FINAL REPORT
PHASE I REMEDIAL INVESTIGATION
OF SELECTED AREAS
OF FORMER RARITAN ARSENAL

DAMES & MOORE

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Volume V

Analytical and Supporting Laboratory Quality Control Data for COE - Former Raritan Arsenal, Pages 001 through 451 (July-August 1992)

Volume VI

Analytical and Supporting Laboratory Quality Control Data for COE - Former Raritan Arsenal, Pages 452 through 957 (July-August 1992)

Volume VII

Analytical and Supporting Laboratory Quality Control Data for COE - Former Raritan Arsenal (September 1992)

ACRONYMS

ATV	All-terrain vehicle
BTEX	Benzene, toluene, ethylene, and xylenes
C	Centigrade
CCS	Continuing calibration standard
CLP	Contract Laboratory Program
CVAA	Cold vapor atomic absorption
DCA	1,1-dichloroethane
DCE	1,1-dichloroethene
DOD	Department of Defense
ESE	Environmental Science and Engineering
FID	Flame ionization detector
GC	Gas chromatograph
GFAA	Graphite furnace atomic absorption
ICP	Inductively coupled plasma
LEAD	Letterkenny Army Depot
MCC	Middlesex County College
μg/L	Micrograms per liter (parts per billion)
MRD	Missouri River District
MS	Matrix spike
MSD	Matrix spike duplicate
MW	Monitoring well

N.J.A.C.	New Jersey Administrative Code
NJDEPE	New Jersey Department of Environmental Protection and Energy
NOAA	National Oceanic and Atmospheric Administration
NTU	Nephelometric turbidity unit
OBG	O'Brien and Gere
OD	Outside diameter
PCBs	Polychlorinated biphenyls
ppb	Parts per billion
ppbv	Parts per billion, vapor
ppm	Parts per million
PQL	Practical quantitation level
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
RPD	Relative percent difference
SG	Soil gas
SOC	Synthetic organic chemical
SS	Surface sediment
SW	Surface water
TCE	Trichloroethene
TRPH	Total recoverable petroleum hydrocarbons
TVHC	Total volatile hydrocarbons

USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UXB	UXB International (ordnance contractor)
UXO	Unexploded ordnance
VOA	Volatile organic analyte
VOC	Volatile organic compound
WS	Water sample (collected during the soil gas survey)
WWI	World War I
WWII	World War II

1.0 INTRODUCTION

This report presents the results of the first phase of a remedial investigation of selected areas of the U.S. Army's former Raritan Arsenal in Edison, New Jersey. The intent of the investigation was to begin the assessment of the presence and extent of soil and ground water contamination attributable to operations and activities formerly conducted at the arsenal. Field activities during this investigation included the performance of soil gas surveys, ordnance searches at sample locations and along access routes, soil and sediment sampling and analyses, monitoring well installation, and ground water sampling and analyses. This program was conducted in general conformance with Dames & Moore's *Chemical Data Acquisition Plan* and *Work Plan*, both dated October 1991; these documents were developed under USACE Contract DACW41-89-D-0122.

2.0 BACKGROUND

2.1 GENERAL BACKGROUND

The former Raritan Arsenal was located in Middlesex County, New Jersey, approximately 20 miles southwest of lower Manhattan. The arsenal was bordered on the north and northwest by Woodbridge Avenue, on the west and southwest by Millville Road, and on the south and east by the Raritan River; it included a total of approximately 3200 acres.

The site was used extensively by the U.S. Army from 1917 to 1963. Operations at the site included the receipt, storage, shipment, and decommissioning of ordnance, arms, and machinery. It has been reported that explosive materials routinely were destroyed by burning in chamber pits or on the ground surface. Accidental explosions in magazine buildings and outdoor storage areas reportedly scattered explosive materials over large areas and forced ordnance fragments into the ground.

Additional historical information concerning the areas formerly occupied by the Raritan Arsenal can be found in *Archive Search Report for Middlesex County College and Thomas A. Edison Park*, dated October 7, 1991, by Metcalf & Eddy, Inc., and in *Archive Search Report for Raritan Center and GSA Area* by Metcalf & Eddy, Inc.

2.2 PREVIOUS INVESTIGATIONS

The Army began phasing out its operations at the arsenal in 1961. A decontamination study of the arsenal was conducted in 1963 as part of the decommissioning process. The study was begun under the direction of Raritan Arsenal personnel and was completed under the direction of personnel from the Letterkenny Army Depot (LEAD) and Army Material Command Safety Office. During this study, LEAD identified 17 areas within the former arsenal as potentially contaminated because of ordnance related activities. The Army subsequently designated each of these areas for "Unrestricted Use," "Surface Use Only," or "Non-Use," as deemed appropriate on the basis of the LEAD study.

O'Brien and Gere (OBG) of New Jersey, under contract to the U.S. Army Corps of Engineers (USACE), began a contamination evaluation study in September of 1987. The objectives of this evaluation were to perform field investigations and make preliminary

determinations of whether chemical and/or ordnance contamination, which may have been caused by Department of Defense (DOD) related activities, were present at the site. OBG's findings were presented in their report, *Final Engineering Report, Former Raritan Arsenal, Contamination Evaluation, Edison, New Jersey, Project No. CO2NJ008400*, dated August 1989.

2.3 SITE GEOLOGY

The Raritan Arsenal site lies within the Inner Coastal Plain Physiographic Province near its convergence with the Piedmont Province. The Coastal Plain province is characterized by unconsolidated sediments of Cretaceous age unconformably overlying Triassic aged sedimentary bedrock. The Triassic bedrock identified beneath the site consists of sandstone, shale and argillite of the Newark Group. Diabase intruded into the Newark Group Formations during the Triassic, creating the Palisades Sill, which extends from Haverstraw, New York south through the study area to Mercer County in southern New Jersey. The bedrock underlying the site dips northwest at angles of 5 to 15 degrees. Depth to bedrock at the Raritan Arsenal ranges from 20 feet in the northern areas to 78 feet near the Raritan River.

The upper bedrock beneath the arsenal is primarily the shale of the Brunswick Formation. In the extreme southeast corner of the site, the formation has been intruded by a gray-black quartz diorite-to-diabase sill, causing contact metamorphism of the intruded shale. The shale is inferred to grade from red to gray to black to a brittle black slate with increasing proximity to the intrusion. Apparently-unaltered red shale was encountered during the Dames & Moore investigation only in the northern portion of the site; black or gray shale was encountered throughout the southern half of the site, in the approximate center of the site, and at the western perimeter of the site.

The Cretaceous-age Raritan Formation overlies the bedrock at the site. Members of the Raritan Formation discernible at the site include the Raritan Fire Clay and the Farrington Sand. The Raritan Fire Clay, a silty clay of low plasticity, directly overlies the bedrock throughout most of the site, and varies in thickness throughout the Arsenal from about 4 feet to 8 feet. Overlying this silty clay layer are unconsolidated sediments composed of orange-brown to gray, silty, fine to coarse-grained sand with varying amounts of clay and gravel (in which the Farrington Sand unit lies). In the southern half of the Arsenal, there is a black clayey organic mat (peat) layer which separates the silty fine to coarse sands into two distinct units above and below the peat. This peat layer is up to 21 feet thick in the southern part of the Arsenal. The

sediments below the peat in the southern part of the Arsenal are up to 38 feet thick. The peat layer terminates in the central area of the Arsenal. Where these two deposits meet, the unconsolidated sediments are about 20 feet thick. The total thickness of the unconsolidated sediments above bedrock throughout the Arsenal ranges from 52 feet in the south-southeast to 20 feet in the north-northwest.

For the most part, the Quaternary and Upper Cretaceous strata have been eroded in the Arsenal area. One exception is the Quaternary-aged Cape May Formation, a light-colored quartz sand described as clayey, pebbly, and glauconitic which extends across the northern section of the site trending northeast-southwest.

The principle aquifer at the Raritan Arsenal site is the Raritan Member Farrington Sand. Ground water flow in the unconsolidated sediments throughout the Arsenal is to the south and southeast, toward the Raritan River. Depth to ground water ranges from immediately below ground surface near the Raritan River to approximately 12 feet below grade in the northern section of the Arsenal. The Farrington Sand Aquifer average porosity by volume is approximately 34 percent; the hydraulic conductivity is estimated at approximately 1200 to 1500 gal/day/ft^2 (Van Houten, 1969). The unconsolidated sediments above the clayey peat layer in the southern part of the Arsenal compose an unconfined perched aquifer; tides in the Raritan River appear to influence this aquifer.

The ground water gradient is steeper, and the flow pattern is better defined and more consistent, in the northern and central areas of the former arsenal. Near the Raritan River, ground water levels measured in the monitoring wells generally do not indicate a consistent ground water flow direction, and the gradient generally is minimal.

Figure 18 shows the generalized shallow aquifer ground water flow directions based on the ground water levels measured August 14, 1992.

Generalized cross sections depicting the site geology are shown on Figures 21 through 26; cross section traverses are shown on Figure 20. These cross sections were developed from information on the borehole logs of monitoring wells installed by Dames & Moore throughout the site. In many cases the boreholes were advanced at significant distances from one another; therefore, caution should be used when reviewing the cross sections. The soil conditions between the boreholes have been inferred; although the cross sections are a reasonable

approximation of general soil conditions at the site, the drawings may not represent actual soil conditions at any specific location other than the boreholes used to develop the drawings.

2.4 CURRENT USE OF SITE

At present, the site is a mixture of intensive use and open space/marshlands.

The northern and central portion of the site (refer to Figure 1) is occupied by Raritan Center, a multi-use light industrial, warehouse, and business park. The southern and eastern portions of Raritan Center, adjacent to the Raritan River, are marshlands and wetlands; these areas have not yet been developed for commercial use. The southern and eastern portions of the site were heavily developed during the arsenal period, with an extensive road and railroad network, piers, and buildings for the storage of munitions. Many of the munitions storage buildings have been removed since 1963; however, a significant portion of the land fixtures are still present. Raritan Center, including the undeveloped marshlands/wetlands, consists of approximately 2000 acres.

The southwestern portion of the former arsenal is occupied by Middlesex County College, a local community college. The college is a mixture of new buildings and buildings constructed during the arsenal period. Middlesex County College consists of approximately 190 acres.

The southern portion of the site was transferred to Middlesex County in 1962; the county has since developed the site into a public park known as Thomas A. Edison Park. Based on visual observations, significant cut and fill operations have been conducted in the western and central portions of the park to accommodate the installation of multi-use fields, tennis courts, ballfields, and parking areas. The eastern portion of the park appears to be essentially as it existed during the arsenal period, although many of the magazines formerly in this area have been removed. The park consists of approximately 160 acres.

The west central portion of the site is occupied by the USEPA, Region II. This area formerly contained the maintenance and non-ordnance warehousing operations of the former arsenal. The USEPA currently utilizes several of the buildings constructed during the arsenal period for storage and administration purposes. The USEPA area consists of approximately 650 acres.

Finally, a portion of the arsenal was located across the current alignment of Woodbridge Avenue, in the area currently occupied by Raritan Park and the Times building.

3.0 FIELD EXPLORATION PROGRAM

The field exploration program was conducted in general conformance with Dames & Moore's Work Plan, dated October 1991. Portions of the Work Plan are summarized below to aid in understanding the scope of work performed; the reader is referred to the Work Plan for complete details of the program. Significant deviations from the Work Plan are noted in Section 4.0, along with an explanation for the need to have deviated from the plan. All changes to the Work Plan were discussed with USACE personnel prior to implementation; in some cases, deviations from the Work Plan were undertaken at the request of USACE personnel.

The following field work was performed:

- Unexploded ordnance (UXO) searches at sampling locations and access routes;
- Soil gas surveys;
- Advancement of 183 soil borings and collection of soil samples for laboratory analyses;
- Installation of 21 shallow and 6 deep monitoring wells;
- Sampling of 27 newly installed and 25 existing monitoring wells;
- Collection of sediment and surface water samples for laboratory analyses;
- Collection of a surface soil sample in Area 11 for laboratory analyses;
- Collection of data concerning site hydrogeologic conditions; and
- Visual inspections of portions of Areas 12 and 16.

3.1 UXO SEARCHES

UXO surveys were conducted to clear access routes, soil gas survey locations, and soil sampling and ground water monitoring well locations prior to the initiation of invasive activities. UXO surveys were conducted by UXB International, under the supervision of Dames & Moore personnel.

The UXO searches were conducted utilizing both a White's Eagle II Metal Detector and a Foerster Ferex (MK 26) Ordnance Locator. When used together, these instruments are capable of detecting the presence of both ferrous and non-ferrous metallic objects. UXB indicated the UXO survey was reliable to a depth of 5 feet at soil gas survey locations. Clearing to a depth of 2 feet was considered appropriate around soil sampling locations, and along access paths. Boreholes were checked for ordnance every 2 feet as they were advanced. All UXO searches were performed in accordance with Dames & Moore's Site Health and Safety Plan, dated October, 1991.

The size of the area cleared of possible ordnance varied according to the nature of the invasive activity to be performed (e.g., soil gas survey or soil sampling) and the size of the equipment needed to accomplish the activity. For example, a circular area approximately 60 feet in diameter was scanned and cleared for each monitoring well location because of the large size of the drill rig required, while the soil sampling points advanced with a tripod rig were cleared of potential ordnance for an area approximately 15 feet in diameter. Access routes typically were cleared in paths approximately 15 feet wide.

When ordnance was encountered, the location was marked and reported to the USACE. When possible, an alternate route was cleared around the ordnance item; alternately, the item was safely removed according to the procedures stated in UXB International's Safety Plan Supplement, and disposed of by USACE personnel in accordance with procedures established for the site.

3.2 SOIL GAS SURVEYS

Soil gas surveys were conducted by Tracer Research Corporation (Tracer); a copy of their report is included in Volume IV of this report, Appendix F.

Soil gas surveys were conducted in an effort to detect the presence of seven volatile organic compounds (VOCs) that may have been associated with the Army's former activities at the arsenal; the work was performed in accordance with Section 3.6 of the Work Plan. The compounds listed in the Work Plan were detected in ground water samples analyzed by OBG during their 1987-88 contamination evaluation and, based on the OBG report, represent the major VOC contamination in the ground water. The compounds assessed were 1,1-dichloroethane (DCA); 1,1-dichloroethene (DCE); trichloroethene (TCE); and benzene, toluene, ethylbenzene, and total xylenes (BTEX). BTEX are constituents of gasoline and the lighter grades of petroleum products. Samples also were analyzed for total volatile hydrocarbons (TVHC). Soil gas samples were obtained at a depth of 5 feet if ground water was not encountered prior to that depth. If ground water was encountered before a depth of 5 feet was reached, the soil gas sample was obtained from the soil zone immediately above the ground water table (the vadose zone). In some cases, because of a high ground water table, samples of the ground water were collected in place of soil gas samples. Data from the soil gas surveys were used to determine the placement of shallow monitoring wells, and to determine the location of soil borings for soil sampling in the Middlesex County College ballfield area and in portions of Area 2.

3.2.1 Soil Gas Sampling Procedures

Soil gas sampling and analysis were performed by Tracer under the supervision of a Dames & Moore field representative. A van-mounted hydraulic unit was used to push a 0.75-inch diameter galvanized steel pipe, with a detachable drive tip, to the desired sampling depth. A vacuum pump, attached via a polyethylene tube to an adaptor on the above ground end of the soil gas probe, pulled approximately 2 to 5 liters of soil gas through the sample collection system to purge it of any residual vapors from previous sampling activities and ensure collection of a representative sample. A vacuum gauge measured the gas pressure in the probe to verify soil gas flow. Vacuums ranged from less than 5 inches Hg to 22 inches Hg; approximately 90% of the vacuum gauge readings were less than 5 inches Hg. Following purging, a soil gas sample was collected by inserting a disposable syringe needle into a silicone rubber manifold in the evacuation line and extracting approximately 10 milliliters of gas for analysis.

Samples were analyzed immediately with a portable Varian 3300 Gas Chromatograph (GC) installed in the van. The samples were analyzed for two analyte classes: halogenated hydrocarbons (DCE, DCA, TCE), and hydrocarbons (BTEX and TVHC). Halogenated

hydrocarbons were separated on a 6′ x 1/8" outside diameter (OD) packed column with carbo pack (SP-1000) as the stationary phase in a temperature-controlled oven, and were detected with an electron capture detector. Hydrocarbons were separated on a 3′ x 1/8" OD packed column with chromosorb (OV-101) as the stationary phase in a temperature-controlled oven and were detected on a Flame Ionization Detector (FID). Nitrogen was used as the carrier gas. Soil gas samples were directly injected into the GC where they were swept through the analytical columns by the carrier gas. The components of the sample passed through the column at different rates, were detected by the appropriate detector, and were identified by the time it took them to pass through the column.

The procedures used by Tracer for ground water sampling and analysis were similar to those noted above. The well point was driven to a depth of 5 feet, then retracted several inches to create a hole into which ground water would flow. The water accumulated in the hole was removed by vacuum through a ¼-inch disposable polyethylene tube and was collected in 40-ml VOA vials. The vials were completely filled to exclude air, and then were capped with Teflon-lined septa seals. Approximately half of the liquid in the vial then was decanted, the vials were shaken vigorously, and a sample of the gas from the headspace within the vial was injected into the GC. Analyses then proceeded as stated above.

3.2.2 Quality Control/Quality Assurance Procedures

Quality control (QC) and quality assurance (QA) samples periodically were analyzed to confirm the validity of the data. These samples included ambient air samples, analytical method blanks, field system blanks, reagent blanks, and duplicate samples. Ambient air samples were obtained by sampling the air immediately outside the analytical van and injecting it directly into the GC; this was done to determine atmospheric background levels, and typically was performed once every ten samples. Analysis of analytical method blanks consisted of injecting an inert carrier gas, such as nitrogen, into the GC to verify the analytical instrumentation was not contaminated. Field blanks also were analyzed approximately once every ten samples to check for contamination of the sampling apparatus; they were collected by following standard sampling procedures, but without inserting the probe into the ground. The analytical results of the field blanks then were compared to those obtained from ambient air samples. Reagent blanks were analyzed to ensure that the solvent used to dilute the stock standards was not contaminated. Approximately 20 percent of the field samples were duplicated to verify quantitative precision of the analytical instrumentation; duplicate samples were obtained by subsampling vapors from

the original syringe. Analytical instruments were calibrated daily using fresh working standards made from National Institute of Sciences and Technology traceable standards and reagent grade solvents; the instrument calibration was checked at least once every five samples.

Sampling equipment was decontaminated between sampling events by steam cleaning, or by washing with soap and water and baking in the GC oven.

3.3 SOIL SAMPLING

3.3.1 Soil Borings

Soil borings were advanced, and soil samples were collected for laboratory analysis, in Areas 2, 3, 4, 6A, 6B, 6B North, 7, 10, 11, 12, 14, 16, and 17A. Samples from the ground surface to a depth of 2 feet were collected with a hand auger by UXB International personnel, in accordance with Dames & Moore's Site Health and Safety Plan. Soil samples were obtained from depths greater than 2 feet with a 2-inch outside diameter, 2-foot long split spoon sampler driven by a 140-pound hammer with a 30-inch drop.

All soil borings were described in accordance with the Unified Soil Classification System based on visual observations by an experienced Dames & Moore field geologist. The standard USACE MRK Form 55 field drilling log was filled out for each borehole. During drilling, the gases in the borehole and the ambient air were monitored for the presence and concentration of explosive gases with an MSA explosimeter/oxygen meter, and for VOCs with a Photovac Tip II photoionization detector. All unusual characteristics observed during drilling activities, such as discoloration of soil, odors, or air monitoring results, were noted on the field logs; these observations are discussed in the relevant sections of the report. Copies of the field drilling logs are included in Volume II of this report, Appendix A.

3.3.2 Sample Handling

Soil samples were collected with hand augers and split spoon samplers, as described above. Soil samples were removed from the split spoon sampler and the hand augers with a stainless steel sampling knife and placed into laboratory-supplied 4-ounce glass containers for VOC analysis, and 2-liter amber jars for all other analyses. A label displaying the laboratory-supplied sample number, job number, owner, location, boring number, sampling depth interval,

date, and time of sample collection was affixed to each sample container. The samples then were placed into ice-filled coolers for shipment to the analytical laboratory, Environmental Science and Engineering (ESE), Gainesville, Florida. Chain-of-custody procedures were followed.

Composite samples for all analyses except VOCs were obtained by retaining all soils collected with the split-spoon sampler from the sample interval, and mixing the soils thoroughly in a stainless steel mixing bowl until uniformity of texture, color, and other visual indicators of homogeneity had been achieved. A sample from the resulting blend then was packaged and submitted for analysis.

Discrete samples were collected for VOC analysis. A sample was collected from each 2-foot sampling interval. The sample was split, and a portion was placed in a sample jar for possible VOC analysis. A second portion of the split was placed into a jar until the jar was approximately half full, the jar was capped with aluminum foil, and a headspace analysis was performed to determine total organic vapor concentrations. The soil sample associated with the highest headspace reading was submitted for laboratory analysis for VOCs.

3.3.3 Decontamination Procedures

Split spoon samplers and other tools used to obtain soil samples for laboratory analysis were decontaminated after each sampling effort according to the following procedure:

1. Scrub off majority of soil;
2. Wash with a mixture of potable water and Alconox™ detergent;
3. Rinse with potable water;
4. Rinse twice with distilled water; and
5. Rinse with reagent-grade distilled water.

The operating end of the drill rig, augers, drill rods, and other large items of equipment were steam-cleaned before use at each borehole to prevent cross-contamination. Steam-cleaning was performed in a low-lying portion of the area in which sampling activities were being conducted; a 6-mil sheet of polyethylene was laid on the ground to collect debris and runoff water. Fifty-five-gallon, Type 17 E/H drums were used to contain the decontamination water and debris.

The decontamination zone for sampling equipment also was established in a low-lying area near each borehole; a 6-mil sheet of polyethylene was used to prevent the fluids from entering the soil. Sampling equipment decontamination water was drummed along with the fluids generated during steam-cleaning of the drill rig. At the completion of decontamination procedures at each borehole, the used plastic, gloves, and other disposable equipment were deposited in 55-gallon, Type 17 E/H drums, as specified in the Work Plan, for disposal.

In areas where no visible signs of contamination were noted (such as staining, odors, FID readings), water removed during development and stabilization, and soil cuttings generated during the advancement of borings, were disposed of by carefully draining or spreading the material onto low-lying areas near the monitoring well or boring from which they were removed, taking care to ensure they would not drain or be washed into adjacent areas. In areas which contained known ground water contamination, based on the OBG 1987-88 investigation, water removed during development and stabilization was pumped into 55-gallon drums; these fluids were disposed of in a permitted treatment and disposal facility along with decontamination fluids generated during the project. Drilling muds were disposed of off site at a special waste landfill. All disposal procedures were in accordance with New Jersey Department of Environmental Protection and Energy, Division of Hazardous Site Mitigation, Appendix VII - Guidance Memorandum: Disposition of Material Generated During Site Investigations.

3.3.4 Quality Control/Quality Assurance

Quality control (QC) samples were collected at a frequency of approximately one QC sample for every ten field samples. These split or duplicate samples were shipped to the ESE laboratory in Gainesville, Florida, for analysis. The analytical laboratory was not informed these samples were splits or duplicates, thus preventing preferential treatment of the samples.

Quality assurance (QA) samples also were obtained at a frequency of approximately one QA sample for every ten field samples. These samples were shipped to the USACE MRD laboratory in Omaha, Nebraska, for analysis.

Split soil samples for all analyses other than VOC analyses were obtained by thoroughly mixing the soil from discrete sampling depths in a stainless steel bowl until the mixture appeared to be uniform in texture and color, then packing the resulting mixture in separate jars for the required analyses. Duplicate samples for VOC analysis were obtained by splitting the split

spoon sample vertically; this procedure helped to ensure that stratification of contaminants was distributed equally between the samples, while minimizing volatilization of contaminants from the soil.

Finally, trip blanks accompanied all samples that were to be analyzed for VOCs to assess bottle preparation and field handling techniques.

3.3.5 Headspace Analyses

Headspace analyses were performed in Areas 2, 6A, 7, 11, 12, 14, and 17A to select discrete soil samples for VOC analysis. The following headspace analysis procedure was followed:

- Continuous samples for headspace analysis were obtained at 2-foot intervals to the depth of the borehole. This modification of the Work Plan was necessary to accommodate the high ground water tables encountered in many portions of the site, as further discussed in Section 4.0 of this report.

- After the soil sample was logged, it was split vertically using a stainless steel sampling knife. A portion of the sample was placed into a 4-ounce glass sample jar, completely filling the jar. This jar was marked with a temporary identification number and placed in an iced cooler.

- A portion of the remaining sample was placed in a 16-ounce soil sample jar; sufficient material was used to half fill the jar.

- The opening of the 16-ounce jar was covered with aluminum foil, and the jar was capped.

- The 16-ounce jar was marked with the same temporary identification number as the full 4-ounce jar containing the other portion of the sample.

- The soil sample in the 16-ounce jar was brought to a temperature of 20 to 32°C for a period of at least 10 minutes.

- After sufficient time had elapsed, the cap was removed from the 16-ounce jar, and the probe of an organic vapor analyzer was pushed through the aluminum foil.

- The highest meter response was recorded as the headspace concentration.

- The full 4-ounce jar that corresponded to the highest headspace reading was retained for chemical analysis. Soil samples not selected for analysis were either returned to the borehole (in areas where ground water was not encountered), or carefully spread on the ground surface near the borehole (in areas where ground water was encountered). Soils could not be returned to the borehole if ground water was encountered because the Work Plan required the boreholes to be backfilled with a cement/bentonite grout. The 4-ounce sample jars which had contained soils not selected for analysis were placed in drums for later disposal.

- The 16-ounce jars used for the headspace analysis were decontaminated in accordance with the procedures stated in Section 7.2 of the Work Plan and reused. New 4-ounce sample containers were used at all times.

- OVA instrument calibration was checked at least every 10 analyses or daily, whichever was more stringent.

3.4 GROUND WATER SAMPLING

Throughout this report it is stated that ground water monitoring wells were installed in the assumed downgradient or upgradient direction from the area of concern. Unless stated differently in the body of this report, the direction of ground water flow was predicted on the basis of the topography of the area, the location of the Raritan River, and the results of a previous investigation conducted by O'Brien & Gere in 1987-1988. Many of the wells installed during the current investigation were installed in portions of the site which had not previously been assessed; therefore, only limited knowledge was available on which to base the location of the wells. Consequently, Dames & Moore was not always successful in predicting ground water gradients. Discussions concerning the appropriateness of the location of each of the monitoring wells installed by Dames & Moore (i.e., were the wells installed in the intended downgradient,

cross gradient, or upgradient direction from the area of concern) are included in this report only if Dames & Moore was not successful in predicting the ground water gradient.

3.4.1 Soil Borings

Soil borings for well installations were advanced in accordance with the Work Plan. Borings for shallow monitoring wells were advanced using 6¼-inch inside diameter, hollow-stem augers; deep monitoring wells were advanced with a 12-inch rotary bit to allow the installation of steel or PVC casing to the first aquitard or to a depth below the screened interval of the adjacent well. Monitoring well boring logs are included in Volume III of this report, Appendix B.

The monitoring wells generally were installed at the locations shown in the Work Plan. Deviations from the locations shown in the Work Plan are discussed in Section 4.0. Typically, five potential monitoring well locations were assessed for each shallow monitoring well by conducting a soil gas survey; the location with the highest soil gas reading was selected for installation of the well.

In those locations where a cluster of monitoring wells was required by the Work Plan, the deep monitoring well was installed less than 5 feet from the shallow well, in the assumed crossgradient direction, in conformance with procedures stated in the Work Plan.

3.4.2 Monitoring Well Construction, Development and Sampling

Monitoring wells were constructed of 2-inch diameter, 0.01-inch slotted PVC screen and 2-inch PVC riser pipe. Number One well sand was tremied into place around the well screen and to a depth of 2 feet above the top of the screen to provide an effective filter. A 2-foot long bentonite seal then was tremied into place above the sand pack to prevent the migration of surface water down the borehole and into the well. A grout consisting of Portland cement and up to 3 percent bentonite powder was tremied into the annulus around the well, extending from the top of the bentonite seal to a depth approximately 2 feet below the ground surface. A protective outer steel casing then was placed over the well and grouted into place; this outer casing was locked to preserve the well's integrity. Each well was seated in a 4-foot square, 4-inch thick concrete pad; three 2-inch diameter steel posts were installed around each well for protection.

Deep monitoring wells were advanced with a 12-inch OD rotary mud drill. Drilling muds which conformed to common industry standards were circulated down the borehole during drilling. The boring initially was advanced to the bottom of the adjacent shallow well (when a monitoring well cluster was being installed), or 2 feet into the first aquitard. The bottom 3 feet of the boring were grouted with a 3 percent bentonite/cement mix, and an 8-inch steel or PVC casing was set 2 feet into the grout; steel casing was used in four of the wells, and PVC was used in two of the wells. The annular area outside of the casing then was grouted to the surface with the use of a tremie pipe, and the grout was allowed to cure for at least 48 hours. Following curing, the casing was flushed with water, and the boring was advanced to the intended depth of the well with a 6.5 inch OD rotary mud drill. The well then was completed in accordance with the well installation procedures described above.

Monitoring well permits were obtained for each well prior to installation, in accordance with New Jersey state regulations, and permanent identification tags were attached to each well.

Following installation, the grout in each well was allowed to cure for at least 48 hours prior to development. Development was accomplished by mechanically surging and pumping, where practical. Surging was performed a minimum of three times; following each surging event, a quantity of water equivalent to one well volume was removed. After the final surge, water was pumped from the well until turbidity readings were less than 50 nephelometric turbidity units (NTUs), as requested by the USACE.

In some cases, monitoring well construction, development and sampling varied from that shown in the Work Plan because of conditions encountered in the field, or at the request of the USACE. However, the techniques followed were in conformance with common industry standards and produced water samples that we believe are representative of the aquifer. Deviations from the Work Plan are stated in Section 4.0.

Additional details of well construction and development are presented in Volume III of this report, Appendices C, D, and E.

3.4.3 Sample Handling

Ground water samples were obtained from the monitoring wells using an ISCO Series 3600 non-dedicated well sampling system. The pumping rate during sampling was not

measured; however, it was kept low enough to prevent any aeration or bubbling from occurring, particularly when obtaining samples for VOC analyses.

The pump was decontaminated prior to sampling each monitoring well by pouring a mixture of Alconox® detergent and potable water through the pump, followed by three rinses with distilled water; the final rinse used reagent-grade distilled water. One rinsate blank was obtained by collecting the reagent-grade distilled water; analysis of this sample provided an assessment of the effectiveness of the ISCO pump decontamination procedure. New suction and discharge tubing was used with the ISCO pump at each monitoring well.

Prior to sample collection, a stabilization test was performed on each well to help ensure that standing water in the well had been removed, and that the sample was representative of the aquifer. The stabilization test consisted of the removal of a minimum of three well volumes to obtain three successive equivalent readings (taken at intervals of one well volume) of specific conductance, pH, and temperature. The measurements were considered to be equivalent if they fell within the following ranges:

Specific conductance	$\pm$ 10 μmhos/cm
pH	$\pm$ 0.1 pH unit
Temperature	$\pm$ 0.5°C

This procedure could not be followed for MW-52A, MW-53, MW-54, or MW-55A; this deviation from the Work Plan is explained in Section 4.0.

Labeling for ground water samples generally followed those stated above for soil samples.

3.4.4 Quality Control/Quality Assurance

Ground water QC/QA samples were obtained at a frequency of one sample for every ten field samples. Split ground water samples were collected at the same time as normal field samples by sequentially filling sample jars. Sample containers, preservatives, and handling were identical for each portion of the split sample. QC samples were labeled as if they were normal field samples; the analytical laboratory was not informed the samples were duplicates, thus preventing preferential treatment of the samples.

Rinsate blanks were obtained by collecting the reagent-grade distilled water used for the final rinse of the ISCO pump; analysis of these samples provided an assessment of the effectiveness of the ISCO pump decontamination procedure.

Trip blanks accompanied all samples that were to be analyzed for VOCs.

3.4.5 Ground Water Levels

Dames & Moore performed three surveys of ambient ground water levels in the monitoring wells to determine ground water gradients; these data are shown in Table 30. Ground water contour lines and general ground water flow in the shallow aquifer are shown on Figure 18, based on an analysis of these data.

4.0 DEVIATIONS FROM THE WORK PLAN

Generally, all work was performed in accordance with the approved Work Plan, with the exceptions stated below. All deviations were discussed with, and approved by, USACE personnel prior to implementation.

- At the time the Work Plan was developed, the NJDEPE was relying on contaminant concentrations stated in the Interim Soil Action Levels to determine if remedial action at a site was appropriate. However, the Interim Soil Action Levels are no longer valid. In February, 1992 the NJDEPE proposed new criteria, which were health risk based, to determine acceptable concentrations of contaminants in soils. The proposed soil cleanup criteria varied for surface soils (defined as 0 to 2 feet deep) and subsurface soils (defined as depths greater than 2 feet), and for residential and non-residential uses. Additionally, NJDEPE Proposed Rule 7:26D - 3.2(a)1,ii, stated that if the proposed subsurface soil criteria for a contaminant was less than the surface soil cleanup criteria and protection of ground water was required because of the presence of potable water receptors, then the subsurface criteria would apply to both the surface and subsurface soil.

- On February 8,1993 the proposed soil cleanup criteria were further modified by the NJDEPE because of errors identified during the comment period, and because of new toxicological information obtained since the original proposal of the criteria. During the preparation of this report, the contaminants detected during the Phase I investigation have been compared to the February 8, 1993 criteria. However, it should be noted, as stated in the NJDEPE standards:

  "Notwithstanding, where the following criteria are based on human health impacts, the Department shall still consider environmental impacts when establishing site specific cleanup criteria. This along with other site specific factors including background conditions may result in site specific cleanup criteria which differ from the criteria listed below. Therefore, this list shall not be assumed to represent approval by the Department of any remedial action or to represent the Department's opinion that a site requires remediation."

- Throughout this report, comparisons are made between the analytical data obtained during this investigation and the NJDEPE proposed soil standards for residential use. The proposed regulations state, in part, that residential standards must be applied to a site unless the owner applies to the NJDEPE to use non-residential standards. NJDEPE approval to use non-residential standards will require, at a minimum, that the owner restrict the use of the site to non-residential activities. Further, the owner must execute a "Declaration of Environmental Restrictions and Grant of Easement" which will be binding on the owner and upon owner's successors and assigns, and will run with the property.

  Dames & Moore has no knowledge of the future uses of the sites assessed during this Phase I remedial investigation. Therefore, the residential standards are referenced throughout the report.

- The NJDEPE also proposed ground water cleanup criteria in February, 1992; the revised criteria were promulgated into law in February, 1993. The criteria define three classes of ground water systems and present criteria for determining ground water quality in each of the classes.

  Portions of the Raritan site may fall into Class II-A or Class III-B ground water quality, according to criteria presented in Section 7:9-6.5 of the New Jersey Register, Volume 25, Number 3. Class II-A ground water systems include all ground water of the State except for ground water designated in Classes I, II-B, or III. Class III-B ground water systems consist of all geologic formations or units which contain ground water having natural concentrations or regional concentrations (through the action of salt water intrusion) exceeding 3000 mg/L total dissolved solids, or where the natural quality of ground water is otherwise not suitable for conversion to potable uses. Figure 4 in the Appendix of the New Jersey Register referenced above shows that the portion of the Farrington Aquifer south-southeast of the site is considered to be a Class III-B aquifer; this indicates a similar designation for the ground waters of the former Raritan Arsenal may be possible.

  The final determination of the ground water class at the site must be made by the NJDEPE after further study.

Specific ground water criteria have been promulgated only for Class II-A ground water (potable ground water); criteria applicable to Class I and Class III ground water systems are developed on a site-specific basis. Therefore, to provide a basis of comparison for the contaminants detected in the Raritan ground water samples, criteria for Class II-A ground water (potable ground water) have been used throughout this report.

For some analytes, ground water criteria are lower in concentration than the corresponding Practical Quantitation Level (PQL). Section 7:9-6.4 of the New Jersey Register, Volume 25, Number 3 defines the PQL as "the lowest concentration of a constituent that can be reliably achieved among the laboratories within specified limits of precision and accuracy during routine laboratory operating conditions". Where the PQL exceeds the criteria the PQL may become the de facto standard. This report generally contains references only to those samples that contain concentrations of contaminants that exceed both the cleanup criteria and the PQL.

- Several of the contaminants detected in the Raritan ground water are not included in the Class II-A ground water listing. Cleanup standards for these compounds must be developed based on appropriate toxicological data. The NJDEPE has proposed a 5 ppb interim generic ground water quality criteria for each synthetic organic chemical (SOC), with a total concentration of 25 ppb for all SOCs which lack specific criteria, where there is evidence of carcinogenicity. The NJDEPE also has proposed a 100 ppb interim generic ground water quality criteria for each SOC, with a total concentration of 500 ppb for all SOCs which do not have specific criteria, where there is no evidence of carcinogenicity.

- Analytical results for surface waters have been compared to the NJDEPE Water Quality Standards (N.J.A.C. 7:9-4.1 et seq.)

- Sediment data have been compared to the National Oceanic Service, National Oceanic and Atmospheric Administration (NOAA), "Potential for Biological Effects of Sediment - Sorbed Contaminants Tested in the National Status and Trends Program", March 1990, NOAA/TM/NOS/OMA-52, Table 54A, ER-L and ER-M Concentrations. ER-L concentrations refer to the low end (lower

10%) of the range of reported concentrations in which biological effects were observed or predicted. ER-M concentrations refer to the midpoint of the range of the reported concentrations in which biological effects were observed or predicted.

- The high ground water table found in portions of the site required modification of the installation procedures for the monitoring wells. The Work Plan required the installation of the well screens so that 7 feet of the screen was below the current water table and 3 feet of screen was above the water table; installation of the screen in this manner would have helped to account for seasonal fluctuations of the ground water table, and would have detected any free product (such as diesel fuel or waste oils) floating on the surface of the ground water. Discussions with USACE personnel indicated they were more concerned with obtaining a proper bentonite seal than monitoring the surface of the ground water table. Accordingly, wells were installed with the top of the screen at a minimum depth of 7 feet to leave sufficient room to install a proper seal; in some cases, this resulted in the installation of the entire screen within the ground water. It should be noted that several of the contaminants detected during the OBG study, particularly the TCE and explosives, are heavier than water or have good solubility in water, including fuel components such as BTEX. fuel components such as BTEX also have good solubility in water. Installation of the well screens completely within the ground water would not be expected to significantly influence the detection of these compounds.

- The Work Plan states that a minimum of three well volumes would be removed from each well during the well development process, with no monitoring of pH, conductivity, temperature, or turbidity required, until relatively sediment-free water was obtained. This development procedure was revised by the USACE to include a requirement that wells be developed until the turbidity of the water was less than 50 nephelometric turbidity units (NTUs); this resulted in the removal of at least 4 well volumes during development.

- Several of the shallow wells (MW-52A, MW-53, MW-54, and MW-55A) are slow recharging wells; normal mechanical surging and pumping were not considered appropriate to develop these wells. Although the Work Plan states

that no foreign sources of water would be added during the well development process, USACE personnel requested that distilled water be used to aid the development process, as follows:

1. The level of water in the well was measured;

2. The well was surged;

3. Any water remaining in the well after surging was pumped out;

4. Distilled water was added to the well to bring the water level back to the original level -- this generally required the addition of approximately 3 gallons of distilled water;

5. The well was again surged and pumped;

6. The process was repeated three times, resulting in the addition of a total of 12 gallons of distilled water;

7. Prior to sampling, a total of 36 gallons of water (the equivalent of 3 times the volume of distilled water added to the well) were removed from the well over a period of several days; and

8. The well then was sampled after it had recharged to its original level.

- The design of the monitoring wells was slightly modified by the USACE in the field in an effort to prevent damage to the well from ground freezing. The Work Plan states that a cement/bentonite grout would be placed in the annulus around the well casing from the top of the bentonite seal to the ground surface. USACE personnel requested that no grout or other material be placed between the well casing and the protective cover within approximately 2 feet of the ground surface. It is anticipated this air space will allow some ground movement without damaging the well.

- The Work Plan states that a 10 inch rotary bit would be used to advance the borings for the deep monitoring wells to the top of the first aquitard; an 8-inch casing then would be set. However, a minimum of 2 inch annular space was needed between the outside of the casing and the wall of the boring to accommodate the tube used to tremie the grout. This required the rotary bit to be at least 12 inches in diameter.

- At the request of the USACE, the installation procedures for the bentonite seal were modified. After the bentonite was tremied into the annulus around the well riser, distilled water was poured on the bentonite; the bentonite then was allowed to hydrate for at least 12 hours before the cement/bentonite grout was tremied into the annulus above the bentonite seal. While hydrating, the well was covered with 6-mil plastic sheeting to prevent the migration of contaminants into the well.

- The Work Plan states that shallow wells were to be installed with a 10-foot long screen. During the drilling of several wells, however, confining layers were encountered before the desired minimum depth of 17 feet was reached. It was necessary to custom-make 2-foot and 3-foot long well screens respectively for MW-55A and MW-56 by cutting the screen sections to the appropriate length, and to install 5-foot screens in monitoring wells MW-47A, MW-50, MW-52A, MW-53, and MW-57 because of the presence of shallow confining layers.

- The Work Plan for Area 17A required soil sampling at six borings adjacent to the soil gas survey holes which had the highest VOC readings; composite samples were to be obtained from depth intervals of 0 to 5 feet (discrete samples for VOC analysis would be obtained based on headspace analysis). Based on a review of the Metcalf & Eddy Archive Search Report, it was obvious the site had been regraded, and the elevation of the burning grounds may have been lower than the current elevation of the ball field. Accordingly, after discussions with the USACE, three boreholes were advanced to a depth of 10 feet adjacent to the soil gas survey holes with the highest VOC readings; composite samples were obtained from depth intervals of 0 to 5 feet and 5 to 10 feet. A discrete sample was obtained at each borehole for VOC analysis.

- The Work Plan states that soil borings were to be advanced with a truck-mounted or ATV-mounted drill rig. However, in some locations the site was too marshy or contained too many obstructions to use these vehicles. Discussions with USACE personnel resulted in permission to conduct soil sampling activities with a tripod-mounted soil sampling apparatus. Additional conversations with USACE personnel and representatives of Middlesex County College resulted in a request that Dames & Moore advance the soil borings in the baseball field with the tripod to minimize damage to the turf. The tripod rig consisted of a portable steel tripod, approximately 6 feet tall. A cable system was mounted at its apex to stabilize and manipulate standard drilling rods and split spoons; a pulley was used to raise and drop a 140 lb hammer a distance of 30" to advance the split spoons. Thus, the tripod rig was basically a portable, self-contained equivalent of the split spoon advancement apparatus found on standard drill rigs.

- MW-48A and MW-48B were moved approximately 250 feet closer to the former location of MW-5 because marshy site conditions in the originally proposed location for MW-48A and MW-48B precluded access by a drill rig.

- MW-43 was moved approximately 500 feet south and 1000 feet west of the location shown on the sampling plan because the originally proposed location for MW-43 contained large blocks of concrete, reinforcing rods, and other construction debris. It was not possible to install the monitoring well in the original location because the buried metal in the construction debris could not be distinguished from ordnance. Alternate locations that would have monitored Area 4 were discussed with the USACE but were rejected because the area is scheduled to be turned into a wetlands area. The new location of MW-43 is not appropriate to monitor conditions in Area 4. This well was installed to monitor conditions in Area 7; the soil gas survey indicated the presence of significant contamination in this area.

- MW-50 was moved approximately 250 feet west of the location shown on the sampling plan because marshy conditions in the originally proposed location precluded access by a drill rig.

- MW-40 was installed north of Fieldcrest Avenue in Raritan Plaza II, on the upgradient boundary of the site, to monitor background hydrogeologic conditions. This well originally was to have been installed along the railroad tracks which comprise the northern boundary of Area 2, as stated in the Work Plan. However, information obtained subsequent to acceptance of the Work Plan indicated a significant number of monitoring wells already had been installed in this area, by private industry, in an effort to define the source and extent of known ground water contamination. Therefore, MW-40 was moved further upgradient to prevent duplication of effort.

- The Work Plan states that most soil borings would be advanced to a depth of 5 feet or to the depth of ground water, and that samples would be collected at intervals of 0 to 1 foot for metals and explosives analyses; 2 to 3 feet for explosives analyses; and 4 to 5 feet for metals and VOCs analyses. Ground water levels encountered during the field work frequently were much shallower than 5 feet; therefore, sampling intervals were modified as follows, after discussion with the USACE:

Ground Water Level	Sampling Intervals and Parameters
1′ or higher	0-1′ for all parameters
2′	0-2′ for metals and explosives; 1-2′ for VOCs
3′	0-1′ and 2-3′ for metals and explosives 2-3′ for VOCs
4′	0-1′ and 2-3′ for explosives; 0-1′ and 3-4′ for metals; 3-4′ for VOCs

- Proposed deep monitoring wells MW-41, MW-42B, MW-46B, and MW-47B were not installed because of the absence of permeable soils between the shallow aquifer and bedrock.

- Monitoring wells MW-62, MW-63, and MW-64 were added to the original scope of work. These wells were installed to replace proposed deep monitoring wells

MW-41, MW-42B, MW-46B, and MW-47B which could not be installed because of soil conditions encountered at the site; generally, bedrock was encountered before a deep aquifer was found.

- The four soil borings advanced in Area 3 - Grassy Strip (near MW-15) were advanced with a hand auger rather than a drill rig because the abundance of ordnance fragments in the area made it impractical to clear the access routes and working areas to the degree necessary to use a drill rig.

- Because of the presence of mounds of soil and what appeared to be filled areas, the sampling plan in Area 2 was changed as follows:

  - Boreholes in portions of the area that appeared to be at original grade were advanced to a depth of 5 feet or to the depth of ground water, and were sampled according to the provisions stated above;

  - Boreholes in other portions of the area were advanced to a depth of 10 feet; composite samples were collected from intervals of 0 to 5 feet and 5 to 10 feet for metals and explosives analysis; discrete samples were collected from each interval for VOC analysis.

- Deep monitoring wells MW-55B and MW-52B originally were intended to be screened in the lower portion of the same aquifer in which shallow wells MW-55A and MW-52A were screened; however, confining layers were encountered at depths too shallow to allow the deep wells to be screened in the same aquifer. Therefore, the deep wells were screened in the aquifer underlying the confining layer.

- Deep monitoring well MW-44 was screened from 25 to 50 feet rather than from 24 to 58 feet as specified in the Work Plan because a confining layer was encountered at 50 feet.

- Monitoring well MW-46A was installed with a flush-mounted protective casing because site conditions precluded the installation of a well with a stick-up in this truck loading area.

- Water samples were collected for on-site GC analysis during the soil gas survey in portions of Areas 7 and 11 because ground water levels were too high to allow Tracer to collect soil gas samples.

- Because several of the wells had a slow recharge rate which prevented the use of normal development procedures, both dissolved and total metal analyses were performed on water samples from these wells. The use of dissolved metal analysis decreases the probability that relatively high contaminant concentrations will be detected as a result of sediments in the samples.

- Because ground water often was encountered before a depth of 5 feet was reached, it was necessary to modify the depths at which soil samples were collected for headspace analysis. In those areas where headspace analyses were performed, samples were obtained at 2-foot sampling intervals to the depth of the borehole because it was not known when ground water would be encountered; this is a minor deviation from the Work Plan which states that samples for head space analysis generally would be obtained from depths of 0 to 2 feet and 3 to 5 feet in borings advanced to a depth of 5 feet. In Area 7, the only area of the site where borings to a depth of 10 feet were anticipated in the Work Plan, samples for headspace analyses were obtained at 2-foot intervals to the depth of the borehole, in accordance with the Work Plan. This latter sampling procedure also was followed in those areas of the site, such as Area 2 and Area 17A, where site conditions required sampling to a depth of 10 feet.

5.0 FIELD INVESTIGATIONS AND ANALYTICAL RESULTS

The following sections provide a brief history of the areas of concern; the results of UXO searches and soil gas surveys; soil sampling depths, locations, and analytical results of soil samples; monitoring well installation procedures and ground water analytical results; descriptions of soil geology; and the results of ground water level measurements.

These sections also include figures depicting the location of ordnance detected, soil gas sampling locations, soil sampling locations, monitoring well locations, and surface water and sediment sampling locations (when applicable). Additionally, summary tables presenting the results of the analyses are included in each section; these tables include only those analytes that were detected in the samples.

The laboratory also has prepared detailed summary sheets of the analyses; these sheets present all of the analytes included in the analyses, and show the detection limit for each of the analytes. These summary sheets are presented in the Appendices to this report. For convenience, the appendices have been separated into soil and ground water analyses, and have been arranged to include all soil analyses or ground water analyses in the same section of the appendix for each individual area of concern.

5.1 AREA 1

The GSA/USEPA area is a portion of the former Raritan Arsenal that is currently occupied by the United States Environmental Protection Agency. Many of the maintenance and refurbishing activities performed as a part of arsenal activities were housed in this area. As stated in the Work Plan, potential areas of concern include the presence of underground storage tanks, the EPA pond (which has now been partially remediated), shops and warehouses which may have used or stored solvents, and landfill areas. This area will be thoroughly investigated during later phases of the Remedial Investigation.

5.1.1 Dames & Moore Field Investigation

Because of the proximity of Area 1 to the areas currently being assessed, ground water samples were obtained from monitoring wells installed in this area by OBG during their 1987-88 investigation; OBG detected significant concentrations of VOCs (primarily TCE and DCE) in ground water samples from these wells.

Additionally, at the request of the USACE, a shallow monitoring well (MW-64) was installed to assess potential ground water contamination which may have resulted from reported spills or leaks of petroleum hydrocarbons from an aboveground storage tank. Although not a part of Area 1, the storage tank is located in the GSA/USEPA area, in the apparent upgradient direction from the USEPA pond (Area 18A on Figure 1) and Area 1.

Monitoring well boring logs, well installation details, well development data, and well stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.1.2 Monitoring Well Installation and Sampling

Shallow monitoring well MW-64 was installed in the assumed downgradient direction from an aboveground storage tank. The direction of ground water flow was inferred from the topography of the site and the location of the Raritan River. The boring was advanced to a depth of 25 feet. Light gray silty clay was encountered at a depth of 23 feet; therefore, a 10-foot-long PVC screen was set from depths of 13-23 feet, immediately on top of the clay, in light brown fine to coarse sand.

Ground water samples were obtained from MW-64 and from the four wells previously installed by OBG (MW-7, MW-8, MW-9, and MW-31). These samples were analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, and pesticides. MW-7 and MW-31 were slow recharging wells; therefore, in accordance with revisions to the Work Plan approved by the USACE, filtered and unfiltered samples for metals analysis were collected from these two wells and analyzed for dissolved metals and total metals, respectively.

5.1.2.1 Analytical Results

Metals

As shown in Table 1-1, total arsenic was detected in water samples from MW-7 (10.7 ppb) and MW-9 (12.8 ppb) in concentrations that exceeded the NJDEPE criteria of 0.02 ppb and the PQL of 8 ppb. The dissolved concentration of arsenic in the filtered sample from MW-7 (15.2 ppb) also exceeded the NJDEPE criteria and PQL, and is higher than the total arsenic concentration; Dames & Moore has no explanation for this anomaly.

Total lead was detected in water samples from MW-9 (11 ppb) and MW-31 (199 ppb) in concentrations that exceeded the NJDEPE criteria of 5 ppb and the PQL of 10 ppb. However, no lead was detected in the filtered sample from MW-31, indicating the removal of most of the sediments by filtration reduced the lead concentration in the ground water sample; therefore, the high total lead concentration may be the result of sediments in the water sample from this slow recharging well.

Concentrations of other metals detected in the samples were below NJDEPE criteria.

VOCs

As shown in Table 1-2, trichloroethene (TCE) was detected in ground water samples from MW-7 (5.2 ppb), MW-8 (130 ppb), and MW-31 (130 ppb) in concentrations that exceeded the NJDEPE criteria of 1 ppb. Concentrations of all other VOCs detected were below NJDEPE criteria and/or PQLs.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 1-2, concentrations of phthalates were reported in ground water samples from three of the five wells sampled. All concentrations reported are below NJDEPE criteria. It should be noted that phthalates, particularly bis(2-ethylhexyl)phthalate, are common laboratory contaminants.

Others

No explosives or pesticides were detected in ground water samples from monitoring wells MW-7, MW-8, MW-9, MW-31, and MW-64.

5.1.3 Soil Geology, Area 1 and Monitoring Well MW-64 (Area 18)

5.1.3.1 Area 1

Information concerning geological conditions in Area 1 has been derived from the 1987-1988 investigation conducted by OBG in this area. OBG installed four monitoring wells in this area during their investigation.

A review of the soil boring logs of the four wells indicates the soils consist of brown-gray silts and silty fine to coarse sands. A reddish clay, presumably the Raritan Fireclay, was encountered at a depth of 13 to 14 feet and extended to bedrock. Bedrock, a red shale, was encountered 20 feet below grade.

The peat layer found in other portions of the site was not mentioned on the OBG boring logs, and apparently is absent in Area 1. OBG encountered organic matter in some of the soil borings advanced in this area for soil sampling, but not in any of the borings advanced for the monitoring wells. The organic deposits encountered are probably local lenses, and are probably discontinuous with the peat layer which exists further south/southeast.

5.1.3.2 Monitoring Well MW-64 (Area 18)

Dames & Moore advanced one soil boring in Area 18 for the installation of MW-64. This monitoring well is located approximately 0.5 miles west of Area 1, in the portion of the former Raritan Arsenal currently occupied by the USEPA, Region II. The discussion of the soil conditions encountered at MW-64 are included in this section because no other investigations were conducted in Area 18 during this phase of the project, and Area 1 also is located on the property occupied by the USEPA.

A review of the soil boring logs indicates the soils at the location of MW-64 consist of silty sands and silty clays to a depth of 5 feet. A light brown fine to medium sand, grading to fine to coarse sand, extended from 5 feet to 23 feet below grade. Underlying this soil layer is a light gray silty clay, presumed to be the Raritan Fire Clay. The total thickness of the clay in this area is not known; the boring did not penetrate the clay. Bedrock was not encountered, nor was the peat or clayey peat layer which is found in other portions of the site.

5.1.4 Ground Water Level Readings

Three rounds of ground water level measurements were taken at the monitoring wells installed by Dames & Moore and OBG; the elevations in the monitoring wells are stated below in feet above mean sea level:

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-7	24.35	1510	24.36	0927	24.88	1253
MW-8	26.73	1514	16.67	0925	27.17	1257
MW-9	23.44	1515	23.41	0922	24.0	1259
MW-31	23.35	1512	23.37	0930	23.38	1256
MW-64	49.16	1520	49.16	0917	49.15	1300

These data indicate the ground water flow is generally toward the southeast, as expected.

TABLES FOR AREA 1

TABLE 1-1

AREA 1
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-7	MW-7[2]	MW-8	MW-9	MW-31	MW-31[2]	MW-64[1]
Arsenic	0.02	8	10.7	15.2	--	12.8	--	--	--
Barium	200	200	29	30.5	89	77	43	40.9	63
Cadmium	4	2	--	--	--	--	--	--	--
Chromium	100	10	--	--	--	8	--	--	9.5
Lead	5	10	9.2	--	3.2	11	199	--	3.2
Mercury	2	0.5	--	0.5	--	--	--	--	--
Selenium	50	10	--	--	--	--	--	--	--
Silver	20	2	--	--	--	--	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
[1] Monitoring well is installed in Area 18, upgradient of Area 1.
[2] Dissolved metal concentration.
Water Criteria Reference: 24 N.J.R. 389, Subchapter 4, Table 4-1, revised 2/1/93.

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TABLE 1-2

AREA 1
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-7	MW-8	MW-9	MW-31	MW-64[1]
Volatile Organic Compounds							
1,2-DCE (total)	110[2]	2	--	7.3	12	9.6	--
1,1,1-TCA	30	1	--	--	--	--	9.1
TCE	1	1	5.2	130	--	130	--
Base/Neutral and Acid Extractable Compounds							
Bis(2-ethylhexyl)phthalate	3[3]	30	--	1.0	2.3	--	--
Diethyl phthalate	5000	10	1.0	--	--	--	--

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
Water Criteria Reference: 24 N.J.R. 389, Subchapter 4, Table 4-1, revised 2/1/93.
[1] Monitoring well is installed in Area 18, upgradient of Area 1.
[2] NJDEPE criteria for cis-1,2-DCE and trans 1,2-DCE are 10 and 100 μg/L, respectively.
[3] Federal MCL = 6 μg/L.

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5.2 AREA 2

Area 2 is partially developed; the undeveloped portion is part of an area studied by the New Jersey State Hazardous Waste Facilities Siting Commission as a potential location for a hazardous waste incinerator. The undeveloped portions of Area 2 and the western portion of Area 3 are contiguous and do not have a well-defined boundary between them. For this reason, the following sections describing the UXO searches and soil gas survey refer to both areas. The undeveloped portions of Area 2/3 consist of a wooded and brushy area bounded on the south by Raritan Center Parkway and Clover Place, on the west by Fieldcrest Avenue, on the east by the fenced portion of Area 4, and on the north by a pair of active Conrail railroad tracks. Raritan Center Parkway divides the east and west portions of Area 3.

The ground surface is uneven, and several mounds of very loose soils were noted in Area 2. Area 3 is very low-lying, with many marshy areas and some standing water. In the approximate center of Area 2/3 is a fenced area that is devoid of vegetation and contains several of the mounded soil structures.

OBG reported that Area 2 consists of approximately 14 acres and was used as a demolition ground between 1917 and the early 1930s. The area was cleaned by LEAD during the 1963 decontamination effort, and was recommended for "Surface Use Only".

OBG conducted a contamination evaluation of Area 2 in 1987-88; the area was considered to be a medium priority site. The contamination evaluation consisted of two UXO searches; geophysical surveys; the collection of surficial and subsurface soil samples; and the installation of shallow monitoring wells. The UXO searches uncovered no ordnance, but the geophysical surveys detected subsurface anomalies at depths of 3 to 9 feet. Analysis of soil and ground water samples revealed the presence of volatile organic compounds and metals. One ground water sample contained total recoverable petroleum hydrocarbons (TRPH).

5.2.1 UXO Searches, Areas 2/3

Several pieces of live and inert ordnance were found in Area 2/3, including 42 grenade fuses, 4 point detonating fuses, 5 base fuses, one 3-inch Stokes mortar, 50-caliber and small arms cartridges, and miscellaneous pieces of frag and shrapnel. Approximate locations where these items were found are shown on Figure 2-3. The items were safely excavated by UXB

International, in accordance with Dames & Moore's Health and Safety Plan and UXB's Health and Safety Plan Supplement, and in accordance with previous arrangements made with USACE personnel; the items were reported to USACE personnel, who removed and disposed of them in accordance with procedures established for the site. Non-ordnance related trash and scrap also was detected, including railroad spikes, rebar, wire, beverage cans, bottle caps, scrap aluminum foil, ferrous rocks, horseshoes, and other pieces of trash, and were most numerous in areas adjacent to roadways. The portion of Area 3 south of Clover Place, which consists of a grassy strip adjacent to Campus Plaza, contained inert ordnance items in such abundance that clearing of the area sufficiently to allow safe access by a drill rig was not practical. Approximate locations of these ordnance items are shown on Figure 3-2.

5.2.2 Soil Gas Survey, Areas 2/3

Thirty soil gas samples were collected in the undeveloped portions of Area 2/3 and were analyzed for the volatile organic compounds stated in Section 3.2. Soil gas survey points were advanced along the perimeter and in the interior of both areas. Soil gas samples were collected at depths ranging from 2 to 5 feet, depending upon the depth to ground water.

Ten soil gas samples were collected to determine placement of one shallow and one deep monitoring well. Five soil gas samples were collected along the railroad tracks upgradient of Area 2/3 to determine the placement of MW-40, and five soil gas samples were collected near the Federal Business Center office, in Campus Plaza, to determine the placement of MW-41. As explained below, the location of MW-40 was moved further upgradient, to Raritan Plaza II, subsequent to the soil gas survey.

Seven soil gas survey locations were sampled along the railroad tracks north of Area 2/3 to assess the presence of VOCs upgradient of the area.

Low but detectable concentrations of TCE, benzene, toluene, and total volatile hydrocarbons were found in some samples. Concentrations of TCE ranged from 0.003 to 2.0 parts per billion, vapor (ppbv). Concentrations of benzene ranged from 0.06 to 0.3 ppbv. Matrix interference from adjacent peaks precluded definitive analysis for benzene or toluene at soil gas locations SG2-1, SG2-19, and SG3-1.

Soil gas data are summarized in Table 2-1. Sampling locations are shown on Figures 2-1 and 2-1A.

5.2.3 Soil Sampling Depths/Locations

Forty soil borings were advanced in Area 2. Criteria used to determine sampling locations included the existence of anomalous features on the surface (i.e., mounds); the results of the soil gas survey; the results of the previous investigation of the area by OBG; and use of a grid system to systematically characterize the area. Soil samples were collected for laboratory analysis for metals, explosives, and VOCs in accordance with the Work Plan; however, sampling intervals and depths varied according to the location of the boring and the depth to ground water.

Borings advanced in mounds or other apparently artificially elevated areas were terminated at a depth of 10 feet or at ground water; composite samples were collected from sampling intervals of 0 to 5 feet and 5 to 10 feet for analysis for metals and explosives. Discrete samples for headspace analysis were collected from 2-foot sample intervals; laboratory VOC analysis was performed on the sample with the highest headspace organic vapor concentration at each sample location. Fourteen borings were advanced in mounds.

Borings advanced in areas that appeared to represent original grade were terminated at a depth of 5 feet or at the ground water table. Samples were collected at intervals of 0 to 1 foot, 2 to 3 feet, and 4 to 5 feet, unless ground water was encountered at a depth of less than 5 feet; when this occurred, the third sampling interval consisted of the 6- to 12-inch soil column above the ground water table. Samples collected from the highest and lowest sampling intervals were analyzed for metals; samples from the highest and middle intervals were analyzed for explosives; and samples from the lowest interval were analyzed for VOCs. Twenty-six borings were advanced in areas that appeared to represent original grade.

Three borings (B2-35, B2-36, and B2-37) were advanced within 15 feet of OBG's boring B-10; 25.8 ppm mercury had been detected in B-10 during the OBG investigation. The three borings were advanced to assess the vertical and horizontal extent of mercury in the area around B-10.

Soil boring locations are shown on Figure 2-2. Boring logs are included in Volume II of this report, Appendix A.

5.2.3.1 Analytical Results

Metals

As shown in Table 2-2, metal contamination exceeding NJDEPE proposed residential soil cleanup standards was detected in ten soil samples.

Three samples obtained from depths of 0 to 1 foot from borings B2-1, B2-2, and B2-5 contained arsenic in concentrations ranging from 2.14 to 2.98 ppm; the NJDEPE proposed standard is 2 ppm.

One sample obtained at a depth of 0 to 1 foot from boring B2-3 contained lead at a concentration of 214 ppm (the NJDEPE proposed standard is 100 ppm), and arsenic at a concentration of 9.67 ppm.

Samples obtained from B2-7 contained arsenic in concentrations of 3.10 ppm (depth interval of 0 to 5 feet) and 2.05 ppm (depth interval of 5 to 10 feet).

Samples obtained from B2-30 contained arsenic in concentrations of 7.12 ppm (depth interval of 0 to 1 foot) and 2.0 ppm (depth interval of 1 to 2 feet).

Sample B2-36, obtained at a depth of 0 to 1 foot, contained mercury at a concentration of 26.2 ppm; the NJDEPE proposed standard is 14 ppm. B2-36 is one of the borings located within 15 feet of OBG boring B-10. None of the other soil samples obtained from this area, including a sample from B2-36 obtained at a depth of 4 to 5 feet, contained mercury at a concentration that exceeded the NJDEPE proposed standard.

Sample B2-40, obtained at a depth of 0 to 1 foot, slightly exceeded the NJDEPE proposed standard for lead with a detected concentration of 106 ppm; this sample also contained 2.65 ppm arsenic.

Explosives

Explosives were not detected in any soil sample from this area.

VOCs

As shown in Table 2-3, low concentrations of various VOCs were detected at random locations throughout the area; all detected concentrations were several orders of magnitude lower than NJDEPE proposed standards.

Trichlorofluoromethane was the most widely detected VOC contaminant in this area; concentrations detected in 12 of the 40 sample locations ranged from 6.5 to 14 ppb. No standards have been proposed by the NJDEPE for this compound.

5.2.4 Monitoring Well Installation and Sampling

Dames & Moore installed two shallow monitoring wells to assess hydrogeologic conditions and ground water quality within and upgradient of Area 2.

MW-58 was installed near the downgradient perimeter of Area 2, near Raritan Center Parkway, at the approximate location where soil gas survey sample SG2-15 was collected. MW-58 was screened from 7 to 17 feet in brown fine to coarse sand that contained varying amounts of silt, and was terminated in the gray clay layer that appears to overlie bedrock over much of the site.

MW-40 was installed north of Fieldcrest Avenue in Raritan Plaza II, on the upgradient boundary of the site, to monitor background hydrogeologic conditions. This well originally was to have been installed along the railroad tracks which comprise the northern boundary of Area 2, as stated in the Work Plan; a soil gas survey was conducted in this area to evaluate five potential locations for installation of the well. Information obtained subsequent to the performance of the soil gas survey, however, indicated a significant number of monitoring wells already had been installed in this area, by private industry, in an effort to define the source and extent of known ground water contamination. Therefore, MW-40 was moved further upgradient to prevent duplication of effort and provide information concerning the quality of the ground

water entering the site. The well was screened from depths of 7 to 17 feet in brownish yellow fine to medium sand with varying amounts of silts and coarse sands.

The Work Plan required the installation of a second downgradient well. It was anticipated MW-41 would be a deep well, with the screen set at depths of 15 to 25 feet. However, gray clay was encountered at a depth of 18.8 feet, and extended to the top of bedrock at a depth of 30 feet. Because of the absence of ground water in the clay, the boring was grouted and abandoned.

The two wells installed by Dames & Moore (MW-40 and MW-58) and four OBG monitoring wells (MW-12, MW-13, MW-14, and MW-15) were sampled for laboratory analysis for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, and pesticides. Total and dissolved metal analyses were performed for MW-58 because of the slow recharge rate of this well.

Monitoring well MW-12, installed by OBG to monitor ground water conditions upgradient of Area 7, also could be considered downgradient of Area 2. Therefore, the analytical results of a ground water sample from this well are included in this section. No significant contamination was detected in the ground water sample from this well.

Monitoring well boring logs, well construction details, and well development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.2.4.1 Analytical Results

<u>Metals</u>

As shown in Table 2-4, arsenic was detected in the ground water sample from MW-15 in a concentration (13.1 ppb) that exceeded the NJDEPE criteria of 0.02 ppb and the PQL of 8 ppb.

Cadmium also was detected in the ground water sample from MW-15 in a concentration (5 ppb) that exceeded the NJDEPE criteria of 4 ppb.

All other metals detected in the water samples were below NJDEPE criteria and/or PQLs.

Explosives

One explosive, 1,3-dinitrobenzene, was detected in the ground water sample from MW-15 at a concentration of 0.645 ppb; the NJDEPE has not proposed a criteria for this compound.

VOCs

As shown in Table 2-5, ground water samples from MW-13, MW-14, MW-40, and MW-58 contained concentrations of VOCs that exceeded NJDEPE criteria; TCE, the most predominant ground water contaminant at the site, was detected in the samples from each of these wells. Monitoring wells MW-12 and MW-15 did not contain detectable concentrations of TCE.

Others

The concentration of pesticide detected in MW-58 did not exceed the NJDEPE criteria or the PQL. The concentrations of bis(2-ethylhexyl)phthalate detected in ground water samples from MW-13, MW-15, MW-40 and MW-58 were below the NJDEPE PQL of 30 ppb, but were above the criteria of 3 ppb, as shown in Table 2-5. The concentration of bis(2-ethylhexyl)phthalate in MW-14 was below both the NJDEPE criteria and the PQL.

5.2.5 Soil Geology, Area 2

The soils in Area 2 typically consist of brown to dark brown silty sands to a depth of approximately 2 feet. Beneath this layer are brown, brown and gray, yellowish-brown, and yellowish-red fine to medium sands, and fine to coarse sands, with varying amounts of silt, and occasional lenses of silt and clay. Gray clay, presumed to be the Raritan Fireclay, underlies the sands; the clay was encountered at depths of 16.5 to 24 feet in various borings advanced by Dames & Moore and OBG, and extends to red shale bedrock found approximately 30 feet below ground surface.

Surficial peat layers were encountered in a few borings; one boring (B2-26) contained a 3-inch layer of peat at a depth of 3'. These thin layers of peat are representative of the local low-energy depositional environment, and are unrelated to the layer of peat encountered at greater depths elsewhere on site.

Many of the shallow sands found in Area 2 appear to be fill material which may have been transported from other areas of the site. OBG indicated in their report that soils excavated from other areas of the arsenal had been deposited in Area 3; it is possible soils also were deposited in Area 2 since these two areas are contiguous. This conclusion is further substantiated by the presence of mounds of loose sands scattered throughout Area 2 and part of Area 3. The depth of this fill material appears to be highly variable. Some portions of the area, primarily in the northern half of Area 2, appear to be largely or entirely native, undisturbed soils. However, coal was encountered at a depth of 9 feet in the boring advanced for MW-58, indicating extensive backfilling at this location.

Ground water levels encountered during drilling in Area 2 generally were between 4 and 6 feet deep.

5.2.6 Ground Water Level Readings

Three rounds of ground water level measurements were taken from the two shallow monitoring wells installed by Dames & Moore, and from OBG monitoring wells MW-13, MW-14, and MW-15. The elevations of the water are stated below in feet above mean sea level:

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-12	6.6	1310	6.57	1035	6.69	1146
MW-13	18.72	1410	18.70	0943	18.77	1218
MW-14	9.15	1320	9.13	1048	9.19	1154
MW-15	7.38	1330	7.35	1056	7.53	1158

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-40	52.09	1433	52.09	0937	52.09	1240
MW-58	18.5	1412	18.46	0948	18.44	1221

A review of this data indicates the general ground water flow is toward the southeast, as expected.

TABLES FOR AREA 2

TABLE 2-1

AREA 2/3
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG2-2-5′	--	--	0.07	--	--	--	--	--
SG2-3-5′	--	--	0.3	--	--	--	--	--
SG2-5-5′	--	--	0.4	--	--	--	--	--
SG2-7-5′	--	--	0.003	--	--	--	--	0.4
SG2-9-5′	--	--	--	0.2	--	--	--	1
SG2-10-5′	--	--	0.004	--	--	--	--	0.5
SG2-14-5′	--	--	--	0.1	0.1	--	--	0.6
SG2-15-2′	--	--	2	--	--	--	--	0.4
SG2-17-3′	--	--	--	I*	I	--	--	--
SG2-19-3′	--	--	0.01	I	I	--	--	--
SG3-1-5′	--	--	--	I	I	--	--	--
SG2-22-4′	--	--	0.02	--	--	--	--	--

*I = Matrix interference.

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

[d:\...\job\19577014\march93\usac0814.voc]

TABLE 2-1 (continued)

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG2-31-4′	--	--	0.002	--	--	--	--	--
SG-2-36-3′	--	--	--	0.3	0.2	--	--	0.7
SG-2-37-3′	--	--	--	0.06	--	--	--	0.07
MW-41-2-5′	--	--	--	--	0.6	--	--	0.6
MW-41-3-5′	--	--	0.005	--	--	--	--	--
MW-41-4-5′	--	--	0.002	--	--	--	--	--
MW-40-1-5′	--	--	--	--	--	--	--	1
MW-40-2-5′	--	--	0.1	--	--	--	--	1
MW-40-3-5′	--	--	0.3	--	--	--	--	1
MW-40-4-5′	--	--	--	--	0.2	--	--	1
MW-40-5-5′	--	--	--	--	--	--	--	1

Note: Units are in $\mu g/L$ (parts per billion, vapor).
-- = Not detected.

[d:\...\job\19577014\march93\usac0814.voc]

TABLE 2-2

AREA 2
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B2-1, 0-1′, #2	**2.98**	--	--	--	--	--	--	--
B2-2, 0-1′, #5	**2.14**	--	--	--	--	--	--	--
B2-3, 0-1′ #8	**9.67**	--	--	--	**214**	--	--	--
B2-5, 0-1′, #13	**2.78**	--	--	--	--	--	--	--
B2-7, 0-5′, #19	**3.10**	--	--	--	--	--	--	--
B2-7, 5-10′, #20	**2.05**	--	--	--	--	--	--	--
B2-30, 0-1′ #88	**7.12**	--	--	--	--	--	--	--
B2-30, 1-2′, #89	**2.00**	--	--	--	--	--	--	--
B2-36, 0-1′ #106	--	--	--	--	--	**26.2**	--	--
B2-40, 0-1′ #119	**2.65**	--	--	--	**106**	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million)
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, Revised 2/8/93.

[d:\...\job\19577014\march93\area2.met]

TABLE 2-3

AREA 2
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

SAMPLE DESCRIPTION	ACETONE	CHLOROBENZENE	METHYLENE CHLORIDE	TOLUENE	TRICHLOROFLUOROMETHANE	XYLENE
Residential Surface Soil Cleanup Standard	1,000,000	37,000	49,000	1,000,000	NS	410,000
Impact to Ground Water Soil Cleanup Standard	50,000	1,000	10,000	500,000	NS	10,000
B2-2, #7, 4-5′	--	--	--	12	--	6.6
B2-8, #24, 4-5′	--	--	--	--	12	--
B2-14, #42, 9-10′	11	--	--	--	--	--
B2-24, #72, 6-8′	--	--	--	--	6.8	--
B-2-25, #75, 4-6′	--	--	--	--	6.5	--
B2-26, #78, 6-8′	--	--	--	--	7.2	--
B2-28, #84, 6-8′	--	10	--	7.4	--	--
B2-29, #87, 6-8′	--	--	--	--	8.5	--
B2-32, #96, 4-5′	--	--	--	--	9.2	--
B2-33, #99, 4-5′	--	--	--	--	9.9	--
B2-34, #102, 4-5′	--	--	5.5	--	--	--
B2-38, #115, 4-5′	--	--	--	--	14	--

TABLE 2-3 (cont'd)

SAMPLE DESCRIPTION	ACETONE	CHLOROBENZENE	METHYLENE CHLORIDE	TOLUENE	TRICHLOROFLUOROMETHANE	XYLENE
Residential Surface Soil Cleanup Standard	1,000,000	37,000	49,000	1,000,000	NS	410,000
Impact to Ground Water Soil Cleanup Standard	50,000	1,000	10,000	500,000	NS	10,000
B2-39, #118, 4-5'	--	--	--	--	9.1	--
B2-40, #1121	--	--	--	--	12	--

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates concentration is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, Revised 2/8/93.

[d:\...\job\19577014\march93\area2.voc]

TABLE 2-4

AREA 2/3
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-12[a]	MW-13	MW-14	MW-15	MW-40	MW-58	MW-58[b]
Arsenic	0.02	8	--	2.8	--	13.1	--	--	--
Barium	2000	200	35.0	60	68	124	52	68	53
Cadmium	4	2	--	--	--	5.0	--	--	--
Chromium	100	10	--	9.7	--	--	--	37	--
Lead	5	10	2.8	3.1	2.0	6.0	--	7.7	--
Mercury	2	0.5	--	--	--	--	--	--	--
Selenium	50	10	--	--	2.2	--	--	--	--
Silver	20	2	--	--	--	--	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
[a]Monitoring well MW-12 is installed in Area 7, downgradient of Area 2/3.
[b]Dissolved metal concentration.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

[d:\...\job\19577014\March93\tbl0914.24]

TABLE 2-5

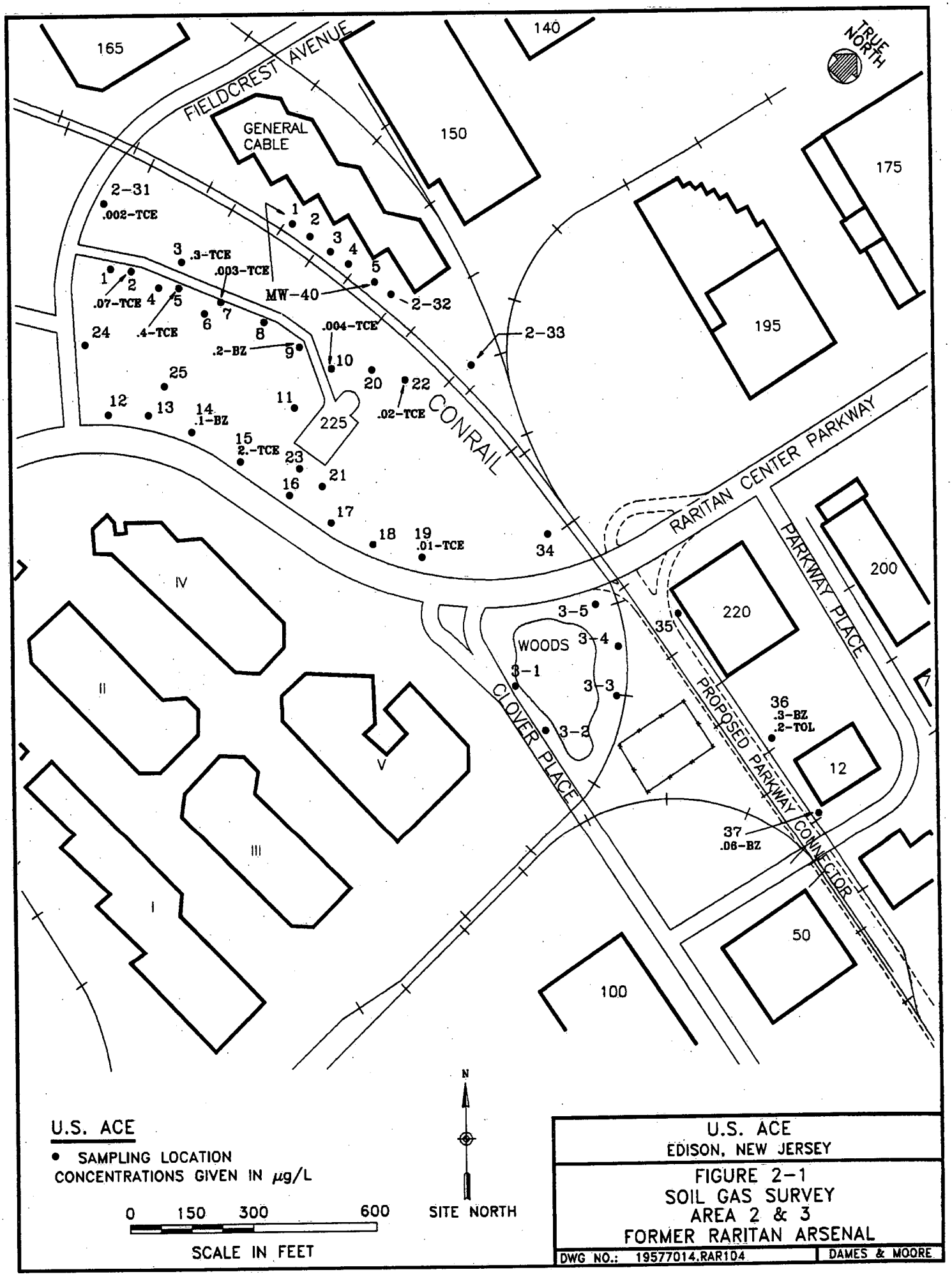
AREA 2/3
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVELS (PQL)	MW-12[1]	MW-13	MW-14	MW-15	MW-40	MW-58
Explosives								
1,3-Dinitrobenzene	NS	NS	--	--	--	0.695	--	--
Pesticides								
DDT, PP'	0.1	0.06	--	--	--	--	--	0.058
Volatile Organic Compounds								
1,2-DCE (total)	110[2]	2	--	120	--	--	4.3	68
Tetrachloroethene	0.4	1	--	23	--	--	3.5	11
TCE	1	1	--	310	5.4	--	9.0	170
Vinyl chloride	0.08	5	--	15	--	--	--	--
Base/Neutral and Acid Extractable Compounds								
Bis(2-ethylhexyl)phthalate	3[3]	30	--	6.2	2.7	3.9	10.0	4.0

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
[1]MW-12 is installed in Area 7, downgradient of Area 2/3.
[2]NJDEPE criteria for cis-1,2-DCE and trans-1,2-DCE are 10 and 100 μg/L, respectively.
[3]Federal MCL = 6 μg/L
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

[d:\...\job\19577014\March93\tbl0914.25]

FIGURES FOR AREA 2

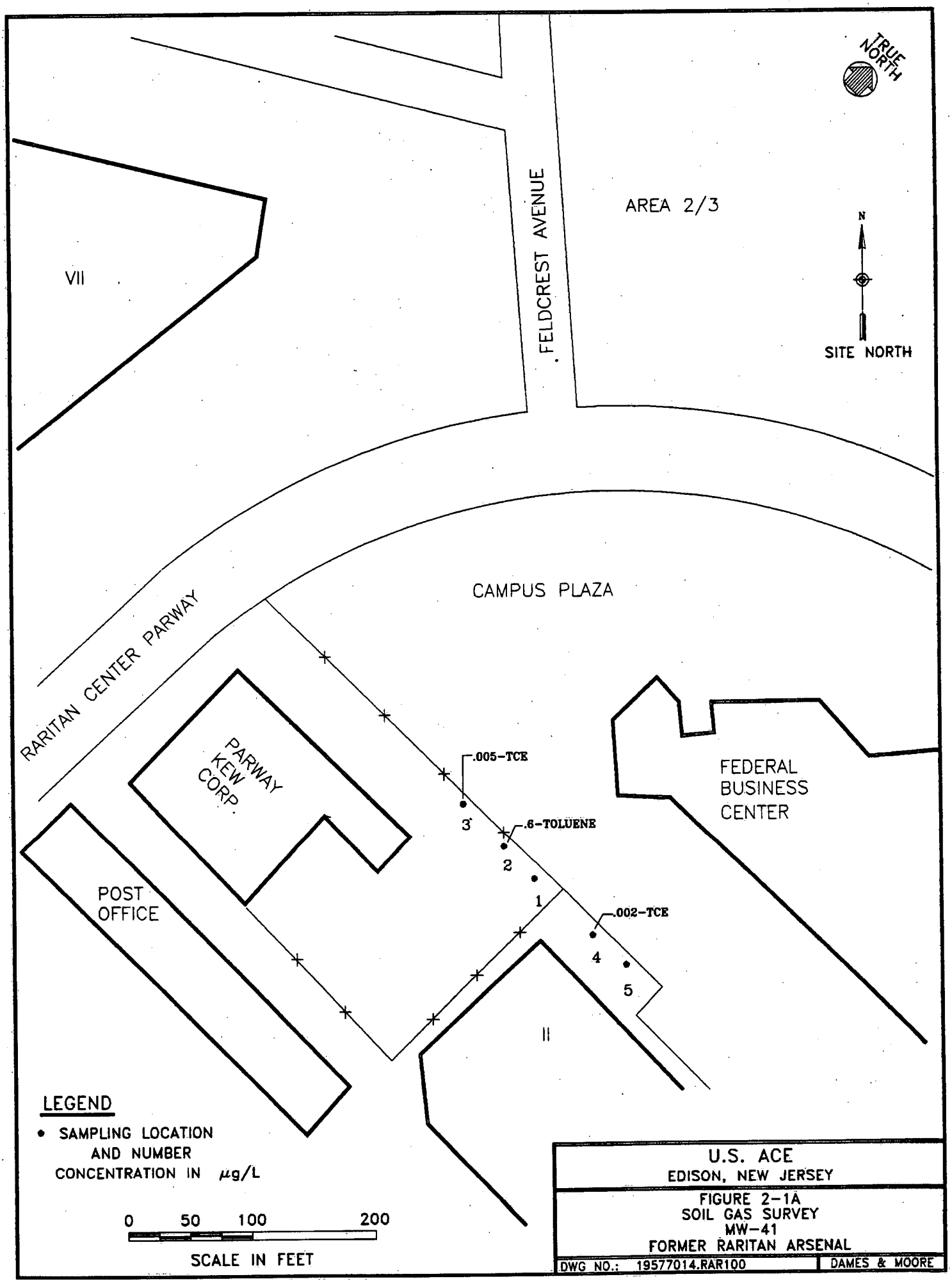


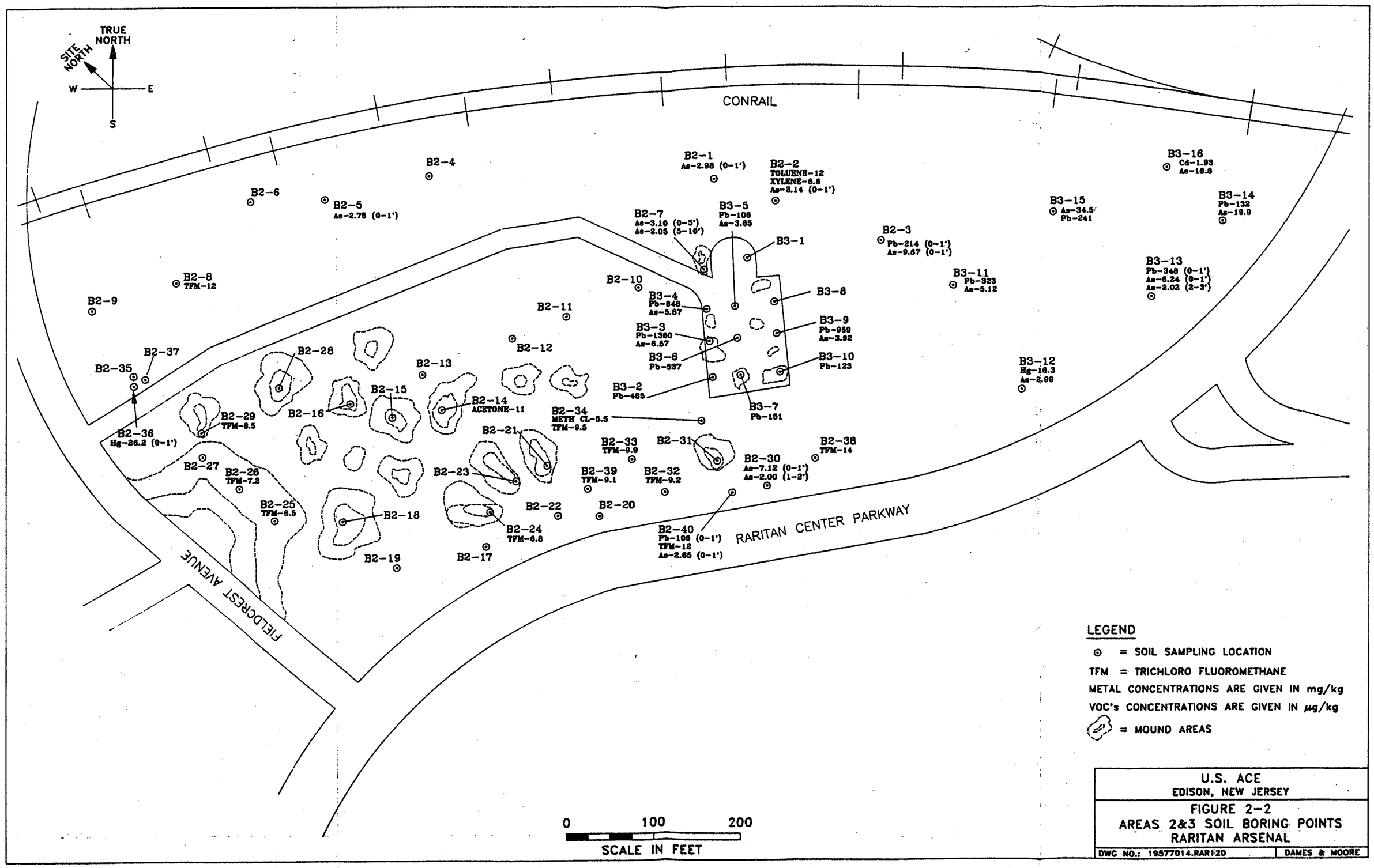
U.S. ACE
EDISON, NEW JERSEY

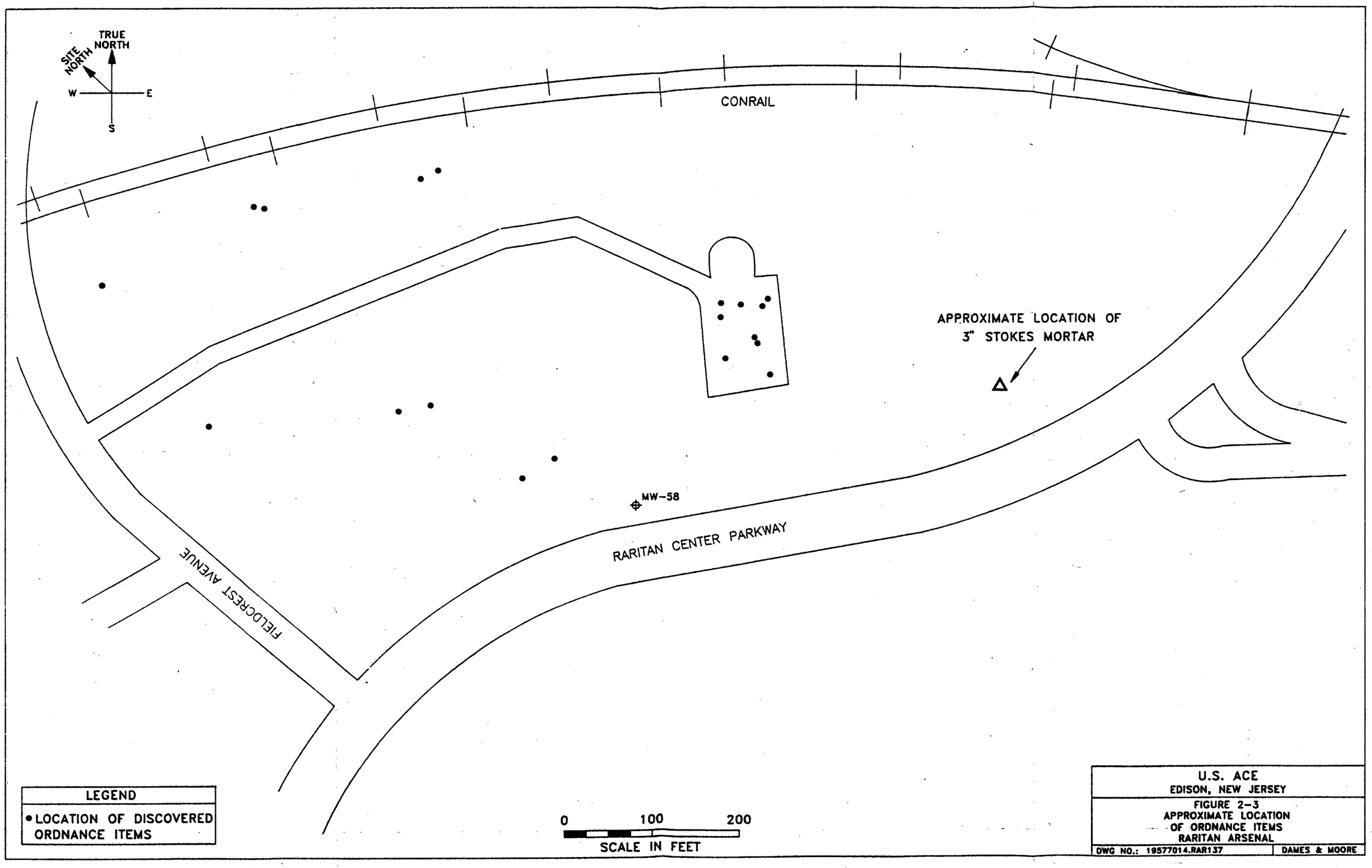
FIGURE 2-1
SOIL GAS SURVEY
AREA 2 & 3
FORMER RARITAN ARSENAL

DWG NO.: 19577014.RAR104

DAMES & MOORE


TRUE NORTH
AREA 2/3
FELDCREST AVENUE
VII
N
SITE NORTH
CAMPUS PLAZA
RARITAN CENTER PARWAY
PARWAY KEW CORP.
FEDERAL BUSINESS CENTER
.005-TCE
.6-TOLUENE
.002-TCE
3
2
1
4
5
POST OFFICE
II
LEGEND
• SAMPLING LOCATION AND NUMBER CONCENTRATION IN μg/L
0 50 100 200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 2-1A
SOIL GAS SURVEY
MW-41
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR100
DAMES & MOORE


TRUE NORTH
SITE NORTH
W
E
S
CONRAIL
B2-1
As-2.98 (0-1')
B2-2
TOLUENE-12
XYLENE-6.6
As-2.14 (0-1')
B2-3
Pb-214 (0-1')
As-9.67 (0-1')
B2-4
B2-5
As-2.78 (0-1')
B2-6
B2-7
As-3.10 (0-5')
As-2.05 (5-10')
B2-8
TFM-12
B2-9
B2-10
B2-11
B2-12
B2-13
B2-14
ACETONE-11
B2-15
B2-16
B2-17
B2-18
B2-19
B2-20
B2-21
B2-22
B2-23
B2-24
TFM-6.8
B2-25
TFM-6.5
B2-26
TFM-7.2
B2-27
B2-28
B2-29
TFM-8.5
B2-30
As-7.12 (0-1')
As-2.00 (1-2')
B2-31
B2-32
TFM-9.2
B2-33
TFM-9.9
B2-34
METH CL-5.5
TFM-9.5
B2-35
B2-36
Hg-26.2 (0-1')
B2-37
B2-38
TFM-14
B2-39
TFM-9.1
B2-40
Pb-106 (0-1')
TFM-12
As-2.65 (0-1')
B3-1
B3-2
Pb-485
B3-3
Pb-1360
As-6.57
B3-4
Pb-848
As-5.87
B3-5
Pb-106
As-3.65
B3-6
Pb-537
B3-7
Pb-151
B3-8
B3-9
Pb-959
As-3.92
B3-10
Pb-123
B3-11
Pb-323
As-5.12
B3-12
Hg-16.3
As-2.99
B3-13
Pb-348 (0-1')
As-6.24 (0-1')
As-2.02 (2-3')
B3-14
Pb-132
As-19.9
B3-15
As-34.5
Pb-241
B3-16
Cd-1.93
As-16.6
RARITAN CENTER PARKWAY
FIELDCREST AVENUE
0
100
200
SCALE IN FEET
LEGEND
= SOIL SAMPLING LOCATION
TFM = TRICHLORO FLUOROMETHANE
METAL CONCENTRATIONS ARE GIVEN IN mg/kg
VOC's CONCENTRATIONS ARE GIVEN IN µg/kg
= MOUND AREAS
U.S. ACE
EDISON, NEW JERSEY
FIGURE 2-2
AREAS 2&3 SOIL BORING POINTS
RARITAN ARSENAL
DWG NO.: 19577014.RAR120
DAMES & MOORE


TRUE NORTH
SITE NORTH
W
E
S
CONRAIL
APPROXIMATE LOCATION OF
3" STOKES MORTAR
MW-58
RARITAN CENTER PARKWAY
FIELDCREST AVENUE
LEGEND
• LOCATION OF DISCOVERED ORDNANCE ITEMS
0
100
200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 2-3
APPROXIMATE LOCATION
OF ORDNANCE ITEMS
RARITAN ARSENAL
DWG NO.: 19577014.RAR137
DAMES & MOORE

5.3 AREA 3

OBG reported that portions of Area 3 were used as a demolition and burning ground until 1948. Components destroyed at the site included booster adapters, projectiles, and point and base detonating fuses. Portions of Area 3 reportedly had been filled with several feet of soil prior to 1963; based solely on a comparison of the elevation of the undeveloped portion of Area 3 with the adjacent railroad, it did not appear the area investigated had been filled.

Much of Area 3 is developed and covered with buildings, pavement, and landscaping. Descriptions of the undeveloped portions of Area 3 are included in the discussion of Dames & Moore's investigation of Area 2. Discussions of the UXO and soil gas surveys conducted in Area 3 also are included in the discussion of Area 2, above.

5.3.1 Soil Sampling Depths/Locations

Twenty-six soil borings were advanced in the fenced area and other undeveloped portions of Area 3. Each boring was advanced to a depth of 5 feet or until ground water was encountered; ground water generally was found at depths of less than 3 feet.

Ten borings (B3-1 through B3-10) were advanced in the fenced portion of Area 3 based on a 40-foot grid. Samples were collected and analyzed for metals and explosives to assess the horizontal and vertical extent of contamination originally detected by OBG.

Twelve soil borings (B3-11 through B3-22) were advanced in marshy parts of Area 3. Six of these borings were advanced at the nodes of an approximate 100-foot grid superimposed on the low-lying part of Area 3 contiguous with Area 2, and six were advanced in the low-lying area east of Raritan Center Parkway. The locations of several borings were modified significantly due to access constraints and surface obstacles. All 12 borings were terminated at depths of less than 5 feet because of the presence of a high ground water table; depths of borings ranged from 1 to 4 feet. Samples from these locations were analyzed for VOCs, metals, and explosives.

Four borings (B3-23 through B3-26) were advanced at approximately 100-foot intervals in the grassy strip which contains OBG monitoring well MW-15. These borings were placed in areas that appeared to approximate original grade. Borings were terminated at depths of 2

to 5 feet, depending upon ground water level, and samples were collected for analysis for metals, explosives, and VOCs.

Soil boring locations are shown on Figures 2-2 and 3-1. Boring logs are included in Volume II of this report, Appendix A.

5.3.1.1 Analytical Results

Explosives

Two samples contained detectable concentrations of explosives. Sample B3-15, collected at a depth of 0 to 1 foot, contained 8.06 ppm of nitroglycerin. Sample B3-18, collected at a depth of 0 to 1 foot, contained 17.2 ppm of PETN. No standards have been proposed by the NJDEPE for explosives.

Metals

As shown in Table 3-1, lead and arsenic were detected in many of soil samples obtained from the fenced area in concentrations that exceeded the NJDEPE proposed standards. Lead was detected in 9 of 10 shallow (0 to 1 foot) samples at concentrations ranging from 106 to 1360 ppm; the NJDEPE proposed standard is 100 ppm. Arsenic was detected in 4 of 10 samples at concentrations ranging from 3.65 to 6.57 ppm; the NJDEPE proposed standard is 2 ppm.

In the marshy portions of Area 3, lead, cadmium and arsenic were detected in soil samples in concentrations that exceeded the NJDEPE proposed standards. Lead was found at six sample locations in concentrations ranging from 103 to 348 ppm. Cadmium was detected in soil samples from four locations in concentrations ranging from 1.93 to 3.72 ppm; the NJDEPE proposed standard is 1 ppm. Arsenic was detected in fifteen soil samples at concentrations ranging from 2.02 to 34.5 ppm; the NJDEPE proposed standard is 2 ppm.

In the grassy strip, lead and arsenic were detected in concentrations which exceeded the NJDEPE proposed standards. A concentration of 203 ppm of lead was detected in soil boring B3-25. Arsenic was found in five samples in concentrations ranging from 2.19 to 2.60 ppm;

at least one sample from each of the four borings advanced in the grassy strip contained arsenic which exceeded the proposed standards.

All other metal concentrations in the soil samples were below NJDEPE proposed standards.

VOCs

As shown in Table 3-2, various VOCs were detected in five soil samples. All concentrations detected were several orders of magnitude below NJDEPE proposed standards with the exception of TCE. A TCE concentration of 230 ppb was detected in soil sample B3-19, obtained from a depth of 2 to 3 feet; this is less than one order of magnitude below the proposed NJDEPE subsurface standard of 1000 ppb.

5.3.2 Surface Water/Sediment Samples

One surface water sample (SW-1) and one sediment sample (SS-1, #600) were collected from a marshy area/small stream southeast of Raritan Center Parkway. Samples were analyzed for metals, explosives, VOCs, base/neutral and acid extractable compounds, and pesticides. Sampling locations are shown on Figure 3-2. Table 3-3 summarizes the analytes which exceeded NOAA ER-L concentrations for sediments.

5.3.2.1 Analytical Results

Metals

The sediment sample contained 76.9 ppm of lead and 0.248 ppm of mercury; these concentrations exceed the NOAA ER-L concentrations of 35 ppm and 0.15 ppm, respectively.

Base/Neutral and Acid Extractable Organic Compounds

The sediment sample contained benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, phenanthrene, and pyrene at concentrations which exceeded the NOAA ER-L concentrations. A summary of the analytical results for this sample is presented in Table 3-3.

Others

No explosives or pesticides were detected in the surface water or sediment samples. Concentrations of other analytical parameters in both the surface water sample and the sediment sample were either below detection levels or were below the referenced standards.

5.3.3 Soil Geology - Area 3

The shallow soils in the fenced portion of Area 3 typically consist of brown to dark brown silty sands to a depth of approximately 2 feet. Beneath this layer are brown, brown and gray, yellowish-brown, and yellowish-red fine to medium and fine to coarse sands with varying amounts of silt and occasional lenses of silt and clay. Gray clay, presumed to be the Raritan Fireclay, underlies the sands; the clay was encountered at depths of 16.5 to 24 feet in various borings advanced by Dames & Moore and OBG, and extends to red shale bedrock found approximately 30 feet below ground surface. Surficial peat layers were encountered in a few borings; these thin layers of peat are representative of the local low-energy depositional environment, and are unrelated to the layer of peat encountered at greater depths elsewhere on the site.

Shallow soils in the unfenced portion of Area 3 differ slightly from those encountered in Area 2, and from those encountered in the fenced portion of Area 3. In the portion of Area 3 that is contiguous with Area 2, the sands are generally finer and contain a higher percentage of organics, silts, and clays than were encountered in the adjacent portions of Area 2. In the noncontiguous, undeveloped portion of Area 3, across Raritan Center Parkway, the soils are still finer, and local lenses of silts, clays, and peat were encountered; these soils are typical for the marshy terrain found in the unfenced portion of Area 3.

Many of the shallow sands found in the fenced portion of Area 3 appear to be fill material transported from other areas of the site. OBG indicated in their report that soils excavated from other areas of the arsenal had been deposited in Area 3; this conclusion is further substantiated by the presence of mounds of loose sands within the fenced part of Area 3. In the boring advanced for monitoring well MW-58, coal was encountered at a depth of 9 feet, indicating extensive backfilling at this location.

Ground water generally was encountered in the low-lying portions of Area 3 at depths of 1 to 2.5 feet.

Significant quantities of ordnance were detected in the grassy strip of Area 3; ordnance was found throughout the depth of the borings (to a maximum of 5 feet deep), indicating the area has been extensively filled. Remediation of this area to remove shallow ordnance was begun under the direction of the USACE/Huntsville in February, 1993.

5.3.4 Ground Water Level Readings

Ground water levels in the wells installed near Area 3 were discussed in Section 5.2.6, Area 2; these areas are contiguous.

TABLES FOR AREA 3

TABLE 3-1

AREA 3
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B3-2, 0-1', #136	--	--	--	--	485	--	--	--
B3-3, 0-1', #139	6.57	--	--	--	1360	--	--	--
B3-4, 0-1', #142	5.87	--	--	--	848	--	--	--
B3-5, 0-1', #145	3.65	--	--	--	106	--	--	--
B3-6, 0-1', #148	--	--	--	--	537	--	--	--
B3-7, 0-1', #151	--	--	--	--	151	--	--	--
B3-9, 0-1', #157	3.92	--	--	--	959	--	--	--
B3-10, 0-1', #160	--	--	--	--	123	--	--	--
B3-11, 0-1', #163	5.12	--	--	--	323	--	--	--
B3-12, 0-1', #166	2.99	--	--	--	--	16.3	--	--
B3-13, 0-1', #169	6.24	--	--	--	348	--	--	--
B3-13, 2-3', #170	2.02	--	--	--	--	--	--	--
B3-14, 0-1', #172	19.9	--	--	--	132	--	--	--
B3-15, 0-1', #175	34.5	--	--	--	241	--	--	--
B3-16, 0-1', #178	16.8	--	1.93	--	--	--	--	--
B3-17, 0-1', #181	15.7	--	3.72	--	--	--	--	--
B3-18, 0-1', #184	15.8	--	2.23	--	--	--	--	--

TABLE 3-1 (continued)

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B3-18, 2-3', #185	**16.4**	--	--	--	**122**	--	--	--
B3-19, 0-1', #187	**17.8**	--	**3.04**	--	--	--	--	--
B3-19, 2-3', #188	**2.94**	--	--	--	--	--	--	--
B3-20, 0-1', #190	**11.9**	--	--	--	--	--	--	--
B3-21, 0-1', #193	**7.05**	--	--	--	--	--	--	--
B3-22, 0-1', #196	**9.00**	--	--	--	**103**	--	--	--
B3-23, 0-1', #200	**2.32**	--	--	--	--	--	--	--
B3-23, 3-4', #1201	**2.26**	--	--	--	--	--	--	--
B3-24C, 0-2', #202	**2.60**	--	--	--	--	--	--	--
B3-25, 0-1', #205	--	--	--	--	**203**	--	--	--
B3-25, 3-4', #207	**2.55**	--	--	--	--	--	--	--
B3-26C, 0-2', #1208	2.19	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, Revised 2/8/93.

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TABLE 3-2

AREA 3
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

SAMPLE DESCRIPTION	ACETONE	METHYL ETHYL KETONE	TOLUENE	TRICHLOROETHENE
Residential Surface Soil Cleanup Standard	1,000,000	NS	1,000,000	23,000
Impact to Ground Water Soil Cleanup Criteria	50,000	NS	500,000	1,000
B3-15, #175, 0-1'	--	--	--	43
B3-18, #185, 2-3'	280	--	74	75
B3-19, #188, 2-3'	600	63	--	--
B3-24, #203, 1-2'	120	--	--	--
B3-25, #207, 3-4'	16	--	--	--

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion)
-- indicates concentration is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, Revised 2/8/93.

[d:\...\job\19577014\march93\area3.voc]

TABLE 3-3

AREA 3
CONCENTRATIONS OF ANALYTES
EXCEEDING NOAA ER-L CONCENTRATIONS
SEDIMENT SAMPLE SS-1

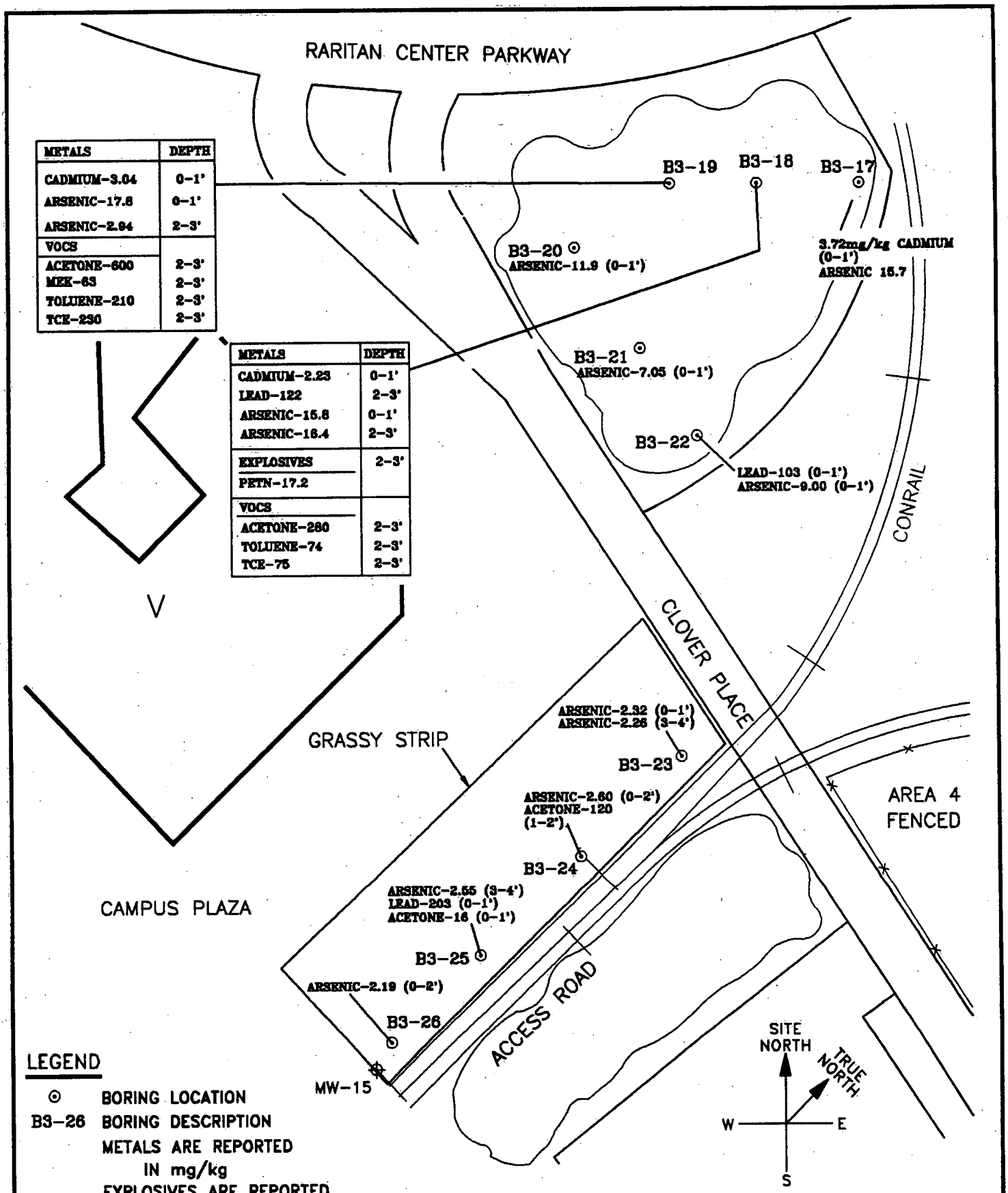
PARAMETER	NOAA ER-L	NOAA ER-M	CONCENTRATION
Metals (mg/kg)			
Lead	35	110	76.9
Mercury	0.15	1.3	0.248
Base/Neutrals and Acid Extractable Compounds (μg/kg)			
Benzo (a) anthracene	230	1,600	610
Benzo (a)pyrene	400	2,500	430
Chrysene	400	2,800	720
Fluoranthene	600	3,600	1,000
Phenanthrene	225	1,380	680
Pyrene	350	2,200	1,000

Notes: National Oceanic Service, National Oceanic and Atmospheric Administration (NOAA), "Potential for Biological Effects of Sediment-Sorbed Contaminants tested in the National Status and Trends Program", March 1990, NOAA/TM/NOS/OMA-52, Table 54A.

Metals concentrations are given in mg/kg (parts per million).
Organic concentrations are given in μg/kg (parts per billion).

[d:\...\job\19577014\march93\tbl0323.33]

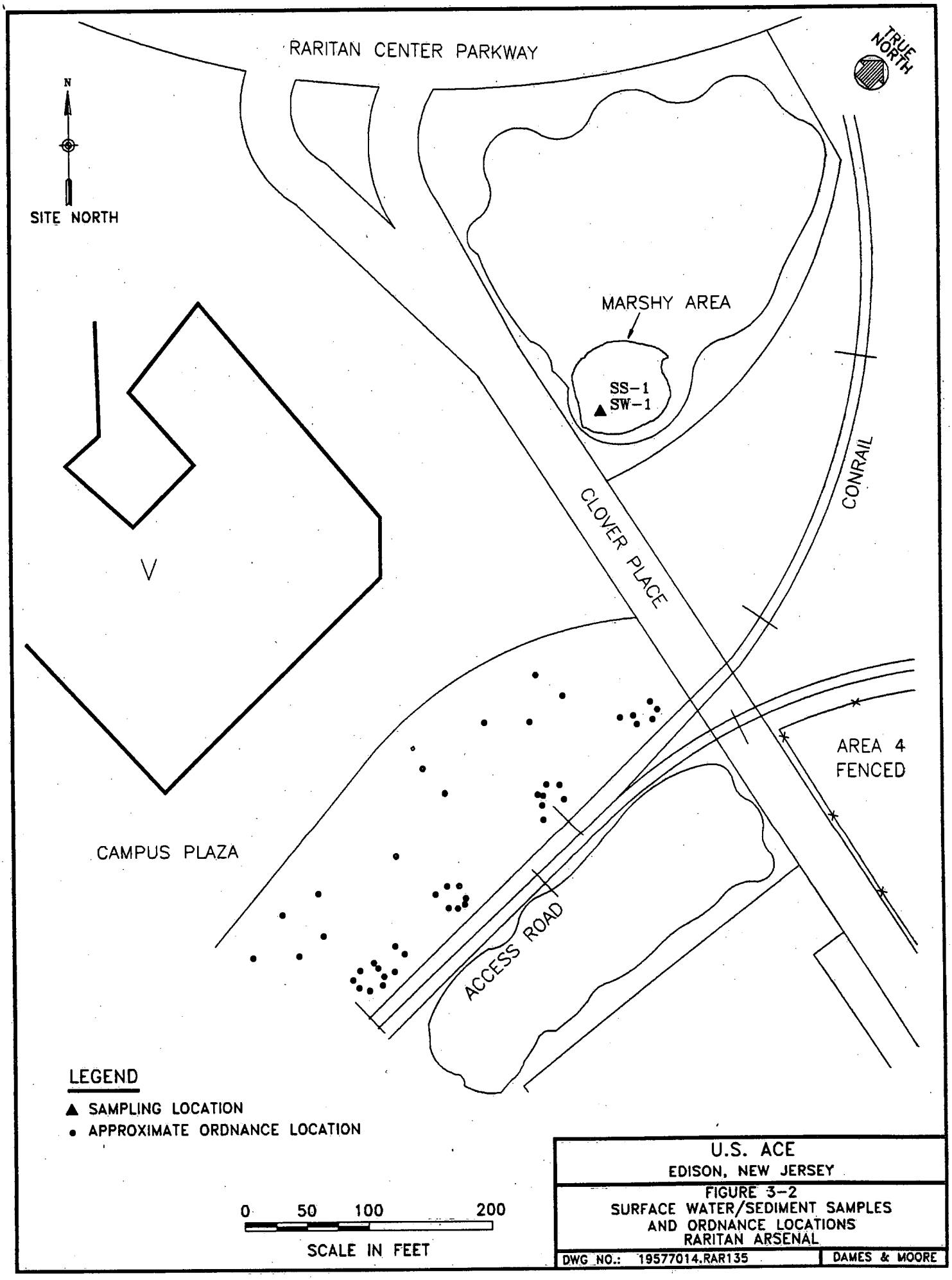
FIGURES FOR AREA 3



U.S. ACE
EDISON, NEW JERSEY

FIGURE 3-1
AREA 3 SOIL BORING POINTS
RARITAN ARSENAL

DWG NO.: 19577014.RAR113 | DAMES & MOORE



U.S. ACE
EDISON, NEW JERSEY

FIGURE 3-2
SURFACE WATER/SEDIMENT SAMPLES
AND ORDNANCE LOCATIONS
RARITAN ARSENAL

DWG NO.: 19577014.RAR135 | DAMES & MOORE

5.4 AREA 4

OBG reported that Area 4 was a high explosive salvage and melt-out area used by the Columbia and Delaware Salvage Company from WWI until the early 1920s. Area 4 encompasses approximately 25 acres; most of it is developed, with the undeveloped portion consisting of low-lying and marshy woodlands.

In 1963, LEAD performed a visual inspection of the area. On the basis of this inspection, LEAD recommended that 7.09 acres be fenced and classified for "Non-use". No recommendations were made for the remainder of the area.

OBG conducted an investigation of Area 4 as part of its 1987-88 contamination evaluation of the Raritan Arsenal. Included in their investigation was a UXO survey which detected scattered bulk high explosives and fragments of various explosives and projectiles; surface and subsurface soil sampling and analysis which detected contamination by lead and explosives (principally 2,4,6-TNT); and the installation and sampling of monitoring wells which detected the presence of explosives and metals in the ground water. On the basis of the OBG investigation, the fenced area was deemed to be a high-priority site by the USACE; the remainder of the area was classified as low-priority. Potential hazards for this area included surficial and subsurface unexploded ordnance and explosives, and contamination of soil and ground water by explosives and heavy metals.

The fenced portion of Area 4 was excavated and remediated for bulk TNT as part of a remediation effort performed under the direction of the USACE, Huntsville, Alabama. The soils in this area were excavated and screened to remove pieces of explosive greater than 1/2 inch in size. Dames & Moore conducted an investigation of the fenced area approximately one month after the preliminary ordnance remediation was completed.

5.4.1 Dames & Moore Activities

Dames & Moore conducted a UXO search, a soil gas survey, soil sampling activities, monitoring well installation and sampling, and surface water and sediment sampling activities as part of its remedial investigation of Area 4.

5.4.2 UXO Search

The soil gas survey points, soil sampling locations, monitoring well locations, and access routes were scanned and cleared of potential ordnance by personnel from UXB International. Various pieces of trash were detected on the surface and subsurface, but no ordnance was found.

5.4.3 Soil Gas Survey

Nine soil gas samples were collected and analyzed for VOCs to aid in the placement of three monitoring wells. Soil gas samples were collected at depths of 4 to 5 feet, depending upon the depth to ground water. Five soil gas samples were collected to determine the location of monitoring well cluster MW-42A and MW-42B, and four samples were collected to determine the placement of MW-43. One soil gas survey point associated with MW-42 contained 0.002 ppbv TCE; MW-42A was installed at this location. None of the soil gas samples collected to determine the location of MW-43 contained detectable concentrations of any of the VOCs of concern; however, matrix interference precluded definitive analysis for benzene and toluene.

Soil gas survey sampling locations are shown on Figures 4-1A and 4-1B.

5.4.4 Soil Sampling Depths/Locations

Eleven borings (B4-7 through B4-17) were advanced in the fenced portion of Area 4; soil samples were collected for analysis for metals, explosives, and VOCs. Six boring locations were established along the perimeter of the fenced area, at approximate 150-foot intervals. The remaining five borings were located in the interior of the fenced area, with specific sampling locations chosen to target areas of apparent contamination while obtaining an approximate uniform distribution of sampling points across the area. Areas of apparent contamination included discolored soil and surface water stained red from TNT residues. Other borings were advanced near a drum storage area used during the remediation of the area by the Huntsville group, a tanker containing decontamination water, and an apparent former decontamination area.

Six borings (B4-1 through B4-6) were advanced on the south side of Clover Place. This area includes a marshy woodland, and a parking lot adjacent to the woodland. Soil samples were analyzed for metals, explosives, and VOCs.

Soil sampling locations are shown on Figure 4-2. Boring logs are included in Volume II of this report, Appendix A.

5.4.4.1 Analytical Results

Metals

As shown in Table 4-1, metal concentrations which exceeded NJDEPE proposed cleanup standards were detected in two samples from the unfenced area and six samples from the fenced area.

Samples obtained from B4-2 and B4-3, from a depth interval of 0 to 1 foot, contained arsenic in concentrations of 2.77 and 8.24 ppm, respectively; the NJDEPE proposed standard is 2 ppm. The sample obtained from B4-3 also contained 169 ppm lead; the NJDEPE proposed standard is 100 ppm. Both of these borings were advanced in the unfenced portion of Area 4, south of Clover Place.

Six of the samples obtained from borings advanced in the fenced portion of Area 4 contained elevated concentrations of lead and/or arsenic. A sample obtained from a depth of 4 to 5 feet in B4-14 contained lead at a concentration of 127 ppm. Five samples contained arsenic in concentrations ranging from 2.30 to 2.86 ppm.

Explosives

As shown in Table 4-2, explosives were detected in 14 soil samples, including one sample obtained from the unfenced area (B4-1 at 4.6 ppm of 2,4,6-TNT). All 14 samples contained 2,4,6-TNT at concentrations ranging from 1.68 to 1320 ppm. Low concentrations of other explosives also were found in soil samples from sampling locations B4-13 and B4-14.

The remediation of the fenced area used a vibrating screen with a 0.5-inch screen opening to remove the larger chunks of TNT; the detection of explosives in this area indicates the presence of smaller particles that were not removed by the screening process.

VOCs

As shown in Table 4-3, low concentrations of acetone and methylene chloride were reported in six samples. All concentrations were orders of magnitude lower than NJDEPE proposed standards. Further, both compounds are common laboratory contaminants; the results shown may not be representative of the concentrations in the field samples.

5.4.5 Monitoring Well Installation and Sampling

Dames & Moore installed one shallow monitoring well (MW-42A) to monitor ground water quality downgradient of Area 4. This well was screened from depths of 7 to 17 feet in brown to brownish gray fine sands that contained varying amounts of silts and medium to coarse sands.

Dames & Moore attempted to install a deep monitoring well (MW-42B) adjacent to MW-42A to monitor ground water quality at a lower depth in the same aquifer. This pair of wells was intended to assess the presence of both floaters (compounds less dense than water) and sinkers (compounds more dense than water) in the same aquifer. MW-42B was advanced to 17 feet, and an 8-inch casing was set and grouted in accordance with the procedures stated in Dames & Moore's Work Plan. After allowing the grout to cure, drilling was resumed. Light gray silty clay was encountered almost immediately below the bottom of MW-42A at a depth of 18 feet. The boring was advanced to a depth of 29 feet; clay was present to a depth of 28.5 feet, where black weathered shale was encountered. Because the remainder of the aquifer underlying MW-42A was of insufficient thickness to warrant installation of a monitoring well, the boring was grouted and abandoned.

The Work Plan also required the installation of a third monitoring well downgradient of Area 4. However, site conditions prevented the installation of the well in the location shown in the Work Plan. The location originally selected would have required installing the well through what appears to be a construction debris landfill containing large blocks of concrete, reinforcing rods, and other metal objects. Dames & Moore could not install the well in this area and be in conformance with the site health and safety plan; the metal present could not be distinguished from ordnance. Alternate locations which could have served the purpose of monitoring Area 4 were discussed with the USACE but were rejected because representatives of Federal Business Centers revealed the alternate locations were scheduled to be converted into

wetlands in 1 to 4 years. Because the original location was not appropriate to conduct long-term monitoring, the well location was moved approximately 1200 feet southwest, to the southern end of Campus Plaza, with the approval of the USACE. This new location is not suitable to monitor ground water conditions downgradient of Area 4; MW-43 was installed to monitor ground water conditions near Area 7, an area where significant contamination was detected by the soil gas survey.

Ground water samples were obtained from three wells previously installed by OBG (MW-17, MW-18, and MW-19) and from monitoring well MW-42A installed by Dames & Moore near Area 4. Samples were analyzed for VOCs, base/neutral and acid extractable compounds, explosives, pesticides, and metals; ground water samples obtained from MW-17 and MW-42A were analyzed for both total (unfiltered) and dissolved (filtered) metals because of the slow recharge rate of these wells.

Monitoring well boring logs, well installation details, and well development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.4.5.1 Analytical Results

<u>Metals</u>

As shown in Table 4-4, ground water samples from MW-42A contained concentrations of total metals that exceeded NJDEPE criteria and/or PQLs. Total cadmium was detected at a concentration of 5 ppb; the NJDEPE criteria is 4 ppb. Total lead was detected at a concentration of 11.1 ppb; the NJDEPE criteria is 5 ppb with a PQL of 10 ppb. Arsenic was detected at a concentration of 5.4 ppb; the NJDEPE criteria is 0.02 ppb with a PQL of 8 ppb. Because this well was slow to recharge, a filtered sample was obtained to assess dissolved metals. No dissolved cadmium or lead was detected in this sample; however, arsenic was detected at a concentration above the NJDEPE criteria of 0.02 ppb, but below the PQL of 8 ppb.

Concentrations of all other metals detected in the ground water samples were below NJDEPE criteria.

Explosives

As shown in Table 4-5, explosive compounds were detected in ground water samples from MW-17 and MW-18. The NJDEPE has not proposed a criteria for 1,3-dinitrobenzene, detected in MW-18 at a concentration of 0.735 ppb. The concentration of 2,4-dinitrotoluene detected in MW-17 (4.77 ppb) was higher than the NJDEPE criteria of 0.05 ppb, but lower than the PQL of 10 ppb.

Degradation Products of Mustard Agent

The analytical laboratory mistakenly analyzed the water sample from MW-19 for thiodiglycol, a degradation product of mustard agent; a concentration of 22.3 ppb was detected. A second sampling and analysis of a water sample from this well resulted in the detection of a thiodiglycol concentration of 6.17 ppb.

The NJDEPE has not proposed a criteria for thiodiglycol.

Others

No VOCs were detected in ground water samples from this area.

As shown in Table 4-5, bis(2-ethylhexyl) phthalate was detected in four monitoring wells. The concentrations detected in three of the wells exceeded the NJDEPE criteria of 3 ppb, but were below the PQL of 30 ppb. The concentration in the fourth well was below both the NJDEPE criteria and the PQL.

5.4.6 Surface Water and Sediment Sampling

Surface water and sediment samples were collected from two areas of standing water. One set of samples (SW-2 and SS-2) was collected from a marshy area approximately 25 feet west of the fenced portion of Area 4; a slight sheen was noted on the water surface at the point where the sample was collected. The second set of samples (SW-3 and SS-3) was collected from a small stream downgradient of the wooded portion of Area 4; the water and sediment were inspected for surface sheens or other discoloration, but nothing unusual was noted. Samples were analyzed for VOCs, base/neutral and acid extractable organic compounds, metals,

explosives, and pesticides. Sampling locations are shown on Figure 4-4. Summaries of the analytical results for these samples are presented in Tables 4-6 and 4-7.

5.4.6.1 Analytical Results

Metals

As shown in Table 4-6, both sediment samples contained lead in concentrations that exceeded the NOAA ER-L concentration of 35 ppm; SS-2 contained 115 ppm and SS-3 contained 154 ppm. SS-3 also contained 0.277 ppm of mercury which exceeded the NOAA ER-L concentration of 0.15 ppm.

Surface water sample SW-3 contained two metals in concentrations that exceeded the New Jersey Surface Water Quality Standards. Lead was detected at a concentration of 434 ppb (the standard is 50 ppb). Arsenic was detected at a concentration of 55 ppb (the standard is 50 ppb). However, significant quantities of suspended material were noted in the sample; this material may be the source of the high concentrations of metals reported.

Base/Neutrals and Acid Extractables

As shown in Table 4-6, sediment sample SS-2 had concentrations of benzo(a)anthracene, benzo(b)pyrene, chrysene, fluoranthene, phenanthrene, and pyrene which exceeded the NOAA ER-L concentrations. Analysis of sediment sample SS-3 did not detect any semivolatile organic compounds which exceeded the NOAA ER-L concentrations.

Others

No explosives or pesticides were detected in the surface water or sediment samples from this area.

5.4.7 Soil Geology, Area 4

The unconsolidated sediments in the unfenced portion of Area 4 consist of silty sands, sands, clay, and local deposits of peat. Shallow soils consisted of 1 to 4 feet of brown to black silty fine to medium sands with some organic matter. Underlying this soil layer in the small

wooded marshland south of the fenced area was a peat layer approximately 1 foot thick. This layer may create a local perched water table; ground water typically was found when the peat layer was encountered. Peat also was encountered in one of two borings drilled approximately 300 feet south of the Area 4 marshland. However, the peat is not laterally continuous throughout Area 4; one boring drilled by Dames & moore to a depth of 17 feet, and four borings drilled to a depth of 15 feet by OBG, did not encounter peat. Underlying the peat is approximately 13 feet of brown to brownish gray sand and silty sand. This sand unit is underlain by the Raritan Fireclay, which extends from depths of 18 feet to 28 feet in the southern portion of the area and directly overlies black shale bedrock.

5.4.8 Ground Water Level Measurements

Three rounds of ground water level measurements were taken at Dames & Moore monitoring wells MW-42A and MW-43, and OBG monitoring wells MW-17, MW-18, and MW-19. Ground water elevations in these wells are stated below in feet above mean sea level:

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-17	4.12	1350	4.12	1104	4.21	1207
MW-18	14.55	1355	14.52	1110	14.72	1211
MW-19	2.09	1440	2.09	0854	2.34	0919
MW-42A	7.65	1343	7.63	1100	7.70	1205
MW-43	6.01	1325	5.92	1053	6.72	1156

A review of this data indicates that ground water generally flows toward the south-southeast, as expected.

TABLES FOR AREA 4

TABLE 4-1

AREA 4
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B4-2, 0-1', #229	2.77	--	--	--	--	--	--	--
B4-3, 0-1', #232	8.24	--	--	--	169	--	--	--
B4-14, 4-5', #267	--	--	--	--	127	--	--	--
B4-7, #244, 0-1'	2.47	--	--	--	--	--	--	--
B4-10, #253, 0-1'	2.38	--	--	--	--	--	--	--
B4-16, #271, 0-1'	2.86	--	--	--	--	--	--	--
B4-16, #273, 4-5'	2.30	--	--	--	--	--	--	--
B4-17 #274, 0-1'	2.61	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 4-2

AREA 4
DETECTABLE CONCENTRATIONS OF EXPLOSIVES
SOIL SAMPLES

SAMPLE DESCRIPTION	PARAMETER			
	2,4,6-TNT	1,3-DINOTROBENZENE	2,4-DNT	1,3,5-TNB
B4-1, 2-3', #227	4.60	--	--	--
B4-7, 0-1', #244	1.68	--	--	--
B4-7, 2-3', #245	6.26	--	--	--
B4-8, 0-1', #247	4.45	--	--	--
B4-8, 2-3', #248	3.49	--	--	--
B4-10, 0-1', #253	4.16	--	--	--
B4-12, 0-1', #259	110	--	--	--
B4-12, 2-3', #260	3.45	--	--	--
B4-13, 0-1', #262	1320	0.535	4.62	1.08
B4-13, 2-3', #263	62.4	--	--	--
B4-14, 0-1', #265	25.3	--	--	--
B4-14, 2-3', #266	390	--	1.47	--
B4-15, 0-1', #268	37.6	--	--	--
B4-15, 2-3', #269	61.5	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
No cleanup standards have been proposed for these compounds.

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TABLE 4-3

AREA 4
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA	#225, 3-4', B4-10	#258, 4-5', B4-11	#261, 4-5', B4-12	#264, 4-5', B4-13	#267, 4-5' B4-14	#270, 3-3.5', B4-15
Acetone	1,000,000	50,000	13	16	13	14	27	--
Methylene Chloride	49,000	10,000	6.3	7.8	7.8	8.4	8.1	6.9

Notes: Concentrations expressed in $\mu g/kg$
-- = Not detected.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 4-4

AREA 4
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-17	MW-18	MW-19	MW-42A	MW-42A*	MW-17*
ARSENIC	0.02	8	6.5	--	--	5.4	5.1	3.9
BARIUM	2000	200	32	37	38.7	48	21	23
CADMIUM	4	2	--	--	--	5	--	--
CHROMIUM	100	10	23	--	--	49	--	--
LEAD	5	10	3.5	3	--	11.1	--	--
MERCURY	2	0.5	--	--	--	--	--	--
SELENIUM	50	10	--	--	--	--	--	--
SILVER	20	2	--	--	--	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
*Dissolved metal concentration.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

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TABLE 4-5

AREA 4
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-17	MW-18	MW-19	MW-42A
Explosives						
1,3-Dinitrobenzene	NS	NS	--	0.735	--	--
2,4-Dinitrotoluene	0.05	10	4.77	--	--	--
Thiodiglycol	NS	NS	--	--	22.3	--
Base/Neutral and Acid Extractable Compounds						
Bis(2-ethylhexyl)phthalate	3*	30	6.0	4.0	--	4.5

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
* Federal MCL = 6 μg/L.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

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TABLE 4-6

AREA 4
CONCENTRATIONS OF ANALYTES
EXCEEDING NOAA ER-L CONCENTRATIONS
SEDIMENT SAMPLES

PARAMETER	NOAA ER-L	NOAA ER-M	SS-2	SS-3
Metals (mg/kg)				
Lead	35	110	115	154
Mercury	0.15	1.3	--	0.277
Base/Neutrals and Extractable Acids (μg/kg)				
Benzo (a) anthracene	230	1,600	550	--
Benzo (a) pyrene	400	2,500	580	--
Chrysene	400	2,800	1,100	--
Fluoranthene	600	3,600	1,600	--
Phenanthrene	225	1,380	600	--
Pyrene	350	2,200	1,800	--

Notes: -- Indicates concentration is below NOAA ER-L.
National Oceanic Service, National Oceanic and Atmospheric Administration (NOAA), "Potential for Biological Effects of Sediment-Sorbed Contaminants tested in the National Status and Trends Program", March 1990, NOAA/TM/NOS/OMA-52, Table 54A.

Metals concentrations are given in mg/kg (parts per million).
Organic concentrations are given in μg/kg (parts per billion).

[d:\...\job\19577014\march93\tbl0323.46]

TABLE 4-7

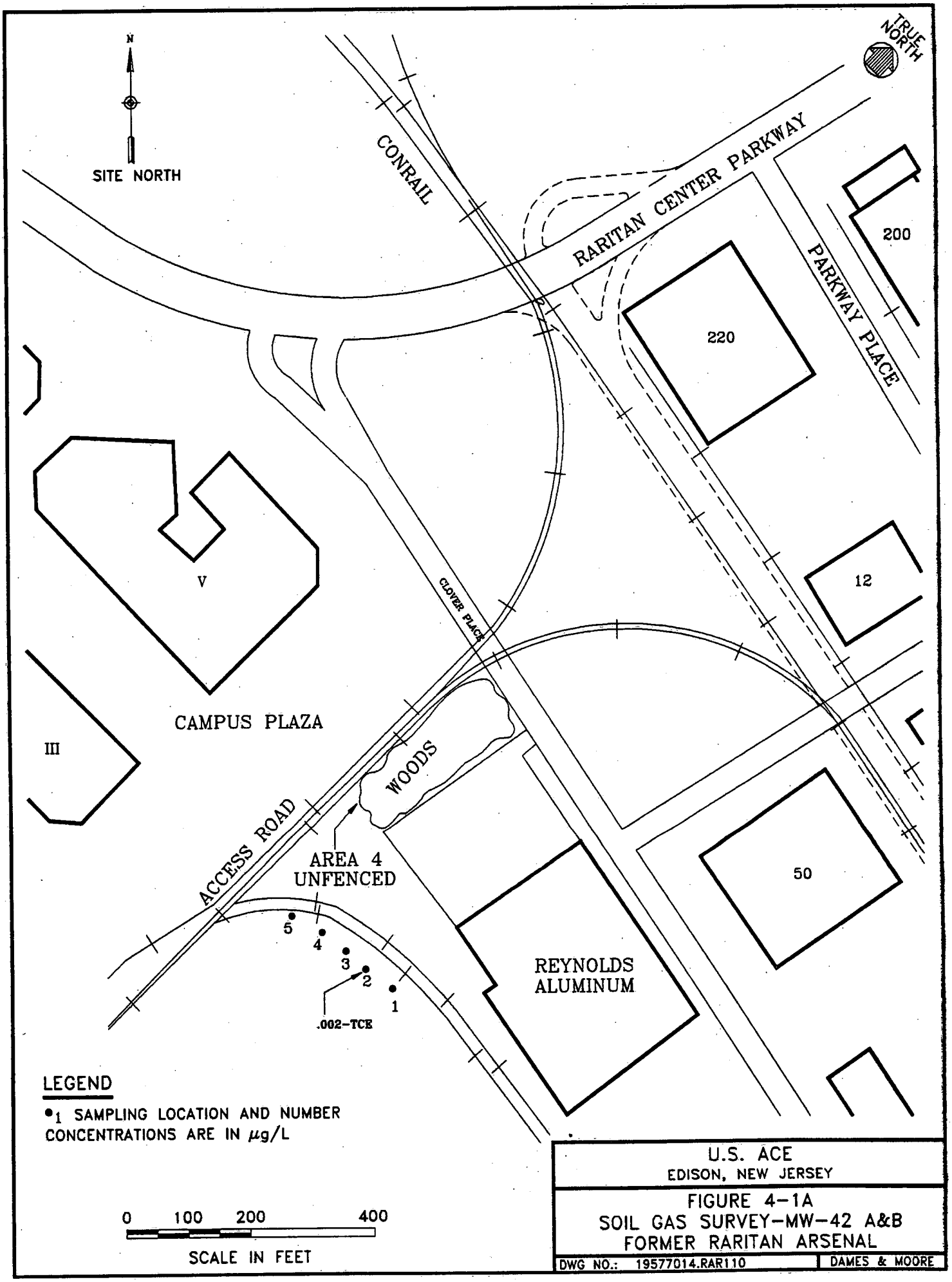
AREA 4
DETECTABLE CONCENTRATIONS OF ANALYTES
SURFACE WATER SAMPLES

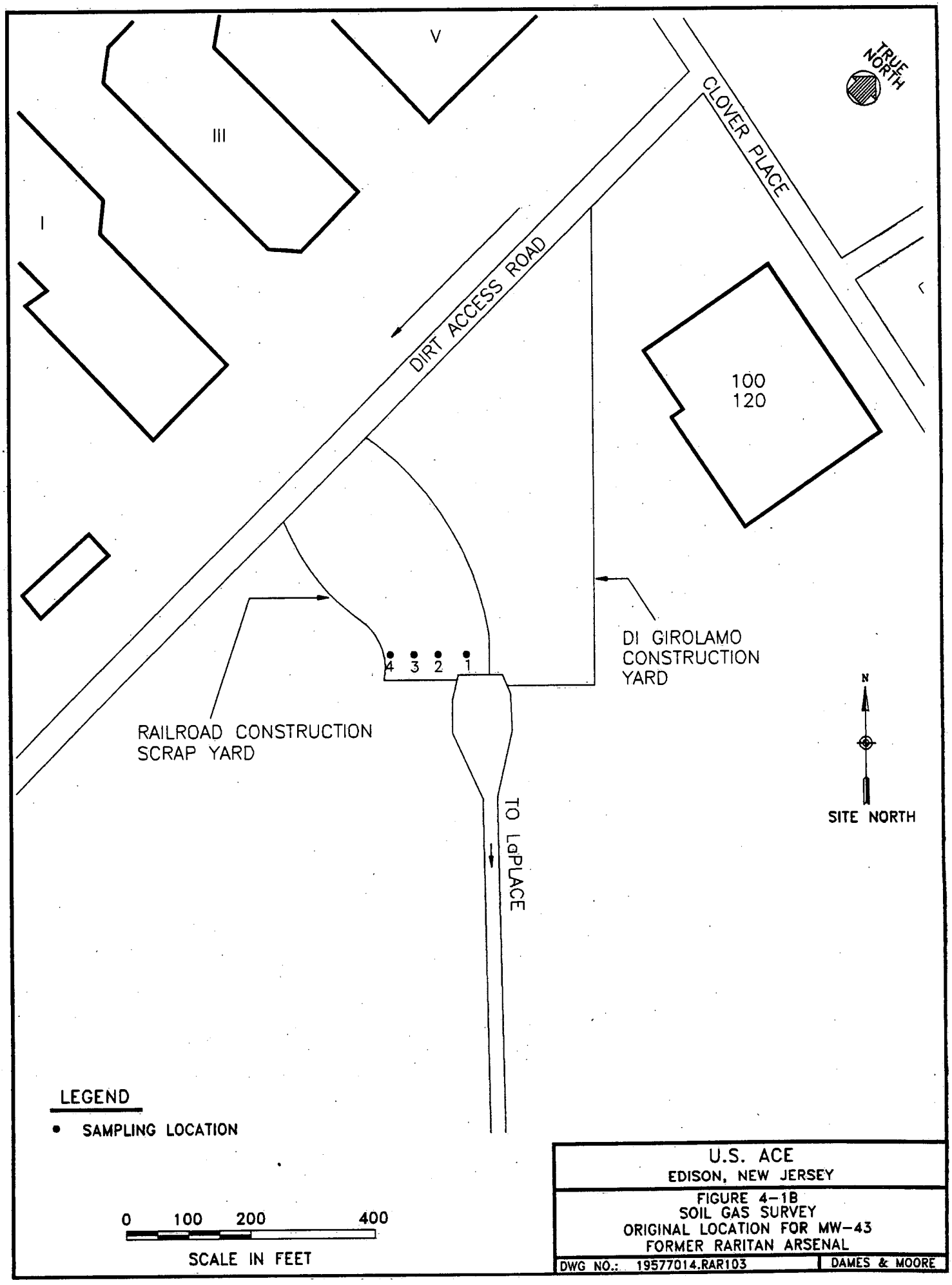
PARAMETER	NJDEPE SURFACE WATER STANDARDS	SW-2	SW-3
Metals (Total)			
Arsenic	50	--	55.0
Barium	1,000	45.9	141
Chromium	50	--	39.8
Lead	50	8.8	434
Mercury	2	--	0.58
Selenium	10	--	3.2
Explosives			
2, 4-Dinitrotoluene	NS	--	0.503
2, 6-Dinitrotoluene	NS	--	0.678
VOCS			
Toluene	NS	2.1	--
Semivolatile Organic Compounds			
Benzoic Acid	NS	10.3	--
4-Methyl Phenol	NS	5.14	--

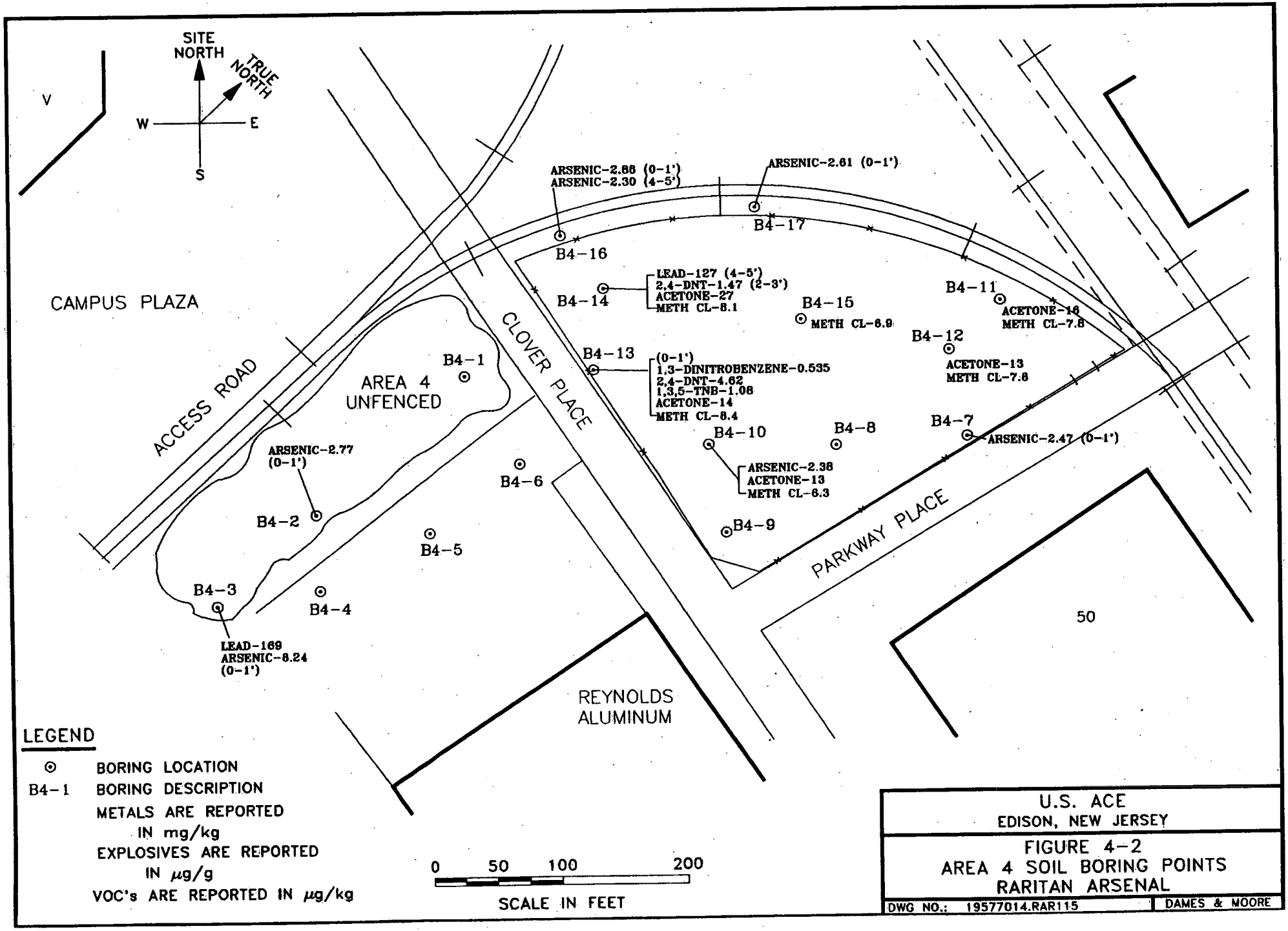
Notes: NS = No Standard Proposed
-- = Compound not detected
Concentrations are given in μg/L (parts per billion).
New Jersey Surface Water Quality Standards (N.J.A.C.7: 9-4.1 e. seq.)

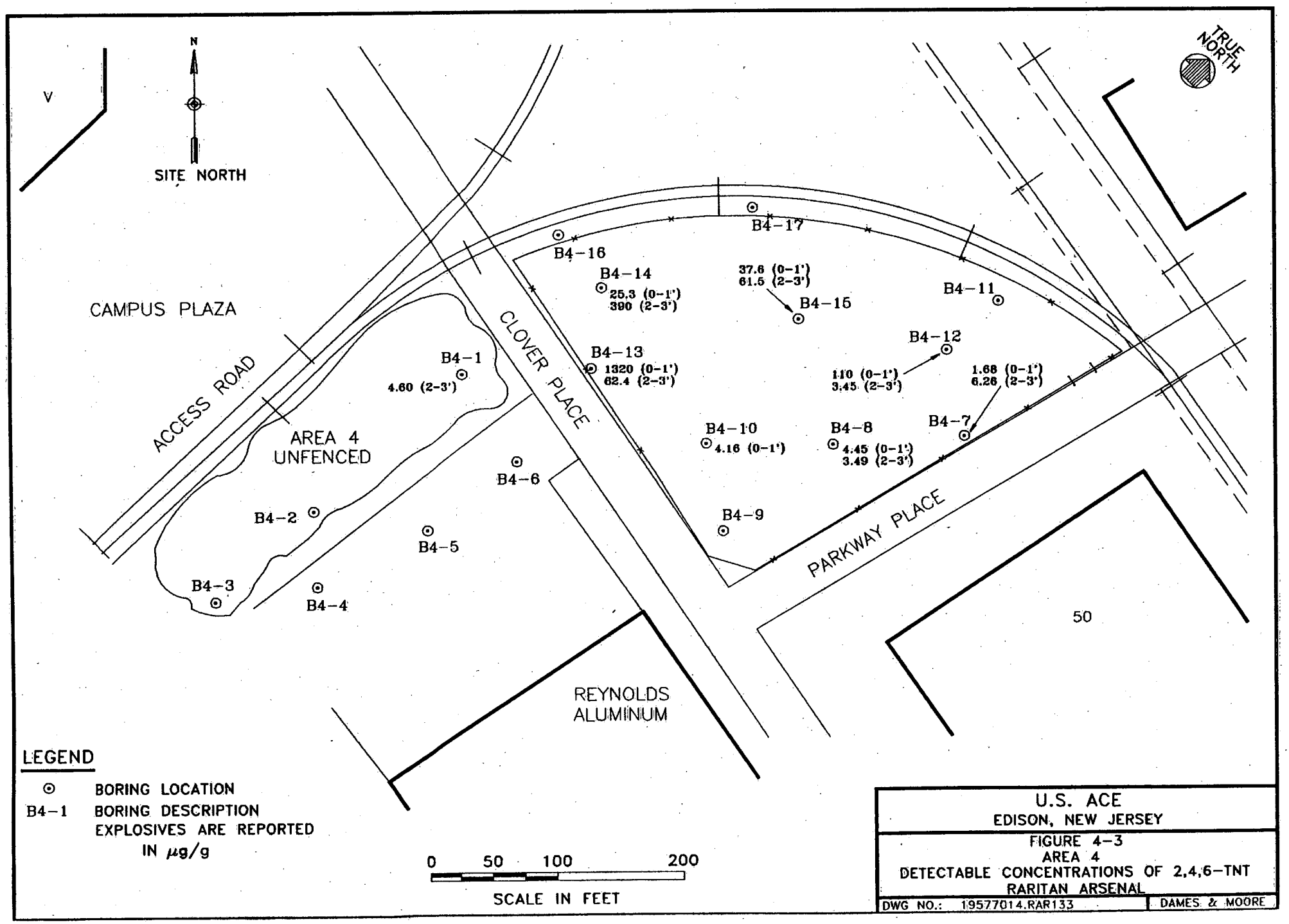
[d:\...\job\19577014\march93\surf0326.47]

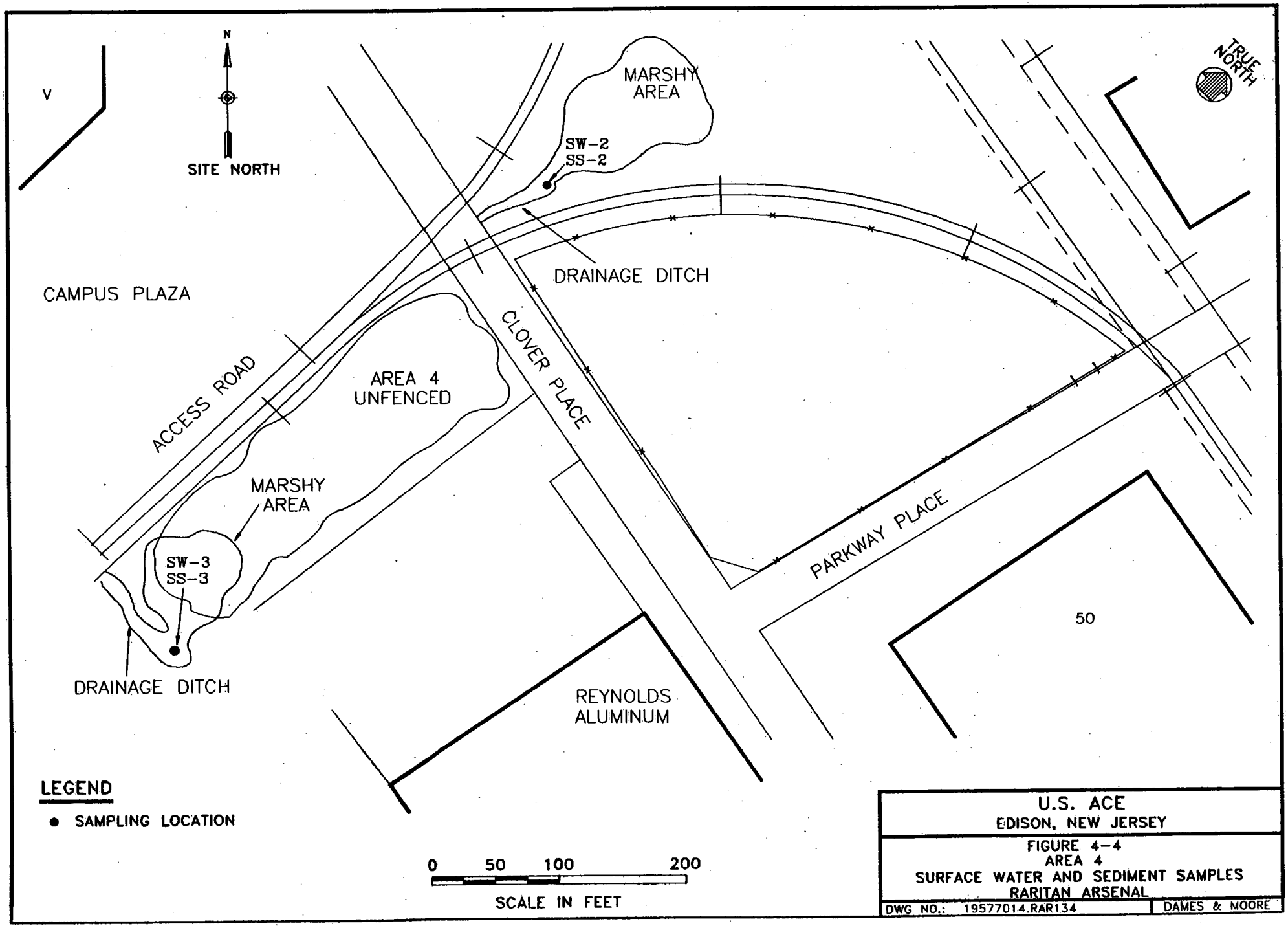
FIGURES FOR AREA 4


N
SITE NORTH
TRUE NORTH
CONRAIL
RARITAN CENTER PARKWAY
PARKWAY PLACE
200
220
12
50
V
III
CAMPUS PLAZA
CLOVER PLACE
WOODS
ACCESS ROAD
AREA 4
UNFENCED
5
4
3
2
1
.002-TCE
REYNOLDS
ALUMINUM
LEGEND
•1 SAMPLING LOCATION AND NUMBER
CONCENTRATIONS ARE IN μg/L
0 100 200 400
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 4-1A
SOIL GAS SURVEY-MW-42 A&B
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR110
DAMES & MOORE


V
III
I
TRUE NORTH
CLOVER PLACE
DIRT ACCESS ROAD
100
120
DI GIROLAMO
CONSTRUCTION
YARD
4 3 2 1
RAILROAD CONSTRUCTION
SCRAP YARD
TO LaPLACE
N
SITE NORTH
LEGEND
• SAMPLING LOCATION
0 100 200 400
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 4-1B
SOIL GAS SURVEY
ORIGINAL LOCATION FOR MW-43
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR103
DAMES & MOORE


SITE NORTH
TRUE NORTH
W
E
S
V
CAMPUS PLAZA
ACCESS ROAD
AREA 4
UNFENCED
CLOVER PLACE
PARKWAY PLACE
REYNOLDS ALUMINUM
50
ARSENIC-2.86 (0-1')
ARSENIC-2.30 (4-5')
ARSENIC-2.61 (0-1')
B4-17
B4-16
LEAD-127 (4-5')
2,4-DNT-1.47 (2-3')
ACETONE-27
METH CL-8.1
B4-14
B4-15
METH CL-6.9
B4-11
ACETONE-16
METH CL-7.8
B4-12
ACETONE-13
METH CL-7.8
B4-13
(0-1')
1,3-DINITROBENZENE-0.535
2,4-DNT-4.62
1,3,5-TNB-1.08
ACETONE-14
METH CL-8.4
B4-1
B4-10
B4-8
B4-7
ARSENIC-2.47 (0-1')
ARSENIC-2.38
ACETONE-13
METH CL-6.3
ARSENIC-2.77
(0-1')
B4-6
B4-2
B4-9
B4-5
B4-3
B4-4
LEAD-169
ARSENIC-6.24
(0-1')
LEGEND
BORING LOCATION
B4-1 BORING DESCRIPTION
METALS ARE REPORTED IN mg/kg
EXPLOSIVES ARE REPORTED IN µg/g
VOC's ARE REPORTED IN µg/kg
0 50 100 200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 4-2
AREA 4 SOIL BORING POINTS
RARITAN ARSENAL
DWG NO.: 19577014.RAR115
DAMES & MOORE


N
SITE NORTH
TRUE NORTH
CAMPUS PLAZA
ACCESS ROAD
CLOVER PLACE
PARKWAY PLACE
AREA 4
UNFENCED
REYNOLDS
ALUMINUM
50
B4-1
4.60 (2-3')
B4-2
B4-3
B4-4
B4-5
B4-6
B4-7
1.68 (0-1')
6.26 (2-3')
B4-8
4.45 (0-1')
3.49 (2-3')
B4-9
B4-10
4.16 (0-1')
B4-11
B4-12
110 (0-1')
3.45 (2-3')
B4-13
1320 (0-1')
62.4 (2-3')
B4-14
25.3 (0-1')
390 (2-3')
B4-15
37.6 (0-1')
61.5 (2-3')
B4-16
B4-17
LEGEND
BORING LOCATION
B4-1 BORING DESCRIPTION
EXPLOSIVES ARE REPORTED IN μg/g
0 50 100 200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 4-3
AREA 4
DETECTABLE CONCENTRATIONS OF 2,4,6-TNT
RARITAN ARSENAL
DWG NO.: 19577014.RAR133
DAMES & MOORE


N
SITE NORTH
TRUE NORTH
MARSHY AREA
SW-2
SS-2
DRAINAGE DITCH
CAMPUS PLAZA
CLOVER PLACE
ACCESS ROAD
AREA 4
UNFENCED
MARSHY AREA
SW-3
SS-3
DRAINAGE DITCH
PARKWAY PLACE
50
REYNOLDS ALUMINUM
LEGEND
● SAMPLING LOCATION
0 50 100 200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 4-4
AREA 4
SURFACE WATER AND SEDIMENT SAMPLES
RARITAN ARSENAL
DWG NO.: 19577014.RAR134
DAMES & MOORE

5.5 AREA 5

Area 5 reportedly was used by the U.S. Army Chemical Corps for burial of mustard agent, potassium cyanide, fuming red nitric acid, and possibly other chemicals from after WWI until the 1960s; however, other reports indicate the area was not used prior to WWII. The chemicals reportedly were buried in trenches to a depth of 5 feet. Soil samples collected to depths of 4.5 feet in 1961 and tested with an M-18 chemical agent detector kit yielded positive results for mustard agent. Samples collected to a depth of 3 feet in 1971 by representatives of Edgewood Arsenal and tested with the M-18 detector kit produced inconclusive results. In 1963, LEAD erected a fence around the area and recommended the site for "Non-use"; no decontamination efforts were made.

OBG conducted a contamination evaluation of Area 5 in 1987-88. This evaluation included UXO and geophysical surveys, installation of three shallow monitoring wells, and collection and field screening of soil samples for cyanide and mustard agent. This investigation uncovered evidence of subsurface anomalies, including large metal objects. The field screening indicated the possible presence of cyanide. Metals were detected in ground water samples in concentrations below MCLs.

5.5.1 Dames & Moore Activities

Dames & Moore collected surface water and sediment samples from a marsh adjacent to Area 5, and sampled the three wells installed by OBG.

5.5.2 Ground Water Sampling

Ground water samples were obtained from three monitoring wells installed by OBG (MW-20, MW-21, and MW-22), and were analyzed for VOCs, base/neutral and acid extractable compounds, metals, cyanide, diathiane, oxathiane, thiodiglycol, explosives and pesticides. The ground water sample obtained from MW-20 was analyzed for both total and dissolved metals because of the slow recharge rate of this well.

5.5.2.1 Analytical Results

Metals

As shown in Table 5-1, all metals detected in the ground water samples were below NJDEPE criteria and/or PQLs.

Explosives

As shown in Table 5-2, three explosives were detected in the water sample from MW-21; the NJDEPE has not proposed criteria for HMX (detected at a concentration of 12.8 ppb), RDX (detected at a concentration of 1.64 ppb), or 1,3,5-trinitrobenzene (detected at a concentration of 0.551 ppb).

Others

No VOCs, base/neutral and acid extractable compounds, pesticides, cyanide, diathiane, oxathiane, or thiodiglycol were detected in the water samples from this area.

Monitoring well stabilization data are included in Volume III of this report, Appendix E.

5.5.3 Surface Water and Sediment Sampling

One surface water and one sediment sample were obtained from the marshy area between MW-20 and MW-21, and were analyzed for VOCs, base/neutral and acid extractable organic metals, explosives, pesticides, cyanide, diathiane, oxathiane, and thiodiglycol. The marsh was inspected for sheens or other evidence of apparent contamination; nothing unusual was noted. Samples were packaged and shipped according to the procedures specified in Dames & Moore's Work Plan for samples collected from Area 5.

The sampling location is shown on Figure 5-1. Summaries of the analytical results are presented in Tables 5-3 and 5-4.

5.5.3.1 Analytical Results

VOCs

Toluene was reported in surface water sample SW-6 at a concentration of 8.5 ppb; no other VOCs were detected in the sample. Toluene is a common laboratory contaminant; the concentration reported may not be representative of the concentration in the water sample. The concentration reported does not exceed the New Jersey Surface Water Quality Standards.

Base/Neutral and Acid Extractable Compounds

Bis(2-ethylhexyl)phthalate was detected in surface water sample SW-6 at a concentration of 3.5 ppb; no other semivolatile compounds were detected in the sample. It should be noted that bis(2-ethylhexyl)phthalate is a common laboratory contaminant, and the concentration detected does not exceed the New Jersey Surface Water Quality Standards.

Metals

Sediment sample SS-6 contained four metals in concentrations that exceeded the NOAA ER-L concentrations for sediments, as shown in Table 5-3. Arsenic was detected at a concentration of 65 ppm (NOAA ER-L concentration is 33 ppm). Lead was detected at a concentration of 193 ppm (NOAA ER-L concentration is 35 ppm). Mercury was detected at a concentration of 1.2 ppm (NOAA ER-L concentration is 0.15 ppm). Silver was detected at a concentration of 2.57 ppm (NOAA ER-L concentration is 1 ppm).

Surface water sample SW-6 contained three metals in concentrations that exceeded New Jersey Surface Water Quality Standards, as shown in Table 5-6. Lead was detected at a concentration of 606 ppb (the standard is 50 ppb). Arsenic was detected at a concentration of 85.8 ppb (the standard is 50 ppb). Chromium was detected at a concentration of 117 ppb (the standard is 50 ppb). It should be noted, however, that significant quantities of suspended material were present in the water sample; this material may account for the relatively high concentrations of metals reported.

Explosives

Surface water sample SW-6 contained 0.352 ppb of 1,3,5-trinitrobenzene. The State of New Jersey has not proposed a standard for this compound.

Pesticides

Surface water sample SW-6 contained DDD at a concentration of 0.132 ppb. The State of New Jersey has proposed a standard for this compound.

Others

Concentrations of all other contaminants in both the surface water sample and the sediment sample were below detection limits or were present in concentrations below the referenced standards.

5.5.4 Soil Geology Area 5

Dames & Moore did not perform any subsurface investigation within the boundaries of Area 5; therefore, knowledge of subsurface soil geology in this area is limited to a review of the information obtained as a result of the OBG investigation.

OBG advanced three borings near the periphery of Area 5 for the installation of monitoring wells MW-20, MW-21, and MW-22. Reddish, orange, and brown silty fine-to-coarse sands with varying amounts of intermixed clays and gravels were encountered from the ground surface to depths of 25 to 35 feet. A gray-white silty clay, probably the Raritan Fireclay, was encountered immediately beneath the sands. The thickness of the clay and the depth to bedrock are unknown; however, OBG has postulated that bedrock is present at depths of 35 to 40 feet in this area.

A peat layer was encountered in one of the three borings, at depths of 2 to 4 feet, in the boring advanced for the installation of MW-21. Because the peat was not encountered in the boring advanced for the installation of MW-20, it is probable this layer is a local condition and is not continuous with the peat and peaty clay encountered in Area 6 and other portions of the site.

5.5.5 Ground Water Level Measurements

Three rounds of ground water level measurements were taken at the shallow monitoring wells installed by OBG in Area 5. The ground water elevations in these wells are stated below in feet above mean sea level:

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-20	2.06	1011	1.89	1543	2.31	0935
MW-21	1.56	1015	1.39	1540	1.82	0936
MW-22	2.64	1443	2.61	0900	3.03	0920

A review of this data indicates a general ground water gradient toward the south; a ground water gradient toward the southeast had been anticipated. The ground water flow in this and other marsh areas may be influenced by the Raritan River, Black Ditch, and other bodies of surface water in the marshlands.

TABLES FOR AREA 5

TABLE 5-1

AREA 5
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-20	MW-21	MW-22	MW-20*
Arsenic	0.02	8	2.9	--	--	--
Barium	2000	200	52.5	19.5	71.3	30.9
Cadmium	4	2	--	--	--	--
Chromium	100	10	23.5	--	--	--
Lead	5	10	6.4	--	2.1	--
Mercury	2	0.5	--	--	--	--
Selenium	50	10	--	--	--	--
Silver	20	2	--	--	--	--

Notes: Metal concentrations are given in $\mu g/L$ (parts per billion).
-- = Not detected.
*Dissolved metal concentration.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

[d:\...\job\19577014\March93\tbl0914.51]

TABLE 5-2

AREA 5
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATIVE LEVEL (PQL)	MW-20	MW-21	MW-22
Explosives					
HMX	NS	NS	--	12.8	--
RDX	NS	NS	--	1.64	--
1,3,5-trinitrobenzene	NS	NS	--	0.551	--

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

[d:\...\job\19577014\march93\tbl0914.52]

TABLE 5-3

AREA 5
ANALYTES ABOVE NOAA ER-L CONCENTRATIONS
SEDIMENT SAMPLE NUMBER SF-6

PARAMETER	NOAA ER-L	NOAA ER-M	CONCENTRATION
Metals (mg/kg)			
Arsenic	33	85	65.0
Lead	35	110	193
Mercury	0.15	1.3	1.20
Silver	1.0	2.2	2.57
Pesticides (μg/kg)			
Dieldrin	0.02	8	5.41
Endrin	0.02	45	7.55
Base/Neutrals and Acid Extractable Compounds (μg/kg)			
Pyrene	350	2,200	370

Notes: National Oceanic Service, National Oceanic and Atmospheric Administration (NOAA), "Potential for Biological Effects of Sediment-Sorbed Contaminants tested in the National Status and Trends Program", March 1990, NOAA/TM/NOS/OMA-52, Table 54A.

Metals concentrations are given in mg/kg (parts per million).
Organic concentrations are given in μg/kg (parts per billion).

[d:\...\job\19577014\march93\tbl0323.53]

TABLE 5-4

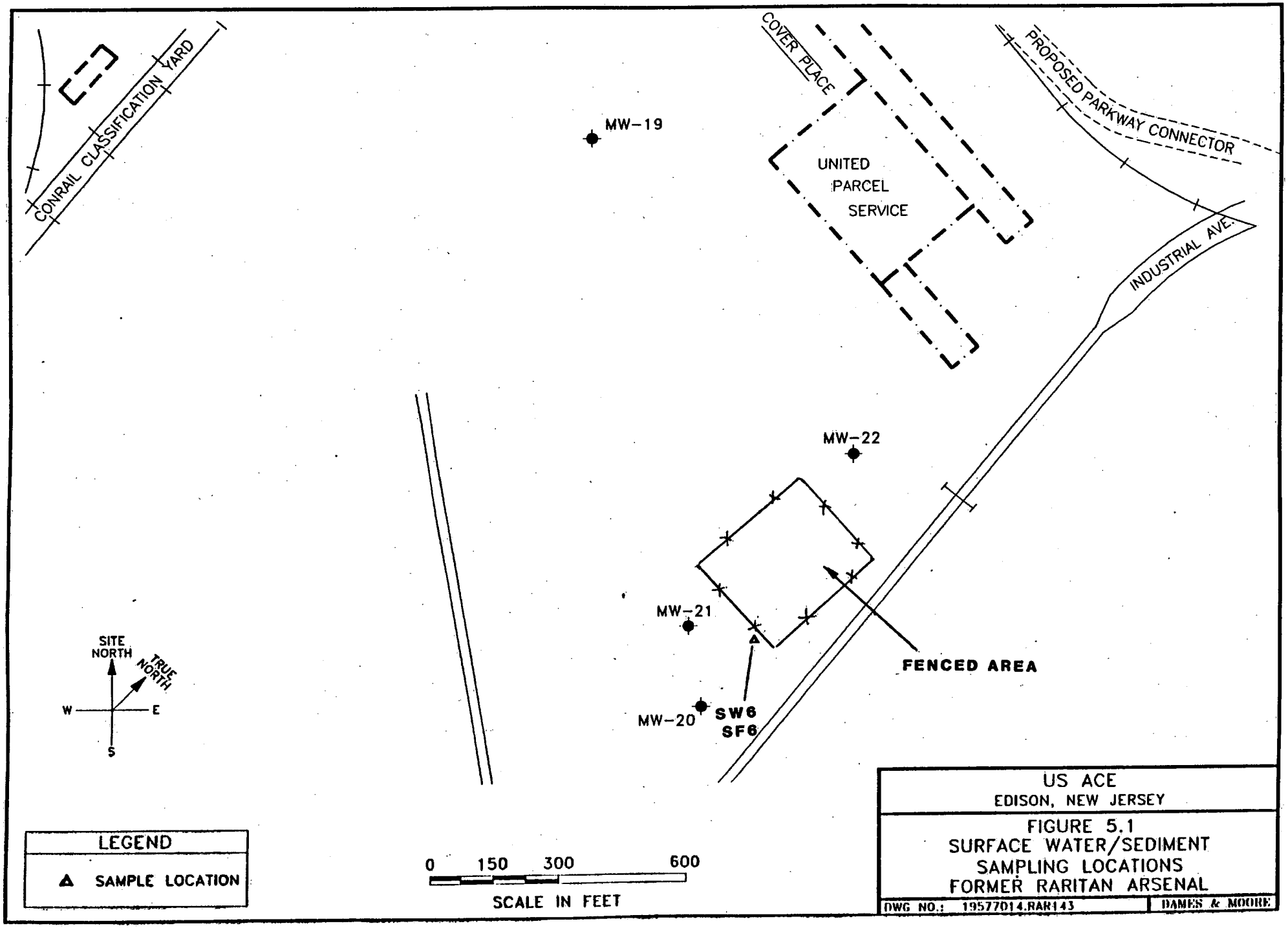
AREA 5
DETECTABLE CONCENTRATIONS OF ANALYTES
SURFACE WATER SAMPLE SW-6

PARAMETER	NJDEPE SURFACE WATER STANDARD	SW-6 CONCENTRATION
Metals (Total)		
Arsenic	50	85.8
Barium	1,000	394
Cadmium	10	7.0
Chromium	50	117
Lead	50	606
Mercury	2	0.80
Silver	50	8.0
Explosives		
1, 3, 5-trinitrobenzene	NS	0.352
Pesticides		
DDD, pp[1]	0.0010	0.132
DDE, pp[1]	0.0010	0.020
VOCS		
Toluene	NS	8.5
Semivolatile Organic Compounds		
Bis (2 ethyl hexyl) phthalate	NS	3.5

Notes: NS = No Standard Proposed
Concentrations are given in μg/L (parts per billion).
New Jersey Surface Water Quality Standards (N.J.A.C.7: 9-4.1 e. seq.)

[d:\...\job\19577014\march93\surf0326.54]

FIGURE FOR AREA 5


CONRAIL CLASSIFICATION YARD
COVER PLACE
PROPOSED PARKWAY CONNECTOR
MW-19
UNITED
PARCEL
SERVICE
INDUSTRIAL AVE.
MW-22
MW-21
FENCED AREA
MW-20
SW6
SF6
SITE NORTH
TRUE NORTH
W
E
S
LEGEND
SAMPLE LOCATION
0 150 300 600
SCALE IN FEET
US ACE
EDISON, NEW JERSEY
FIGURE 5.1
SURFACE WATER/SEDIMENT
SAMPLING LOCATIONS
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR143
DAMES & MOORE

5.6 AREA 6

Area 6 encompasses a total of 6 acres in two distinct sections, designated as 6A and 6B; these areas are separated by a waterway known as Black Ditch. Both sections reportedly were used until 1963 as burning grounds to destroy various ammunition components. In 1966, LaPlace, Inc. built a sulfuric acid production plant in Area 6A. Area 6B is characterized by several mounds of soil that contain pieces of asphaltic concrete; portions of the soil also were found to have an odor of burnt firecrackers and a peat-like consistency. Distribution of these mounds in Area 6B falls roughly into two clusters, referred to herein as 6B and 6B North. The remainder of Area 6 consists primarily of undeveloped marshland, with filled, built-up areas supporting roads, railroads, and levees.

Surface and near-surface soils in Area 6 have been cleaned several times. On three separate occasions, the soil was disked to a depth of 6 inches and surface-cleaned of ammunition and components. In 1963, LEAD surface-cleaned the soil and subsequently recommended the area for "Unrestricted Use".

Area 6 was included in the OBG 1987-88 contamination evaluation of the arsenal. OBG conducted a UXO search, collected surface soil samples and advanced soil borings, and installed three shallow and two deep monitoring wells. No significant metal contamination was detected in soil or ground water samples. No VOCs were detected in soil or ground water samples. Explosives were not detected in soils or ground water from shallow wells, but 1.54 ppb tetryl was discovered in a ground water sample collected from deep monitoring well MW-16, presumed to be downgradient of Area 6A.

5.6.1 Dames & Moore Field Investigation

Dames & Moore conducted a UXO search, a soil gas survey, collected soil samples from borings, and installed shallow and deep monitoring wells.

5.6.2 UXO Search

Personnel from UXB International scanned and cleared ordnance from soil gas sampling points, soil boring locations, monitoring well locations, and access routes. Some inert ordnance components, including three bomb vanes and several small pieces of frag, were recovered in

Area 6A; no other ordnance was detected. The approximate locations where the inert ordnance items were recovered are shown on Figure 6A-4.

5.6.3 Soil Gas Survey - Area 6A

Three soil gas samples were collected immediately downgradient of LaPlace, Inc. Samples were collected at depths of 2 to 3 feet because of the presence of a high ground water table. None of the samples contained detectable concentrations of the compounds of concern.

Soil gas sampling locations are shown on Figure 6-1.

5.6.4 Soil Gas Survey - Areas 6B and 6B North

Soil gas samples were collected in Areas 6B and 6B North to aid in the placement of a monitoring well, and to assess ground water quality downgradient of the mounds. Two of the locations assessed for the placement of MW-45 contained benzene and toluene in concentrations of 0.2 to 0.3 ppbv. The four soil gas samples collected in Area 6B contained TVHC in concentrations ranging from 0.5 to 1300 ppbv. One sample collected in 6B North contained 0.2 ppbv benzene and 0.3 ppbv toluene.

Soil gas sampling locations are shown on Figure 6-1.

5.6.5 Soil Sampling - Area 6A, Depths/Locations

Twenty soil borings were advanced in Area 6A. Borings were preferentially located in areas with visual evidence of potential contamination, in apparent landfill areas, areas of distressed or unusual vegetation, and in paths of surface drainage. Soil borings were advanced to depths of 1 to 5 feet, depending upon the depth to ground water. Because of the shallow ground water table in the area, 13 borings were terminated at depths of 1 to 2 feet.

Samples collected from the upper and lower sampling intervals were analyzed for metals. Samples from the upper and middle intervals were analyzed for explosives. Samples for VOC analysis were selected on the basis of headspace analyses performed on soil samples from each borehole location; in accordance with the Work Plan, a total of 16 samples were submitted for laboratory VOC analysis. Finally, six samples collected from areas with distressed vegetation,

stained soils, or in drainage pathways were analyzed for base/neutral and acid extractable organic compounds.

Soil boring locations are shown on Figure 6A-2. Boring logs are included in Volume II of this report, Appendix A.

5.6.5.1 Analytical Results

Metals

As shown in Table 6A-1, metal concentrations which exceeded NJDEPE proposed cleanup standards were detected in 23 samples.

Arsenic was found in 23 samples in concentrations ranging from 2.06 to 12.5 ppm; the NJDEPE proposed standard is 2 ppm.

Cadmium was found in seven samples at concentrations ranging from 1.8 to 16 ppm; the NJDEPE proposed standard is 1 ppm.

Lead was found in three samples at concentrations ranging from 159 to 984 ppm; the NJDEPE proposed standard is 100 ppm.

Elevated concentrations of chromium also were detected in three soil samples at sample locations B6A-1C (261 ppm), B6A-3C (152 ppm), and B6A-6 (294 ppm). According to Gwen Barunas, NJDEPE, the State has been using 500 ppm (total chromium) and 10 ppm (hexavalent chromium) as their standards; however, these figures have not been included in the proposed standards. Based on Ms. Barunas' comments, the chromium concentrations detected in the samples would be acceptable to the State.

VOCs

As shown in Table 6A-2, six soil samples had low but detectable concentrations of VOCs. All concentrations were orders of magnitude lower than NJDEPE proposed standards. As previously stated, acetone -- found in five of the samples -- is a common laboratory contaminant; the concentrations reported may not be representative of actual soil conditions.

Explosives

No explosives were detected in any of the samples.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 6A-3, two soil samples contained semivolatile compounds. Both compounds were detected in concentrations that were at least one order of magnitude below the NJDEPE proposed standards.

5.6.6 Soil Sampling - Areas 6B and 6B North, Depths/Locations

Soil borings advanced in Areas 6B and 6B North were located adjacent to and within the network of mounds that form the chief distinguishing features of these areas. Two borings (one in Area 6B and one in Area 6B North) were advanced in mounds covered with the peat-like material to assess the contamination potential of this substance.

Four soil borings were advanced in Area 6B. One boring (B6B-1) was advanced to a depth of 5 feet in a mound covered with a peat-like material; the soils from this mound were composited for metals and explosives analyses. The other three borings were terminated at depths of 2 to 3 feet due to high ground water levels; samples collected at depths of 0 to 1 foot and 2 to 3 feet were submitted for metals and explosives analysis.

Eight soil borings were advanced in Area 6B North. One boring (B6BN-8A) was advanced to a depth of 5 feet in one of the peat-covered mounded structures; the soils from this boring were composited for metals and explosives analysis. The remaining seven borings were advanced to depths of 1 to 5 feet, depending upon ground water depth. Samples generally were collected from depths of 0 to 1 foot, 2 to 3 feet, and 4 to 5 feet; sample intervals were modified according to the depth of ground water level, as stated in Section 4.0. Samples from the upper and lower sampling intervals were analyzed for metals and base/neutral and acid extractable compounds; samples from the upper and middle intervals were analyzed for explosives; and samples from the lower interval were analyzed for VOCs. However, in borings B6BN-3 and B6BN-4, no soil from the 2 to 3 foot interval was recovered from the sampler; therefore, samples were submitted from the 3 to 4 foot interval.

Sampling locations are shown on Figures 6B-1 and 6B-2. Boring logs are included in Volume II of this report, Appendix A.

5.6.6.1 Analytical Results

Metals

Six samples collected from Area 6B and 11 samples collected from Area 6B North contained concentrations of arsenic that exceeded the NJDEPE proposed cleanup standard of 2 ppm. In Area 6B, elevated concentrations of arsenic ranged from 2.36 to 16.0 ppm, and in Area 6B North, elevated concentrations ranged from 2.04 to 10.4 ppm.

Concentrations and sampling locations are shown in Table 6B-2.

Explosives

None of the soil samples collected from Area 6B or 6B North contained detectable concentrations of explosives.

VOCs

As shown in Table 6B-3, two soil samples obtained from Area 6B North contained low but detectable concentrations of VOCs. The concentration of acetone detected (110 ppb at both locations) is orders of magnitude lower than NJDEPE proposed standards. Methyl ethyl ketone was detected at concentrations of 13 and 14 ppb; the NJDEPE has not proposed a cleanup standard for this compound.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 6B-4, base/neutral and acid extractable organic compounds were detected in nine soil samples from Area 6B North. Although many of the compounds exceeded the NJDEPE proposed standards, they are found in only two samples, B6BN-2 and B6BN-5. The concentrations detected in the other samples were below NJDEPE proposed standards, or no standards have been proposed for the detected compounds.

5.6.7 Surface Water and Sediment Sampling

Three surface water and sediment sample sets were collected from marshy areas in Area 6A. These samples were collected from a marshy area at the end of a drainage ditch on the northern/northwestern side of the plant (SW-7/SS-7); at the end of a drainage path on the western side of the plant (SW-8/SS-8); and near a sulfur landfill area on the south/southwestern side of the plant (SW-9/SS-9). A sheen was noted on the water surface at the locations where SW-7 and SW-8 were collected, and the vegetation in the vicinity of the sulfur landfill area, where SW-9 and SS-9 were collected, was discolored.

All samples were analyzed for VOCs, base/neutral and acid extractable compounds, metals, explosives, and pesticides.

Summaries of the analytical results are presented in Tables 6A-4 and 6A-5. Sampling locations are shown on Figure 6A-3.

5.6.7.1 Analytical Results

Metals

Five metals were detected in the surface water samples in concentrations that exceeded New Jersey Surface Water Quality Standards. Three metals were detected in sediment samples which exceeded NOAA ER-L concentrations.

Arsenic was detected in SW-7 in a concentration (550 ppb) that exceeded the New Jersey Surface Water Quality Standard of 50 ppb. Dames & Moore requested that ESE review its arsenic analyses for SW-7. The laboratory complied with this request and confirmed the reported concentration of 550 μg/L.

Barium was detected in two surface water samples, SW-7 (5250 ppb) and SW-9 (2340 ppb), in concentrations that exceeded the New Jersey Surface Water Quality Standard of 1000 ppb.

Chromium was detected in three surface water samples, SW-7 (3880 ppb), SW-8 (667 ppb), and SW-9 (243 ppb), in concentrations that exceeded the New Jersey Surface Water

Quality Standard of 50 ppb. Chromium also was detected in one sediment sample, SS-7 (101 ppm) in a concentration that exceeded the NOAA ER-L concentration of 80 ppm.

Lead was detected in three surface water samples, SW-7 (1280 ppb), SW-8 (452 ppb), and SW-9 (277 ppb), in concentrations that exceeded the New Jersey Surface Water Quality Standard of 50 ppb. Lead also was detected in one sediment sample, SS-7 (40.7 ppm), at a concentration that exceeded the NOAA ER-l concentration of 35 ppm.

Mercury was detected in three surface water samples, SW-7 (6.8 ppb), SW-8 (44.7 ppb), and SW-9 (2.52 ppb), in concentrations that exceeded the New Jersey Surface Water Quality Standard of 2 ppb. Mercury also was detected in one sediment sample, SS-9 (0.204 ppm), at a concentration that exceeded the NOAA ER-L concentration of 0.15 ppm.

It should be noted that significant quantities of suspended solids were present in the surface water samples. These solids may account for the relatively high concentrations of metals reported.

Explosives

Nitroglycerin was detected at a concentration of 61.6 ppb and PETN was detected at a concentration of 30.8 ppb in surface water sample SW-9.

Pesticides

DDT was detected in one sediment sample, SS-7 (18.4 ppb), at a concentration that exceeded the NOAA ER-L concentration of 2 ppb.

DDE and dieldrin were detected in one sediment sample, SS-9, in concentrations of 9.56 ppb and 6.27 ppb respectively. These concentrations exceeded the NOAA ER-L concentrations of 2 ppb for DDE and 0.02 ppb for dieldrin.

Others

Concentrations of other contaminants were below detection limits, or were below New Jersey Surface Water Quality Standards or NOAA ER-L concentrations.

5.6.8 Monitoring Well Installation and Sampling

Dames & Moore installed two deep wells and one shallow well to monitor hydrologic conditions and ground water quality in Area 6.

Deep monitoring well MW-44 was installed in the northwestern portion of Area 6A, near OBG's shallow monitoring well MW-27, to aid in determining the origin of explosives detected in deep monitoring well MW-16. Based on hydrogeologic data obtained from the OBG investigation, ground water flow in the deep aquifer was inferred to be toward the south-southwest; the location of MW-44 was chosen with the intention of monitoring ground water conditions upgradient of MW-16. The boring was advanced to a depth of 52 feet and was terminated in a greenish gray silty clay layer. The well screen was set at depths from 25 to 50 feet in reddish brown to brown and gray sands that contained varying amounts of gravel and silts.

Dames & Moore installed deep monitoring well MW-62 near the intersection of Pershing Avenue and East Patrol Road, in the inferred crossgradient direction from Area 6. This location was added subsequent to acceptance of the Work Plan to provide additional information concerning the ground water quality in the deep aquifer, and as a replacement for one of the deep wells which could not be installed because of the absence of permeable soils between the shallow aquifer and bedrock (refer to Section 4.0). The boring was drilled 1 foot into an aquitard encountered at a depth of 10 feet, and an 8-inch outer casing was set and grouted. After allowing the grout to cure for more than 48 hours, drilling was resumed and the boring was advanced to a depth of 59 feet. Bedrock, a light gray weathered shale, was encountered at a depth of 58 feet. A 20-foot long PVC screen was installed from depths of 38 to 58 feet in reddish brown and brown sands and gravels.

A shallow monitoring well, MW-45, was installed southeast of Area 6B North and Area 5 to monitor ground water conditions downgradient of these two areas; ground water flow in this area was predicted to be toward the south or southeast. Ground water levels measured during the current investigation indicate this assumption may be incorrect; there is no apparent consistent direction of ground water flow in this area, as shown on Figure 18. The boring was advanced to a depth of 17 feet, and a screen was set from depths of 7 to 17 feet in fine to medium sands.

Ground water samples were obtained from the three wells installed by Dames & Moore (MW-44, MW-45, and MW-62) and from the five wells previously installed by OBG (MW-16, MW-25, MW-26, MW-27, and MW-34). These samples were analyzed for VOCs, base/neutral and acid extractable compounds, explosives, pesticides, metals, cyanide, diathiane, oxathiane, and thiodiglycol.

Monitoring well boring logs, well installation details, well development data, and well stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.6.8.1 Analytical Results

Metals

As shown in Table 6-1, arsenic was detected in three monitoring wells -- MW-25 (18.8 ppb), MW-27 (18 ppb), and MW-44 (9.3 ppb) -- in concentrations that exceeded the NJDEPE criteria of 0.02 ppb and the PQL of 8 ppb.

Lead was detected in two monitoring wells -- MW-45 (11.9 ppb) and MW-62 (10.9 ppb) -- in concentrations that exceeded the NJDEPE criteria of 5 ppb and the PQL of 10 ppb.

All other metals detected were below NJDEPE criteria.

Explosives

As shown in Table 6-2, explosives were detected in ground water samples from two wells. Nitroglycerin was detected in MW-16 at a concentration of 22.1 ppb, and 1,3-dinitrobenzene was detected in MW-45 at a concentration of 0.789 ppb; the NJDEPE has not proposed criteria for these compounds.

Degradation Products of Mustard Agent

Thiodiglycol, a degradation product of mustard agent, was detected in MW-25 at a concentration of 5.68 ppb. This well was resampled and analyzed; no thiodiglycol was detected during the second analysis which had a detection limit of 4.46 ppb.

The NJDEPE has not proposed criteria for thiodiglycol.

Pesticides

As shown in Table 6-2, BHC,A was detected in a water sample from deep well MW-44 at a concentration of 0.025 ppb; this concentration exceeded the NJDEPE criteria of 0.006 ppb and the PQL of 0.02 ppb. BHC,B also was detected in MW-44, at a concentration of 0.013 ppb; this concentration is below the NJDEPE criteria of 0.2 ppb.

VOCs

As shown in Table 6-2, chloroform was detected in a water sample from deep well MW-62 at a concentration of 35 ppb; this concentration exceeded the NJDEPE criteria of 6 ppb.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 6-2, bis(2-ethylhexyl)phthalate was reported in a water sample from MW-45 at a concentration of 60 ppb; this concentration exceeded the NJDEPE criteria of 3 ppb and the PQL of 30 ppb.

All other semivolatile organic compounds detected were below NJDEPE criteria and/or PQLs.

5.6.9 Soil Geology, Area 6

5.6.9.1 Area 6A

Shallow soil borings advanced in Area 6A encountered brown, yellowish brown, dark brown, and yellowish red fine to coarse sands and fine to medium sands. Trace amounts of fine gravel and silts frequently were encountered, as were plant organic matter and clam shells. Ground water generally was found at depths of less than 5 feet, and frequently was found at depths of less than 2 feet.

A black peat with some clay was encountered at a depth of 5 feet in the boring advanced for MW-44. The peat extends to a depth of 9.5 feet where it is underlain by a dark gray silty clay with some organics. The clay layer extends to a depth of 14 feet where a dark brown peat is encountered; this second peat layer extends to a depth of 20 feet. In the southern portion of Area 6 the depth to the top of peat varies from about 10 to 15 feet.

Underlying the clay and peat layers is a 3-foot thick, dark gray silty sand and gravel layer overlying a reddish brown to dark brown, fine to coarse sand and gravel layer. These sands range in depth from approximately 28 feet at OBG monitoring well MW-34 in the northern portion of Area 6, to a depth of 50 feet at Dames & Moore monitoring wells MW-44 and MW-57, to 60 feet at Dames & Moore monitoring well MW-62 and OBG monitoring well MW-16.

Greenish gray to light gray and black silty clay (the Raritan Fireclay) underlies the sands and extends to the top of bedrock. The clay unit was not encountered during the installation of Dames & Moore monitoring well MW-62, approximately 1600 feet southwest of MW-16; however, the clay may grade into a light gray weathered shale.

Previous investigations conducted by OBG indicated that bedrock in the southern portion of Area 6A, at MW-16, is a gray-black diabase sill. Approximately 2500 feet west-northwest, at MW-34, bedrock consists of a brittle gray-black slate (i.e., metamorphosed shale); this indicates the west-northwest contact between the sill and the Brunswick Shale is located between these two wells. Approximately 1600 feet southwest of MW-16, at MW-62, bedrock appears to be gray shale; this indicates the southwest contact between the sill and the Brunswick Shale is located between these two wells.

5.6.9.2 Area 6B and 6B North

Shallow soil borings were advanced in and near several large mounds of fill material deposited in these two areas. Soils encountered generally were a mixture of different types of fill; the predominant soil types included brown and dark brown silty clays and silty sands, fine and fine-to-medium sands of various colors, and a peat-like substance that exhibited a burnt odor.

Natural shallow soils encountered in these borings included grayish brown and brown silty sands, and brown and brownish yellow fine to medium sands.

A 1-foot thick layer of dark brown peat with some silty clay was encountered at 9 feet at Dames & Moore MW-45; previous borings advanced by OBG approximately 500 feet northwest, in Area 5, did not encounter any peat. The peat encountered in Area 6B North may be continuous with the peat encountered at depth elsewhere on the site; if true, MW-45 is very near the northern boundary of the peat layer.

Beneath the peat are grayish brown silty fine sands and yellowish-red-brown fine to medium sands.

5.6.10 Ground Water Level Measurements

Three rounds of ground water level measurements were taken at the four shallow aquifer and four deep aquifer monitoring wells installed in these areas. The elevations of the ground water in these wells are stated below in feet above or below mean sea level.

SHALLOW AQUIFER MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-25	3.3	1100	3.16	1350	3.7	1015
MW-26	3.4	1057	3.3	1352	3.54	1012
MW-27	3.23	1052	3.06	1354	3.63	1007
MW-45	3.01	1020	2.82	1547	3.24	0945

No definable ground water gradient is evident in the shallow aquifer in Area 6. Ground water levels in these wells probably are affected by the nearby Raritan River; tides also may influence the ground water levels.

DEEP AQUIFER MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-16	0.08	1055	-0.22	1351	0.53	1010
MW-34	0.92	1045	0.79	1410	1.1	1000
MW-44	1.96	1047	1.74	1400	2.14	1005
MW-62	-3.81	1130	-3.85	1640	-3.81	1057

The differences in ground water levels between the shallow aquifer wells and adjacent deep aquifer wells ranged from about 1.3 feet to more than 3.5 feet. These differences are sufficient to indicate the two aquifers are hydraulically separated.

No definable ground water gradient is evident in the deep aquifer, based on the above water levels.

Monitoring wells MW-16, MW-34, and MW-44 display a significant amount of daily variation in ground water levels. MW-62 displays very little daily variation in recorded ground water levels, and consistently contains levels 4 to 5 feet below those recorded in deep wells installed 1500 to 3000 feet north-northeast. Insufficient data are available to adequately explain this apparent anomaly.

TABLES FOR AREA 6

TABLE 6-1

AREA 6
DETECTABLE CONCENTRATIONS OF METALS AND CYANIDE
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-26	MW-25	MW-16	MW-27	MW-34	MW-44	MW-45	MW-62
CYANIDE	200	40	--	--	--	--	--	--	2	NRQ
ARSENIC	0.02	8	3.3	18.8	7.1	18.0	--	9.3	2.3	3.5
BARIUM	2000	200	49.0	22.0	27.0	22.0	19.0	32.0	70.1	52.5
CADMIUM	4	2	--	--	--	--	--	--	--	--
CHROMIUM	100	10	--	--	--	--	--	13.0	9.0	--
LEAD	5	10	--	--	--	2.2	3.7	4.9	11.9	10.9
MERCURY	2	0.5	--	--	--	--	--	--	--	--
SELENIUM	50	10	--	--	--	--	--	--	--	--
SILVER	20	2	--	--	--	--	--	18.0	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1 revised 2/1/93.

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TABLE 6-2

AREA 6
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-26	MW-25	MW-16	MW-27	MW-34	MW-44	MW-45	MW-62
Explosives										
Thiodiglycol	NS	NS	--	5.68	--	--	--	--	--	--
1,3-Dinitrobenzene	NS	NS	--	--	--	--	--	--	0.789	--
Nitroglycerin	NS	NS	--	--	22.1	--	--	--	--	--
Pesticides										
BHC, A	0.006	0.02	--	--	--	--	--	0.025	--	--
BHC, B	0.2	0.04	--	--	--	--	--	0.013	--	--
Volatile Organic Compounds										
Bromodichloromethane	0.3	1	--	--	--	--	--	--	--	3.4
Chloroform	6	1	--	--	--	--	--	--	--	35
Base/Neutral and Acid Extractable Compounds										
Bis(2-ethylhexyl)phthalate	3*	30	--	--	--	--	--	--	60	--
Diethylphthalate	5000	10	--	--	--	--	--	--	--	1.2
Isophorone	100	10	--	--	--	--	--	--	--	6.7

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
* Federal MCL = 6 μg/L.
Water Criteria Reference: 24 N.J.R. 389, SubChapter 4, Table 4-1, revised 2/1/93.

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TABLE 6A-1

AREA 6A
CONCENTRATIONS OF METALS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B6A-1C, 0-2', #305	6.90	--	--	261	--	--	--	--
B6A-2C, 0-2', #308	4.55	--	--	--	--	--	--	--
B6A-3C, 0-2', #311	6.57	--	1.80	152	--	--	--	--
B6A-4C, 0-1', #314	2.34	--	--	--	--	--	--	--
B6A-6, 0-1', #318	3.5	--	--	294	--	--	--	--
B6A-6, 2-3', #319	3.98	--	--	--	--	--	--	--
B6A-7C, 0-2', #323	5.19	--	16.0	--	--	--	--	--
B6A-8C, 0-2', #326	8.13	--	16.0	--	--	--	--	--
B6A-10C, 0-2', #332	8.40	--	2.15	--	159	--	--	--
B6A-11C, 0-2', $335	9.36	--	14.6	--	984	--	--	--
B6A-12C, 0-2', #338	3.44	--	5.21	--	406	--	--	--
B6A-13, 2-3', #340	2.83	--	--	--	406	--	--	--
B6A-14, 0-1', #342	3.99	--	1	--	--	--	--	--
B6A-14, 2-3', #343	5.97	--	--	--	--	--	--	--
B6A-15, 0-1', #345	4.82	--	--	--	--	--	--	--
B6A-15, 2-3', #346	4.82	--	--	--	--	--	--	--
B6A-16, 0-1', #348	12.5	--	11.7	--	--	--	--	--
B6A-17, 0-1', #351	4.33	--	2.97	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.

NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.

Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 6A-2

AREA 6A
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

SAMPLE DESCRIPTION	ACETONE	XYLENE
Residential Surface Soil Cleanup Standard	1,000,000	410,000
Impact to Ground Water Soil Cleanup Criteria	50,000	10,000
B6A-1, #304, 1-2′	28	--
B6A-4, #313, 1-2′	22	--
B6A-6, #319, 2-3′	12	--
B6A-10, #331, 1-2′	16	--
B6A-11, #334, 1-2′	13	--
B6A-15, #346, 2-3′	--	7.1

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates compound was not detected.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

TABLE 6A-3

AREA 6A
DETECTABLE CONCENTRATIONS OF
SEMIVOLATILE ORGANIC COMPOUNDS
SOIL

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE	
			B-6A-11C, #335	B6A-15, #346
Bis(2-ethylhexyl)phthalate	49,000	100,000	300	10,000
Pyrene	1,700,000	500,000	83	--

Notes: Concentrations expressed in μg/kg (parts ber billion).
-- indicates compound is below laboratory detection limit.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 6A-4

AREA 6A
CONCENTRATIONS OF ANALYTES
EXCEEDING NOAA ER-L CONCENTRATIONS
SEDIMENT SAMPLES

PARAMETER	NOAA ER-L	NOAA ER-M	SS-7	SS-8	SS-9
Metals (mg/kg)					
Chromium	80	145	101	--	--
Lead	35	110	40.7	--	--
Mercury	0.15	1.3	--	--	0.204
Pesticides (μg/kg)					
DDE, pp[1]	2	15	--	--	9.56
DDT, pp[1]	1	7	18.4	--	--
Dieldrin	0.02	8	--	--	6.27

Notes: National Oceanic Service, National Oceanic and Atmospheric Administration (NOAA), "Potential for Biological Effects of Sediment-Sorbed Contaminants tested in the National Status and Trends Program", March 1990, NOAA/TM/NOS/OMA-52, Table 54A.
-- = concentration did not exceed ER-L.
Metals concentrations are given in mg/kg (parts per million).
Organic concentrations are given in μg/kg (parts per billion).

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TABLE 6A-5

AREA 6A
DETECTABLE CONCENTRATIONS OF ANALYTES
SURFACE WATER SAMPLES

PARAMETER	NJDEPE SURFACE WATER STANDARD	SW-7	SW-8	SW-9
Metals (Total)				
Arsenic	50	550	31.7	49.1
Barium	1,000	5,250	1,660	2,340
Cadmium	10	--	13.4	--
Chromium	50	3,880	667	243
Lead	50	1,280	452	277
Mercury	2	6.85	44.7	2.52
Selenium	10	3.5	--	4.8
Silver	50	22.0	30	35.4
Explosives				
Nitroglycerin	NS	17.90	--	61.6
PETN	NS	95.7	--	30.8
VOCS				
Acetone	NS	--	--	11
Semivolatile Organic Compounds				
Benzoic Acid	NS	--	6.68	14.7
4-Methyl Phenol	NS	--	--	10.1
Phenol	NS	--	--	4.2

Notes: Concentrations are given in μg/L (parts per billion).
New Jersey Surface Water Quality Standards (N.J.A.C.7: 9-4.1 e. seq.)
-- = Compound not detected.
NS = No Standard Proposed

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TABLE 6B-1

AREA 6B
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG6B-6	--	--	--	0.2	0.3	--	--	1.0
MW45-1	--	--	--	0.3	0.3	--	--	0.6
MW45-2	--	--	--	0.2	0.3	--	--	0.5
SG6B-1	--	--	--	--	--	--	--	1
SG6B-2	--	--	--	--	--	--	--	1300
SG6B-3	--	--	--	--	--	--	--	0.5
SG6B-4	--	--	--	--	--	--	--	0.5
MW45-5	--	--	--	--	--	--	--	0.5

Notes: Units are in $\mu g/L$ (parts per billion, vapor).
-- = Not detected.

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TABLE 6B-2

AREA 6B
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B6B-1, 0-5', #369	8.72	--	--	--	--	--	--	--
B6B-2, 0-1', #372	2.36	--	--	--	--	--	--	--
B6B-3, 0-1', #375	12.4	--	--	--	--	--	--	--
B6B-3, 2-3', #376	6.75	--	--	--	--	--	--	--
B6B-4, 0-1', #378	16.0	--	--	--	--	--	--	--
B6B-4, 2-3', #379	4.29	--	--	--	--	--	--	--
Area 6B North								
B6BN-1, 0-1', #383	4.64	--	--	--	--	--	--	--
B6BN-2, 0-1', #386	2.04	--	--	--	--	--	--	--
B6BN-3, 0-1', #389	2.93	--	--	--	--	--	--	--
B6BN-3, 3-4', #390	2.19	--	--	--	--	--	--	--
B6BN-4, 0-1', #392	3.70	--	--	--	--	--	--	--
B6BN-4, 3-4', #393	6.78	--	--	--	--	--	--	--
B6BN-5, 0-1', #395	2.68	--	--	--	--	--	--	--
B6BN-5, 2-3', #396	2.14	--	--	--	--	--	--	--
B6BN-6, 0-1', #398	2.16	--	--	--	--	--	--	--
B6BN-7, 0-1', #402	10.4	--	--	--	--	--	--	--
B6BN-8A, 0-5', #283	6.02	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed soil cleanup standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, Revised 2/8/93.

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TABLE 6B-3

AREA 6B
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

PARAMETERS	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP	#390, B6BN-3, 3-4′	#396, B6BN-5, 2-3′
Acetone	1,000,000	50,000	110	110
Methyl Ethyl Ketone	NS	NS	14	13

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates compound is below laboratory detection limit.
NS = No soil cleanup standards have been proposed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

TABLE 6B-4

AREA 6B NORTH
DETECTABLE CONCENTRATIONS OF BASE/NEUTRAL AND
ACID EXTRACTABLE SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARDS	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION								
			B6BN-1 0-1' #383	B6BN-2 0-1' #386	B6BN-3 3-4' #390	B6BN-4 3-4' #393	B6BN-5 0-1' #395	B6BN-5 2-3' #396	B6BN-6 0-1' #398	B6BN-6 4-5' #400	B6BN-7 0-1' #401
Acenaphthene	3,400,000	100,000	--	2,400	--	750	190	--	--	--	--
Acenaphthylene	NS	NS	--	4,500	--	--	--	--	--	--	--
Anthracene	10,000,0000	500,000	120	7,500	--	2,100	460	580	170	--	--
Benzo(a)anthracene	900	500,000	530	24,000	--	3,600	1,100	1,200	540	--	--
Benzo(a)pyrene	660	100,000	430	16,000	--	3,100	1,100	1,600	500	--	--
Benzo(b)fluoranthene	900	500,000	580	22,000	--	4,100	1,600	2,000	710	--	--
Benzo(ghi)perylene	660	500,000	220	11,000	--	1,600	390	--	--	--	--
Benzo(k)fluoranthene	900	500,000	150	6,200	--	1,400	540	890	300	--	--
Bis(2-ethylhexyl)phthalate	49,000	100,000	--	--	--	240	--	--	280	--	--
Chrysene	9,000	500,000	550	28,000	160	3,500	1,000	1,200	550	--	160

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion).
-- indicates compound is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 6B-4 (cont'd)

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARDS	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION								
			B6BN-1 0-1' #383	B6BN-2 0-1' #386	B6BN-3 3-4' #390	B6BN-4 3-4' #393	B6BN-5 0-1' #395	B6BN-5 2-3' #396	B6BN-6 0-1' #398	B6BN-6 4-5' #400	B6BN-7 0-1' #401
Dibenz(a,h)anthracene	660	500,000	--	--	--	440	--	--	--	--	--
Dibenzofuran	NS	NS	--	--	--	560	--	--	--	--	--
Fluoranthene	2,300,000	500,000	810	41,000	180	8,400	2,000	2,100	1,100	160	190
Fluorene	2,300,000	100,000	--	8,300	--	1,400	330	--	--	--	--
Indeno(1,2,3-cd)pyrene	900	500,000	280	8,000	--	1,800	400	--	--	--	--
Naphthalene	230,000	100,000	--	--	--	340	250	--	--	--	--
Phenanthrene	NS	NS	750	69,000	140	9,400	1,800	1,700	570	76	270
Pyrene	1,700,000	500,000	1,200	59,000	210	5,500	1,600	1,600	850	140	400
2-methylnaphthalene	NS	NS	--	2,400	--	410	170	--	--	--	--

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates compound is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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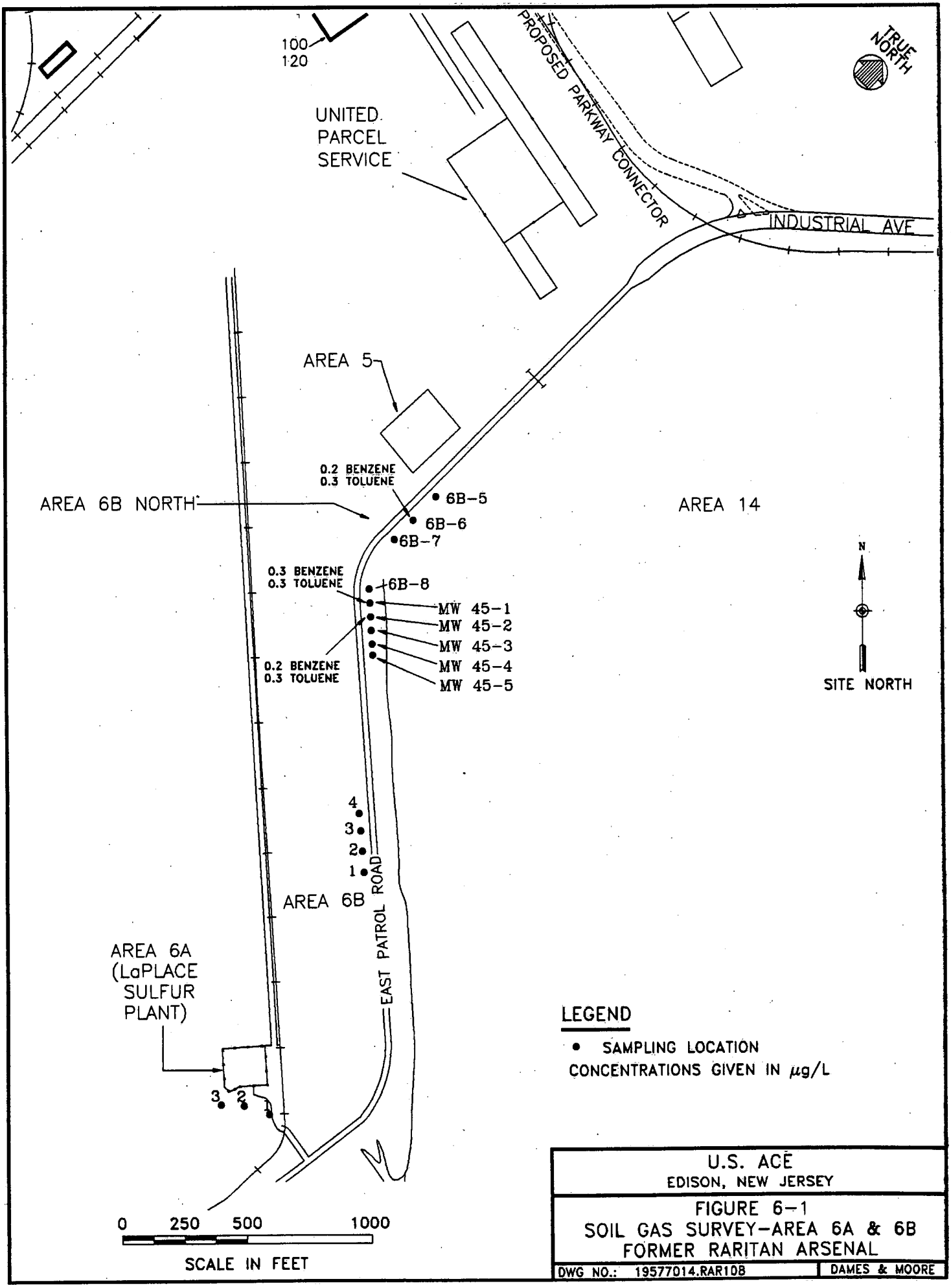
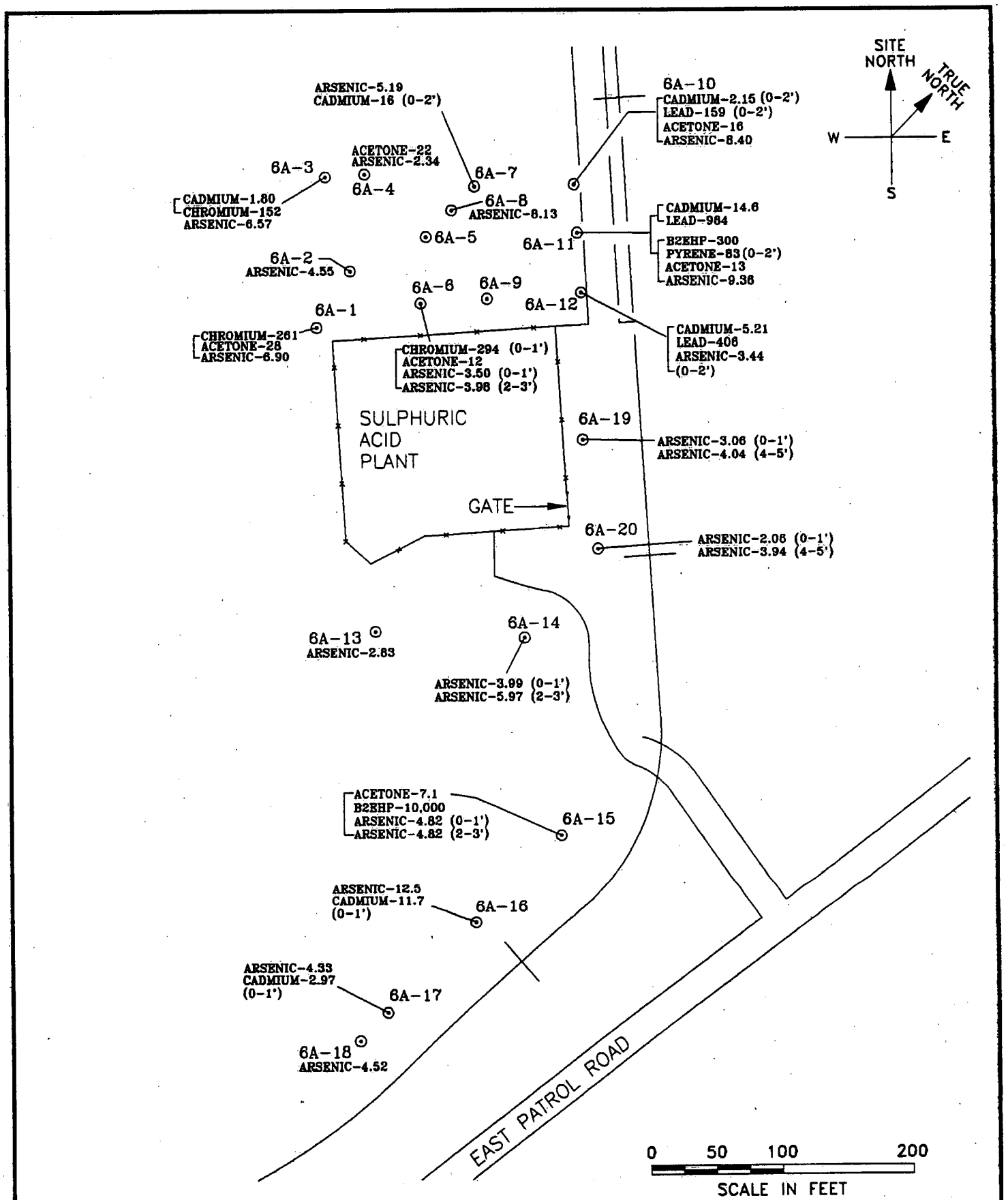
FIGURES FOR AREA 6



U.S. ACE
EDISON, NEW JERSEY

FIGURE 6-1
SOIL GAS SURVEY-AREA 6A & 6B
FORMER RARITAN ARSENAL

DWG NO.: 19577014.RAR10B | DAMES & MOORE



LEGEND

SOIL BORING LOCATIONS
METALS CONCENTRATIONS GIVEN IN mg/kg
SV's AND VOC's CONCENTRATIONS GIVEN IN μg/kg

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FIGURE 6A-2
AREA 6-A SOIL BORING LOCATIONS
RARITAN ARSENAL

DWG NO.: 19577014.RAR114 | DAMES & MOORE

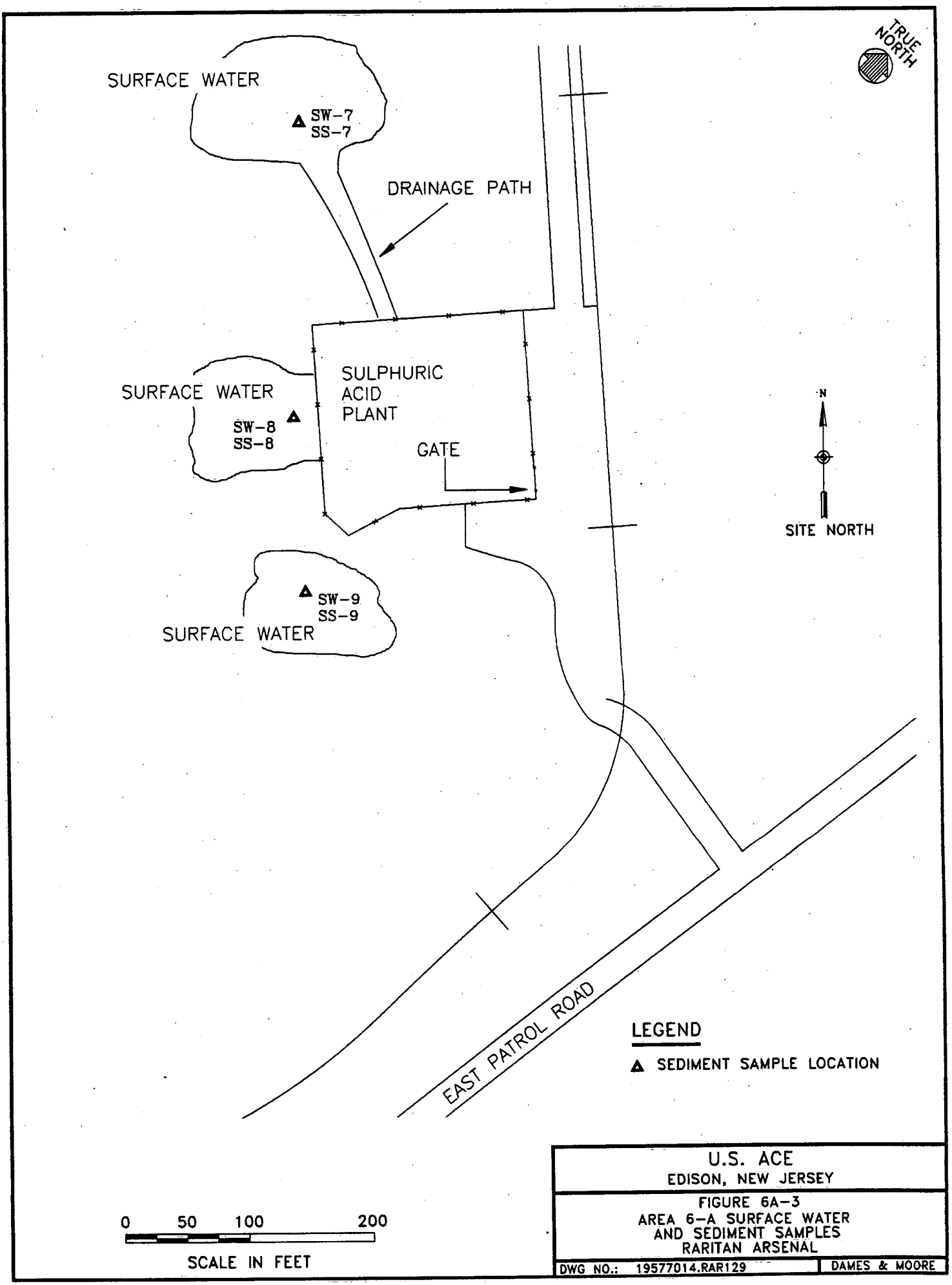

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FIGURE 6A-3
AREA 6-A SURFACE WATER AND SEDIMENT SAMPLES
RARITAN ARSENAL

DWG NO.: 19577014.RAR129 | DAMES & MOORE

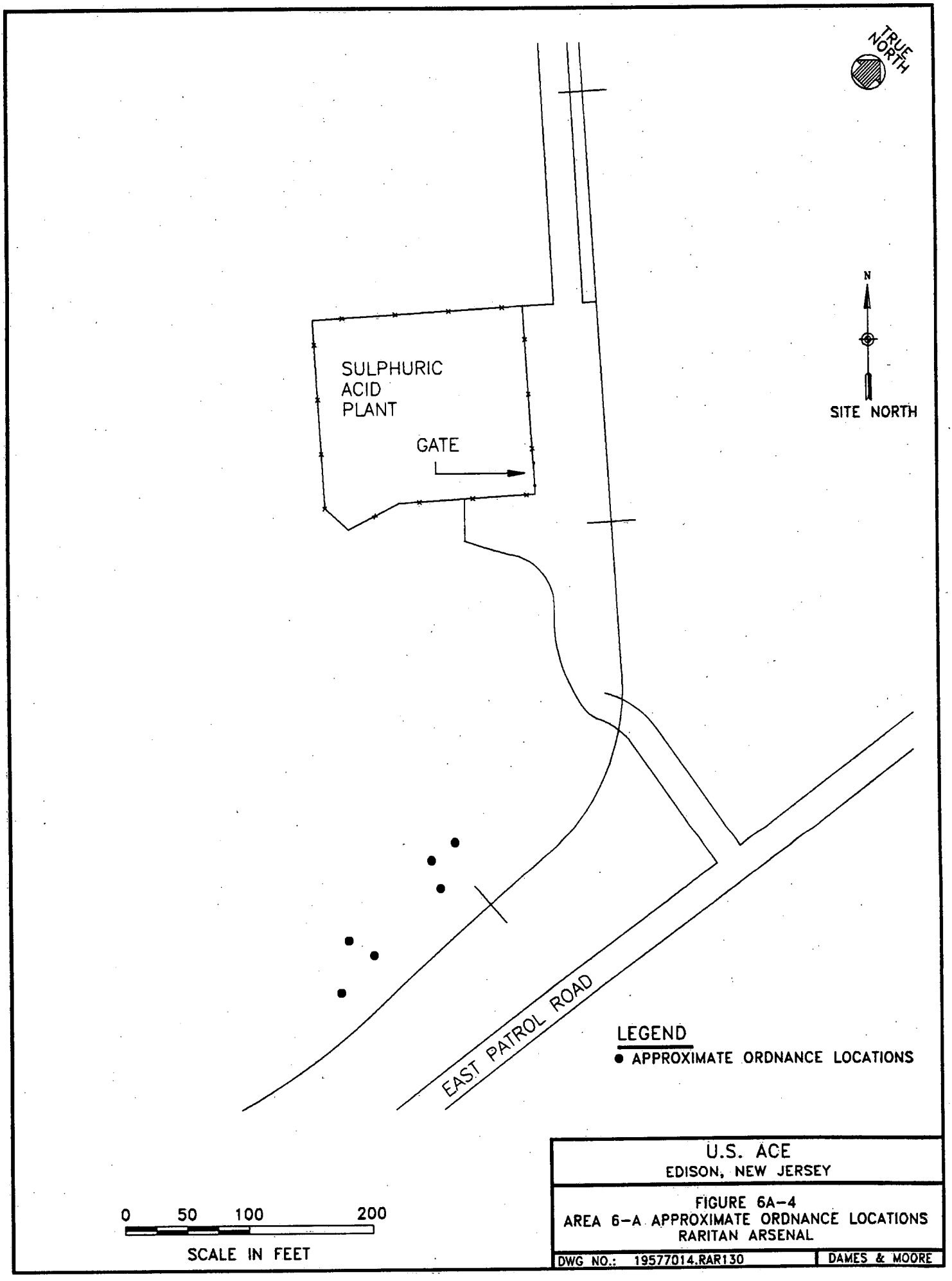

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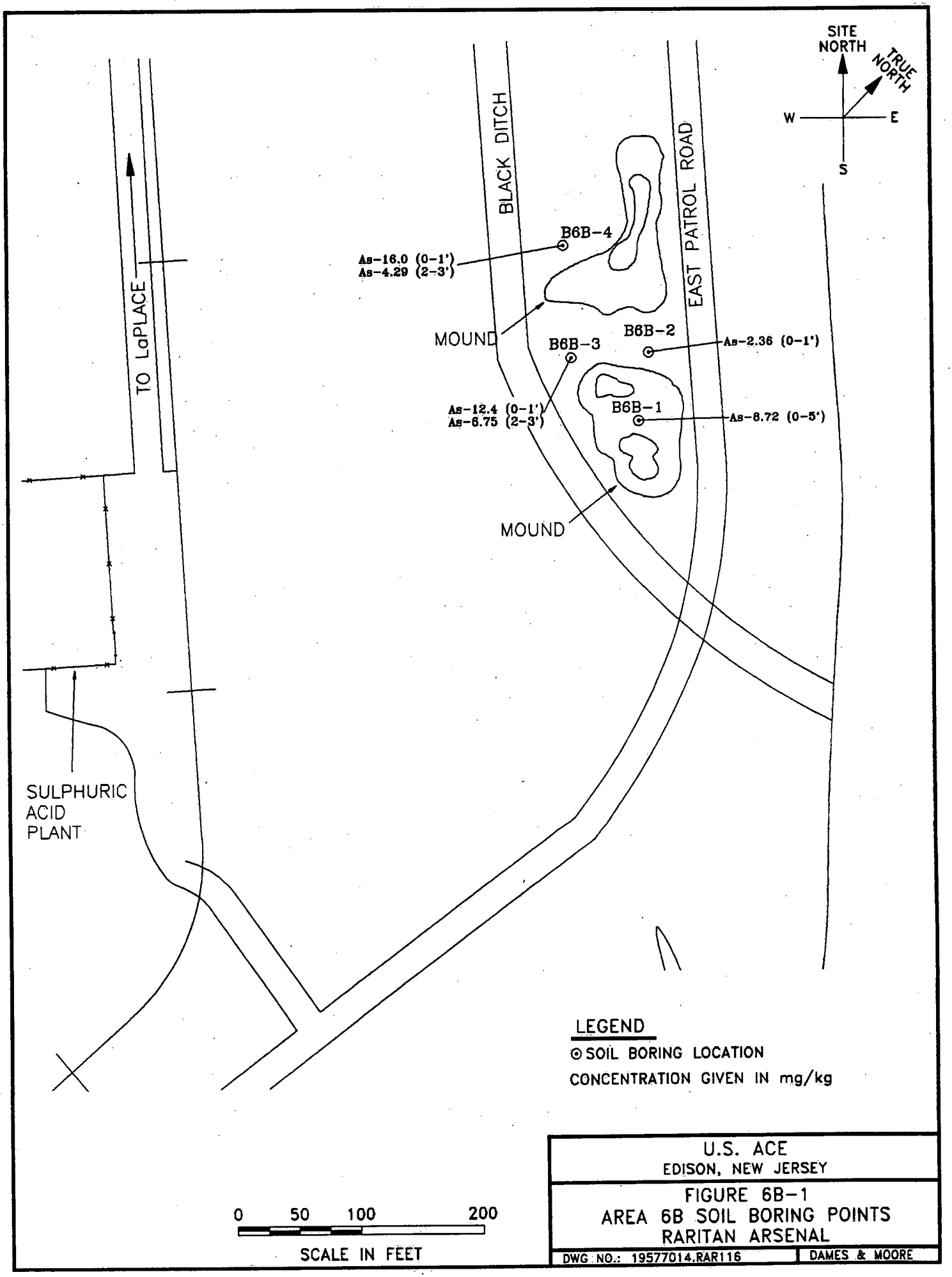
FIGURE 6A-4
AREA 6-A APPROXIMATE ORDNANCE LOCATIONS
RARITAN ARSENAL

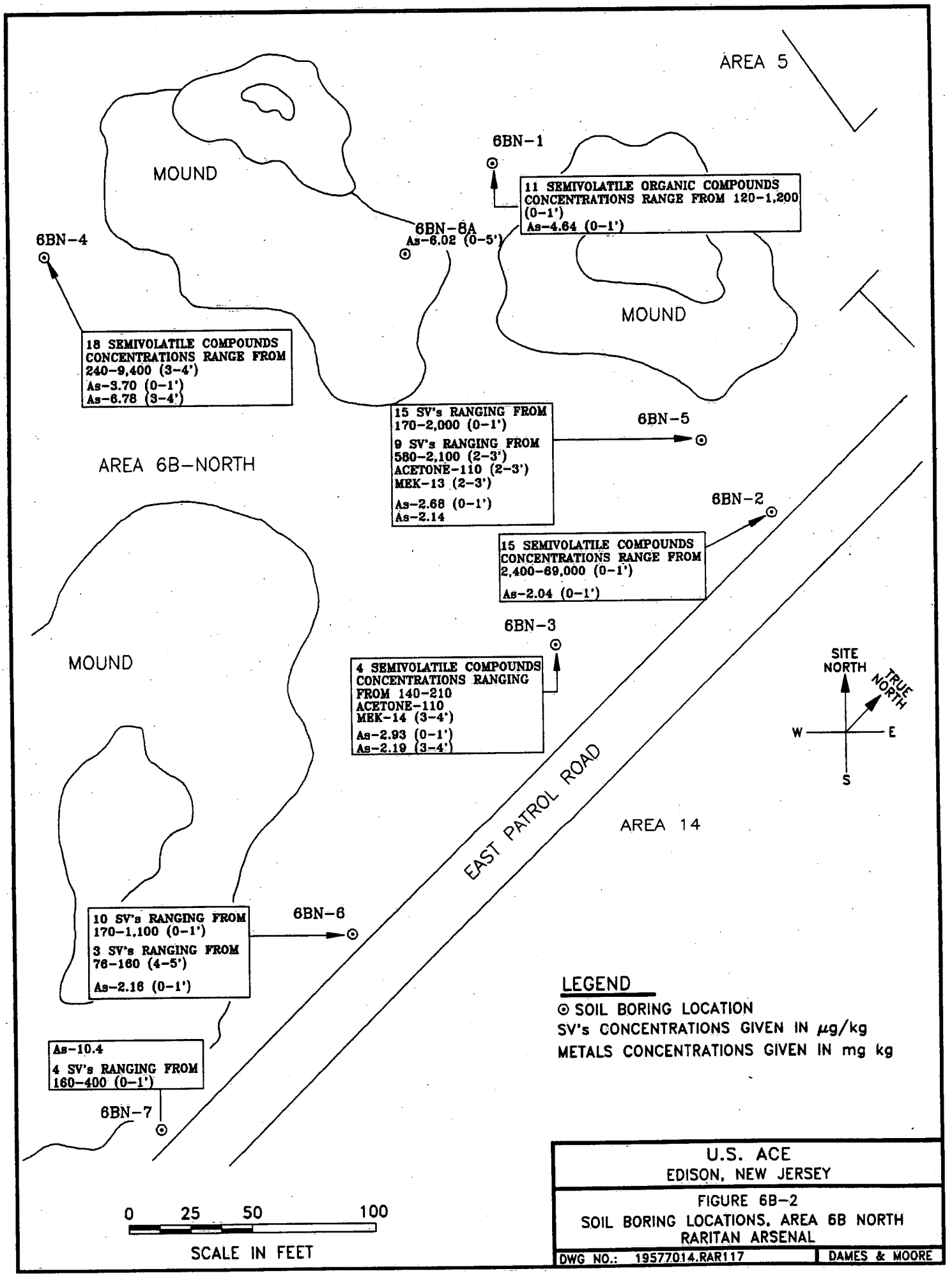
DWG NO.: 19577014.RAR130 | DAMES & MOORE



U.S. ACE
EDISON, NEW JERSEY

FIGURE 6B-1
AREA 6B SOIL BORING POINTS
RARITAN ARSENAL

DWG NO.: 19577014.RAR116 | DAMES & MOORE



U.S. ACE
EDISON, NEW JERSEY

FIGURE 6B-2
SOIL BORING LOCATIONS, AREA 6B NORTH
RARITAN ARSENAL

DWG NO.: 19577014.RAR117 | DAMES & MOORE

5.7 AREA 7

Area 7 reportedly was the site of a TNT melt-out and small arms decommissioning plant; several TNT storage tanks also were present on the site. The area was used during the decommissioning of the arsenal to destroy ammunition components containing less than 600 grains of explosives.

During the 1963 decontamination effort, LEAD excavated and cleaned trenches and sewer lines containing ammunition, explosives, and explosive residues. Approximately 7,000 cubic yards of soil were removed during this effort; Dames & Moore has no knowledge of how these soils were disposed. The area around the sump in Building S-810 was suspected of being heavily contaminated and therefore was fenced and recommended for "Non-Use." The remainder of Area 7 was recommended for "Unrestricted Use."

There is no fenced area, or evidence of a fenced area, currently present in Area 7. Available drawings of the arsenal were reviewed to determine if the area previously assessed by OBG is the sump area. Based on this review, we concur with OBG's location for the sump. The location of the sump is shown on Figure 7-2.

5.7.1 Dames & Moore Field Activities

Dames & Moore conducted UXO and soil gas surveys, collected soil samples for laboratory analysis, and installed three shallow monitoring wells.

5.7.2 UXO Survey

A UXO survey was conducted to clear areas prior to any invasive activities. No ordnance was detected.

5.7.3 Soil Gas Survey

Six shallow ground water samples and 26 soil gas samples were collected in Area 7 and analyzed for the VOCs of concern. An approximate 150-foot grid was established over the PSE&G parking lot, and 18 soil gas and ground water samples were collected at the grid nodes; an additional 14 soil gas samples subsequently were collected in the north parking lot to further

assess the extent of VOC contamination identified during the initial soil gas survey. Soil gas samples were collected at depths of 2 to 5 feet, depending upon ground water level. In six locations, the ground water depth was less than 2 feet, and Tracer personnel were unable to obtain valid soil gas samples; after discussions with USACE personnel, ground water samples were collected from a depth of approximately 5 feet at these points. Water samples were removed by vacuum through a disposable polyethylene tube inserted through the sampling probe into the bottom of the hole. The collected sample was placed in a 40 ml VOA vial and shaken vigorously. A sample of the gas in the headspace of the vial then was collected and injected into the GC. Details of the ground water sampling and analysis procedure are presented in the Tracer report; a copy of the Tracer report can be found in Volume IV of this report, Appendix F.

SGS point SG7-18 contained elevated concentrations of seven of the eight compounds for which GC analysis was performed. This sample contained 60 ppbv 1,1-DCE; 30 ppbv 1,1-DCA; 300 ppbv TCE; 4,000 ppbv benzene; 8,000 ppbv toluene; 3,000 ppbv xylenes; and 30,000 ppbv TVHC. These results were orders of magnitude greater than results from the closest sampling points, approximately 150 feet distant. Because of these results, 14 additional soil gas sampling points were sampled in the north parking lot to further assess the extent of contamination. None of these additional points contained VOCs in concentrations comparable to SG7-18.

Soil gas survey locations are shown on Figures 7-1 and 7-1A. Detectable concentrations of VOCs are summarized in Table 7-1.

5.7.4 Soil Sampling Depths/Locations

Six soil borings were advanced in Area 7. Two borings were advanced at locations thought to have the highest probability to contain contamination based on the results of the soil gas survey: boring B7-1 was advanced to a depth of 5 feet in the north parking lot, at the location where SG7-18 was collected; boring B7-2 was advanced to a depth of 4 feet at the location where WS7-16 was collected. Samples were collected from depths of 0 to 1 foot and 2 to 3 feet for explosives analysis, and at depths of 0 to 1 foot and 3 to 4 feet or 4 to 5 feet (depending upon ground water level) for metals analysis. These sampling intervals were in agreement with procedures for sampling in areas with high ground water tables, as previously described in Section 4.0. Discrete samples were collected at each sample interval for possible

VOC analysis. In boring B7-1, the sample with the highest headspace reading was submitted for VOC analysis. In boring B7-2, the headspace readings were nearly equivalent; therefore, the sample collected from the lowest interval, immediately above the ground water table, was submitted for VOC analysis.

Four borings were advanced in and adjacent to the location of the sump. Each boring was terminated when ground water was encountered, at depths ranging from 1 to 4 feet. Soil samples were collected from intervals of 0 to 1 foot and 3 to 4 feet when ground water conditions permitted. Samples from both intervals were submitted for metals and explosives analyses. Additionally, one sample from each boring was selected for VOC analysis on the basis of headspace readings; samples for headspace analyses were obtained at 2-foot intervals to the depth of the borehole.

Soil sampling locations are shown on Figure 7-2.

5.7.4.1 Analytical Results

Metals

As shown in Table 7-2, arsenic was detected in three samples, in concentrations ranging from 2.04 to 2.56 ppm; the NJDEPE proposed standard is 2 ppm. Lead was detected at a concentration of 110 ppm at sample location B7-5; the NJDEPE proposed standard is 100 ppm.

VOCs

As shown in Table 7-3, two VOCs were detected in concentrations that exceeded NJDEPE proposed standards; both compounds were detected in the sample from location B7-1, collected from a depth of 4 to 5 feet. Tetrachloroethene was detected at a concentration of 34,000 ppb; the NJDEPE proposed standard is 1000 ppb. Xylenes were detected at a concentration of 91,000 ppb; the NJDEPE proposed standard is 10,000 ppb.

Explosives

No explosives were detected in any of the samples collected from Area 7.

5.7.5 Monitoring Well Installation and Sampling

Dames & Moore installed three shallow monitoring wells, MW-43, MW-59 and MW-61, to monitor ground water quality in Area 7.

MW-43 was installed on the southern edge of Campus Plaza. As discussed in Section 4.0, this well originally was to have been installed to monitor ground water quality downgradient of Area 4; because site conditions did not allow the installation of this well at the location stated in the Work Plan, the well was moved to monitor ground water conditions downgradient of Area 7. The well was screened from depths of 7 to 17 feet in brown fine to coarse sands that contained varying amounts of silts.

MW-59 was installed on the downgradient edge of the PSE&G parking lot, near the location of WS-7-16. This location was selected because of the high concentration of contaminants detected in the shallow ground water sample during the soil gas/ground water survey. The well was screened from depths of 7 to 17 feet in brown and gray to orange-brown sands that contained varying amounts of silts and gravel.

MW-61 was installed south of Area 4, near Columbus Avenue, to provide additional information on ground water quality downgradient of Areas 2, 3, 4, and 7.

Ground water samples were obtained from the new wells, and from existing OBG monitoring wells MW-10, MW-11, and MW-12. Samples were analyzed for VOCs, base/neutral and acid extractable compounds, metals, explosives, and pesticides. ground water samples obtained from MW-59 were analyzed for both total and dissolved metals because of the slow recharge rate of this well.

Monitoring well boring logs, construction diagrams, and development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

Areas 2 and 3 are upgradient of Area 7, and could have an impact on the ground water quality in Area 7. For this reason, the results of the ground water analyses from these areas are briefly discussed below. The reader is referred to Section 5.2 of this report, which presents the results of the field investigations of Area 2 and the contiguous portion of Area 3, for further information.

5.7.5.1 Analytical Results

Metals

As shown in Table 7-4, arsenic was detected in a ground water sample from MW-10 at a concentration of 42.7 ppb; the NJDEPE criteria is 0.02 ppb and the PQL is 8 ppb.

In MW-61, arsenic was detected at a concentration of 15.9 ppb, and cadmium was detected at a concentration of 8 ppm; the NJDEPE criteria for cadmium is 4 ppb.

Total cadmium was detected in a ground water sample from MW-59 at a concentration of 17 ppb, and lead was detected at a concentration of 12 ppb; the NJDEPE criteria for lead is 5 ppb with a PQL of 10 ppb. Because MW-59 was a slow recharging well, a filtered sample was obtained to assess dissolved metals. Dissolved cadmium was found at a concentration of 10 ppb; lead was not detected in this sample.

All other metal concentrations detected in the wells installed to monitor Area 7 were below NJDEPE criteria.

A review of Table 2-4 (Area 2/3) indicates that arsenic and cadmium were found in MW-15 in concentrations that exceeded the NJDEPE criteria and/or PQLs. However, based on the ground water contours shown on Figure 18, MW-15 is cross gradient of Area 7, and would not be expected to influence the ground water quality in Area 7.

VOCs

As shown in Table 7-5, significant concentrations of VOCs were found in monitoring wells MW-11 and MW-59 at concentrations that exceeded the NJDEPE criteria and/or PQLs. These wells contained the greatest variety of VOCs detected during this investigation.

MW-11 contained benzene (4.6 ppb -- criteria of 0.2 ppb with a PQL of 1 ppb), chlorobenzene (38 ppb -- criteria of 4 ppb), 1,2-DCA (12 ppb -- criteria of 0.3 ppb with a PQL of 2 ppb), 1,1,2,2-tetrachloroethane (3.7 ppb -- criteria of 2 ppb), TCE (11 ppb -- criteria of 1 ppb), and vinyl chloride (11 ppb -- criteria of 0.08 ppb with a PQL of 5 ppb).

Many of the above compounds also were detected in MW-59, generally at higher concentrations: benzene (14 ppb), chlorobenzene (270 ppb), 1,1-DCA (170 ppb), 1,2-DCA (46 ppb), and TCE (20 ppb).

Other VOCs detected in these wells were below NJDEPE criteria and/or PQLs.

A review of Table 2-5 (Area 2/3) indicates that significant concentrations of organic compounds were detected in ground water samples from MW-13, MW-14, and MW-58; these wells appear to be upgradient of Area 7. Three of the compounds, 1,2-DCE, TCE, and vinyl chloride also were detected in the monitoring wells installed to monitor Area 7.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 7-5, all of the semivolatile organic compounds detected were below the NJDEPE PQL of 30 ppb. However, the sample collected from MW-10 contained a concentration of 3.3 ppb bis(2-ethylhexyl)phthalate which exceeds the NJDEPE criteria of 3 ppb.

Others

No explosives or pesticides were detected in ground water samples from Area 7.

5.7.6 Soil Geology, Area 7

Shallow soils encountered in Area 7 are predominantly brown or brownish yellow fine to medium sands underlain by dark brown silty sands or sandy silt. From depths of 5 feet to 14 feet, the soils are brown or brown and gray fine to coarse sands, or fine to medium sands, with varying amounts of silt and occasional traces of gravel. At a depth of 14 feet, the soil changes to orange brown grading to light brown fine to coarse sand with trace silt.

The peat and clay layer which functions as an aquitard in Area 6 was not found in the borings in Area 7. One boring advanced by Dames & Moore (to install MW-59) encountered a 0.5-foot thick layer of peat and clay at a depth of 3 feet, and one of the borings advanced by OBG (Boring B-7) encountered thin layers of lignite at two separate depths. It is unlikely these layers are continuous with the peat layer encountered in Area 6; borings advanced nearby for OBG monitoring well MW-11 and Dames & Moore monitoring well MW-43, as well as other

soil borings advanced in Area 7, failed to encounter any peat. These thin layers are probably the result of local depositional events.

Ground water levels encountered during drilling varied from about 2 to 4 feet. Ground water levels encountered during the soil gas survey often were less than 1 foot deep; it is likely the differences noted were due to seasonal variations.

5.7.7 Ground Water Levels

Three rounds of ground water level measurements were taken at the four shallow aquifer monitoring wells installed in this area. The elevations of the ground water in these wells are stated below in feet above mean sea level.

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-10	9.02	1315	8.96	1045	9.16	1149
MW-11	4.59	1307	4.56	1033	4.58	1141
MW-12	636	1310	6.57	1040	6.69	1146
MW-43	6.01	1325	5.92	1053	6.72	1156
MW-59	7.55	1312	7.51	1035	7.55	1144
MW-61	3.88	1300	3.84	1028	3.97	1138

A review of these data indicates ground water flow in Area 7 tends toward the southeast, as expected.

TABLES FOR AREA 7

TABLE 7-1

AREA 7
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
WS-7-17-3′	--	5.0	0.001	23	--	--	--	40
WS-7-16-3′	--	8.0	0.07	9.0	13	--	--	150
WS-7-11-5′	--	--	0.03	--	--	--	--	--
SG 7-14-5′	--	2.0	0.02	--	--	--	--	170
SG7-10-5′	--	0.06	--	I[1]	0.5	--	--	0.5
SG7-15-5′	--	--	--	--	0.3	--	--	0.3
SG7-7-5′	--	--	--	0.1	0.4	--	--	0.9
SG7-13-5′	--	--	--	--	0.5	--	0.4	0.8
SG7-18-4′	60	30	300	4000	8000	--	3000	30000
SG-7-19-5′	--	--	0.008	--	--	--	--	12
SG-7-20-2′	--	--	0.003	--	12	--	--	200
SG-7-21-2′	0.8	2	0.02	--	4	--	--	90

[1]I = Matrix interference.

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

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TABLE 7-1 (continued)

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG-7-24-2'	--	--	0.01	--	1	--	--	1
SG-7-23-3'	--	--	0.004	--	4	--	--	12
SG-7-22-5'	0.03	17	0.004	--	42	--	12	630
SG-7-25-2'	--	--	--	--	0.5	--	--	0.5
SG-7-26-2'	--	--	0.004	--	2	--	--	60
SG-7-27-4'	--	--	0.004	--	3	--	--	9
SG-7-30-2'	--	--	--	--	0.9	--	--	2
SG-7-28-2'	--	--	--	--	0.6	--	--	0.5
SG-7-29-2'	--	--	--	--	3	--	2	5
SG-7-32-2'	0.05	--	0.006	--	6	--	1	12

Note: Units are in $\mu g/L$ (parts per billion, vapor).
-- = Not detected.

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TABLE 7-2

AREA 7
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B7-1, 0-1', #410	2.13	--	--	--	--	--	--	--
B7-2, 0-1', #413	2.56	--	--	--	--	--	--	--
B7-4, 2-3.5', #422	2.04	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 7-3

AREA 7
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

PARAMETERS	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	#412, B7-1, 4-5′	#415, B7-2, 3-4′	#420, B7-3 3-4′
Acetone	1,000,000	50,000	--	17	27
Benzene	3,000	1,000	--	--	8.7
Ethylbenzene	1,000,000	100,000	23,000	--	--
Tetrachloroethene	4,000	1,000	34,000	--	--
Toluene	1,000,000	500,000	39,000	--	--
Xylenes, Total	410,000	10,000	91,000	--	18

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates concentration is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 7-4

AREA 7
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-10	MW-11	MW-12	MW-43	MW-59	MW-61	MW-59*
ARSENIC	0.02	8	42.7	3.6	--	--	--	15.9	--
BARIUM	2000	200	47.9	84.0	35.0	101	52.0	177	20.0
CADMIUM	4	2	--	--	--	--	17.0	8.0	10.0
CHROMIUM	100	10	--	--	--	--	62.0	25.0	--
LEAD	5	10	--	--	2.8	7.8	12.0	3.9	--
MERCURY	2	0.5	--	--	--	--	--	--	--
SELENIUM	50	10	--	--	--	--	--	--	--
SILVER	20	2	--	--	--	--	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
*Dissolved metal concentration.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

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TABLE 7-5

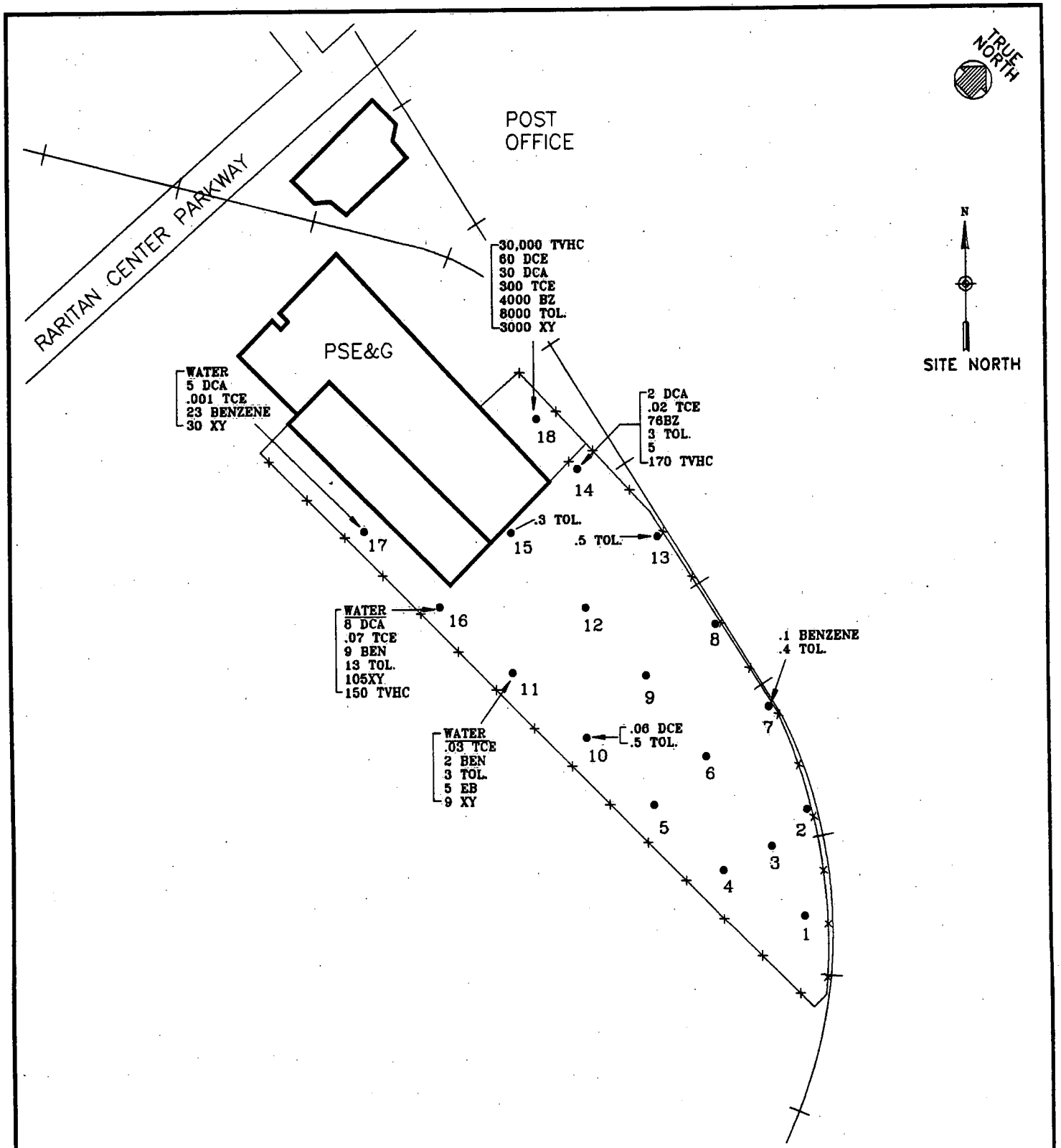
AREA 7
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-10	MW-11	MW-12	MW-59	MW-43	MW-61
Volatile Organic Compounds								
Benzene	0.2	1	--	4.6	--	14	--	--
Chlorobenzene	4	2	--	38	--	270	--	--
Chloroethane	NS	NS	--	--	--	85	--	--
1,1-DCA	70	NS	--	5.0	--	170	--	--
1,2-DCA	0.3	2	--	12	--	46	--	--
1,2-DCE (total)	110[1]	2	--	18	--	17	--	--
1,1,2,2-Tetrachloroethane	2	1	--	3.7	--	--	--	--
TCE	1	1	--	11	--	20	--	--
Vinyl chloride	0.08	5	--	11	--	--	--	--
Base/Neutral and Acid Extractable Compounds								
Bis(2-ethylhexyl)phthalate	3[2]	30	3.3	--	--	--	--	2.1
2-Chlorophenol	40	20	--	--	--	2.1	--	--
1,3-Dichlorobenzene	600	5	--	--	--	1.3	--	--
1,2-Dichlorobenzene	600	5	--	15	--	23	--	--
1,4-Dichlorobenzene	75	5	--	4.2	--	17	--	--

Notes: Concentrations are given in $\mu g/L$ (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
[1] NJDEPE Criteria for cis-1,2-DCE and trans-1,2-DCE are 10 and 100 $\mu g/L$, respectively.
[2] Federal MCL = 6 $\mu g/L$.
Water Criteria Reference: 24 N.J.R. 389 Subchapter 4, Table 4-1, revised 2/1/93.

[d:\...\job19577014\march93\tbl0914.75]

FIGURES FOR AREA 7



LEGEND

• SAMPLING LOCATION

CONCENTRATIONS GIVEN IN $\mu g/L$

0 100 200 400

SCALE IN FEET

U.S. ACE

EDISON, NEW JERSEY

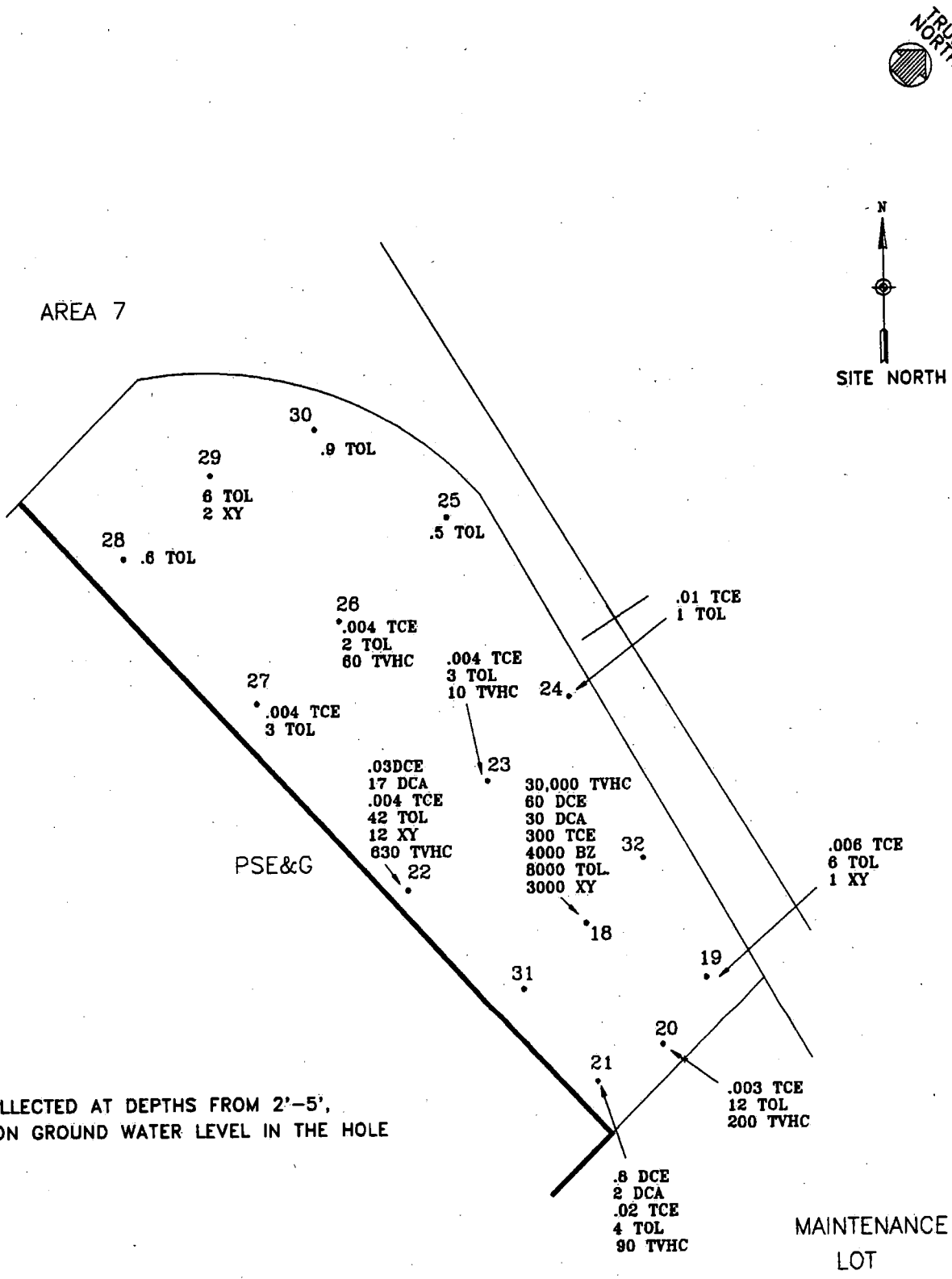
FIGURE 7-1

SOIL GAS SURVEY- AREA 7

FORMER RARITAN ARSENAL

DWG NO.: 19577014.RAR131

DAMES & MOORE



NOTE:
SAMPLES COLLECTED AT DEPTHS FROM 2'–5',
DEPENDING ON GROUND WATER LEVEL IN THE HOLE

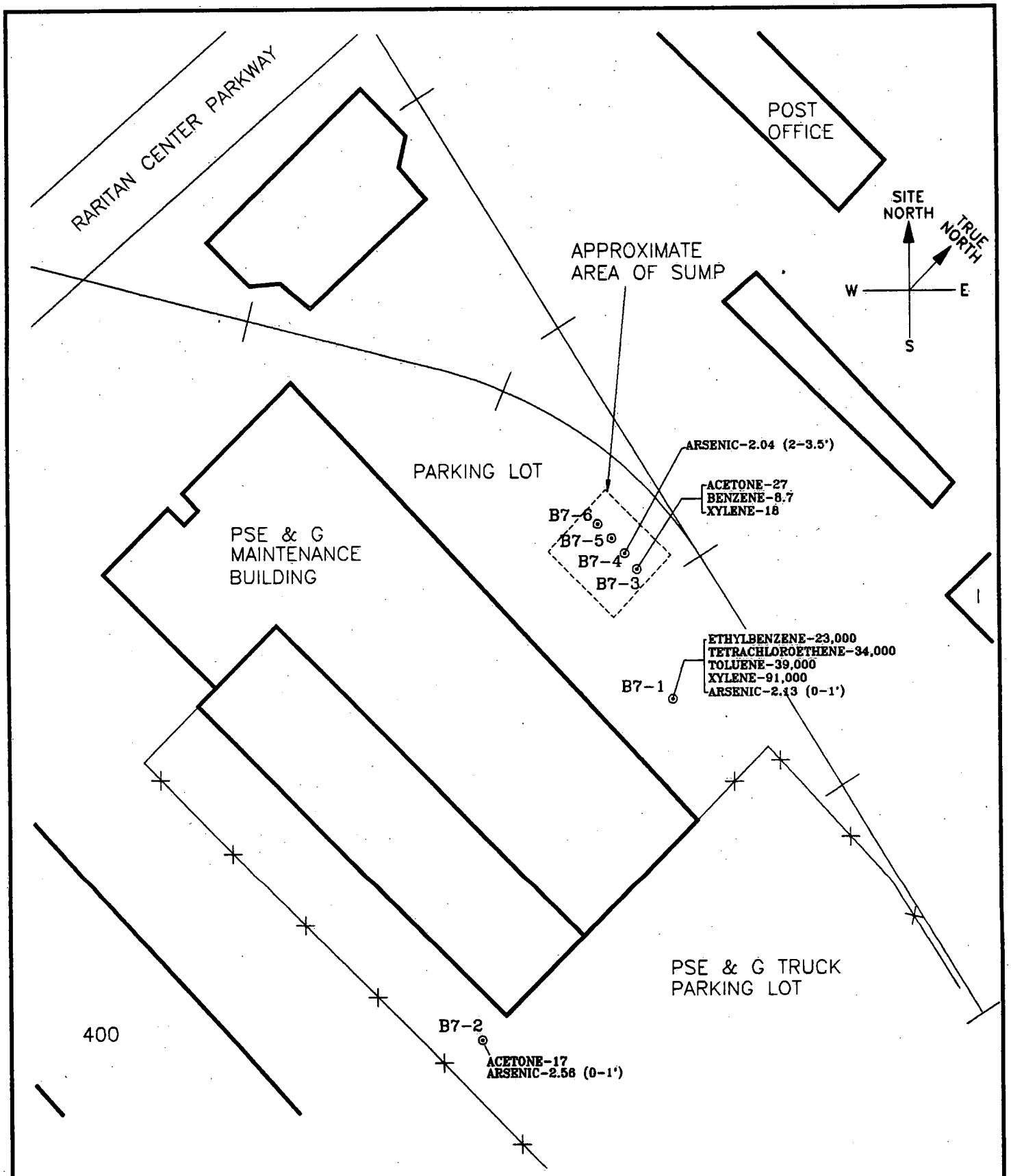
LEGEND
• SAMPLING LOCATION
CONCENTRATIONS GIVEN IN $\mu g/L$

0 15 30 60
SCALE IN FEET

U.S. ACE
EDISON, NEW JERSEY

FIGURE 7-1A
SOIL GAS SURVEY- AREA 7
NORTH PARKING LOT

DWG NO.: 19577014.RAR138 | DAMES & MOORE



LEGEND

⊙ SOIL BORING LOCATION
VOC's CONCENTRATIONS GIVEN IN μg/kg
METALS CONCENTRATIONS GIVEN IN mg/kg

0 50 100 200
SCALE IN FEET

U.S. ACE
EDISON, NEW JERSEY

FIGURE 7-2
AREA 7 SOIL BORING POINTS
FORMER RARITAN ARSENAL

DWG NO.: 19577014.RAR132 | DAMES & MOORE

5.8 AREA 8

OBG reported that Area 8 was used from the early 1930s until the early 1960s as a storage area and possible loading complex for small caliber ammunition and munitions components. In the 1930s, an explosion reportedly scattered large grains of gunpowder over the area. During the 1963 decontamination effort, LEAD disked, raked, and surface-burned the soils in Area 8. The area then was recommended for "Unrestricted Use".

OBG conducted a records search of Area 8, but did not conduct field investigations.

Area 8 has been completely developed and/or disturbed. A large building and asphalt parking lot cover the majority of the area. There also is a large excavated area apparently used for stormwater retention; a sizeable mound of fill material is located adjacent to this area. The only portion of the area which seems to have remained undisturbed is a marsh downgradient of this mound.

A review of aerial photographs indicated the presence of a landfill approximately 1200 feet south of the mound.

5.8.1 Dames & Moore Field Investigation

Dames & Moore conducted UXO and soil gas surveys, and collected surface water and sediment samples from the marsh.

5.8.2 UXO Survey

Personnel from UXB International searched soil gas sampling locations prior to performing invasive activities. No ordnance was discovered.

5.8.3 Soil Gas Survey

Nine soil gas samples were collected downgradient of the landfill to assess the possibility of VOC ground water contamination and to assess the need for ground water monitoring downgradient of Area 8. Two of the soil gas survey points contained 0.2 ppbv benzene, 0.3 ppbv toluene, and 0.5 ppbv TVHC. The concentrations of contaminants detected were not

considered high enough to warrant the installation of a ground water monitoring well in this area during this phase of the investigation.

Soil gas sampling locations and detected concentrations of VOCs are shown on Figure 8-1.

5.8.4 Surface Water and Sediment Sampling

Surface water and sediment samples (SW-5 and SS-5) were collected from the marsh downgradient of the mound of fill material. The sampling location was selected because of it's proximity to the mound of fill material, and the presence of surface water. The water surface and the marsh sediment were inspected for discoloration, sheen, or other visual evidence of contamination; no evidence of contamination was noted. The samples were analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, and pesticides.

The sediment and surface water sampling location is shown on Figure 8-2.

5.8.4.1 Analytical Results

Metals

The sediment sample contained a concentration of lead (38.7 ppm) that exceeded the NOAA ER-L concentration of 35 ppm.

The surface water sample contained a concentration of lead (117 ppb) that exceeded New Jersey Surface Water Quality Standards of 50 ppb. However, significant quantities of suspended solids were present in the sample; this may explain the relatively high concentration of lead reported.

Others

Concentrations of other contaminants in the surface water sample and the sediment sample were below detection limits, or were detected in concentrations below New Jersey Surface Water Quality Standards or NOAA ER-L concentrations.

5.8.5 Soil Geology, Area 8

Dames & Moore did not conduct a subsurface soil investigation in Area 8, and we are not aware of subsurface soil data from other sources; therefore, no discussion of the geology is presented.

TABLES FOR AREA 8

TABLE 8-1

AREA 8
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG 8-3-3′	--	--	--	0.2	0.3	--	--	0.5
SG 8-4-3′	--	--	--	0.2	0.3	--	--	0.5

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

[d:\...\job\19577014\march93\usac0814.81]

TABLE 8-2

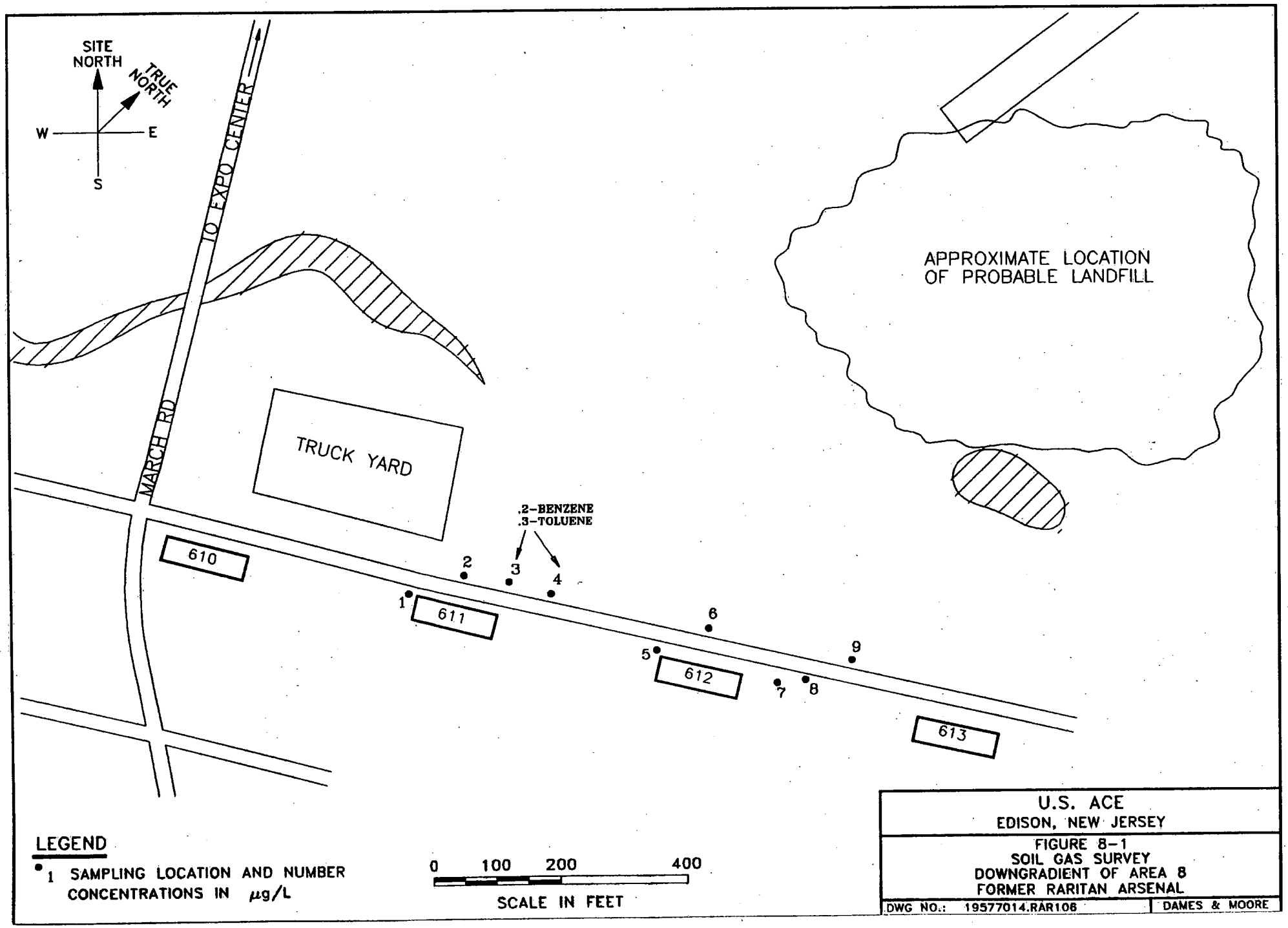
AREA 8
DETECTABLE CONCENTRATIONS OF ANALYTES
SURFACE WATER SAMPLE SW-5

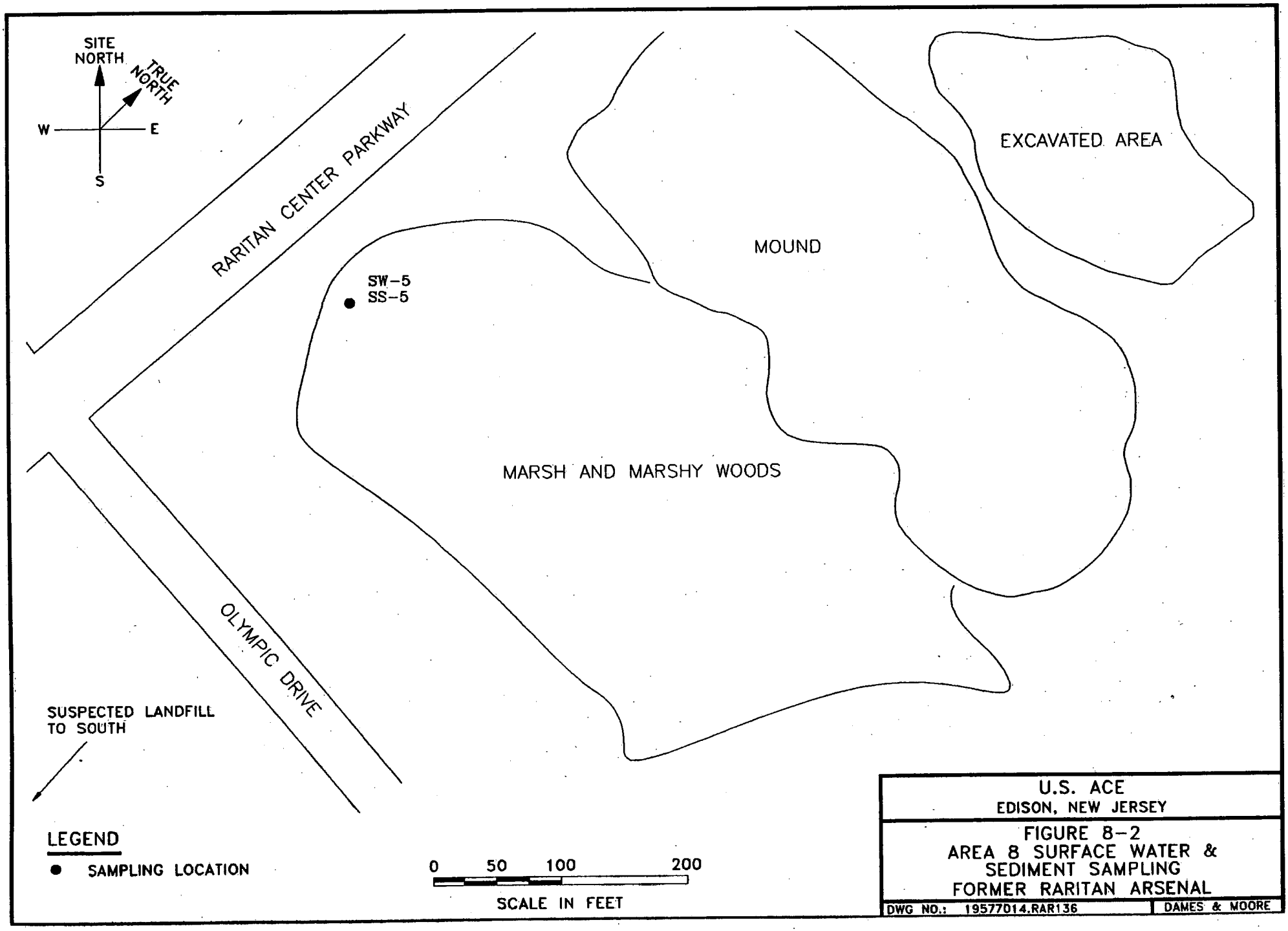
PARAMETER	NJDEPE SURFACE WATER STANDARD	SW-5
Metals (Total)		
Arsenic	50	8.7
Barium	1,000	96.3
Chromium	50	26.3
Lead	50	117
VOCS		
Carbon Disulfide	NS	6.8

Notes: NS = No Standard Proposed
Concentrations are given in μg/L (parts per billion).
New Jersey Surface Water Quality Standards (N.J.A.C.7: 9-4.1 et seq.)

[d:\...\job\19577014\march93\sur0326.82]

FIGURES FOR AREA 8


SITE NORTH
TRUE NORTH
W
E
S
TO EXPO CENTER
MARCH RD
TRUCK YARD
APPROXIMATE LOCATION OF PROBABLE LANDFILL
.2-BENZENE
.3-TOLUENE
610
611
612
613
1
2
3
4
5
6
7
8
9
LEGEND
1 SAMPLING LOCATION AND NUMBER
CONCENTRATIONS IN µg/L
0 100 200 400
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 8-1
SOIL GAS SURVEY
DOWNGRADIENT OF AREA 8
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR108
DAMES & MOORE


SITE NORTH
TRUE NORTH
W
E
S
RARITAN CENTER PARKWAY
OLYMPIC DRIVE
SW-5
SS-5
MOUND
EXCAVATED AREA
MARSH AND MARSHY WOODS
SUSPECTED LANDFILL TO SOUTH
LEGEND
SAMPLING LOCATION
0 50 100 200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 8-2
AREA 8 SURFACE WATER & SEDIMENT SAMPLING
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR136
DAMES & MOORE

5.9 AREA 9

Area 9 was a magazine area in the early 1940s, storing various grades of explosives and ammunition. Magazine Building H-65 exploded in 1943, scattering ammunition, powder, and scrap over a wide area.

In 1963, LEAD disked and surface-burned the soil and swept for mines. Most of Area 9 subsequently was recommended for "Unrestricted Use"; Parts I and II were recommended for "Surface Use Only" on the basis of the mine sweep.

OBG conducted a contamination evaluation of Area 9 in 1987-88. Their investigation included ordnance searches and removal of live shells from Part II; installation of shallow monitoring wells; and collection of surface and subsurface soil samples for laboratory analyses. Ground water analyses indicated the presence of several VOCs in concentrations ranging from 16 ppb to 280 ppb, 5 ppm total recoverable petroleum hydrocarbons (TRPH), 40 ppb total arsenic, and total lead concentrations which ranged from 5 ppb to 14 ppb. No VOCs or explosives were detected in surface soil samples. Analyses of subsurface soil samples detected metals and VOCs below the NJDEPE proposed residential surface and subsurface soil cleanup standards. No explosive analyses were performed on subsurface samples.

Area 9 is heavily developed with buildings, parking lots, landscaped areas, and roads. Two of the OBG monitoring wells (MW-4 and MW-5) could not be located; it is assumed they were removed during site development activities.

5.9.1 Dames & Moore Field Activities

Dames & Moore conducted a soil gas survey and a UXO survey, installed and sampled three monitoring wells, and sampled OBG monitoring well MW-6.

5.9.2 UXO Survey

Personnel from UXB International searched and cleared all soil gas sampling points and monitoring well installation locations prior to initiation of invasive activities. Numerous metallic contacts, primarily miscellaneous pieces of trash and ferrous rocks, were noted along railroad beds and roads. No ordnance was discovered.

5.9.3 Soil Gas Survey

Soil gas samples were collected and analyzed for the selected VOCs stated in the Work Plan to determine the placement of monitoring wells, and to further assess VOC contamination previously detected during the OBG investigation. Sixty-five soil gas samples were collected in and adjacent to Area 9, in both upgradient and cross-gradient directions, to assess the extent of VOC contamination detected in OBG monitoring well MW-4. Lines of sampling points were centered on MW-4, and sampling continued at approximately 300-foot intervals until samples were obtained that contained no detectable concentrations of the selected VOCs. Specific sampling locations varied depending upon accessibility, surface obstructions, and subsurface anomalies. Wherever possible, soil gas samples were collected in islands of undeveloped land, along railroad tracks that existed at the time the arsenal was in use, and in locations that appeared to be at or close to original grade.

Five soil gas samples were collected near the former location of MW-4 to select locations for monitoring well cluster MW-47A and MW-47B. Three soil gas sampling points contained detectable amounts of TCE, ranging from 0.003 to 0.01 ppbv; the point with the highest concentration of TCE was chosen for the installation of MW-47A.

Six soil gas sampling points were evaluated in a truck lot downgradient of Area 9 to determine the location of monitoring well cluster MW-48A and MW-48B. One of the points contained toluene at a concentration of 1.0 ppbv; this location was chosen for the installation of MW-48A.

Soil gas sampling locations are shown on Figures 9-1 and 9-1A. Soil gas data are summarized in Table 9-1.

5.9.4 Monitoring Well Installation and Sampling

Dames & Moore installed three monitoring wells upgradient, downgradient, and within Area 9, and sampled OBG monitoring well MW-6.

MW-47A is a shallow monitoring well installed near the former location of MW-4. The well is screened from depths of 7 to 12 feet in sands, clayey silts, and clay, and was terminated in a gray, silty clay layer.

Boring MW-47B was advanced until black shale bedrock was encountered at a depth of 21.5 feet. The soil consisted of silty clay from depths of 11.5 feet to the top of bedrock. Because no soil layer suitable for well installation was encountered, the boring was grouted to the surface and abandoned.

Monitoring well cluster MW-48A and MW-48B was installed to monitor ground water conditions downgradient of Area 9. MW-48A was drilled to a depth of 17 feet, and was screened from depths of 7 to 17 feet in yellowish red to brown fine to medium sands with varying amounts of coarse sand and fine gravel. MW-48B was installed less than 5 feet from MW-48A, in the inferred crossgradient direction. The well was screened from depths of 19 to 28 feet in sands grading to sandy gravel, and was terminated in a greenish gray clayey silt. Both screens are set in the same aquifer. MW-48A monitors ground water quality in the upper portion of the aquifer to detect contaminants that are less dense than water and tend to float (such as petroleum hydrocarbons); MW-48B monitors ground water quality at the bottom of the aquifer to detect contaminants that are heavier than water and tend to sink (such as explosives and TCE).

Ground water samples were collected from OBG monitoring well MW-6 and the three wells installed by Dames & Moore. Samples were analyzed for VOCs, base/neutral and acid extractable organic compounds, explosives, pesticides, and metals. Ground water samples collected from MW-48A were analyzed for both total and dissolved metals because of the slow recharge rate in this well.

Monitoring well boring logs, construction diagrams, and development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.9.4.1 Analytical Data

Metals

As shown in Table 9-2, concentrations of metals that exceeded the NJDEPE criteria and/or PQLs were detected in ground water samples from three wells.

Total arsenic was detected in water samples from MW-6 (8.6 ppb), MW-47A (15.3 ppb), and MW-48A (8.5 ppb); the NJDEPE criteria for this metal is 0.02 ppb with a PQL of 8 ppb. No arsenic was detected in the filtered sample from MW-48A.

Cadmium was detected in water samples from MW-47A (23 ppb) and MW-48A (6 ppb); the NJDEPE criteria is 4 ppb. No cadmium was detected in the filtered sample from MW-48A.

Lead was detected in the water sample from MW-48A at a concentration of 12.1 ppb; the NJDEPE criteria is 5 ppb with a PQL of 10 ppb. No lead was detected in the filtered sample from MW-48A.

All other metals detected in the water samples from this area were below NJDEPE criteria.

Explosives

One explosive, 1,3,5-trinitrobenzene, was detected at a concentration of 0.368 ppb in the water sample from MW-47A; the NJDEPE has not proposed a criteria for this compound.

VOCs

As shown in Table 9-3, MW-47A contained benzene (9.2 ppb), 1,2-DCE (160 ppb), and TCE (95 ppb) in concentrations that exceeded NJDEPE criteria and/or PQLs. The criteria for benzene is 1 ppb with a PQL of 1 ppb. The criteria for 1,2-DCA is 110 ppb. The criteria for TCE is 1 ppb.

TCE also was found in MW-48B, a deep well, at a concentration of 30 ppb. No TCE was detected in the sample from MW-48A, a shallow well.

No other VOCs were detected in ground water samples from this area.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 9-3, concentrations of semivolatile organic compounds detected in the water samples from this area were below NJDEPE criteria.

Pesticides

No pesticides were detected in the water samples from this area.

5.9.5 Soil Geology, Area 9

Gray and reddish brown silty fine sands were encountered to a depth of 9.5 feet in the boring advanced for monitoring well MW-47B in the northwestern corner of Area 9. Underlying these sands was a 2-foot-thick grayish brown clayey silt.

Sands also were encountered in the southwestern corner of Area 9, where monitoring wells MW-48A and MW-48B were installed. However, these sands differed slightly from those found in the boring for MW-47B in the northwestern portion of the site, approximately 0.6 mile distant. The sands in the boring for MW-48B tended to be yellowish red to reddish brown, were fine to medium and fine to coarse in grade, and contained some fine to coarse gravel. Silt was absent until a depth of 21 feet was reached. At a depth of 23 feet, the soil changed to a sandy gravel.

The silty clay unit was encountered in Area 9. At the location of monitoring well MW-47B, clay was encountered at a depth of 11.5 feet and extended to the top of bedrock at 21 feet. The clay is light gray in its upper portion, grading to black near bedrock. At monitoring well MW-48B, a greenish gray clayey silt was encountered at a depth of 28 feet. The thickness of the clay layer at MW-48B is not known; the boring was advanced to a depth of 29 feet, but did not penetrate the layer.

Bedrock (black shale) was encountered in the borehole for monitoring well MW-47B at a depth of 21 feet. As stated above, bedrock was not encountered in the boring for monitoring well MW-48B.

No clayey peat or peat layers were encountered in any of the borings advanced by Dames & Moore in Area 9.

5.9.6 Ground Water Levels

Three rounds of ground water level measurements were taken at the four monitoring wells in this area. The elevations of the ground water in these wells are stated below in feet above mean sea level.

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-6	2.13	1200	2.11	1017	2.41	1134
MW-47A	8.45	1420	8.42	1007	8.53	1227
MW-48A	2.89	1415	2.83	1009	3.13	1131
MW-48B	3.35	1416	3.29	1010	3.59	1130

Based on a review of this data, the general ground water gradient is toward the south-southeast, as expected.

There is a consistent 0.45-foot difference between the ground water levels recorded in MW-48A and MW-48B. These wells were installed with their screens in the upper and lower portions of the same aquifer; it is not clear why there is a difference in the water elevations in these wells.

TABLES FOR AREA 9

TABLE 9-1

AREA 9
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG 9-4-3′	--	--	0.1	--	--	--	--	0.9
SG MW-47-1-3′	--	--	0.01	--	--	--	--	--
SG 9-5	--	--	--	0.2	--	--	--	0.2
SG MW-47-2-3′	--	--	0.003	--	--	--	--	--
SG MW-47-4-3′	--	--	0.006	--	--	--	--	--
SG 9-6-3′	--	--	0.008	--	--	--	--	--
SG 9-10-4′	--	--	--	--	--	--	2.0	5.0
SG-9-13-5′	--	--	0.2	0.2	--	--	--	0.2
SG-9-15-2′	--	--	--	0.2	0.3	--	--	3
SG 9-21-5′	--	--	--	--	--	--	--	1
SG 9-22-3′	--	--	--	--	--	--	--	5
SG 9-23-5′	--	--	--	--	--	--	--	1
SG 9-24-5′	--	--	0.002	--	--	--	--	--
SG 9-25-3′	--	--	--	--	--	--	--	0.4
SG 9-29-3′	--	--	--	--	--	--	--	33
SG 9-30-3′	--	0.5	--	--	--	--	--	--
SG 9-35-3′	--	--	--	--	0.2	--	--	--

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

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TABLE 9-1 (continued)

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG9-37-3′	--	--	--	0.1	0.2	--	--	0.4
SG9-39-2′	--	--	0.06	0.3	1	--	0.6	3
SG9-40-2′	--	--	--	0.2	0.2	--	--	0.4
SG9-41-3′	--	--	0.02	--	0.3	--	0.4	0.8
SG9-45-3′	--	--	--	0.2	--	--	--	0.2
SG9-46-2′	--	--	0.3	0.9	7	--	5	16
SG9-47-2′	--	--	0.03	0.2	0.3	--	0.2	0.8
SG9-48-2′	--	--	0.002	--	--	--	--	--
SG9-53-5′	--	--	0.1	--	--	--	--	--
SG-9-58-3′	--	--	--	0.08	0.08	--	--	--
SG-9-59-4′	--	--	--	--	0.08	--	--	--
SG-9-61-5′	--	--	--	--	0.2	--	--	0.2
SG-9-63-5′	--	--	--	--	--	--	--	2
SG-9-64-5′	--	--	--	--	0.3	--	--	4
MW48-6-2′	--	--	--	--	1.0	--	--	7
MW48-4-2′	--	--	--	--	--	--	--	11

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

[d:\...\job\19577014\march93\usac0814.91]

TABLE 9-2

AREA 9
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-6	MW-47A	MW-48A	MW-48B	MW-48A*
ARSENIC	0.02	8	8.6	15.3	8.5	--	--
BARIUM	2000	200	124	43.0	104	51	35
CADMIUM	4	2	--	23.0	6.0	--	--
CHROMIUM	100	10	--	--	35	--	--
LEAD	5	10	--	3.6	12.1	2.8	--
MERCURY	2	0.5	--	--	--	--	--
SELENIUM	50	10	--	--	--	--	--
SILVER	20	2	--	--	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
*Dissolved metal concentration.
Water Criteria Reference: 24 N.J.R. 389 Subchapter 4, Table 4-1, revised 2/1/93.

[d:\...\job\19577014\march93\tbl0914.92]

TABLE 9-3

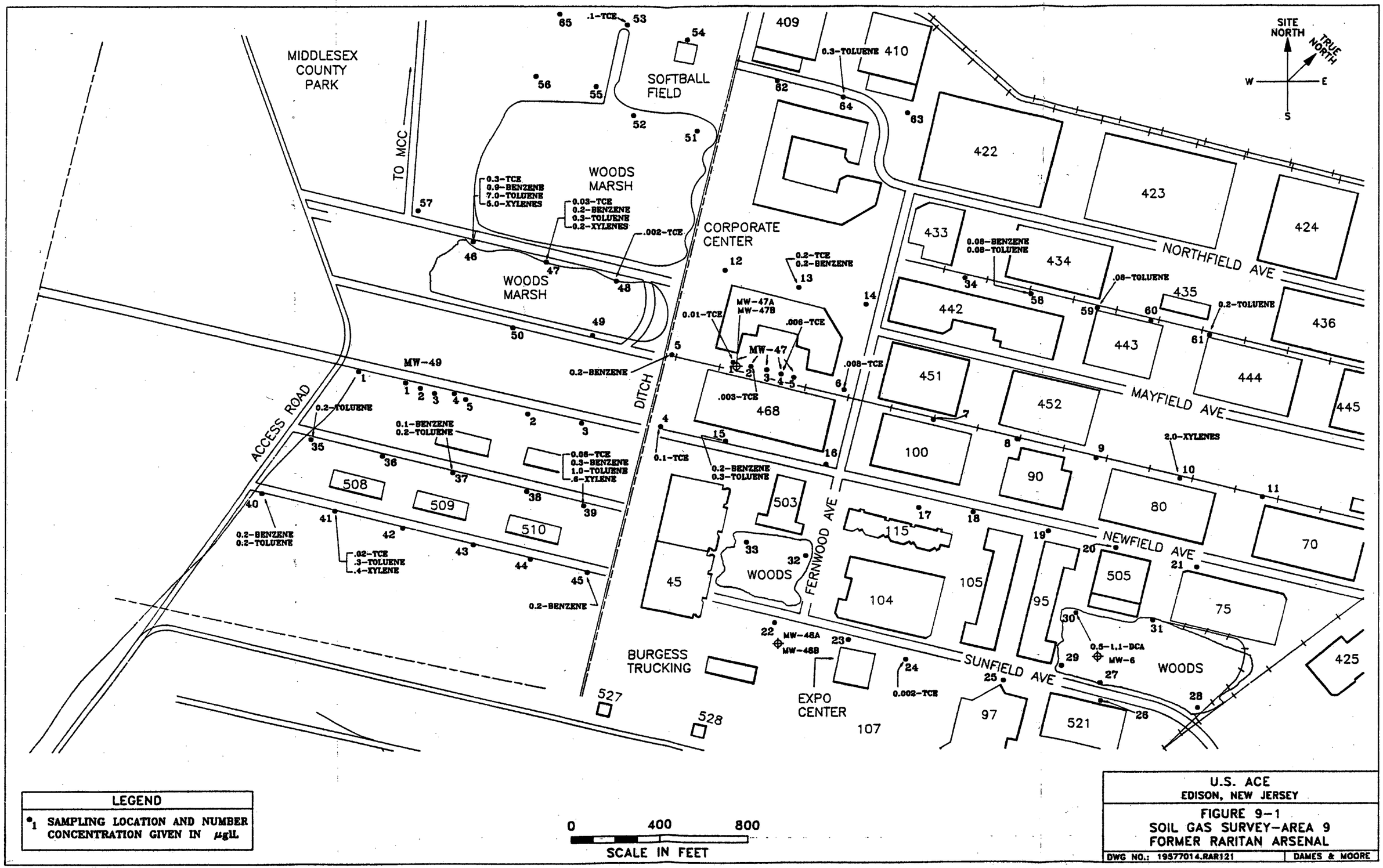
AREA 9
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-6	MW-47A	MW-48A	MW-48B
Explosives						
1,3,5-Trinitrobenzene	NS	NS	--	0.368	--	--
Volatile Organic Compounds						
Benzene	0.2	1	--	9.2	--	--
1,2-DCE (total)	110 [1]	2	--	160	--	--
TCE	1	1	--	95	--	30
Base/Neutral and Acid Extractable Compounds						
Diethylphthalate	5000	10	--	1.6	1.7	--
Naphthalene	30	NS	--	3.3	--	--

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
Water Criteria Reference: 24 N.J.R. 389, Subchapter 4, Table 4-1, revised 2/1/93.
[1] NJDEPE Criteria for cis-1,2-DCE and trans-1,2-DCE are 10 and 100 μg/L, respectively.

[d:\...\job\19577014\march93\tbl0914.93]

FIGURES FOR AREA 9



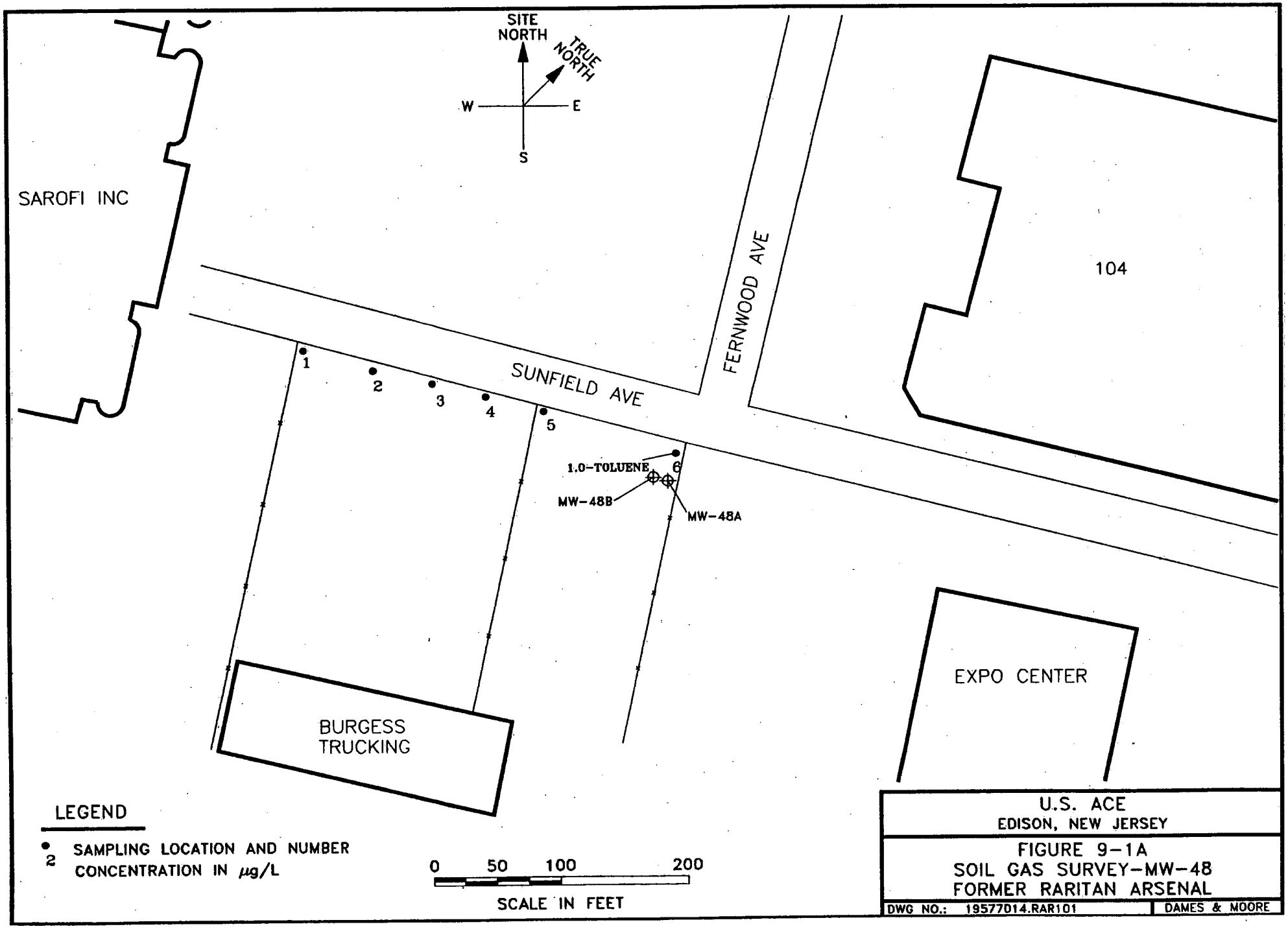
LEGEND

•1 SAMPLING LOCATION AND NUMBER
CONCENTRATION GIVEN IN µg/L

U.S. ACE
EDISON, NEW JERSEY

FIGURE 9-1
SOIL GAS SURVEY-AREA 9
FORMER RARITAN ARSENAL

DWG NO.: 19577014.RAR121 | DAMES & MOORE


SITE NORTH
TRUE NORTH
W
E
S
SAROFI INC
SUNFIELD AVE
FERNWOOD AVE
104
1
2
3
4
5
6
1.0-TOLUENE
MW-48B
MW-48A
BURGESS TRUCKING
EXPO CENTER
LEGEND
2 SAMPLING LOCATION AND NUMBER
CONCENTRATION IN μg/L
0 50 100 200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 9-1A
SOIL GAS SURVEY-MW-48
FORMER RARITAN ARSENAL
DWG NO.: 19577D14.RAR101
DAMES & MOORE

5.10 AREA 10

Although the northeastern portion of Area 10 has been developed as a part of Raritan Center, most of the area has been developed as a public park. Area 10 was used primarily for munitions storage, and for depriming of cartridge cases. An explosion in the 1920s, one of several that had an impact on the area, destroyed six magazines and apparently scattered ordnance fragments over the area now known as Area 10, Parts I and II. During the 1963 decontamination effort, LEAD surface cleaned these two areas and disked parts of them. Parts I and II of Area 10 were recommended by LEAD for "Surface Use Only"; reports indicated the potential presence of buried ordnance beyond the detection capabilities of the instrumentation then available. Potential hazards in this area include the possible presence of subsurface live ammunition, and the potential for ground water and soil contamination by metals, explosives, and explosive residues.

OBG conducted a records review and a subsequent site inspection of Area 10 during their 1987-88 investigation, but did not perform a contamination evaluation in this area. However, UXB International, under contract to OBG, performed a brief visual inspection of an undeveloped portion of Area 10 during the initial OBG site inspection; spot checks with ordnance locators also were performed. These checks located only one ordnance fragment, identified as the remains of a 35-mm cartridge base, at a depth of 6 inches.

A review of drawing D-418 indicated the presence of a sewage disposal system generally located between magazine lines B and D. This system apparently was constructed sometime between 1934 and 1943, according to information in the Metcalf & Eddy Archive Search Report previously mentioned. Dames & Moore conducted a limited soil gas survey in this area which resulted in the installation of a shallow monitoring well.

Before Dames & Moore was able to conduct its investigation of Parts I and II of Area 10, the entire area was cleared of ordnance under the direction of the Huntsville Division of the USACE as part of the ongoing ordnance remediation at the arsenal. This resulted in the complete disturbance of the soils in this area.

5.10.1 Thomas A. Edison Park

5.10.1.1 Soil Gas Survey

Thirty soil gas samples were collected in various areas of Thomas A. Edison Park to assess the placement of one monitoring well cluster (MW-55A and MW-55B) and one shallow monitoring well (MW-49), and to assess the possibility of ground water contamination cross-gradient of Area 9.

Five soil gas samples were collected in the assumed downgradient direction from Area 17A, along the park's northern fence line, to assess the possibility of ground water contamination migrating from Area 17A and to determine the placement of monitoring wells MW-55A and MW-55B. The downgradient direction was predicted based on the topography of the area and the location of the Raritan River. The soil gas sampling points were based on the well locations shown in the Work Plan, and were spaced approximately 50 feet apart; actual locations of the sampling points varied depending upon the presence of subsurface metallic contacts. Three soil gas samples (SG-MW-55-1 through 3) were collected at a depth of 5 feet; the other two samples were collected at a depth of 2 feet due to the presence of ground water below that depth. Volatile organic compounds were detected at one location; SG-MW-55-4 contained 0.4 ppbv TCE. Monitoring wells MW-55A and MW-55B were installed at this location.

Five soil gas samples were collected along Magazine Road 8, adjacent to Parts I and II of Area 10, to aid in the placement of MW-49. The sampling points were spaced approximately 50 feet apart, with actual sampling locations dependent upon the existence of subsurface metallic contacts and surface obstructions. Soil gas samples were collected at depths of 2 to 3 feet because of the presence of a high ground water table. None of the five samples contained detectable concentrations of any of the seven volatile organic compounds of concern; however, matrix interference on SG-MW-49-5 precluded definitive assessment of the presence of benzene and toluene. The matrix interference was detected during Tracer's office review of their data, and was not identified in the field. The location of MW-49 was selected based upon physical and inferred hydrogeologic conditions, rather than on soil gas data, because no VOCs were detected by the soil gas survey; the suspected contaminants of concern were metals and explosive residues which would not have been detected by this field screening method. The soil gas

survey was conducted for MW-49, however, to provide additional information concerning potential VOC contamination at the site.

Thirteen soil gas samples were collected in the eastern half of Thomas A. Edison Park as a continuation of a soil gas survey of Area 9, and to assess the area assumed to be downgradient of the former sewage plant area. The downgradient direction was predicted based on the topography of the area, the location of the Raritan River, and the results of a previous investigation conducted by O'Brien & Gere in 1987-1988. Sampling points were spaced approximately 300 feet apart, with actual sampling locations varying depending upon the existence of subsurface metallic contacts and ease of access. The soil gas survey data from each sample location were evaluated immediately after GC analysis, and additional samples were collected approximately 300 feet away if any of the compounds of concern were detected, in accordance with provisions included in the Work Plan. Samples were collected at depths of 2 to 5 feet, depending on the depth to ground water. Four soil gas samples (SG9-46, 47, 48, and 53) contained TCE in concentrations ranging from 0.1 to 0.3 ppbv. Sample 46 contained 0.9 ppbv benzene, 7.0 ppbv toluene, 5.0 ppbv xylenes, and 0.3 ppbv TCE; monitoring well MW-56 was installed at this location.

Seven additional soil gas samples were collected along the park's northern fence line as part of an effort to characterize ground water contamination from VOC sources upgradient of Area 10. Volatile organic compounds were detected only in sample SG10-6, which contained 5.0 ppbv TCE; this sample was obtained from a small, low lying area near the soccer field.

Soil gas sampling locations are shown on Figure 10-2; data are summarized in Table 10-1.

5.10.1.2 Soil Sampling Depths/Locations

Soil sampling in Parts I and II of Area 10 was performed on a grid basis in accordance with the Work Plan. Twenty shallow soil borings were advanced to a depth of 2 feet, and soil samples were analyzed for metals and explosives. The results of these analyses are presented on Figure 10-3 and are summarized in Table 10-4.

5.10.1.2.1 Analytical Results

Explosives

No explosives were detected in any soil samples from this area.

Metals

As shown in Table 10-4, arsenic was detected in 19 of the 20 soil samples in concentrations that exceeded the NJDEPE proposed cleanup standard of 2 ppm. The concentrations of arsenic detected ranged from 2.06 ppm to 268 ppm. Four borings, located in the northeast corner of the area investigated, adjacent to the foundation of former Magazine 447, contained concentrations of arsenic ranging from 74.7 ppm to 268 ppm; the presence of arsenic in these concentrations may be the result of the use of pesticides around the magazines.

5.10.2 Raritan Center

5.10.2.1 Soil Gas Survey

Five soil gas samples were collected along the railroad tracks northwest of Northfield Avenue, approximately 800 feet east of Fernwood Avenue, to determine the placement of monitoring well cluster MW-46A and MW-46B. Sampling point SG-MW46-1 contained 0.08 ppbv TCE; however, physical constraints and access limitations did not allow the installation of a monitoring well at this location. MW-46A and MW-46B were located as close to this soil gas sampling point as was practical.

Nine additional soil gas samples were collected north of Area 10, along the railroad tracks north of Northfield Avenue, to assess selected VOC contamination along the boundary between Area 10 and the GSA/USEPA area. Four samples contained at least one of the VOCs of concern: 1,1-DCE was detected at a concentration of 0.1 ppbv in SG10-15; TCE was detected at a concentration of 0.2 ppbv in SG10-14; and benzene and toluene were detected at concentrations of 0.2 ppbv in SG10-11 and SG10-16.

Soil gas sampling locations are shown on Figure 10-1. Soil gas data are presented in Table 10-1.

5.10.3 Monitoring Well Installation and Sampling

MW-46A was installed along the railroad tracks upgradient of Northfield Avenue and downgradient of the GSA/USEPA area. The well was screened from depths of 7 to 17 feet in brownish yellow fine to coarse sand, interlayered in its upper levels with gray fine sand. MW-46A is located at the rear of a heavily-used truck parking lot and loading area. Because of the volume of traffic in the area, it was necessary to install the well with a flush-mounted protective casing rather than a stick-up. This revision in monitoring well installation procedures was made after consultation with USACE representatives.

Dames & Moore attempted to install MW-46B crossgradient to MW-46A. The boring was advanced to the bottom of MW-46A and the outer casing was set and grouted. A light gray silty clay was encountered at 18.8 feet, and extended to a reddish brown silty clay encountered at 21 feet. The reddish brown silty clay extended to 27 feet, where weathered reddish shale bedrock was encountered. The boring was terminated at 28 feet, approximately 1 foot into the bedrock. Because no permeable soils were encountered below the depth of MW-46A, the boring was grouted to the surface with a 3 percent bentonite/cement mixture and abandoned.

Monitoring well MW-49 was advanced to a depth of 17 feet. A screen was set from depths of 7 to 10 feet in sands and silty sands.

Monitoring well MW-55A was advanced to a depth of 12 feet where a confining layer of gray to olive-gray silty clay and peat was encountered. A custom-made 2 feet long screen was set at depths of 7 to 9 feet in the silty sands overlying the clay and clayey peat layer.

The soil boring for deep monitoring well MW-55B was advanced to a depth of 12 feet, and an 8" steel casing was set and grouted to a depth of 11 feet. After allowing the grout to cure for more than 48 hours, well installation was resumed by flushing the casing, then drilling through the grout seal in the bottom of the casing and advancing the remainder of the boring with a 6.5 inch OD mud rotary bit while circulating drilling muds. MW-55B was advanced to a depth of 21 feet and terminated at the top of bedrock. The well was screened in the sands from the top of the bedrock to a depth of one foot beneath the base of the clay, from depths of 14 to 21 feet.

Monitoring well MW-56 was terminated at a depth of 10 feet in a blue-gray clay unit believed to be the Raritan Fireclay; a custom-made 3 feet long screen was set in the sands immediately overlying this clay unit.

Based on the soil gas survey, shallow monitoring well MW-57 was installed northwest of Northfield Avenue, at the back of Rheem Manufacturing (building 409 in Figure 10-1), to provide data on ground water quality upgradient of Areas 9 and 10. MW-57 was screened from depths of 9 to 14 feet in alternating layers of orange brown fine to coarse sand and gray or gray and brown clay. This well was one of the six wells located solely on the basis of the soil gas survey.

Monitoring well boring logs, construction diagrams, development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.10.3.1 Analytical Results

Ground water samples were collected from Dames & Moore monitoring wells MW-46A, MW-49, MW-55A, MW-55B, MW-56 and MW-57 and were analyzed for VOCs, metals, explosives, base/neutral and acid extractable organic compounds, and pesticides. Analyses for both dissolved and total metals were performed for water samples from MW-46A because of the slow recharge rate of this well.

<u>Metals</u>

As shown in Table 10-2, lead was detected in the ground water sample from MW-55A at a concentration of 13.2 ppb; this concentration exceeded the NJDEPE criteria of 5 ppb with a PQL of 10 ppb. It should be noted, however, that MW-55A is a slow recharging well; the water sample from this well contained visible amounts of sediment, which could account for the concentration of lead detected.

All other metals detected in ground water samples from this area were below NJDEPE criteria and/or PQLs.

VOCs

As shown in Table 10-3, MW-46A contained benzene (3.3 ppb), 1,2-DCE (130 ppb), TCE (29 ppb), and vinyl chloride (18 ppb) in concentrations that exceeded NJDEPE criteria and/or PQLs. The NJDEPE criteria for benzene is 0.2 ppb with a PQL of 1 ppb. The NJDEPE criteria for 1,2-DCE is dependent on the isomer present; a determination of the isomer was not performed during this investigation. However, it is obvious that the concentration of 1,2-DCE detected will exceed the NJDEPE criteria for at least one of the isomers. The NJDEPE criteria for vinyl chloride is 0.08 ppb with a PQL of 5 ppb.

Base/Neutral and Acid Extractable Organic Compounds

Bis(2-ethylhexyl)phthalate was reported in ground water samples from MW-55A, MW-56 and MW-57 at concentrations below NJDEPE criteria. It should be noted that this semivolatile compound is a common laboratory contaminant.

Others

No explosives or pesticides were detected in ground water samples from this area.

5.10.4 Soil Geology, Area 10

Information concerning the shallow soils in Area 10 was obtained from 20 borings advanced to a depth of 2 feet in Parts I and II of Area 10 in Thomas Edison Park. Two of these borings (B10-16 and B10-17) were advanced in a low-lying wooded area; the remaining 18 borings were advanced in areas covered by landscaping. The soils in these borings were primarily clayey sands overlying sandy gravels which in turn were overlying silty sands. Soils encountered in the wooded area were similar to those encountered in the landscaped areas.

Information concerning the deeper subsurface soil geology was obtained from borings advanced to install monitoring wells at five locations within Area 10; these wells were spaced approximately 1000 to 2000 feet apart.

Two borings were advanced along the western boundary of Area 10 for the installation of monitoring wells MW-55A and MW-55B. The soils encountered in these borings

predominantly were brown and gray fine sands and fine to medium sands with varying amounts of silt, and clayey sands to a depth of 8 feet. A brown to gray clay with some peat was encountered at depths of 9 to 10 feet, and extended to a depth of 13 feet. Beneath the clay were gray and black sands with varying amounts of silt; these sands extended to the top of a black shale bedrock, encountered at a depth of 20.9 feet. The Raritan Fireclay was not encountered in the boreholes advanced for MW-55A and MW-55B.

A soil boring for MW-56 was advanced approximately 1400 feet east of MW-55A and MW-55B, at the edge of a low-lying wooded area bordering Thomas Edison Park. Dark brown silty, clayey, fine to medium sand was encountered to a depth of 2 feet. From depths of 2 feet to 4 feet, the soil consisted of yellowish brown and gray silty clay with a silt seam. These shallow clays were underlain by brown, orange-brown, and red fine to coarse sands with varying amounts of gravel, silt, and clay; these sands extended to a depth of 9.5 feet where a blue-gray clay was encountered. The clay extended beyond the depth of the boring; this clay may be the Raritan Fireclay.

A boring for MW-57 was advanced approximately 1800 feet north-northeast of MW-55A and MW-55B, near the northwestern boundary of Area 10. Soils encountered in this boring were predominantly sands and clays. A dark brown to brownish yellow fine to medium sand was found from the surface to a depth of 4 feet. This soil layer was underlain by a brown and gray clayey silt approximately 2.4 feet thick. Beneath this clayey silt layer were thin layers of gray or gray and brown clays and silts, varying in thickness from approximately 0.3 foot to 0.8 foot, alternating with thin layers of orange-brown fine to coarse sand. These soils extended beyond the bottom of the boring at 14 feet.

Approximately 1500 feet north-northeast of MW-57, near the northwest boundary of Area 10, two borings were advanced for the installation of MW-46A and MW-46B. The near-surface soils encountered in these borings consisted of approximately 2 feet of sandy gravel fill material overlying gray to brownish yellow fine to medium sands and fine to coarse sands with varying amounts of silt. At a depth of 17 feet, this sand layer graded to brownish yellow silty fine sands which are underlain by silty clay; the clay grades from gray to reddish brown, and extended from a depth of 19 feet to the top of bedrock at 27 feet. The bedrock encountered in the borings advanced for MW-46B consisted of red shale.

A boring was advanced for the installation of MW-49 near the south-southeastern border of Area 10, approximately 1100 feet southeast of MW-56. Soils encountered in this borehole predominantly were yellowish brown to brown silty fine sand grading to yellowish red to reddish brown fine to medium sands and fine to coarse sands with trace fine gravel. The sands extended beyond the bottom of the boring (17 feet). Red shale chips were found within the sands, but bedrock was not encountered.

A peat, or clay and peat, layer was only found at one location in Area 10. Peat was found in the borings advanced for the installation of monitoring well cluster MW-55A and MW-55B; a 3 to 4 foot thick layer of clay with some organic matter was encountered at depths of 9 to 10 feet below grade. The closest known occurrence of a similar layer was at monitoring well MW-54, nearly one mile to the southeast. Because a similar layer was not encountered in any of the borings closer to MW-55A and MW-55B, it is probable this layer is a local lens and is not continuous with the clay and peat encountered at MW-54 or elsewhere on site.

Bedrock underlying Area 10 grades from black to red shale. Black shale was encountered in the borehole advanced to install MW-55B. Black shale also was encountered in the borings advanced to install MW-47B in Area 9, approximately 2700 feet east of MW-55B Approximately 3100 feet northeast of monitoring well MW-55B, and 1900 feet north of MW-47B in Area 9, bedrock was found to be red shale. This variation in color probably reflects a certain amount of metamorphism caused by an igneous intrusion. The only reported intrusive body in the upper bedrock underlying the Raritan Arsenal is a quartz diorite-diabase sill encountered at the top of bedrock in Area 6, more than 2 miles east of monitoring well MW-55B. OBG reported this sill is oriented north-south and dips to the northeast; if this report is accurate, the alteration exhibited by the shale encountered at MW-55B and MW-47B is unlikely to have been caused by this sill, since shale encountered at points nearer to the inferred position of the intrusion (i.e., at MW-62, MW-63, and MW-41) displayed a lesser degree of alteration than the shale encountered at these two locations. It is possible the alteration exhibited by shale found at MW-55B and MW-47B has been caused by a separate intrusive body, perhaps a subsidiary dike associated with the sill encountered in the extreme southeast corner of the arsenal. More geologic data are necessary to resolve this question.

5.10.5 Ground Water Levels

Three measurements of the ground water levels were taken at the monitoring wells installed in Area 10. The elevations of the ground water are presented below in feet above mean sea level.

SHALLOW AQUIFER MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-46A	28.66	1427	28.67	0954	28.75	1236
MW-49	7.35	0920	7.49	1615	7.58	0855
MW-55A	40.18	0930	42.18	1622	42.22	0906
MW-56	15.32	0925	15.28	1618	15.45	0900
MW-57	38.89	1422	38.88	1002	38.90	1230

DEEP AQUIFER MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-55B	37.44	0932	37.47	1624	37.53	0905

These data indicate the ground water flow in the unconfined aquifer is generally toward the southeast, as expected. A review of these ground water levels with respect to time uncovered no consistent variation that could be attributed to tidal influence.

Differences between the ground water levels recorded in shallow well MW-55A and deep well MW-55B were consistently more than 2 feet. This difference indicates the aquifers measured by these wells are hydraulically separated within the vicinity of the wells, and the clay layer separating the two screened intervals functions locally as an aquitard.

TABLES FOR AREA 10

TABLE 10-1

AREA 10
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG-10-11-4′	--	--	--	0.2	0.2	--	--	1
SG-10-15-5′	0.1	--	--	--	--	--	--	0.1
SG-10-14-5′	--	--	0.2	--	--	--	--	0.2
SG-10-16-4′	--	--	--	0.2	0.2	--	--	0.6
SG-MW46-4-2′	--	--	--	--	1	--	0.8	2
SG-MW46-5-2′	--	--	--	--	0.1	--	--	0.1
SG-MW46-1-3′	--	--	0.08	--	--	--	--	0.7
MW-49-5-3′	--	--	--	I[1]	I	--	--	--

[1]I = Matrix interference.

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

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TABLE 10-2

AREA 10
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-46A	MW-49	MW-56	MW-57	MW-55A[2]	MW-55B[2]	MW-46A[1]
ARSENIC	0.02	8	3.0	--	--	--	--	--	--
BARIUM	2000	200	42.1	82.1	19.3	50.3	100.0	39.8	29.8
CADMIUM	4	2	--	--	--	--	--	--	--
CHROMIUM	100	10	18.6	--	--	--	11.8	--	--
LEAD	5	10	4.7	--	2.2	--	13.2	--	--
MERCURY	2	0.5	--	--	--	--	--	--	--
SELENIUM	50	10	--	--	--	--	--	--	--
SILVER	20	2	--	--	--	--	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
[1] Dissolved metal concentration.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.
[2] Monitoring wells were installed within Area 10 and downgradient of Area 17A.

[d:\...\job\19577014\march93\tbl0914.102]

TABLE 10-3

AREA 10
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-46A	MW-49	MW-56	MW-57	MW-55A [2]	MW-55B[2]
Volatile Organic Compounds								
Benzene	0.02	1	3.3	--	--	--	--	--
1,2-DCE (total)	110 [3]	2	130	--	--	--	--	--
Toluene	1000	5	3.3	--	--	--	--	--
TCE	1	1	29	--	--	--	--	--
Vinyl chloride	0.08	5	18	--	--	--	--	--
Xylenes (total)	40	1	4.8	--	--	--	--	--
Base/Neutral and Acid Extractable Compounds								
Bis(2-ethylhexyl)phthalate	3 [1]	30	--	--	1.6	2.9	1.8	--

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
[1] Federal MCL = 6 μg/L.
[2] Monitoring wells were installed within Area 10 and downgradient of Area 17A.
[3] NJDEPE Criteria for cis-1,2-DCE and trans-1,2-DCE are 10 and 100 μg/L, respectively.
Water Criteria Reference: 24 N.J.R. 389, Subchapter 4, Table 4-1, revised 2/1/93.

[d:\...\job\19577014\march93\tbl0914.103]

TABLE 10-4

AREA 10
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE PROPOSED SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B10-1, 0-2', #431	2.06	--	--	--	--	--	--	--
B10-2, 0-2', #432	2.94	--	--	--	--	--	--	--
B10-3, 0-2', #433	4.85	--	--	--	--	--	--	--
B10-4, 0-2', #434	3.56	--	--	--	--	--	--	--
B10-5, 0-2', #435	268	--	--	--	--	--	--	--
B10-6, 0-2', #436	228	--	--	--	--	--	--	--
B10-7, 0-2', #437	75.6	--	--	--	--	--	--	--
B10-8, 0-1', #438	74.7	--	--	--	--	--	--	--
B10-9, 0-2', #439	3.36	--	--	--	--	--	--	--
B10-10, 0-2', #440	3.00	--	--	--	--	--	--	--
B10-11, 0-2', #441	3.06	--	--	--	--	--	--	--
B13, 0-2', #443	7.48	--	--	--	--	--	--	--
B14, 0-2', #444	3.61	--	--	--	--	--	--	--
B15, 0-2', #445	3.01	--	--	--	--	--	--	--

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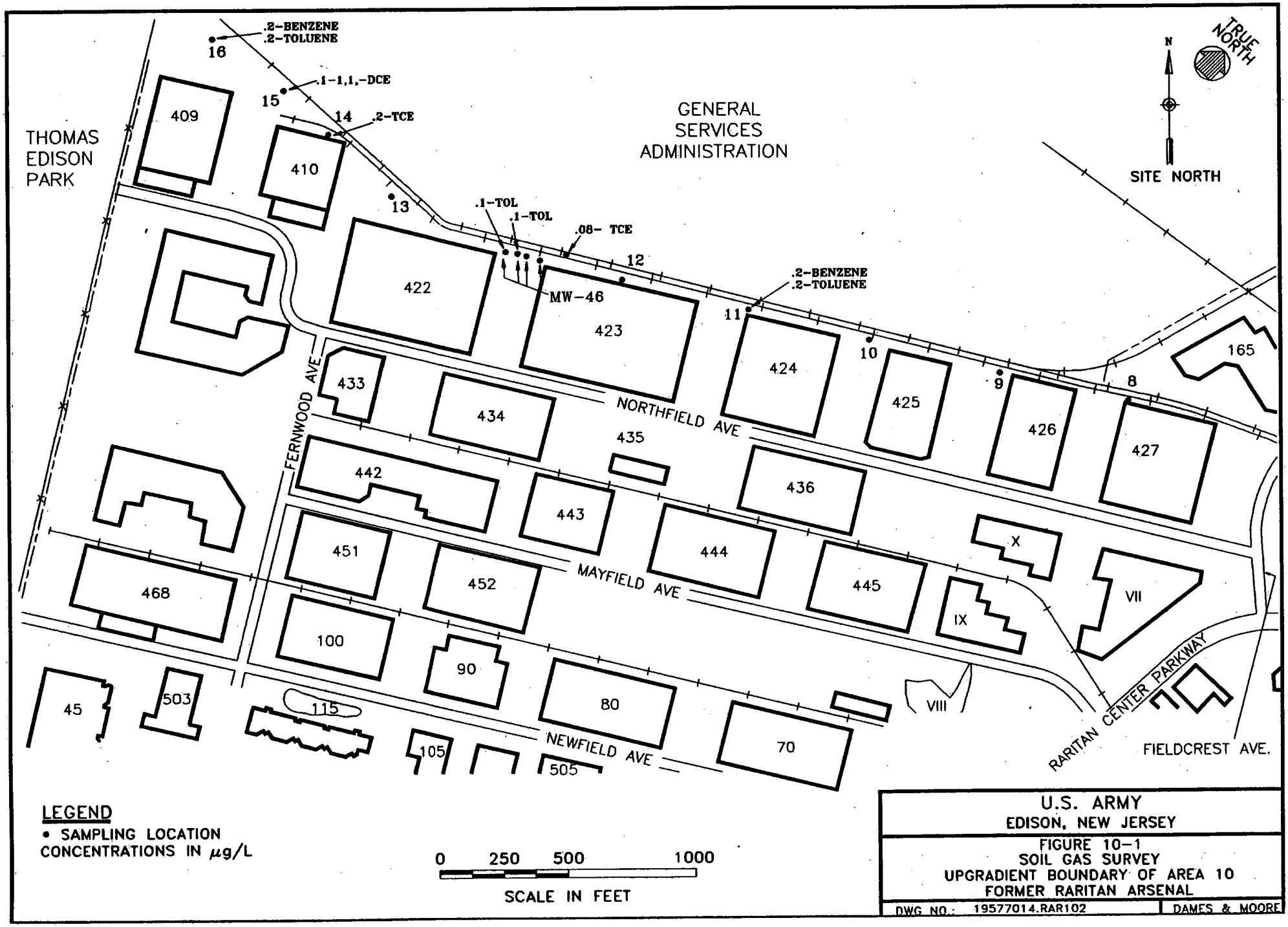
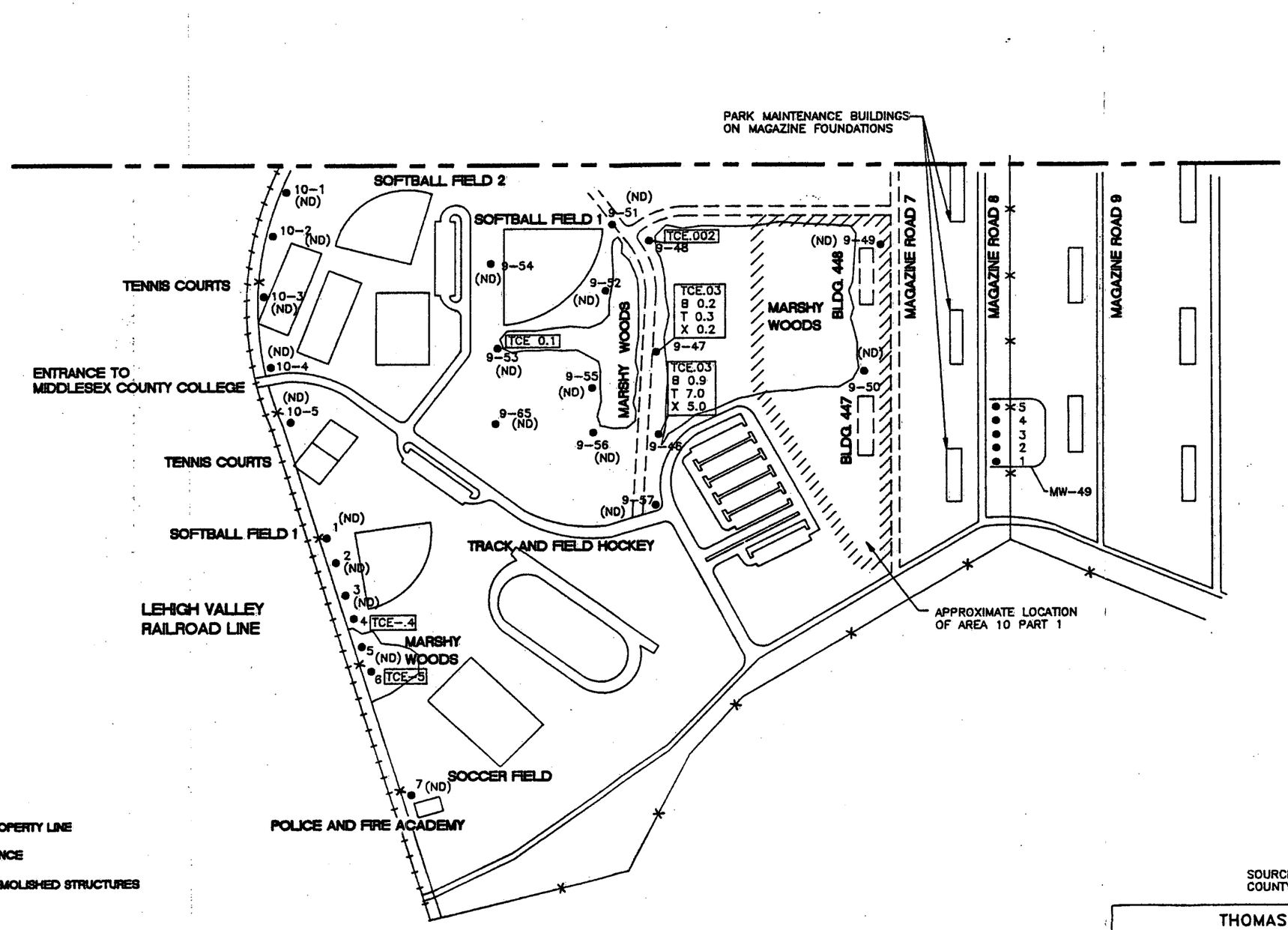
TABLE 10-4 (continued)

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
B16, 0-2', #446	3.81	--	--	--	--	--	--	--
B17, 0-2', #447	10.7	--	--	--	--	--	--	--
B18, 0-2', #448	4.70	--	--	--	--	--	--	--
B19, 0-2', #449	2.89	--	--	--	--	--	--	--
B20, 0-2', #450	3.54	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.

FIGURES FOR AREA 10


.2-BENZENE
.2-TOLUENE
16
.1-1,1,-DCE
15
14
.2-TCE
13
.1-TOL
.1-TOL
.08- TCE
12
MW-46
.2-BENZENE
.2-TOLUENE
11
10
9
8
THOMAS EDISON PARK
GENERAL SERVICES ADMINISTRATION
N
TRUE NORTH
SITE NORTH
409
410
422
423
424
425
426
427
165
433
434
435
436
442
443
444
445
451
452
468
100
90
80
70
45
503
115
105
505
VII
VIII
IX
X
FERNWOOD AVE
NORTHFIELD AVE
MAYFIELD AVE
NEWFIELD AVE
RARITAN CENTER PARKWAY
FIELDCREST AVE.
LEGEND
• SAMPLING LOCATION
CONCENTRATIONS IN μg/L
0 250 500 1000
SCALE IN FEET
U.S. ARMY
EDISON, NEW JERSEY
FIGURE 10-1
SOIL GAS SURVEY
UPGRADIENT BOUNDARY OF AREA 10
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR102
DAMES & MOORE



LEGEND

PROPERTY LINE

FENCE

DEMOLISHED STRUCTURES

TRICHLOROETHENE	(TCE)
BENZENE	(B)
TOLUENE	(T)
XYLENE	(X)

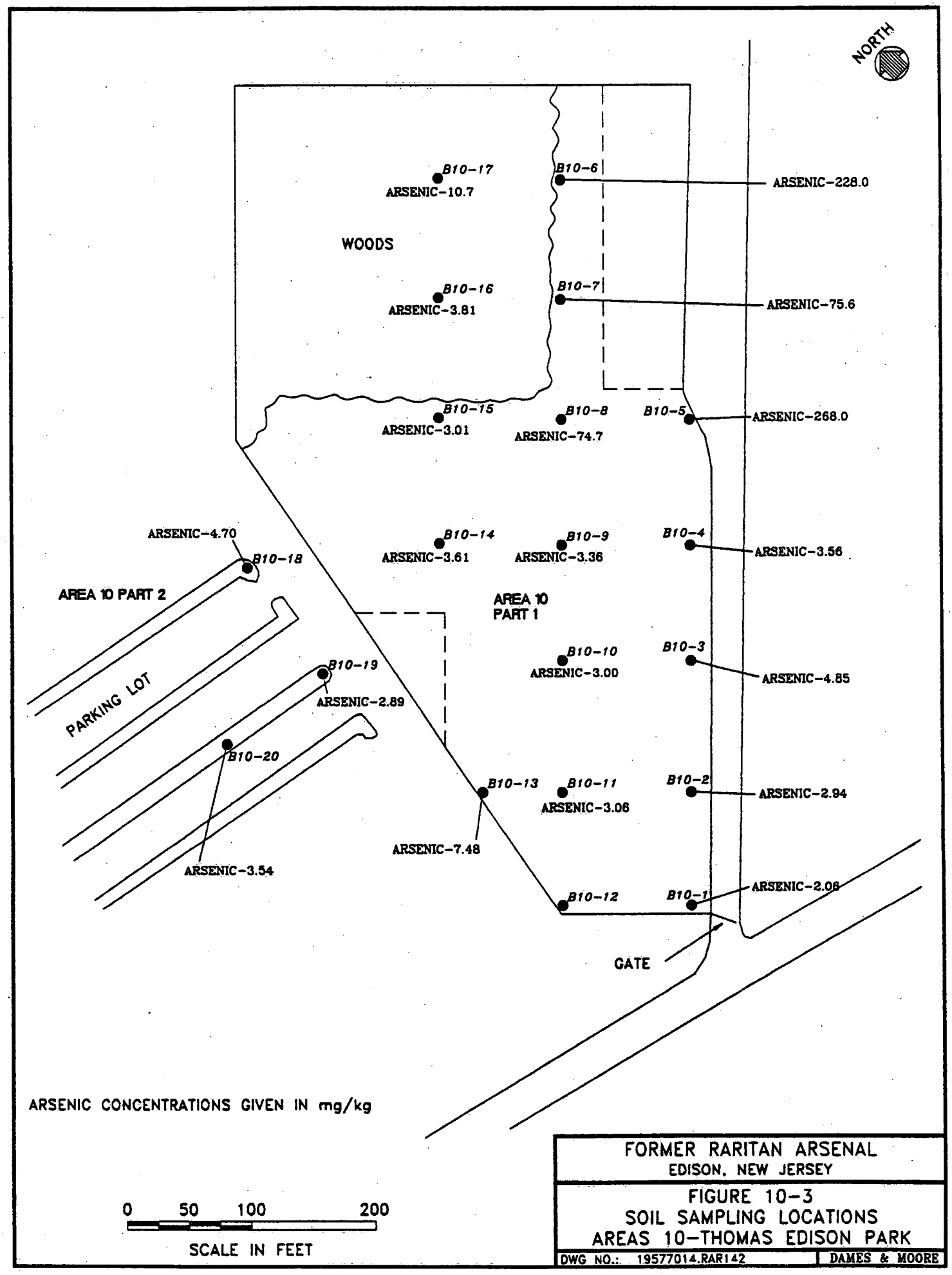
ND- ANALYTICAL COMPOUNDS NOT DETECTED
ALL ANALYTICAL DATA IS REPORTED IN PARTS PER BILLION (PPB)

SOURCE SITE PLAN RARITAN ARSENAL COUNTY PARK, 8/12/74

THOMAS EDISON PARK
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 10-2
SOIL GAS SURVEY
AREA 10 – THOMAS EDISON PARK
FORMER RARITAN ARSENAL

DWG NO.: 19577014.FRA102 | DAMES & MOORE


NORTH
B10-17
ARSENIC-10.7
B10-6
ARSENIC-228.0
WOODS
B10-16
ARSENIC-3.81
B10-7
ARSENIC-75.6
B10-15
ARSENIC-3.01
B10-8
ARSENIC-74.7
B10-5
ARSENIC-268.0
ARSENIC-4.70
B10-18
B10-14
ARSENIC-3.61
B10-9
ARSENIC-3.36
B10-4
ARSENIC-3.56
AREA 10 PART 2
AREA 10
PART 1
B10-10
ARSENIC-3.00
B10-3
ARSENIC-4.85
B10-19
ARSENIC-2.89
PARKING LOT
B10-20
B10-13
B10-11
ARSENIC-3.06
B10-2
ARSENIC-2.94
ARSENIC-7.48
ARSENIC-3.54
B10-12
B10-1
ARSENIC-2.06
GATE
ARSENIC CONCENTRATIONS GIVEN IN mg/kg
0 50 100 200
SCALE IN FEET
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FIGURE 10-3
SOIL SAMPLING LOCATIONS
AREAS 10-THOMAS EDISON PARK
DWG NO.: 19577014.RAR142
DAMES & MOORE

5.11 AREA 11

Area 11 primarily consists of undeveloped marshland adjacent to the Patrol Road northwest of the dock area, and is approximately 6.65 acres in size. Soils and sediments reportedly were dredged from the Raritan River channel and deposited in this area. A series of mounds was noted at the northeast end. Ground water is very shallow and may be influenced by the Raritan River and by tides. Standing water often was present along the roadside. A creek trends from the northwest to the southeast across the southwestern end of the area. A small drainage ditch parallels the road from a ready-mix plant in the southwest corner of the site to its confluence with the creek. The predominant plant growth in this area is phragmites, which often exceed 6 feet in height.

In 1963, LEAD cleaned Area 11 with a drag line and searched it with a metal detector. A hog wire fence was erected around part of the land in the southwestern section of the area; this portion of Area 11 was designated for "Non-use". The remainder of the area was designated for "Unrestricted Use".

OBG conducted a site inspection of Area 11 in 1987-88 which included a subsurface ordnance search and a brief ground surface inspection. The ordnance survey revealed numerous small objects buried in the fenced area. No ordnance was identified on the ground surface. A records review by OBG indicated the area is contaminated with grenades, mortar shells, and small arms components. Analysis of surficial soil samples detected concentrations of VOCs and metals below NJDEPE proposed standards. No explosives were detected.

5.11.1 Dames & Moore Field Activities

Dames & Moore conducted a UXO survey and a soil gas survey; drilled borings and collected soil samples for laboratory analysis; collected a surface water and sediment sample; collected a surface soil sample; and collected ground water samples from the three monitoring wells installed by OBG.

5.11.2 UXO Survey

UXB personnel unearthed two 55-gallon drums containing French rifle grenades and American hand grenades. The drums were sealed at both ends with concrete; this was standard

practice when disposing of ordnance items at sea. Personnel from USACE-Huntsville, Alabama were notified of the discovery of the grenades, in accordance with Dames & Moore's Health and Safety Plan, and the drums were removed and disposed.

The former location of the drums is shown on Figure 11-5.

5.11.3 Soil Gas Survey

Soil gas samples could not be collected in this area because of the high ground water table. Therefore, eleven ground water samples were collected along the assumed downgradient perimeter of Area 11, adjacent to the Patrol Road, and were analyzed for selected VOCs (refer to Section 3.2). The procedures used for sample collection and analyses are presented in the Tracer report which can be found in Volume IV of this report, Appendix F. WS-11-4-5 contained a concentration of 0.06 ppbv TCE. Two samples, WS-11-4 and WS-11-5, contained concentrations of 1 ppbv and 2 ppbv TVHC, respectively. Matrix interference on sample WS-11-11 precluded definitive analysis for benzene.

Soil gas sampling locations are shown on Figure 11-1.

5.11.4 Soil Sampling Depths/Locations

Ten soil borings were advanced in Area 11. Sample locations were selected to achieve an adequate distribution across the area. Four of the borings were advanced within the fenced area, two on the southwest side of the creek and two on the northeast side, to assess the possibility of contamination in this area. Nine borings were terminated at depths of 1 to 2 feet, due to the high ground water table; the tenth boring was advanced to a depth of 4 feet. One composite sample was collected from each boring for analyses for base/neutral and acid extractable organic compounds, metals, explosives, pesticides, and PCBs; one discrete sample from each boring, selected on the basis of headspace analysis, was collected for VOC analysis. The analytical parameters stated above were appropriate because the heavy industrial use of areas along the Raritan River increased the potential that a wide range of contaminants might be present in the dredged sediments, and because of the history of the site.

Soil boring locations are shown on Figure 11-2.

5.11.4.1 Analytical Results

Explosives

The soil sample from boring location B11-3, obtained from a depth interval of 0 to 2 feet, contained PETN at a concentration of 5.22 ppm. No other explosives were detected in soil samples from this area.

Metals

As shown in Table 11-1, all ten samples contained metal concentrations that exceeded NJDEPE proposed standards.

Lead was detected in two soil samples at concentrations of 704 and 181 ppm; the NJDEPE proposed standard is 100 ppm. One of these samples, B11-3, also contained cadmium (1.16 ppm) at a concentration which exceeded the NJDEPE proposed standard of 1 ppm.

Arsenic was detected in every sample at concentrations which exceeded the NJDEPE proposed standard of 2 ppm; concentrations ranged from 3.21 to 39.6 ppm.

VOCs

As shown in Table 11-2, acetone was found in three soil samples; the concentrations detected were orders of magnitude lower than NJDEPE proposed standards.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 11-3, two soil samples contained various base/neutral and acid extractable organic compounds in concentrations that exceeded NJDEPE proposed standards; these soil samples were obtained at locations B11-3 and B11-6. Although various base/neutral and acid extractable compounds were detected in seven additional samples, the concentrations detected were below NJDEPE proposed standards.

Pesticides/PCBs

As shown in Table 11-4, pesticides were detected in nine of the ten soil samples; all concentrations were at least one order of magnitude lower than NJDEPE proposed standards.

No PCBs were detected in the samples from this area.

5.11.5 Ground Water Sampling

Dames & Moore collected ground water samples from the three wells previously installed by OBG (MW-28, MW-29, and MW-30); no additional wells were installed in this area. The samples were analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, and pesticides.

Monitoring well stabilization data are included in Volume III of this report, Appendix E.

5.11.5.1 Analytical Results

Metals

As shown in Table 11-5, arsenic was detected in ground water samples from MW-28 (57.7 ppb), MW-29 (46.7 ppb), and MW-30 (63 ppb) in concentrations that exceeded the NJDEPE criteria of 0.02 ppb and the PQL of 8 ppb.

No other metals were detected in concentrations which exceeded the NJDEPE criteria.

Explosives

As shown in Table 11-6, explosives were detected in ground water samples from two wells.

Nitroglycerin was found in the water sample from MW-28 at a concentration of 12.7 ppb, and PETN (25.4 ppb) and 1,3-dinitrobenzene (0.627 ppb) were detected in the water sample from MW-30; the NJDEPE has not proposed cleanup criteria for these compounds.

Others

No VOCs, semivolatile compounds or pesticides were detected in water samples from this area.

5.11.6 Surface Water and Sediment Sampling

One surface water and one sediment sample (SW-4 and SS-4) were collected at the confluence of the drainage ditch with the creek. A slight sheen was noted on the water surface at the point of sample collection. The samples were analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, and explosives; the sediment sample also was analyzed for pesticides and PCBs.

The sampling location is shown on Figure 11-5; analytical results are summarized in Tables 11-7 and 11-8.

5.11.6.1 Analytical Results

Metals

Sediment sample SS-4 contained lead (52.6 ppm) at a concentration that exceeded the NOAA ER-L concentration of 35 ppm.

Base/Neutral and Acid Extractable Organic Compounds

Sediment sample SS-4 contained phenanthrene (330 ppb) at a concentration that exceeded the NOAA ER-L concentration of 35 ppb.

Other

Concentrations of other contaminants in the surface water and sediment samples were below the New Jersey Surface Water Quality Standards or the NOAA ER-L concentrations, as applicable.

5.11.7 Surface Soil Sampling

One surface soil sample, SS-10, was collected northwest of Building 737, adjacent to a small area of surface water near the Patrol Road. A sheen had been noted on standing water in this area during the initial reconnaissance of the site; no evidence of a sheen was noted at the time of sampling. The sample was analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, pesticides and PCBs.

The sampling location is shown on Figure 11-5.

5.11.7.1 Analytical Results

Metals

Arsenic was detected at a concentration of 28.4 ppm; the NJDEPE proposed standard is 2 ppm. Lead was detected at a concentration of 188 ppm; the NJDEPE proposed standard is 100 ppm.

All other metal concentrations detected were below the NJDEPE proposed standards.

Other

Concentrations of other contaminants were below detection limits, or were detected at concentrations below NJDEPE proposed standards.

5.11.8 Soil Geology, Area 11

Shallow soils in this area are predominantly brown to dark brown silty sands, brown fine to coarse sands, and brown to dark brown and gray fine to medium sands. The soils often contained trace to some gravel, and shell fragments, wood, and roots were frequently found. These heterogeneous sediments reflect both the marshy environment found in Area 11 and the historical dumping of river sediments.

Ground water generally was encountered at depths of 1 to 2 feet while advancing borings for soil sampling.

5.11.9 Ground Water Level Measurements

Dames & Moore conducted three rounds of ground water level measurements at the monitoring wells installed by OBG in Area 11. The elevations of the ground water in these wells are stated below in feet above mean sea level.

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-28	2.4	1127	2.38	1342	1.52	1047
MW-29	2.02	1121	2.03	1335	2.19	1045
MW-30	2.01	1125	2.02	1359	2.4	1050

The ground water gradient cannot be defined in this area from these measurements. For example, the elevation of the ground water in MW-28 varied from the highest elevation of the three wells (elevations of 8/10/92) to the lowest elevation of the three wells (elevations of 8/14/92). Ground water levels in this area may be affected by the Raritan River and the presence of the small creek.

TABLES FOR AREA 11

TABLE 11-1

AREA 11
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B11-1, 0-4', #453	3.89	--	--	--	--	--	--	--
B11-2, 0-2', #454	5.58	--	--	--	--	--	--	--
B11-3, 0-2', #455	18.5	--	1.16	--	704	--	--	--
B11-4, 0-1.5', #456	6.33	--	--	--	--	--	--	--
B11-5, 0-1.16', #457	3.21	--	--	--	--	--	--	--
B11-6, 0-2', #458	5.33	--	--	--	181	--	--	--
B11-7, 0-2', #459	39.6	--	--	--	--	--	--	--
B11-8, 0-2', #460	7.68	--	--	--	--	--	--	--
B11-9, 0-1', #461	20.3	--	--	--	--	--	--	--
B11-10, 0-2', #462	18.4	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, Revised 2/8/93.

[d:\...\19577014\march93\area11.111]

TABLE 11-2

AREA 11
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

PARAMETERS	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	#455, B11-3, 0-2′	#458, B11-6, 1-2′	#462, B11-10, 1-2′
Acetone	1,000,000	50,000	140	15	23

Notes: Concentrations expressed in µg/kg (parts per billion).
-- indicates concentration is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

[d:\...\19577014\march93\area11.112]

TABLE 11-3

AREA 11
DETECTABLE CONCENTRATIONS OF BASE/NEUTRAL AND
ACID EXTRACTABLE SEMIVOLATILE ORGANIC COMPOUNDS - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION									
			B11-1 0-4' #453	B11-2 0-2' #454	B11-3 0-2' #455	B11-4 0-1.5' #456	B11-5 0-1.2' #457	B11-6 0-2' #458	B11-7 0-2' #459	B11-8 0-2' #460	B11-9 0-1' #461	B11-10 0-2' #462
Acenaphthene	3,400,000	100,000	--	--	550	--	--	--	--	--	--	--
Anthracene	10,000,000	500,000	--	--	1,400	--	--	250	--	--	--	--
Benzo(a)anthracene	900	500,000	--	300	7,000	--	--	870	--	--	140	--
Benzo(a)pyrene	660	100,000	--	300	6,600	--	--	930	--	--	--	--
Benzo(b)fluoranthene	900	500,000	--	490	8,300	--	--	1,300	--	--	140	--
Benzo(ghi)perylene	660	500,000	--	--	4,500	--	--	330	--	--	--	--
Benzo(k)fluoranthene	900	500,000	--	130	3,100	--	--	320	--	--	--	--
Bis(2-ethylhexyl)phthalate	49,000	100,000	--	--	--	260	--	690	--	180	--	--
Chrysene	9,000	500,000	150	450	7,100	--	--	970	--	--	--	--
Dibenz(a,h)anthracene	660	500,000	--	--	1,200	--	--	--	--	--	--	--
Fluoranthene	2,300,000	500,000	190	600	11,000	--	170	1,600	160	--	250	--
Fluorene	2,300,000	100,000	--	--	520	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	900	500,000	--	240	5,300	--	--	--	--	--	--	--
Naphthalene	230,000	100,000	--	--	--	--	--	88	140	--	--	--

TABLE 11-3 (continued)

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION									
			B11-1 0-4' #453	B11-2 0-2' #454	B11-3 0-2' #455	B11-4 0-1.5' #456	B11-5 0-1.2' #457	B11-6 0-2' #458	B11-7 0-2' #459	B11-8 0-2' #460	B11-9 0-1' #461	B11-10 0-2' #462
Phenanthrene	NS	NS	190	360	6,300	--	140	420	96	--	240	--
Pyrene	1,700,000	500,000	160	490	8,000	--	150	900	110	--	150	--

Notes: Concentrations expressed in µg/kg (parts per billion).
-- indicates compound is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

[d:\...\19577014\march93\area11.113]

TABLE 11-4

AREA 11

DETECTABLE CONCENTRATIONS OF PESTICIDES - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	B11-2 0-2' #454	B11-3 0-2' #455	B11-4 0-1.5' #456	B11-5 0-1.2' #457	B11-6 0-2' #458	B11-7 0-2' #459	B11-8 0-2' #460	B11-9 0-1' #461	B11-10 0-2' #462
DDD, PP'	3,000	100,000	3.69	4.91	--	3.73	7.38	7.23	--	3.97	7.04
DDE, PP'	2,000	100,000	3.38	--	--	2.10	2.95	18.6	--	10.9	1.69
DDT, PP'	2,000	100,000	13.3	2.11	3.95	6.98	9.36	49.0	2.56	24.7	23.2
Heptachlor	150	500,000	9.89	--	--	--	--	--	--	--	--

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates compound is below laboratory detection limit.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

[d:\...\19577014\march93\area11.114]

TABLE 11-5

AREA 11
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-28	MW-29	MW-30
ARSENIC	0.02	8	57.7	46.7	63.0
BARIUM	2000	200	299	8.4	206
CADMIUM	4	2	--	--	--
CHROMIUM	100	10	--	--	--
LEAD	5	10	--	--	--
MERCURY	2	0.5	--	--	--
SELENIUM	50	10	--	--	--
SILVER	20	2	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

[d:\...\job\19577014\march93\tbl0914.115]

TABLE 11-6

AREA 11
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-28	MW-29	MW-30
Explosives					
1,3-Dinitrobenzene	NS	NS	--	--	0.627
Nitroglycerin	NS	NS	12.7	--	--
PETN	NS	NS	--	--	25.4

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
Water Criteria Reference: 24 N.J.R. 389 Subchapter 4, Table 4-1, revised 2/1/93.

[d:\...\job\19577014\march93\tbl0914.116]

TABLE 11-7

AREA 11
ANALYTES ABOVE NOAA ER-L CONCENTRATIONS
SEDIMENT SAMPLE SS-4

PARAMETER	NOAA ER-L	NOAA ER-M	CONCENTRATION
Metals (mg/kg)			
Lead	35	110	52.6
Base/Neutrals and Extractable Acids (μg/kg)			
Phenanthrene	225	1380	330.0

Notes: National Oceanic Service, National Oceanic and Atmospheric Administration (NOAA), "Potential for Biological Effects of Sediment-Sorbed Contaminants tested in the National Status and Trends Program", March 1990, NOAA/TM/NOS/OMA-52, Table 54A.

Metals concentrations are given in mg/kg (parts per million).
Organic concentrations are given in μg/kg (parts per billion).

[d:\...\job\19577014\march93\tbl0323.117]

TABLE 11-8

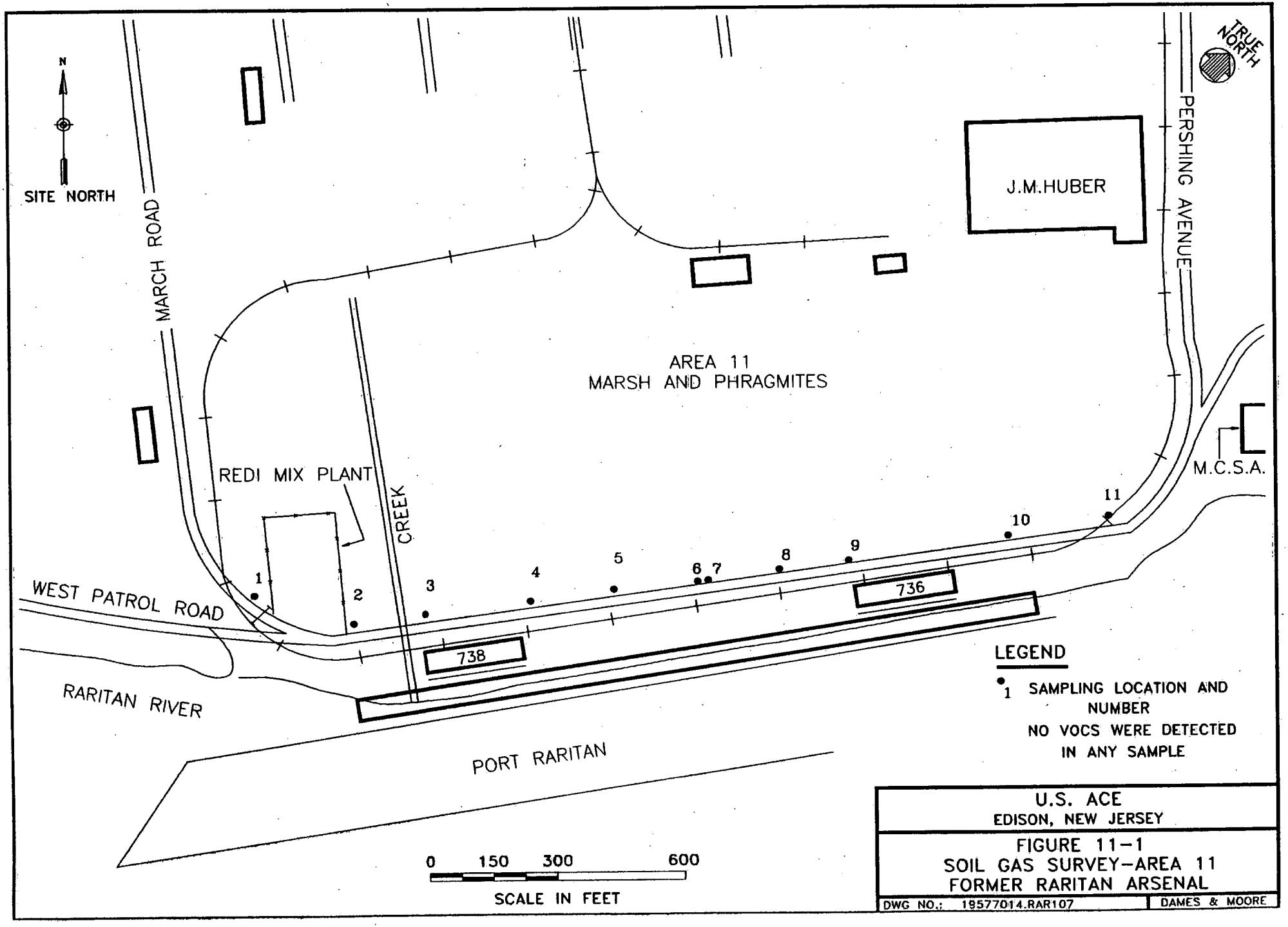
AREA 11
DETECTABLE CONCENTRATIONS OF ANALYTES
SURFACE WATER SAMPLE SW-4

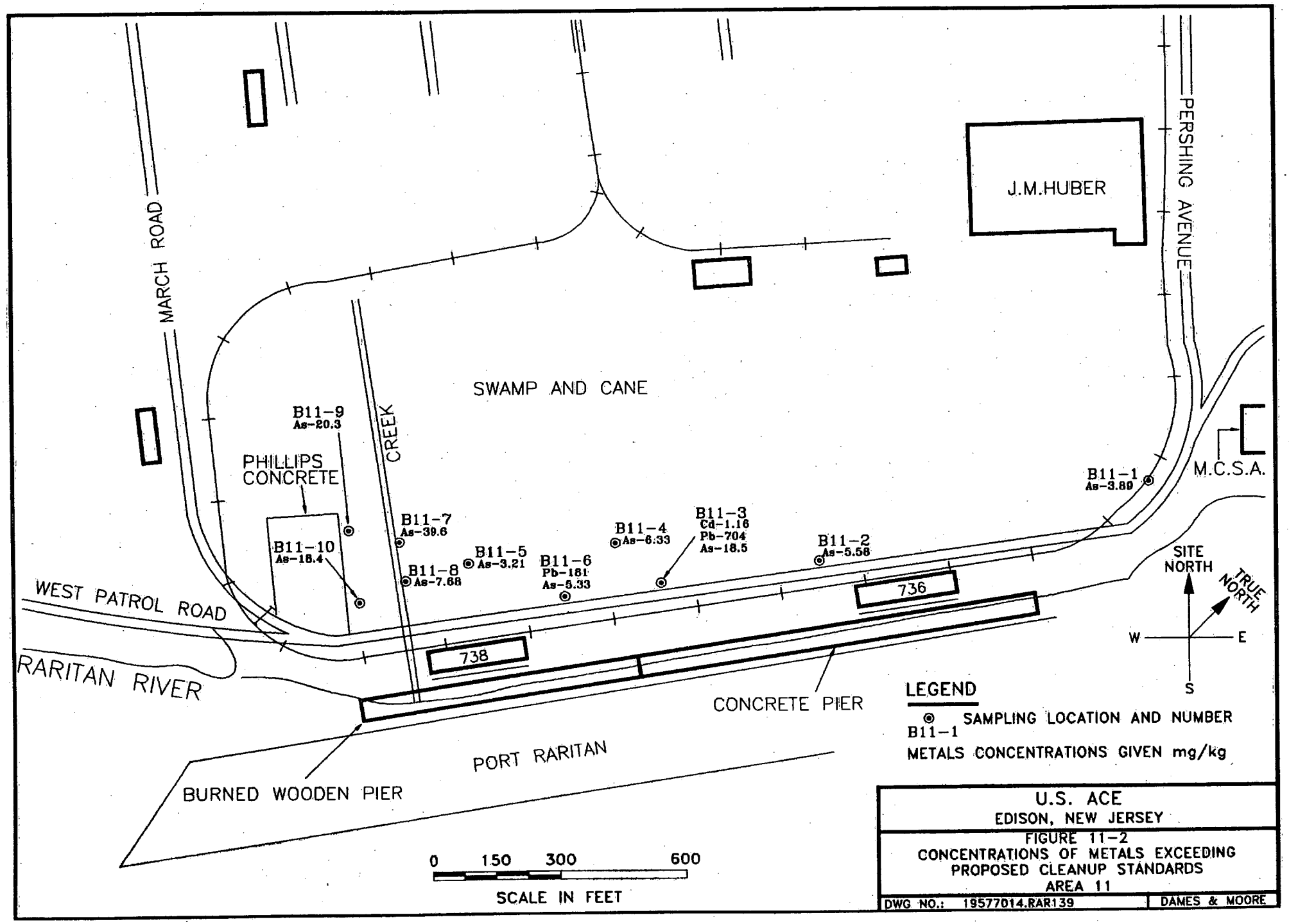
PARAMETER	NJDEPE SURFACE WATER STANDARDS	SW-4
Metals		
Arsenic	50	4.0
Barium	1,000	34.3
Lead	50	13.9

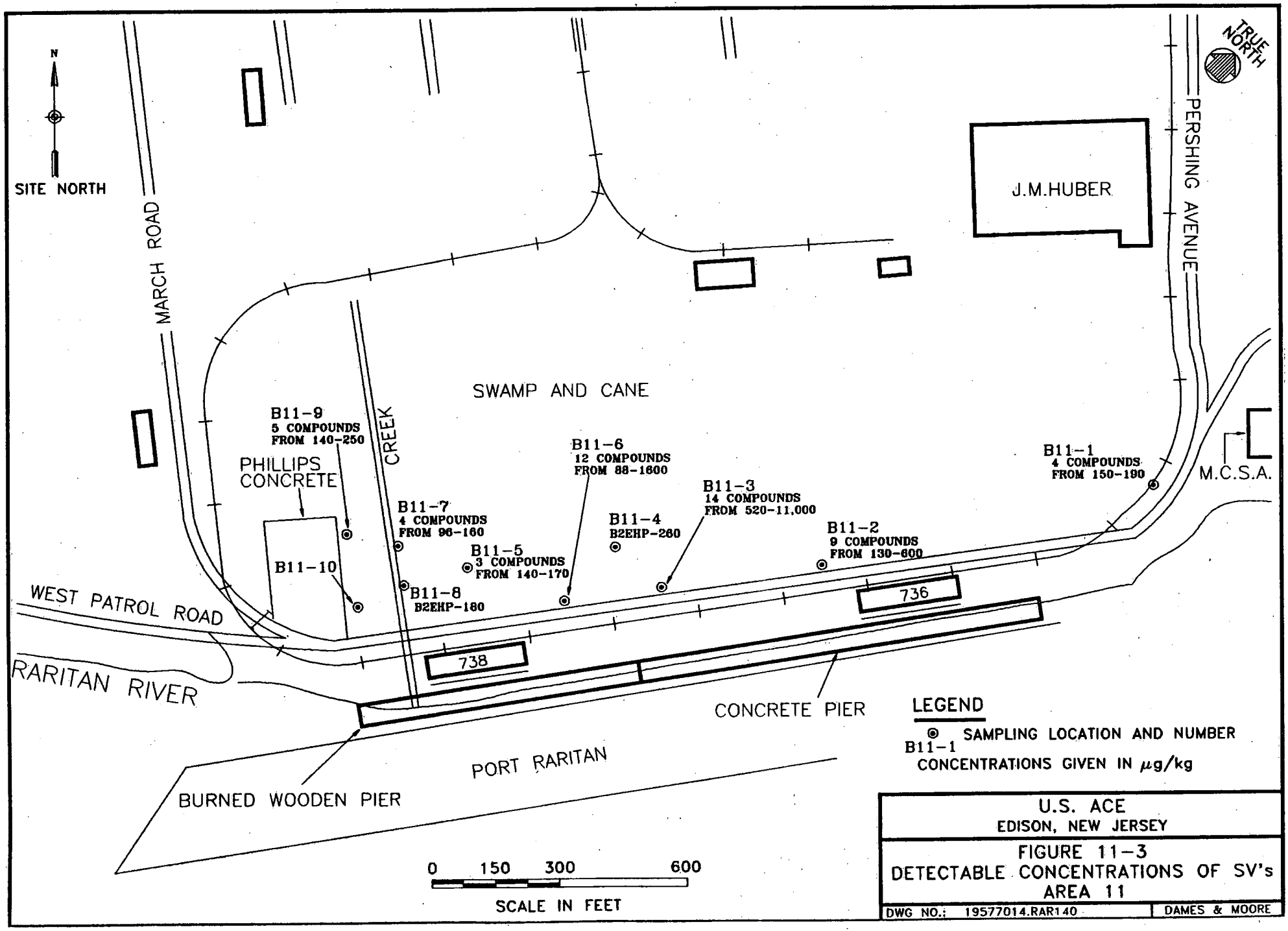
Notes: Metals concentrations are given in μg/L (parts per billion).
New Jersey Surface Water Quality Standards (N.J.A.C. 7: 9-4.1 et. seq.)

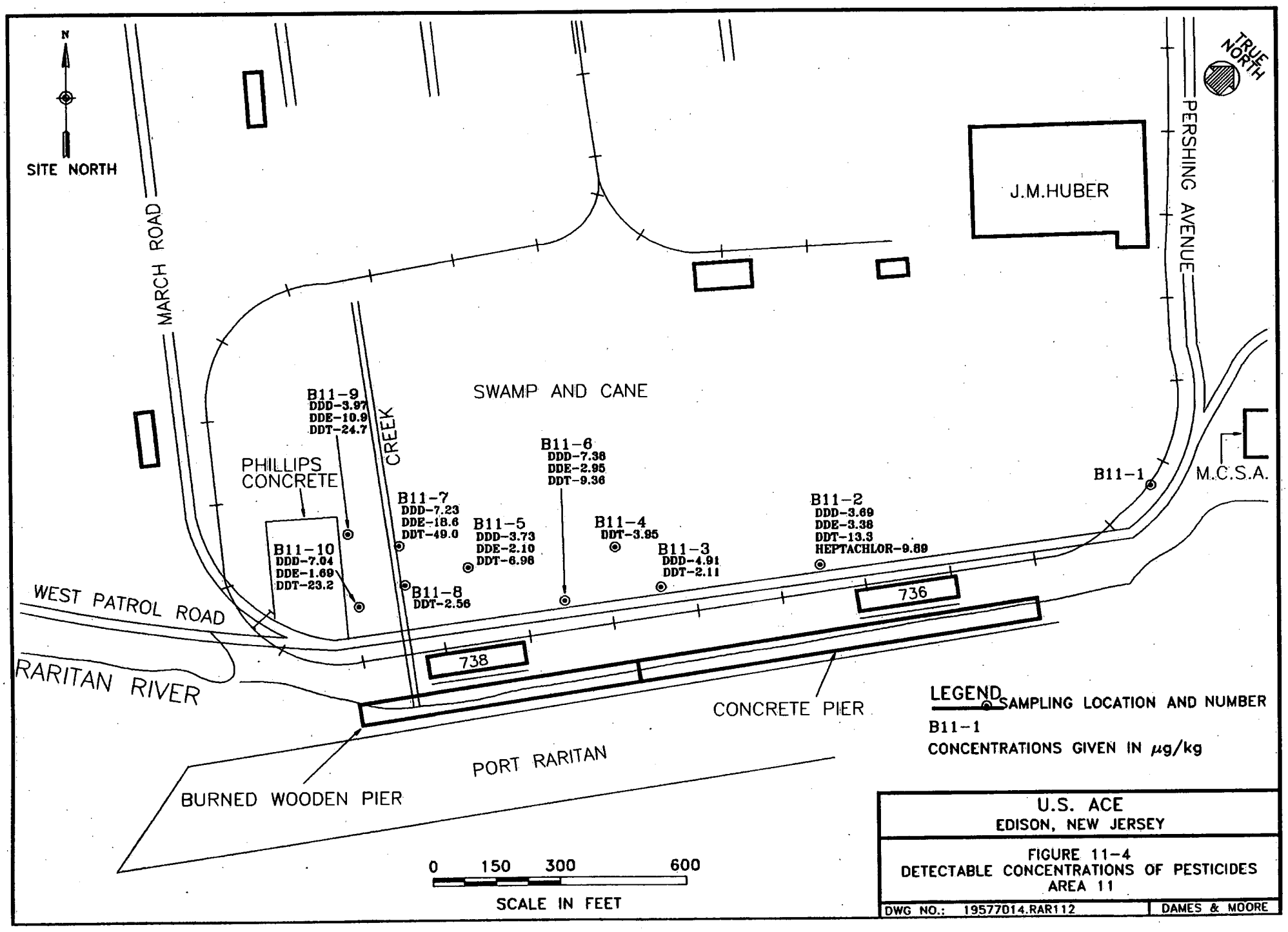
[d:\...\job\19577014\march93\tbl0323.118]

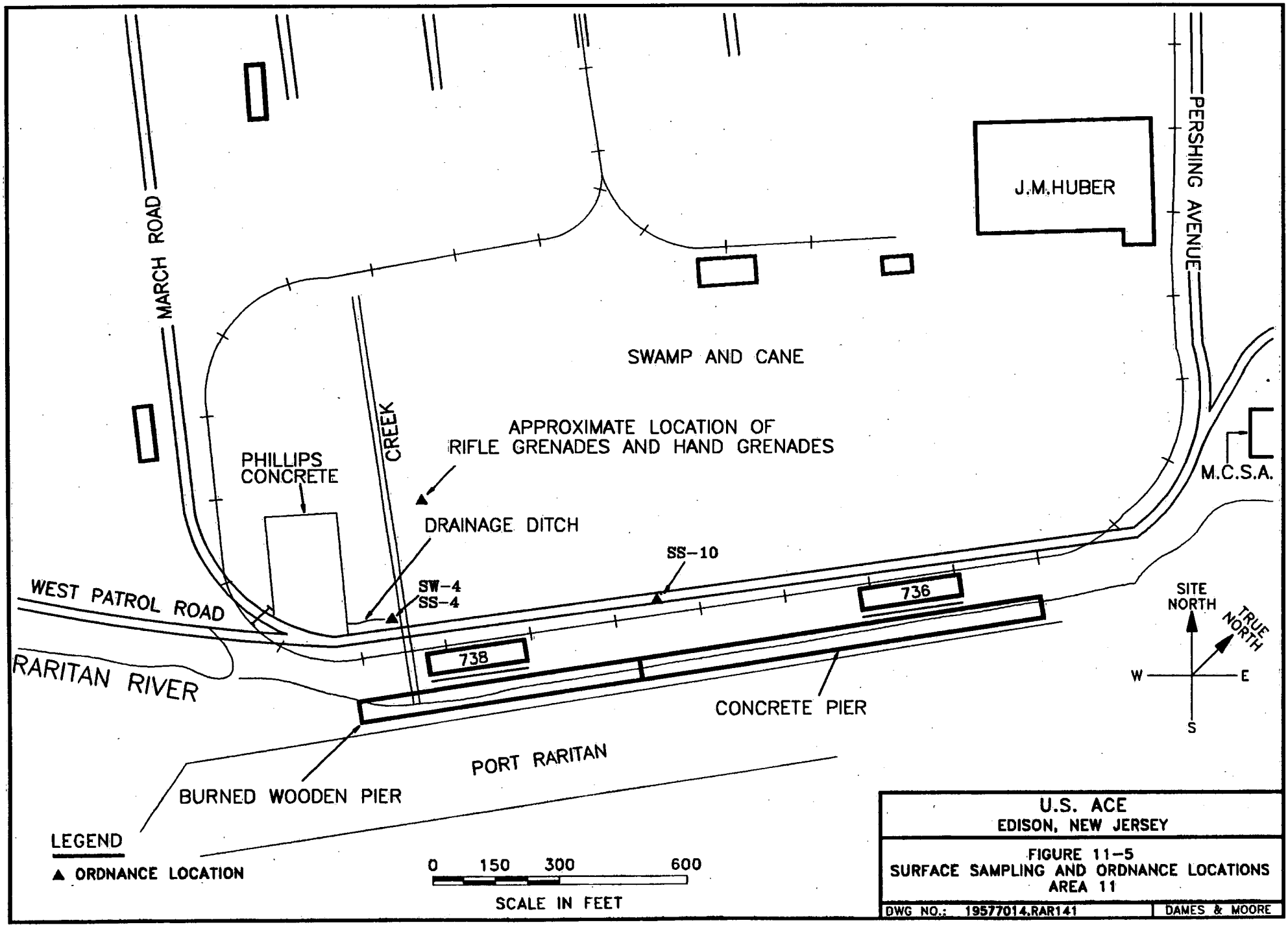
FIGURES FOR AREA 11


N
SITE NORTH
MARCH ROAD
TRUE NORTH
PERSHING AVENUE
J.M.HUBER
AREA 11
MARSH AND PHRAGMITES
REDI MIX PLANT
CREEK
M.C.S.A.
1
2
3
4
5
6
7
8
9
10
11
WEST PATROL ROAD
736
738
RARITAN RIVER
PORT RARITAN
LEGEND
1 SAMPLING LOCATION AND NUMBER
NO VOCS WERE DETECTED IN ANY SAMPLE
0 150 300 600
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 11-1
SOIL GAS SURVEY-AREA 11
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR107
DAMES & MOORE


MARCH ROAD
PERSHING AVENUE
J.M.HUBER
SWAMP AND CANE
CREEK
PHILLIPS CONCRETE
B11-9 As-20.3
B11-10 As-18.4
B11-7 As-39.6
B11-8 As-7.68
B11-5 As-3.21
B11-6 Pb-181 As-5.33
B11-4 As-6.33
B11-3 Cd-1.16 Pb-704 As-18.5
B11-2 As-5.56
B11-1 As-3.89
M.C.S.A.
WEST PATROL ROAD
RARITAN RIVER
738
736
CONCRETE PIER
BURNED WOODEN PIER
PORT RARITAN
SITE NORTH
TRUE NORTH
W
E
S
LEGEND
B11-1 SAMPLING LOCATION AND NUMBER
METALS CONCENTRATIONS GIVEN mg/kg
0 150 300 600
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 11-2
CONCENTRATIONS OF METALS EXCEEDING PROPOSED CLEANUP STANDARDS
AREA 11
DWG NO.: 19577014.RAR139
DAMES & MOORE


N
SITE NORTH
TRUE NORTH
MARCH ROAD
PERSHING AVENUE
J.M.HUBER
SWAMP AND CANE
CREEK
PHILLIPS CONCRETE
B11-9
5 COMPOUNDS
FROM 140-250
B11-10
B11-7
4 COMPOUNDS
FROM 96-160
B11-8
B2EHP-180
B11-5
3 COMPOUNDS
FROM 140-170
B11-6
12 COMPOUNDS
FROM 88-1600
B11-4
B2EHP-260
B11-3
14 COMPOUNDS
FROM 520-11,000
B11-2
9 COMPOUNDS
FROM 130-600
B11-1
4 COMPOUNDS
FROM 150-190
M.C.S.A.
WEST PATROL ROAD
RARITAN RIVER
738
736
CONCRETE PIER
PORT RARITAN
BURNED WOODEN PIER
LEGEND
B11-1 SAMPLING LOCATION AND NUMBER
CONCENTRATIONS GIVEN IN μg/kg
0 150 300 600
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 11-3
DETECTABLE CONCENTRATIONS OF SV's
AREA 11
DWG NO.: 19577014.RAR140
DAMES & MOORE


N
SITE NORTH
TRUE NORTH
MARCH ROAD
PERSHING AVENUE
J.M.HUBER
SWAMP AND CANE
CREEK
PHILLIPS CONCRETE
B11-9
DDD-3.97
DDE-10.9
DDT-24.7
B11-10
DDD-7.04
DDE-1.69
DDT-23.2
B11-7
DDD-7.23
DDE-18.6
DDT-49.0
B11-8
DDT-2.56
B11-5
DDD-3.73
DDE-2.10
DDT-6.98
B11-6
DDD-7.38
DDE-2.95
DDT-9.36
B11-4
DDT-3.95
B11-3
DDD-4.91
DDT-2.11
B11-2
DDD-3.69
DDE-3.38
DDT-13.3
HEPTACHLOR-9.89
B11-1
M.C.S.A.
736
738
WEST PATROL ROAD
RARITAN RIVER
CONCRETE PIER
PORT RARITAN
BURNED WOODEN PIER
LEGEND
SAMPLING LOCATION AND NUMBER
B11-1
CONCENTRATIONS GIVEN IN μg/kg
0 150 300 600
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 11-4
DETECTABLE CONCENTRATIONS OF PESTICIDES
AREA 11
DWG NO.: 19577014.RAR112
DAMES & MOORE


MARCH ROAD
PERSHING AVENUE
J.M.HUBER
SWAMP AND CANE
CREEK
APPROXIMATE LOCATION OF
RIFLE GRENADES AND HAND GRENADES
PHILLIPS
CONCRETE
DRAINAGE DITCH
M.C.S.A.
SS-10
SW-4
SS-4
WEST PATROL ROAD
736
738
RARITAN RIVER
CONCRETE PIER
SITE
NORTH
TRUE
NORTH
W
E
S
PORT RARITAN
BURNED WOODEN PIER
LEGEND
▲ ORDNANCE LOCATION
0 150 300 600
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 11-5
SURFACE SAMPLING AND ORDNANCE LOCATIONS
AREA 11
DWG NO.: 19577014.RAR141
DAMES & MOORE

5.12 AREA 12

Area 12 is predominantly undeveloped marshland adjacent to the Raritan River, in the southern portion of the site. The area is overgrown with phragmites. Ground water levels are very shallow, and standing water was noted throughout the area. Dredged sediments from the Raritan River dock area reportedly were dumped in this area.

During the 1963 decontamination effort, the area was inspected by representatives from the Army Material Command Safety Office and Raritan Arsenal personnel. LEAD recommended Area 12 for "Unrestricted Use".

The U.S. Army Corps of Engineers conducted a study of the area in 1984 and 1985 to assess its suitability for a proposed land disposal site for dredged river spoils from shipping channels in New York and New Jersey ports. The USACE reportedly installed 14 wells and advanced six borings as part of the investigation; however, results of the study are not available.

OBG conducted a site reconnaissance and file search of the area as part of the 1987-88 contamination evaluation of the former arsenal. They reported a 0.5-acre cleared area toward the northeastern end of Area 12 was used by the New Jersey Department of Transportation (DOT) in the early 1980s for explosives testing. At the time of the initial Dames & Moore site reconnaissance this area was devoid of vegetation. Standing water was stained red, indicating the presence of TNT. This area continues to be used for ordnance disposal during the current remediation; it will not be assessed or remediated until it is no longer required for ordnance disposal.

5.12.1 Dames & Moore Field Activities

Dames & Moore conducted a soil gas survey and UXO survey; advanced soil borings and obtained soil samples for laboratory analysis; and installed and sampled a shallow monitoring well.

5.12.2 UXO Survey

Approximately 12 booster adapters were found in and around the DOT testing area; after notifying the USACE of their existence, alternate access routes were cleared around them.

5.12.3 Soil Gas Survey

Ten soil gas samples were collected along the West Patrol Road, the perimeter of Area 12. Samples were collected at depths of 2 feet, due to high ground water levels. Five samples contained benzene in concentrations ranging from 0.09 to 0.4 ppbv, six samples contained toluene in concentrations ranging from 0.2 to 2.0 ppbv, one sample contained xylenes at a concentration of 1.0 ppbv, and seven samples contained TVHC in concentrations ranging from 0.2 to 4.0 ppbv.

Sampling locations are shown on Figure 12-1. Soil gas survey data are summarized in Table 12-1.

5.12.4 Soil Sampling Depths/Locations

Ten soil sampling locations were randomly selected in Area 12. The area was divided into 100 sections, and a random number generator was used to select 10 sections for sampling. Borings were advanced as close to the center of each selected area as site conditions permitted. One composite sample was collected from each boring for analysis of base/neutral and acid extractable organic compounds, metals, explosives, pesticides, and PCBs; one discrete sample at each boring location, selected on the basis of headspace analysis, was retained for VOC analysis. Analysis for these parameters was warranted because the heavy industrial use of areas along the Raritan River increased the possibility that a wide range of contaminants might be present in the dredged sediments. Potential pesticide contamination also was assessed because a pesticide blending operation was housed in Buildings 651 and 652 in Area 16 (northwest of Area 12) during the 1980s.

Soil sampling locations are shown on Figure 12-2.

5.12.4.1 Analytical Results

Metals

As shown in Table 12-2, concentrations of arsenic that exceeded the NJDEPE proposed standard of 2 ppm were found in all ten soil samples; concentrations ranged from 2.45 to 30.0 ppm.

Concentrations of all other metals were below NJDEPE proposed cleanup standards.

VOCs

As shown in Table 12-3, acetone was found in four soil samples at concentrations that are orders of magnitude lower than NJDEPE proposed standards.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 12-4, various semivolatile compounds were detected in two soil samples. However, none of the concentrations exceeded NJDEPE proposed standards.

Pesticides/PCBs

As shown in Table 12-5, pesticides were detected in all soil samples from Area 12. None of the concentrations exceeded NJDEPE proposed standards, and all but one of the concentrations were orders of magnitude lower than the proposed standards.

Pesticide blending operations were conducted in Magazines 651 and 652 after the arsenal was decommissioned; these magazines are located in Area 16, upgradient of Area 12. The soil samples obtained by Dames & Moore in Area 12 were collected between 1200 and 2000 feet from these buildings. It is unlikely the pesticides found in the soil samples from Area 12 are the result of the pesticide blending operations in Magazines 651 and 652.

Explosives

2,4,6-TNT was found in sample B12-4, obtained from a depth of 0 to 1.5 feet, at a concentration of 11.5 ppm. The NJDEPE has not proposed a cleanup standard for this compound.

No other soil sample from this area contained detectable concentrations of explosives.

5.12.5 Monitoring Well Installation and Sampling

One shallow and one deep monitoring well were installed on the assumed downgradient side of Area 12, near the West Patrol Road; there are an insufficient number of wells installed in this area to assess the ground water gradient.

MW-60 is a shallow well screened from depths of 7 to 17 feet in sandy silts and silty sands; it was installed at the location where soil gas sample SG12-5 was collected. MW-60 is one of the wells installed solely on the results of the soil gas survey; the location of this well was discussed with, and approved by, USACE personnel prior to installation.

MW-63 is a deep well installed near the intersection of March Road and West Patrol Road. This well was installed to provide an assessment of the ground water quality in the deep aquifer in the assumed downgradient direction of the site. The location of this well was discussed with, and approved by, USACE personnel prior to installation. This well was a replacement for one of the deep wells that could not be installed in other portions of the site because bedrock was encountered before a deep aquifer was found. A black, silty clay aquitard was encountered at 14 feet and extended to a depth of 33.4 feet. This well was terminated at a depth of 55.8 feet, where gray shale was encountered. The well screen was set from depths of 40.0 feet to 55.5 feet in sands with varying amounts of silts and gravels and occasional traces of clay.

Ground water samples were collected and analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, and pesticides.

Monitoring well boring logs, construction diagrams, development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.12.5.1 Analytical Results

Metals

As shown in Table 12-6, arsenic was detected in MW-63 at a concentration of 8.4 ppb; this exceeded the NJDEPE criteria for arsenic of 0.02 ppb and the PQL of 8 ppb.

No other metals were detected in water samples from this area at concentrations that exceeded NJDEPE criteria.

Explosives

As shown in Table 12-7, explosives were found in both monitoring wells installed in this area. MW-60 contained 1,3-dinitrobenzene (0.811 ppb) and PETN (22.6 ppb). MW-63 contained RDX (1.15 ppb). The NJDEPE has not proposed criteria for these compounds.

VOCs

As shown in Table 12-7, chloroform was detected in deep well MW-63 at a concentration of 19 ppb; the NJDEPE criteria is 6 ppb.

No other VOCs were found in water samples from this area at concentrations that exceeded NJDEPE criteria.

Others

As shown in Table 12-7, three semivolatile organic compounds were detected in water samples from the two wells; however, the concentrations detected were below NJDEPE PQLs. One sample from MW-60 contained bis(2-ethylhexyl)phthalate at a concentration of 18 ppb; this concentration exceeded the NJDEPE criteria of 3 ppb, but is below the PQL of 30 ppb.

No pesticides were detected in the water samples from this area.

5.12.6 Area Reconnaissance

Area 12 was visually inspected for evidence of surface contamination. The area was difficult to inspect because of the presence of phragmites and other dense vegetation, as well as the presence of standing water. Evidence of dumping was noted in the southwestern portion of the area, adjacent to the West Patrol Road; the debris appeared to be related to mobile equipment maintenance, as evidenced by the presence of oil filters and what may have been a lubricant drum. This disposal area is overgrown with weeds and small trees, indicating it has been in existence for some time.

Additionally, a rusted 55-gallon drum containing a deep purple substance was found and reported to local USACE personnel. No visible evidence of soil contamination (i.e., stressed vegetation, lack of vegetation, stained or discolored soil, etc.) was noted adjacent to the drum.

The approximate locations of the debris and the 55-gallon drum are shown on Figure 12-2.

5.12.7 Soil Geology, Area 12

Shallow soils encountered in this area are commonly olive gray and dark brown silts and clays. Roots, wood fragments, and clam or oyster shells are commonly found. From depths of 2 to 4 feet, lenses of dark gray and yellowish red fine to coarse sands were occasionally found.

At depths greater than 2 feet, the predominant soil types in the upper aquifer are fine silty sands and silts. In the boring advanced for monitoring well MW-63, near the northeastern corner of Area 12, a dark gray silty fine sand was found from depths of 2 to 4 feet, a brownish yellow sandy silt was found from 5 to 8 feet, and brownish yellow silty fine sand was found from 10 to 14 feet. Approximately 0.5 mile west, where monitoring well MW-60 was installed, these sand units have graded to brown, and appeared to be slightly coarser; from depths of 2 to 10 feet, the unit consists of a brown fine sand with some silt and trace gravel grading to fine silty sand to light brown fine sandy silt. From a depth of 10.5 feet to the bottom of the boring at 17 feet, the soil in the boring for MW-60 consists of a light brown to brown fine to medium silty sand.

Thin layers of clays were encountered in the borings for each of the wells installed in this area. In the boring advanced to install monitoring well MW-60, a dark gray silty clay was encountered from depths of 10 to 10.5 feet; in the boring advanced to install monitoring well MW-63, a light gray silty clay was encountered from depths of 8 to 10 feet. It is not known if these two layers are laterally continuous, or represent small local lenses.

Black silty clay with some organic content was encountered in the boring advanced to install MW-63 at a depth of 14 feet to 33.5 feet, where the unit became a black organic peat; this latter unit terminated at a depth of 35 feet. A thin peat layer also was encountered from depths of 4 to 5 feet in the boring advanced for MW-63, but is depositionally unrelated to the

deeper unit. Beneath the clay and peat layer are sands and gravels with varying amounts of silts and clays. The sands range from reddish brown to dark gray to brownish yellow, and consist of fine to coarse or fine to medium sands intermixed with fine sands. Gravel content ranged from clayey gravels at depths of 35 to 38 feet, to some gravel at a depth of 50 feet. Gray weathered shale bedrock was encountered at a depth of 55 feet in the boring advanced to install MW-63. The Raritan Fireclay was not found in this area.

The peat and clay unit encountered in the northeastern corner of Area 12 during the installation of monitoring well MW-63 was not found in the boring drilled further southwest to install MW-60. The absence of the peat and clay in the boring advanced to install MW-60 may mean the unit is not as extensive or as uniform as previous investigations had indicated.

Ground water levels encountered while drilling ranged from depths of 1 to 4 feet.

5.12.8 Ground Water Level Measurements

Dames & Moore conducted three rounds of ground water level measurements at the two monitoring wells installed in Area 12. The elevations of the ground water in these wells are stated below in feet above or below mean sea level.

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-60	1.17	1112	1.15	1315	1.22	1035
MW-63	-0.75	1116	-1.07	1310	0.42	0940

Ground water levels in deep aquifer well MW-63 display greater variation than do ground water levels measured in shallow aquifer well MW-60. These variations may reflect tidal influences on the deep aquifer.

TABLES FOR AREA 12

TABLE 12-1

AREA 12
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG-12-1-2′	--	--	--	--	--	--	--	0.6
SG-12-2-2′	--	--	--	0.1	0.2	--	--	2
SG-12-4-2′	--	--	--	0.1	0.2	--	--	1
SG-12-5-2′	--	--	--	0.4	0.8	--	--	1
SG-12-7-2′	--	--	--	--	2	--	1	4
SG-12-8-2′	--	--	--	0.09	0.2	--	--	0.2
SG-12-10-2′	--	--	--	0.2	0.2	--	--	0.2

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

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TABLE 12-2

AREA 12
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B12-1, 0-4', #464	30.0	--	--	--	--	--	--	--
B12-2, 0-1', #467	27.9	--	--	--	--	--	--	--
B12-3, 0-4', #470	5.33	--	--	--	--	--	--	--
B12-4, 0-1.5', #473	10.6	--	--	--	--	--	--	--
B12-5, 0-4', #477	4.21	--	--	--	--	--	--	--
B12-6, 0-1.5', #479	9.34	--	--	--	--	--	--	--
B12-7, 0-2', #482	2.45	--	--	--	--	--	--	--
B12-8, 0-2', #485	2.90	--	--	--	--	--	--	--
B12-9, 0-1.5', #488	16.4	--	--	--	--	--	--	--
B12-10, 0-2', #491	29.8	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 12-3

AREA 12
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

PARAMETERS	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	#1470, B12-3, 2-3′	#477, B12-5, 3-4′	#485, B12-8, 1-2′	#491, B12-10, 1-2′
Acetone	1,000,000	50,000	97	120	65	52

Notes: Concentrations expressed in μg/kg (parts per billion).
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

[d:\...\19577014\march93\area12.123]

TABLE 12-4

AREA 12
DETECTABLE CONCENTRATIONS OF BASE/NEUTRAL AND
ACID EXTRACTABLE SEMIVOLATILE ORGANIC COMPOUNDS - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION									
			B12-1 0-4' #464	B12-2 0-1' #467	B12-3 0-4' #470	B12-4 0-1.5' #473	B12-5 0-4' #477	B12-6 0-1.5' #479	B12-7 0-2' #483	B12-8 0-2' #485	B12-9 0-1.5' #488	B12-10 0-2' #491
Benzo(a)anthracene	900	500,000	--	--	--	--	--	--	--	870	--	--
Bis(2-ethylhexyl)ether	NS	NS	5,100	--	--	--	--	--	--	--	--	--
Chrysene	9000	500,000	--	--	--	--	--	--	--	1,500	--	--
Fluoranthene	2,300,000	500,000	--	--	--	--	--	--	--	2,700	--	--
Pyrene	1,700,000	500,000	--	--	--	--	--	--	--	2,700	--	--

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion).
-- indicates compound is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 12-5

AREA 12

DETECTABLE CONCENTRATIONS OF PESTICIDES - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION									
			B12-1 0-4' #464	B12-2 0-1' #467	B12-3 0-4' #470	B12-4 0-1.5' #473	B12-5 0-4' #477	B12-6 0-1.5' #479	B12-7 0-2' #483	B12-8 0-2' #485	B12-9 0-1.5' #488	B12-10 0-2' #491
DDD, PP'	3,000	100,000	5.69	--	--	--	--	--	--	10.4	--	--
DDE, PP'	2,000	100,000	2.46	9.12	--	4.16	--	6.85	--	--	--	--
DDT, PP'	2,000	100,000	4.78	11.7	6.14	7.98	--	13.1	2.55	7.11	3.26	--
Dieldrin	42	50,000	--	--	--	--	--	--	--	--	--	2.62
Heptachlor	150	500,000	--	--	--	--	10.7	--	74.9	--	--	--

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion).
-- indicates compound is below laboratory detection limit.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 12-6

AREA 12
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-60	MW-63
ARSENIC	0.02	8	4.3	8.4
BARIUM	2000	200	435	135
CADMIUM	4	2	--	--
CHROMIUM	100	10	--	--
LEAD	5	10	--	2.6
MERCURY	2	0.5	--	--
SELENIUM	50	10	--	--
SILVER	20	2	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
Water Criteria Reference: 24 N.J.R. 389 Subchapter 4, Table 4-1, revised 2/1/93.

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TABLE 12-7

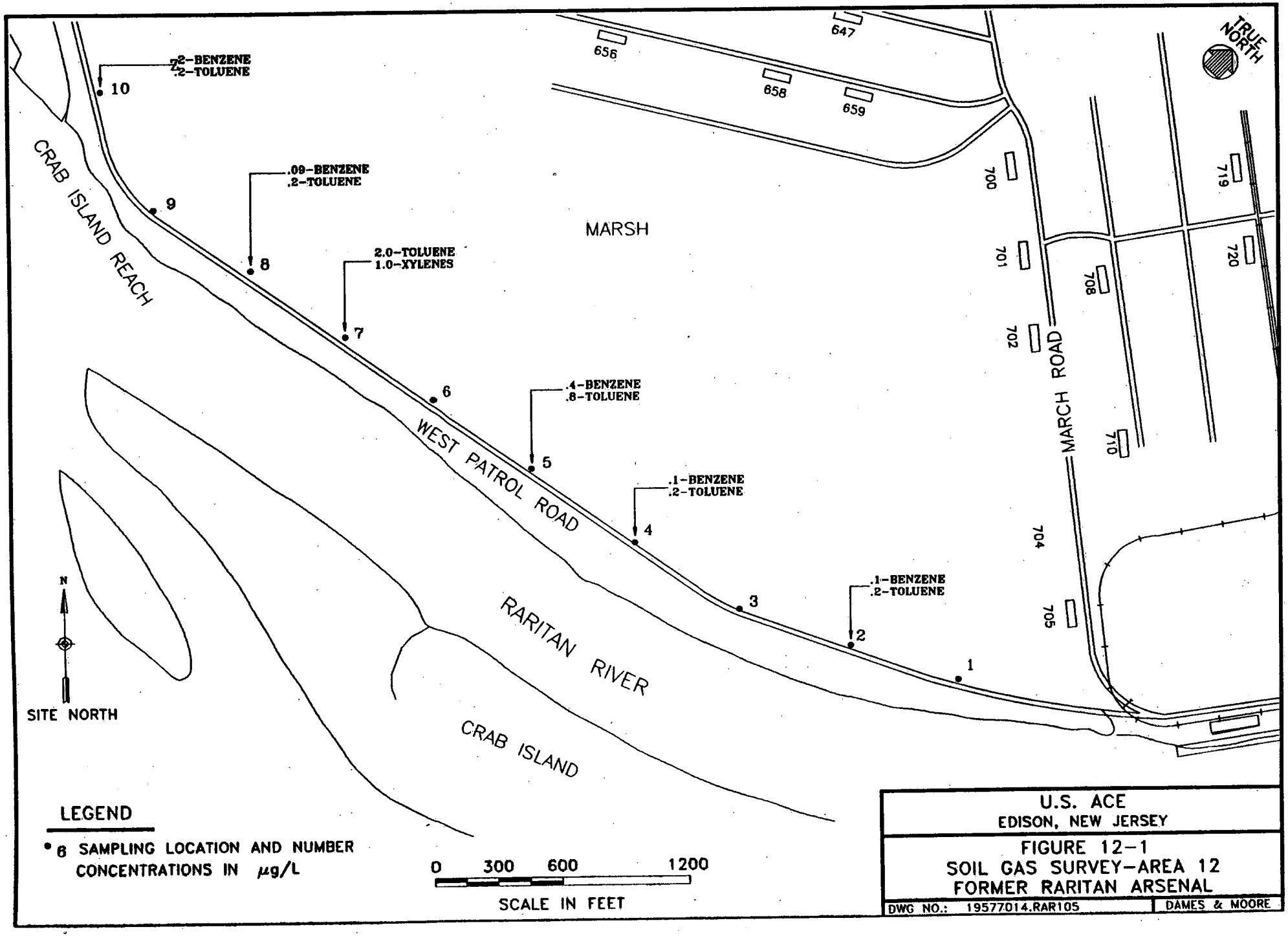
AREA 12
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

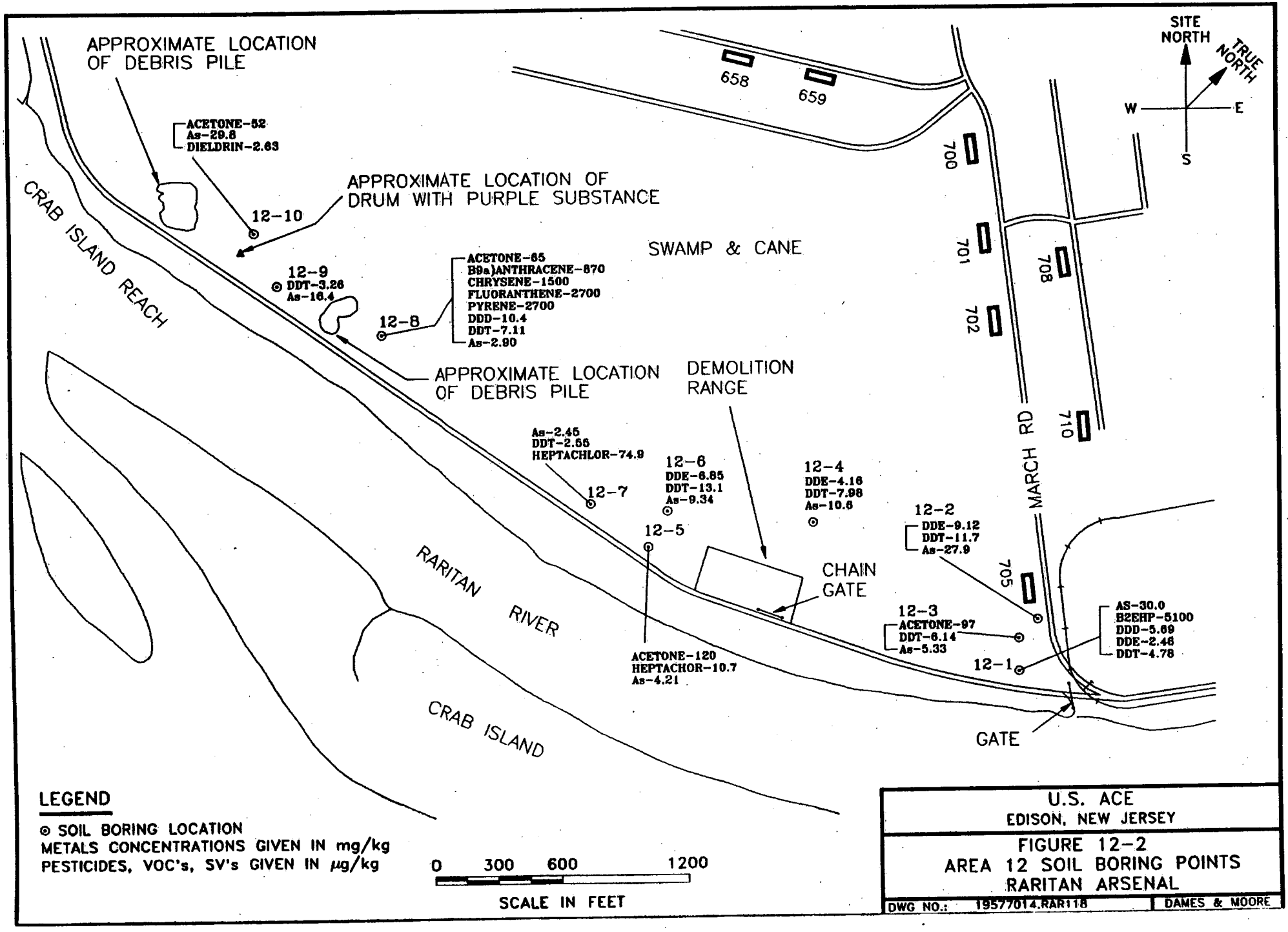
PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-60	MW-63
Explosives				
1,3-Dinitrobenzene	NS	NS	0.811	--
RDX	NS	NS	--	1.15
PETN	NS	NS	22.6	--
Volatile Organic Compounds				
Acetone	700	NS	--	15
Chloroform	6	1	--	19
Semi-Volatile Organic Compounds				
Bis(2-ethylhexyl)phthalate	3*	30	18	--
Isophorone	100	10	--	5.4
Phenol	4000	10	--	8.4

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
NS = No cleanup standard proposed.
* Federal MCL = 6 μg/L.
Water Criteria Reference: 24 N.J.R. 389 Subchapter 4, Table 4-1, revised 2/1/93.

[d:\...\job\19577014\march93\tbl0914.127]

FIGURES FOR AREA 12


TRUE NORTH
647
656
658
659
700
701
702
704
705
708
710
719
720
MARCH ROAD
MARSH
CRAB ISLAND REACH
WEST PATROL ROAD
RARITAN RIVER
CRAB ISLAND
.2-BENZENE
.2-TOLUENE
.09-BENZENE
.2-TOLUENE
2.0-TOLUENE
1.0-XYLENES
.4-BENZENE
.8-TOLUENE
.1-BENZENE
.2-TOLUENE
.1-BENZENE
.2-TOLUENE
1
2
3
4
5
6
7
8
9
10
N
SITE NORTH
LEGEND
• 6 SAMPLING LOCATION AND NUMBER
CONCENTRATIONS IN μg/L
0 300 600 1200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 12-1
SOIL GAS SURVEY-AREA 12
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR105
DAMES & MOORE


APPROXIMATE LOCATION OF DEBRIS PILE
ACETONE-52
As-29.8
DIELDRIN-2.63
APPROXIMATE LOCATION OF DRUM WITH PURPLE SUBSTANCE
12-10
CRAB ISLAND REACH
12-9
DDT-3.26
As-16.4
12-8
ACETONE-65
B9a)ANTHRACENE-870
CHRYSENE-1500
FLUORANTHENE-2700
PYRENE-2700
DDD-10.4
DDT-7.11
As-2.90
SWAMP & CANE
APPROXIMATE LOCATION OF DEBRIS PILE
DEMOLITION RANGE
As-2.45
DDT-2.55
HEPTACHLOR-74.9
12-7
12-6
DDE-6.85
DDT-13.1
As-9.34
12-5
12-4
DDE-4.16
DDT-7.98
As-10.6
12-2
DDE-9.12
DDT-11.7
As-27.9
CHAIN GATE
RARITAN RIVER
ACETONE-120
HEPTACHOR-10.7
As-4.21
12-3
ACETONE-97
DDT-6.14
As-5.33
12-1
AS-30.0
B2EHP-5100
DDD-5.69
DDE-2.46
DDT-4.78
GATE
CRAB ISLAND
MARCH RD
658
659
700
701
702
705
708
710
SITE NORTH
TRUE NORTH
W
E
S
LEGEND
SOIL BORING LOCATION
METALS CONCENTRATIONS GIVEN IN mg/kg
PESTICIDES, VOC's, SV's GIVEN IN µg/kg
0 300 600 1200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 12-2
AREA 12 SOIL BORING POINTS
RARITAN ARSENAL
DWG NO.: 19577014.RAR118
DAMES & MOORE

5.13 AREA 13

Area 13 was not included in the Phase I Remedial Investigation.

5.14 AREA 14

Area 14 is a large, undeveloped marshland area on the northeastern portion of the site, adjacent to the Raritan River. The area reportedly was filled by pumping spoils dredged from the Raritan River into the area and allowing the water to drain and evaporate. Many portions of Area 14 are bare, while other areas are covered with trees, bushes, and marsh grasses. A significant amount of uncontrolled dumping of household and business trash has occurred in the area. Additionally, approximately 5 percent of the area has been used to landfill soils removed during the development of Raritan Center.

During the 1963 decontamination effort, the area was recommended for "Unrestricted Use". Because of the low priority accorded to Area 14, no field investigations of this area were performed by OBG during their 1987-88 investigation.

5.14.1 Dames & Moore Field Activities

Dames & Moore performed a soil gas survey and UXO survey; advanced soil borings; and installed a shallow monitoring well.

5.14.2 Soil Gas Survey

Five soil gas samples were collected and analyzed for selected VOCs to determine the location of shallow monitoring well MW-50. The sampling locations were spaced approximately 50 feet apart; some locations were moved slightly to avoid bushes and other established vegetation. All samples were collected at a depth of 3 feet due to the high ground water level. One sample, SG14-4-3, contained 0.07 ppbv benzene, 0.1 ppbv toluene, and 1.0 ppbv TVHC; this location was selected for the installation of the monitoring well. No VOCs were detected at the other soil gas survey locations.

5.14.3 Soil Sampling Depths/Locations

Ten soil sampling locations were randomly selected in Area 14. The area was divided into 100 sections, and a random number generator was used to select 10 sections for sampling. Borings were advanced as close to the center of each selected area as site conditions permitted. One composite sample was collected from each boring for analysis of base/neutral and acid

extractable organic compounds, metals, explosives, pesticides, and PCBs; one discrete sample at each boring location was retained for VOC analysis. Analysis for these parameters was warranted because the heavy industrial use of areas along the Raritan River increased the possibility that a wide range of contaminants might be present in the dredged sediments.

Soil sampling locations are shown on Figure 14-1.

5.14.3.1 Analytical Results

Metals

As shown in Table 14-1, all ten samples from this area contained metal contamination that exceeded NJDEPE proposed standards.

Arsenic was detected in every sample in concentrations that ranged from 6.21 to 230 ppm; the NJDEPE proposed standard is 2 ppm. Because the concentrations reported by ESE were high, Dames & Moore requested that ESE review their calculations. The laboratory complied with this request, and confirmed the results shown in the table. Further, high concentrations of arsenic reportedly were noted by ESE when doing ICP analyses for other metals.

Cadmium was detected in three samples in concentrations that ranged from 1.04 to 1.98 ppm; the NJDEPE proposed standard is 1 ppm.

Lead was detected in nine samples in concentrations ranging from 155 to 382 ppm; the NJDEPE proposed standard is 100 ppm.

Chromium was detected in nine soil samples at concentrations ranging from 105 to 232 ppm. These concentrations of total chromium are, however, below the 500 ppm concentration mentioned by Gwen Barunas, NJDEPE.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 14-2, base/neutral and acid extractable compounds were detected in eight samples; the sample obtained from B14-5 contained contamination that exceeded NJDEPE proposed standards.

Pesticides/PCBs

As shown in Table 14-3, pesticides were detected in all 10 samples at concentrations lower than NJDEPE proposed standards.

No PCBs were detected in any soil sample from this area.

VOCs

VOCs were reported in two soil samples at concentrations that were orders of magnitude lower than NJDEPE proposed standards.

Explosives

The sample collected from sampling location B14-10 contained 0.555 ppm of RDX; the NJDEPE has not proposed a standard for this compound.

Explosives were not detected in any other soil sample from this area.

5.14.4 Monitoring Well Installation and Sampling

A shallow monitoring well, MW-50, was installed to monitor ground water conditions in the assumed downgradient portion of Area 14. The location was chosen on the basis of the soil gas survey described above and was screened from depths of 7 to 12 feet in a soft to very soft dark brown to dark gray peat and silty clay; the boring was terminated at a depth of 12 feet because the peat layer grew more clayey and appeared to exhibit properties characteristic of an aquitard.

A ground water sample was analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, explosives, and pesticides. Filtered and unfiltered samples were collected for dissolved and total metals analyses, respectively, because of the slow recharge rate in this well.

Monitoring well boring logs, construction diagrams, and development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.14.4.1 Analytical Results

Metals

As shown in Table 14-4, total arsenic was detected in MW-50 at a concentration of 173 ppb; the NJDEPE criteria is 0.02 ppb with a PQL of 8 ppb. Because MW-50 is a slow recharging well, a filtered sample was obtained to assess dissolved metals; dissolved arsenic was detected at a concentration of 111 ppb.

Total lead was detected in MW-50 at a concentration of 43.9 ppb; the NJDEPE criteria is 5 ppb with a PQL of 10 ppb. Dissolved lead was detected in the filtered sample at a concentration of 10.4 ppb.

All other metals detected in the ground water samples from this well were below NJDEPE criteria.

Others

No explosives, VOCs, pesticides or base/neutral and acid extractable compounds were detected in the water samples.

5.14.5 Soil Geology, Area 14

Shallow soils in this area predominantly were brown to dark brown to reddish brown silts, silty sands and silty clays. Organic content of the soils was high. Brown or reddish brown coarse to fine sands and gravels were encountered near the access road along the eastern boundary of the area.

A peat and silty clay layer was encountered at a depth of 4 feet in the boring advanced for the installation of MW-50. This layer extended beyond the terminal depth of the boring (12 feet) and graded more clayey with depth. Four additional borings were advanced to depths of 4 feet or more in Area 14; no peat or peaty clay was encountered in any of these borings. Approximately 2700 feet west of MW-50, in the boring advanced for the installation of MW-45, the layer apparently has thinned to 1 foot in thickness and contains much less clay. Approximately 2200 feet south of MW-50, in the boring advanced for the installation of OBG MW-25, a peat layer reportedly was encountered at a depth of 7 feet, but the extent and clay content of this layer are unknown. These data suggest the peat layer is thick and clayey in the eastern portion of Area 14, near the river, but thins and becomes less clayey toward the west.

Ground water levels encountered while drilling ranged from depths of 1.6 to more than 5 feet.

5.14.6 Ground Water Level Measurements

Dames & Moore conducted three rounds of ground water level measurements at the shallow monitoring well installed in Area 14. The elevations of the ground water in this well are stated below in feet above mean sea level.

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-50	8.36	1032	8.35	1535	8.34	0950

These ground water levels are approximately 5 feet higher than water levels measured in the nearest adjacent shallow monitoring wells in Area 6, indicating the aquifer screened by MW-50 is hydraulically separated from the aquifer screened by the shallow wells installed in Area 6. MW-50 also appears to be hydraulically isolated from the Raritan River. Therefore, it is possible the ground water levels in MW-50 reflect locally perched conditions.

TABLES FOR AREA 14

TABLE 14-1

AREA 14
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B14-1, 0-2', #532	98.3	--	--	105	155	--	--	--
B14-2, 0-5', #533	230	--	1.98	232	382	--	--	--
B14-3, 0-5', #534	168	--	--	202	303	--	--	--
B14-4, 0-4', #535	176	--	1.74	190	277	--	--	--
B14-5, 0-2', #536	203	--	1.04	201	315	--	--	--
B14-6, 0-2', #537	154	--	--	198	272	--	--	--
B14-7, 0-4', #538	204	--	--	193	260	--	--	--
B14-8, 0-2', #539	6.21							
B14-9, 0-2', #540	7.29	--	--	128	194	--	--	--
B14-10, 0-2', #541	184	--	--	--	207	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates compound is below Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 14-2

AREA 14
DETECTABLE CONCENTRATIONS OF
SEMIVOLATILE ORGANIC COMPOUNDS - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION							
			B14-1 0-2′ #532	B14-2 0-5′ #533	B14-3 0-5′ #534	B14-4 0-4′ #535	B14-5 0-2′ #536	B14-6 0-2′ #537	B14-7 0-4′ #538	B14-10 0-2′ #541
Anthracene	10,000,000	500,000	--	--	--	--	290	260	--	160
Benzo(a)anthracene	900	500,000	--	--	--	--	550	650	410	410
Benzo(a)pyrene	660	100,000	--	--	--	--	890	--	--	370
Benzo(b)fluoranthene	900	500,000	840	--	--	--	950	710	480	590
Benzo(ghi)perylene	900	500,000	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	900	500,000	--	--	--	--	440	--	--	520
Bis(2-ethylhexyl)phthalate	49,000	100,000	600	2,600	2,000	3,700	3,200	4,000	1,300	980
Butylbenzylphthalate	1,100,000	100,000	--	--	--	--	--	--	--	--
Chrysene	9,000	500,000	--	--	--	--	1,100	710	720	620
Fluoranthene	2,300,000	500,000	1,000	580	--	890	1,100	1,200	790	740
Indeno(1,2,3-cd)pyrene	900	500,000	--	--	--	--	640	--	--	--
Naphthalene	230,000	100,000	--	--	--	--	350	410	--	290
Phenanthrene	NS	NS	790	--	--	--	620	600	390	350
Pyrene	1,700,000	500,000	1,200	680	--	960	960	970	600	560

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion).
-- indicates compound was not detected.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-01, revised 2/8/93.

TABLE 14-3

AREA 14

DETECTABLE CONCENTRATIONS OF PESTICIDES - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION									
			B14-1 0-2' #532	B14-2 0-5' #533	B14-3 0-5' #534	B14-4 0-4' #535	B14-5 0-2' #536	B14-6 0-2' #537	B14-7 0-4' #538	B14-8 0-2' #539	B14-9 0-2' #540	B14-10 0-2' #541
DDD, PP'	3,000	100,000	109	513	531	267	265	265	404	--	3.48	173
DDE, PP'	2,000	100,000	64.4	254	248	147	147	141	209	--	--	106
DDT, PP'	2,000	100,000	647	387	409	257	342	284	557	6.31	12.3	244
Dieldrin	42	50,000	33.3	--	34.8	29.4	--	--	--	--	6.08	--
Heptachlor	150	500,000	--	--	--	--	--	--	--	16.2	45.6	--

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates compound is below laboratory detection limit.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 14-4

AREA 14
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-50	MW-50*
ARSENIC	0.02	8	173	111
BARIUM	2000	200	58.8	21.6
CADMIUM	4	2	--	--
CHROMIUM	100	10	45.0	11.5
LEAD	5	10	43.9	10.4
MERCURY	2	0.5	--	--
SELENIUM	50	10	4.1	3.1
SILVER	20	2	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
*Dissolved metal concentration.
Water Cleanup Standard Reference: 24 N.J.R. 389 SubChapter 4, Table 4-1, revised 2/1/93.

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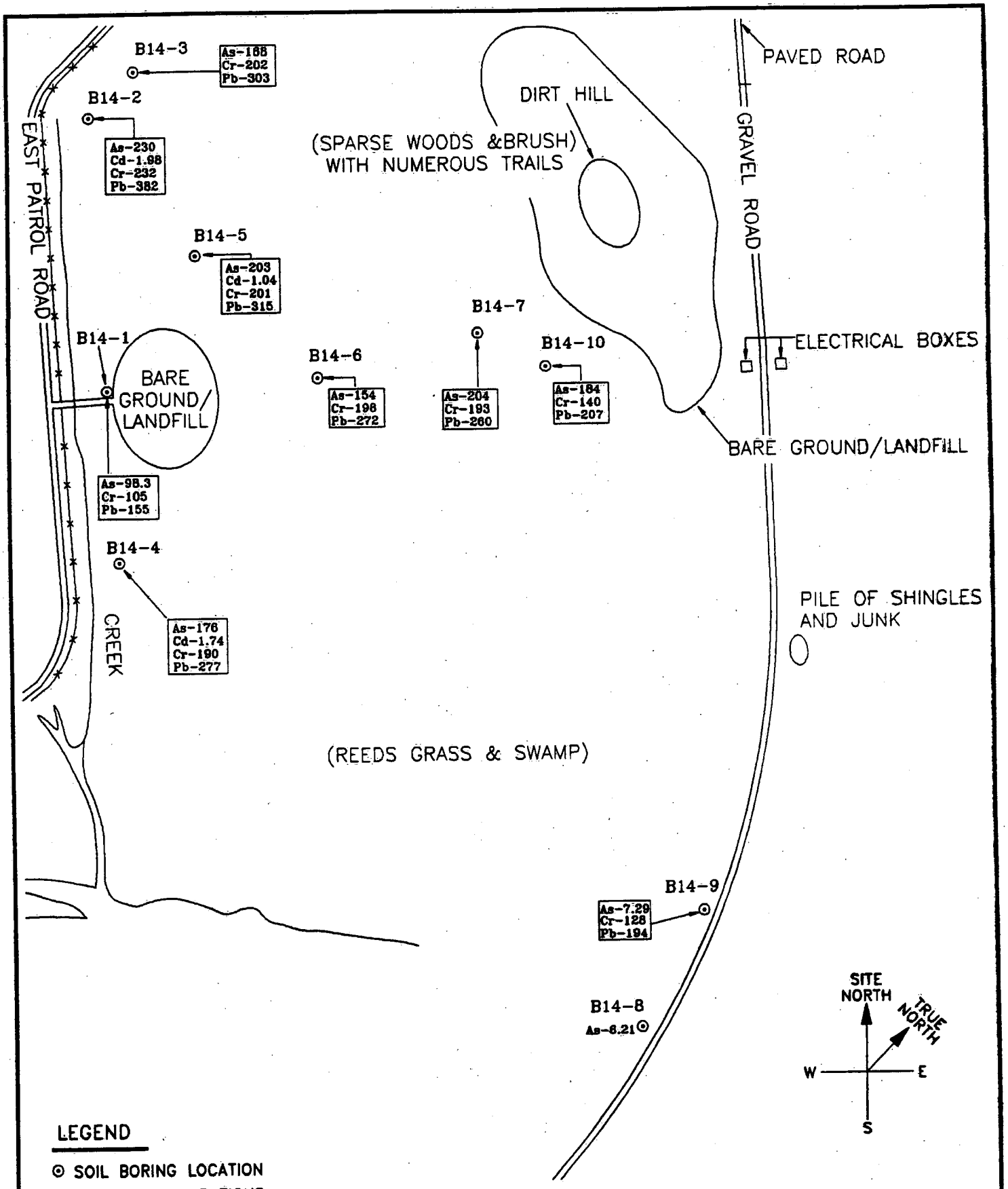
FIGURES FOR AREA 14



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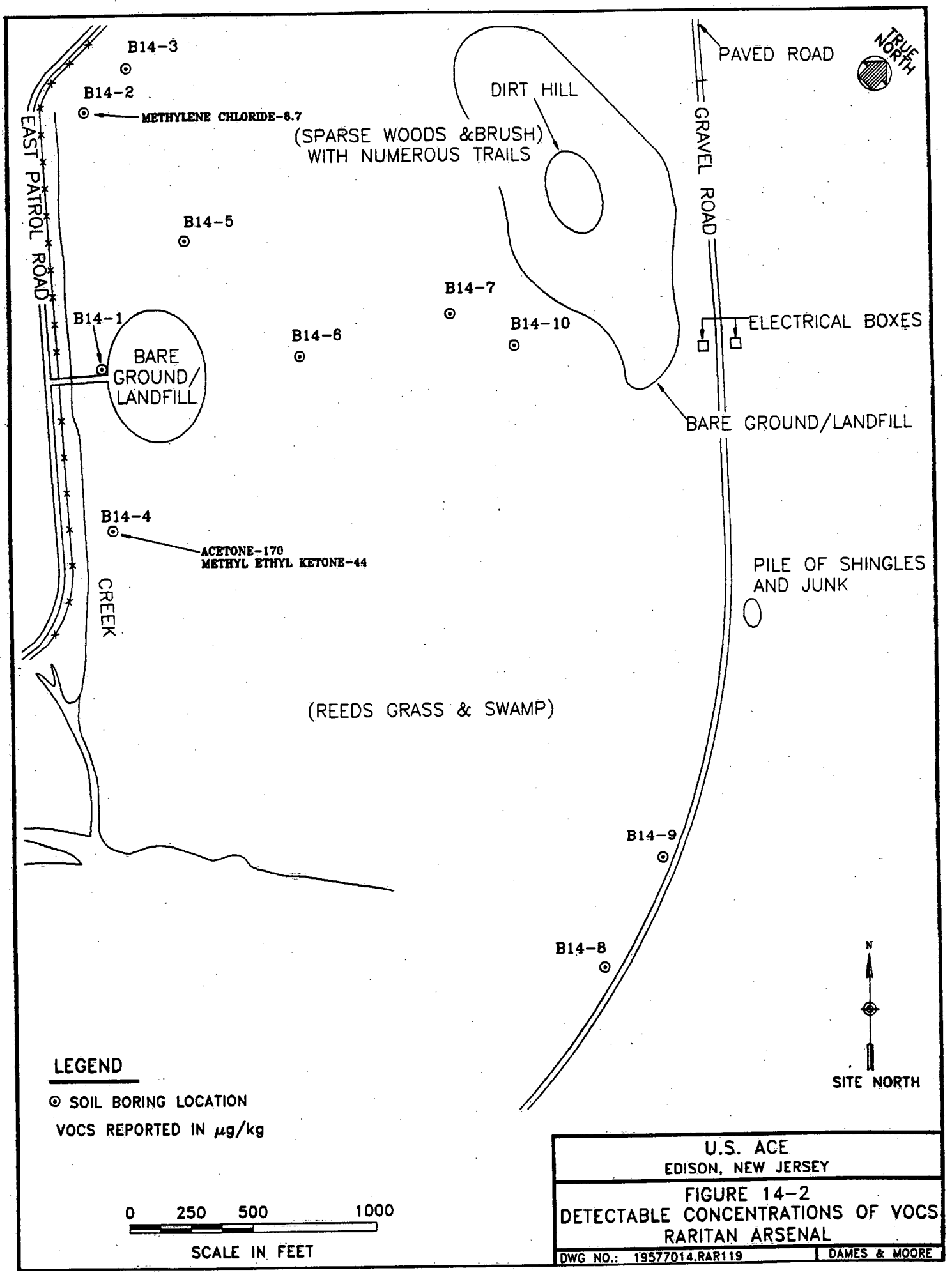
EDISON, NEW JERSEY

FIGURE 14-1
CONCENTRATIONS OF METALS EXCEEDING NJOEPE PROPOSED CLEANUP STANDARDS
RARITAN ARSENAL

DWG NO.: 19577014.RAR125 | DAMES & MOORE



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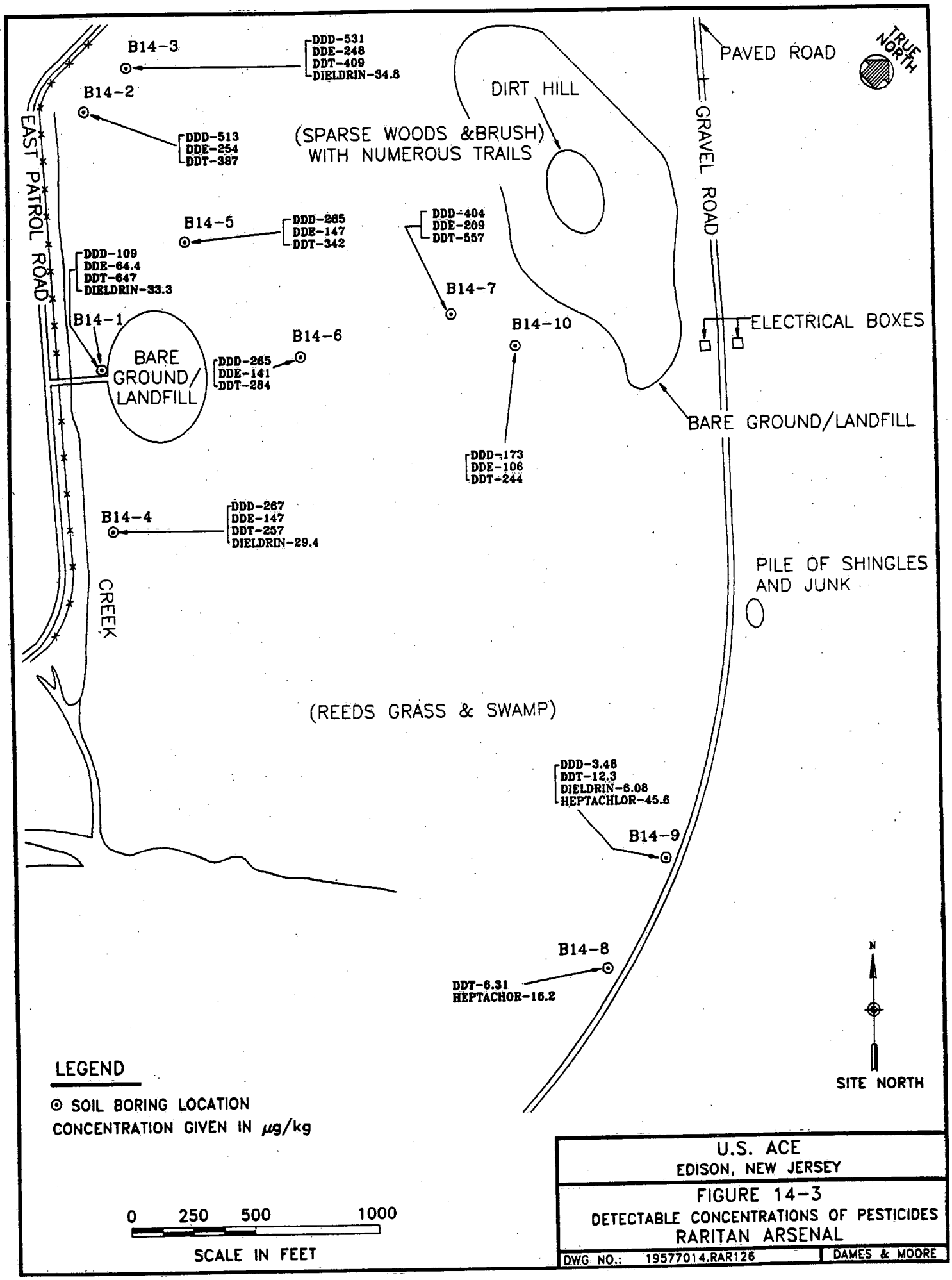
EDISON, NEW JERSEY

FIGURE 14-2
DETECTABLE CONCENTRATIONS OF VOCS
RARITAN ARSENAL

DWG NO.: 19577014.RAR119 | DAMES & MOORE



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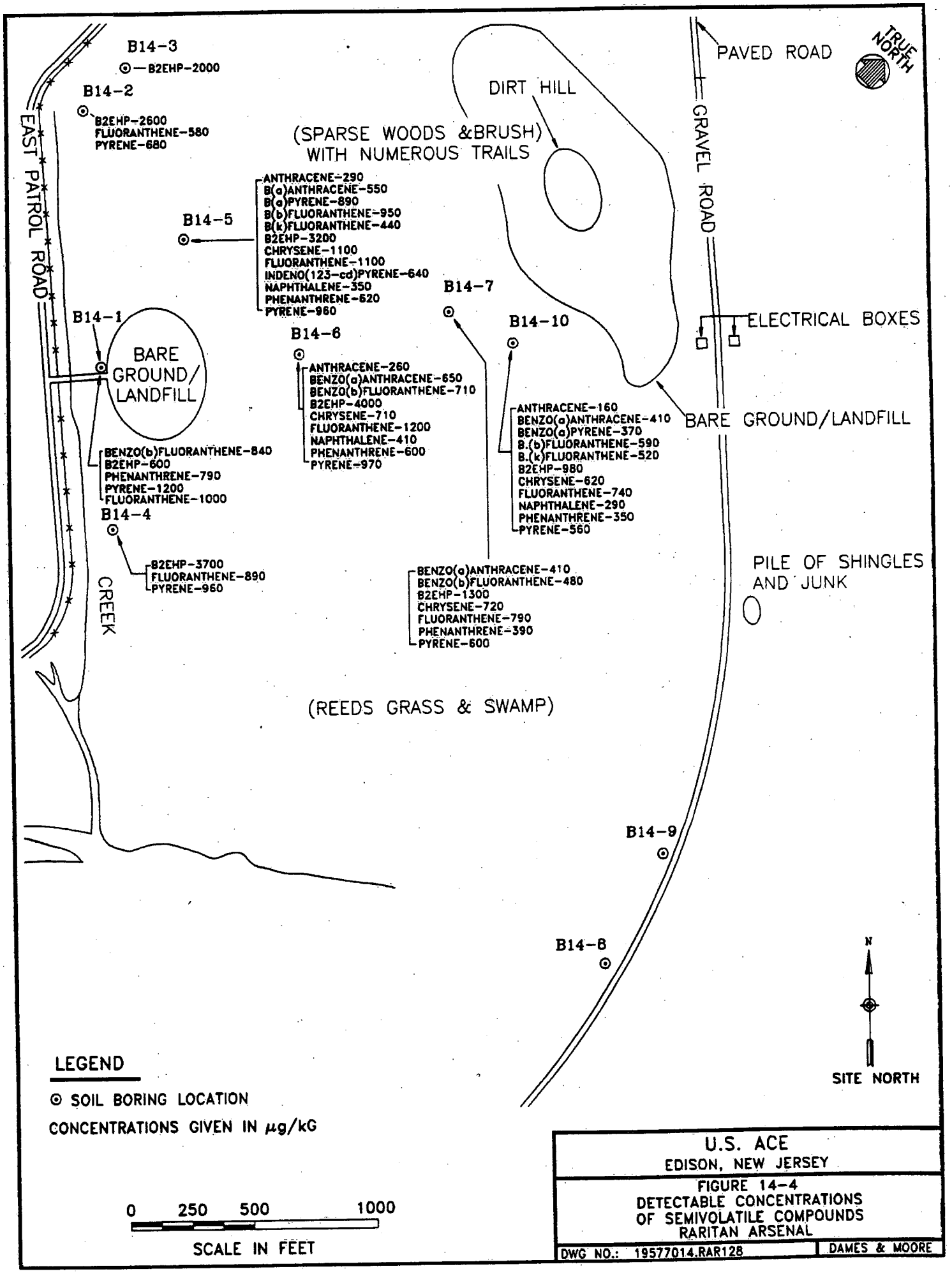
EDISON, NEW JERSEY

FIGURE 14-3
DETECTABLE CONCENTRATIONS OF PESTICIDES
RARITAN ARSENAL

DWG NO.: 19577014.RAR126 | DAMES & MOORE



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EDISON, NEW JERSEY

FIGURE 14-4
DETECTABLE CONCENTRATIONS
OF SEMIVOLATILE COMPOUNDS
RARITAN ARSENAL

DWG NO.: 19577014.RAR128 | DAMES & MOORE

5.15 AREA 15

Area 15 was not a part of the Phase I Remedial Investigation.

5.16 AREA 16

This area was used for the storage of munitions, primarily smokeless powder. It consists primarily of marshland that separates raised railroad spurs that serviced magazine buildings constructed on fill and/or pilings. Some of the remaining magazines have been used by small businesses at various times since the closure of the arsenal. In the 1980s, magazines 651 and 652 reportedly were used to house a pesticide blending plant, and magazine 630 was used to store drums that were reported to have contained acids and petroleum products.

In 1963, LEAD decontaminated the area and recommended it for "Unrestricted Use".

5.16.1 Dames & Moore Field Activities

Dames & Moore conducted a soil gas survey and UXO survey, advanced soil borings, and installed monitoring wells.

Magazine 630 and the surrounding areas were visually assessed for the presence of drums and physical evidence of contamination. No soil discoloration, stressed vegetation, or other visible evidence of contamination was observed in the soil or ground water surrounding the building. Further, no drums were found within the building or the immediate surrounding area.

5.16.2 UXO Survey

No ordnance was detected in this area during this investigation.

5.16.3 Soil Gas Survey

Twenty-four soil gas or water samples were collected and analyzed for the VOCs stated in Section 3.2.

Fourteen soil gas samples were collected along a magazine road adjacent to the upgradient boundary of Area 16 to assess the presence of contamination in ground water entering the area. Two samples contained toluene in concentrations of 0.2 ppbv and 0.06 ppbv, and three samples contained TVHC in concentrations ranging from 0.1 ppbv to 4.0 ppbv. Matrix

interference precluded definitive analysis for benzene and toluene in three samples. Samples were collected at depths of 2 to 3 feet because of a high ground water table.

Five water samples were collected to determine the placement of MW-53 because of a high ground water table. Sample WS-MW53-2 contained 0.5 ppbv benzene and toluene, and 3.0 ppbv TVHC. Sample WS-MW53-3 contained 2.0 ppbv TVHC. Sample WS-MW53-4 contained 2.0 ppbv benzene, 1.0 ppbv toluene, and 4.0 ppbv TVHC; this location was chosen for placement of monitoring well MW-53.

Five water samples also were collected to determine the placement of MW-54. Sample WS-MW54-1 contained 1.0 ppbv TCE and 1.0 ppbv TVHC; no VOCs were detected at the other sampling points. Therefore, location WS-MW54-1 was chosen for the installation of monitoring well MW-54.

Soil gas sampling locations are shown on Figure 16-1. Detectable concentrations of VOCs are stated in Table 16-1.

5.16.4 Soil Sampling Depths/Locations

Nine soil borings were advanced in Area 16. Three borings were advanced in the area of Magazine 643; three borings were advanced in the area of Magazine 644; and three borings were advanced in locations selected to obtain a broad distribution of soil analytical data. Magazines 643 and 644 have been demolished, and the areas have been searched for ordnance and remediated by the USACE-Huntsville; the areas adjacent to these magazines have been completely disturbed. Dames & Moore collected soil samples subsequent to the completion of these remediation efforts to assess the possibility of residual soil contamination from explosives. Borings were advanced to a depth of 5 feet, or to ground water if found at a shallower depth, and composite samples were collected for analyses of metals and explosives.

Soil boring locations are shown on Figure 16-2.

5.16.4.1 Analytical Results

Metals

As shown in Table 16-2, arsenic was detected in six soil samples at concentrations ranging from 3.00 to 23.4 ppm; the NJDEPE proposed standard is 2 ppm.

No other metals were detected at concentrations that exceeded NJDEPE proposed standards.

Explosives

No explosives were detected in any sample from this area.

5.16.5 Monitoring Well Installation and Sampling

Three shallow monitoring wells (MW-51, MW-53, and MW-54) and one monitoring well cluster (MW-52A and MW-52B) were installed to assess ground water quality entering and leaving Area 16, and to assess the ground water quality in Area 16.

MW-51 was installed adjacent to Building 652 to assess potential ground water contamination resulting from the pesticide blending operations formerly conducted in the building. The well was screened from depths of 7 to 17 feet in peat and reddish brown fine to medium sands that contained varying amounts of silt.

Monitoring well cluster MW-52A and MW-52B was installed adjacent to Building 655. Shallow well MW-52A was screened from depths of 7 to 12 feet in brown silty fine sand, peat, and silty clay.

MW-52B was advanced to a depth of 14.5 feet, and an 8-inch protective casing was set and grouted in a brownish gray and black silty clay. After allowing the grout to cure, drilling was resumed, and the boring was advanced to a depth of 26.5 feet. The screen was set from depths of 16.5 to 26.5 feet in a reddish brown fine to coarse sand and gravel.

MW-53 was installed on the downgradient edge of Area 16 based upon the results of the soil gas survey discussed above. The well was screened from depths of 7 to 12 feet in peat and silty clay that contained traces of fine sand.

MW-54 was installed upgradient of Area 16. The well was screened from depths of 7 to 17 feet in peat and silty clay that contained varying amounts of fine sands.

MW-52A, MW-53, and MW-54 were extremely slow rechargers; therefore, distilled water was added to these three wells, in accordance with the development procedures requested by the USACE to promote development of slow-recharging wells, as stated in Section 4.0.

Ground water samples were collected and analyzed for VOCs, base/neutral and acid extractable organic compounds, metals, pesticides, and explosives. Filtered and unfiltered samples were collected from MW-54 for dissolved and total metals analyses.

Monitoring well boring logs, construction diagrams, and development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.16.5.1 Analytical Results

<u>Metals</u>

As shown in Table 16-3, total arsenic was detected in MW-51 (17.1 ppb), deep well MW-52B (10.2 ppb), and MW-54 (12.7 ppb) in concentrations which exceeded the NJDEPE criteria of 0.02 ppb with a PQL of 8 ppb. No dissolved arsenic was detected in the filtered water sample from MW-54.

Total concentrations of chromium (131 ppb) and lead (48.5 ppb) in the water sample from MW-54 also exceeded the chromium NJDEPE criteria of 100 ppb, and the lead criteria of 5 ppb with a PQL of 10 ppb. However, the concentrations of these metals in the filtered sample from this well did not exceed the criteria and/or PQLs.

All other concentrations of metals detected in the ground water samples from this area were below NJDEPE criteria.

Explosives

As shown in Table 16-4, explosives were detected in a water sample from deep monitoring well MW-52B. HMX was detected at a concentration of 3.66 ppb, and nitroglycerin was detected at a concentration of 13.2 ppb. The NJDEPE has not proposed criteria for these compounds.

No other explosives were detected in the water samples from this area.

VOCs

As shown in Table 16-4, concentrations of VOCs detected in ground water samples from this area were below NJDEPE criteria.

Chloroform was detected in deep well MW-52B at a concentration of 5.2 ppb. Although this is below the NJDEPE criteria of 6 ppb, it is significant because chloroform also was detected in deep monitoring well MW-63, located closer to the Raritan River, in the downgradient direction; these wells are almost three-quarters of a mile apart. The source and extent of the chloroform contamination in the deep aquifer is unknown.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 16-3, all base/neutral and acid extractable compounds detected in the ground water samples from this area were below NJDEPE PQLs. Samples from MW-52B and MW-54 contained concentrations of bis(2-ethylhexyl)phthalate which exceeded the NJDEPE criteria of 3 ppb, but were below the PQL of 30 ppb.

Pesticides

No pesticides were detected in the water samples from this area.

5.16.6 Soil Geology, Area 16

Surface soils encountered in this area primarily are brown silty sands with trace fine to coarse gravel and abundant organic matter. Underlying these surface soils are gray and brownish gray fine to coarse sands and gravel, and brown and yellowish silty sands.

A peat or peat and clay layer was encountered in each of the five borings advanced for monitoring wells in Area 16. However, the thickness and other characteristics of this layer varied considerably across the area. The top of the layer was encountered at depths ranging from 5 to 8 feet. Total thickness ranged from 3 feet in the boring advanced for the installation of MW-51 to 8 feet in the borings advanced for MW-52A and MW-52B; the total thickness of the unit near MW-53 is unknown. The unit also exhibited a great deal of lithologic variation; the deposits encountered in the borings advanced for MW-51 and MW-54 were predominantly peat, whereas the clay content was higher throughout the layer and graded into a silty clay in the borings advanced for MW-52A, MW-52B, and MW-53.

Small lenses of silts and clays were encountered above the peat in a few locations. In the boring advanced for MW-52, a thin layer of light gray silty clay was encountered from depths of 5 to 5.8 feet. A 0.5 to 1 foot gray clayey silt layer was encountered directly above the peat in the borings advanced for MW-51 and MW-54. It is not known if these two thin layers are connected.

Underlying the peat or peat and clay layer was sand and gravel. These soils were typically reddish brown fine to coarse sands or fine to medium sands with trace to some gravel and varying amounts of silt. Gravel content seemed to be higher near the top of the unit. The top of the unit varied from depths of about 10 to 16 feet. The total thickness of this unit in Area 16 is unknown.

5.16.7 Ground Water Level Measurements

Dames & Moore conducted three rounds of ground water level measurements at the monitoring wells installed in Area 16. The elevations of the ground water in the wells are stated below in feet above mean sea level.

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-51	0.59	1142	0.67	1144	0.97	1112
MW-52A	0.99	1145	1.01	1148	1.08	1116
MW-53	1.18	1137	1.15	1135	1.27	1106
MW-54	1.27	1150	1.28	1158	1.33	1125

A review of this data indicates a very generalized gradient toward the south-southwest, toward the Raritan River.

MONITORING WELL	8/10/92		8/11/92		8/14/92	
	READING	TIME	READING	TIME	READING	TIME
MW-52B	0.6	1145	0.62	1152	0.80	1117

The ground water levels measured in deep aquifer well MW-52B are within 0.4 foot of the ground water levels measured in shallow aquifer monitoring well MW-52A. Monitoring well clusters elsewhere on the site typically exhibited a difference in ground water levels of approximately 1 to 3 feet between the paired shallow and deep wells. The closer agreement between water levels in MW-52A and MW-52B may indicate there is some communication between the two regimes screened by these two wells.

TABLES FOR AREA 16

TABLE 16-1

AREA 16
SOIL GAS SURVEY
DETECTABLE CONCENTRATIONS OF SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC
SG-16-1-2′	--	--	--	--	0.2	--	--	4
SG-16-3-2′	--	--	--	--	0.06	--	--	0.1
SG-16-10-3′	--	--	--	I[1]	I	--	--	--
SG-16-11-2′	--	--	--	I	I	--	--	--
SG-16-12-2′	--	--	--	I	I	--	--	--
SG-16-13-2′	--	--	--	--	--	--	--	0.1
WS-MW53-2-4′	--	--	--	0.5	0.5	--	--	3
WS-MW53-3-4′	--	--	--	--	--	--	--	2
WS-MW53-4-4′	--	--	--	2	1	--	--	4
WS-MW54-1-5′	--	--	1	--	--	--	--	1

[1]I = Matrix interference.

Note: Units are in μg/L (parts per billion, vapor).
-- = Not detected.

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TABLE 16-2

AREA 16
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B16-2, 0-3.5', #545	4.32	--	--	--	--	--	--	--
B16-3, 0-2', #546	11.5	--	--	--	--	--	--	--
B16-5, 0-4', #548	17.4	--	--	--	--	--	--	--
B16-6, 0-4', #549	4.03	--	--	--	--	--	--	--
B16-7, 0-4', #550	23.4	--	--	--	--	--	--	--
B16-8, 0-5', #551	3.00	--	--	--	--	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates compound is below Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussions with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 16-3

AREA 16
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-51	MW-52A	MW-52B	MW-53	MW-54	MW-54*
ARSENIC	0.02	8	17.1	--	10.2	3.4	12.7	--
BARIUM	2000	200	227	44.0	55.9	78	145	10.6
CADMIUM	4	2	--	--	--	--	--	--
CHROMIUM	100	10	10.7	--	17.7	--	131	8.3
LEAD	5	10	--	--	3.8	--	48.5	--
MERCURY	2	0.5	--	--	--	--	--	--
SELENIUM	50	10	2.6	--	--	--	--	--
SILVER	20	2	--	--	--	--	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
*Dissolved metal concentration).
Water Criteria Reference: 24 N.J.R. 389, Subchapter 4, Table 4-1, revised 2/1/93.

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TABLE 16-4

AREA 16
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-51	MW-52A	MW-52B	MW-53	MW-54
Explosives							
HMX	NS	NS	--	--	3.66	--	--
Nitroglycerin	NS	NS	--	--	13.2	--	--
Volatile Organic Compounds							
Acetone	700	NS	--	--	58	--	--
Chloroform	6	1	--	--	5.2	--	--
Ethylbenzene	700	5	--	--	1.5	--	--
Base/Neutral and Acid Extractable Compounds							
Bis(2-ethylhexyl)phthalate	3 *	30	2.2	--	6.0	--	3.8
Diethylphthalate	5000	10	--	--	--	3.4	9.8
Naphthalene	30	NS	--	--	2.1	--	--
Phenol	4000	10	--	--	9.6	--	--

Notes: Concentrations are given in µg/L (parts per billion).
-- = Not detected.
NS = No criteria proposed.
* Federal MCL = 6 µg/L.
Water Criteria Reference: 24 N.J.R. 389, Subchapter 4, Table 4-1, revised 2/1/93.

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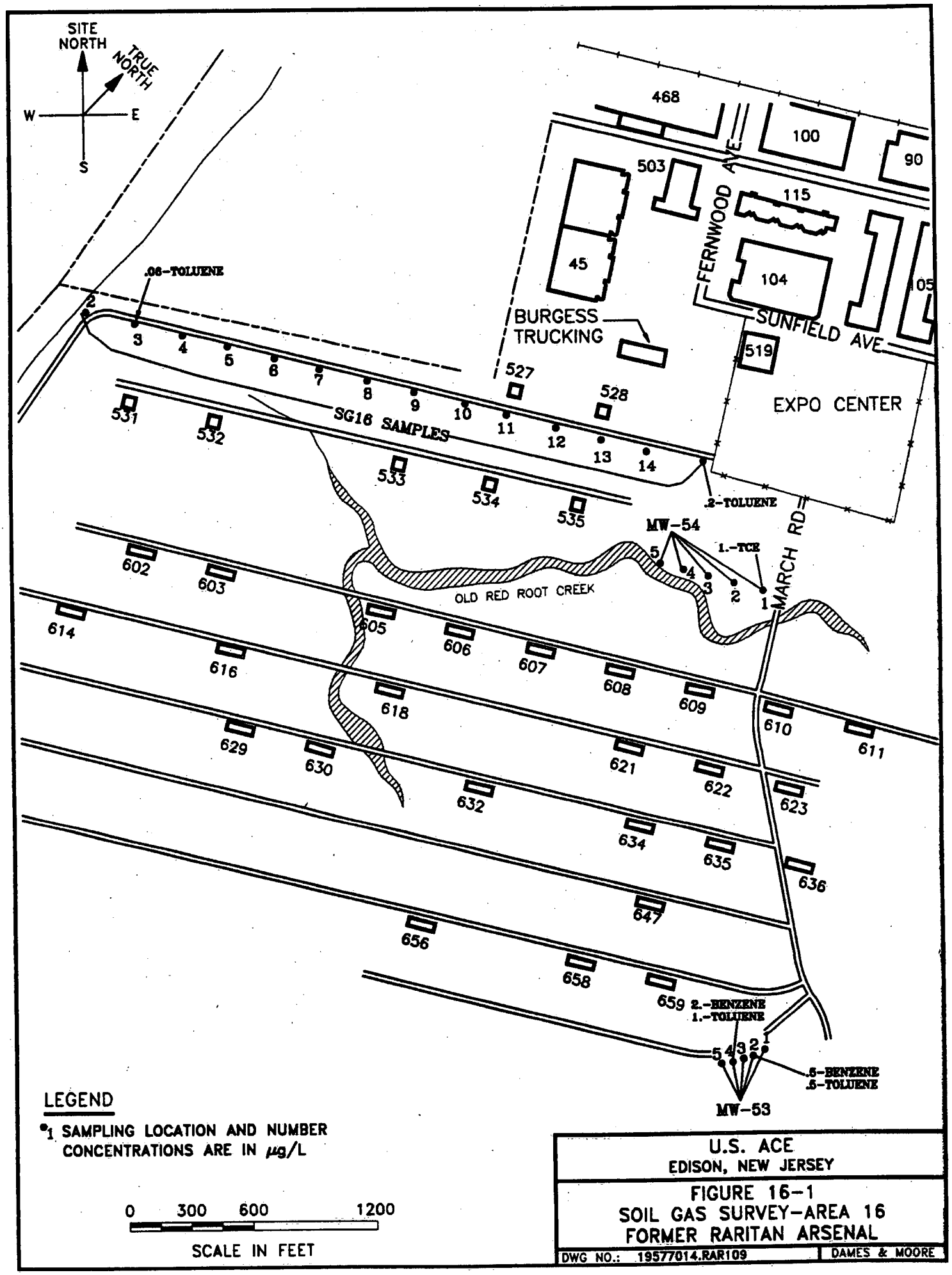
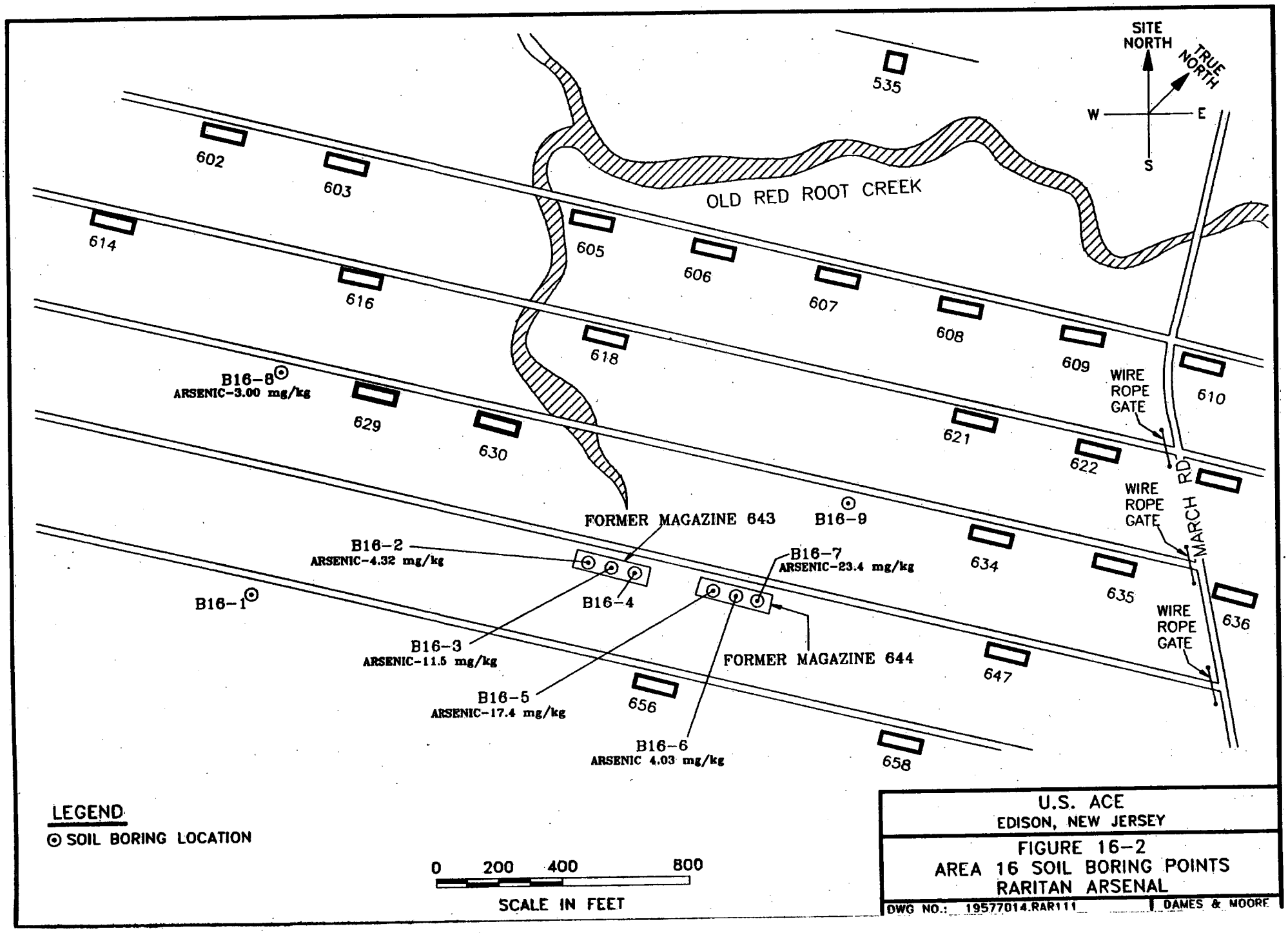
FIGURES FOR AREA 16


SITE NORTH
TRUE NORTH
W
E
S
468
100
90
503
115
FERNWOOD AVE
45
104
105
BURGESS TRUCKING
SUNFIELD AVE
519
EXPO CENTER
527
528
.06-TOLUENE
2
3
4
5
6
7
8
9
10
11
12
13
14
SG16 SAMPLES
531
532
533
534
535
.2-TOLUENE
MW-54
1.-TCE
MARCH RD
OLD RED ROOT CREEK
602
603
605
606
607
608
609
610
611
614
616
618
621
622
623
629
630
632
634
635
636
647
656
658
659
2.-BENZENE
1.-TOLUENE
.5-BENZENE
.5-TOLUENE
MW-53
LEGEND
•1 SAMPLING LOCATION AND NUMBER
CONCENTRATIONS ARE IN μg/L
0
300
600
1200
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 16-1
SOIL GAS SURVEY-AREA 16
FORMER RARITAN ARSENAL
DWG NO.: 19577014.RAR109
DAMES & MOORE


SITE NORTH
TRUE NORTH
W
E
S
535
602
603
614
616
605
606
607
608
609
610
618
629
630
621
622
634
635
636
647
656
658
OLD RED ROOT CREEK
B16-8
ARSENIC-3.00 mg/kg
WIRE ROPE GATE
WIRE ROPE GATE
WIRE ROPE GATE
MARCH RD.
FORMER MAGAZINE 643
B16-9
B16-2
ARSENIC-4.32 mg/kg
B16-7
ARSENIC-23.4 mg/kg
B16-1
B16-4
B16-3
ARSENIC-11.5 mg/kg
FORMER MAGAZINE 644
B16-5
ARSENIC-17.4 mg/kg
B16-6
ARSENIC 4.03 mg/kg
LEGEND
SOIL BORING LOCATION
0 200 400 800
SCALE IN FEET
U.S. ACE
EDISON, NEW JERSEY
FIGURE 16-2
AREA 16 SOIL BORING POINTS
RARITAN ARSENAL
DWG NO.: 19577014.RAR111
DAMES & MOORE

5.17 AREA 17A

The parcel of land that is now the site of Middlesex County College (MCC) was acquired by the government for the arsenal in 1917. The majority of the land was used for officer quarters, barracks, service buildings, and the base hospital area. A portion of the site, identified as Area 17 in the 1963 study conducted by LEAD during the decommissioning of the arsenal, was used as a disposal site and salvage yard; it is now overlain by portions of an ecological park, the MCC physical education facility, and the MCC student center. A 1963 decontamination effort by LEAD in Area 17 included the removal of scrap metal and inert ammunition components, and surface scrapping and cleaning. Following this effort, LEAD classified Area 17 for "Unrestricted Use." In 1988, OBG performed a review of excavation and construction files of Area 17; these files indicated that no potentially hazardous articles were found during the construction and development in the area. No field investigations were performed by OBG. Based on the results of the OBG file search, and the almost total development of the area, this area was excluded from Dames & Moore's scope of work.

Dames & Moore's review of Drawing D-418, dated February, 1954, indicated the presence of a burning grounds south of Area 17. This area has been designated Area 17A, and is currently overlain by the MCC baseball field.

No visible evidence of the burning grounds currently exists at the site. It was necessary, therefore, to determine the location of the burning grounds using available drawings and aerial photographs. Objects that could be identified on both Drawing D-418 and an aerial photograph dated May 12, 1988, were used to determine the scale of the aerial photograph and locate the burning grounds in relationship to the ball field at the MCC. There is a potential for inaccuracies using this method, particularly because Drawing D-418 has a scale of 1 inch equals 600 feet, and there may have been minor inaccuracies in the preparation of the drawing.

Dames & Moore compared the location for the burning grounds, as determined above, with that shown in the Metcalf & Eddy Archive Search Report. Although there are some differences (the Metcalf & Eddy location is slightly east and south of the Dames & Moore location), there is a reasonable amount of agreement. To assess the possibility the burning ground was located slightly to the east, Dames & Moore installed one additional row of soil gas survey holes in the right field area of the ball field; with the exception of one location where 0.2

ppbv of benzene and 0.3 ppbv of toluene were detected, no volatile organic compounds were detected by the soil gas survey in the two easternmost rows of survey holes.

As shown on the boring logs provided in Appendix B, fragments of glass, metal, and wood were found in borings B17A-1 and B17A-3. Although this is not conclusive proof that these borings were advanced in the burning grounds, it is probable the trash encountered in the boreholes resulted from the operation of the burning grounds.

5.17.1 Dames & Moore Field Activities

Dames & Moore's scope of work for this area included a soil gas survey of the former burning grounds, and obtaining soil samples from three soil borings. Additionally, a monitoring well cluster consisting of a deep well and a shallow well was installed in the assumed downgradient direction of Area 17A to assess ground water quality which may have been impacted by activities conducted in Area 17A. The downgradient direction was predicted based on the topography of the area and the location of the Raritan River.

5.17.2 Soil Gas Survey

Soil gas surveys were conducted in the MCC ballpark to aid in locating the former burning grounds. Because of the lack of information concerning the burning grounds, the soil gas survey was used as a field screening technique to assess the presence of one class of contamination (VOCs) which may have been present; in similar investigations, Dames & Moore has detected solvents and petroleum products which had seeped into the ground before they could burn. The methods of disposal used in the burning area are unknown; wastes may have been burned in an incinerator, concrete-lined pit, or directly on the ground. Further, the types of wastes disposed in this area also are unknown; waste types may have included solid wastes (such as packaging materials), waste lubricants from maintenance of mobile equipment, solvents, and other types of combustible wastes.

Thirty soil gas samples were collected from the former burning grounds area and were analyzed for the VOCs stated in Section 3.2. A 40-foot grid was superimposed upon the area, and samples typically were collected at the grid nodes; some sampling points were moved slightly to avoid subsurface metallic objects, in accordance with provisions stated in Dames & Moore's Work Plan and Health and Safety Plan. All soil gas samples were collected from a

depth of 5 feet. Borings either collapsed upon removal of the sampling tube, or were backfilled with material obtained from a stockpile of the sand used to dress the base paths. A sample of this fill material previously had been analyzed for RCRA metal content; no significant contamination was detected during this analysis.

Low but detectable concentrations of TCE, benzene, toluene, and TVHC were found in some of the soil gas samples. Fifteen samples contained TCE, in concentrations ranging from 0.002 to 0.8 ppbv. Benzene was found in three samples, in concentrations ranging from 0.2 to 2.0 ppbv. Toluene was detected in two samples, at concentrations of 0.3 and 1.0 ppbv. TVHC was found in three samples, with concentrations ranging from 0.2 to 41 ppbv.

Soil gas sampling locations are shown on Figure 17A-1. Data are summarized in Table 17A-1.

5.17.3 Soil Sampling Depths/Locations

Based on the results of the soil gas survey, soil samples were obtained at soil gas survey locations 23, 27, and 28 for analysis of VOCs, base/neutral and acid extractable organic compounds, metals, pesticides, PCBs, and explosives. These soil gas survey points correspond to borings B17A-1, B17A-2, and B17A-3, respectively.

Composite samples were collected from intervals of 0 to 5 feet and 5 to 10 feet for all analyses except VOCs; discrete samples were collected from each 2-foot sampling interval for possible VOC analysis. The discrete samples were subjected to headspace analysis; the sample with the highest headspace reading from each borehole was submitted for VOC analysis.

5.17.3.1 Analytical Results

Metals

As shown in Table 17A-2, five soil samples contained concentrations of metals that exceeded NJDEPE proposed standards.

Arsenic was detected in five samples in concentrations ranging from 2.34 to 26.4 ppm; the NJDEPE proposed standard is 2 ppm.

Barium was detected at a concentration of 766 ppm in the soil sample obtained from a depth interval of 5 to 10 feet at sample location B17A-3; the NJDEPE proposed standard is 700 ppm.

Cadmium concentrations ranged from 7.5 to 23.9 ppm; the NJDEPE proposed standard is 1 ppm.

Lead concentrations ranged from 2560 to 10,300 ppm; the NJDEPE proposed standard is 100 ppm. Because of the high concentrations of lead detected in the soil analyses, Dames & Moore requested that the ESE laboratory review the analyses for lead and barium; this review did not detect any errors in the calculations. The laboratory then reanalyzed the samples using a portion of the same extract originally analyzed; this reanalysis confirmed the original results. Finally, a second extraction was performed on the soils; this resulted in barium and lead concentrations of 8.49 and 10.0 ppm respectively, for sample #561. All analyses performed for lead and barium on the other samples yielded concentrations equivalent to those originally reported. The variation in the barium and lead concentrations can be explained by the lack of homogeneity of soil samples, even after thorough blending.

Based on the Metcalf and Eddy archive search, there is no reason to believe that materials containing hexavalent chromium may have been disposed at the site; therefore, chromium speciation was not performed. The presence of hexavalent chromium will be assessed during subsequent phases of the remedial investigation.

VOCs

Low concentrations of VOCs were detected in soil samples from the three borings. However, in some cases the VOCs detected during the soil gas survey were not detected in the soil samples. TCE was detected during the soil gas survey at locations 23, 27 and 28; although TCE was found in the soil samples from locations 23 and 28, it was not found in sample location 27. Benzene was detected at locations 23 and 28, and toluene was detected at location 28; however, no benzene or toluene were detected in the soil samples. It should be noted that concentrations of VOCs detected during the soil gas survey ranged from 0.3 ppbv to 2.0 ppbv whereas the laboratory detection limit for soils generally was in the range of 5 ppm. Because the VOCs detected during the soil gas survey were found in concentrations that were orders of

magnitude lower than the analytical laboratory soil detection limit, the failure to find these contaminants in the soil samples is not considered significant.

As shown in Table 17A-3, low concentrations of TCE, acetone and trichlorofluoromethane were detected in the soil samples. The concentrations of acetone and TCE detected were below NJDEPE proposed standards; no standard has been proposed for trichlorofluoromethane.

Base/Neutral and Acid Extractable Organic Compounds

As shown in Table 17A-4, low concentrations of base/neutral contaminants were detected in five of the six soil samples obtained from Area 17A. None of the concentrations exceeded NJDEPE proposed cleanup standards.

Pesticides/PCBs

As shown in Table 17A-5, five of the six soil samples contained detectable concentrations of pesticides. However, all concentrations were below NJDEPE proposed standards.

PCBs were detected in one soil sample from the burning grounds at a concentration of 210 ppb. The presence of PCBs in the soils of the burning grounds is significant because of the possible generation of dioxins during the burning of oils which contain PCBs; dioxins are considered a greater health hazard than PCBs.

Explosives

No explosives were detected in the soil samples from this area.

5.17.4 Monitoring Well Installation and Sampling

Dames & Moore installed one monitoring well cluster, MW-55A and MW-55B, in the assumed downgradient direction of the burning grounds. These wells are located in Thomas A. Edison Park on the boundary between the MCC and the Park, and were discussed in Section 5.10. They are also discussed in this section.

MW-55A was drilled to a depth of 9.5 feet, and was screened from depths of 7 to 9 feet in brown and gray silty fine sand with traces of fine gravel, medium sand, and peat. MW-55B was installed less than 5 feet from MW-55A in the inferred crossgradient direction. The well was screened from depths of 14 to 21 feet. Clay was encountered at a depth of 10 feet. The boring was drilled into this aquitard, and an 8-inch outer casing was set and grouted. After allowing the grout to cure for more than 48 hours, drilling was resumed and the boring was advanced to a depth of 21 feet. Black shale bedrock was encountered at 20.9 feet. The 7-foot screen was set in black fine to medium sand that contained traces of coarse sand, gravel, and silt.

Ground water samples from monitoring wells MW-55A and MW-55B were analyzed for VOCs, base/neutral and acid extractable organic compounds, explosives, metals, and pesticides.

The monitoring well boring logs, construction diagrams, and development and stabilization data are included in Volume III of this report, Appendices B, C, D, and E.

5.17.4.1 Analytical Results

<u>Metals</u>

As shown in Table 17A-6, lead was detected in MW-55A at a concentration of 13.2 ppb; the NJDEPE criteria is 5 ppb with a PQL of 10 ppb.

All other metals detected in the ground water samples from this area were below NJDEPE criteria.

<u>Base/Neutral and Acid Extractable Organic Compounds</u>

Bis(2-ethylhexyl)phthalate was reported in the water sample from MW-55A at a concentration of 1.8 ppb; this is below the NJDEPE criteria and PQL. It should be noted that this compound is a common laboratory contaminant; the concentration reported may not be representative of the concentration in the aquifer.

No other base/neutral and acid extractable compounds were detected in the water samples from this area.

Others

No explosives, pesticides, or VOCs were detected in the water samples from this area.

5.17.5 Soil Geology

The borehole logs from Area 17A indicate the borings advanced in the former burning ground area were terminated in sands. Glass, metal, and other manmade objects were encountered in two of the three borings at depths of four to six feet. The sands encountered at depths from 6 to 10 feet are comparable in texture, composition, and compaction to those encountered at the shallower depths. It is possible, therefore, that the sands encountered in the lower portion of the borings are naturally occurring soils, and the sands in the upper portion of the borings are the result of cut and fill operations.

TABLES FOR AREA 17A

TABLE 17A-1

SOIL GAS SURVEY - AREA 17A
DETECTABLE CONCENTRATIONS OF
SELECTED VOLATILE ORGANIC COMPOUNDS

SAMPLE DESCRIPTION	PARAMETER							
	1,1-DCE	1,1-DCA	TCE	BENZENE	TOLUENE	ETHYLBENZENE	XYLENES	TVHC*
SG17A-1, 5'	--	--	0.009	--	--	--	--	0.2
SG17A-2, 5'	--	--	0.002	--	--	--	--	--
SG17A-6, 5'	--	--	--	0.2	0.3	--	--	--
SG17A-11, 5'	--	--	0.2	--	--	--	--	--
SG17A-12, 5'	--	--	0.007	--	--	--	--	--
SG17A-18, 5'	--	--	--	0.04	--	--	--	--
SG17A-19, 5'	--	--	--	0.01	--	--	--	--
SG17A-20, 5'	--	--	0.04	--	--	--	--	--
SG17A-23, 5'	--	--	0.8	0.3	--	--	--	3
SG17A-24, 5'	--	--	0.09	--	--	--	--	--
SG17A-26, 5'	--	--	0.003	--	--	--	--	--
SG17A-27, 5'	--	--	0.3	--	--	--	--	--
SG17A-28, 5'	--	--	0.6	2.0	1.0	--	--	41
SG17A-29, 5'	--	--	0.3	--	--	--	--	--

* = Total volatile hydrocarbons
-- = Not Detected
Concentrations in $\mu g/L$ (parts per billion, vapor)

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TABLE 17A-2

AREA 17A
CONCENTRATIONS OF METALS
EXCEEDING NJDEPE SOIL CLEANUP STANDARDS
SOIL SAMPLES

SAMPLE DESCRIPTION	ARSENIC	BARIUM	CADMIUM	CHROMIUM	LEAD	MERCURY	SELENIUM	SILVER
Residential Surface Soil Cleanup Standard	2	700	1	NS	100	14	63	110
B17A-1, 0-5', #1554	4.92	--	7.50	115	2560	--	--	--
B17A-1, 5-10', #555	4.85	--	15.6	107	2660	--	--	--
B17A-2, 0-5', #557	2.34	--	--	--	--	--	--	--
B17A-3, 0-5', #560	17.0	--	15.4	302	5350	--	--	--
B17A-3, 5-10', #561	26.4	766	23.9	303	10300	--	--	--

Notes: Concentrations expressed in mg/kg (parts per million).
-- indicates metal concentration is below NJDEPE proposed Soil Cleanup Standards.
NS = No soil cleanup standards have been published for chromium. Discussion with NJDEPE personnel indicate a value of 500 ppm (total) should be used.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

[d:\...\19577014\march93\area17a.2]

TABLE 17A-3

AREA 17A
DETECTABLE CONCENTRATIONS OF
VOLATILE ORGANIC COMPOUNDS
SOIL

PARAMETERS	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	#556, b17a-1, 4-6′	#559, b17a-2, 6-8′	#562, b17a-3, 8-10′
Acetone	1,000,000	50,000	--	--	12
Trichloroethene	23,000	1,000	13.0	--	22
Trichlorofluoromethane	NS	NS	9.7	6.6	10

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates compound is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387, Subchapter 3, Table 3-1, revised 2/8/93.

[d:\...\march93\area17A.173]

TABLE 17A-4

AREA 17A
DETECTABLE CONCENTRATIONS OF BASE/NEUTRAL AND ACID EXTRACTABLE SEMIVOLATILE ORGANIC COMPOUNDS - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION				
			B17A-1 0-5' #554	B17A-1 5-10' #555	B17A-2 0-5' #557	B17A-2 5-10' #558	B17A-3 5-10' #561
Acenaphthene	3,400,000	100,000	--	--	--	--	--
Anthracene	10,000,000	500,000	--	--	240	--	--
Benzo(a)anthracene	900	500,000	--	--	690	--	--
Benzo(a)pyrene	660	100,000	--	--	520	--	--
Benzo(b)fluoranthene	900	500,000	170	--	690	--	--
Benzo(ghi)perylene	660	500,000	--	--	390	--	--
Benzo(k)fluoranthene	900	500,000	--	--	230	--	--
Bis(2-ethylhexyl)phthalate	49,000	100,000	430	360	380	2,400	--
Chrysene	9,000	500,000	--	--	740	--	150
Dibenz(a,h)anthracene	660	500,000	--	--	--	--	--
Fluoranthene	2,300,000	500,000	140	79	1,200	--	200
Fluorene	2,300,000	100,000	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	900	500,000	--	--	430	--	--
Naphthalene	230,000	100,000	--	--	--	--	--
Phenanthrene	NS	NS	91	--	1,000	--	110
Pyrene	1,700,000	500,000	210	94	1,300	--	210

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion).
-- indicates compound is below laboratory detection limit.
NS = No soil cleanup standards have been developed for this compound.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 17A-5

AREA 17A

DETECTABLE CONCENTRATIONS OF PESTICIDES AND PCBs - SOILS

PARAMETER	RESIDENTIAL SURFACE SOIL CLEANUP STANDARD	IMPACT TO GROUND WATER SOIL CLEANUP CRITERIA	SAMPLE DESCRIPTION					
			B17A-1 0-5′ #554	B17A-1 5-10′ #555	B17A-2 0-5′ #557	B17A-2 5-10′ #558	B17A-3 0-5′ #560	B17A-3 5-10′ #561
DDD, PP′	3,000	100,000	--	513	6.74	2.51	--	--
DDE, PP′	2,000	100,000	10.7	18.0	9.51	1.03	--	2.10
DDT, PP′	2,000	100,000	20.3	--	20.2	2.15	--	10.5
PCB, 1260	490	100,000	--	210	--	--	--	--

Notes: Concentrations expressed in μg/kg (parts per billion).
-- indicates compound is below laboratory detection limit.
Soil Cleanup Standard Reference: 24 N.J.R. 387 Subchapter 3, Table 3-1, revised 2/8/93.

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TABLE 17A-6

AREA 17A
DETECTABLE CONCENTRATIONS OF METALS
GROUND WATER SAMPLES

PARAMETER	CLASS IIA GROUND WATER CRITERIA	PRACTICAL QUANTITATION LEVEL (PQL)	MW-55A	MW-55B
ARSENIC	0.02	8	--	--
BARIUM	2000	200	100.0	39.8
CADMIUM	4	2	--	--
CHROMIUM	100	10	11.8	--
LEAD	5	10	13.2	--
MERCURY	2	0.5	--	--
SELENIUM	50	10	--	--
SILVER	20	2	--	--

Notes: Metal concentrations are given in μg/L (parts per billion).
-- = Not detected.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

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TABLE 17A-7

AREA 17A
DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS
GROUND WATER SAMPLES

PARAMETER	CLEANUP STANDARD CLASS IIA GROUND WATER	PRACTICAL QUANTITATION LEVEL (PQL)	MW-55A	MW-55B
Base/Neutral and Acid Extractable Compounds				
Bis(2-ethylhexyl)phthalate	3*	30	1.8	--

Notes: Concentrations are given in μg/L (parts per billion).
-- = Not detected.
* Federal MCL = 6 μg/L.
Water Criteria Reference: 24 N.J.R. 389 Sub Chapter 4 Table 4-1, revised 2/1/93.

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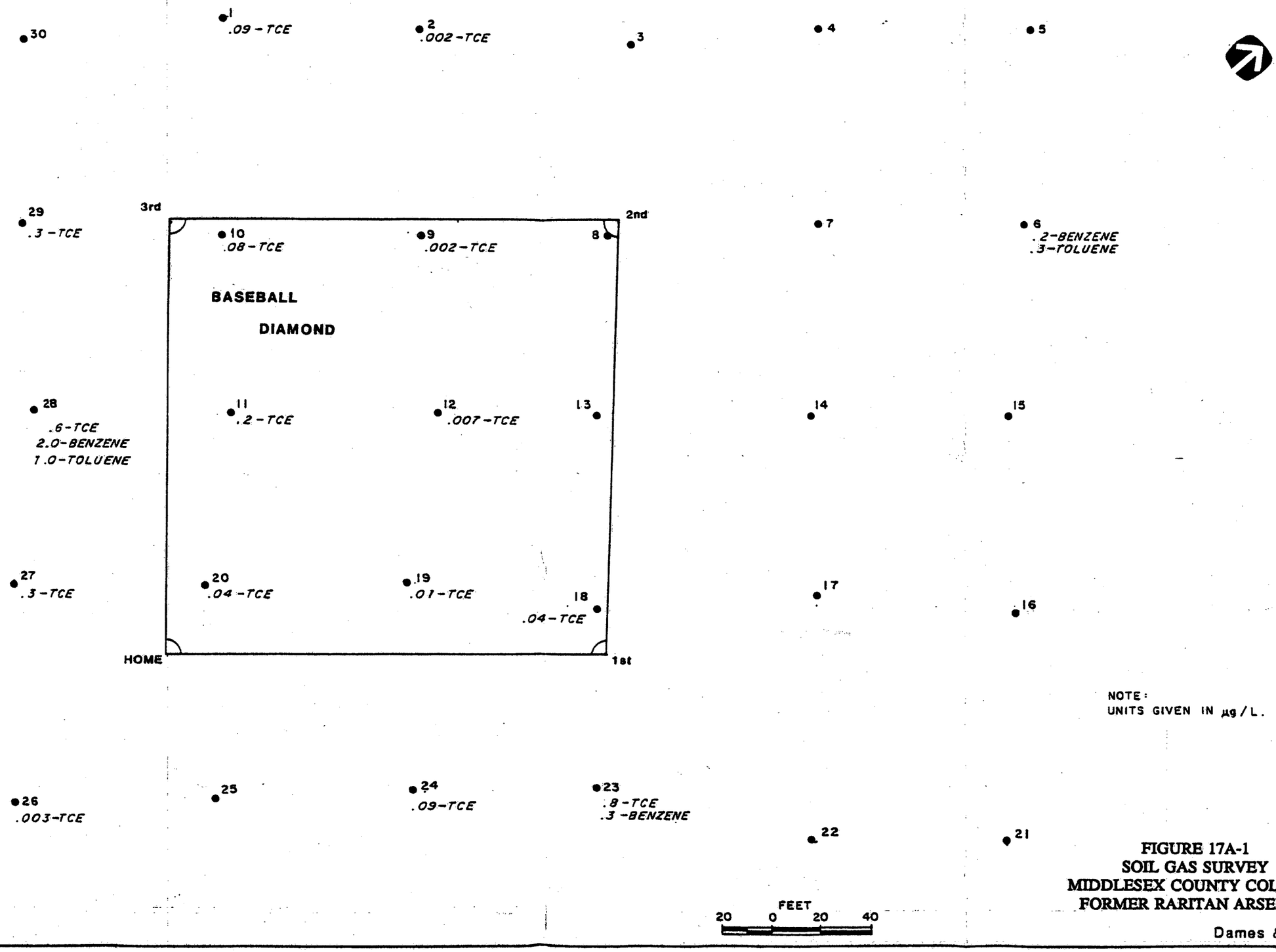
FIGURES FOR AREA 17A



NOTE:
UNITS GIVEN IN µg/L.

FIGURE 17A-1
SOIL GAS SURVEY
MIDDLESEX COUNTY COLLEGE
FORMER RARITAN ARSENAL

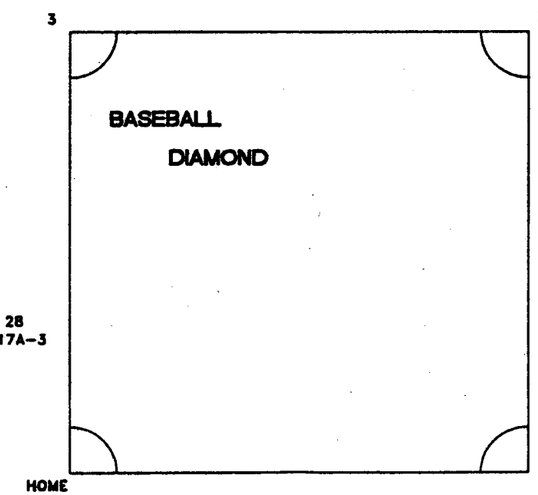
Dames & Moore

NORTH

PARAMETERS	#560 (0-5')	#561 (5'-10')	#562 (8'-10')
RCRA METALS (PPM)			NRQ
ARSENIC	17	26.4	
BARIUM	613	766	
CADMIUM	15.4	23.9	
CHROMIUM	302	303	3
LEAD	5350	10,300	
MERCURY	0.134	0.187	
SILVER	14.8	26.4	
EXPLOSIVES (ppb)			NRQ
PETN, SOIL	BDL	6.36	
PCB'S/PESTICIDES (ppb)			NRQ
DDE, PP	BDL	2.10	
DDT,PP	BDL	10.5	
AE/BN'S (ppb)			NRQ
CHRYSENE	BDL	150	
FLUORANTHENE	BDL	200	
PHENANTHRENE	BDL	110	
PYRENE	BDL	210	
VOLATILE ORGANICS (ppb)	NRQ	NRQ	
ACETONE			12
TRICHLOROETHENE			22
TRICHLOROFLUOROMETHANE			10

LEGEND:

- ⊕ APPROXIMATE SOIL BORING LOCATIONS
- AE/BN's – ACID EXTRACTABLES/BASE NEUTRALS (SEMI VOLATILES)
- #554 (0-5') – LABORATORY SAMPLE NUMBER (DEPTH OF SOIL SAMPLE)
- NRQ – ANALYSIS NOT REQUESTED



PT 28
B17A-3

B17A-2
PT 27

B17A-1
SOIL GAS SURVEY POINT 23

PARAMETERS	#1554 (0-5')	#555 (5'-10')	#556 (4'-6')
RCRA METALS (PPM)			NRQ
ARSENIC	4.92	485	
BARIUM	332	376	
CADMIUM	7.5	15.6	
CHROMIUM	115	107	
LEAD	2560	2660	
MERCURY	0.094	0.118	
SILVER	9.48	18	
EXPLOSIVES (ppb)	BDL	BDL	NRQ
PCB'S/PESTICIDES (ppb)			
DDE, PP'	10.7	18	
DDT, PP'	20.3	BDL	NRQ
PCB, 1260	BDL	210	
AE/BN'S (ppb)			NRQ
BENZO (B)FLUORANTHENE	170	BDL	
BIS (2-ETHYHEXYL) PHTHALATE	430	360	
FLUORANTHENE	140	79	
PHENANTHENE	91	BDL	
PYRENE	210	94	
VOLATILE ORGANICS (ppb)	NRQ	NRQ	
TRICHLOROETHENE			13
TRICHLOROFLUOROMETHANE			9.7

PARAMETERS	#557 (0-5')	#558 (5'-10')	#559 (6'-8')
RCRA METALS (PPM)			NRQ
ARSENIC	2.34	0.802	
BARIUM	50.3	65.4	
CHROMIUM	13.4	15.7	
LEAD	54.7	BDL	
MERCURY	0.034	BDL	
SELENIUM	0.294	BDL	
SILVER	0.949	BDL	
EXPLOSIVES (ppb)	BDL	6.36	NRQ
PCB'S/PESTICIDES (ppb)			NRQ
DDD, PP	6.74	2.51	
DDE, PP	9.51	1.03	
DDT,PP	20.2	2.15	
AE/BN'S (ppb)			NRQ
ANTHRACENE	240	BDL	
BENZO (A) ANTHRACENE	690	BDL	
BENZO (A) PYRENE	520	BDL	
BENZO (B) FLUORANTHENE	690	BDL	
BENZO (GHI) PERYLENE	390	BDL	
BENZO (K) FLUORANTHENE	230	BDL	
BIS (2-ETHYLHEXYL) PHTHALATE	380	2400	
CHRYSENE	740	BDL	
FLUORANTHENE	1200	BDL	
INDENO (1,2,3-CD) PYRENE	430	BDL	
PHENANTHRENE	1000	BDL	
PYRENE	1300	BDL	
VOLATILE ORGANICS (ppb)	NRQ	NRQ	
TRICHLOROFLUOROMETHANE			6.6

0 15 30 60

APPROXIMATE SCALE

MIDDLESEX COUNTY COLLEGE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 17A-2
SOIL BORING LOCATIONS
MIDDLESEX COUNTY COLLEGE

DWG NO.: 9577014.FRA101 | DAMES & MOORE

6.0 QUALITY CONTROL

The project data supplied to Dames & Moore by ESE as a result of analyses of soils, sediments, ground water and surface water were reviewed in accordance with the Chemical Data Acquisition Plan (October 1991). In general, the field and laboratory QC requirements were met, indicating the analytical data are acceptable.

It is the policy of ESE to document the performance of the analytical method, and base sample data acceptance on the results of the quality control checks on a known or standard matrix. Sample matrix spikes also are analyzed, evaluated, and reported for precision and accuracy of the sample matrix analyses, but are not used for method control; they should be interpreted accordingly.

When both the standard matrix data and the sample matrix data fall within the method acceptance criteria, the data are considered unbiased acceptable data. When the standard matrix data falls within the acceptance criteria, but the sample matrix data is outside the acceptance criteria, the method is considered to be in control and the data are considered biased acceptable data; in this case, ESE generally attributes the sample matrix exceedances to matrix interference.

FIELD QUALITY CONTROL

6.1 DUPLICATE OR SPLIT SAMPLES

6.1.1 Ground Water Samples

Five duplicate ground water samples were obtained for quality control purposes. The samples were prepared by sequentially filling two sets of sampling jars and submitting the jars to the laboratory as if they both were field samples. Duplicate samples were labelled in accordance with the procedures stated in the Work Plan, and were not identified as duplicate samples to prevent preferential treatment of the samples in the laboratory. Each set of duplicate samples was analyzed for the same analytical parameters.

In general, there was acceptable agreement between the field samples and the corresponding QC sample.

One minor discrepancy was noted. The sample designated MW-78 was a duplicate of MW-61. Although sample MW-78 contained 18.4 ppb PETN, the sample obtained from MW-61 did not contain a detectable concentration of PETN. The detection limit for these analyses was 16 ppb; therefore, it is possible sample MW-61 contained a concentration of PETN slightly below the detection limit and was not reported. The discrepancy in this pair of duplicate samples is not considered significant.

Analytical data from the duplicate ground water samples are summarized in Table 18.

6.1.2 Soil Samples

Duplicate samples from 13 locations were analyzed for VOCs. Samples obtained for duplicate VOC analyses were collected by vertically splitting the soil in the split spoon sampler and packaging each half in separate sample jars to achieve an even distribution of contamination with a minimum of volatilization.

Split samples from 33 locations were analyzed for metals and explosives; split samples from nine locations were analyzed for semivolatile compounds; and split samples from four locations were analyzed for pesticides and PCBs. Split samples were prepared by thoroughly blending soils from the sample interval in a stainless steel bowl until the mixture appeared to be homogeneous. The blended soils then were placed in two sample jars and labeled as different samples; this method of labeling prevented preferential treatment of the samples in the laboratory.

6.1.2.1 Metals

Split samples from 33 locations were analyzed for metals. The variations detected in the metal concentrations can be explained by the fact that soil samples, even when thoroughly blended, are not identical.

Comparative QC data for metals analyses are presented in Table 19.

6.1.2.2 VOCs

Duplicate samples from 13 locations were analyzed for VOCs. Most of the VOCs detected in the soil samples were found in concentrations of less than 1 ppm. Relative percent differences (RPDs) for VOCs detected in the samples ranged from approximately 20% to 48%. This latter RPD was calculated from samples obtained from Area 7, Boring B7-1, the area which had the highest detected concentrations of VOCs in soil.

The variations in concentration detected in the duplicate soil samples can be explained by the fact that split soil samples are not identical. Additionally, in many cases the VOCs detected in one sample but not its counterpart were present in concentrations close to the method detection limit; it is possible the concentrations in the duplicate samples were slightly below the detection limit and, therefore, were not reported. Finally, many of the VOCs reported to be present in low concentrations are common laboratory contaminants; the concentrations reported may not represent the actual concentrations in the samples.

Comparative QC data for VOC analyses are presented in Table 20.

6.1.2.3 Pesticides

Split samples from four locations were analyzed for pesticides. Two of the samples, collected from borings B12-7 and B14-9, contained DDT and heptachlor which were not detected in their respective counterparts. DDT was detected in both samples at concentrations slightly above the detection limit. The failure to detect this compound in the duplicate sample is not considered significant; it is possible the concentrations of DDT in the paired sample were slightly below the detection limit and, therefore, were not reported. Heptachlor was detected in one of the paired samples in concentrations of approximately 30% and 50% of the NJDEPE proposed standard; in our opinion, this variation is the result of the non-homogeneity of the soils, even after thorough blending.

Comparative QC data for pesticides are presented in Table 21.

6.1.2.4 Semivolatile Compounds

Split samples from nine locations were analyzed for semivolatile organic compounds.

Eight of the sample pairs contained detectable concentrations of at least one semivolatile compound. In seven sample pairs, at least one compound was detected in one of the paired samples, but not in its counterpart. Sample #557 contained one compound not detected in its counterpart. Samples #567, #555, and #542 contained two compounds not detected in their counterparts. Samples #543 and #463 contained four compounds not detected in their counterparts. Sample #563 contained six compounds not detected in its counterpart. The concentrations of semivolatile organic compounds detected were very low, and often were near the method detection limit; it is possible the contaminants were present in the duplicate sample at concentrations slightly below the detection limit and, therefore, were not reported. The variations also may be the result of the non-homogeneity of the soil.

Comparative QC data for semivolatile compounds are presented in Table 22.

6.1.2.5 Explosives

Split samples from 33 locations were analyzed for explosives. One of the samples, obtained from boring B14-4 (#542), contained 0.591 ppm RDX; this compound was not detected in the duplicate sample. Because explosives were not detected in any other sample, no table has been prepared to compare QC sample analytical results with field sample analytical results.

6.1.2.6 PCBs

Split samples from four locations were analyzed for polychlorinated biphenyls (PCBs). No PCBs were detected in any of the samples.

6.2 RINSATE BLANKS

Five rinsate blanks were collected and analyzed to assess the efficiency of decontamination efforts during the ground water sampling program. The samples were obtained by pouring laboratory-provided, deionized water through the ISCO sampling pump bladder after the pump had been decontaminated. The resulting rinsate blanks were collected in bottles for

laboratory analysis for the same parameters as the field samples. At least one compound or metal was detected in each rinsate blank.

Two of the blanks, #84 and #67, contained acetone in concentrations of 26 ppb and 13 ppb respectively. Sample #34 contained 5.3 ppb of bis(2-ethylhexyl)phthalate, a semivolatile organic compound. Both of these compounds are common laboratory contaminants. No other organic compounds were detected in any of the rinsate blanks.

Rinsate sample #49 contained 2.4 ppb arsenic; this rinsate sample was obtained after sampling monitoring well MW-10. Arsenic was detected in the sample from MW-10 at a concentration of 42.7 ppb. However, no arsenic was detected in MW-12, the well sampled after collection of rinsate sample #49. Therefore, no cross contamination occurred.

Rinsate sample #12 contained 1.3 ppb barium and 5.4 ppb lead; this rinsate sample was obtained after sampling monitoring well MW-55B. Barium was detected in the sample from MW-55B at a concentration of 39.8 ppb; however, no lead was detected in the sample. Barium and lead were detected in the sample collected from MW-55A, at respective concentrations of 100 ppb and 13.2 ppb; this well was sampled after the collection of rinsate sample #12. Based on the low concentration of barium and lead detected in the rinsate blank compared to the concentrations detected in the sample from MW-55A, it is considered unlikely that cross contamination occurred.

6.3 TRIP BLANKS

Trip blanks were analyzed only for VOCs: no VOCs were detected in any of the trip blanks.

6.4 QA/QC REVIEW OF LABORATORY RESULTS

6.4.1 Holding Time

The holding time requirements were met for all samples with the following exceptions:

The holding time prior to extraction for explosive analysis of RARS 1*125 was exceeded. This sample was obtained from Area 2 on April 2, 1992, extracted May 20, 1992, and analyzed

May 26,1992. The chain of custody for this sample did not request analysis for explosives; although Dames & Moore requested this analysis several days after the arrival of the sample at the laboratory, the appropriate department in the laboratory was not notified. The sample ultimately was analyzed, and no explosives were detected in the sample; however, because the holding time was exceeded, the results should be considered an estimate.

ESE stated that samples RARS1*149 and RARS1*152 were analyzed for all parameters of interest except metals because of an oversight on their part. The samples ultimately were analyzed for metals, and the data are included in this report. However, due to the delay in the analyses, mercury was analyzed outside of the EPA-established holding time of 28 days. The mercury concentrations presented in this report for these two samples should be considered estimates.

6.4.2 Method Blanks

A total of nine compounds were detected in the method blanks for the water samples, and fifteen compounds were detected in the method blanks for the soil samples. Tables 26A, 26B, and 26C present summaries of the contaminants detected by the method blank analyses.

According to the ESE laboratory Quality Assurance Plan (QAP), the detection of contaminants in the method blanks at concentrations less than or equal to two times the typical detection limit is acceptable. However, the detection of acetone, methylene chloride, toluene and xylenes in the method blank may be five times greater than the typical detection limit and still meet the criteria stated in the ESE QAP.

The above criteria were met for all analytes except barium during this project. ESE has determined the soil used to prepare the standard method blanks for metals contains barium; this background concentration often causes barium to be present in the standard method blanks at concentrations greater than twice the detection limit.

Method blanks for explosives are not addressed in the ESE QAP. The RDX concentration reported in the standard method blank in batch G28218 was above the detection limit. The analyst attributed the detection of RDX in the blank to an interference peak; this peak was not detected during the confirmation run.

6.4.3 Standard Matrix Spike Recovery

It is the policy of ESE to document the performance of the analytical method, and base sample data acceptance on the results of the quality control checks on a known or standard matrix. Sample matrix spikes also are analyzed, evaluated, and reported for precision and accuracy of the sample matrix, but are not used for method control; they should be interpreted accordingly.

When both the standard matrix data and the sample matrix data fall within the method acceptance criteria, the data are considered unbiased acceptable data. When the standard matrix data falls within the acceptance criteria, but the sample matrix data is outside the acceptance criteria, the method is considered to be in control and the data are considered biased acceptable data; in this case, ESE generally attributes the sample matrix exceedances to matrix interference.

The standard matrix spike recoveries were positively and/or negatively biased for organosulfur, explosives, and semivolatile organic compounds in the batches mentioned below. Based on the explanations provided by ESE, the standard matrix spikes (SP) in each batch indicate the methods were in control, and the data is acceptable.

6.4.3.1 General

Endrin was the only pesticide sample that was not within the acceptance criteria. The data indicates 83.33% of the endrin analyses are unbiased acceptable data (Table 25A). ESE provided the following explanation:

> No recovery of endrin was reported for sample SP1* none * 1. These data are supported by the second column. The breakdown occurred before the sample was analyzed (possibly during the extraction process) since all other analytes had normal recoveries for SP1 * none *1.
>
> Other compounds that were not within the recovery acceptance criteria were phenol, 4-chloro-3 methyl phenol, 2,4-dinitrotoluene, 3-chlorophenol, and pentachlorophenol; these semivolatile compounds were positively biased. For semivolatile soil samples, the percentages of unbiased acceptable data for these compounds are 62.5, 75.0, 62.5, 87.5, and 87.5, respectively. For semivolatile water samples, the percentages of unbiased

acceptable data are: phenol, 33.3; 4-chloro-3 methyl phenol, 33.3; 2,4-dinitrotoluene, 66.7; pentachlorophenol, 33.3; and 4-nitrophenol, 33.3. ESE provided the following explanation for the biased results:

For phenol, the recovery range for all spikes was 98.32% to 113.81% with an upper limit of 89%. For 4-chloro-3-methyl phenol the recovery range for all spikes was 112.98% to 148.91% with an upper limit of 97%. For 4-nitrophenol, the recovery range for all spikes was 97.39% to 138.95% with an upper limit of 80%. For pentachlorophenol the recovery range for all spikes was 113.22% to 129.55% with an upper limit of 103%. For 2,4-dinitrotoluene, SP1*none*SP2 and SPM1*RARWS*2 were in control; the recovery range for the other four spikes was 97.49% to 110.93% with an upper limit of 96%. The rather high consistent recoveries for these analytes would suggest that the spike factors were high in their concentrations of the above analytes, and for the RF of the continuing calibration, standards were low.

Surrogate recovery for phenol-D5 was high for the following samples: RARW1* 2, 3, 7, SPM1, SPM2, SP1*none*1, SP1*none*2, RARWS*2, 3, 5, 7, SPM1, SPM2. Surrogate recovery for 2, 4, 6-tribromophenol was high for RARW1*5.

All samples which had surrogate failures were reanalyzed; all samples which originally failed phenol-D5 also failed the surrogate on reanalysis.

ESE attributes the relatively consistent slightly high SP recoveries in batch G27893 to an inaccurate spike concentration. Because this can not be documented, the data in this batch should be considered estimates.

6.4.3.1 Standard Matrix Spike Recovery, Water Sample

Organosulfur, explosives, and semivolatile organic compound recoveries were not within acceptance criteria in water samples in the following batches. ESE provided the following explanations for each of the batches in question.

Organosulfur Method UL04 produced standard matrix spike recoveries below acceptance criteria for batches G30078, G30507 and G29863 (see Table 25B).

- For Batch G30078, an analysis of the spiking solution was used. Because the chromatography and spiking solution were good, this implied the low recoveries were due to low extraction efficiencies for the analytes of concern in this batch. There were no visible peaks or integrator responses in the region of interest in any sample. Evaluation of the chromatograms indicates there were no detectable concentrations of the analytes of concern, providing confidence in the data in spite of the low STD spike recoveries.

- For Batch G30507, the standard matrix spike check was not within criteria. A good spike check (see Batch data) and continuing calibration verification sample results indicate an extraction problem. The recoveries may indicate a low bias in the data for the compounds with low recoveries. These compounds were not detected in the five ground water samples in the batch to which the QC data applies.

- Explosives Method UW32 indicated one compound in batch G29387 (water) had a recovery slightly above criteria. The recovery for 2,4-dinitrotoluene was 0.4% above criteria in one of four standard spikes. All other QC was acceptable. ESE reported the method was in control.

Semivolatile Method SW8270 produced three compounds above standard matrix spike acceptance criteria for batches G30557, G31034, and G29951 (Table 25B).

- For Batch G30557, ESE explained the standard matrix spike recoveries were 100% for 4-dinitrotoluene with an acceptable limit of 80%, and 102% for 2,4-dinitrotoluene with an acceptable limit of 96%. These recoveries are considered very good for this method. The range limits applied are from the CLP and are only advisory for the CLP program. The recovery limits were established for separatory funnel extractions. However, continuous extractors were used during the analyses of these samples; continuous extractors yield higher recoveries.

- For Batch G31034, as explained in the paragraph above, the recovery ranges were determined for extraction by separatory funnels. However, these samples were extracted by continuous extractors which yield higher recoveries.

- For Batch G29951, ESE explained that a recovery of 110% (criteria 103%) for pentachlorophenol does not affect the data because the standard matrix spike recoveries for the other ten parameters tested, and the surrogate spike recoveries, were within acceptance criteria.

6.4.3.2 Standard Matrix Spike Recovery, Soil Samples

Explosives Method LW12 (SW8830) produced three compounds slightly below acceptance criteria in batches G29919 and G30296 (Table 25B). ESE provided the following explanation for each batch:

- For batch G29919, both recoveries were slightly below acceptance criteria. QC for this batch contained extra spikes (which are required only by USATHAMA). Three standard spikes were analyzed in this batch; only one is required. The standard spikes demonstrate the method is in control.

- For Batch G30296, PETN is slightly below the recovery acceptance criteria in the low spike; however, the low spike is optional QC for this project. Higher spikes and matrix spikes were within acceptance criteria. No PETN was detected in either sample.

Semivolatile Method SW8270 indicated one compound had a recovery above acceptance criteria in batch G30422 (Table 25B); 4-chloro-3-methyl-phenol had a recovery of 106% in the standard spike with an upper criteria of 103%. The surrogates in this batch were within acceptance criteria, as were the internal standards. The samples were extracted with a more efficient extraction procedure than was utilized in determining the method acceptance criteria. The method was in control.

6.4.4 Sample Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The ESE laboratory was contacted concerning the results of sample matrix spike/matrix spike duplicate recoveries and relative percent differences. Generally, ESE believes the data are valid because standard matrix analyses yielded acceptable results, indicating the method was in control. Recoveries and relative percent differences which exceeded acceptance criteria were attributed to matrix interferences and non-homogeneity in soil samples.

Sample matrix interferences were most noticeable (i.e., sample matrix spike recovery criteria sometimes were not met) when analyzing for arsenic, selenium, and thiodiglycol.

Biases detected in specific groups of analyses are outlined below.

6.4.4.1 Metals (ICP Method)

The data set provided by ESE included 42 sample matrix MS/MSD sets for lead, chromium, silver, cadmium, and barium in soils and sediments, and two sample matrix MS/MSD sets for barium in water. The results of the MS/MSD analyses are shown in Table 23A.

Silver and cadmium soil and sediment data showed some positive bias, but 95.5% and 97.7%, respectively, of the samples are considered unbiased acceptable data.

Lead and chromium soil and sediment data are considered to be 85.7% and 69% unbiased acceptable data, respectively. ESE attributed the biased acceptable data to a lack of sample homogeneity. One MS/MSD set for chromium had a low recovery (25.9%, 23.0%); this sample had a high unspiked concentration. Lead data generally appear to be acceptable; only four of the 42 samples had a recovery slightly higher than the recovery criteria, and two samples with low recovery percentages were within 2 percent of the acceptance criteria.

Lead and barium sediment data were slightly above the acceptance criteria in batches G29685 and G30204 (see Table 23B). ESE believes there may have been a lack of homogeneity in the sample for batch G29685; the standard matrix spike was within acceptance criteria, and the method was considered to be in control. For Batch G30204, matrix interference is believed to be the cause of the slightly elevated sample matrix spike; ESE noted the standard matrix spike was within acceptance criteria for all parameters, and the method was considered to be in control.

Two barium water samples (Batch #G27752) were submitted for MS/MSD analysis. The barium concentrations in both sets of MS/MSD are negatively biased. ESE believes this discrepancy may be due to a possible matrix effect. It should be noted that barium concentrations detected in ground water samples did not approach NJDEPE standards, and are not considered to be a significant contaminant at the site.

6.4.4.2 Metals, GFAA Method (Arsenic, Selenium) and Metals, CVAA Method (Mercury)

The soil and sediment data included 44 sample matrix MS/MSD sets for arsenic and selenium analyses, and 43 sample matrix MS/MSD sets for mercury. The data indicate 31.8% of the arsenic soil and sediment analyses, 29.5% of the selenium soil and sediment analyses, and 83.7% of the mercury soil and sediment analyses are considered unbiased acceptable data (Table 23A). Because the methods were in control, ESE believes the erratic recoveries are due to the non-homogeneity of the samples, or possible matrix interferences.

Arsenic sediment data in Batches G30167 and G30459 were below MS/MSD acceptance criteria (see Table 23B). For Batch G30167, the low recovery for the sample matrix MSD is believed to be due to matrix interference; because the sample matrix MS and the standard matrix MS were within acceptable recovery criteria, the method was in control. For batch G30459, ESE stated the method also was in control. The sample matrix MS/MSD exceedances generally are attributed to matrix interference because of the high unspiked concentration in sample RARS1*609.

Selenium sediment data in batches G30411 and G30131 were below MS/MSD acceptance criteria (see Table 23B). ESE believes the selenium sediment data exceedances in Batch G30411 are due to the non-homogeneity of the sample. Matrix interference is believed to have caused the low recoveries for the sample matrix MS/MSD in batch G30131. The standard MS was within acceptance criteria for both Batches G30411 and G30131; therefore the method was in control.

Arsenic (total), lead (total), and selenium (total) data were below or above acceptable recovery criteria for water matrix MS/MSD sets in batches G30432, G30966, and G29465 (see Table 23C). The standard MS were within acceptable recovery criteria; therefore, the method was in control. ESE believes the discrepancies in these batches were due to possible matrix effects.

6.4.4.3 Volatile Organic Compounds (VOCs)

Forty sample-matrix MS/MSD sets were analyzed for VOCs. The results indicated more than 95% of the data are considered unbiased acceptable data (Table 23A).

Toluene data were found to be positively biased and 1,1-dichloroethylene data were found to be negatively biased. ESE attributed the low recovery levels of 1,1-dichloroethylene to an inaccurate spiking solution.

6.4.4.4 Semivolatile Organic Compounds

The results of MS/MSD analyses for semivolatile compounds indicated phenol, 2-chlorophenol, 1,4 dichlorobenzene, N-nitroso-di-n-propylamine, 4-chloro-3-methyl phenol, pentachlorophenol, 2,4-dinitrotoluene, 4-nitrophenol, acenaphthene, 1,2,4-trichlorobenzene and pyrene are positively or negatively biased. The semivolatile sample data are presented in Table 23.

ESE provided the following explanation for the MS/MSD samples analyzed on April 7, 1992; these statements apply only to Batch G27116:

> For phenol, the SPM1 and SPM2 recoveries were 94.56% and 98.54%, with an acceptable upper limit of 90%. For 2-chlorophenol, the SPM2 recovery was 103.56%, with an acceptable upper limit of 102%. For 4-chloro-3-methylphenol, the SPM1 and SPM2 recoveries were 105.23% and 111.73%, with an acceptable upper limit of 103%. For 2,4-DNT, the SPM2 recovery was 92.41%, with an acceptable upper limit of 89%. These recoveries are within ESE's range of historical data.
>
> The 4-nitrophenol recoveries for SPM1 and SPM2 were 123.65% and 144.36%, with an acceptable upper limit of 114%. The PCP recoveries for SPM1 and SPM2 were 140.59% and 120.02% with an acceptable upper limit of 109%. These recoveries were higher than ESE's historical range of recoveries; however, they are not so abnormal as to indicate a problem with the extraction.

ESE provided the following explanation for the MS/MSD samples analyzed on March 30, 1992, April 3, 1992 and April 16, 1992; this comment refers to batches G26937, G27257, and G27116:

> The recovery ranges for matrix spike compounds in soil were established using sonication. These samples were extracted by the soxhlets method and thus have higher

recoveries. According to CLP SOW 2/88, recovery ranges for the matrix spikes are advisory; the failure to fall within these ranges does not require reanalysis.

2-fluorophenol was outside the recovery range for samples RARSI*386 and RARSI*389. According to CLP 2/88, one acid and one base neutral may fall outside the recovery range and not initiate reanalysis. This comment refers to batch G27257.

ESE provided the following explanation for the MS/MSD samples analyzed on May 6, 1992; this comment refers to batch G27926:

All recoveries in the standard matrix spike were within the recovery range, and QC of the other samples were acceptable. However, sample 606 had something in its matrix which caused the recoveries of all surrogates and matrix spike compounds to be about 5% of what they should be. ESE did not provide any additional explanation.

Three additional water sample MS/MSDs were above acceptance criteria (see Table 23C). A review of the data in Batch G30557 indicated 92% of the data are considered unbiased acceptable data. For Batch G30243 where 83% of the data are considered unbiased acceptable data, ESE explained that matrix spike recoveries are only advisory when following CLP SOW 2/88; falling outside these ranges does not require reanalysis.

6.4.4.5 Explosives

A review of the explosives MS/MSD data indicates 2,4,6-TNT (soil) and RDX (soil) are positively or negatively biased (Table 23A). As indicated in Table 23A, the percentages of unbiased acceptable data for the above explosive samples are 93.9% and 98%, respectively.

A review of the data for 1,3,5-trinitrobenzene and 2,4-dinitrotoluene samples in batches G30785 and G30786 indicated the recoveries were below acceptance criteria; however, 92% of the data are considered unbiased acceptable data.

For explosives Method UW32, two parameters were above criteria in Batches G30224 and G30653 (Table 23C). ESE provided the following explanations for batches G30224 and G30653:

For batch G30224, ESE explained there was a possible matrix effect. The standard matrix and the water sample matrix were spiked with a solution used for extended range spikes. The concentrations of the QC analytes, therefore, are quite high because 1.0 ml of this solution was spiked; normally only 0.5 ml is spiked in order to stay within the range of the curve. Due to a mistake in the workup of the samples during extraction, they were brought to 9 ml volume instead of 6 ml; therefore the spike levels (responses) are below the highest standard for all QC analytes. The data should be considered acceptable.

ESE explained that PETN in Batch G30653 (water), which was slightly above the acceptance criteria, was probably due to matrix interference. The standard matrix spike was within the acceptable recovery criteria and the method was in control.

6.4.4.6 Cyanide

Cyanide recovery was below acceptance criteria in the water sample matrix MS/MSD sets in batch G29839 (see Table 23C). ESE explained the method was in control; therefore, the MS/MSD recoveries are assumed to be low because of a possible matrix problem. ESE believes the Raritan sample was not impacted.

6.4.4.7 Thiodiglycol

Thiodiglycol recoveries were above acceptance criteria in batch G30032 (water) and below acceptance criteria in batch G30514 (water). For batch G30032, ESE explained this was a difficult matrix to work with and quantitation of matrix spikes was difficult; the matrix required a 1:10 dilution. The standard spikes were acceptable and the sample-matrix spikes were slightly elevated; because the method was in control, the data are considered acceptable. For batch G30514, ESE explained that although the sample-matrix MSD was below the acceptance recovery criteria, the standard matrix spike was within criteria; therefore the method was in control and the data are acceptable.

Thiodiglycol recovery was below MS/MSD criteria in Batch G30513 (soil), as shown in Table 8. ESE believes the low recoveries were the result of a matrix effect; the sample was more than 68% water and closely resembled sludge. The standard matrix spike recoveries

indicated the method was in control. Matrix interference may cause low MS/MSD recoveries; therefore, the data may be biased low.

6.4.5 Continuing Calibration Verification Sample

A review of the Continuing Calibration Verification sample (CCS) data indicated five compounds were positively and/or negatively biased (Table 24A). Of the five compounds, two compounds (2,4-dinitrotoluene-soil, and 2,6-dinitrotoluene-soil) are considered to be greater than 90% unbiased acceptable data. The percentage of unbiased acceptable data for the other compounds, tetryl (sediment), 2,4-dinitrotoluene (water), nitroglycerin-total (water), and nitrobenzene (water) are 77.2, 75.0, 33.3, and 83.3, respectively. ESE provided the following explanation:

- The tetryl had degraded; therefore, a new standard was made. Initial and post-run CCS values were within acceptance criteria. No samples with detectable concentrations of tetryl were found during the analyses of the field samples.

- In some samples, the beginning and ending CCS values were within criteria. In explosives batch G26818, below criteria values were noted for two mid-run continuing calibration verification samples. According to USATHAMA Method LW12, only the post-run CCS must be within criteria; because this occurred, the method was in control for this batch.

Explosives Method UW32 indicated two parameters in water samples were slightly (1% to 8%) above the recovery criteria for continuing calibration verification for batches G29387, G29954, G30224, and G30391 (see Table 24B). As indicated in Table 24B, the percentage of unbiased acceptable data for the explosive samples are 88% and 95%.

6.4.6 Surrogate Spike Recovery

Surrogate spike recoveries for water samples indicated that explosives, pesticides/PCBs, and semivolatile organic compounds are positively and/or negatively biased. The results indicated more than 90% of the data (see Table 27) should be considered unbiased acceptable data. Overall, the methods were in control during the analyses. All recoveries in the surrogate spike analyses for soil samples were within the recovery acceptance criteria.

6.4.7 Conclusions

1. No volatile organic compounds were detected in trip blank samples.

2. Two of the five rinsate blanks contained acetone, and one of the rinsate blanks contained bis(2-ethylhexyl)phthalate. The presence of these compounds in the low concentrations reported may be the result of laboratory contamination; both compounds are common laboratory contaminants. No other organic contaminants were detected in the rinsate blanks. Two rinsate blanks contained low concentrations of metals; a review of the data indicated no cross contamination had occurred.

3. Generally, there was acceptable agreement between the results of the analyses of the water samples and the corresponding duplicate sample.

4. Relative percent differences for soil samples and the corresponding duplicate sample generally were higher than those calculated for water samples. This can be explained by the fact that many of the organic contaminants detected were found in very low concentrations, and often were found at concentrations close to the method detection limit; a small change in the concentrations detected resulted in a relatively large RPD. Additionally, soil samples are not identical, even after thorough blending; variations in contaminant concentrations in soil are not unusual. Variations in metal concentrations between duplicate samples also can be explained by the non-homogeneity of the soil samples.

5. Holding times were not exceeded in any of the samples except for the explosives analysis on sample RARS1*125, Area 2, which exceeded the seven day extraction time limit, and mercury analyses of samples RARS1*149 and RARS1*152 which exceeded the 28 day holding time. The results of these analyses should be considered estimates.

6. Most of the sample-matrix MS/MSD data indicate greater than 90% acceptable unbiased data. The compounds detected as positively or negatively biased in the MS/MSD data were lead, chromium, barium, arsenic, selenium, mercury, phenol, 2-chlorophenol, 1,4 dichlorobenzene, N-nitroso-di-n-propylamine, 4-

chloro-3-methyl phenol, pentachlorophenol, acenaphthene, pyrene, 1,2,4-trichlorobenzene, 2,4-dinitrotoluene, and 4-nitrophenol. According to the laboratory, the biased data generally can be attributed to matrix interference, or to the non-homogeneity of the soil samples.

7. Relatively consistent slightly high standard spike recoveries in batch G27893, attributed to an inaccurate spike concentration, indicate the analyses in this batch should be considered estimates. These are semivolatile analyses for surface water samples (SW-1, SW-2, SW-3, SW-4, SW-7. SW-8, and SW-9).

8. Acetone, chloroform, methylene chloride, and bis(2-ethylhexyl)phthalate were detected in some of the method blanks; all of these compounds are common laboratory contaminants. Based on the explanations received from ESE, analyses of the method blanks were within acceptable recovery criteria except barium. ESE stated the soil used to prepare the method blanks for metals contains barium; this background concentration often causes barium to be present in the method blank at levels greater than twice the detection limit.

TABLES FOR SECTION 6.0

TABLE 18

COMPARISON OF DUPLICATE ANALYSES
QUALITY CONTROL RESULTS
GROUND WATER SAMPLES
RARITAN ARSENAL - EDISON, NEW JERSEY

PARAMETER	MW-61 (AREA 4)	MW-78 (DUP OF MW-61)	MW-22 (AREA 5)	MW-81 (DUP OF MW-22)	MW-46A (AREA 10)	MW-79 (DUP OF MW-46A)	MW-51 (AREA 16)	MW-80 (DUP OF MW-51)	MW-49 (AREA 10)	MW-49D (DUP OF MW-49)
Arsenic, total	15.9	15.0	<2.3	2.7	3.0	5.2	17.1	15.6	<2.3	<2.3
Barium, total	177	167	71.3	71.0	42.1	36.7	227	214	82.1	80.7
Barium, dissolved	NRQ	NRQ	NRQ	NRQ	29.8	28.9	NRQ	NRQ	NRQ	NRQ
Cadmium, total	8.0	9.0	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4
Chromium, total	25.0	16.0	<7.4	<7.4	18.6	13.7	10.7	10.0	<7.4	<7.4
Lead, total	3.9	5.6	2.1	3.5	4.7	4.3	<2.0	<2.0	<2.0	<2.0
Selenium, total	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.6	<2.0	<2.0	<2.0
PETN	<16.0	18.4	<16.0	<16.0	<16.0	<16.0	<16.0	<16.0	<16.0	<16.0
Benzene	--	--	--	--	3.3	3.3	--	--	--	--
1,2-Dichloroethene	--	--	--	--	130	120	--	--	--	--
Bis(2-ethylhexyl)phthalate	2.1	10.0	--	--	--	--	2.2	7.1	--	--
Toluene	--	--	--	--	3.3	2.6	--	--	<1.7	2.0
Trichloroethene	--	--	--	--	29	26	--	--	--	--
Vinyl chloride	--	--	--	--	18	17	--	--	--	--
Xylenes, total	--	--	--	--	4.8	<3.7	--	--	--	--

Notes: All concentrations are expressed in μg/L.
-- = Below detection limit.
NRQ = Not requested.

TABLE 19

COMPARISON OF DUPLICATE ANALYSES
QUALITY CONTROL RESULTS
METALS ANALYSES
SOIL SAMPLES

Sample		Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
B2-12 (0-1')	34	0.939	9.51	--	4.78	60.1	0.174	--	--
	121 Dup	0.472	7.49	--	4.21	7.88	0.052	--	--
B2-12 (3.5-4.5')	36	0.557	7.65	--	5.47	--	--	--	--
	123 Dup	0.609	5.32	--	5.69	--	--	--	--
B2-15 (0-5')	43	1.32	14.20	--	8.39	<6.83	--	--	--
	124 Dup	1.28	14.10	--	9.16	7.73	--	--	--
B2-15 (5-10')	44	0.468	6.26	--	5.71	--	--	--	--
	125 Dup	0.562	2.62	--	6.87	--	--	--	--
B2-17 (0-1')	49	1.30	11.70	--	6.26	8.82	0.088	--	--
	126 Dup	1.32	9.68	--	6.55	12.40	0.079	--	--
B2-19 (0-1')	55	1.75	11.70	--	3.54	16.60	7.73	0.393	--
	127 Dup	2.99	6.50	--	3.72	18.80	8.53	0.314	--
B2-20 (4-5')	60	0.756	5.52	--	4.59	--	--	--	--
	129 Dup	0.886	--	--	4.48	--	--	--	--
B2-22 (0-1')	64	0.935	9.53	--	7.11	7.64	0.040	--	--
	130 Dup	1.17	5.92	--	7.79	<6.72	0.036	--	--

TABLE 19 (CONTINUED)

Sample		Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
B2-23 (0-5')	67	1.36	35.30	--	6.12	32.40	0.236	0.255	--
	1130 Dup	1.49	28.90	--	7.52	35.60	0.231	<0.301	--
B2-24 (0-5')	70	1.12	8.92	--	4.43	9.01	0.485	--	--
	131 Dup	1.22	4.42	--	4.70	8.78	0.585	--	--
B2-25 (0-5')	73	1.07	10.30	--	6.13	7.36	0.313	--	--
	132 Dup	1.31	5.96	--	6.98	8.22	0.342	--	--
B2-26 (0-5')	76	1.26	10.90	--	5.85	10.8	0.726	--	--
	1133 Dup	1.44	6.44	--	8.16	14.70	0.609	--	--
B2-29 (0-5')	85	1.38	11.20	--	10.30	7.25	0.438	--	--
	1135 Dup	1.29	11.60	--	10.50	8.77	0.251	--	--
B2-29 (5-10')	86	0.737	3.30	--	5.19	--	0.897	--	--
	1136 Dup	0.698	3.18	--	5.26	--	0.558	--	--

TABLE 19 (CONTINUED)

Sample		Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
B2-20 (0-1')	58	1.31	10.30	--	6.58	10.60	0.052	--	--
	128 Dup	1.59	6.11	--	8.75	13.9	0.049	--	--
B3-14 (0-1')	172	19.90	80.50	--	23.10	132	0.167	1.46	--
	174 Dup	18.20	28.30	--	8.60	55.20	0.151	2.37	--
B3-18 (0-1')	184	15.80	38.20	2.23	32.30	69.50	0.102	0.991	--
	186 Dup	12.70	69.70	2.64	38.40	71.10	0.195	0.849	--
B3-22 (0-1')	196	9.00	71.30	--	18.50	103	0.133	0.914	--
	197 Dup	8.87	53.00	--	29.60	59.70	0.102	0.491	--
B6A-19	357	3.06	26.40	--	5.83	13.60	--	--	--
	364 Dup	2.34	27.50	--	5.64	13.70	0.052	--	--
B14-4	535	176	176	1.74	190	277	4.91	3.65	10.3
	542 Dup	169	171	1.64	191	275	5.27	3.96	10.80
B14-9	540	7.29	116	--	128	194	0.067	--	5.59
	543 Dup	7.17	19.10	--	11.60	13.20	0.107	--	--
B16-1 (0-3.5')	544	1.41	14.70	--	6.93	--	--	--	--
	553 Dup	1.91	14.30	--	6.68	--	--	--	--
B16-5 (0-4')	548	17.40	17.00	--	10.90	33.20	0.063	--	--
	554 Dup	9.35	19.20	--	12.50	21.70	0.154	0.283	--

TABLE 20

COMPARISON OF DUPLICATE ANALYSES
QUALITY CONTROL SAMPLES
DETECTABLE CONCENTRATIONS OF VOCS
SOIL SAMPLES
RARITAN ARSENAL - EDISON, NEW JERSEY

SAMPLE DESCRIPTION	SAMPLE NUMBER	Trichlorofluoromethane	Acetone	Methylene Chloride	Ethylbenzene	Tetrachloroethene	Toluene	MEK	Xylene
B2-29 (6-8')	87	8.5	--	--	--	--	--	--	--
	1137	8.4	--	--	--	--	--	--	--
B2-30 (1-2')	90	--	--	--	--	--	--	--	--
	1138	9.8	--	--	--	--	--	--	--
B2-32	96	9.2	--	--	--	--	--	--	--
	1139	6.4	--	--	--	--	--	--	--
B2-33	99	9.9	--	--	--	--	--	--	--
	1140	9.6	11	--	--	--	--	--	--
B2-34	102	9.5	--	5.5	--	--	--	--	--
	141	--	--	--	--	--	--	--	--
B7-1 (4-5')	412	--	--	--	23000	34000	39000	--	91000
	430	--	--	--	14000	28000	25000	--	60000

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion).
-- = Compound was not detected

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TABLE 20 (continued)

SAMPLE DESCRIPTION	SAMPLE NUMBER	Trichlorofluoromethane	Acetone	Methylene Chloride	Ethylbenzene	Tetrachloroethene	Toluene	MEK	Xylene
B7-2 (3-4')	415	--	--	<5.5	--	--	--	--	--
	416	--	--	5.6	--	--	--	--	--
B12-9	488	--	<14	--	--	--	--	--	--
	489	--	46	--	--	--	--	--	--
B14-4	535	--	170	<8.4	--	--	--	44	--
	542	--	--	10	--	--	--	<17	--

Notes: Concentrations expressed in $\mu g/kg$ (parts per billion).
-- = Compound was not detected

[d:\...\19577014\march93\qual0329.T20]

TABLE 21

COMPARISON OF DUPLICATE ANALYSES
QUALITY CONTROL SAMPLES
DETECTABLE CONCENTRATIONS OF PESTICIDES
SOIL SAMPLES
RARITAN ARSENAL - EDISON, NEW JERSEY

SAMPLE DESCRIPTION	SAMPLE NUMBER	DDD	DDE	DDT	HEPTACHLOR	DIELDRIN
B11-7	459	7.23	18.6	49.0	--	--
	463	7.98	19.8	45.1	--	--
B12-7	482	--	--	<1.29	74.9	--
	483	--	--	2.55	<1.29	--
B14-4	535	267	147	257	--	29.4
	542	294	141	276	--	41.9
B14-9	540	3.48	--	12.3	45.6	6.08
	543	15.5	--	--	--	15.1

Notes: Concentrations expressed in µg/kg (parts per billion).
-- = Compound was not detected

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TABLE 22

COMPARISION OF DUPLICATE ANALYSES
QUALITY CONTROL SAMPLES
SEMIVOLATILE COMPOUNDS

SOIL SAMPLES
RARITAN ARSENAL - EDISON, NEW JERSEY

PARAMETER	B11-7 459	463 Dup of 459	B17A-1 0-5' 1554	563 Dup of 1554	B17A-1 5-10' 555	564 Dup of 555	B17A-2 0-5' 557	565 Dup of 557	B17A-2 5-10' 558	566 Dup of 558	B17A-3 0-5' 560	567 Dup of 560
Anthracene	--	--	--	--	--	--	240	93	--	--	--	--
Benzo(a)anthracene	--	--	<110	380	--	--	690	410	--	--	--	--
Benzo(a)pyrene	--	--	<160	860	--	--	520	330	--	--	--	--
Benzo(b)fluoranthene	<130	210	170	940	--	--	690	450	--	--	--	--
Benzo(ghi)perylene	--	--	<180	930	--	--	390	260	--	--	--	--
Benzo(k)fluoranthene	--	--	<110	240	--	--	230	160	--	--	--	--
Bis(2-ethylhexyl)phthalate	<130	210	430	920	360	420	380	<110	2400	170	<110	780
Chrysene	<130	150	<110	410	--	--	740	380	--	--	--	--
Fluoranthene	160	150	140	330	79	<78	1200	640	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	<180	760	--	--	430	230	--	--	--	--
N-nitrosodi-n-propyl amine	<190	320	--	--	--	--	--	--	--	--	--	--
Naphthalene	140	240	--	--	--	--	--	--	--	--	--	--
Phenanthrene	96	110	91	300	--	--	1000	480	--	--	<79	440
Pyrene	110	170	210	370	94	<78	1300	690	--	--	--	--

TABLE 22 (continued)

PARAMETER	B14-4 535	542 Dup of 535	B14-9 540	543 Dup of 540
Anthracene	--	--	--	--
Benzo(a)anthracene	--	--	--	--
Benzo(a)pyrene	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--
Benzo(ghi)perylene	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--
Bis(2-ethylhexyl)phthalate	3700	4600	--	--
Chrysene	<840	890	<110	170
Fluoranthene	890	1000	<79	220
Indeno(1,2,3-cd)pyrene	--	--	--	--
N-nitrosodi-n-propyl amine	--	--	--	--
Naphthalene	--	--	--	--
Phenanthrene	<590	600	<79	84
Pyrene	960	1100	<79	170

TABLE 23A

SUMMARY RESULTS OF SAMPLE MATRIX SPIKE AND MATRIX SPIKE DUPLICATE SAMPLES
RARITAN ARSENAL, EDISON, NEW JERSEY

TOTAL NUMBER MATRIX SPIKE/ MATRIX SPIKE DUPLICATE ANALYSES	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY	RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA*
ICP METALS						
42	Lead, Sed	4+	9.5	G26909 127.8 G27084 111.2 G27356 100.7 G27574 134.4	79-109	85.7
		2-	4.8	G26909 78.9, 77.6		
42	Chromium, Sed	9+	21.4	G27046 111.3 G27356 110.0, 130.0 G27387 121.0, 111.4 G27477 115.5 G27574 124.7, 114.0 G27643 111.7	79-109	69.0
		4-	9.5	G27084 25.9, 23.0 G27356 72.9, 75.9		
42	Silver (soil)	2+	4.8	G27356 130.2, 115.2	73-107	95.2
42	Cadmium (soil)	1+	2.4	G27356 109.6	80-108	97.6
42	Barium (sediment)	1-	2.4	G27574 84.1	86-106	97.6
2	Barium (water)	2-	100.0	G27752 53.5, 24.0	86-106	0.0

Note: Summary reflects quality control data received in July 1992

*Unbiased acceptable data fall within the recovery criteria range.

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TABLE 23A (continued)

TOTAL NUMBER MATRIX SPIKE/ MATRIX SPIKE DUPLICATE ANALYSES	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY	RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA*
GFAA METALS (Arsenic and Selenium) and CVAA (Mercury)						
44	Arsenic, Sed	9+	20.5	G26970 328.1 G26981 146.1, 123.7 G27048 577.5, 128.6 G27176 130.2 G27833 131.0, 128.5 G28002 120.3	72-120	31.8
		21-	47.7	G26827 70.4, -76.4 G26914 -11.2, -25.6, 68.5 G26970 -169 G27048 -161, 58.7 G27291 62.4, 56.7, 70.1 G27390 67.5, 34.5, 44.0 G27486 62.4 G27499 56.3, 60.2, 69.9, 68.1 G28080 55.2, 64.5		
44	Selenium, Sed	31-	70.5	G26835 34.0, 46.8, 43.3, 28.0 G26915 66.8, 43.0, 36.1 G26977 46.5, 53.9, 52.7, 38.3 G26995 67.8, 62.9 G27112 15.8, 29.5, 55.9, 67.1 G27206 58.1, 43.3, 70.8, 65.2 G27321 51.8, 50.7, 54.6, 57.5 G27359 54.0, 49.1, 34.2, 35.6 G28079 33.0, 33.0	71-129	29.5

Note: Summary reflects quality control data received in July 1992

*Unbiased acceptable data fall within the recovery criteria range.

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TABLE 23A (continued)

TOTAL NUMBER MATRIX SPIKE/ MATRIX SPIKE DUPLICATE ANALYSES	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY	RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA*
43	Mercury, Sed	2+	4.7	G27361 133.7 G27750 305.5	83-125	83.7
		5-	11.6	G27361 61.7 G27559 73.1, 78.4 G27562 74.2 G27750 -119		
VOLATILE ORGANIC COMPOUNDS (VOCs)						
40	Toluene (soil)	1+	2.5	G27479 333	59-139	97.5
40	1,1-Dichloroethylene	1-	2.5	G27480 56	59-172	97.5
EXPLOSIVES						
49	2, 4, 6-TNT (soil)	1+	2.0	G27422 237.2	72-118	93.9
		2-	4.1	G27214 69.3 G27422 -117		
49	RDX (soil)	1+	2.0	G27140 118.0	71-107	98.0
SEIMIVOLATILE ORGANIC COMPOUNDS						
18	Phenol (soil)	7+	38.9	G26937 100, 92 G27116 91, 100 G27257 95 G27404 128, 115	26-90	38.9
		4-	22.2	G27926 3.7, 3.8, 3.3, 3.9		
6	Phenol (water)	4+	66.7	G27893 109, 109, 118, 118	12-89	33.3

Note: Summary reflects quality control data received in July 1992

*Unbiased acceptable data fall within the recovery criteria range.

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TABLE 23A (continued)

TOTAL NUMBER MATRIX SPIKE/ MATRIX SPIKE DUPLICATE ANALYSES	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY		RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA*
18	2-Chlorophenol (soil)	3+	16.7	G26937 G27404	108 110, 103	25-102	61.1
		4-	22.2	G27926	3.7, 3.7, 3.7, 3.8		
18	1, 4-Dichlorobenzene (soil)	4-	22.2	G27926	4.0, 3.8, 4.3, 4.5	28-104	77.8
18	N-Nitrosodi-N-Propylamine (soil)	4-	22.2	G27926	4.0, 4.0, 4.0, 0.0	41-126	77.8
18	4-Chloro-3-Methyl Phenol (soil)	6+	33.3	G26937 G27116 G27257 G27404	108 109 104, 108 115, 108	26-103	44.4
		4-	22.2	G27926	3.5, 3.1, 3.0, 3.2		
6	4-Chloro-3-Methyl Phenol (water)	4+	66.7	G27893	136, 136, 155, 145	23-97	33.3
18	Pentachlorophenol (soil)	7+	38.9	G26937 G27116 G27257 G27404	117 136, 118 120, 117 128, 115	17-109	38.9
		4-	22.2	G27926	0.0, 0.0, 0.0, 0.0		
6	Pentachlorophenol (water)	4+	66.7	G27893	127, 136, 118, 136	9-103	33.3
18	Acenaphthene (soil)	4-	22.2	G27926	3.8, 3.6, 3.3, 3.3	31-137	77.8
18	1,2,4-Trichlorobenzene	4-	22.2	G27926	3.8, 0.0, 3.3, 3.6	38-107	77.8
18	Pyrene (soil)	4-	2.2	G27296	3.1, 3.6, 4.0, 4.0	35-142	77.8

Note: Summary reflects quality control data received in July 1992

*Unbiased acceptable data fall within the recovery criteria range.

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TABLE 23A (continued)

TOTAL NUMBER MATRIX SPIKE/ MATRIX SPIKE DUPLICATE ANALYSES	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY		RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA*
18	2,4-Dinitrotoluene (soil)	7+	38.9	G26937 G27116 G27257 G27404	108, 107 93 100, 108 102, 102	28-89	38.9
		4-	22.2	G27926	0.0, 0.0, 0.0, 0.0		
6	2,4-Dinitrotoluene (water)	3+	50.0	G27893	107, 112, 98	24-96	50.0
18	4-Nitrophenol (soil)	6+	33.3	G27116 G27257 G27404	118, 145 132, 145 116, 116	11-114	44.4
		4-	22.2	G27926	0.0, 0.0, 0.0, 0.0		
6	4-Nitrophenol (water)	4+	66.7	G27893	118, 109, 100, 118	10-80	33.3

Note: Summary reflects quality control data received in July 1992

*Unbiased acceptable data fall within the recovery criteria range.

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TABLE 23B

SUMMARY RESULTS OF SAMPLE MATRIX SPIKE RECOVERY, SOIL
RARITAN ARSENAL - EDISON, NEW JERSEY

SAMPLE MATRIX SPIKE RECOVERY SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA
Metals, ICP Methods								
SPM_2*RARS1*424	Lead, sed	G29685	1+	4	25	110.3	79-109	75
SPM_2*RARS1*609	Barium, sed	G30204	1+	4	25	107.7	86-106	75
Metals, GFAA Method								
SPM_2*RARS1*424 SPM_1*RARS1*609 SPM_2*RARS1*609	Arsenic, sed	G30167 G30459	3-	4	75	63 -718 -719	72-120	25
SPM_2*RARS1*609 SPM_1*RARS1*424 SPM_2*RARS1*424	Selenium, sed	G30411 G30131	3-	4	75	48 62.0 59.3	71-129	25
Thiodiglycol								
SPM_1*RARS1*608 SPM_2*RARS1*608	Thiodiglycol	G30513	2-	4	50	3.68 2.27	60-100	50

Note: Summary reflects quality control data received in September 1992.

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TABLE 23C

SUMMARY RESULTS OF MATRIX SPIKE RECOVERY, WATER
RARITAN ARSENAL - EDISON, NEW JERSEY

SAMPLE MATRIX SPIKE RECOVERY SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA
SPM_1*NASJW2B*14 SPM_2*NASJW2B*14	Cyanide	G29839	2^-	5	40	64.6 52.1	81-117	60
Metals, GFAA Method								
SPM_1*$RARW_1$*22 SPM_2*$RARW_2$*22	Arsenic, total	G30432	2^-	12	33	15.5 25.5	72-120	67
SPM_1*$RARW_1$*43 SPM_2*$RARW_2$*43			2^+			145 140.5		
SPM_1*$RARW_1$*84	Lead, total	G30966	1^+	10	10	125.5	71-125	90
SPM_1*$RARW_1$*14 SPM_2*$RARW_1$*14	Selenium, total	G29465	2^-	12	17	70.5 69	71-129	83
Thiodiglycol								
SPM_1*$RARW_1$*15 SPM_2*$RARW_1$*15	Thiodiglycol	G30032	2^+	8	37	124 130.1	37-119	63
SPM_2*$RARW_1$*39		G30514	1^-			29.7		

Note: Summary reflects quality control data received in September 1992.

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TABLE 23C (continued)

SAMPLE MATRIX SPIKE RECOVERY SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA
Explosives								
SPM_1*$RARW_1$*32 SPM_2*$RARW_1$*32	2,4-nitrotoluene	G30224	2^+	12	17	107.3 103.7	60-102	83
SPM_2*$RARW_1$*39	Petn	G30653	1^+	6	33	123.3	67-123	67
SPM_2*$RARW_1$*59	1,3,5-trinitrobenzene	G30785	1^-	12	8	45.5	46-102	92
SPM_2*$RARW_1$*77	2,4-dinitrotoluene	G30786	1^-	12	8	58.7	60-102	92
Semivolatiles								
SPM_1*$RARW_1$*21 SPM_2*$RARW_1$*21	Pentachlorophenol	G30243	2^+	12	17	109 118	9-103	83
SPM_2*$RARW_1$*36	N-Nitrosodi-N-Proplamine	G30557	1^+	12	8	118	41-116	92
SPM_2*$RARW_1$*36	2-4-Dinitrotoluene	G30557	1^+	12	8	100	24-96	92

Note: Summary reflects quality control data received in September 1992.

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TABLE 24A

SUMMARY RESULTS OF CONTINUING CALIBRATION VERIFICATION SAMPLES

RARITAN ARSENAL, EDISON, NEW JERSEY

NUMBER OF CONTINUING CALIBRATION VERIFICATION ANALYSES	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY		RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA*
79	Tetryl (sediment)	4+	5.1	G26916 G26925	181, 168 179, 162	80-120	77.2
		14-	17.7	G26818 G26852 G27067 G27122 G27140 G27213 G27214 G27255 G27300 G27422 G27791 G27824	50.9, 36.6 76.2 16.3 16.3 16.3 74.4, 29.1 25.3 67.6 53.8 28.2 67.6 75.0		
3	Nitroglycerin, total (water)	2+	66.7	G28124	117, 118	80-112	33.3
79	2,4-Dinitrotoluene (soil)	6+	7.6	G27140 G27122 G27140	114 119, 123, 132 132, 119	68-106	92.4
12	2,4-Dinitrotoluene (water)	3+	25.0	G28113	106, 105, 110	60-102	75.0
79	2,6-Dinitrotoluene (soil)	2+	2.5	G27122 G27140	77.9 77.9	80-120	97.5
12	Nitrobenzene (water)	2+	16.7	G28113	110, 111	44-108	83.3

Note: Summary reflects all quality control data received in July 1992.

*Unbiased acceptable data fall within the recovery criteria range.

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TABLE 24B

SUMMARY RESULTS OF CONTINUING CALIBRATION VERIFICATION SAMPLES, WATER
RARITAN ARSENAL - EDISON, NEW JERSEY

CONTINUING CALIBRATION VERIFICATION SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA[1]
Explosives								
CCS*887021-C2*6	1,3,5-Trinitrobenzene	G29387	7+	58	12	103	46-102	88
CCS*887021-D5*4		G29954				103		
CCS*887021-D*6						104		
CCS*887021-D5*6						106		
CCS*887021-C2*6						103		
CCS*887052-B*5		G30224				103		
CCS*887052-B*5		G30391				103		
CCS*887021-D*6	2,4-Dinitrotoluene	G29387	3+	58	5	105	60-102	95
CCS*887021-D*4		G29954				110		
CCS*887021-D5*5						107		

Notes: [1] Unbiased acceptable data fall within the recovery criteria range.
Summary reflects quality control data received in September, 1992.

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TABLE 25A

SUMMARY RESULTS OF STANDARD MATRIX SPIKE RECOVERY VERIFICATION SAMPLES

RARITAN ARSENAL, EDISON, NEW JERSEY

STANDARD MATRIX SPIKE SAMPLE NUMBERS	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY	RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA
61	1,3,5-TNB (soil)	2-	3.3	G26916 60.7 G27067 46.1	65-115	96.7
61	2,4,6-TNT (soil)	1-	1.6	G27214 69.9	72-118	98.4
61	RDX (soil)	1+	1.6	G27213 107.3	71-107	96.7
		1-	1.6	G27300 60.3		
4	RDX (water)	1-	25.0	G28218 38.3	51-111	75.0
6	PETN (water)	1-	16.7	G28123 63.8	72-110	83.3
6	ENDRIN (soil)	1-	16.7	G27695 0.0	52-126	83.3
8	Phenol (soil)	3+	37.5	G26937 104 G27257 96 G27404 97	26-90	62.5
3	Phenol (water)	2+	66.7	G27893 98, 110	12-89	33.3
8	2-Chlorophenol (soil)	1+	12.5	G26937 103	25-102	87.5
8	4-Chloro-3-Methyl Phenol (soil)	2+	25.0	G26937 121 G27404 113	26-103	75.0
3	4-Chloro-3-Methyl Phenol (water)	2+	66.7	G27893 110, 120	23-97	33.3
8	2,4-Dinitrotoluene (soil)	3+	37.5	G26937 103 G27257 115 G27404 106	28-89	62.5

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TABLE 25A (continued)

STANDARD MATRIX SPIKE SAMPLE NUMBERS	PARAMETER	# OF FINDINGS AND BIAS	% FINDINGS	BATCH NO. AND % RECOVERY		RECOVERY CRITERIA	TOTAL % OF UNBIASED ACCEPTABLE DATA
3	2,4-Dinitrotoluene (water)	1+	33.3	G27893	104	24-96	66.7
8	Pentachlorophenol (soil)	1+	12.5	G27257	121	17-109	87.5
3	Pentachlorophenol (water)	2+	66.7	G27893	120, 110	9-103	33.3
3	4-Nitrophenol (water)	2+	66.7	G27893	140, 120	10-80	33.3

Note: Summary reflects quality control data received in July, 1992.

TABLE 25B

SUMMARY RESULTS OF STANDARD MATRIX SPIKE RECOVERY, WATER
RARITAN ARSENAL - EDISON, NEW JERSEY

STANDARD MATRIX SPIKE SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA
Organosulfur Compounds								
SP*QC*1 SP_1*QC*1 SP*QC*1	Dimethyldisulfide	G30078 G30507 G29863	3^-	3	100	34.8 49.8 75.9	85-115	0
SP*QC*1 SP_1*QC*1	1,4-Dithiane	G30078 G30507	2^-	3	67	68.1 68.5	80-120	33
SP*QC*1 SP_1*QC*1 SP*QC*1	P-Clphenylmethyl sulfide	G30078 G30507 G29863	3^-	3	100	43.1 65.2 59.0	80-120	0
SP_1*QC*1	P-Clphenylmethyl sulfoxid	G30507	1^-	3	33	67.9	80-120	67
Explosives								
SP_4*QC*1	2,4 Dinitrotoluene	G29387	1^+	6	17	102.4	60-102	83
Semivolatiles								
SP_1*QC*1 SP_1*QC*0811	2,4 Dinitrotoluene	G30557 G31034	2^+	6	33	102 98	24-96	67
SP_1*QC*1 SP_1*QC*0811	4-nitrophenol	G30557 G31034	2^+	6	33	100 92	10-80	67
SP_1*0720*1	Pentachlorophenol	G29951	1^+	6	17	110	9-103	83

TABLE 25B (continued)

STANDARD MATRIX SPIKE SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA
Explosives								
SP_1*QC*1	1,3,5 TNB, soil	G29919	1^-	4	25	57.9	65-115	75
SP_2*QC*1	2,4,6-TNT, soil	G29919	1^-	4	25	71.1	72-118	75
SP_1*QC*2	Petn, soil	G30296	1^-	4	25	69.2	70-114	75
Semivolatiles								
SP_1*QC*1	4-Chloro-3-methyl Phenol	G30422	1^+	2	50	106	26-103	50

Note: Summary reflects quality control data received in September, 1992.

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TABLE 26A

SUMMARY RESULTS OF METHOD BLANKS
RARITAN ARSENAL, EDISON, NEW JERSEY

PARAMETER	BATCH	CONCENTRATION	TOTAL NUMBER OF ANALYSES	NUMBER OF FINDINGS	% OF FINDINGS	% OF METHOD BLANKS WITH NO COMPOUNDS DETECTED
METALS						
Barium (sediment)	G26909 G27046 G27084 G27356 G27387 G27441 G27477 G27640 G27964 G28073	4.78, 4.38 mg/kg - dry 3.55 mg/kg - dry 3.24, 3.30 mg/kg - dry 0.275, 0.274 mg/kg - dry 0.203, 0.213 mg/kg - dry 3.49, 3.36 mg/kg - dry 3.52, 3.17 mg/kg - dry 2.83 mg/kg - dry 0.562 mg/kg - dry 3.09 mg/kg - dry	22	16	72.7	27.3
EXPLOSIVES						
HMX (soil)	G27300	0.135 µg/g - dry	21	1	4.8	95.2
RDX (soil)	G27300	0.280 µg/g - dry	21	1	4.8	95.2
RDX (water)	G28218	1.11 µg/L	2	1	50.0	50.0
Nitrobenzene (soil)	G27300	0.236 µg/g - dry	21	1	4.8	95.2
Nitrobenzene (water)	G28218	0.291 µg/L	2	1	50.0	50.0
1,3,5-Trinitrobenzene (water)	G28218	0.071 µg/L	2	1	50.0	50.0
1,3-Dinitrobenzene (water)	G28218	0.605 µg/L	2	1	50.0	50.0
PESTICIDES						
BHC, G (Lindane) (soil)	G27617	0.041 µg/g	7	1	14.3	85.7

TABLE 26A (continued)

PARAMETER	BATCH	CONCENTRATION	TOTAL NUMBER OF ANALYSES	NUMBER OF FINDINGS	% OF FINDINGS	% OF METHOD BLANKS WITH NO COMPOUNDS DETECTED
VOLATILE ORGANIC COMPOUNDS						
Acetone (soil)	G27003	9.2 µg/kg - dry	25	20	80.0	20.0
	G27031	7.9 µg/kg - dry				
	G27044	14 µg/kg - dry				
	G27051	22 µg/kg - dry				
	G27052	15 µg/kg - dry				
	G27053	12 µg/kg - dry				
	G27055	8.5 µg/kg - dry				
	G27119	6.4, 9.2 µg/kg - dry				
	G27339	1.6 µg/kg - dry				
	G27344	2.7 µg/kg - dry				
	G27440	7.7 µg/kg - dry				
	G27444	10.0 µg/kg - dry				
	G27461	13 µg/kg - dry				
	G27465	8.6 µg/kg - dry				
	G27466	9.8 µg/kg - dry				
	G27656	1.9 µg/kg - dry				
	G27751	8.3 µg/kg - dry				
	G27857	1.4 µg/kg - dry				
	G27965	15 µg/kg - dry				
Acetone (water)	G27006	6.3 µg/L	9	4	44.4	55.6
	G27227	4.4 µg/L				
	G27372	4.2 µg/L				
	G28047	2.5 µg/L				
Chloroform (soil)	G27119	1.8 µg/kg - dry	25	2	8.0	92.0
	G27465	0.47 µg/kg - dry				
Chloroform (water)	G27006	0.50 µg/L	9	5	55.6	44.4
	G27227	0.36 µg/L				
	G27372	0.80 µg/L				
	G27645	0.38 µg/L				
	G28047	0.32 µg/L				

TABLE 26A (continued)

PARAMETER	BATCH	CONCENTRATION	TOTAL NUMBER OF ANALYSES	NUMBER OF FINDINGS	% OF FINDINGS	% OF METHOD BLANKS WITH NO COMPOUNDS DETECTED
Trichlorofluoromethane (soil)	G27031 G27348	0.65 µg/kg - dry 5.3 µg/kg - dry	25	2	8.0	92.0
Methylene Chloride (soil)	G27339 G27344	1.9 µg/kg - dry 1.9 µg/kg - dry	25	2	8.0	92.0
Methylene Chloride (water)	G27372 G28047	0.24 µg/L 0.48 µg/L	9	2	22.2	77.8
Methl Isobutyl Ketone (soil)	G27344	9.8 µg/kg - dry	25	1	4.0	96.0
1,1,2,2-Tetrachloroethane (water)	G28047	0.43 µg/L	9	1	11.1	88.9
SEMIVOLATILE ORGANIC COMPOUNDS						
Bis (2-ethylhexyl) Phthalate (soil)	G27799 G26937 G27116 G27257 G27404 G27414 G27794	66 µg/kg - dry 76 µg/kg - dry 77 µg/kg - dry 160 µg/kg - dry 110 µg/kg - dry 130 µg/kg - dry 6.6 µg/kg - dry	7	7	100.0	0.0
Bis (2-ethylhexyl) Phthalate (water)	G27893	4.4 µg/L	2	1	50.0	50.0
Benzo (A) Anthracene (water)	G27893	1.4 µg/L	2	1	50.0	50.0
Chrysene (water)	G27893	1.6 µg/L	2	1	50.0	50.0

Note: Summary reflects quality control data received in July, 1992.

TABLE 26B

SUMMARY RESULTS OF METHOD BLANKS, WATER
RARITAN ARSENAL - EDISON, NEW JERSEY

PARAMETER	BATCH #	# OF FINDINGS	TOTAL NUMBER OF ANALYSES	% OF FINDING	ANALYTICAL RESULT (µg/L)	% OF METHOD BLANKS WITH NO COMPOUNDS DETECTED
Cyanide	G29839	1	3	33.33	0.2	66.67
Explosives						
RDX	G293871 G29954 G30224 G30391 G30785 G30786	6	6	100	0.136 0.310 0.015 0.367 0.664 0.312	0.0
1,3,5-trinitrobenzene	G29954	1	6	17	0.037	83
HMX	G30391	1	6	17	0.038	83
VOCs						
Methylene Chloride	G29196 G29529 G29703	3	18	17	0.53 0.34 3.0	83

TABLE 26B (continued)

PARAMETER	BATCH #	# OF FINDINGS	TOTAL NUMBER OF ANALYSES	% OF FINDING	ANALYTICAL RESULT (μg/L)	% OF METHOD BLANKS WITH NO COMPOUNDS DETECTED
Chloroform	G29196 G29371 G29529 G29703 G30418	5	18	28	1.0 0.41 0.42 0.46 0.97	72
Acetone	G29371 G29529 G29703 G30242 G30418 G30451	7	18	39	3.9, 5.1 6.7, 3.4 4.8, 8.9 12	61
Toluene	G29529 G29703 G30418	3	18	17	0.50 0.44 0.42	83
Semi-VOCs						
Bis (2-ethylhexyl) phthalate	G29951 G30506 G30557 G31034	4	7	57	0.71 4.1 6.0 7.5	43

Note: Summary reflects quality control data received in September, 1992.

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TABLE 26C

SUMMARY RESULTS OF METHOD BLANKS, SOIL
RARITAN ARSENAL - EDISON, NEW JERSEY

PARAMETER	BATCH #	# OF FINDINGS	TOTAL NUMBER OF ANALYSES	% OF FINDING	ANALYTICAL RESULT (mg/kg)	% OF METHOD BLANKS WITH NO COMPOUNDS DETECTED
ICP						
Barium	G29685 G30204	2	2	100	0.936 0.874	0.0
Chromium	G30204	1	2	50	0.079	50
Explosives						
HMX, soil	G30296	1	2	50	0.019	50
1,3,5-Trinitrobenzene	G30296	1	2	50	0.013	50
1,3-Dinitrobenzene	G30296	1	2	50	0.030	50
Nitrobenzene, soil	G30296	1	2	50	0.099	50
Tetryl, sed	G30296	1	2	50	0.090	50
Nitroglycerin, soil	G30296	1	2	50	0.354	50
2,4,6-Trinitrotoluene	G30296	1	2	50	0.003	50
2,4-Dinitrotoluene	G30296	1	2	50	0.52	50
2,6-Dinitrotoluene	G30296	1	2	50	0.016	50
PETN, soil	G30296	1	2	100	0.529	50

Note: Summary reflects quality control data received in September 1992.

TABLE 26C (continued)

PARAMETER	BATCH #	# OF FINDINGS	TOTAL NUMBER OF ANALYSES	% OF FINDING	ANALYTICAL RESULT (µg/kg)	% OF METHOD BLANKS WITH NO COMPOUNDS DETECTED
VOCs						
Methylene-chloride	G29530	1	1	100	5.7	0.0
Acetone	G29530	1	1	100	14	0.0
Trichlorofluoromethane	G29530	1	1	100	5.5	0.0

Note: Summary reflects quality control data received in September 1992.

TABLE 27

SUMMARY RESULTS OF SURROGATE SPIKE RECOVERY, WATER
RARITAN ARSENAL - EDISON, NEW JERSEY

SURROGATE SPIKE RECOVERY SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA
Explosives								
DA*RARW1*15	3,4-DNT	G29954	2^-	132	4	13.2	67-133	96
DA*RARWS*15						14.5		
SPM_2*RARW1*59		G30785	1^-			65		
SPM_1*RARW1*77		G30786	2^-			58.7		
SPM_2*RARW1*77						60.90		
Pesticides/PCBs								
DA*RARW1*46	Dibutylchlorendate	G30581	2^+	115	5	148	46-146	95
DA*RARWS*46						147		
DA*RARW1*65		G30710	2^-			28.1		
DA*RARWS*65						26		
DA*RARW1*77		G30739	2^-			31.7		
DA*RARWS*77						31.7		

TABLE 27 (continued)

SURROGATE SPIKE RECOVERY SAMPLE I.D.	PARAMETER	BATCH #	# OF FINDINGS AND BIAS	TOTAL NUMBER OF ANALYSES	% OF FINDING	% OF RECOVERY	RECOVERY CRITERIA	% OF UNBIASED ACCEPTABLE DATA
Semi-VOCs								
DA*RARW1*9 DA*RARW1*10 DA*RARW1*11 DA*RARWS*9 DA*RARWS*10 DA*RARWS*11 DA*RARW1*21 DA*RARWS*21	2-Fluorophenol	G29472 G30243	6 2	91	9	9.4 12 8.5 9.3 12 1.5 13 15	21-100	91
DA*RARW1*9 DA*RARW1*10 DA*RARW1*11 DA*RARWS*9 DA*RARWS*10 DA*RARWS*11	Phenol-D(5)	G29472	6	91	7	6.2 12 1.0 6.4 8.5 0.98	10-94	93
SPM_2*RARW1*21	2-Fluorobiphenyl	G30243	1	91	1	13	43-116	99

Note: Summary reflects quality control data received in September 1992.

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7.0 RESULTS OF THE OBG CONTAMINATION EVALUATION

O'Brien and Gere performed the following tasks to complete their 1987-88 evaluation of the arsenal:

1. Unexploded Ordnance (UXO) Survey
2. Magnetometer Surveys
3. Ground Penetrating Radar Surveys
4. Electromagnetic Surveys
5. Subsurface Exploration
   - A. Soil; Analytical/Geotechnical
   - B. Ground Water; Monitoring Well Installation and Sampling
6. Surface Water Sampling

Geophysical surveys were performed in Areas 1 through 5, 7, 10, 11, and 16.

Subsurface soil samples were obtained by the use of continuous split-spoon sampling to the designated 15-foot depth; a total of 28 soil borings were drilled. Soil samples were analyzed for VOCs, metals, and explosives.

Thirty monitoring wells were installed throughout the former arsenal, including 27 shallow wells and 3 deep wells. All shallow wells were installed to the first confining layer. Deep monitoring wells MW-34 and MW-16 were installed within the confined aquifer, and MW-31 was installed in clay and weathered bedrock. Ground water samples were analyzed for volatile organic compounds, metals (total and dissolved), petroleum hydrocarbons, and explosives. Tables 28 and 29 describe the analytical results reported for ground water and subsurface soils.

The reader is referred to OBG report, entitled *Final Engineering Report, Former Raritan Arsenal Contamination Evaluation*, for additional information.

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TABLES FOR SECTION 7.0

TABLE 28

MONITORING WELLS FROM OBG'S "FINAL ENGINEERING REPORT-FORMER RARITAN ARSENAL CONTAMINATION EVALUATION EDISON, NEW JERSEY PROJECT #CO2NJ008400 - AUGUST 1989"

PARAMETER	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16
VOCs (ppb)													
1,1-Dichloroethylene	26	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	220	-	-	-	-	-	-	-	-	-	-	-	-
Trans 1,2-Dichloroethylene	-	-	-	-	8	4	-	-	-	18	-	-	-
Benzene	16	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene	380	-	-	5	170	3	-	-	-	43	6	-	-
Metals, Dissolved (ppm)													
Arsenic	-	-	0.01	-	-	-	-	-	-	-	-	-	-
Barium	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	.005	-	-	0.010
Chromium	-	-	-	-	-	-	-	-	-	-	-	-	0.03
Silver	-	-	-	0.01	-	0.01	0.01	-	-	-	-	-	-
Metals, Total (ppm)													
Arsenic	-	-	0.04	-	-	-	-	-	-	-	-	-	-
Barium	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-	0.011
Chromium	-	-	-	-	-	-	0.011	-	-	-	0.014	-	0.031
Lead	0.009	0.014	-	-	-	0.006	-	I	I	0.005	I	-	I
Mercury	-	-	-	-	-	-	-	-	-	0.0004	-	-	-
Explosives (ppm)													
Tetryl	-	-	-	-	-	-	-	-	-	-	-	-	1.54*
HMX	-	-	I	-	-	-	-	I	-	I	-	I	1
RDX	-	-	I	I	-	-	-	I	-	I	-	I	-
1,3,5-TNB	-	-	I	-	-	-	-	-	-	I	-	I	-
Petroleum Hydrocarbons (ppm)	5	-	-	-	-	-	-	-	-	6	-	-	-

TABLE 28 (continued)

PARAMETER	MW-17	MW-18	MW-19	MW-20	MW-21	MW-22	MW-25	MW-26	MW-27	MW-28	MW-29	MW-30	MW-31	MW-34	MW-35	MW-36	MW-37
VOCs (ppb)																	
Trans 1,2-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	250	-	-	-	-
Metals, Dissolved (ppm)																	
Arsenic	-	-	-	-	-	-	0.01	-	-	I	0.02	0.05	-	-	-	-	-
Barium	-	-	-	-	-	-	-	-	-	0.208	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	0.01	-	-	0.01	-	0.010	0.020	-	-	-
Silver	-	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-
Metals, Total (ppm)																	
Arsenic	-	-	-	-	-	-	0.01	-	0.02	I	0.02	0.04	-	-	-	-	-
Barium	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	0.008	-	0.005	-	-	-	-	-
Chromium	-	0.023	-	0.035	0.020	-	0.01	0.01	-	0.03	0.02	0.02	-	-	0.011	0.026	0.010
Lead	0.016	-	-	-	I	-	-	-	-	I	0.011	0.011	-	-	-	0.007	-
Mercury	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Explosives (ppm)																	
Tetryl	-	-	-	NRQ	NRQ	NRQ	-	-	-	I	I	I	-	-	-	-	-
HMX	-	-	1.43	NRQ	NRQ	NRQ	-	-	-	I	I	I	-	-	I	-	-
RDX	2.09	-	-	NRQ	NRQ	NRQ	-	-	-	I	I	I	-	-	I	-	-
1,3,5-TND	3.93	-	-	NRQ	NRQ	NRQ	-	-	-	I	I	I	-	-	-	-	-
Petroleum Hydrocarbons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- Indicates not detected.
I = Indicates that compound was not detected, but detection limit was elevated due to matrix interference.
NRQ = Not requested.
*Reported as ppm by OBG. Discussions with USACE personnel indicated the correct units should be ppb.

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TABLE 29

SOIL BORINGS
FROM OBG's "FINAL ENGINEERING REPORT-FORMER RARITAN ARSENAL CONTAMINATION EVALUATION
EDISON, NEW JERSEY - PROJECT #CO2NJ008400 - AUGUST 1989"

	AREA 1*									AREA 2*					
PARAMETER	B-4 (0-5)	B-4 (5-10)	B-4 (10-15)	B-5 (0-5)	B-5 (5-10)	B-5 (10-15)	B-6 (0-5)	B-6 (5-10)	B-6 (10-15)	B-10 (0-5)	B-10 (5-10)	B-10 (10-15)	B-11 (0-5)	B-11 (5-10)	B-11 (10-15)
VOCs (ppb)															
Trans 1,2-Dichloroethylene	-	-	-	-	2J	-	-	4J	5J	-	-	-	-	-	-
1,1-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	2JB	3JB	2JB	-	9JB	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	1JB	2JB	1JB	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	-	-	-	-	-	-	-	-	-	-	-	-	10J	6J	19
Toluene	-	-	-	-	-	-	-	-	-	-	-	-	3J	-	24
Trichloroethene	-	-	19	-	10	6J	-	4J	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ppm)															
Arsenic	-	-	-	1.42	-	2.71	3.23	-	2.20	2.21	-	-	1.34	1.52	-
Barium	-	-	-	-	-	80.3	-	-	57.7	-	-	-	-	-	-
Chromium	5.72	13.0	11.8	10.6	6.88	36.2	7.05	9.77	39.1	7.82	3.97	3.49	3.56	3.66	10.2
Lead	2.27	4.13	5.12	2.60	5.87	22.7	25.3	6.05	19	14.0	1.47	0.69	1.7	1.6	2.9
Calcium	205	-	-	208	159	3880	441	210	2090	175	-	145	546	-	124
Sodium	132	138	118	207	168	359	-	-	242	225	194	204	171	136	140
Potassium	-	-	-	-	-	10,400	-	-	8860	-	-	-	-	-	-
Mercury	-	-	-	-	-	-	-	-	-	25.8	0.584	0.140	-	-	-
Silver	-	-	-	-	-	-			-	-	-	-	-	-	-
Explosives (ppm)															
2,4,6-TNT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 29 (continued)

AREA 3*

PARAMETER	B-12 (0-5)	B-12 (5-10)	B-12 (10-15)	B-13 (0-5)	B-13 (5-10)	B-13 (10-12)	B-14 (0-5)	B-14 (5-10)	B-14 (10-15)	B-15 (0-5)	B-15 (5-10)	B-15 (10-15)	B-16 (0-5)	B-16 (5-10)	B-16 (10-15)	B-17 (0-5)	B-17 (5-10)	B-17 (10-15)	B-18 (0-5)	B-18 (5-10)	B-18 (10-15)
VOCs (ppb)																					
Trans 1,2-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachlorethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	-	-	-	36B	33B	43B	15	-	16	41B	12B	9JB	-	-	-	21B	23B	20B	-	-	16B
Toluene	-	-	-	-	-	-	2J	9J	-	3J	10J	12J	-	3J	4J	1J	6J	12J	24	30	14
Xylenes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1JB	-	1JB	-	-	-
Metals (ppm)																					
Arsenic	-	-	-	2.25	-	-	1.65	1.37	-	3.35	3.24	1.55	-	-	-	1.99	16.6	8.34	2.18	2.28	-
Barium	-	-	95.4	27.0	-	-	-	-	-	-	39.6	-	-	-	-	140	-	-	27.7	-	-
Chromium	3.91	8.01	4.66	6.37	7.40	13.2	16.1	7.44	3.37	10.7	8.22	9.69	15.3	14.0	13.4	22.7	15.1	13.8	7.82	7.48	5.47
Lead	82.9	7.37J	2.48	27.5	1.8	6.14	10.9	5.61	2.0	12.2	51.1	9.05	14.9	3.19	3.34	188	28.7	2.56	157	53.8	2.1
Calcium	-	-	-	171.0	145	142	3510	-	285	1820	428	324	-	145	-	340	439	221	516	372	141
Sodium	227	221	236	133	160	183	371	-	173	433	143	162	189	244J	195	227	316	205	157	162	142
Potassium	-	-	-	-	-	-	286	120	-	323	241	221	-	-	-	-	-	1100	-	137	-
Selenium	0.739	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Explosives (ppm)																					
2,4,6-TNT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 29 (continued)

AREA 4*

PARAMETER	B-19 (0-5)	B-19 (5-10)	B-19 (10-15)	B-20 (0-5)	B-20 (5-10)	B-20 (10-15)	B-21 (0-5)	B-21 (5-10)	B-21 (10-15)	B-22 (0-5)	B-22 (5-10)	B-22 (10-15)
VOCs (ppb)												
Trans 1,2-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	4J	-	-	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	-	5JB	-	23JB	5JB	6JB	-	-	8J	10J	-	-
Toluene	10J	-	-	-	-	-	-	7J	4J	6J	9J	-
Xylenes	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ppm)												
Arsenic	-	-	-	-	1.63	-	-	-	2.77	-	-	3.97
Barium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	4.84	1.78	12.9	3.45	8.91	5.07	3.85	3.83	5.26	6.17	2.04	7.96
Lead	15.1	1.7	7.6	22.2	5.86J	4.18	3.03	1.08	2.58	2.92	1.51	7.39
Calcium	208	433	177	120	124J	-	-	-	-	1630	167	217
Sodium	134	131	168	177	210J	154	172	227	167	276	208	154
Potassium	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	-	-	-	-	-	-	-	-	-	-	-	-
Silver	-	-	-	1.15	-	-	-	-	-	-	-	-
Explosives (ppm)												
2,4,6-TNT	47.7	-	-	-	-	-	-	-	-	-	-	-

TABLE 29 (continued)

PARAMETER	AREA 6*									AREA 7*								
	B-28 (0-5)	B-28 (5-10)	B-28 (10-15)	B-29 (0-5)	B-29 (5-10)	B-29 (10-15)	B-30 (0-5)	B-30 (5-10)	B-30 (10-15)	B-7 (0-5)	B-7 (5-10)	B-7 (10-15)	B-8 (0-5)	B-8 (5-10)	B-8 (10-15)	B-9 (0-5)	B-9 (5-10)	B-9 (10-15)
VOCs (ppb)																		
Trans 1,2-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	-	-	-	-	-	-	-	-	-	1J	51	-	-	-	-	-	-	-
Benzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	2JB	24B	-	-	-	-	-	9B	4JB	-	-	-	-	-	-	10J	-	-
Toluene	3J	5J	-	-	-	-	-	2J	-	-	-	-	-	-	-	-	7J	-
Xylenes	-	-	-	-	-	-	-	-	-	7	109	-	-	-	-	-	-	-
Metals (ppm)																		
Arsenic	4.55	4.49	8.56	3.64	3.20	9.00	5.51	18.8	24.4	-	-	-	1.22	-	-	2.82	5.07	3.41
Barium	-	-	-	31.2	-	-	-	-	30.7	-	-	-	-	-	-	-	-	-
Chromium	12.0	11.2	13.8	12.9	5.99	21.0	37.0	34.9	49.3	7.50	6.02	4.67	6.88	5.01	4.02	19.1	13.8	19.3
Lead	11.2	7.21	20.0	16.6	7.1	14.4	28.1	27.9	14.8	12.2	3.55	2.17	10.1	1.89	2.27	11.8	6.79J	3.33
Calcium	1790	6380	3260	205	207	1560	440	2350	663	1890	195	127	615	183	159	1820	239	167
Sodium	143	230	3230	279	299	5830	168	4660	1090	122	-	-	191	170	132	262	155	-
Potassium	1080	1280	1670	238	137	1100	592	2260	1120	117	-	-	-	-	-	-	605J	231
Mercury	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Explosives (ppm)																		
2,4,6-TNT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 29 (continued)

PARAMETER	AREA 9*									AREA 15*								
	B-1 (6-5)	B-1 (5-10)	B-1 (10-15)	B-2 (0-5)	B-2 (5-10)	B-2 (10-15)	B-3 (0-5)	B-3 (5-10)	B-3 (10-15)	B-31 (0-5)	B-31 (5-10)	B-31 (10-15)	B-32 (0-5)	B-32 (5-10)	B-32 (10-15)	B-33 (0-5)	B-33 (5-10)	B-33 (10-15)
VOCs (ppb)																		
Trans 1,2-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	-	-	2J	-	-	-	-	-	-	-	-	-	2JB	2JB	2JB	-	-	-
Tetrachloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	2JB	26B	2JB	15	9J	-	84	20J	10J	8J	10JB	8JB	17B	17B	14B	26B	18B	26B
Benzene	-	-	-	-	-	-	5J	-	-	-	-	-	3JB	-	-	-	-	-
Toluene	8	5J	3J	32	8J	-	250	18J	9J	-	-	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ppm)																		
Arsenic	2.98	11.0	2.46	4.82	6.62J	-	3.46	-	1.69	1.14	1.47	2.07	-	-	-	2.17	3.12	2.32
Barium	-	-	-	39.7	-	-	-	-	-	-	-	-	-	-	-	29.0	36.6	-
Chromium	9.37	16.5	5.87	20.2	4.81	7.38	12.7	-	9.9	8.46	2.75	4.75	3.82	20.6	8.74	13.6	17.3	12.4
Lead	13.6	10.2	4.4	42.6	3.3	3.8	30.2	7.2	4.7	25.1	5.34	6.08	2.07	2.22	4.02	276	16.3	18.6
Calcium	638	213	121	4440	173	341	4330	636	132	196	118	217	123	-	252	666	414	454
Sodium	150	132	-	291	118	135	759	232	128	170	-	135	-	197	631	172	277	490
Potassium	244	702	297	1080	136	295	413	460	-	-	-	-	-	-	-	456	365	154
Mercury	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Explosives (ppm)																		
2,4,6-TNT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- Indicates not Detected
B Analytical also found in method blank, indicating possible/probable lab blank contamination.
J Indicates estimated value below method detection limit.
I Indicates compound was not detected, but detection limit was elevated due to matrix interference.

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GENERAL SITE TABLES

TABLE 30

GROUND WATER LEVELS
RARITAN ARSENAL - EDISON, NEW JERSEY

MONITORING WELL	AREA	WATER LEVEL MEASUREMENTS (IN FEET)						RISER PIPE ELEVATION	PAD ELEVATION
		READING 8/10/92	TIME 8/10/92	READING 8/11/92	TIME 8/11/92	READING 8/14/92	TIME 8/14/92		
MW-7	1	5.75	15:10	5.74	9:27	5.22	12:53	30.1	-
MW-8	1	3.42	15:14	3.48	9:25	2.98	12:57	30.15	-
MW-9	1	6.27	15:15	6.30	9:22	5.71	12:59	29.71	-
MW-31	1	7.30	15:12	7.28	9:30	7.27	12:56	30.65	-
MW-13	2/3	10.04	14:10	10.06	9:43	9.99	12:18	28.76	-
MW-14	2/3	13.80	13:20	13.82	10:48	13.76	11:54	22.95	-
MW-15	2/3	8.40	13:30	8.43	10:56	8.25	11:58	15.78	-
MW-40	2/3	8.50	14:33	8.50	9:37	8.50	12:40	60.59	58.99
MW-58	2/3	8.04	14:12	8.08	9:48	8.10	12:21	26.54	24.89
MW-17	4	6.63	13:50	6.63	11:04	6.54	12:07	10.75	-
MW-18	4	8.93	13:55	8.96	11:10	8.76	12:11	20.27	-
MW-19	4	6.13	14:40	6.13	8:54	5.88	9:19	8.22	-
MW-42A	4	6.09	13:43	6.11	11:00	6.04	12:05	13.74	11.03
MW-20	5	10.21	10:11	10.38	15:43	9.96	9:35	12.27	-
MW-21	5	4.23	10:15	4.40	15:40	3.97	9:36	5.79	-
MW-22	5	4.30	14:43	4.33	9:00	3.91	9:20	6.94	-
MW-16	6	10.78	10:55	11.08	13:51	10.33	10:10	10.86	-
MW-25	6	3.86	11:00	4.00	13:50	3.46	10:15	7.16	-
MW-26	6	7.46	10:57	7.56	13:52	7.32	10:12	10.86	-
MW-27	6	4.58	10:52	4.75	13:54	4.18	10:07	7.81	-
MW-34	6	5.61	10:45	5.74	14:10	5.43	10:00	6.53	-
MW-44	6	5.82	10:47	6.04	14:00	5.64	10:05	7.78	5.62
MW-45	6	8.59	10:20	8.78	15:47	8.36	9:45	11.60	9.02
MW-62	6	15.21	11:30	15.25	16:40	15.21	10:57	11.40	9.12
MW-10	7	6.82	13:15	6.88	10:45	6.68	11:49	15.84	-
MW-11	7	9.03	13:07	9.06	10:33	9.04	11:41	13.62	-
MW-12	7	7.97	13:10	8.00	10:40	7.88	11:46	14.57	-

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TABLE 30 (continued)

MONITORING WELL	AREA	WATER LEVEL MEASUREMENTS (IN FEET)						RISER PIPE ELEVATION	PAD ELEVATION
		READING 8/10/92	TIME 8/10/92	READING 8/11/92	TIME 8/11/92	READING 8/14/92	TIME 8/14/92		
MW-59	7	6.34	13:12	6.38	10:35	6.34	11:44	13.89	12.13
MW-43	7	7.93	13:25	8.02	10:53	7.22	11:56	13.94	12.21
MW-61	7	8.91	13:00	8.95	10:28	8.82	11:38	12.79	11.62
MW-6	9	6.13	12:00	6.15	10:17	5.85	11:34	8.26	-
MW-47A	9	8.63	14:20	8.66	10:07	8.55	12:27	17.08	14.59
MW-48A	9	6.09	14:15	6.15	10:09	5.85	11:31	8.98	6.64
MW-48B	9	4.54	14:16	4.60	10:10	4.30	11:30	7.89	6.80
MW-46A	10	2.71	14:27	2.70	9:54	2.62	12:36	31.37	32.16
MW-49	10	6.14	9:20	6.00	16:15	5.91	8:55	13.49	11.03
MW-56	10	6.76	9:25	6.80	16:18	6.63	9:00	22.08	20.15
MW-57	10	8.32	14:22	8.33	10:02	8.31	12:30	47.21	44.20
MW-55A	10*	7.84	9:30	5.84	16:22	5.80	9:06	48.02	45.28
MW-55B	10*	9.43	9:32	9.40	16:24	9.34	9:05	46.87	45.04
MW-28	11	3.54	11:27	3.56	13:42	3.40	10:47	5.94	-
MW-29	11	4.59	11:21	4.58	13:35	4.42	10:45	6.67	-
MW-30	11	3.01	11:25	3.00	13:59	2.67	10:50	5.02	-
MW-60	12	4.72	11:12	4.74	13:15	4.67	10:35	5.89	3.96
MW-63	12	8.92	11:16	9.24	13:10	7.75	9:40	8.17	5.69
MW-50	14	5.11	10:32	5.12	15:35	5.13	9:50	13.47	11.13
MW-51	16	7.07	11:42	6.99	11:44	6.69	11:12	7.66	5.18
MW-52A	16	8.24	11:45	8.22	11:48	8.15	11:16	9.23	6.67
MW-52B	16	7.92	11:45	7.90	11:52	7.72	11:17	8.52	6.70
MW-53	16	4.93	11:37	4.96	11:35	4.84	11:06	6.11	5.19
MW-54	16	5.44	11:50	5.43	11:58	5.38	11:25	6.71	4.11
MW-64	18	16.00	15:20	16.00	9:17	16.01	13:00	65.16	63.66

Water levels were measured in feet from the top of the riser pipe.
Elevations are given in feet above mean sea level.
Pad elevations for monitoring wells installed by OBG are not available.

*Monitoring wells are installed within Area 10 to determine ground water quality downgradient of Area 17A.

[d:\...\job\19577014\march93\waterlvl.tbl]

GENERAL SITE FIGURES

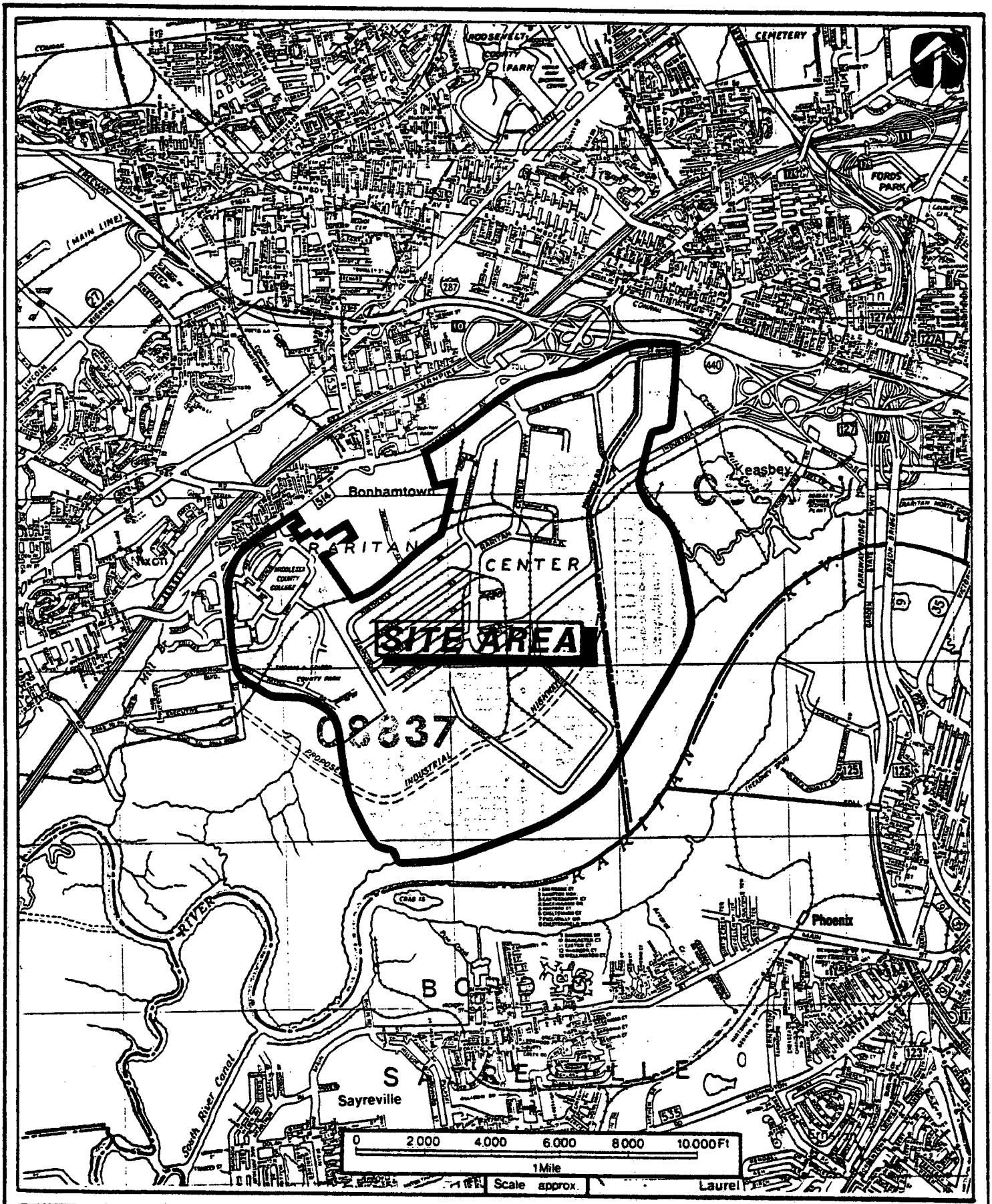
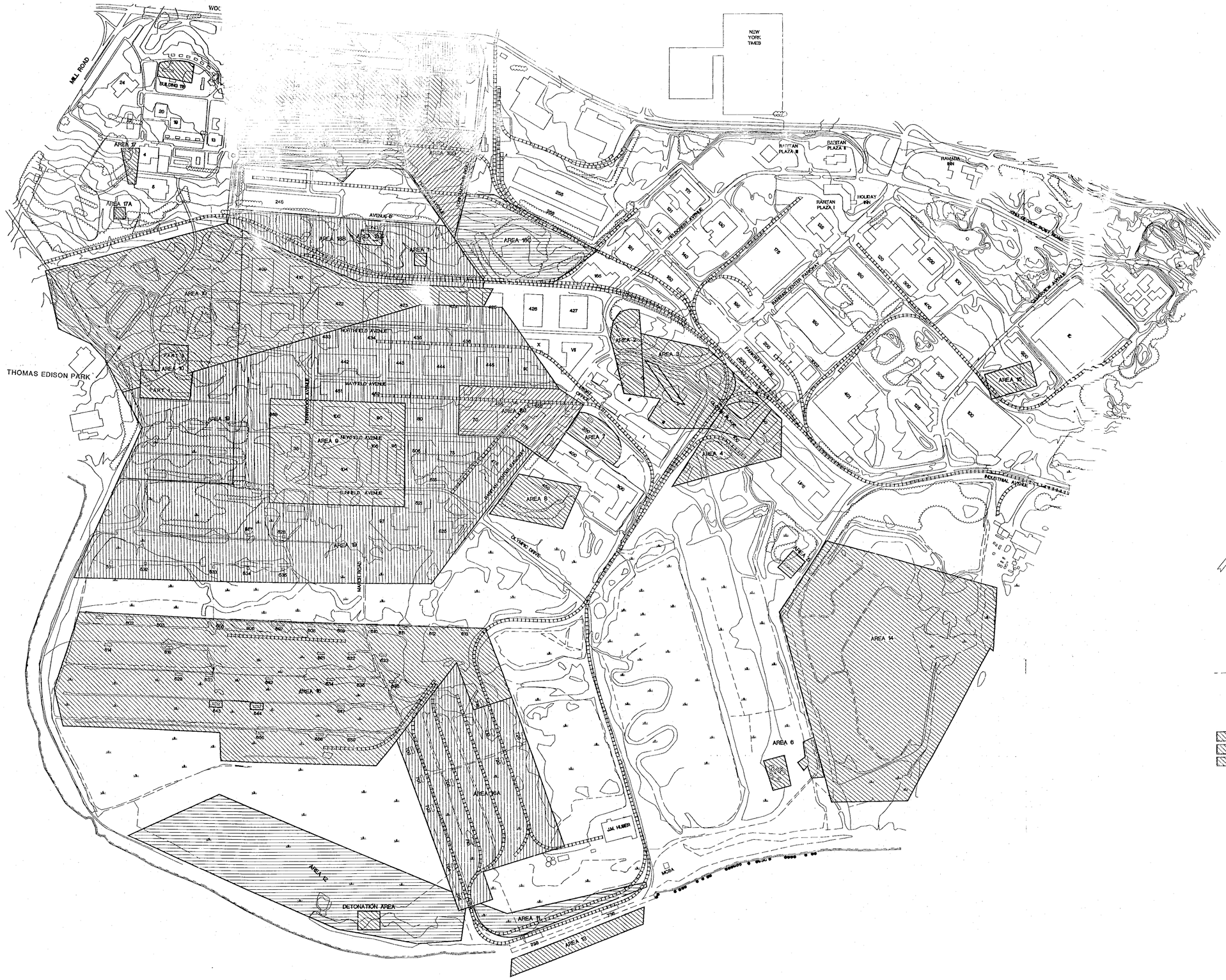


FIGURE 1
SITE LOCATION MAP

SOURCE: Taken from Hagstrom Map: Middlesex County, New Jersey: 1990

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS



AREAS	SQ. FT.	ACRES
AREA 1	24873.05	0.57
AREA 2	355603.63	8.16
AREA 3	303428.02	11.56
AREA 4	600076.80	13.78
AREA 5	60584.40	1.39
AREA 6	198721.03	4.56
AREA 7	258429.08	5.93
AREA 8	505532.96	11.60
AREA 9	2328206.95	53.46
AREA 10	6269601.92	143.95
AREA 11	483148.20	11.09
AREA 12	3672596.20	84.32
AREA 13	367395.23	8.44
AREA 14	6408078.45	147.13
AREA 15	199985.34	4.59
AREA 16	8428980.84	193.53
AREA 16A	3650768.60	83.82
AREA 17	81678.42	1.87
AREA 17A	22740.96	0.52
AREA 18A	47950.41	1.10
AREA 18B	1871847.23	42.98
AREA 18C	1323905.05	30.40
AREA 18D	1362338.00	31.28
AREA 18E	405818.55	9.32
AREA 18F	1875862.26	43.06
AREA 18G	902213.08	20.71
AREA 19	12782952.61	293.50
AREA 20	1009997.18	23.18

LEGEND:

- WATERWAY
- TREE AREA
- WETLAND
- RAILROAD
- BUILDING
- AREA UNDER WORK
- AREA COMPLETED
- AREA OF CONCERN

500 0 500 1000

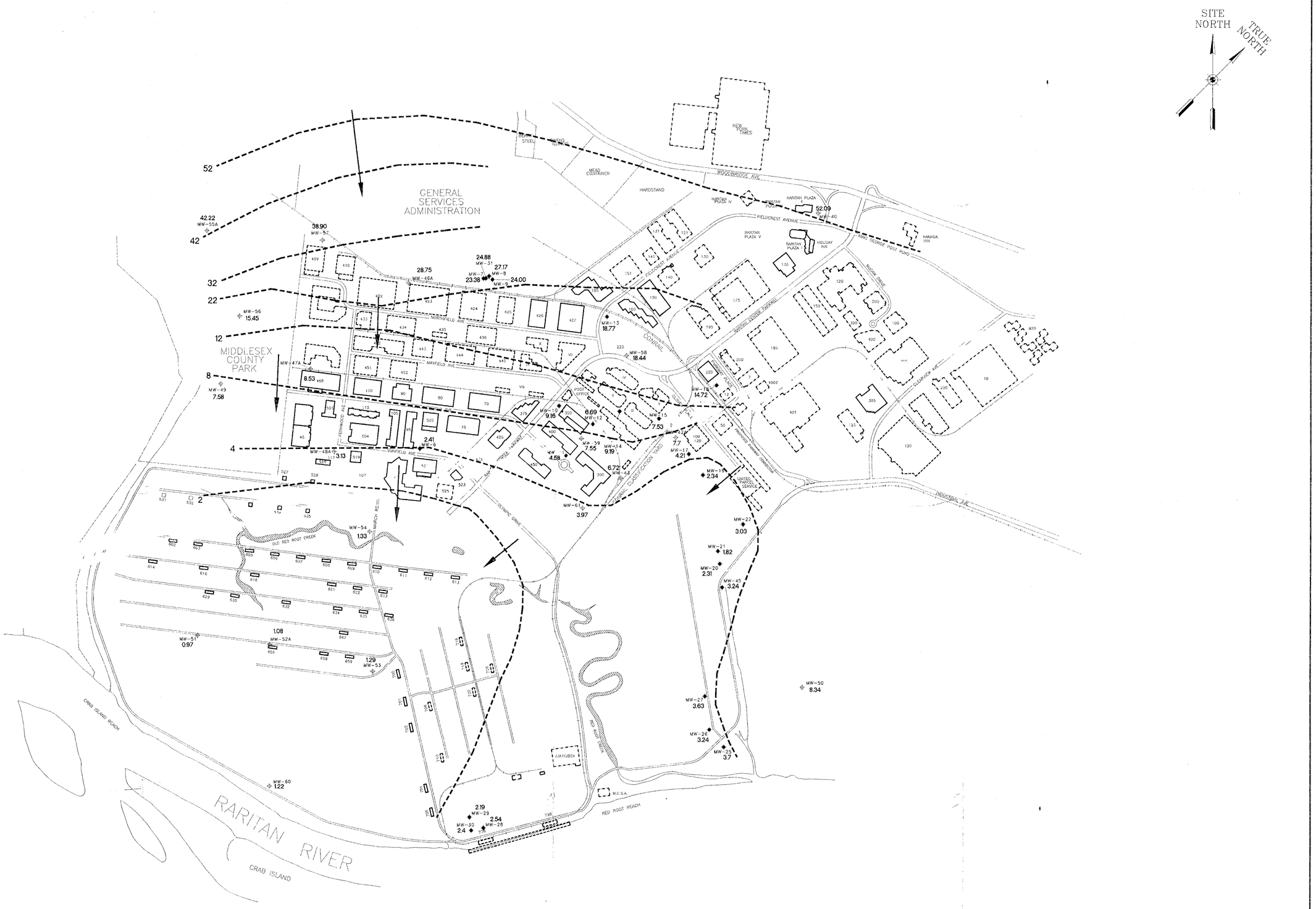
SCALE OF FEET

FIGURE 1A
GENERAL SITE MAP
FORMER RARITAN ARSENAL

SOURCE:
SAILER & SAILER, INC. ENGINEERS-LAND SURVEYORS
GENERAL SITE PLAN, FORMER RARITAN ARSENAL SITE

INTERNATIONAL TECHNOLOGY CORPORATION
SITE MAP- RARITAN ARSENAL, JANUARY 1992

0	--/--/--	SITEMAP.DWG



LEGEND:

- PROPERTY OF SUMMIT ASSOCIATES INC.
- PROPERTY OF FEDERAL BUSINESS CENTERS, INC
- PROPERTY OWNED BY OTHER THAN SUMMIT OR FEDERAL

MW-50 = DAMES & MOORE MONITORING WELL
MW-45 = O'BREIN & GERE MONITORING WELL
24.88 = GROUND WATER ELEVATION IN FEET
= GROUND WATER CONTOUR
= FLOW DIRECTION OF GROUND WATER

GROUND WATER LEVELS READ ON AUGUST 14, 1992

0 300 600 1200 1800
DISTANCE IN FEET

DAMES & MOORE

FORMER RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 18
POTENTIOMETRIC MAP
SHALLOW AQUIFER

DESIGNED BY	
DRAWN BY	MR
CHECKED BY	
COMPUTER FILE NAME	19577014
DATE	9/29/92
DRAWING NO.	RCMAP-12
REVISION	0

LEGEND:

- PROPERTY OF SUMMIT ASSOCIATES INC.
- PROPERTY OF FEDERAL BUSINESS CENTERS, INC
- PROPERTY OWNED BY OTHER THAN SUMMIT OR FEDERAL

MW-50 = DAMES & MOORE MONITORING WELL

MW-45 = O'BREIN & GERE MONITORING WELL

* = MONITORING WELL WAS NOT INSTALLED. BORING WAS ADVANCED TO TOP OF BEDROCK AND NO DEEP SOIL UNIT SUITABLE FOR WELL SCREENING WAS ENCOUNTERED. SEE TEXT AND BORING LOGS FOR ADDITIONAL INFORMATION.

0 300 600 1200 1800

DISTANCE IN FEET

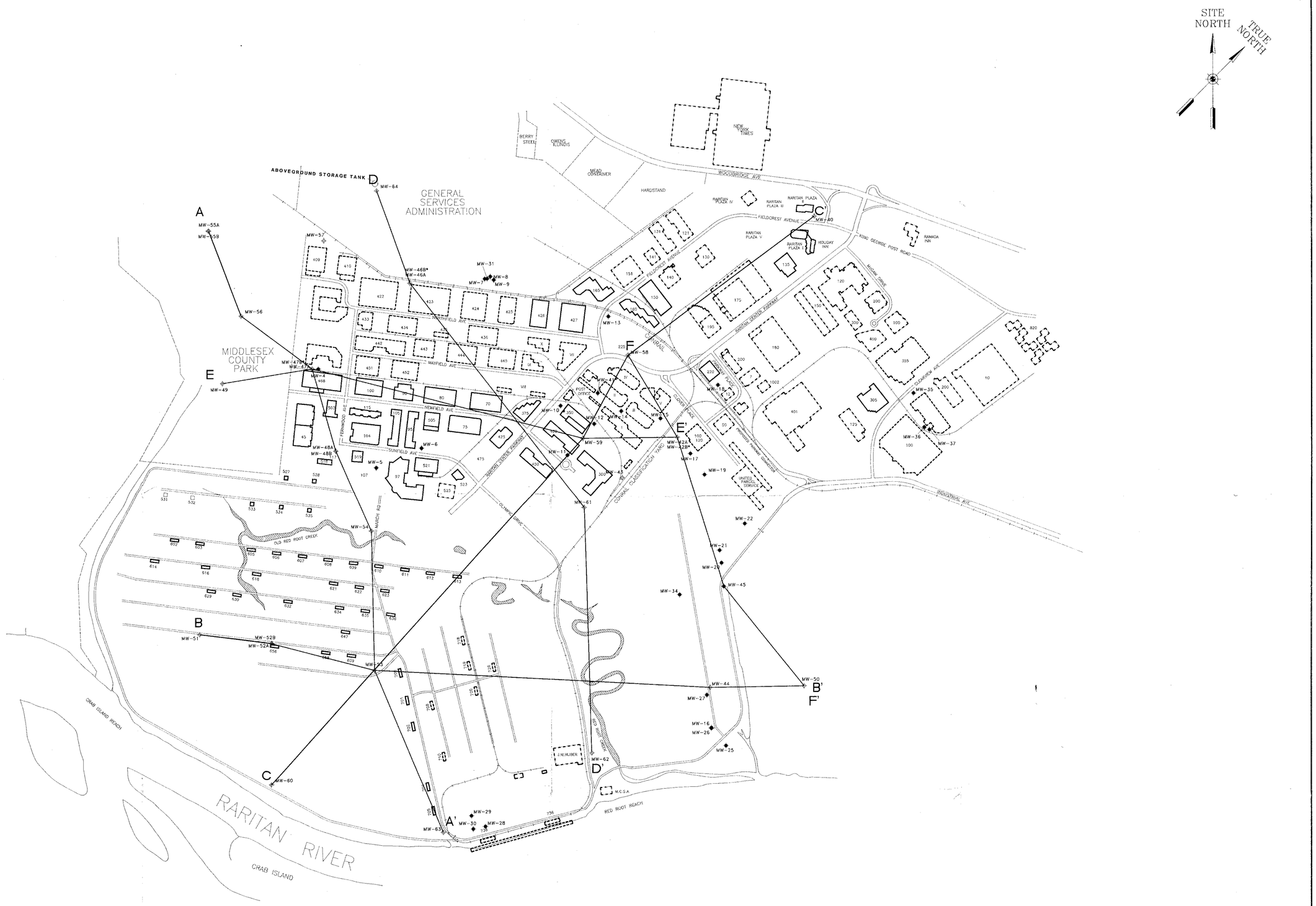
DAMES & MOORE

DESIGNED BY	
DRAWN BY	MR
CHECKED BY	
COMPUTER FILE NAME	19577014

FORMER RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 19
MONITORING WELL
LOCATIONS

DATE	DRAWING NO.	REVISION
9/29/92	RCMAP-11	0



LEGEND:

PROPERTY OF SUMMIT ASSOCIATES INC.

PROPERTY OF FEDERAL BUSINESS CENTERS, INC

PROPERTY OWNED BY OTHER THAN SUMMIT OR FEDERAL.

MW-50 = DAMES & MOORE MONITORING WELL

MW-45 = O'BREIN & GERE MONITORING WELL

* = MONITORING WELL WAS NOT INSTALLED. BORING WAS ADVANCED TO TOP OF BEDROCK AND NO DEEP SOIL UNIT SUITABLE FOR WELL SCREENING WAS ENCOUNTERED. SEE TEXT AND BORING LOGS FOR ADDITIONAL INFORMATION.

CROSS-SECTION LINES A-A' THROUGH F-F' ARE DEPICATED.

0 300 600 1200 1800

DISTANCE IN FEET

DAMES & MOORE

DESIGNED BY

DRAWN BY MR

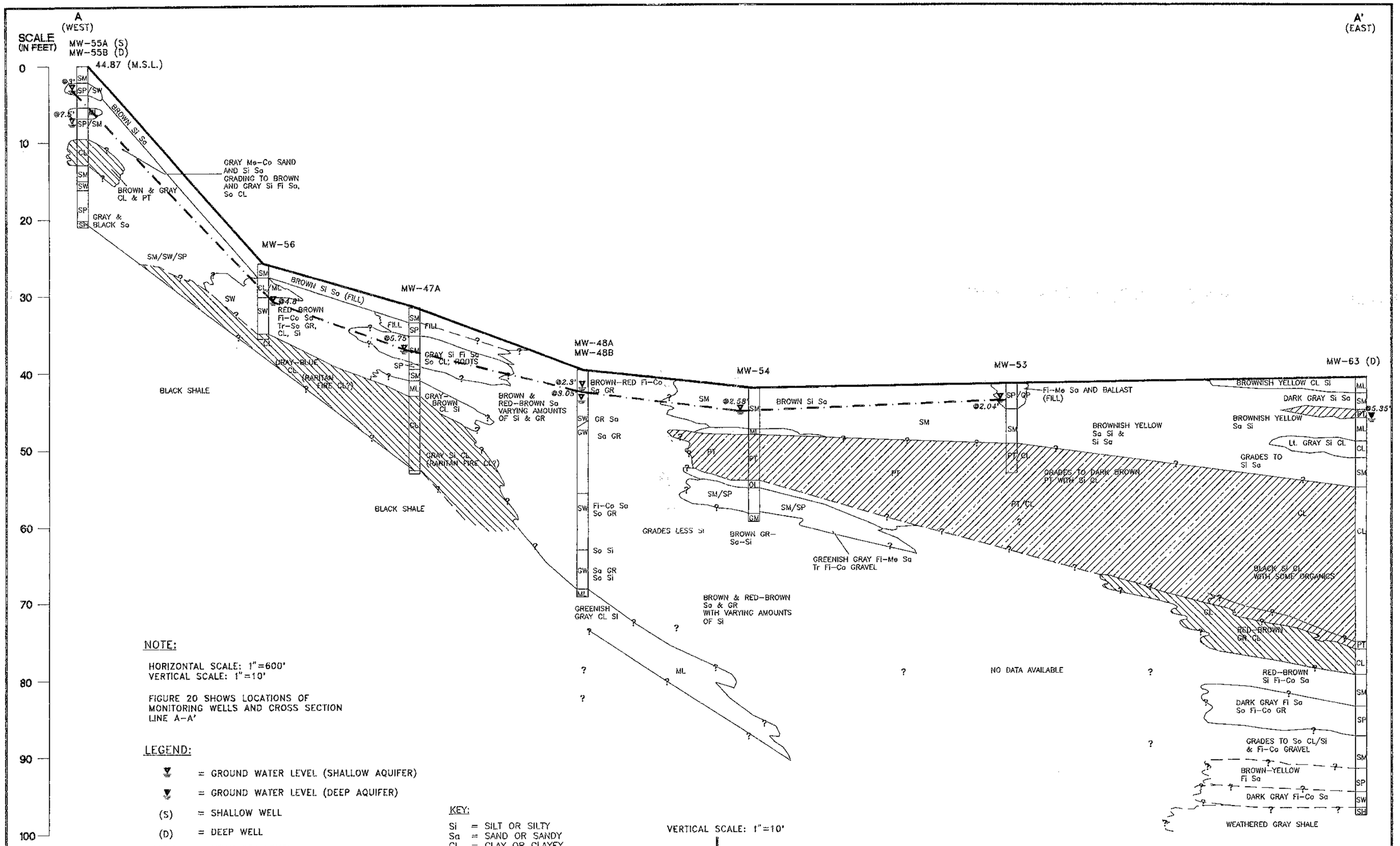
CHECKED BY

COMPUTER FILE NAME: 19577014

FORMER RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 20
CROSS-SECTION LINES

DATE	DRAWING NO.	REVISION
9/29/92	RCMAP-11	0



NOTE:

HORIZONTAL SCALE: 1"=600'
VERTICAL SCALE: 1"=10'

FIGURE 20 SHOWS LOCATIONS OF MONITORING WELLS AND CROSS SECTION LINE A-A'

LEGEND:

- ▼ = GROUND WATER LEVEL (SHALLOW AQUIFER)
- ▼ = GROUND WATER LEVEL (DEEP AQUIFER)
- (S) = SHALLOW WELL
- (D) = DEEP WELL
- M.S.L. = MEAN SEA LEVEL
- — · — = INFERRED GROUND WATER TABLE SHALLOW AQUIFER

GROUND WATER LEVELS SHOWN WERE MEASURED 08/14/92

KEY:

- Si = SILT OR SILTY
- Sa = SAND OR SANDY
- CL = CLAY OR CLAYEY
- PT = PEAT
- GR = GRAVEL
- Fi = FINE
- Me = MEDIUM
- Co = COARSE
- So = SOME
- Tr = TRACE

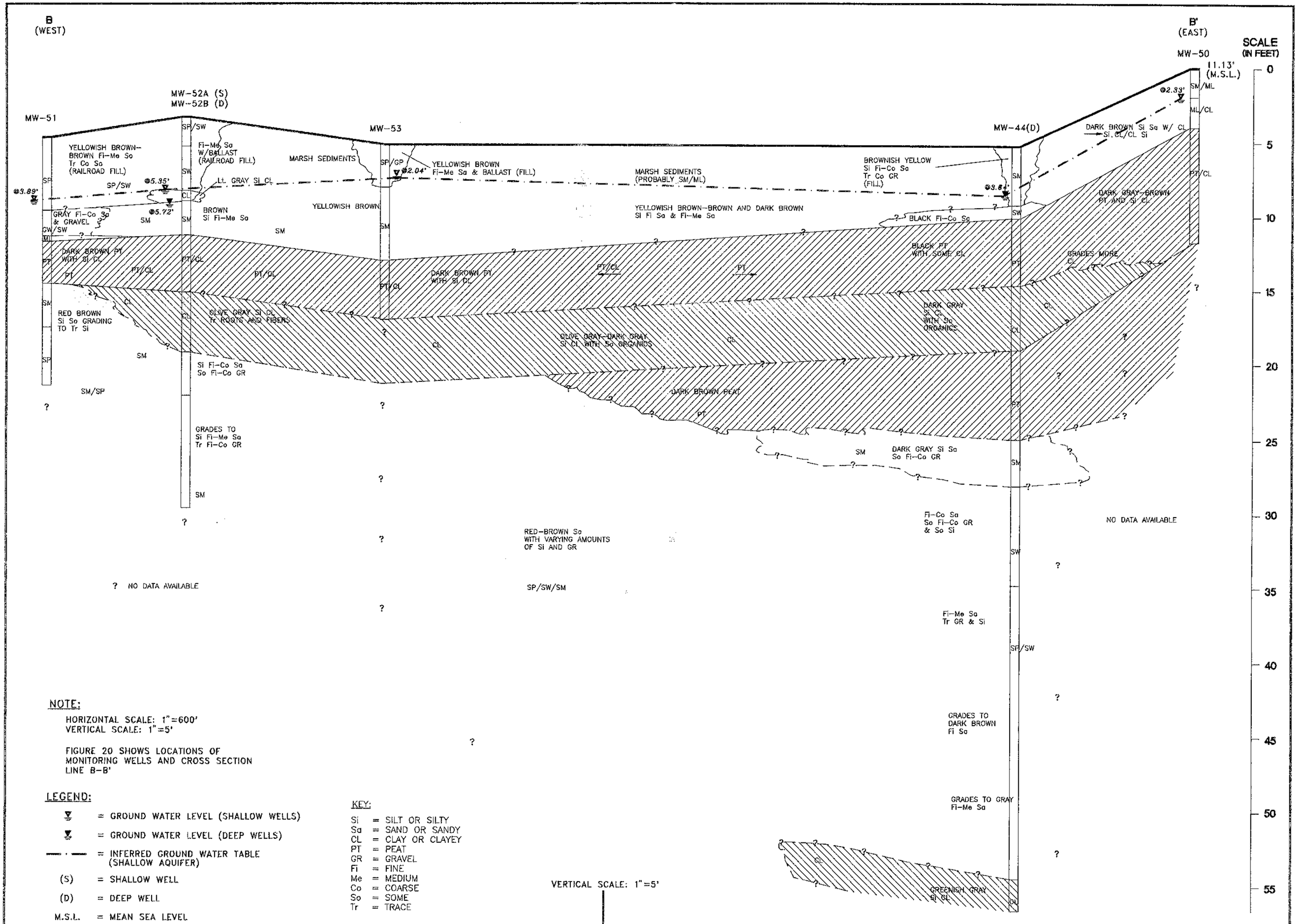
VERTICAL SCALE: 1"=10'

HORIZONTAL SCALE: 1"=600'

RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 21
WEST - EAST CROSS-SECTION A-A'

DWG NO.: 19577014.CR0103 | DAMES & MOORE



NOTE:

HORIZONTAL SCALE: 1"=600'
VERTICAL SCALE: 1"=5'

FIGURE 20 SHOWS LOCATIONS OF MONITORING WELLS AND CROSS SECTION LINE B-B'

LEGEND:

- ▼ = GROUND WATER LEVEL (SHALLOW WELLS)
- ▼ = GROUND WATER LEVEL (DEEP WELLS)
- —·— = INFERRED GROUND WATER TABLE (SHALLOW AQUIFER)
- (S) = SHALLOW WELL
- (D) = DEEP WELL
- M.S.L. = MEAN SEA LEVEL

GROUND WATER LEVELS SHOWN WERE MEASURED 08/14/92

KEY:

- Si = SILT OR SILTY
- Sa = SAND OR SANDY
- CL = CLAY OR CLAYEY
- PT = PEAT
- GR = GRAVEL
- Fi = FINE
- Me = MEDIUM
- Co = COARSE
- So = SOME
- Tr = TRACE

VERTICAL SCALE: 1"=5'

HORIZONTAL SCALE: 1"=600'

RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 22
WEST - EAST CROSS-SECTION B-B'

DWG NO.: 19577014.CR0102 | DAMES & MOORE

NOTE:

HORIZONTAL SCALE: 1"=600'
VERTICAL SCALE: 1"=5'

FIGURE 20 SHOWS LOCATIONS OF MONITORING WELLS AND CROSS SECTION LINE C-C'

LEGEND:

▼ = GROUND WATER LEVEL

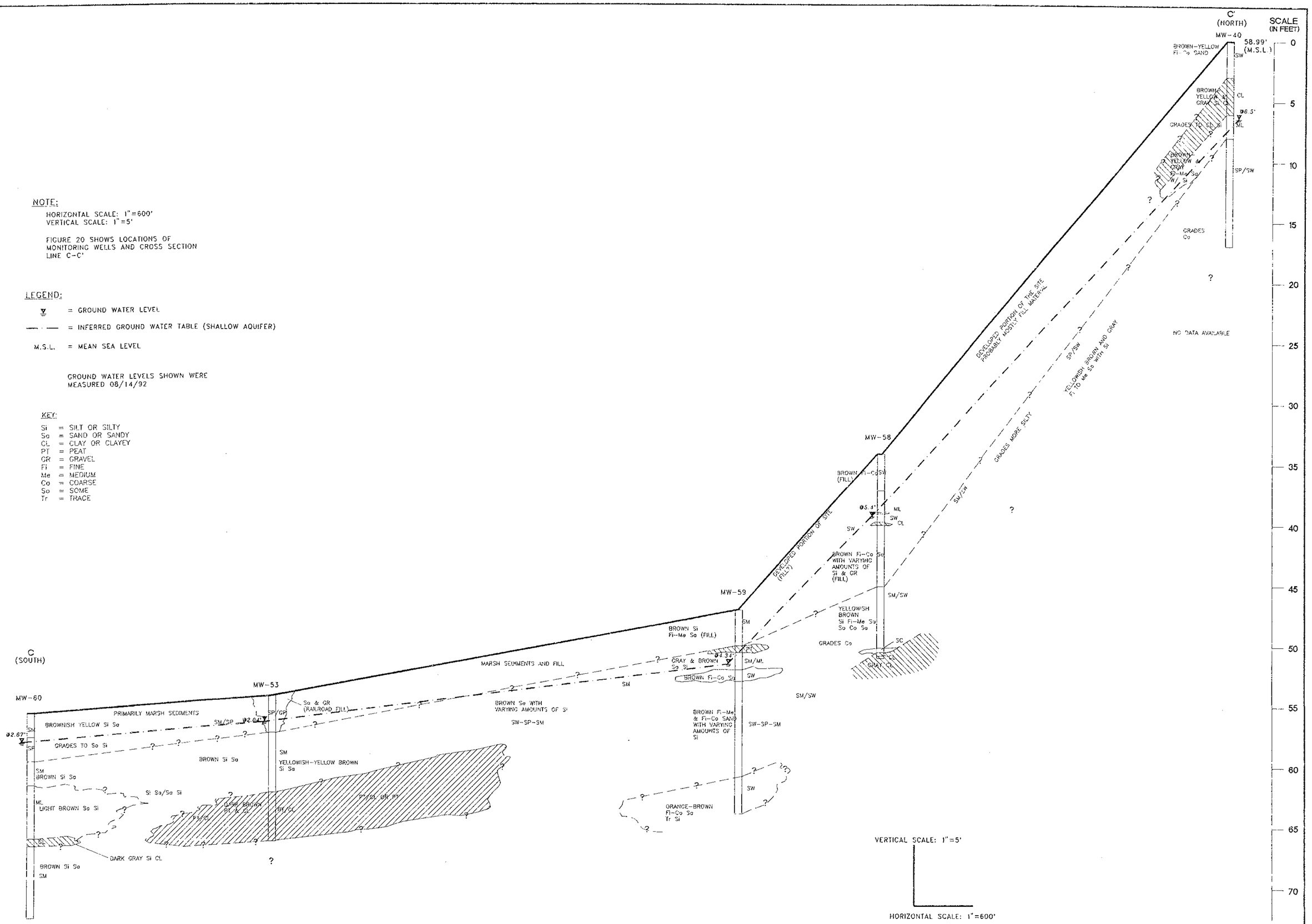
—·— = INFERRED GROUND WATER TABLE (SHALLOW AQUIFER)

M.S.L. = MEAN SEA LEVEL

GROUND WATER LEVELS SHOWN WERE MEASURED 08/14/92

KEY:

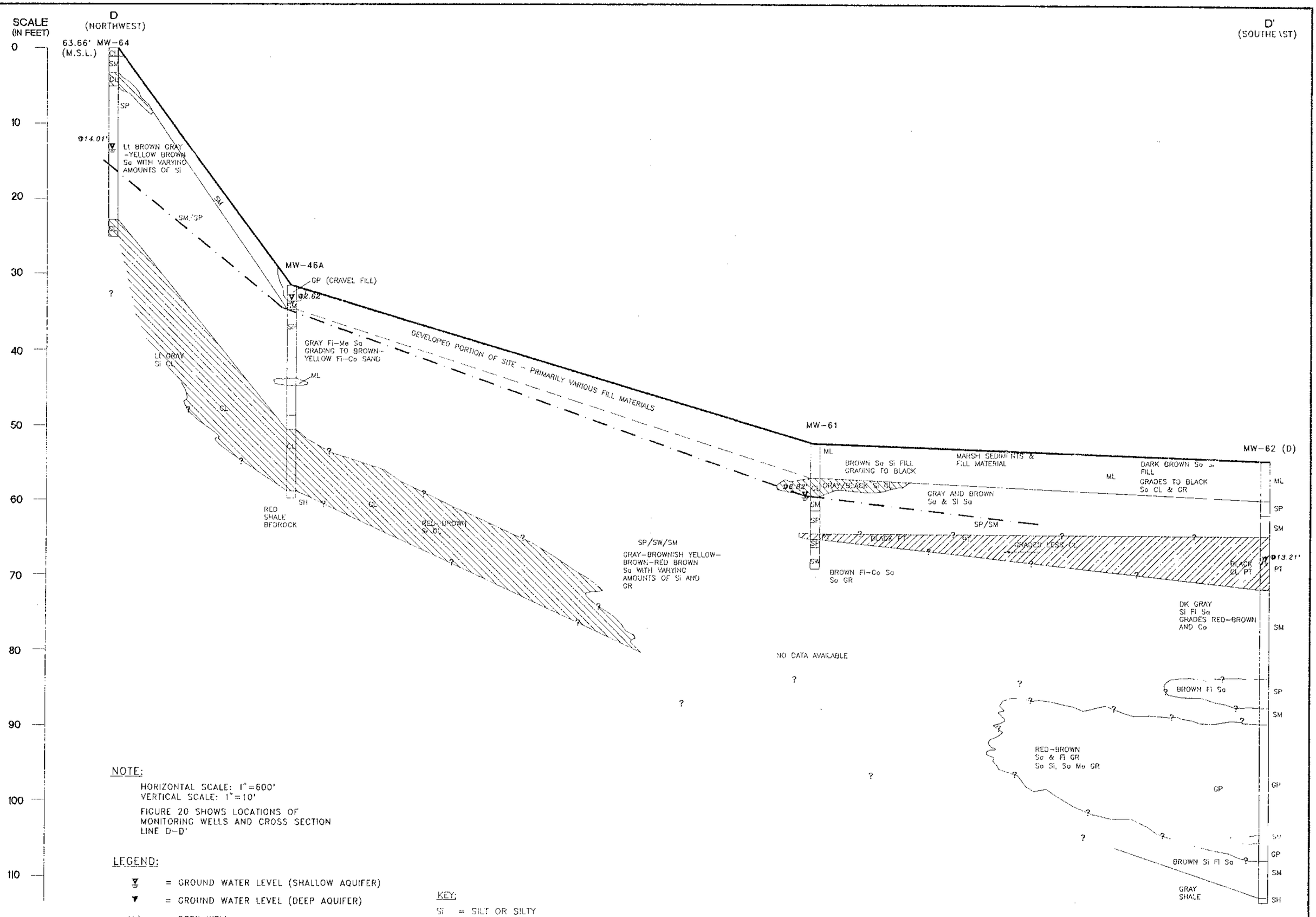
Si = SILT OR SILTY
Sa = SAND OR SANDY
CL = CLAY OR CLAYEY
PT = PEAT
GR = GRAVEL
Fi = FINE
Me = MEDIUM
Co = COARSE
So = SOME
Tr = TRACE



RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 23
SOUTH - NORTH CROSS-SECTION C-C'

DWG NO.: 19577014.CR0105 | DAMES & MOORE



NOTE:

HORIZONTAL SCALE: 1"=600'
VERTICAL SCALE: 1"=10'

FIGURE 20 SHOWS LOCATIONS OF MONITORING WELLS AND CROSS SECTION LINE D-D'

LEGEND:

- ▽ = GROUND WATER LEVEL (SHALLOW AQUIFER)
- ▼ = GROUND WATER LEVEL (DEEP AQUIFER)
- (D) = DEEP WELL
- M.S.L. = MEAN SEA LEVEL
- — · — = INFERRED GROUND WATER TABLE (SHALLOW AQUIFER)

GROUND WATER LEVELS SHOWN WERE MEASURED 08/14/92

KEY:

- Si = SILT OR SILTY
- Sa = SAND OR SANDY
- CL = CLAY OR CLAYEY
- PT = PEAT
- GR = GRAVEL
- Fi = FINE
- Me = MEDIUM
- Co = COARSE
- So = SOME
- Tr = TRACE

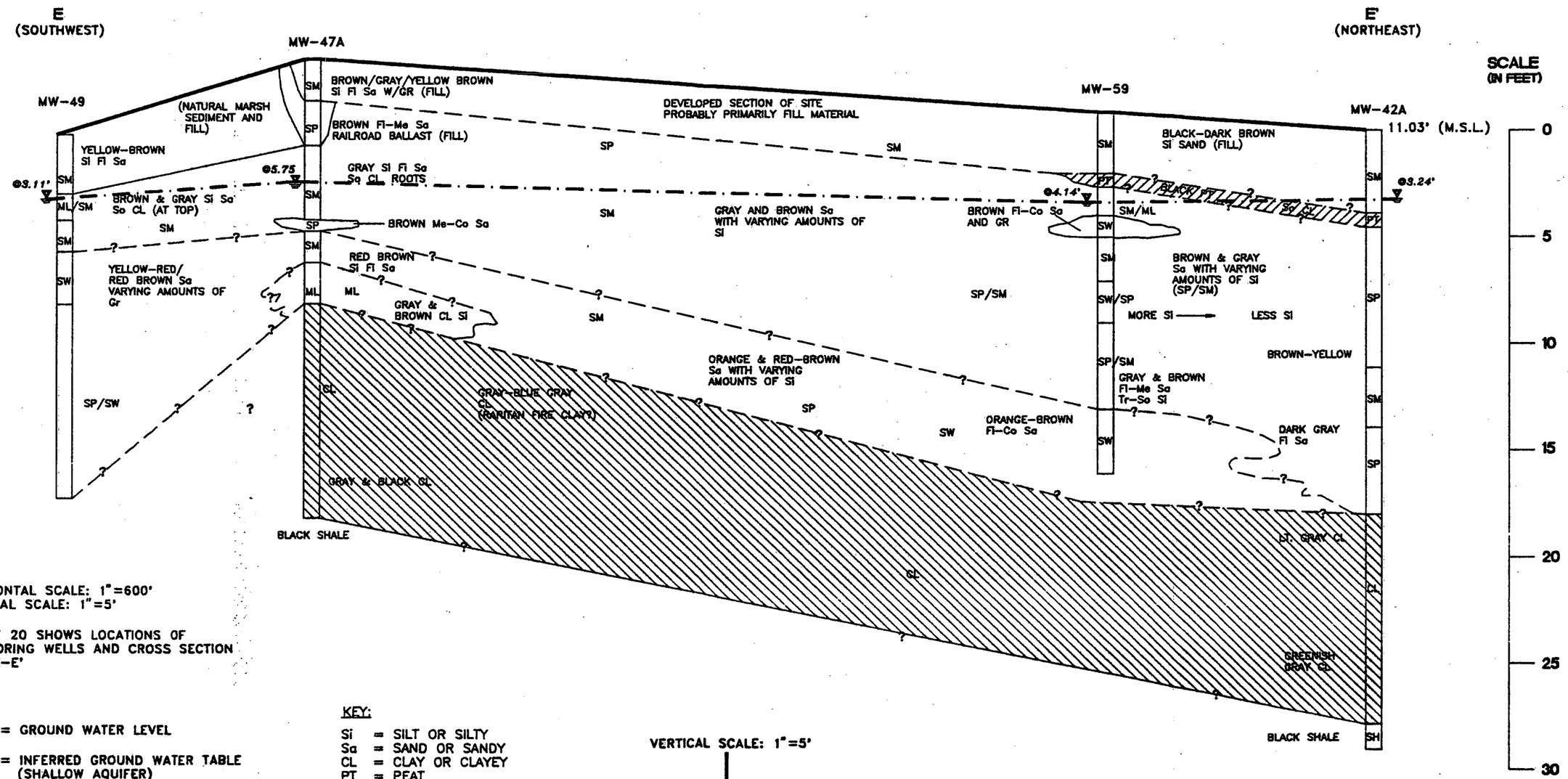
VERTICAL SCALE: 1"=10'

HORIZONTAL SCALE: 1"=600'

RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 24
NORTHWEST - SOUTHEAST
CROSS-SECTION D-D'

DWG NO.: 19577014.CR0104 | DAMES & MOORE



NOTE:

HORIZONTAL SCALE: 1"=600'
VERTICAL SCALE: 1"=5'

FIGURE 20 SHOWS LOCATIONS OF MONITORING WELLS AND CROSS SECTION LINE E-E'

LEGEND:

▼ = GROUND WATER LEVEL

—·— = INFERRED GROUND WATER TABLE (SHALLOW AQUIFER)

M.S.L. = MEAN SEA LEVEL

GROUND WATER LEVELS SHOWN WERE MEASURED 08/14/92

KEY:

Si = SILT OR SILTY
Sa = SAND OR SANDY
CL = CLAY OR CLAYEY
PT = PEAT
GR = GRAVEL
Fi = FINE
Me = MEDIUM
Co = COARSE
So = SOME
Tr = TRACE

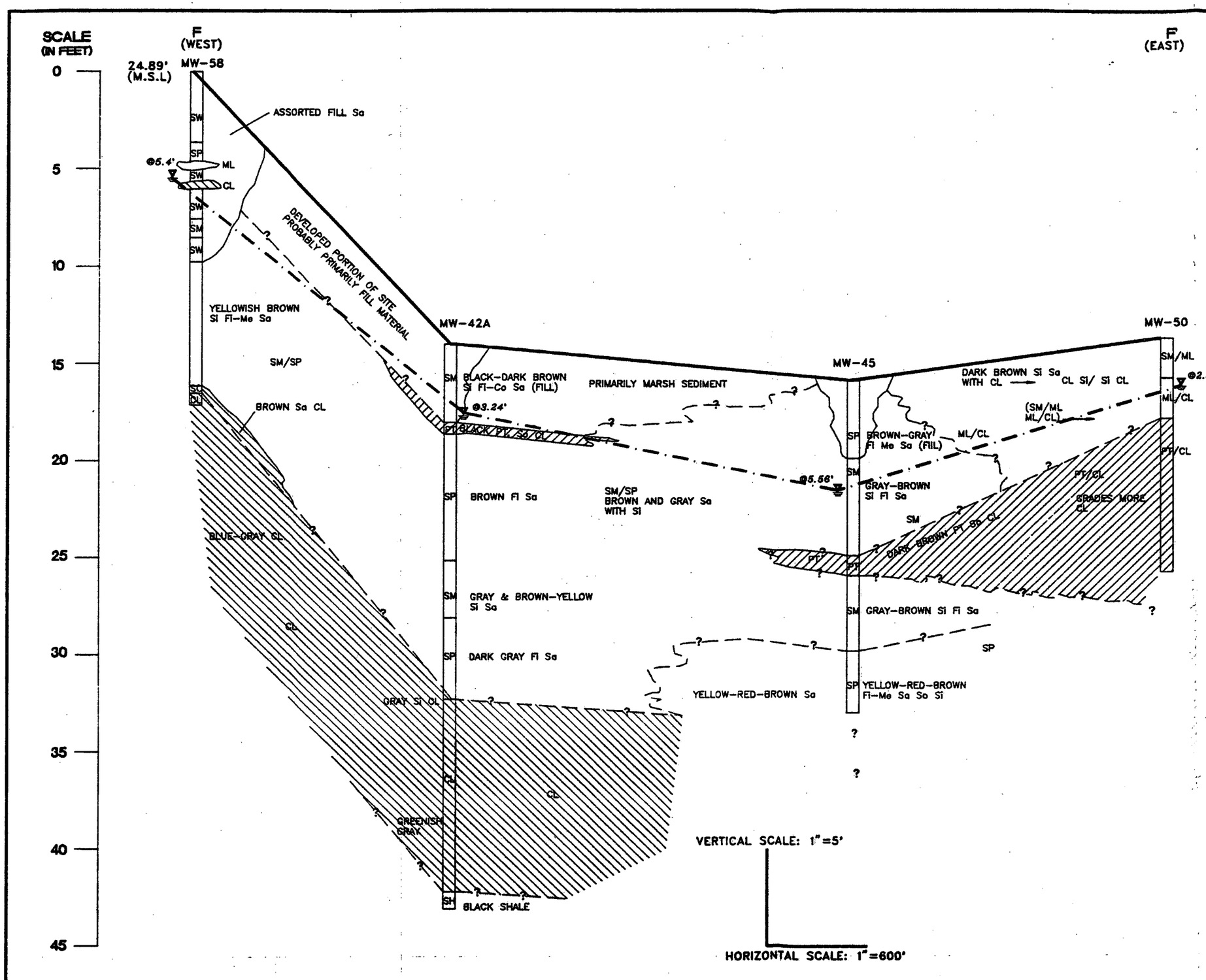
VERTICAL SCALE: 1"=5'

HORIZONTAL SCALE: 1"=600'

RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 25
SOUTHWEST - NORTHEAST
CROSS-SECTION E-E'

DWG NO.: 19577014.CR0101 | DAMES & MOORE



KEY:

Si = SILT OR SILTY
Sa = SAND OR SANDY
CL = CLAY OR CLAYEY
PT = PEAT
GR = GRAVEL
Fi = FINE
Me = MEDIUM
Co = COARSE
So = SOME
Tr = TRACE

NOTE:

HORIZONTAL SCALE: 1"=600'
VERTICAL SCALE: 1"=5'

FIGURE 20 SHOWS LOCATIONS OF MONITORING WELLS AND CROSS SECTION LINE F-F'

LEGEND:

▼ = GROUND WATER LEVEL

—·— = INFERRED GROUND WATER TABLE (SHALLOW AQUIFER)

M.S.L. = MEAN SEA LEVEL

GROUND WATER LEVELS SHOWN WERE MEASURED 08/14/92

RARITAN ARSENAL
EDISON, NEW JERSEY

FIGURE 26
WEST - EAST CROSS-SECTION F-F'

DWG NO.: 19577014.CR0100 | DAMES & MOORE

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE	GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO.4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

SOIL CLASSIFICATION CHART

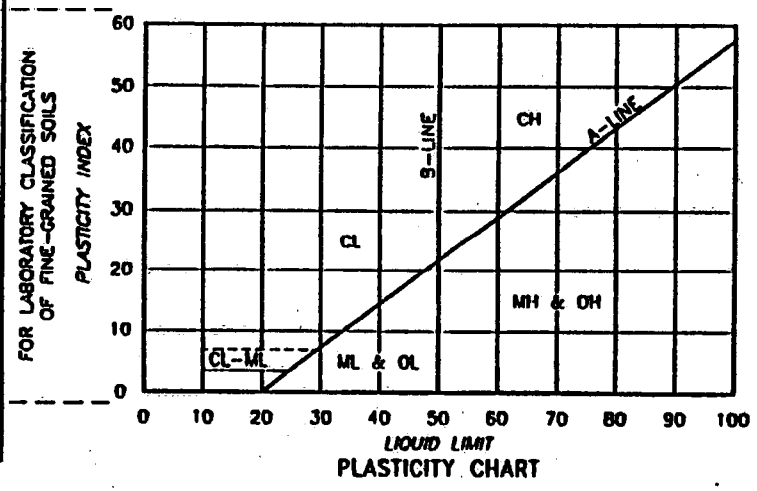
MATERIAL SIZE		PARTICLE SIZE			
		LOWER LIMIT		UPPER LIMIT	
		MILLIMETERS	SIEVE SIZE*	MILLIMETERS	SIEVE SIZE*
SAND	FINE	.074	#200*	0.42	#40*
	MEDIUM	0.42	#40*	2.00	#10*
	COARSE	2.00	#10*	4.76	#4*
GRAVEL	FINE	4.76	#4*	19.1	3/4"*
	COARSE	19.1	3/4"*	76.2	3"*
COBBLES		76.2	3"*	304.8	12"*
BOULDERS		304.8	12"*	914.4	36"

* = U.S. STANDARD • = CLEAR SQUARE OPENINGS

GRADATION CHART

KEY TO SAMPLES:

- THE NUMBER OF BLOWS REQUIRED TO DRIVE THE 3.25" O.D. BY 2.42" I.D. DAMES & MOORE TYPE U SAMPLER 12" OR LENGTH INDICATED WITH A 340 POUND HAMMER FALLING 24".
- 9 ■ DEPTH OF RELATIVELY UNDISTURBED SAMPLE OBTAINED WITH THE DAMES & MOORE SAMPLER.
- ☒ DEPTH OF DISTURBED SAMPLE OBTAINED WITH THE DAMES & MOORE SAMPLER.
- ☐ DEPTH OF SAMPLING ATTEMPT WITH NO RECOVERY USING THE DAMES & MOORE SAMPLER.
- THE NUMBER OF BLOWS REQUIRED TO DRIVE THE 2.0" O.D. BY 1.4" I.D. STANDARD SPLIT SPOON SAMPLER 12" OR LENGTH INDICATED WITH A 140 POUND HAMMER FALLING 30".
- 15 ☑ DEPTH OF DISTURBED SAMPLE OBTAINED WITH THE SPLIT SPOON SAMPLER.
- ☐ DEPTH OF SAMPLING ATTEMPT WITH NO RECOVERY USING THE SPLIT SPOON SAMPLER.



PLASTICITY CHART

NOTES

1. DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE CLASSIFICATIONS OR INTERMIXED STRATA.
2. WHEN USED ON THE BORING LOGS, THE FOLLOWING TERMS ARE USED TO DESCRIBE THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE COMPACTNESS OF COHESIONLESS SOILS:

COHESIVE SOILS (APPROXIMATE SHEARING STRENGTH IN KSF)

VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.5
MEDIUM STIFF	0.5 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	GREATER THAN 4.0

COHESIONLESS SOILS

N = BLOW COUNT = 6-12" + 12-18"

0-5 VERY LOOSE	THESE ARE USUALLY BASED ON AN EXAMINATION OF SOIL SAMPLES, PENETRATION RESISTANCE, AND SOIL DENSITY DATA
6-10 LOOSE	
11-30 MEDIUM DENSE	
31-50 DENSE	
>51 VERY DENSE	

3. WHEN USED ON THE BORING LOGS, THE FOLLOWING TERMS INDICATE THE PERCENTAGES OF THE MINOR SOIL COMPONENTS: SOME: 10 TO 20% TRACE: 0 TO 10%
4. ELEVATIONS REFER TO MEAN SEA LEVEL (MSL).

PLATE A-2

UNIFIED SOIL CLASSIFICATION SYSTEM AND KEY TO LOG OF BORINGS

DAMES & MOORE