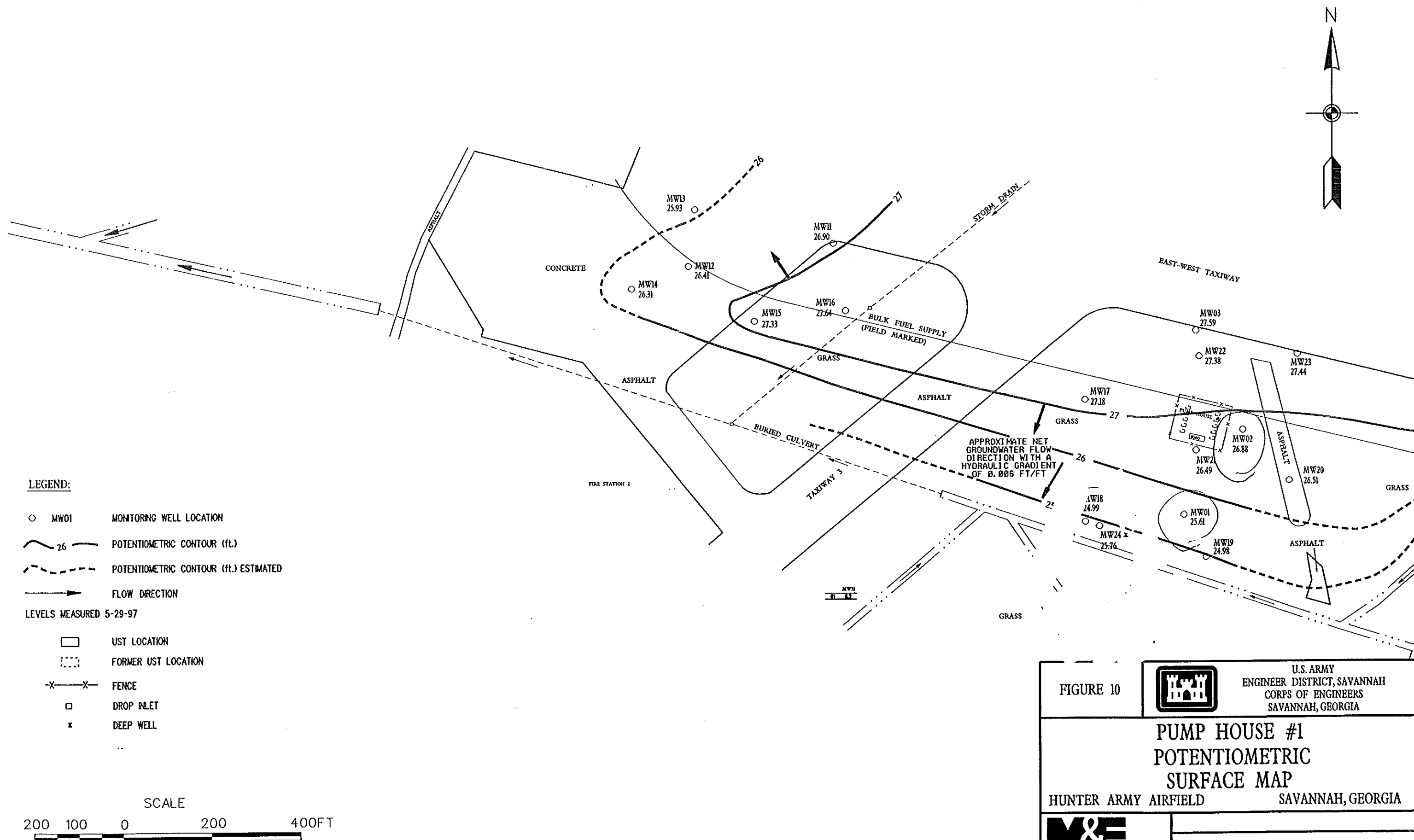



FIGURE 10

 U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

**PUMP HOUSE #1
POTENTIOMETRIC
SURFACE MAP**

HUNTER ARMY AIRFIELD SAVANNAH, GEORGIA

M&E
METCALF & EDDY

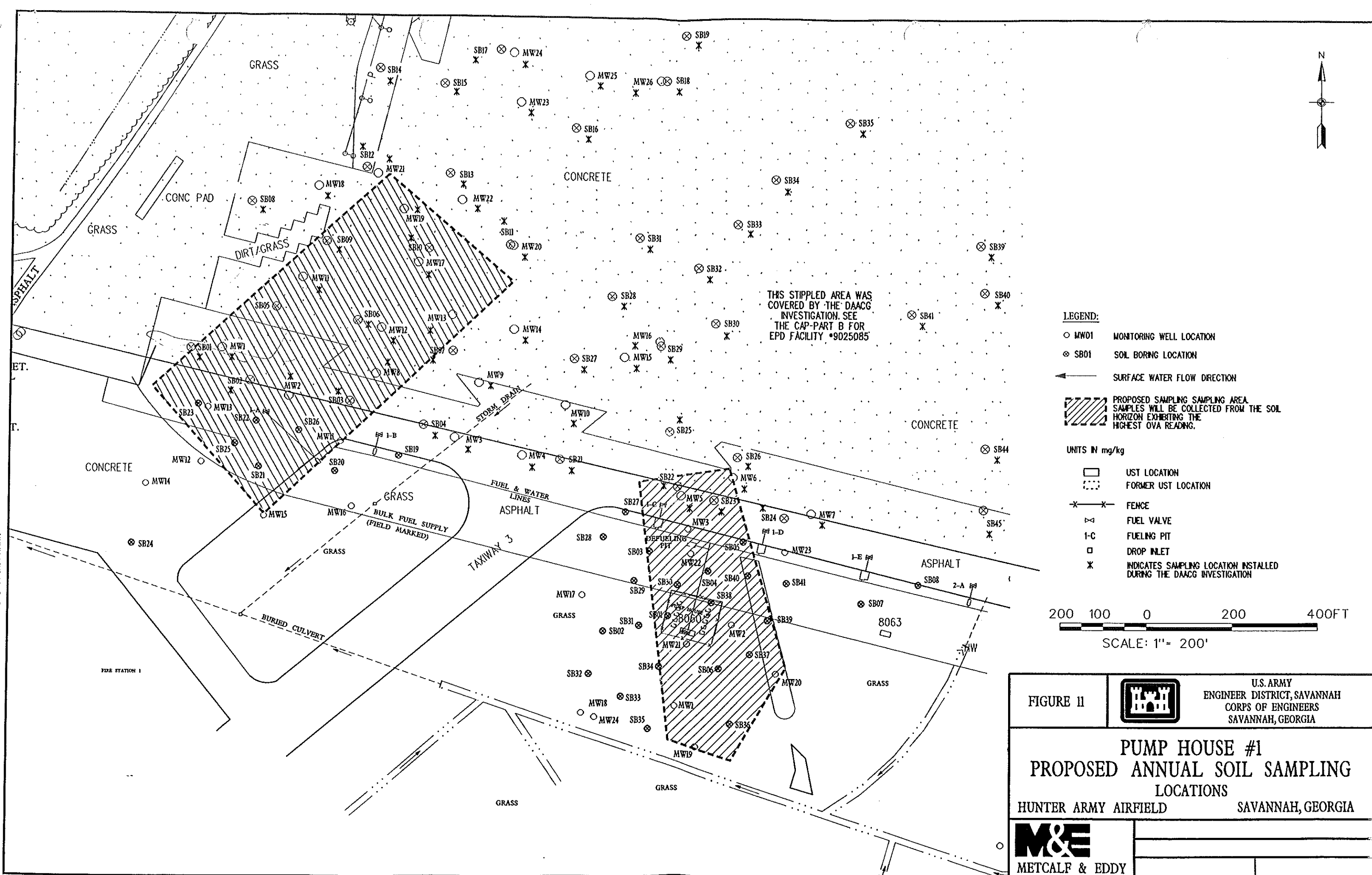


FIGURE 11



PUMP HOUSE #1
PROPOSED ANNUAL SOIL SAMPLING
LOCATIONS

HUNTER ARMY AIRFIELD

SAVANNAH, GEORGIA



METCALF & EDDY

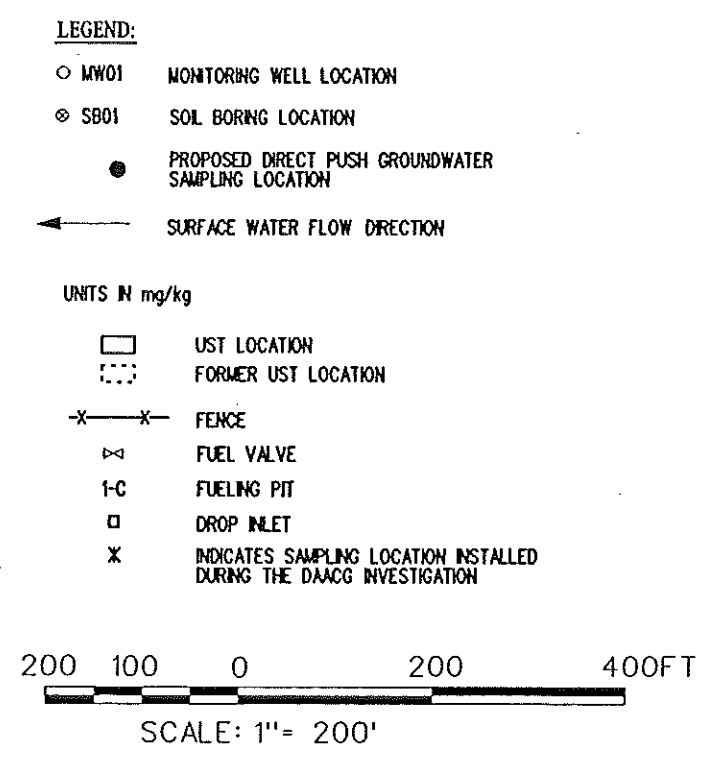
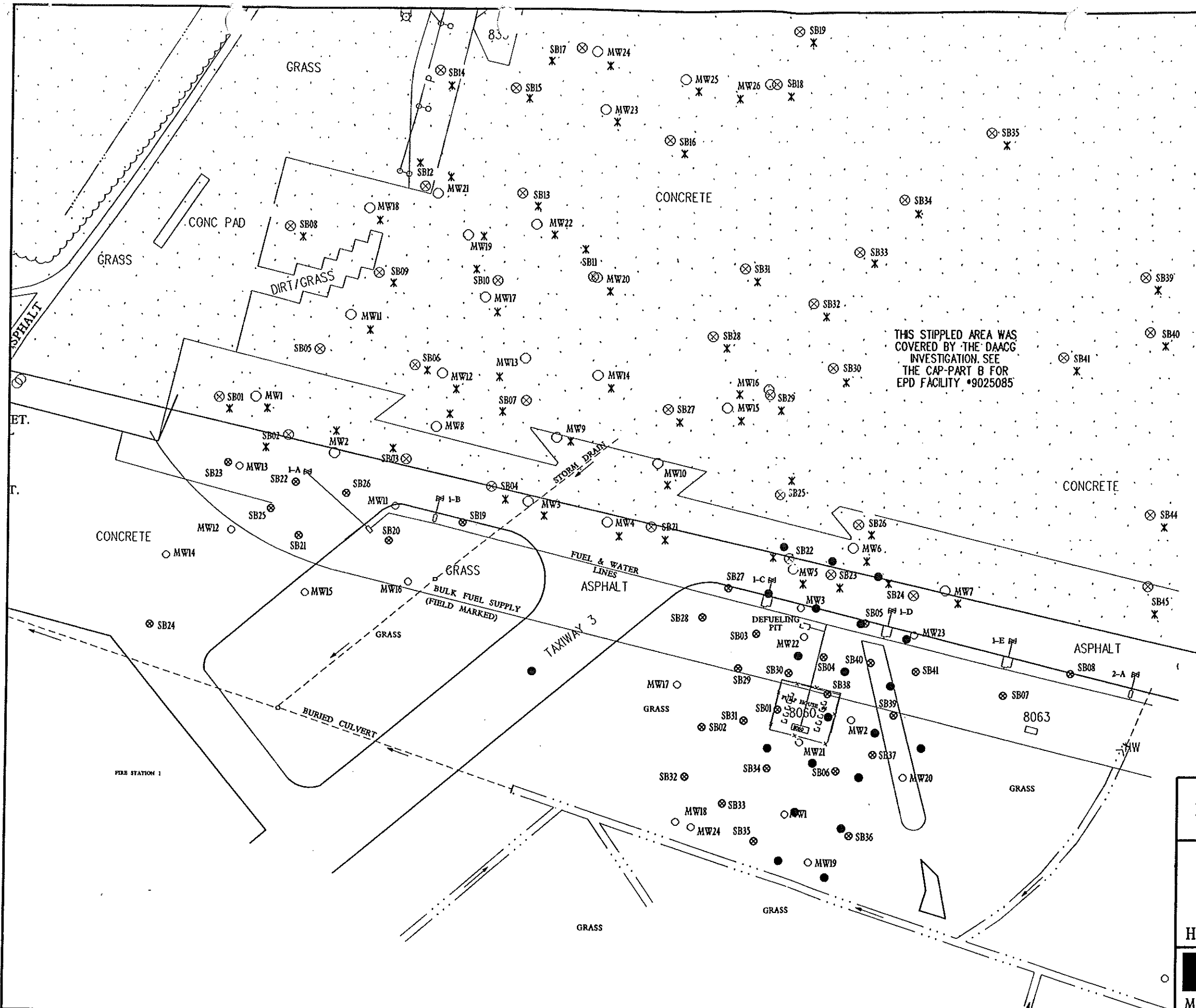


FIGURE 12		U.S. ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA	
		<p>PUMP HOUSE #1</p> <p>PROPOSED VERTICAL PROFILE</p> <p>GROUNDWATER SAMPLING LOCATIONS</p> <p>HUNTER ARMY AIRFIELD SAVANNAH, GEORGIA</p>	