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Final Report

Contaminated Ground Water Study

Marine Corps Base Camp LeJeune, N.C. Hadnot Point Area

Contract No. N62470-86-C-8740

Naval Facilities Engineering Command
Norfolk, Virginia

December 1988

O'BRIEN & GERE

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MARINE CORPS BASE

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HADNOT POINT AREA

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NAVAL FACILITIES ENGINEERING COMMAND

NORFOLK, VIRGINIA

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SECTION 1 - INTRODUCTION

1.01 Site Description

Marine Corps Base (MCB) Camp Lejeune is located in Onslow County, North Carolina (Figure 1). The facility has a roughly triangular outline and covers approximately 170 square miles. Eleven miles of Atlantic shoreline form the eastern boundary of Camp Lejeune. The western and northeastern boundaries are U.S. Rt. 17 and State Rt. 24, respectively. The town of Jacksonville, North Carolina is the northern boundary of the base (ESE, 1985).

Construction of MCB Camp Lejeune began in 1941, at the Hadnot Point area, where major functions were centered. As the facility grew and developed, Hadnot Point became crowded with maintenance and industrial activities (Water and Air Research, 1983). The general Hadnot Point area is illustrated on Figure 2.

The Hadnot Point Fuel Farm (HPFF), the specific area of this hydrogeologic investigation, is located approximately 1200 feet to the southeast of Holcombe Boulevard, adjacent to Ash Street as depicted on Figure 1. The HPFF was constructed in about 1941 and consists of 15 fuel storage tanks. There is one (1) above ground 600,000 gallon tank (Tank 10), six underground (6) 12,000 gallon tanks (Tanks 2, 3, 7, 8 11, 12), and eight underground (8) 15,000 gallon tanks (Tanks 1, 4, 5, 6, 9, 13, 14, and 15). All tanks except the 600,000 gallon tank were originally placed at grade and completely covered with soil. The existing tanks are the original tanks that were installed in about 1941. The large 600,000 gallon tank contains diesel fuel, the other tanks contain leaded gasoline, unleaded gasoline and kerosene.

The area surrounding the tank farm is relatively flat, with the soil covered tank farm forming a topographic mound that extends approximately 10 feet above the surrounding grade. It is a highly developed area of the base. The natural drainage has been modified by extensive areas of asphalt and concrete, and by ditches and storm sewers. The surface water body in nearest proximity to the tank farm is Beaverdam Creek, located approximately 2000 feet east of the Tank Farm. Beaverdam Creek drains into Wallace Creek, which discharges into New River as shown on Figure 1.

1.02 Background Purpose and Scope

Previous investigations have indicated that leaks may have occurred in the fuel lines and tanks within the HPFF (Water and Air Research, 1983) and that dissolved fuel constituents and/or a floating product layer may exist within the shallow ground water in the vicinity of the tank farm (ESE, 1988).

The characterization Step Report for Hadnot Point Industrial Area (HPIA) prepared by ESE in 1988 summarizes the results of the Verification Step Study conducted by ESE in 1985 and presents the findings of the Characterization Step Study. The study efforts encompassed the entire HPIA, a portion of which focused specifically on the HPFF. These investigations identified the presence of volatile organic compounds (VOC's) within both the shallow aquifer at the tank farm and a single deep supply well located approximately 1200 to the northwest of the HPFF. Specifically, shallow ground water samples were found to contain elevated levels of fuel-derived compounds such as benzene, ethylbenzene, toluene, and lead.

O'Brien & Gere Engineers was retained to provide the follow-up hydrogeologic services necessary to investigate the hydrogeology and evaluate the extent of fuel leakage from the underground storage tanks and associated transfer lines at the HPFF, as indicated by the previous studies.

The purpose of this Investigation Report is to present the information that has been gathered during the hydrogeologic investigation regarding the presence of any product pool or soluble hydrocarbons in the ground water in the vicinity of Hadnot Point area. A site investigation was completed which included monitoring well installations, product thickness measurements, and ground water sampling and analysis. This report presents a summary of the hydrogeologic conditions at the site and an assessment of the petroleum hydrocarbon occurrence, as well as recommendations for further investigations and site remediation.

SECTION 2 - HISTORY OF FUEL LOSSES

2.01 History of Fuel Losses

Available information regarding the history of fuel losses and leakage areas was reviewed in order to identify potential areas of petroleum product accumulation. The areas of investigation included the age of the tanks, locations of known losses, inventory records, and types and volumes of fuel losses. A summary of fuel losses is given in Table 1, and the fuel loss locations are shown on Figure 3.

As stated in Section 1.01, the tanks were installed in about 1941. The other information about the history of fuel losses at the HPFF is summarized in the Preliminary Report.

Review of this information indicates that between 23,150 gallons and 33,150 gallons of fuel product have been lost from the tank farm. In addition, there have been two recorded episodes of fuel loss where the amounts lost were unknown; in another case, the amount lost was not noticeable in inventory.

Of the 23,150-33,150 gallons of known lost product, 3,150 gallons were unleaded fuel. The 20,000-30,000 gallon loss that occurred in 1979 was comprised of unknown amounts of diesel and unleaded fuel; regular fuel may also have been lost. Of the two instances where unknown amounts of fuel were lost, one was diesel fuel and the other was unleaded fuel.

Inventory records do not reveal any known fuel losses from leakage of the tanks; most of the losses have likely occurred through leaks in the transfer lines or through leaks in transfer line valves.

SECTION 3 - FIELD INVESTIGATIONS

3.01 Monitoring Well Installations

A total of twenty (20) ground water monitoring wells were installed in the vicinity of the HPFF from February to March, 1988 by ATEC Associates, Inc. of Raleigh, NC, under the supervision of an O'Brien & Gere Engineers, Inc. hydrogeologist. The locations of the monitoring wells were based upon consideration of the hydrogeologic conditions and the assessment of petroleum leakage in the study area. The placement of the wells, as illustrated in Figure 4, was selected to provide a preliminary assessment of the extent of any product pool, and to confirm the previously evaluated hydrogeologic conditions. The locations for the initial ten (10) 2 inch inside diameter (I.D.) wells were selected to provide a preliminary assessment of the extent of the petroleum hydrocarbons. Based upon field evaluation of this preliminary data, locations for five (5) additional 2 inch I.D. monitoring wells, and five (5) 4 inch I.D. monitoring wells were selected. The criteria for the selection of additional well locations included estimated ground water flow directions, geologic conditions, observations of any encountered petroleum product, and soil sample screening (discussed below).

During the drilling program, the boreholes were advanced using conventional hollow stem auger drilling methods. Samples of the subsurface materials were collected at a minimum of every five feet or as directed by the supervising hydrogeologist, using ASTM method D-1586 for split barrel sampling.

Each soil sample was screened in the field using a photoionization organic vapor detector to identify the presence of any petroleum product within the soils. The field screening provided a preliminary assessment of the vertical and horizontal extent of petroleum hydrocarbons. These data were used, in conjunction with the other criteria discussed above, to select the optimum locations of the other monitoring wells during the drilling program. The locations of the five (5) 4 inch I.D. wells were selected to serve as potential product and/or ground water recovery wells. All wells were installed and constructed in accordance with applicable North Carolina, Federal and NAVFAC specifications and guidelines following the attached monitoring well installation procedures (Appendix A).

Wells MW-1 and MW-2 are 17 feet deep, with the screened interval extending from 7 to 17 feet below the ground surface. Wells MW-3 through MW-10 are 15 feet deep with the screened interval extending from 5 to 15 feet below the ground surface. Due to the thickness of product found in MW-2 and MW-7, it was decided to increase the depth of the remaining wells to 25 feet in order to intersect the entire thickness of any floating product layer. Wells MW-11 through MW-20 were 25 feet deep with the screened interval extending from 5 to 25 feet. Boring logs containing detailed descriptions of the subsurface conditions and well construction diagrams were prepared for each well location and are included in Appendices B and C, respectively.

All equipment used in the drilling and well installation program that came in contact with potentially contaminated materials was decontaminated using high pressure steam cleaning equipment. The water source for the steam cleaner was a potable water supply designed by navy personnel. The fluid generated by the decontamination procedures was either discharged onto the ground surface or collected in an oil/water separator used by Marine and Navy personnel for cleaning tactical military equipment.

3.02 Ground Water Elevation and Product Thickness Monitoring

Ground water elevations and product thickness measurements were collected from all of the wells on two separate occasions. One set of measurements was collected on March 15, 1988, prior to well development. A second complete set of measurements was collected on April 20, 1988. An electronic oil/water interface tape was used to measure the depths to the product layer and ground water. In wells where no product layer was detected using the oil/water interface tape, a clean Lexan® bailer was utilized to visually examine the surface of the ground water to determine the presence of any product sheen. Table 2 summarizes the ground water elevation data and well specifications, and Table 3 summarizes the product thickness data.

3.03 Engineering Survey

An engineering survey was completed at the site on April 19, 1988 to establish horizontal locations and elevations of each of the monitoring wells. The locations of the wells were surveyed to the nearest foot and were plotted on a 1" = 200' scale map provided by the Marine Corps Base Facilities Department (Figure 4). The elevations at the wells were surveyed to the nearest 0.01 foot relative to an established USGS Benchmark datum. The well elevation data is included in Table 2.

3.04 Ground Water Sampling and Analysis

A ground water sample was collected from each of the monitoring wells on April 20-21, 1988 according to the attached protocols (Appendix D). The wells that contained a product layer were evacuated and sampled using a Waterra Hand Pump^{R} system, which consists of a Delrin^{R} (high density plastic, similar to Teflon^{R}) foot valve connected to a length of polypropylene tubing. The pumping action is based on the inertia of the water in the tubing created by the up and down movement of a hand crank attached to the tubing. The advantage of this system is its simplicity as well as its ability to sample the water below the product layer without agitating the sample or exposing the sample to air before it is placed into the sample container. The wells without a product layer were sampled using a clean, stainless steel bailer. The ground water samples were analyzed by OBG Laboratories, Inc. of Syracuse, NY for volatile organic compounds (VOC's) using EPA Methods 601 and 602. One field blank and one replicate sample were also analyzed for VOC's for QA/QC controls.

In addition, product samples were collected from five of the six wells that contained a measurable product layer. These samples were analyzed using a Gas Chromatograph/Flame Ionization Detector (GC/FID) scan for petroleum hydrocarbon identification. Product samples were collected from the following wells: MW-2, MW-7, MW-12, MW-16, and MW-18. The laboratory analyses are summarized on Tables 4 and 5.

SECTION 4 - HYDROGEOLOGIC ASSESSMENT

4.01 Regional Hydrogeology

4.01.1 Regional Geologic Conditions

Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The Coastal Plain is underlain by unconsolidated deposits. The formations consist mostly of sand and clay with minor amounts of gravel. Some beds of marl and shell rock are reported. Regionally, these deposits dip gently southeastward in a thickening wedge that overlies the underlying bedrock (Todd, 1983).

The surficial deposits of the Coastal Plain are mostly permeable, unconsolidated sand and gravel. These surficial deposits, together with the updip parts of deeper aquifers, constitute the unconfined (water table) aquifer of the Coastal Plain. The water table aquifer can be vulnerable, both to saline encroachment and to surface pollutants, due to the permeable nature of the sediments (Todd, 1983).

A sequence of unconsolidated sedimentary deposits approximately 1400 to 1700 feet thick exists beneath Camp Lejeune. The following discussion of the site geology will be restricted to the uppermost 300 feet of the sequence, since these strata contain the aquifers which are the source of fresh water for the base. These deposits are comprised of unconsolidated and semiconsolidated materials (NCDNR & CD, 1980, Water and Air Research, 1983).

At the top of the sequence, undifferentiated Pleistocene and Recent sands and clays form the most seaward band of sediments.

These deposits can reach a thickness of 35 feet (NCDNR & CD, 1980, Water and Air Research, 1983).

The Yorktown Formation, of Pliocene age, underlies the Pleistocene and Recent deposits, outcropping in a bank east and south of Jacksonville. This unit consists of lenses of sand, clay, mark, and limestone; it can reach a thickness of 60 feet (NCDNR & CD, 1980, Water and Air Research, 1983).

An unnamed formation of Oligocene age underlies the Yorktown Formation. These sediments consist of fossiliferous limestone, calcareous sand, and clay. The Oligocene deposits vary in thickness from approximately 40 feet to more than 200 feet (NCDNR & CD, 1980, Water and Air Research, 1983).

The Castle Hayne Limestone, of Eocene age, unconformably underlies the Oligocene deposits. This unit consists of shell limestone, marl, calcareous sand, and clay. In Onslow County, the Castle Hayne varies in thickness from 100 feet to more than 200 feet (NCDNR & CD, 1980, Water and Air Research, 1983).

4.01.2 Regional Ground Water Flow Patterns

Some of the formations in the Coastal Plain are permeable and have been defined as aquifers. Most of these formations are of wide areal extent. Hydraulic connections between aquifers is common through the complex interbedding that is characteristic of Coastal Plain sediments. Most of the aquifers are not separate and independent hydrogeologic units; rather, each is part of a complex hydrologic system. This system may even include streams and lakes where the aquifers are at or near the land surface (Ref. 4).

The aquifer system at Camp Lejeune consists of an unconfined (water table) aquifer and a semi-confined aquifer. The water table aquifer extends from the land surface to the first significant confining bed that is encountered (NCDNR & CD, 1980, Water and Air Research, 1983).

The semi-confined aquifer is composed of limestone and calcareous sands of the Yorktown Formation, the Oligocene deposits, and the Castle Hayne Limestone. The confining beds that form the bottom of the water table aquifer and that are present in the semi-confined aquifer consist of clay, sandy clay, silty clay, and occasionally dense limestone. These beds are discontinuous lenses and may be present at any depth (NCDNR & CD, 1980, Water and Air Research, 1983).

4.02 Site Hydrogeology

4.02.1 Site Geologic Conditions

The discussion of the site geology will be limited to the uppermost 25 feet of the unconsolidated soils, which is the maximum depth of the subsurface investigation for this project. The primary soils encountered during the investigation were fine and medium sands, mixed with lesser amounts of silt. Discontinuous, trace amounts of fine gravel were noted in the silty sand mixtures throughout the site. Clay stringers were found consistently throughout the silty sand mixtures with an occasional thin layer of clay (up to 2 feet thick). Minor amounts of naturally occurring organic materials, including organic silts and clays, peat, wood fragments, and plant debris were found in several of the borings, including MW-11, 13, 14 and 20, indicating the presence of a former coastal marshland. Up to 4 feet of miscellaneous fill material was found in borings that were adjacent to buildings and developed roads.

4.02.2 Site Ground Water Flow Patterns

Figure 5 shows the ground water elevations in the twenty monitoring wells at the site on April 20, 1988. Because the presence of a floating product layer tends to depress the water table, due to hydrostatic pressure, the ground water elevations in the wells containing a product layer were corrected to give elevations that would be representative of the aquifer without the effects of the floating product layer. The calculation used to correct the ground water elevations takes into consideration the thickness of the product layer, the densities of the product and ground water, and the soil properties (CONCAWE, 1979). The correction factor is represented by the formula:

$E_c = E + (0.82 \times T)$, where

E_c = Corrected ground water elevation:

E = Elevation of the ground water under the influence of the product layer; and

T = Product thickness

Tables 2 and 3 have been complied summarizing the corrected and actual ground water elevations and the product thickness data, respectively.

Due to the extreme variability of the product thickness (see Table 3) and the complex interbedded nature of the soils at the site, the ground water gradient in the immediate vicinity of the HPFF cannot be interpreted from the available data. The average regional ground water gradient with in the HPIA has been interpreted to be approximately 0.20 feet per foot (ft/ft). Ground water movement in the shallow aquifer in this area is generally toward the southwest, towards the New River (ESE, 1988). The varying product thicknesses cause differential depression of the ground water throughout the study area. Measurements of free product in the wells have inherent inaccuracies due to fluctuations in the water table (CONCAWE, 1979). Other factors that affect the actual and corrected ground water elevations include the geologic conditions at the site, the complete assemblage of underground utilities shown on Figure 3, and the mounding of soils over the tanks. The presence of discontinuous lenses of clay and silty clay can cause localized semi-confined conditions in the unconfined aquifer, as well as localized perched water table conditions.

SECTION 5 - PETROLEUM HYDROCARBON ASSESSMENT

5.01 Free-Phased Product

Free-phased product was detected floating on the ground water in six of the monitoring wells installed at the site, including MW-2, 7, 12, 15, 16, and 18. The product thickness data is summarized in Table 3. The thickness of the floating layer ranged from 0.24 feet in MW-15 to 15.34 feet in MW-16 on April 20, 1988. None of the other monitoring wells contained measurable product layers or visible sheens. The measured thickness of product in the well may represent approximately four times the actual thickness of the free-floating product on the ground water surface due to the accumulation of product within the open well casing (CONCAWE, 1979). The actual thickness of the floating product layer on the water table is estimated to range from approximately 0.06 feet to 3.84 feet. The product thickness data collected on April 20, 1988 is illustrated on Figure 6. It is apparent from the data collected to date that two separate product pools are present in the vicinity of the HPFF. One pool extends toward the northwest from the northwestern portion of the fuel farm, while the other pool exists at the southeastern edge of the fuel farm oriented on a northeast/southwest axis. The product pool northwest of the fuel farm is smaller in area, but thicker than the more widespread, thinner pool to the southeast. This indicates that the product pool on the southeastern edge of the fuel farm has been there longer and has had more time to spread out.

Product samples were collected from MW-2, MW-7, MW-12, MW-16, and MW-18 on April 20, 1988. These samples were shipped to OBG Laboratories in Syracuse, NY for analysis using a Gas Chromatograph/

Flame Ionization Detector (GC/FID) scan for petroleum hydrocarbon identification. The laboratory analyses identified the product as gasoline for all five of the monitoring wells sampled.

5.02 Soluble Constituents

The ground water samples collected from the wells on April 20-21, 1988 were shipped to OBG Laboratories for analysis for petroleum hydrocarbons and solvents using the purge and trap/GC method. The analytical results are summarized in Table 5, and the laboratory reports are included in Appendix E. Figures 7 and 8 illustrate the iso-concentration contours of the benzene and total hydrocarbon concentrations, respectively.

Table 5 and Figures 7 and 8 indicate that the ground water analyses are consistent with the location of the product pools. The most significant concentrations of benzene and total hydrocarbons (THC) were found in the wells containing product and those adjacent to the product pool. The wells containing product had benzene concentrations of 4,700 parts per billion (ppb) to 29,000 ppb. Wells not containing product had concentrations of benzene ranging from 1 ppb in MW-9 to 19,000 ppb in MW-1. Total hydrocarbon concentrations ranged from 43,000 ppb to 300,000 ppb in wells contained product, and from 10 ppb to 97,000 ppb in wells not containing product. Other compounds found within the ground water include toluene, ethyl benzene, xylenes, and methyl tertiary butyl ethylene (MTBE). The concentrations of the individual compounds at each well are detailed in Table 5.

The size, shape, and axial orientation of the benzene and total hydrocarbon plumes identified at the HPFF coincide closely with the product pools. It is apparent that the source of the benzene, toluene, and xylenes (BTX) and total hydrocarbons in the ground water is the free-phased gasoline floating on the ground water as indicated on Figure 6. The limits of the benzene concentrations are defined in MW-9, MW-3, and MW-4 on the southeast side of the fuel farm, by MW-5 and MW-11 to the northwest and MW-13 to the northeast. These wells were below the EPA Maximum Contaminant Limit (MCL) of 5 ppb for benzene in drinking water (CFR, 1987). The limits of benzene concentrations above the EPA MCL are undefined in those areas denoted by a dashed line on Figure 7. The limits of the total hydrocarbon concentrations (i.e. 100 ppb) are defined by MW-9 to the south of the fuel farm, MW-4 on the east side, MW-13 to the north, and MW-5, 8, 11, and 14 on the west side of the fuel farm. The concentrations of total hydrocarbons above the 100 ppb level are undefined in those areas denoted by a dashed line on Figure 8.

The benzene and total hydrocarbons were considered to be the most significant compounds in the ground water at the HPFF, therefore, their concentrations were illustrated using equal-concentration contour maps (Figures 7 and 8). The distribution of the other compounds found in the ground water at the site is consistent with the benzene and total hydrocarbon concentrations, and iso-concentration contour maps would illustrate similar trends. Benzene, as well as toluene, ethylbenzene, and xylenes are components of gasoline, and indicate contamination by gasoline. MTBE is an additive to gasoline, and also indicates contamination by gasoline.

Only trace levels of chlorinated solvents not associated with petroleum hydrocarbons were detected within the ground water, including 1 ppb of trichloroethylene (TCE) in MW-20, and 4 ppb of tetrachloroethylene (PERC) in MW-3. However, higher levels of these compounds as well as other chlorinated solvents were detected within the shallow ground water in the other areas of the HPIA (ESE, 1988).

SECTION 6 - REMEDIAL ALTERNATIVES

Based on the results of the hydrogeologic investigation, the following remedial alternatives are presented for the Navy's consideration.

Leak Source Detection - Product inventory records should be assembled and a risk assessment for the tanks should be conducted to identify the potential sources of petroleum product loss. Following this assessment an integrity testing program could be initiated for these tanks and lines that are found to have a high potential for leakage. However, due to the high cost ($400,000) of replacing the valves and conducting this testing (ESE 1988), the MCB has decided that this testing is not cost effective.

Tank Removal - Based on the high probability of the tanks leaking due to their age (47 years), removal of the leaking underground tanks may be considered to discontinue the source of petroleum hydrocarbons detected within the ground water. The tanks should be removed in accordance with the National Fire Protection Association (NFPA) and federal, state and local underground storage tank regulations.

Soil Remediation - Following the tank removal all contaminated soils should be remediated to the depth of ground water. Alternative methods for soil remediation may include one or more of the following: soil removal and off-site disposal, soil removal and on-site aeration, in-situ vacuum extraction, and in-situ biodegradation. The selected method will be based upon the extent of soil contamination.

Installation of Product Recovery System - A product recovery system should be installed to effectively remove the free phase product floating on the ground water surface. In addition, the recovery system should remove petroleum hydrocarbon constituents (i.e. benzene, toluene, xylene) that are dissolved within the ground water. The system designed for removal of the dissolved petroleum hydrocarbons should also be designed for removal of the chlorinated solvents detected in the vicinity of the tank farm. Based on the hydrogeologic conditions at the site (high permeability materials, gentle gradient, localized plume configuration), it appears that a recovery well system is the most cost effective method for product recovery.

Additional field investigations are needed to determine the size and number of product recovery wells that would be necessary for a product recovery system. Installation of additional monitoring wells is necessary in order to fully define the extent of the containment plume. In addition, six inch diameter test wells should be installed, and pump tests should be performed to determine the zone of capture, as well as anticipated flow rates for the product recovery and ground water treatment system. These test wells can be converted into recovery wells. The existing wells, including ground water monitoring wells installed by ESE, Inc., will be utilized to the extent possible in the development of the necessary data for the design of a recovery system.

SECTION 7 - CONCLUSIONS AND RECOMMENDATIONS

7.01 Conclusions

The following conclusions were drawn from the data collected during the field investigation and subsequent data evaluation:

1. Fuel losses of gasoline have likely occurred predominantly through leaks in the transfer lines or valves.
2. As a result of the fuel losses, two product pools have accumulated in the areas indicated on Figure 6.
3. The geology of the site consists primarily of silty sand, with occasional discontinuous clay layers and stringers.
4. The ground water flow conditions are locally influenced by the presence of the product pool combined with the presence of discontinuous clay layers, numerous underground utilities, and the mound of soil above the tank farm. No localized gradients were delineated, however, the regional gradient is approximately 0.20 ft/ft, with flow to the southwest toward the New River.
5. The free-phased product layer floating on the ground water has been identified as gasoline.
6. The ground water analyses indicate that the floating product layer has contributed significant levels of dissolved petroleum compounds including benzene, toluene xylene, and ethylbenzene into the ground water.
7. Benzene was detected at concentrations exceeding the EPA's Maximum Contaminant Level for drinking water of 5 parts per billion.

8. Although the benzene plume has been characterized in the immediate vicinity of the tank farm, the extent of the benzene plume has not been fully defined to a resolution of 5 ppb, which represent the Maximum Contaminant Limit established by the EPA.

9. Trace levels of non-petroleum, volatile organic compounds (VOCs) including trichloroethylene and tetrachloroethylene have been detected at levels less than 5 parts per billion within the fuel farm. Previous investigations indicate the presence of elevated levels of VOC's in other areas of the Hadnot Point Industrial Area.

7.02 Recommendations

Based on the conclusions stated above, we have developed the following recommendations for the tanks. We have structured the recommendations into three basic categories. The first category includes Leak/Source detector alternatives to help identify which of the tanks may be acting as sources. The second category includes Soil/Ground water remediation for those tanks which are identified as potential sources. The third category is primarily hydrogeologic recommendations which will serve to further identify the extent of the existing plume, and an ultimate remedial scheme. This last category should be implemented as soon as possible, preferably concurrent with the activities of the first two categories.

A. Leak Source Detection Alternatives:

1. Assemble product inventory records for each tank. Reconcile product inventory stored versus usage for each tank.

Reconciliation records should indicate which tanks may be leaking and a gross leakage rate.

2. Initiate storage tank management program to provide for the systematic removal of the leaking storage tanks while providing temporary petroleum storage in the non-leaking tanks until a total replacement program could be undertaken.

3. As an alternate to the program identified above, the Navy could undertake a systematic complete tank removal and replacement program. All 14 underground gasoline tanks and associated piping would be removed and replaced (as required) with new tanks and piping having secondary containment.

B. <u>Soil/Ground Water Remediation</u>

1. Following tank removal activities, all contaminated soil above the water table should be remediated. Initially, a soil sampling program should be conducted to delineate the vertical and horizontal extent of soil contamination. Based on the extent of soil contamination, one of the following remedial alternatives should be implemented; in-situ biodegradation, in-situ vacuum extraction, excavation with off-site disposal, excavation with on-site disposal.

2. Localized product recovery (vacuum truck, sorbents, etc.) to remove the free-phase product floating on ground water surface. Unrecovered product and miscible contaminants would be recovered in the site wide remedial program described in the hydrogeologic recommendations below.

C. Hydrogeologic Recommendations

1. It is recommended that up to ten (10) additional ground water monitoring wells be installed to define the benzene plume boundaries to the EPA Maximum Contaminant Level of five part per billion.

2. Two test wells should be installed, one within each of the product pools identified in the vicinity of the tank farm. Soil samples from the monitoring wells should be analyzed for grain size distribution to design the well screen of the test wells. These test wells can be converted into product recovery wells.

3. Following installation of the test wells, an 8-hour pump test should be conducted on each test well to determine the hydraulic characteristics of the aquifer such as hydraulic conductivity, transmissivity and well yield. This data will be utilized to determine design conditions for the product recovery system such as: well yield, well diameter, water level drawdown, and influent/effluent concentrations of dissolved petroleum hydrocarbons (i.e. benzene, toluene, xylene).

4. Following the pump tests, design drawings and specifications should be prepared for a product recovery system following the installation of the test wells and the pump testing of the wells.

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5. "Protection of Ground Water from Oil Pollution," Conservation of Clean Air and Water - Europe (CONCAWE), Report No. 3, 1979.

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Tables

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TABLE 1

HISTORY OF FUEL LOSSES
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

Location*	Date	Fuel Type	Amount of Loss	Notes
1	4/83	diesel	not noticeable in inventory	line leak (pinhole)
2	(1983)	diesel	unknown	surface seepage
3	3/82	unleaded	unknown	line leak (broken, repaired on same day)
4	1/86	unleaded	1,038 gallons	- - -
5	3/85	unleaded	1,618 gallons	valve leaks
6	(1979)	diesel, unleaded, possibly regular	20,000 - 30,000 gallons	line leak
-	8/87	unleaded	47 gallons	noticed in inventory
-	9/87	unleaded	447 gallons	noticed in inventory

* Locations correspond to Figure 3.

Table 2
Well Specifications and Ground Water Elevation Data
Hadnot Point Fuel Farm
Camp Lejeune, NC

Well Number	Ground Elev. (ft.)	Casing Elev. (ft.)	Well Depth (ft.)	Corrected Ground Water Elevations* 3/15/88	4/20/88
MW-1	28.3	30.00	17.0	19.38	19.41
MW-2	30.0	31.68	17.0	18.41	18.53
MW-3	29.0	29.23	15.0	19.72	19.83
MW-4	29.8	31.61	15.0	21.69	21.73
MW-5	28.5	28.54	15.0	21.45	21.25
MW-6	27.8	29.95	15.0	19.26	19.20
MW-7	27.7	27.68	15.0	N/A	20.54
MW-8	26.6	26.35	15.0	20.12	20.18
MW-9	28.8	30.73	15.0	18.78	18.75
MW-10	28.1	28.01	15.0	18.26	18.42
MW-11	26.5	28.52	25.0	19.49	18.63
MW-12	26.9	28.62	25.0	20.47	19.36
MW-13	28.8	30.56	25.0	20.94	20.87
MW-14	27.7	27.87	25.0	19.72	20.05
MW-15	28.3	30.13	25.0	20.22	19.71
MW-16	28.4	30.33	25.0	18.67	18.74
MW-17	29.5	31.70	25.0	19.25	18.97
MW-18	29.9	31.80	25.0	18.68	18.86
MW-19	29.4	31.99	25.0	18.72	18.45
MW-20	26.8	31.01	25.0	20.84	19.65

*Corrected ground water elevations =
ground water elevation + (0.82 x product thickness).
N/A = Data not available.

Table 3
Product Thickness Data
Hadnot Point Fuel Farm
Camp Lejeune, NC

Well Number	3/15/88	4/20/88
MW-1	----	----
MW-2	2.97	3.17
MW-3	----	----
MW-4	----	----
MW-5	----	----
MW-6	----	----
MW-7	N/A	0.35
MW-8	----	----
MW-9	----	----
MW-10	----	----
MW-11	----	----
MW-12	4.33	9.81
MW-13	----	----
MW-14	----	----
MW-15	0.86	0.24
MW-16	14.85	15.34
MW-17	----	----
MW-18	4.59	5.10
MW-19	----	----
MW-20	----	----

N/A = Data not available.
---- = No product layer detected.

Table 4

Product Sample Analisis
Hadnot Point Fuel Farm
Camp Lejeune,NC

Well Number	Product Identification
MW-2	Gasoline
MW-7	Gasoline
MW-12	Gasoline
MW-16	Gasoline
MW-18	Gasoline

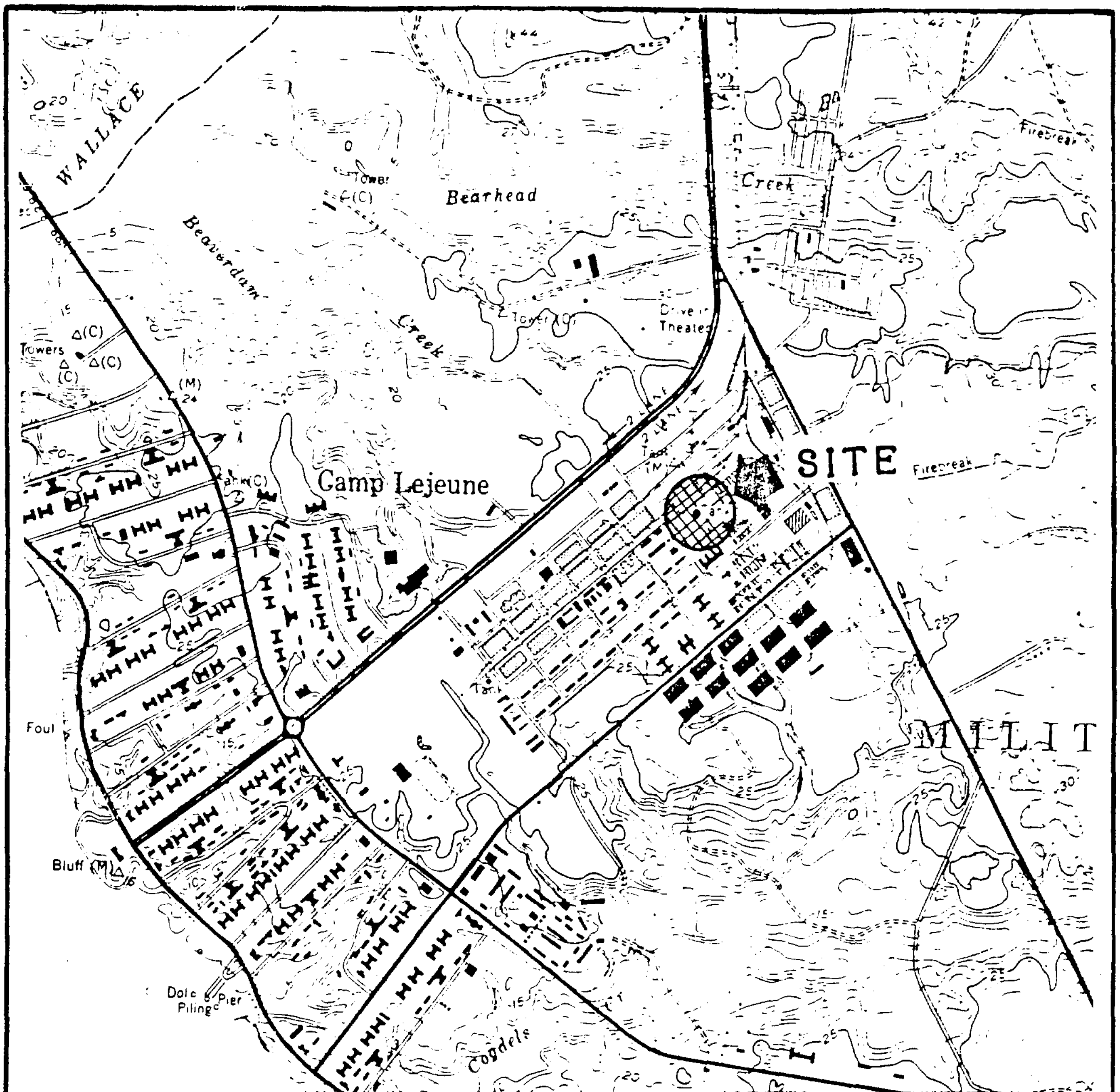
Table 5
Ground Water Sample Analysis
Hadnot Point Fuel Farm
Camp Lejeune, NC

Well No.	Date	BEN (ppb)	TOL (ppb)	EBEN (ppb)	XYL (ppb)	TCE (ppb)	PERC (ppb)	MTBE (ppb)	THC (ppb)
MW-1	4/20/88	19000	36000	3200	21000	<1000	<1000	<10000	97000
MW-2	4/21/88	29000	110000	11000	48000	<1000	<1000	<10000	300000
MW-3	4/20/88	<1	2	<1	4	<1	4	<10	480
MW-4	4/20/88	<1	<1	<1	2	<1	<1	<10	16
MW-5	4/20/88	<1	1	<1	2	<1	<1	<10	<10
MW-6	4/20/88	600	1700	1600	7100	<100	<100	<1000	13000
MW-7	4/21/88	28000	26000	2800	12000	<1000	<1000	<10000	68000
MW-8	4/20/88	19	1	<1	<1	<1	<1	<10	26
MW-9	4/20/88	<1	<1	2	8	<1	<1	<10	92
MW-10	4/20/88	51	1	9	14	<1	<1	<10	170
MW-11	4/20/88	1	1	<1	1	<1	<1	<10	<10
MW-12	4/21/88	19000	17000	1500	8400	<1000	<1000	<10000	50000
MW-13	4/20/88	2	2	2	8	<1	<1	<10	23
MW-14	4/20/88	6	<1	<1	2	<1	<1	<10	11
MW-15	4/21/88	4700	18000	2400	13000	<1000	<1000	<10000	43000
MW-16	4/21/88	28000	28000	1900	12000	<1000	<1000	<10000	79000
MW-17	4/21/88	11000	13000	2500	9100	<100	<100	2800	42000
MW-18	4/21/88	24000	42000	1900	12000	<1000	<1000	<10000	96000
MW-19	4/21/88	21	150	53	130	<1	<1	<10	640
MW-20	4/21/88	60	160	79	96	1	<1	<10	870

LEGEND: BEN - Benzene
TOL - Toluene
EBEN - Ethylbenzene
XYL - Xylenes
TCE - Trichloroethene
PERC - Tetrachloroethene
MTBE - MTBE
THC - Total Hydrocarbons

Figures

O'BRIEN & GERE



N
MN
5 1/2°

SITE LOCATION MAP

ADAPTED FROM USGS. 7.5 MIN. CAMP LEJEUNE, NC. QUADRANGLE
(1952 PHOTOREVISED 1971)

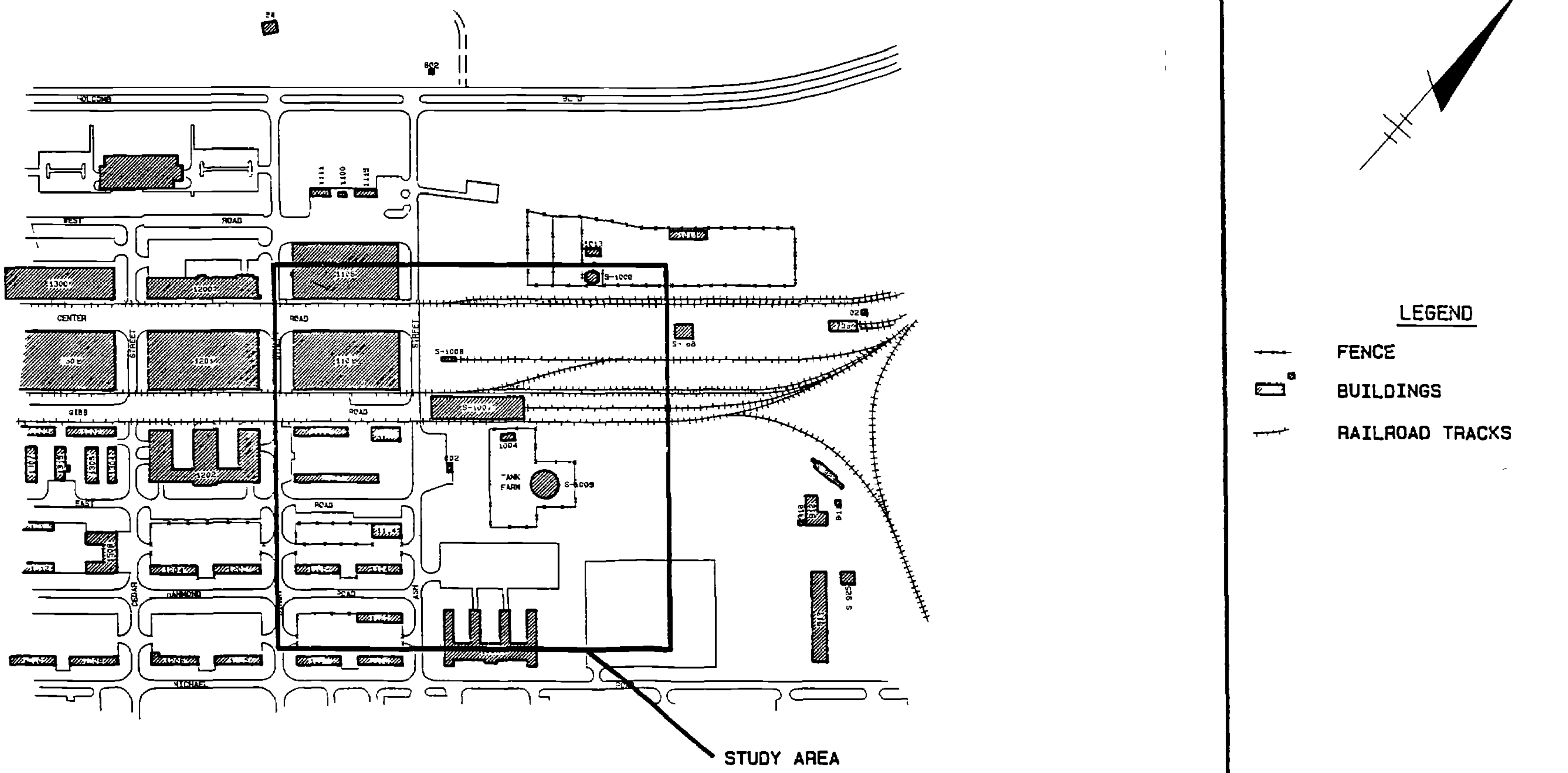
SCALE 1" = 2000'
CONTOUR INTERVAL 5'

2000 0 2000 4000
1" = 200'

FIGURE 2

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N.C.

HADNOT POINT
INDUSTRIAL AREA

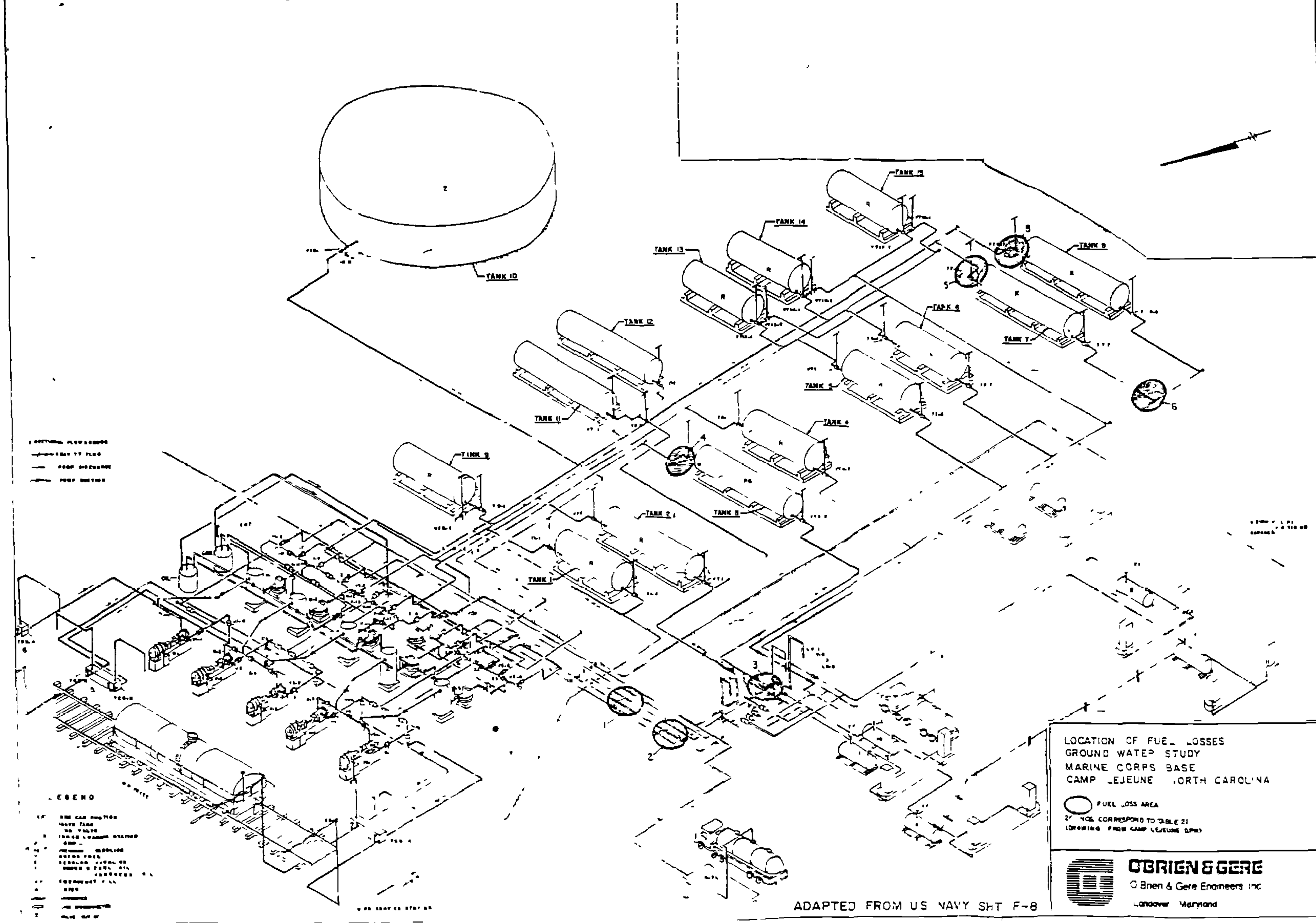


O'BRIEN & GERE ENGINEERS

00417F012

TANK TABLE

TANK 1 4 5 6, 9 13 14 & 15	15 000 GAL. EACH	TOTAL	120,000 GAL. STORAGE (REGULAR)
TANK 2, 11, 12	12,000 GAL. EACH	TOTAL	36,000 GAL. STORAGE (REGULAR)
TANK 3	12,000 GAL. EACH	TOTAL	12,000 GAL. STORAGE (PREMIUM GASOLINE)
TANK 7, 8	12,000 GAL. EACH	TOTAL	24,000 GAL. STORAGE (KEROSENE NO. 1)
TANK 10	600,000 GAL. EACH	TOTAL	600,000 GAL. STORAGE (FUEL OIL 2)



LOCATION OF FUEL LOSSES
GROUND WATER STUDY
MARINE CORPS BASE
CAMP LEJEUNE NORTH CAROLINA

FUEL LOSS AREA

NOS. CORRESPOND TO TABLE 21
(DRAWING FROM CAMP LEJEUNE DPW)

ADAPTED FROM US NAVY SHT F-8

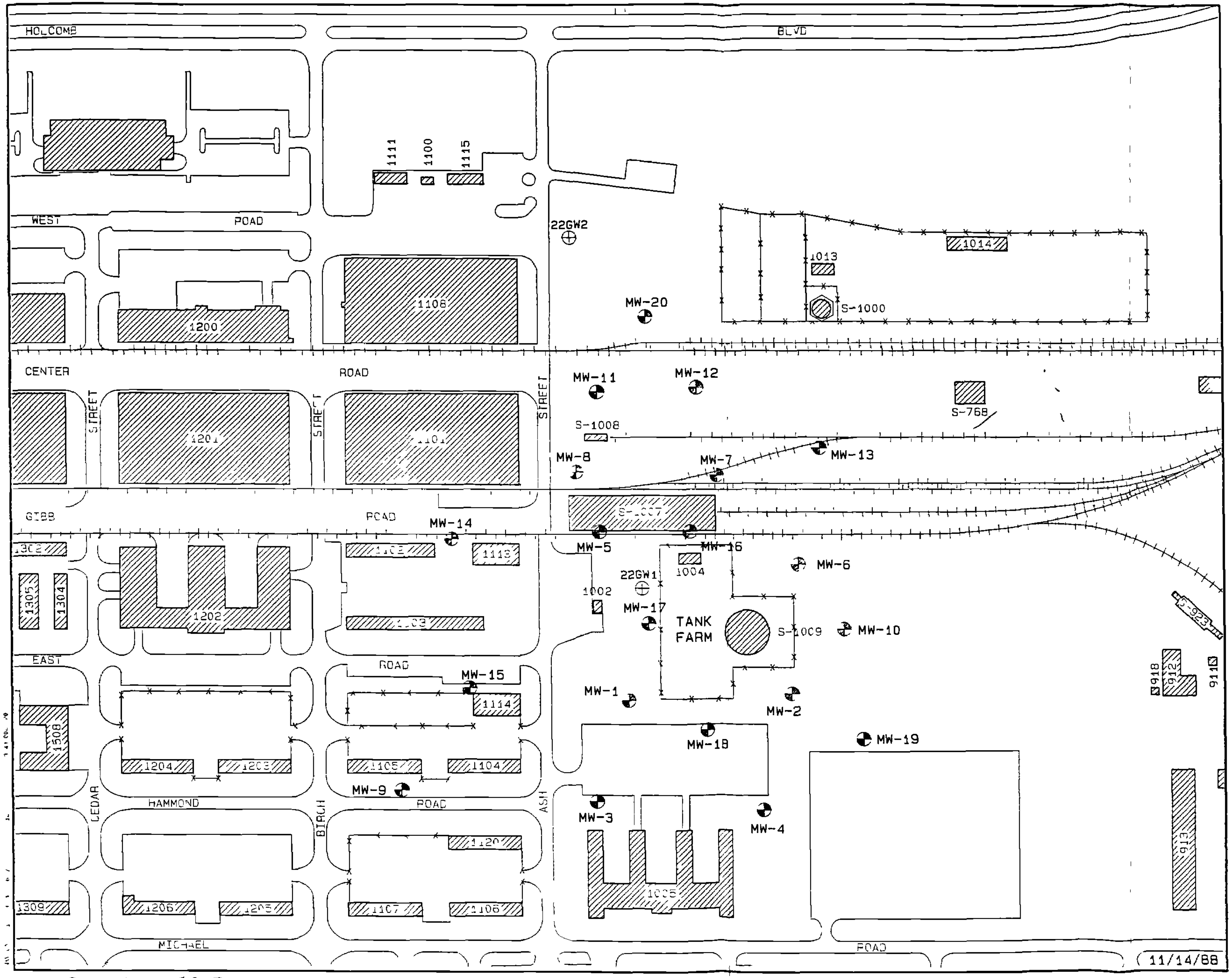
OBRIEN & GERE
O'Brien & Gere Engineers Inc
Landover Maryland

00417F022

FIGURE 4

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N C

SITE PLAN



LEGEND

MONITORING WELL

ESE, INC MONITORING WELL

0 200 400

HORIZ SCALE IN FEET

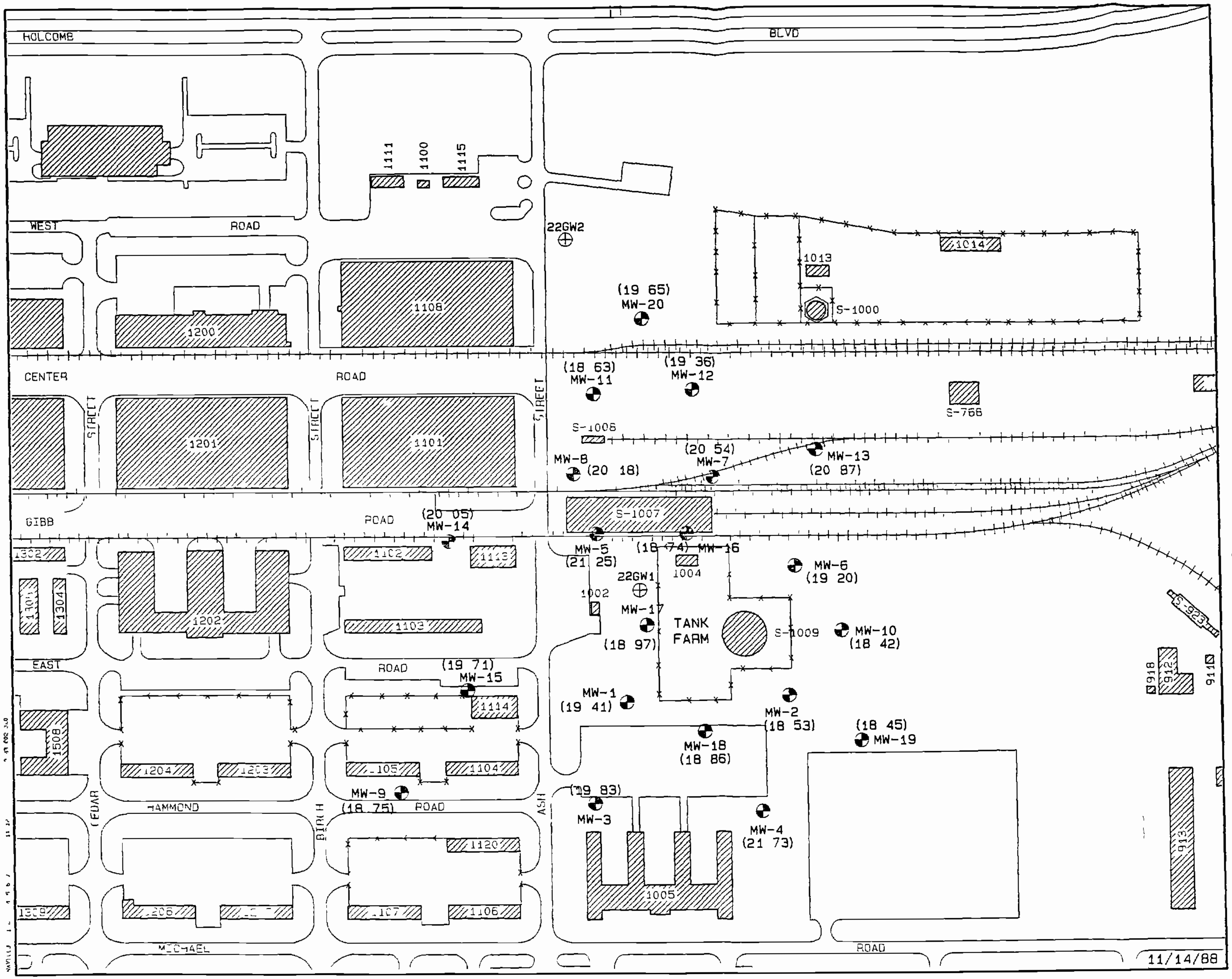
O'BRIEN & GERE
ENGINEERS INC
Syracuse, New York

00417F03Z

FIGURE 5

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N C

CORRECTED GROUND WATER ELEVATIONS 4/20/88



LEGEND

- MONITORING WELL
- ESE, INC MONITORING WELL
- (19 65) GROUND WATER ELEVATION IN FEET ABOVE MSL

0 200 400

HORIZ. SCALE IN FEET

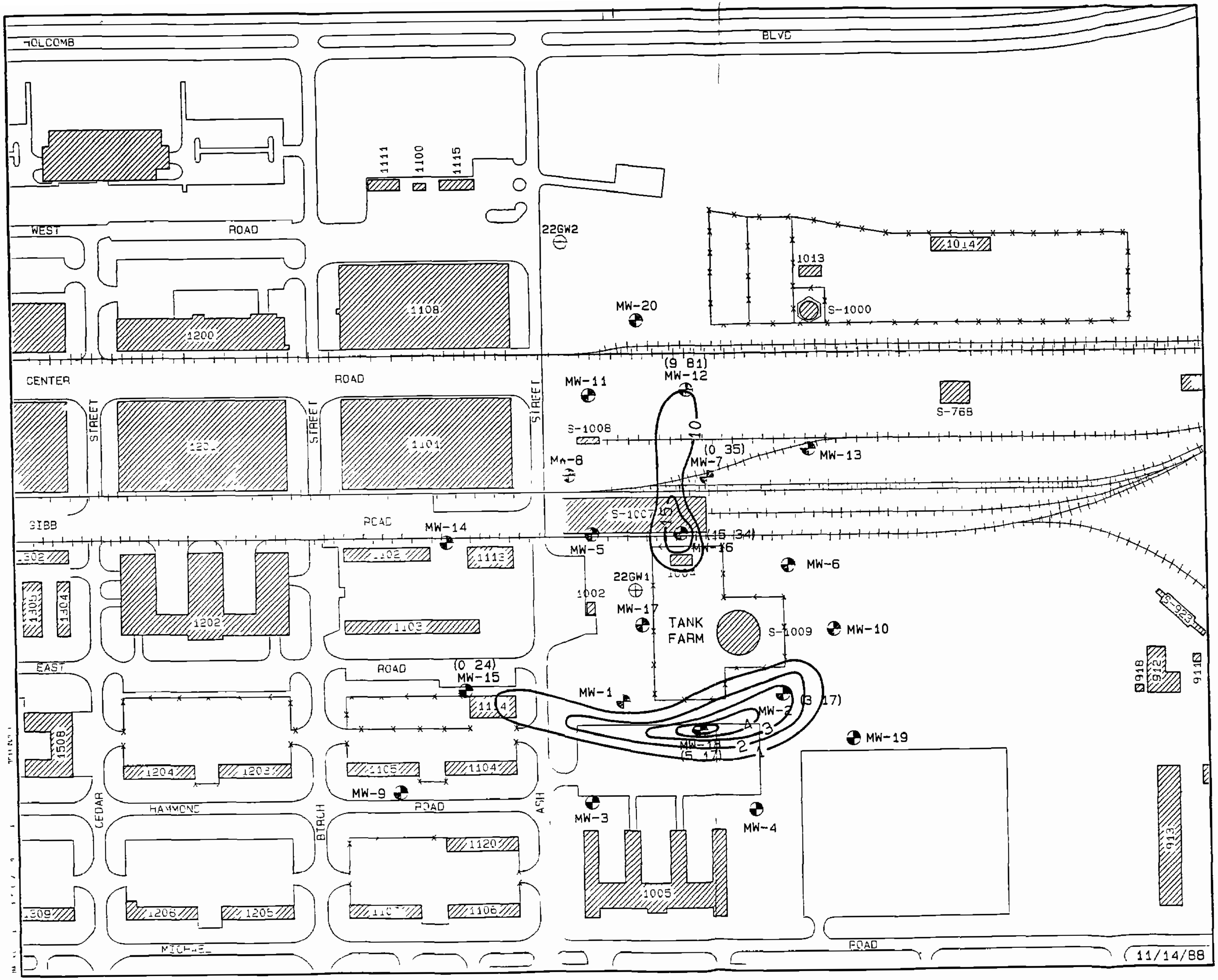
O'BRIEN & GERE ENGINEERS INC
Syracuse, New York

00417F042

FIGURE 6

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N C

PRODUCT THICKNESS
4/20/88



LEGEND

MONITORING WELL

ESE, INC MONITORING WELL

PRODUCT THICKNESS CONTOUR (FEET)

0 200 400

HORIZ SCALE IN FEET

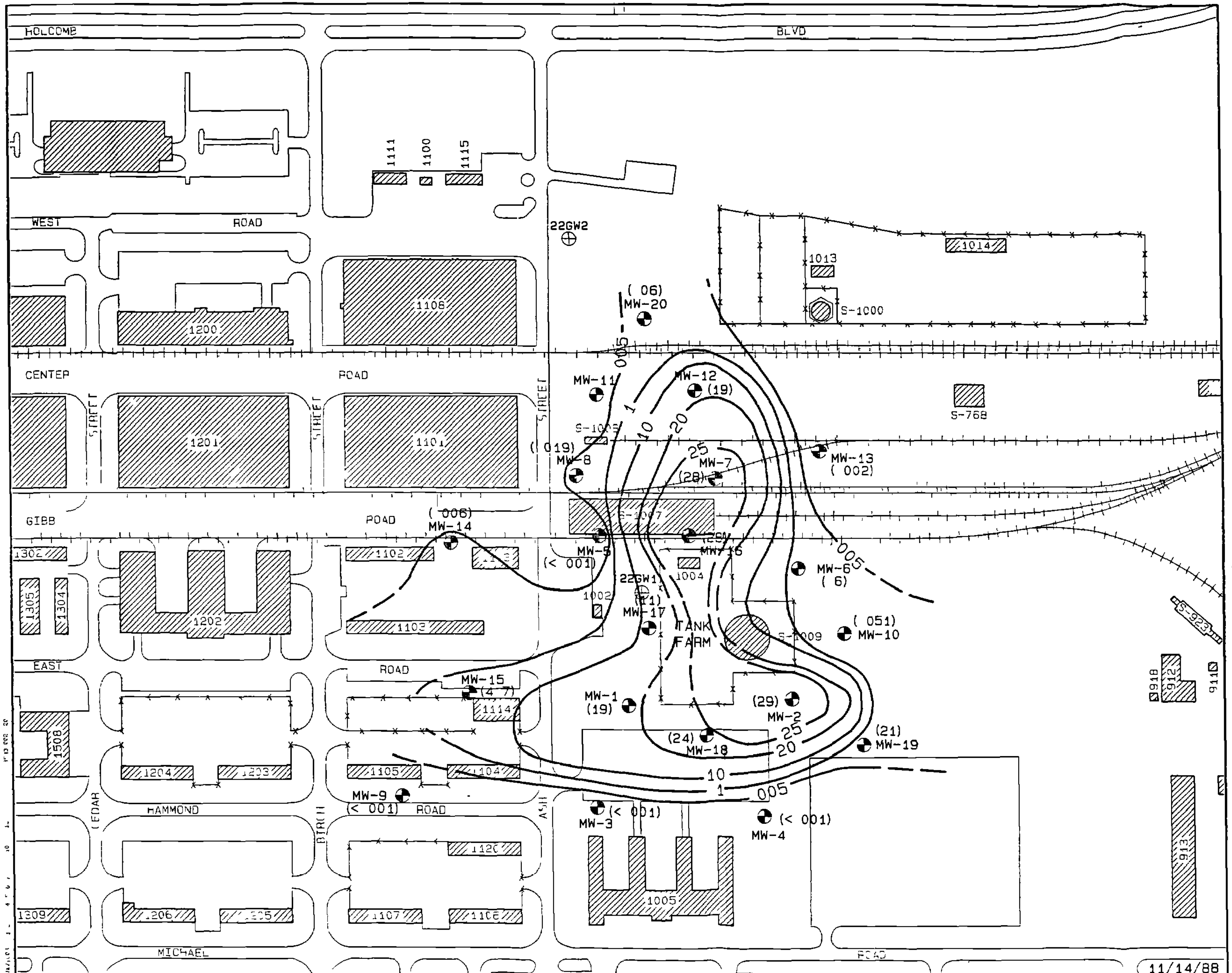
O'BRIEN & GERE ENGINEERS INC

00417F05Z

FIGURE 7

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N C

BENZENE CONCENTRATIONS
4/20/88 TO 4/21/88



LEGEND

MONITORING WELL

ESE, INC MONITORING WELL

BENZENE CONCENTRATION CONTOUR (PPM)

0 200 400

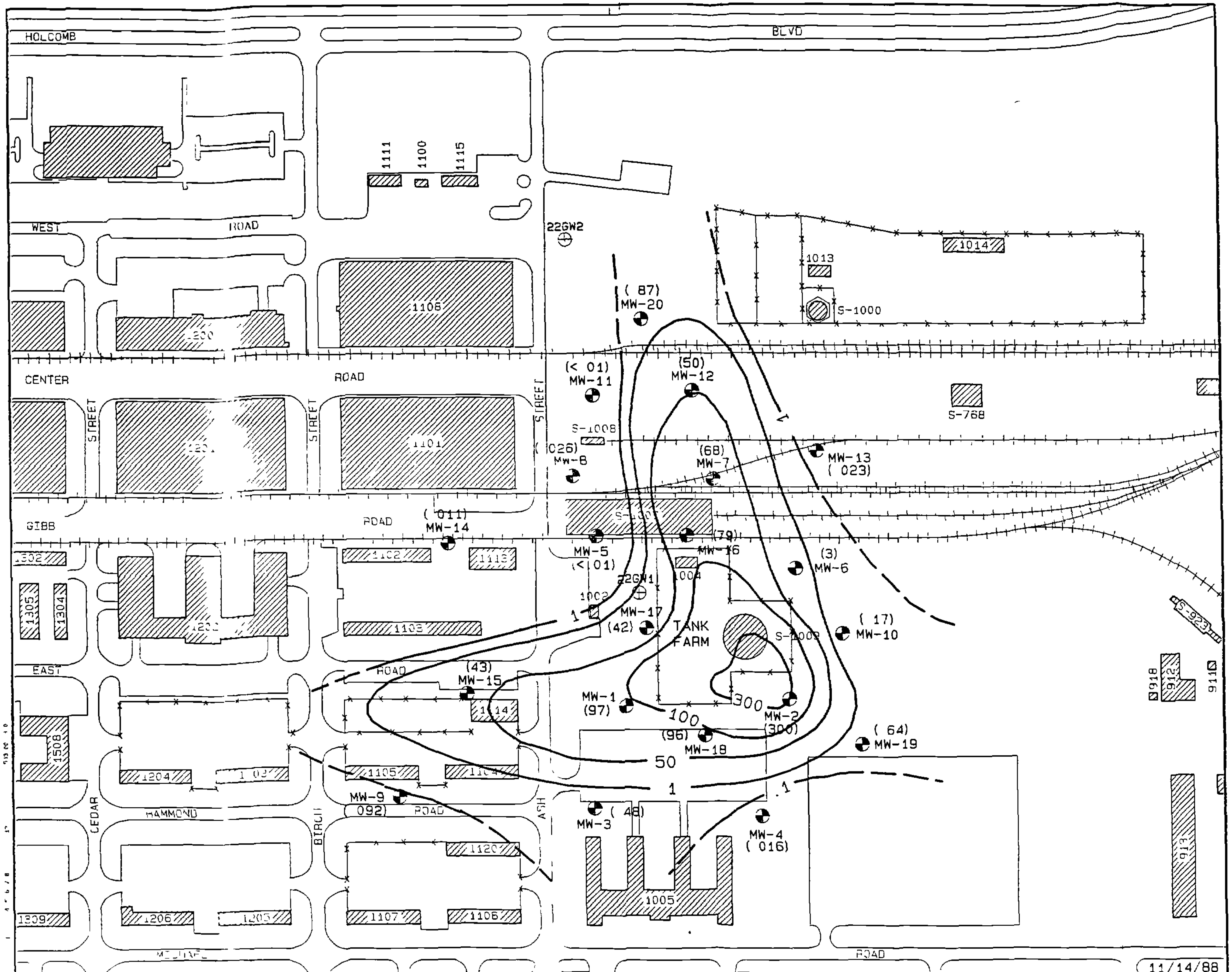
HORIZ SCALE IN FEET

OBRIEN & GERE ENGINEERS INC

FIGURE 8

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N C

TOTAL HYDROCARBONS
4/20/88 TO 4/21/88



LEGEND

- MONITORING WELL
- ESE, INC MONITORING WEL
- TOTAL HYDROCARBON CONTOU (PPM)

0 200 400

HORIZ SCALE IN FEET

OBRIEN & GERE ENGINEERS INC

Appendices

O'BRIEN & GERE

APPENDIX A

MONITORING WELL INSTALLATION PROCEDURES

Drilling and Sampling Procedures

All monitoring wells will be installed using the hollow stem auger drilling method. A drill crew shall consist of an experienced driller and a driller assistant to work on each rig. A geologist experienced in hazardous waste site investigations shall be on site to supervise the drilling and monitor for safety control. The well depths will be specified by the supervising hydrogeologist, however, the wells shall not exceed a maximum depth of 25 feet. A potable water source on base will be designated by the government.

During the drilling samples of the encountered subsurface materials shall be collected at a minimum of every five feet and/or change in material at the discretion of the supervising hydrogeologist. The sampling method employed shall be ASTM-D-1586/Split Barrel Sampling for standard penetration tests. Upon retrieval of the sampling barrel, the collected sample shall be placed in glass jars labelled and retained for future reference. The hydrogeologist will prepare a descriptive log of each boring which will include: soil texture, odor, moisture content, depth to ground water and any visual indications of contamination. Additionally, the supervising hydrogeologist will monitor organic vapors using an HNU PID to assess the presence of contaminated soil and assess site safety conditions and the need for respiratory protection while drilling.

Monitoring Well Completion

After the completion of the soil sampling and drilling to the specified depth, a monitoring well will be installed in accordance with the attached well detail. The wells will be constructed of either two inch or four inch diameter, flush joint threaded, Schedule 40 or 80, PVC well screen and casing. A ten to twenty foot section of PVC well screen with a .020 slot size will be used in each well. The well casing and screen assembly will be placed into the borehole to the specified depth and a suitable sand pack will be placed in the annular space around the screen, extending two feet above the top of the screen. The sand pack shall consist of a well sorted silica sand that allows a maximum of ten percent of the material to pass through the screen slots. A one foot thick layer of bentonite pellets will be installed on top of the sand pack. A grout mixture consisting of two parts sand, one part cement and up to ten percent bentonite will be thoroughly mixed with the specified amount of water and place in the annular space above the sand pack.

In non-traffic areas, and when the casing will not cause an obstruction, a four inch diameter protective steel casing shall be installed over the PVC casing and extend at least 2.5 feet into the ground and two to three feet above the ground surface, as shown on Figure 7. The steel casing will be provided with a vented hinged locking cap for security. In areas of heavy traffic or when the casing may cause an obstruction, the protective casing will be grouted inside a 12-inch diameter watertight manhole that is flush with the ground surface, as shown on Figure 8. A concrete apron measuring five feet by five feet by 0.5 feet will be constructed around each well. The concrete will consist of

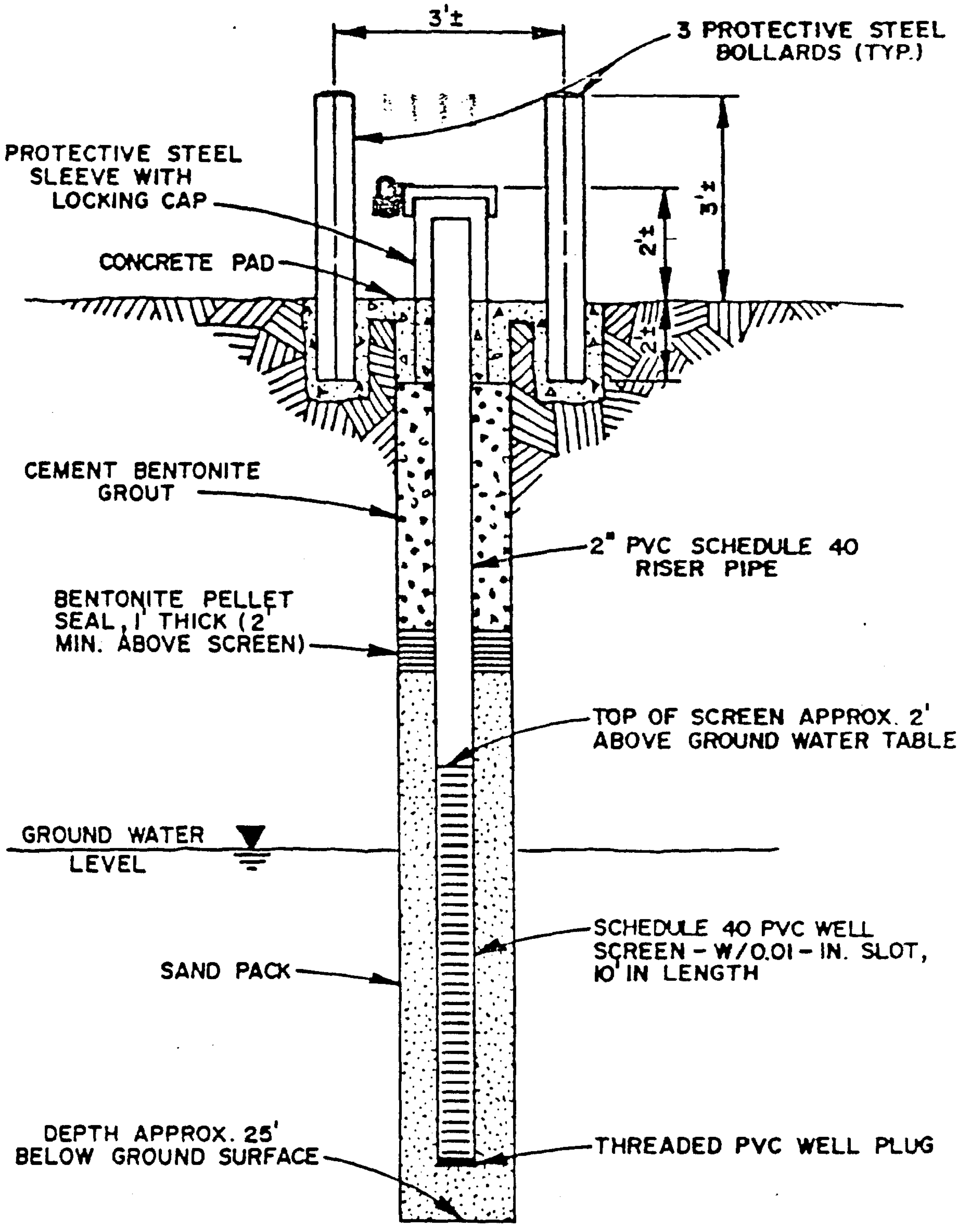
3,000 psi ready mixed concrete and will be crowned 3/4-inch above the existing surface to promote surface runoff away from the wall. The above ground wells will be protected with three Schedule 40 steel pipes, three inch ID, imbedded in a minimum of 2.5 feet of 3,000 psi concrete. The concrete to secure the three pipes will be poured at the same time as the five feet by five feet by 0.5 feet concrete apron and be an integral part of the pad. The steel pipes will be filled with concrete and painted day-glow yellow. Each well will be properly labelled by metal stamping on the exterior of the locking cap or manhole cover and by labelling the exterior of the security pipe. A sign reading "Not for Potable Use or Disposal" shall be firmly attached to each well. Well permits by state agencies will be the responsibility of the drilling contractor.

Well Development

Following well construction each monitoring well will be developed or cleared of fine grained materials and sediments that have settled in or around the well to ensure the well screen is transmitting a representative flow groundwater. The development will be accomplished using either the bailing or continuous low-yield pumping methods. Well development discharge may be disposed of on the ground surface near each well.

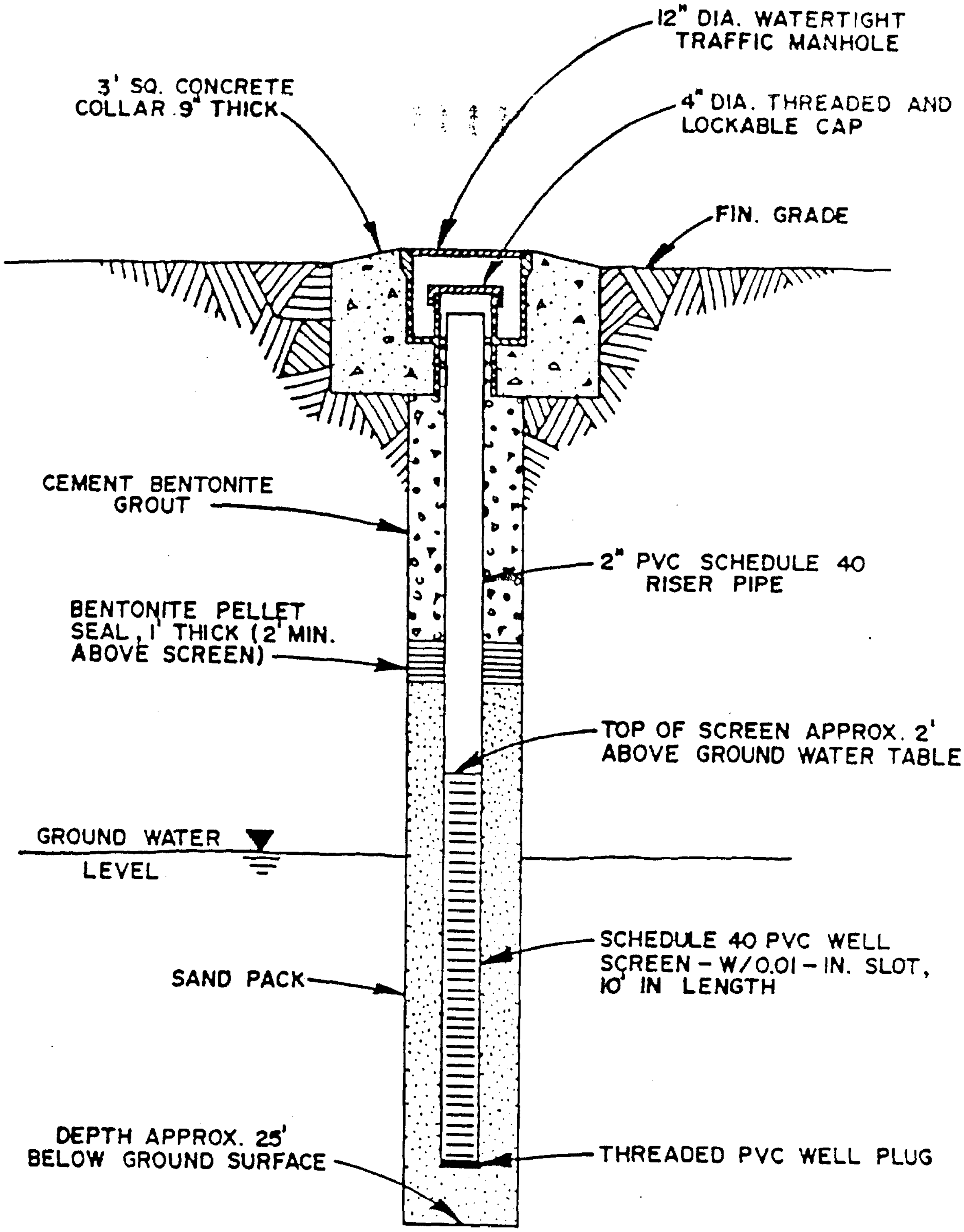
Decontamination

All drilling equipment including augers, drilling rods and split spoon sampling equipment, will be cleaned between each drilling location using a high pressure steam cleaner to avoid potential cross contamination of the monitoring wells. Wash water will not be contained and allowea to seep into the ground locally, unless otherwise directed by the E.I.C.



MONITORING WELL CONSTRUCTION DETAIL (NON TRAFFIC AREA)

NOT TO SCALE



MONITORING WELL CONSTRUCTION DETAIL
(TRAFFIC AREA)
NOT TO SCALE

APPENDIX B

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

REPORT OF BORING NO. MW1 SHEET 1 OF 1

PROJECT LOCATION: Camp Lejeune

CLIENT: Navy

SAMPLER
TYPE: split spoon
HAMMER: 140 lbs.
FALL: 30 inches

GROUND WATER
DEPTH DATE ELEV.
DEPTH DATE ELEV.

FILE NO.:

BORING CO.: ATEC
FOREMAN: Sanford Sweetey
OBG GEOLOGIST: Mike Wittner

BORING LOCATION:
GROUND ELEVATION:
DATES: STARTED: 2 /24 88 ENDED: 2 /24 88

DEPTH	SAMPLE No.	SAMPLE DEPTH	SAMPLE BLOWS /6"	SAMPLE PENETRN/ RECOVERY	SAMPLE "N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED		EQUIPMENT INSTALLED	RMKS*
0	1	0-2	3-4-5-5	24/18	9	18-5" dry, dark brown grading to tan-buff, silty SAND: 5-0" dry, tan, clayey SAND HNV:4					
5	2	5-7	4-4-5-6	24/24	9	24-21" dry, darkbrown, clayey SAND 21-0" dry, white - lt, tan, fine SAND HNV:60					
10	3	10-12	7-10-8-8	24/18	18	18-15" damp, dirty brown, clayey SAND 15-0" damp, white, med. SAND strong odor HNV: 140					
15	4	15-17	11-13-15 18	24/	28	damp, white & tan with some gray streaks, med. SAND HNV:180					

* water table approx. 9' BGL

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

REPORT OF BORING NO. MW2 SHEET 1 OF 1

PROJECT LOCATION: Camp Lejeune

CLIENT: Navy

SAMPLER
TYPE: split spoon
HAMMER: 140 lbs
FALL: 30 inches

GROUND WATER
DEPTH DATE ELEV.
DEPTH DATE ELEV.

FILE NO.:

BORING CO.: ATEC
FOREMAN: Sanford Sweetey
OBG GEOLOGIST: Mike Wittner

BORING LOCATION:
GROUND ELEVATION:
DATES: STARTED: 2/24/88 ENDED: 2/24/88

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETR/ RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED		EQUIPMENT INSTALLED	RMKS
0	1	0-2	6-6-4-4	24/20	10	dry, tan fine SAND: one "charred" black spot - coal chunk? HNV: 100/10-20					
5	2	5-7	4-6-11-12	24/24	17	24-21" dry, brown, fine SAND with silt 21-0" dry, brown, fine SAND; odor HNV: 100/10					
10	3	10-12	1-3-5-10	24/24	8	24-12" sl. damp, white-gray, fine SAND with some iron staining 12-4" sl. damp, white-gray, sandy CLAY; odor 4-0" same as 24-12"					
15	4	15-17	4-5-9-9	24/	14	HNV:50-100 wet, white-lt, gray, fine SAND odor HNV: 100-150					

water table approx. 13' BGL

Note if HNV reading is in following format: x/y, x= initial peak, y= steady state

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG
[redacted]

REPORT OF BORING NO. MW3 SHEET 1 OF 1

PROJECT LOCATION: Camp Lejeune

CLIENT: Navy

SAMPLER
TYPE: split spoon
HAMMER: 140 lbs
FALL: 30 inches

GROUND WATER
DEPTH DATE ELEV.
DEPTH DATE ELEV.

FILE NO.:

BORING CO.: ATEC
FOREMAN: Sanford Sweetey
OBG GEOLOGIST: Mike Wittner

BORING LOCATION:
GROUND ELEVATION:
DATES: STARTED: 2 25/88 ENDED: 2 /25/88

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRN/ RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED		EQUIPMENT INSTALLED	RMKS*
0	1	0-2	3-4-4-3	24/20	8	dry, dirty brown and tan, fine SAND HNV: <1					
5	2	5-7	3-5-7-10	24/24	12	24-21" dry, dirty brown, silty fine SAND 21-0" dry to sl. damp. tan and white-gray, fine-med, SAND HNV: <1					
10	3	10-12	4-4-4-2	24/12	8	12-3" damp, tan-brown, fine-med, SAND 3-0" damp, gray to brown, fine SAND HNV: <1					
15	4	15-17	6-9-13-13	24/24	22	sl, damp, lt, gray, fine-med. SAND HNV:<1					

* water table approx. 10.5' BGL
when drilled from 5' to 10', changed from white sand to tan sand
when drilled from 10' to 15', changed from tan sand to brown sand

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

REPORT OF BORING NO. MW 4 SHEET 1 OF 1

PROJECT LOCATION: Camp Lejeune
CLIENT: Navy

SAMPLER
TYPE: split spoon
HAMMER: 140 lbs
FALL: 30 inches

GROUND WATER
DEPTH DATE ELEV.
DEPTH DATE ELEV.

FILE NO.:

BORING CO.: ATEC
FOREMAN: Sanford Sweetey
OBG GEOLOGIST: Mike Wittner

BORING LOCATION:
GROUND ELEVATION:
DATES: STARTED: 2 /25/ 88 ENDED: 2 /25/88

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRN/ RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED		EQUIPMENT INSTALLED	RMKS
0	1	0-2	3-4-6-5	24/21	10	dry, tan, lt. olive green, and dirty brown, fine SAND HNV:<1					
5	2	5-7	8-13-21 28	24/18	34	dry, white-lt, gray, fine-med. SAND HNV:<1					
10	3	10-12	1-1-1-1	24/12	2	damp, white-lt. tan, clayey and sandy SILT HNV:<1					
15	4	15-17	2-4-6-8	24/24	10	24-22" damp, brown, find SAND 22-20" damp, gray, fine SAND 20-17" damp, gray, CLAY 17-12" damp, gray, fine SAND 12-11" damp, gray, CLAY 11-10" damp, gray, fine SAND 10-0" damp, tan to orange tan, fine SAND HNV:<1					

* water table approx. 9.5' BGL

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	REPORT OF BORING NO. MW5 SHEET 1 OF 1
PROJECT LOCATION: Camp Lejeune CLIENT: Navy	SAMPLER TYPE: split spoon HAMMER: 140 lbs FALL: 30 inches	GROUND WATER DEPTH DATE ELEV. DEPTH DATE ELEV. FILE NO.:

BORING CO.: ATEC FOREMAN: Sanford Sweetey OBG GEOLOGIST: Mike Wittner	BORING LOCATION: GROUND ELEVATION: DATES: STARTED: 2/25/88 ENDED: 2/25/88

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRN/ RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED		EQUIPMENT INSTALLED	RMKS*
0	1	0-2	4-7-28	24/12	35	12-2" surface gravel & concrete					
			10			2-0" sl. damp, brown, organic layer-original soil surface; wood lose in spoon tip-from railroad tie? HNV: 0					
5	2	5-7	2-1-2-2	24/20	3	sl. damp, lt. gray-lt. green, sandy CLAY HNV:<1					
10	3	10-12	3-3-3-4	24/18	6	damp to wet, med, gray, fine SAND HNV:<1					
15	4	15-17	6-6-9-9	24/18	15	wet, tan, fine SAND HNV:<1					

* water table approx. 10.5' BGL

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring No.: MW-6
Sheet 1

Project Location: Hadnot Point Tank Farm
Camp Lejeune, N.C.
Client: U.S. Navy
EN
Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

SAMPLER
Type: Split Spoon
Hammer: 140 lbs. Fall: 30 inches

Ground Water Depth Date
Depth Date
File No.: 3543.002.320

Boring Location:
Ground Elevation:
Dates: Started: 3/01/88 Ended: 3/01/88

Depth	Sample No	Sample Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	3-5	24/13	11	Brown MEDIUM/FINE SAND, little silt, damp, medium dense, slight petroleum odor.					1	
			6-5									
5	2	5-7	2-4	24/24	9	Gray with light brown mottling FINE/MEDIUM SAND, some silt, moist, loose, slight petroleum odor.	5.5'				1	
			5-7									
						Groundwater encountered at 9.5 ft.						
10	3	10-12	7-11	24/18	23	- Grading to medium SAND with some fine sand and little silt. Strong gasoline/ petroleum odor. Wet.					150	
			12-13									
15	4	15-17	4-8	24/19	18	- Same, petroleum odor and product present					165	
			10-10									
						Bottom of Hole at 17.0 ft.						
20												

10

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

Report of Boring No.: MW-7
Sheet 1

Project Location: Hadnot Point Tank Farm
Camp Lejeune, N.C.
ent: U.S. Navy

SAMPLER
Type: Split Spoon
Hammer: 140 lbs. Fall: 30 inches

Ground Water Depth Date
Depth Date
File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/01/88 Ended: 3/01/88

Depth	Sample No	Sample Depth in ft.	Sample Blows /6"	Sample Penetr/ Recovry	Sample "N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	11-7	24/24	12	Sand and GRAVEL ROAD FILL.					45	
			5-5			light gray FINE/MEDIUM SAND, some silt, moist, medium dense. Strong petroleum odor due to petroleum staining.	0.7'					
5	2	5-7	3-3	24/20	6	- Grading to MEDIUM/FINE SAND with little silt. Some light brown mottling, loose. Slight petroleum odor.					120	
			3-3									
						Groundwater encountered ~ 8.0 ft.						
10	3	10-12	2-5	24/19	9	- Mottled gray/light brown medium sand, some fine sand. Sand is wet with gasoline/petroleum product, strong odor. 0.3' layer of black petroleum soaked sand at 11.7' to 12.0'.					180	
			4-3									
15	4	15-17	2-2	24/24	8	- Same, with some dark gray mottling. Petroleum product and odor present.					195	
			6-7									
						Bottom of Hole at 17.0 ft.						
20												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-8 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. …nt: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

…ing Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/01/88 Ended: 3/01/88

Depth	Sample No	Sample Depth in ft.	Sample Blows /6"	Sample Penetr/ Recovry	Sample "N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	14-11	24/19	20	SAND and GRAVEL ROAD FILL.	0.5'				4	
			9-9			Dark brown with light brown mottling FINE/ MEDIUM SAND, little silt, trace fine gravel, occasional wood/plant fragment, damp, medium dense.						
						- Grading to black black/dark gray fine/ medium sand, softer with higher fine content, moist.						
5	2	5-7	1-2	24/23	5						3	
			3-3			Light gray MEDIUM/FINE SAND, little silt, moist, soft, slight petroleum odor.	6.5'					
						Groundwater encountered at ~ 9.0 ft.						
10	3	10-12	2-4	24/24	8	- Grading to medium sand with some fine sand, little silt, wet.					2	
			4-5									
15	4	15-17	4-4	24/23	7	- Same					1	
			3-4									
						Bottom of Hole at 17.0 ft.						
20												

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG

REPORT OF BORING NO. MW9 SHEET 1 OF 1

PROJECT LOCATION: Camp Lejeune
CLIENT: Navy

SAMPLER
TYPE: split spoon
HAMMER: 140 lbs
FALL: 30 inches

GROUND WATER
DEPTH DATE ELEV.
DEPTH DATE ELEV.

FILE NO.:

BORING CO.: ATEC
FOREMAN: Sanford Sweetey
OBG GEOLOGIST: Mike Wittner

BORING LOCATION:
GROUND ELEVATION:
DATES: STARTED: 2/25/88 ENDED: 2/25/88

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRN/ RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRTUM CHANGE DEPTH	EQUIPMENT INSTALLED		EQUIPMENT INSTALLED	RMKS
0	1	0-2	1-2-5-5	24/12	7	damp, tan with some brown spots, fine SAND HNV:<1					
5	2	5-7	5-9-11-14	24/24	20	damp, tan and white, fine SAND HNV:<1					
10	3	10-12	2-4-9-13	24/22	13	22-18" sl. damp, orange-tan and dirty brown, fine SAND 18-0" sl. damp, lt. gray with discontinuous rusty lines, CLAY HNV:<1					
15	4	15-17	2-3-5-10	24/24	8	24-12' wet, white-very lt. tan, silty CLAY 12-0" wet, white-very lt. tan, fine-med. SAND HNV:<1					

O'BRIEN & GERE ENGINEERS, INC.

TEST BORING LOG
[redacted]

REPORT OF BORING NO. MW10 SHEET 1 OF 1

PROJECT LOCATION: Camp Lejeune
CLIENT: Navy

SAMPLER
TYPE: split spoon
HAMMER: 140 lbs
FALL: 30 inches

GROUND WATER
DEPTH DATE ELEV.
DEPTH DATE ELEV.

FILE NO.:

BORING CO.: ATEC
FOREMAN: Sanford Sweetey
OBG GEOLOGIST: Mike Wittner

BORING LOCATION:
GROUND ELEVATION:
DATES: STARTED: 2/25/88 ENDED: 2/25/88

DEPTH	SAMPLE No.	SAMPLE DEPTH	BLOWS /6"	PENETRN/ RECOVERY	"N" VALUE	SAMPLE DESCRIPTION	STRATUM CHANGE DEPTH	EQUIPMENT INSTALLED		EQUIPMENT INSTALLED	RMKS
0	1	0-2	11-10-8-10	24/20	18	20-18" gravel & pavement 18-17" dry, brown, fine SAND 17-0' dry, tan-med, brown clayey and sandy SILT tight material HNV:<1					
5	2	5-7	7-10-13-15	24/24	23	dry, dirty brown (top 1"), white and orange tan, fine SAND (white matl.) and med. SAND (orange tan, brown matl.) HNV: <1					
10	3	10-12	8-10-12-13	24/20	22	wet, tan, fine SAND HNV: 1-1.5					
15	4	15-17	4-8-11-13	24/18	19	wet, white, fine-med, SAND odor HNV:25/10-15					

*water table approx. 9.5' BGL

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-11 Sheet 1
Project Location: Hadnot Point Tank Farm, Camp Lejeune, N.C. ent: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc. Foreman: Sanford Sweetey OBG Geologist: John C. Brod	Boring Location: Ground Elevation: Dates: Started: 3/02/88 Ended: 3/02/88

Depth	Sample No	Sample Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	5-10	24/19	28	Light brown SAND and GRAVEL ROAD FILL.					0.5	
			18-18				1.5'					
						Mottled grayish brown MEDIUM/FINE SAND, little silt, moist, medium dense.						
5	2	5-7	2-2	24/17	4	- Grading to mottled gray MEDIUM SAND, some fine sand, little silt, soft, very moist, with occasional plant and wood fragments.					0	
			2-3									
10	3	10-12	2-3	24/18	7	- Grading with more medium sand, wet, medium dense.					0	
			4-5									
15	4	15-17	2-3	24/21	5	- Same, slight solvent or chemical odor.					0	
			2-4									
20	5	20-22	3-3	24/24	6	- Grading with little fine sand, very wet.					55	
			3-3									
25	6	25-27	WOH/12"	24/22	1	- Grading to darker gray, strong solvent odor.					110	
			1/12"									
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-12 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. ...t: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date; Depth Date; File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/07/88 Ended: 3/07/88

Depth	Sample No	Sample Depth in ft.	Sample Blows /6"	Sample Penetr/ Recovry	Sample "N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	10-12	24/20	28	Dard brown SAND and GRAVEL ROAD FILL.					1	
			16-23			Grayish brown FINE/MEDIUM SAND, little silt and fine/medium gravel, trace coarse sand and coarse gravel, damp, medium dense.	0.5'					
							1.8'					
5	2	5-7	2-2	24/15	5						1	
			3-3									
							8.5'					
10	3	10-12	2-2	24/18	4	Gray FINE SAND, some medium sand and silt, very moist, soft.					1	
			2-3									
15	4	15-17	2-2	24/19	5	- Grading to FINE/MEDIUM SAND, some silt, trace fine gravel, wet, medium stiff. Some layering of dark gray medium/fine sand present.					2	
			3-2									
							18.5'					
						Gray CLAY, little silt, damp, medium stiff, high plasticity.						*
20	5	20-22	9-10	24/20	22		20.5'				150	
			12-15			Light gray MEDIUM/FINE SAND, little silt, wet, medium dense. Petroleum/gasoline odor and product present.						
25	6	25-27	2-2	24/24	5	- Grading with less silt, some dark gray mottling, saturated with gasoline.					125	
			3-1									
						Bottom of Hole at 27.0 ft.						
30												

* Water above confining clay layer had no noticable product of odor.
Material below the confining layer was saturated with gasoline.

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-13 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. t: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.	Boring Location:
Foreman: Sanford Sweetey	Ground Elevation:
OBG Geologist: John C. Brod	Dates: Started: 3/09/88 Ended: 3/09/88

Depth	Sample No	Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Sp Cond	HNU	Rmks*
0	1	0-2	11-7	24/18	15	Tan SAND and GRAVEL ROAD FILL.					5	
			8-11			Dark brown SILT and FINE SAND, trace medium sand, some wood fragments, roots and organic material, moist, medium dense.	1.0'					
5	2	5-7	4-5	24/0	9	- No recovery -					----	
			4-4									
							7.5'					
10	3	10-12	2-1	24/19	3	Gray FINE/MEDIUM SAND, some silt, occasional clay stringer, very moist, soft.					1	
			2-4									
15	4	15-17	5-9	24/13	23	- Grading to MEDIUM/FINE SAND, little silt wet, medium dense.					2	
			14-15									
20	5	20-22	2-2	24/21	5	- Grading to FINE/MEDIUM SAND, loose.					1	
			3-4									
25	6	25-27	5-7	24/23	21	Dark gray SILT, some clay and fine sand.	25.5'				1	
			14-15			Brown ORGANIC SILT/PEAT, wood fragments, roots, little fine sand, moist stiff.	26.0'					
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-14 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. ent: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/08/88 Ended: 3/08/88

Depth	Sample No	Sample Depth in ft.	Sample Blows /6"	Sample Penetr/ Recovry	Sample "N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	8-9	24/7	11	Grayish brown SAND and GRAVEL ROAD FILL, some silt, medium dense, dry.					1	
			3-4									
							4.0'					
						Grayish brown with tan mottling, FINE SAND, some silt, little medium sand, moist, medium dense.						
5	2	5-7	10-11	24/22	20						6	
			9-8									
						- Occasional chunks of wood/organic matter						
10	3	10-12	3-1	24/16	2		11.0'				1	
			1-2			Gray FINE SAND and SILT, trace medium sand, wet, soft. Occasional clay stringer.						
						Light gray FINE/MEDIUM SAND, little silt, wet, loose.						
15	4	15-17	1-2	24/21	4		16.0'				1	
			2-3			Dark brown ORGANIC SILT/PEAT, wood fragments, roots, moist, soft.						
						- Thin layer of organic clay.						
20	5	20-22	1-2	24/16	8		21.0'				2	
			6-15			Light gray FINE/MEDIUM SAND, little silt, wet, medium dense.						
25	6	25-27	3-4	24/8	7	- Same with some dark gray discoloration and brown mottling. Petroleum odor.					15	
			3-3									
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-15 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. ent: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/08/88 Ended: 3/08/88

Depth	Sample No	Sample Depth in ft.	Sample Blows /6"	Sample Penetr/ Recovry	Sample "N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	2-3	24/16	6	Brown FINE SAND, little medium sand and silt, moit, loose.					3	
			3-2									
							5.2'					
5	2	5-7	2-1	24/19	4	Gray FINE SAND, some medium sand, little silt, moist, loose.					2	
			3-7									
10	3	10-12	5-10	24/19	22	- Grading to FINE/MEDIUM SAND, little silt, wet, medium dense.					18	
			12-15									
15	4	15-17	6-12	24/18	22	- Same, with brown mottling and discoloration, petroleum/disel fuel odor.					14	
			10-9									
20	5	20-22	2-2	24/24	5	Gray MEDIUM/FINE SAND with occasional clay stringer, loose. Strong petroleum/gasoline odor, material saturated with gasoline.					138	
			3-4									
25	6	25-27	3-3	24/24	6	- Same					95	
			3-4									
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-16 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. ent: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/10/88 Ended: 3/10/88

Depth	Sample No	Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Sp Cond	HNU	Rmks*
0	1	0-2	2-2	24/13	4	Tan SAND and GRAVEL FILL					4	
			2-3			Grayish tan with some dark brown mottling FINE/MEDIUM SAND, some silt, moist, medium stiff, petroleum odor.	0.8'					
5	2	5-7	4-5	24/15	12	Gray FINE SAND, some silt and medium sand wet, medium dense. Petroleum product and odor.					150	
			7-7									
10	3	10-12	4-5	24/15	12	- Grading to FINE/MEDIUM SAND, little silt, occasional clay stringer.					165	
			7-7									
15	4	15-17	2-2	24/24	6		15.5'				190	
			4-4			Light gray SILT, some clay and fine sand, moist, soft petroleum odor.						
						- Grading with more fine sand.						
20	5	20-22	4-5	24/17	13						135	
			8-8			Light gray FINE/MEDIUM SAND, little silt, wet, medium dense. Saturated with gasoline.	21.0'					
25	6	25-27		24/19			25.6'				150	
						Dark gray/black FINE/MEDIUM SAND, some silt, wet, medium dense. Color due to petroleum discoloration.						
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-17 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. Client: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc. Foreman: Sanford Sweetey OBG Geologist: John C. Brod	Boring Location: Ground Elevation: Dates: Started: 3/09/88 Ended: 3/09/88

Depth	Sample No	Sample Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0	1	0-2	2-5	24/23	12	Mottled grayish brown FINE/MEDIUM SAND, some silt, trace fine gravel, moist, medium dense. Petroleum odor and discoloration.					35	
			7-7									
5	2	5-7	3-3	24/19	8	Light gray FINE/MEDIUM SAND, some silt, moist, loose. Petroleum odor.	5.5'				5	
			5-5									
10	3	10-12	3-9	24/21	19	- Grading to MEDIUM/FINE SAND, little silt, reddish tan discoloration due to presence of gasoline product.					150	
			10-11									
15	4	15-17	3-5	24/15	10	- Same, with grayish tan color.					55	
			5-7									
20	5	20-22	5-7	24/22	16	- Grading to MEDIUM SAND, some fine sand, little silt, occasional clay stringer, strong gasoline odor.					175	
			9-11									
25	6	25-27	3-5	24/24	11	- Grading with slightly more silt and fine sand.					125	
			6-6									
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-18 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. ent: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/11/88 Ended: 3/11/88

Depth	Sample No	Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Sp Cond	HNU	Rmks*
0	1	0-2	2-3	24/16	6	Olive brown FINE SAND and SILT, little medium sand, trace fine gravel, damp, medium stiff, odor.					25	
			3-4									
							3.5'					
5	2	5-7	5-6	24/22	14	Mottle light gray/tan FINE/MEDIUM SAND, little silt, moist, medium dense. Slight odor.					2	
			8-11									
10	3	10-12	3-6	24/18	11	- Grading with some silt, less tan mottling, petroleum odor.					150	
			5-3									
15	4	15-17	3-6	24/16	12	- Same, with occasional clay stringer, wet strong petroleum odor.					155	
			6-8									
20	5	20-22	2-3	24/24	5	- Grading to FINE SAND, some medium sand and silt, loose. Solvent/petroleum odor.					125	
			2-4									
25	6	25-27	4-3	24/19	6	- Same, with layers of medium sand.					11	
			3-3									
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-19 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. Client: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/14/88 Ended: 3/15/88

Depth	Sample No	Sample Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Sp Cond	HNU	Rmks*
0	1	0-2	7-7	24/11	13	Tan SAND and GRAVEL ROAD FILL						
			5-5			Light brown FINE SAND, little silt and medium sand, moist, medium dense.	1.0'					
5	2	5-7	7-11	24/21	24	Light gray FINE SAND, little silt and mediumsand, moist, medium dense.	5.0'					
			13-17									
10	3	10-12	2-3	24/20	9	- Grading to FINE/MEDIUM SAND, little silt, loose.						
			6-6									
15	4	15-17	2-4	24/22	10	- Grading to MEDIUM/FINE SAND, little silt, some layering of medium sand, some tan mottling, wet, medium dense.						
			6-10									
20	5	20-22	1-4	24/20	8	- Same, with color changing to orange/ brown.						
			4-5									
25	6	25-27	3-3	24/24	6	- Same						
			3-3									
						Bottom of Hole at 27.0 ft.						
30												

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-20 Sheet 1
Project Location: Hadnot Point Tank Farm Camp Lejeune, N.C. ient: U.S. Navy	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 3543.002.320

Boring Co.: ATEC Assoc., Inc.
Foreman: Sanford Sweetey
OBG Geologist: John C. Brod

Boring Location:
Ground Elevation:
Dates: Started: 3/14/88 Ended: 3/14/88

Depth	Sample No	Sample Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Sp Cond	HNU	Rmks*
0	1	0-2	2-4	24/16	9	Tan FINE SAND, some medium sand (FILL)					<1	
			5-4			Dark brown SILT and FINE SAND, little medium sand and fine gravel, little organic material and wood fragments, moist, medium dense.	0.5'					
							4.0'					
5	2	5-7	1-1	24/22	3	Grayish brown FINE SAND, some silt and medium sand, some interbedding of gray silty clay, trace fine gravel, moist, soft.					<1	
			2-2									
10	3	10-12	1-1	24/2	3	- Same					<1	
			2-1									
15	4	15-17	4-2	24/19	5	- Grading to gray FINE/MEDIUM SAND, little silt, trace fine gravel and organic material, wet, loose.					<1	
			3-2									
20	5	20-22	6-6	24/17	12	- Grading to MEDIUM/FINE SAND, little silt occasional thin silty clay layer, medium dense.					1	
			6-8									
25	6	25-27	WOH/24"	24/14	---	- Grading to dark gray MEDIUM SAND, some fine sand, little silt, wet, very loose.					<1	
						Bottom of Hole at 27.0 ft.						
30												

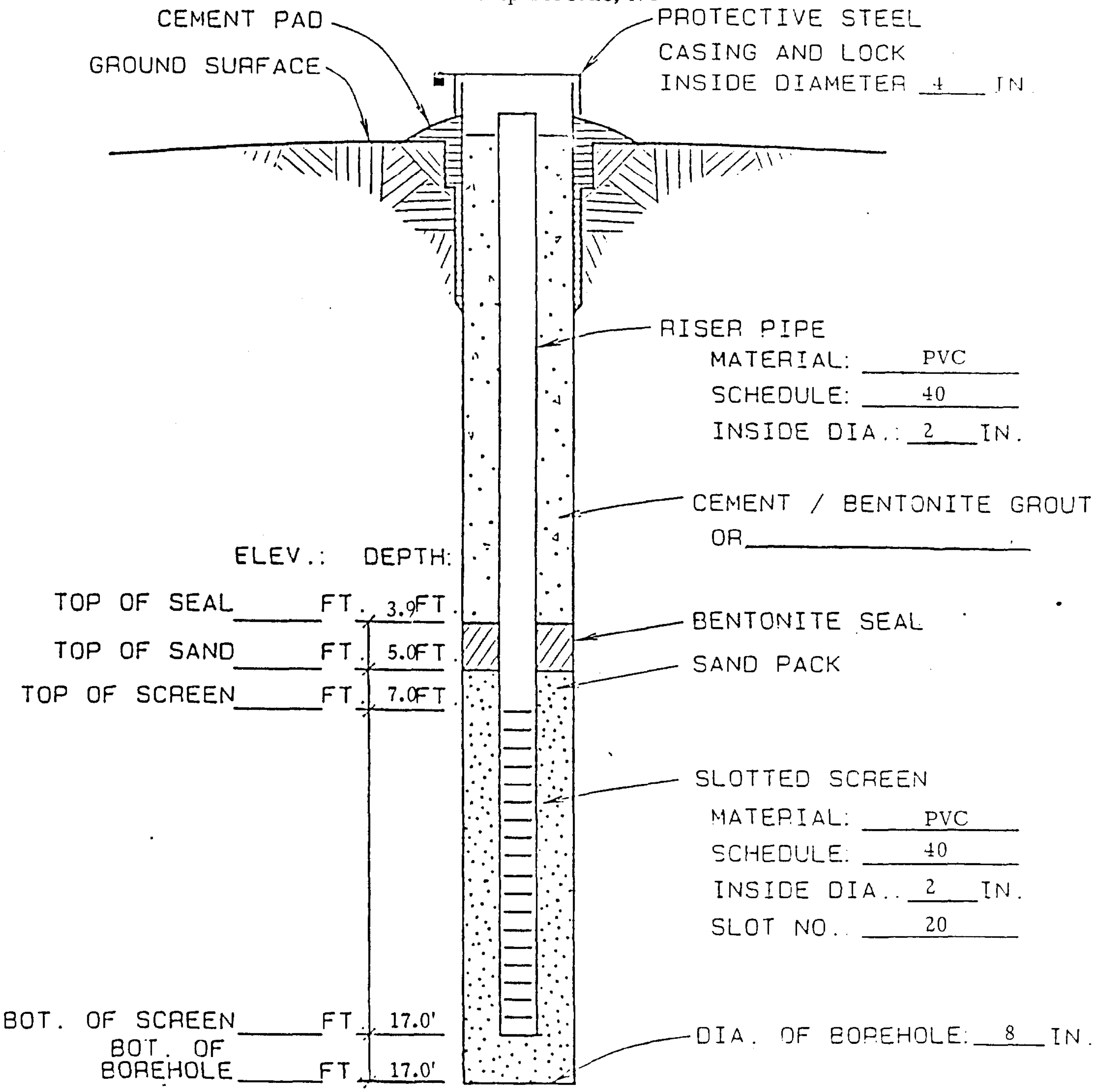
* WOH = Weight of Hammer.

APPENDIX C

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-1



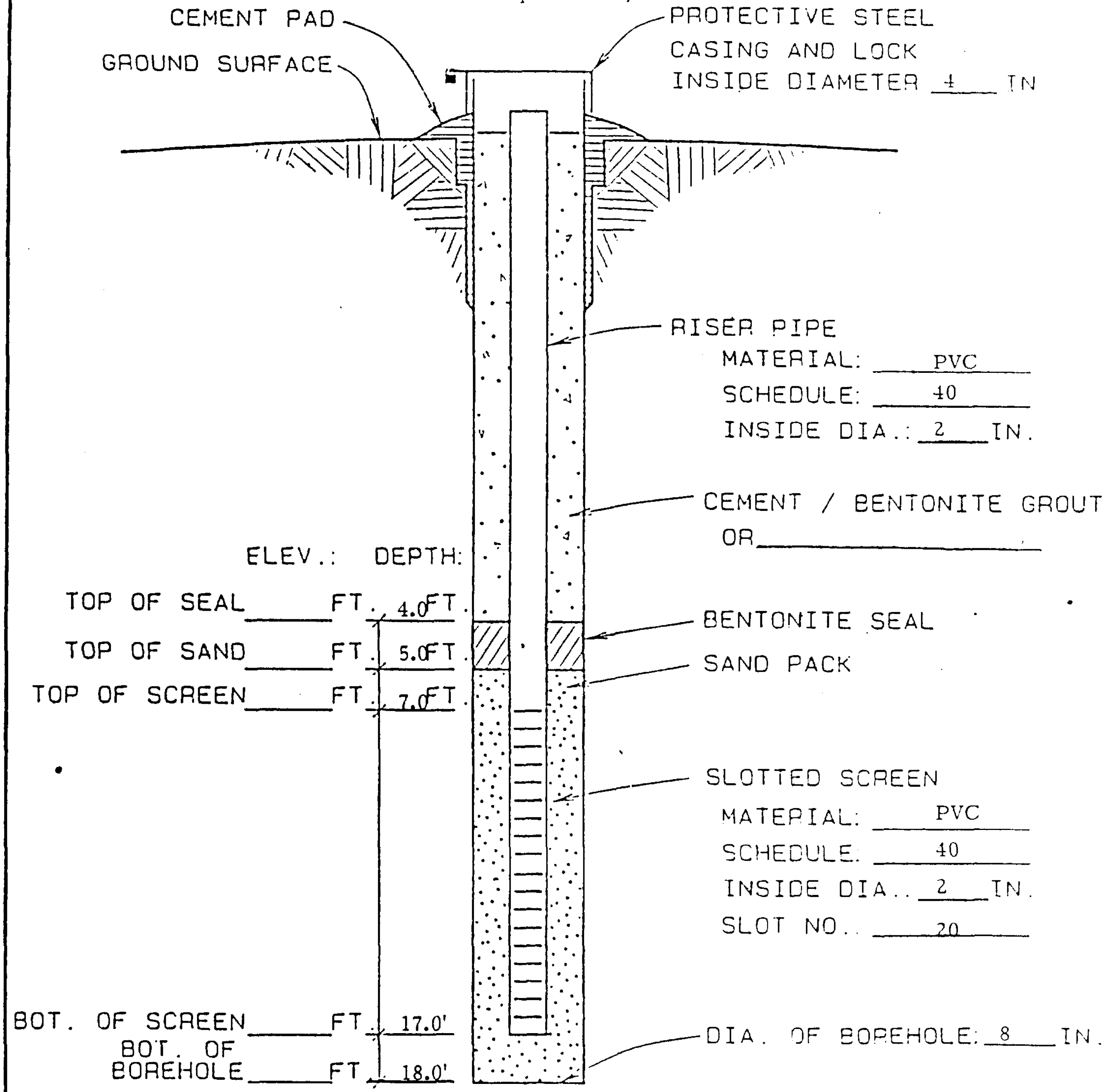
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-2



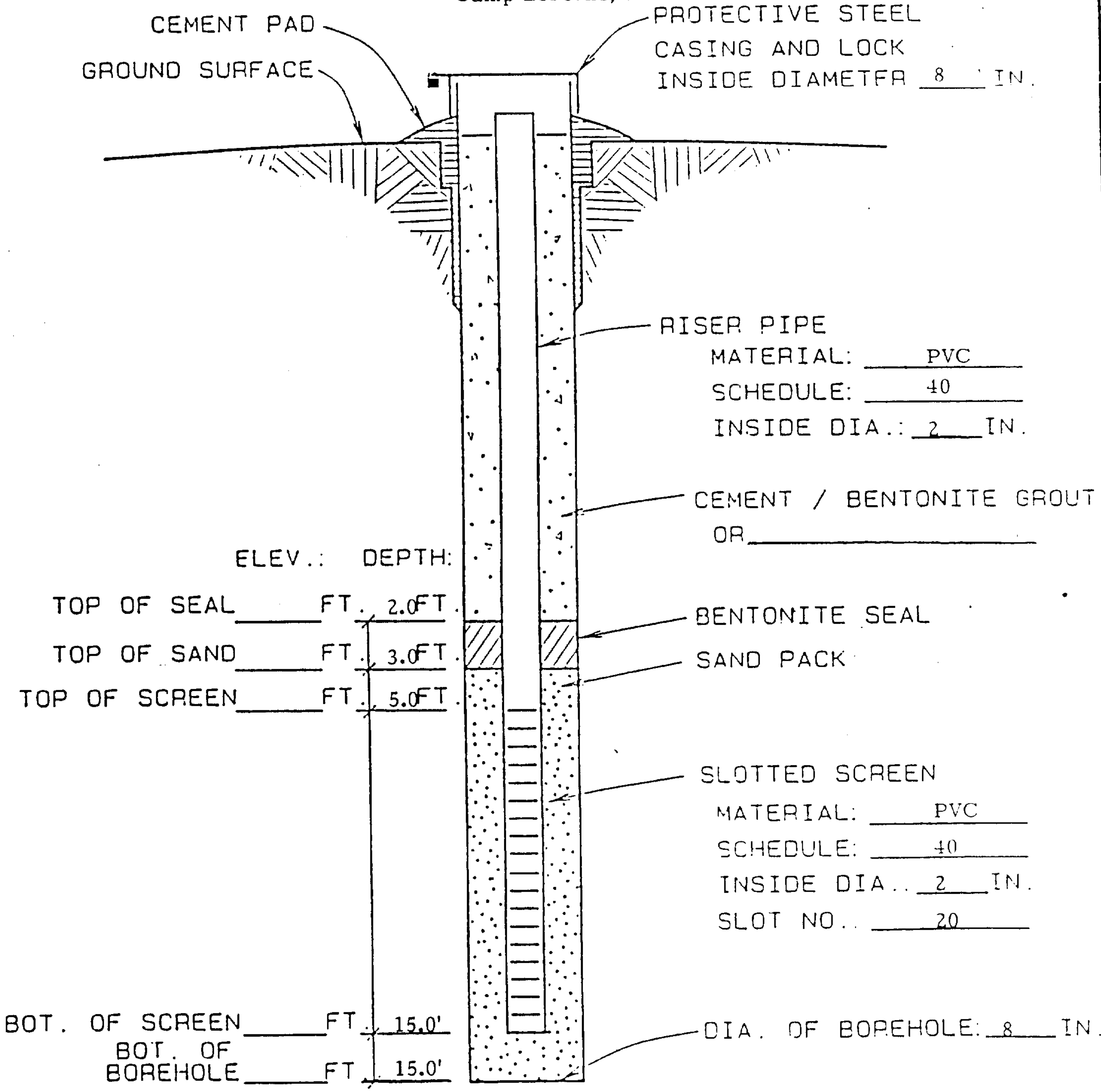
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-3



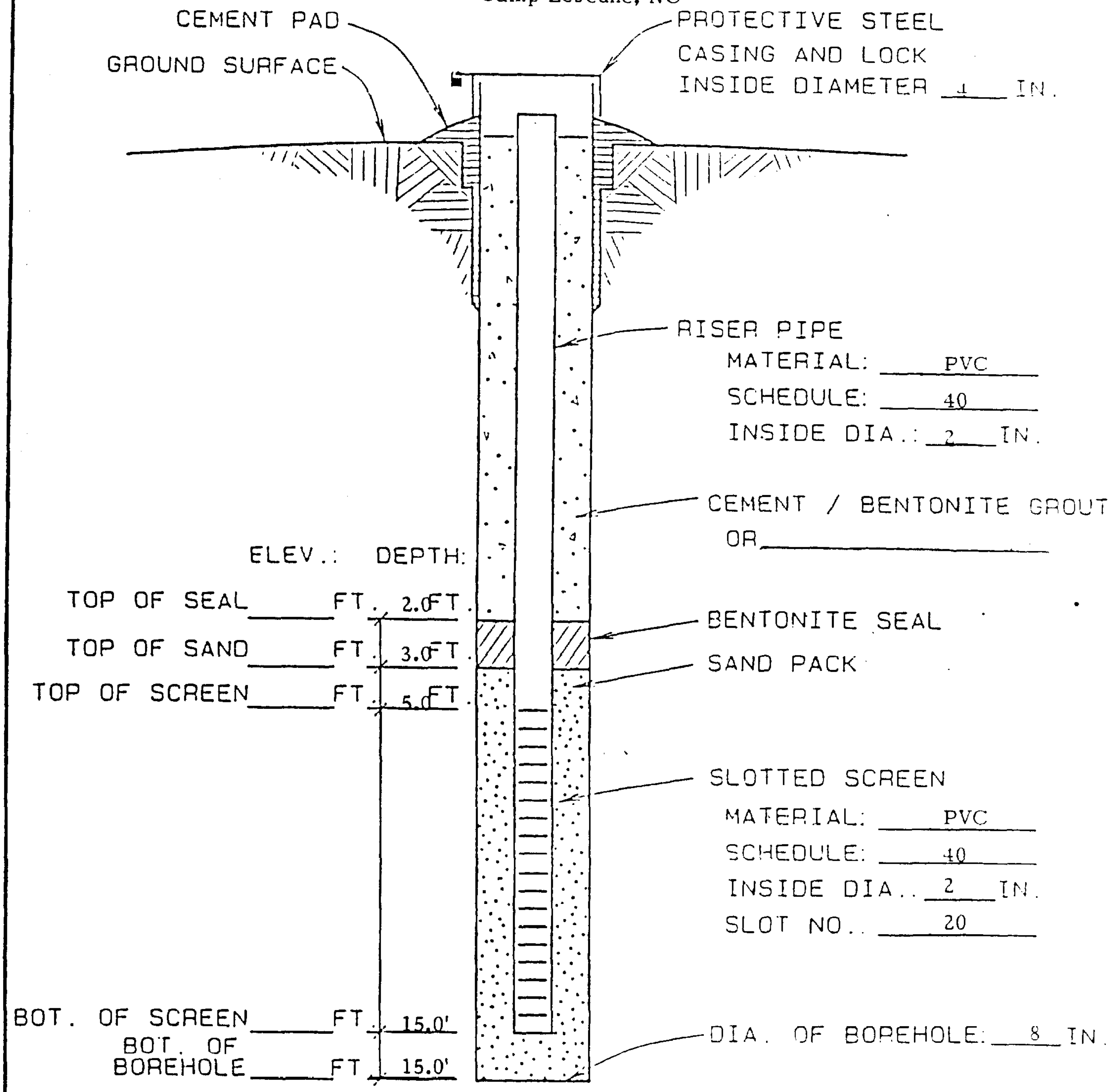
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-4



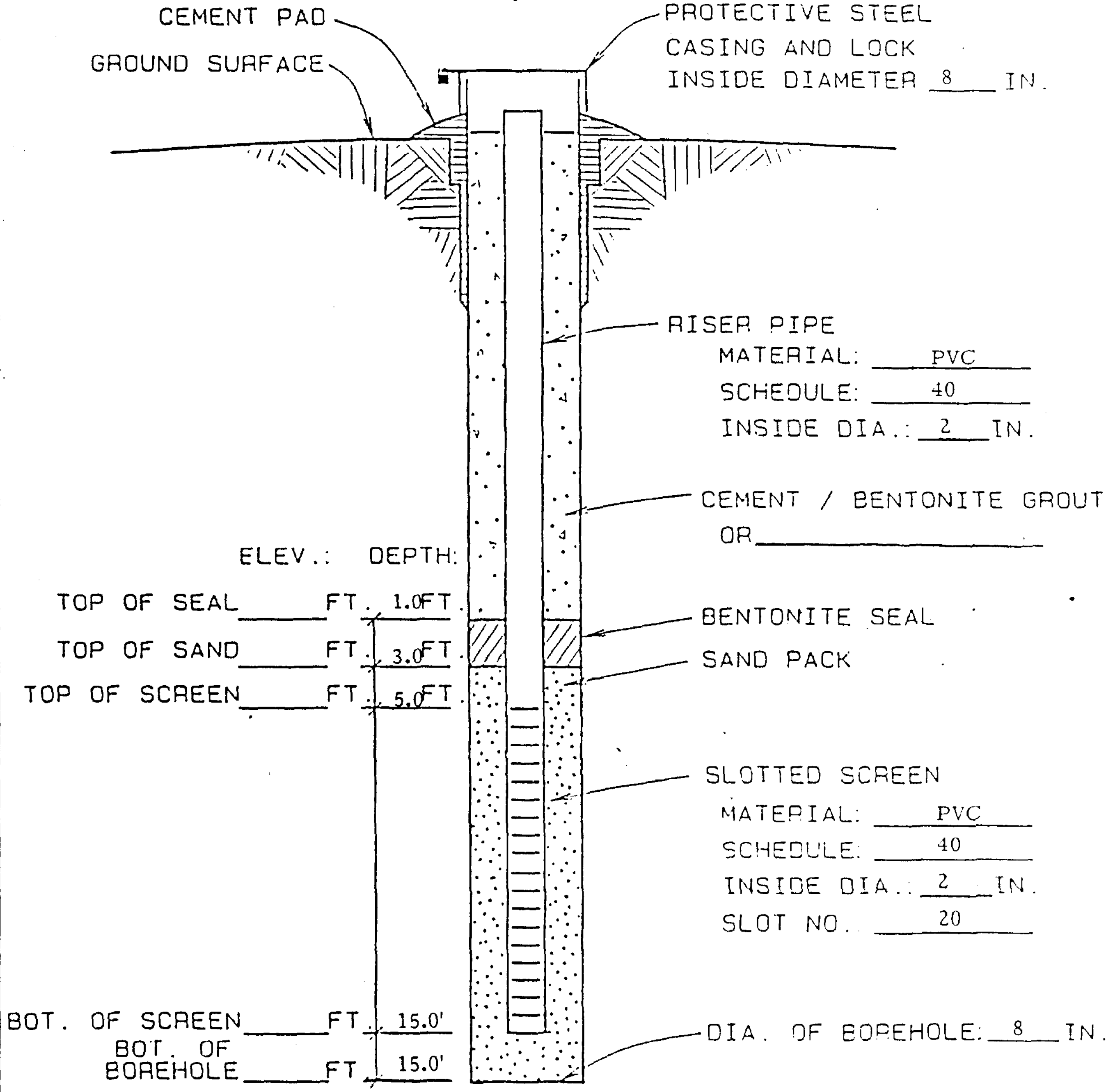
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-5



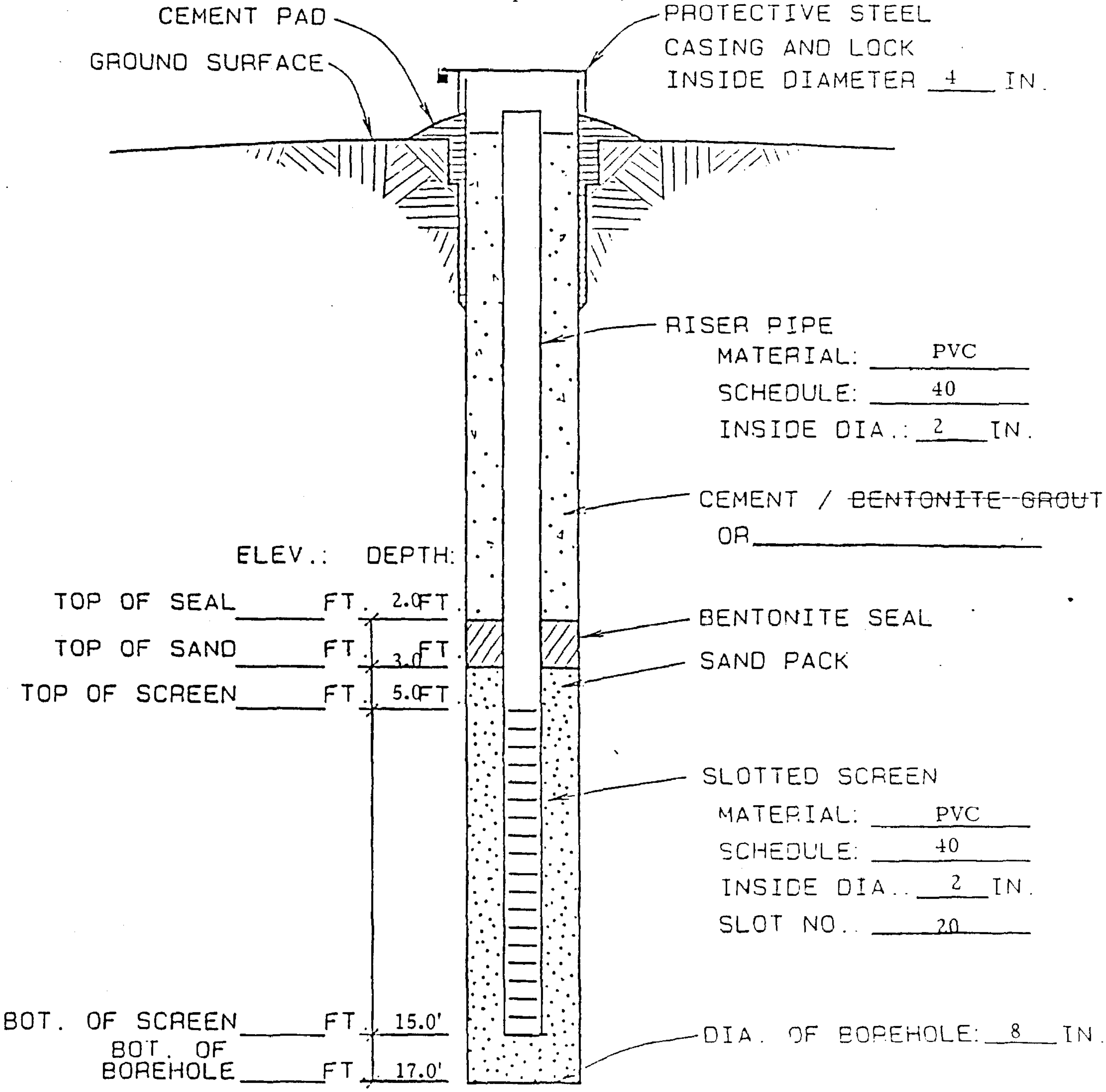
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-6



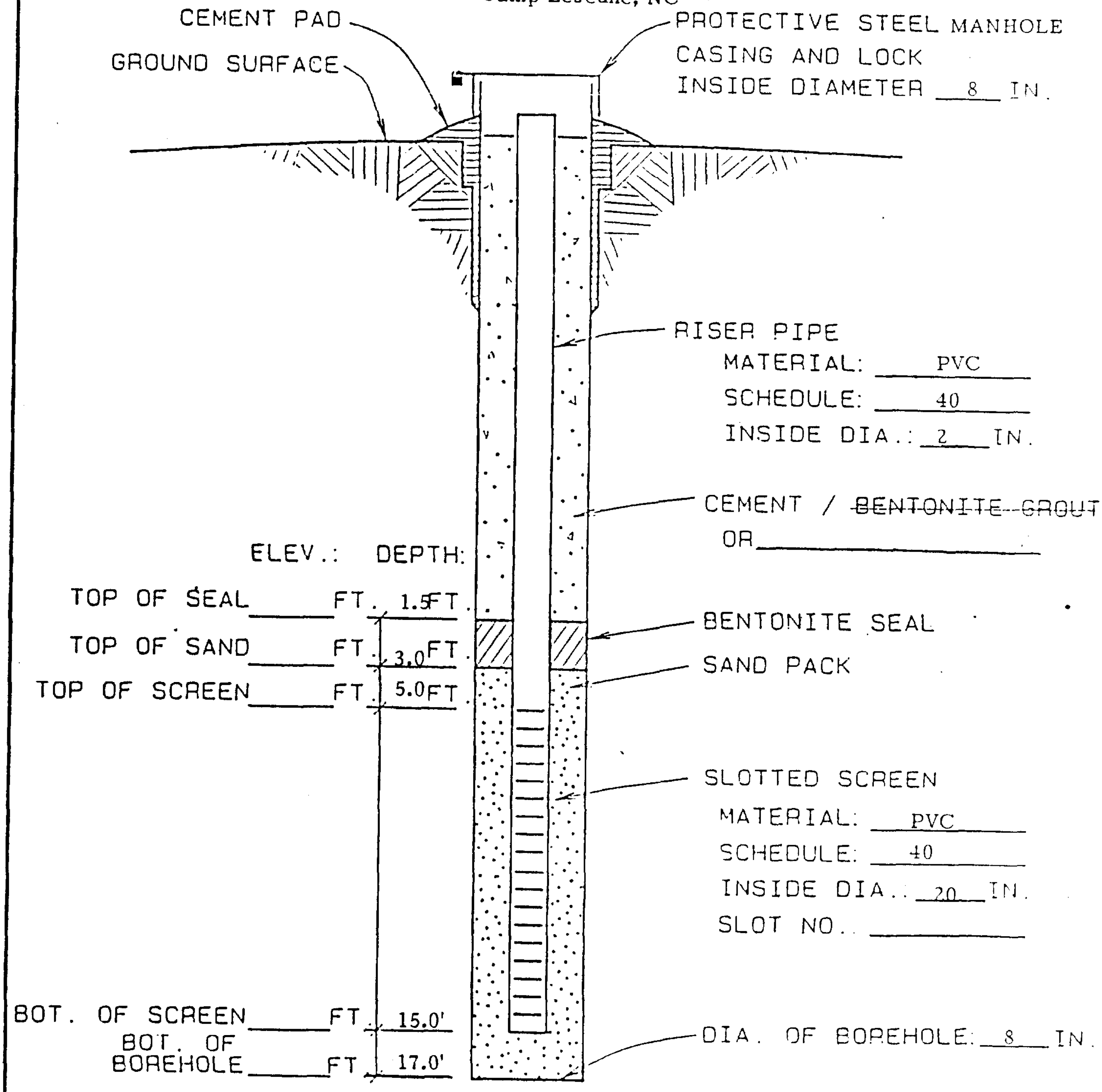
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-7



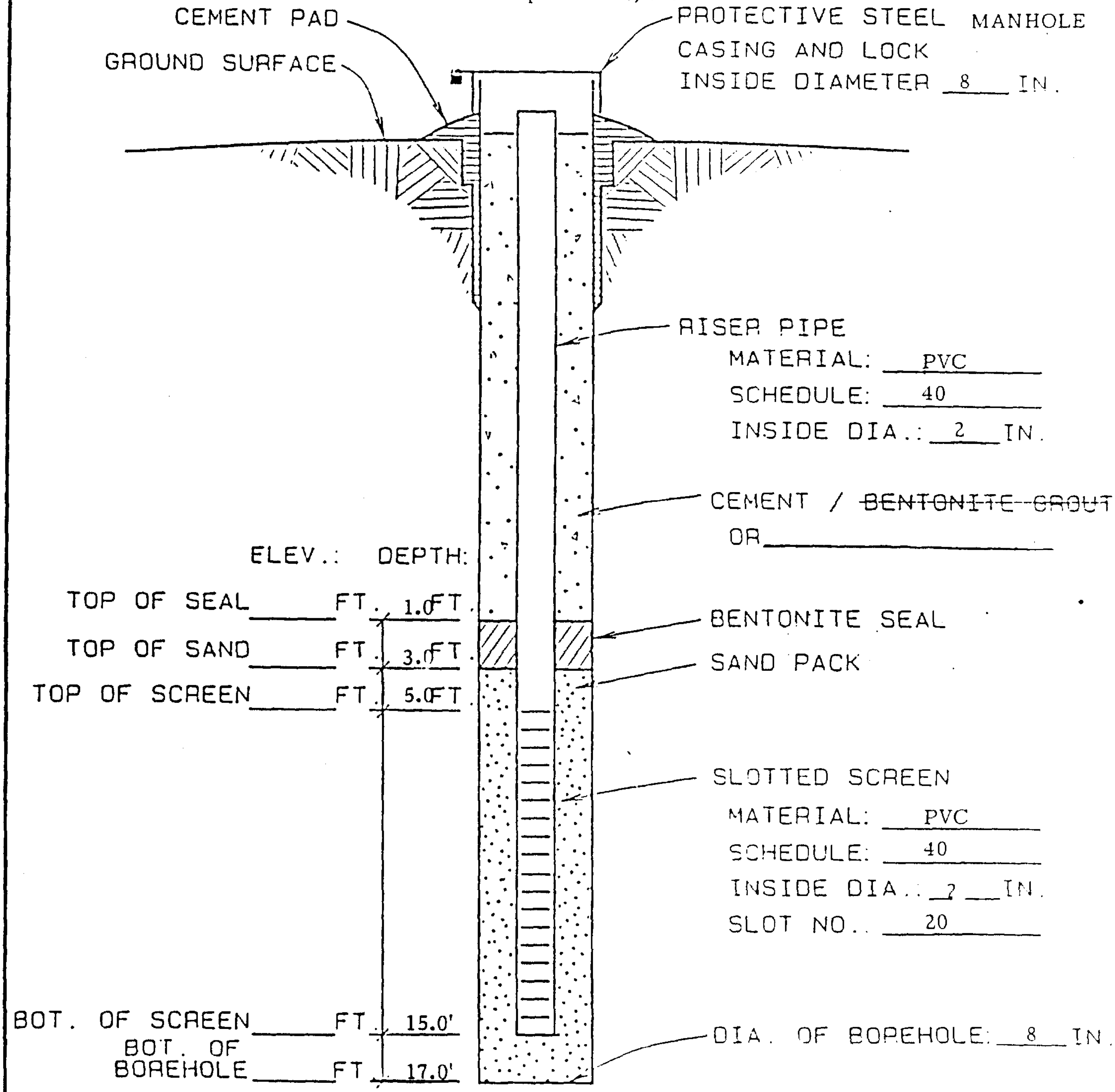
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-8



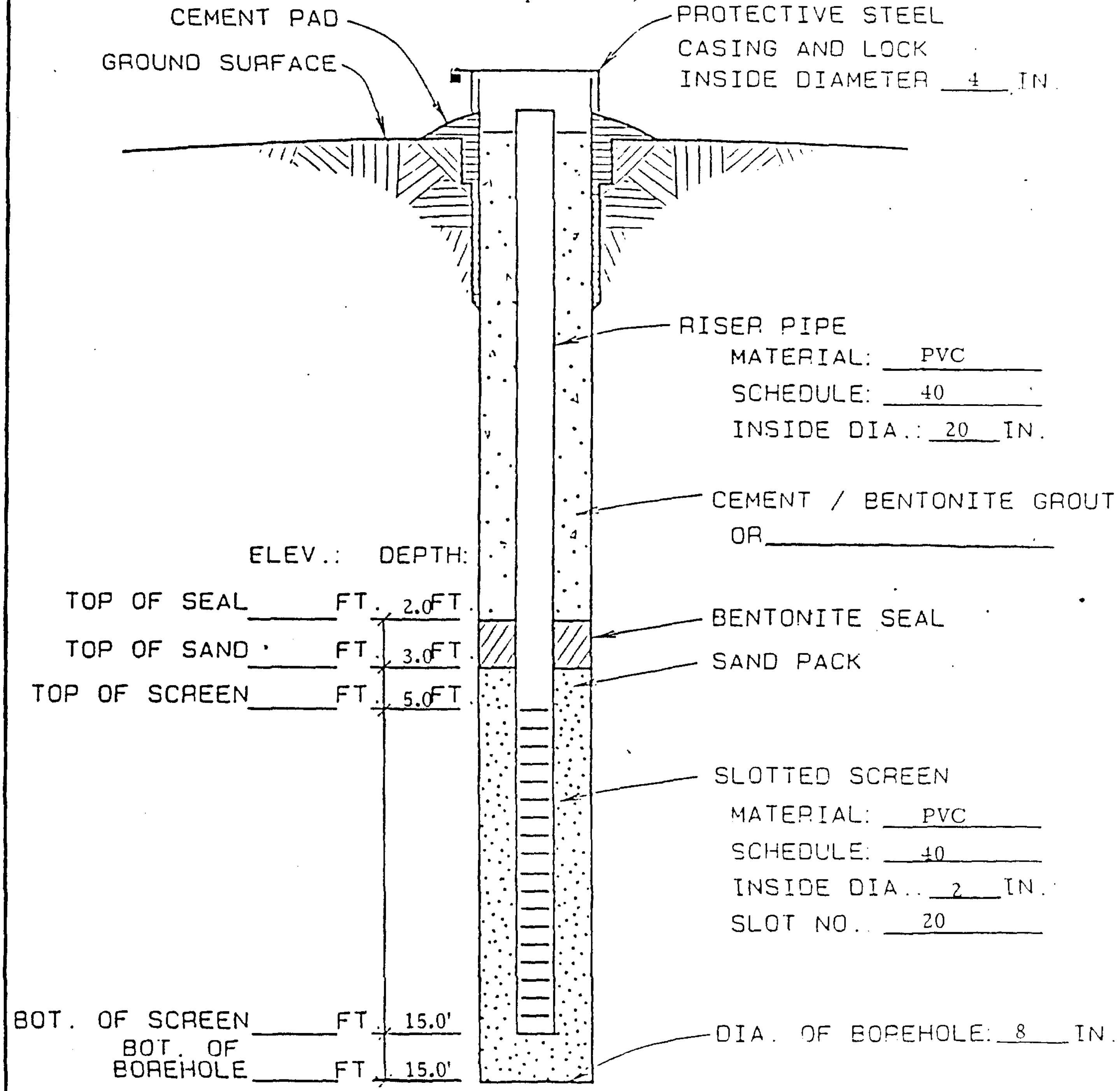
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-9



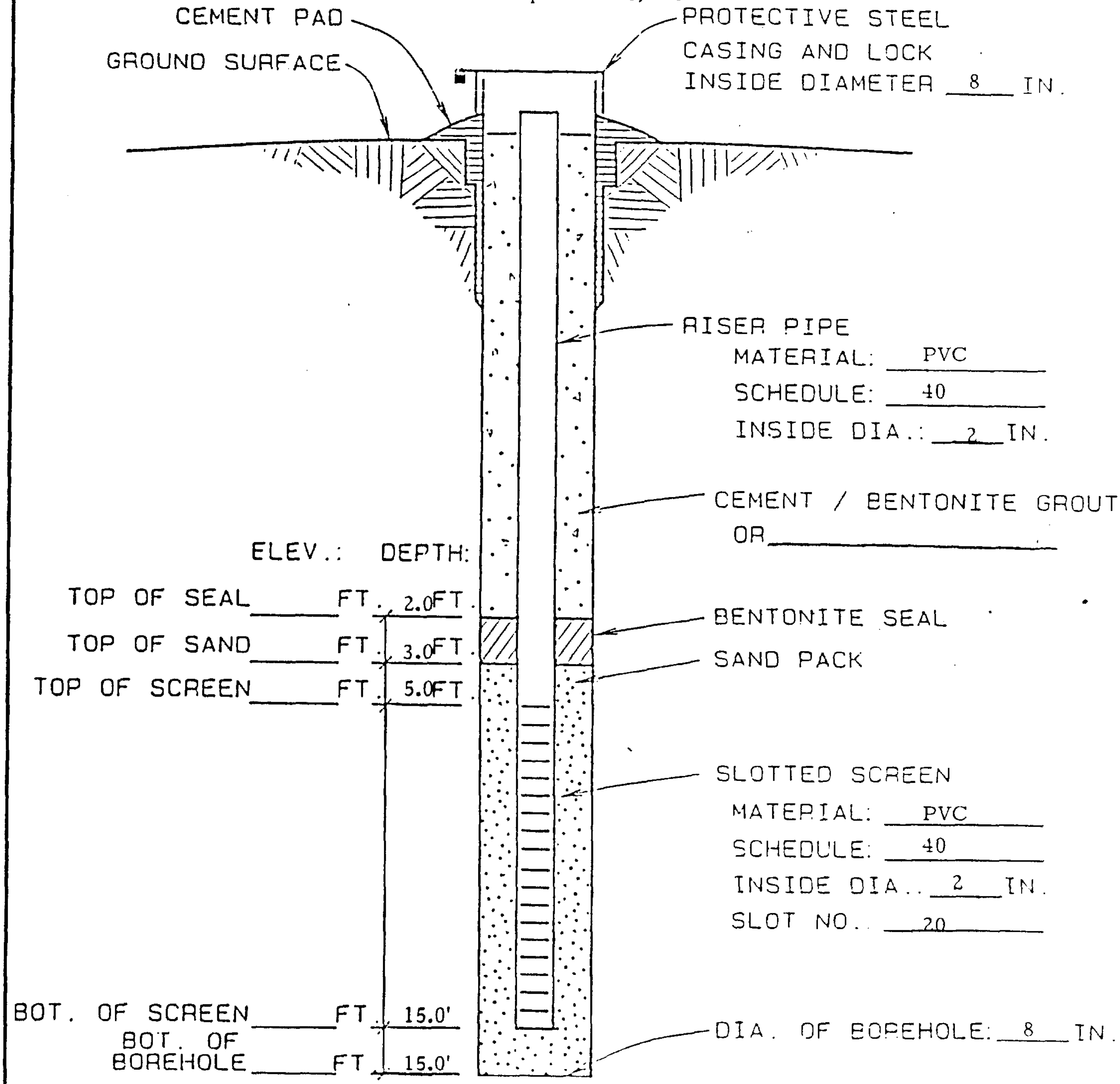
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW 10



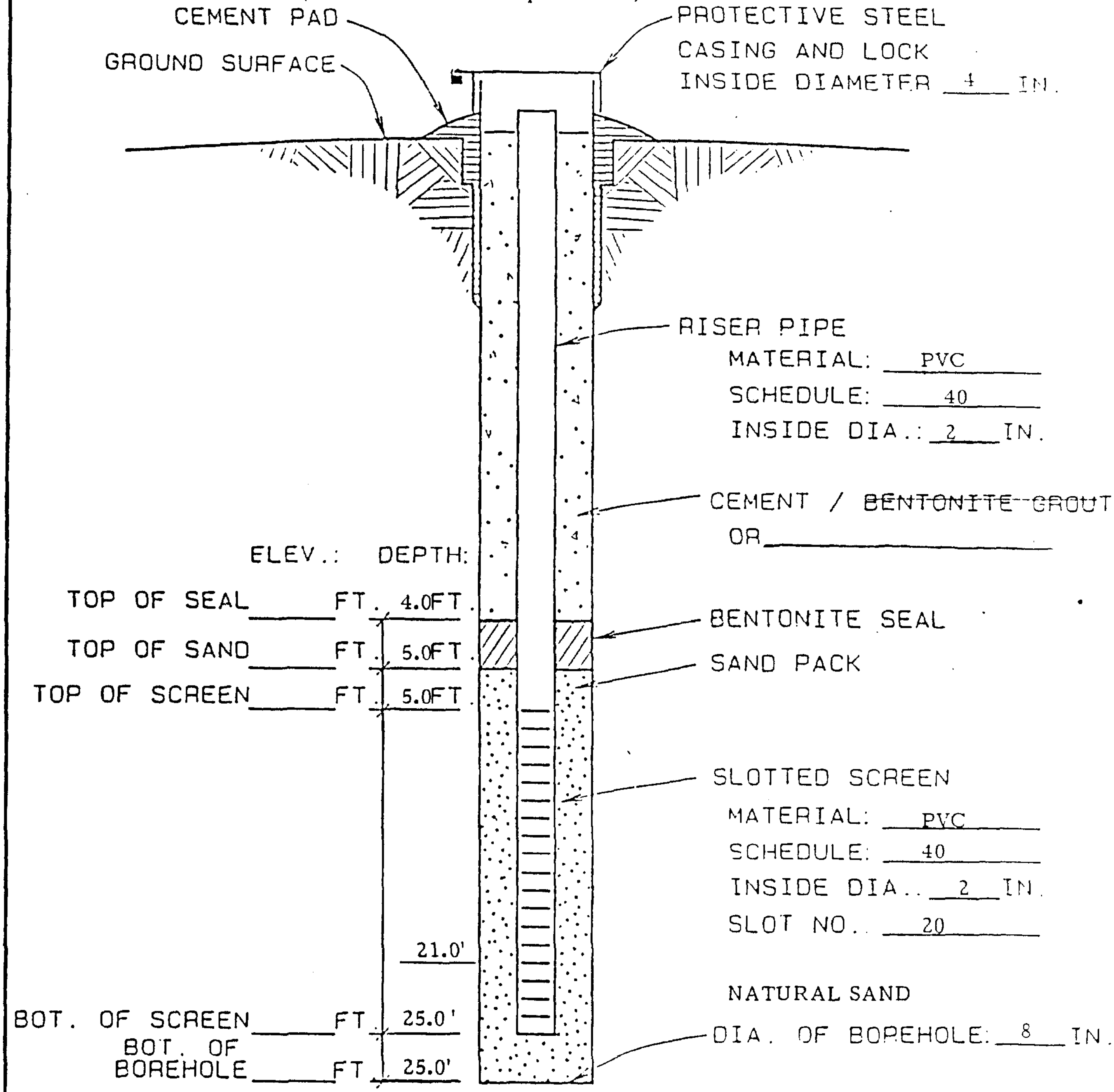
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-11



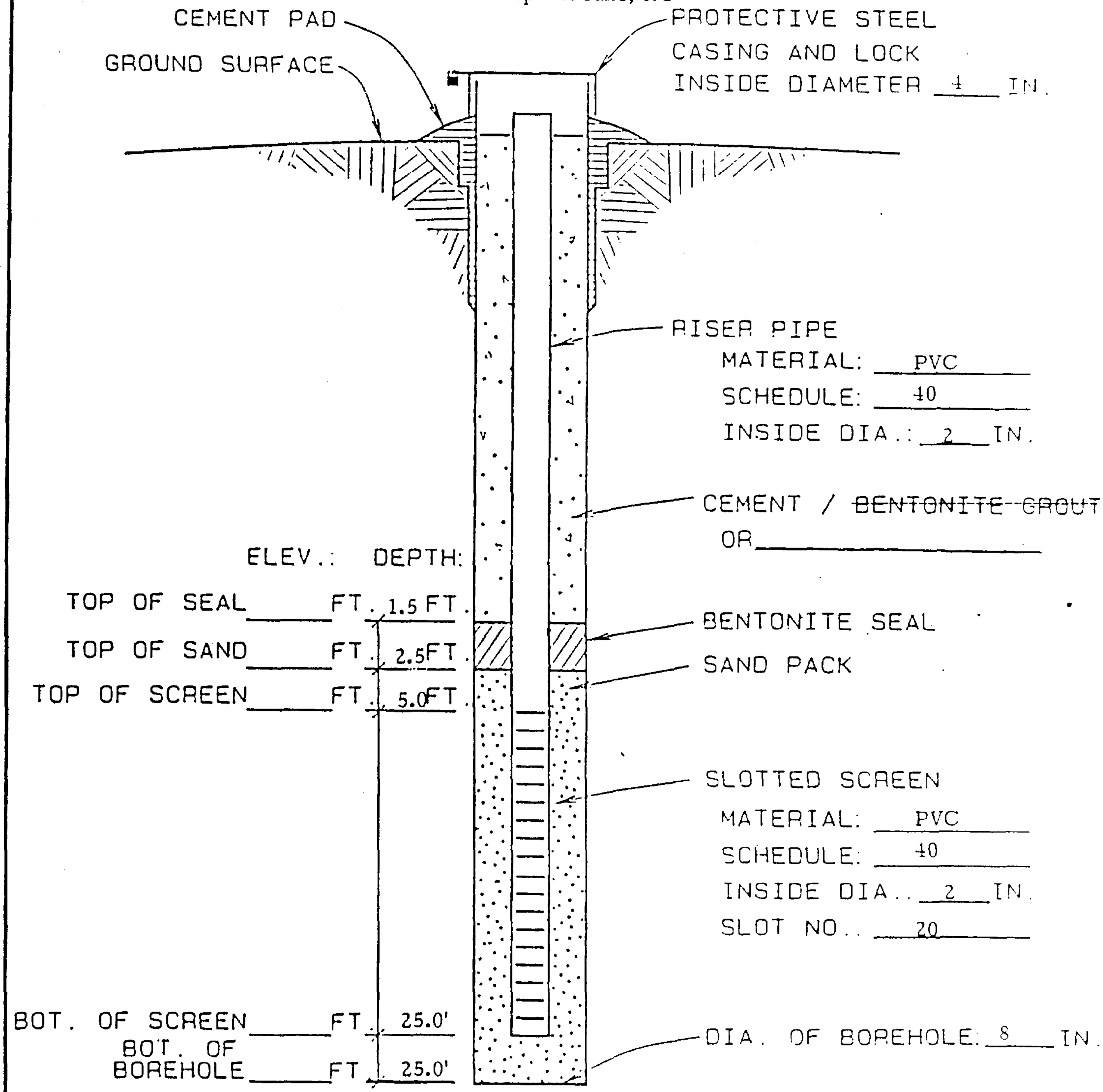
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-12



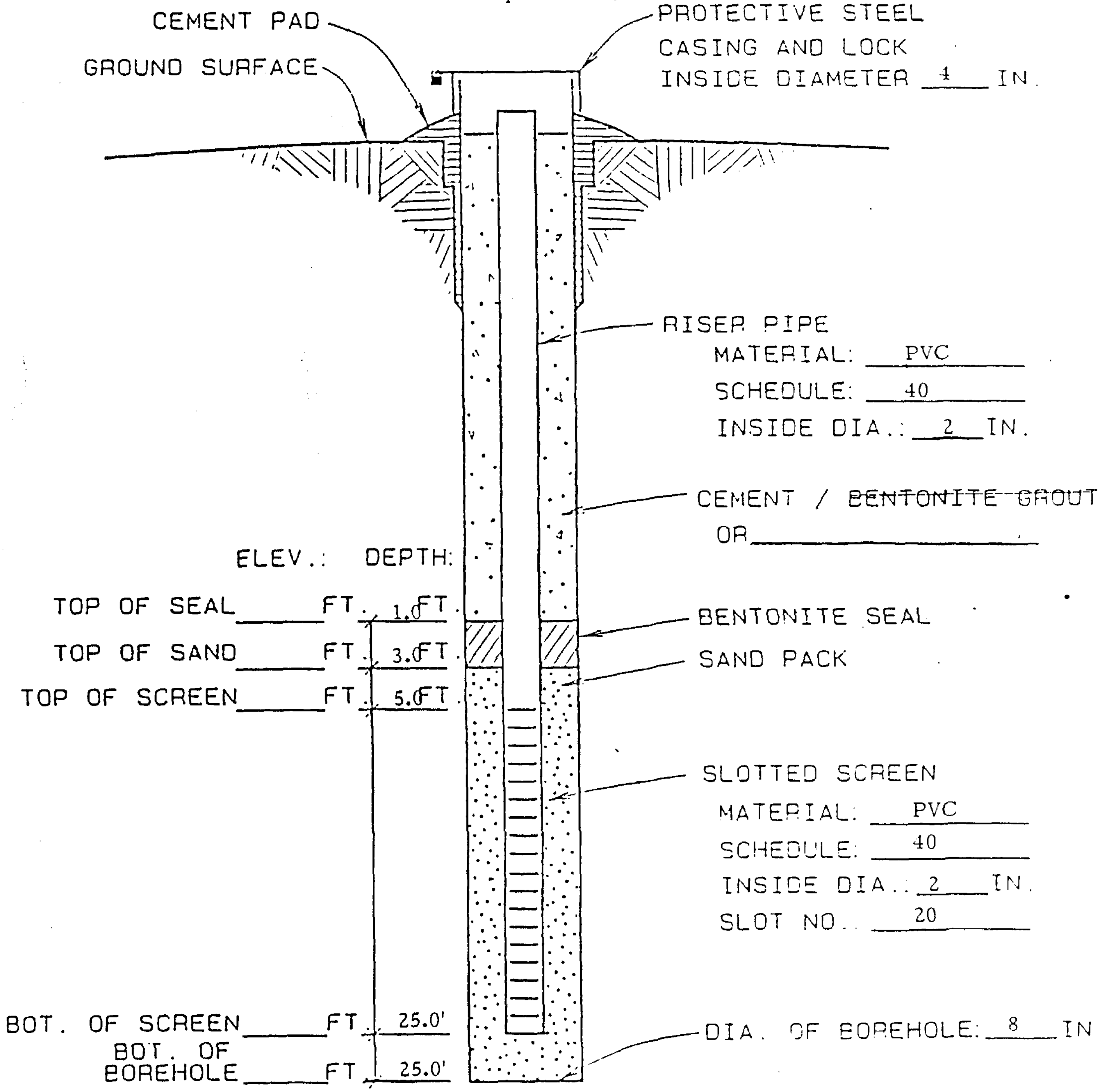
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-13



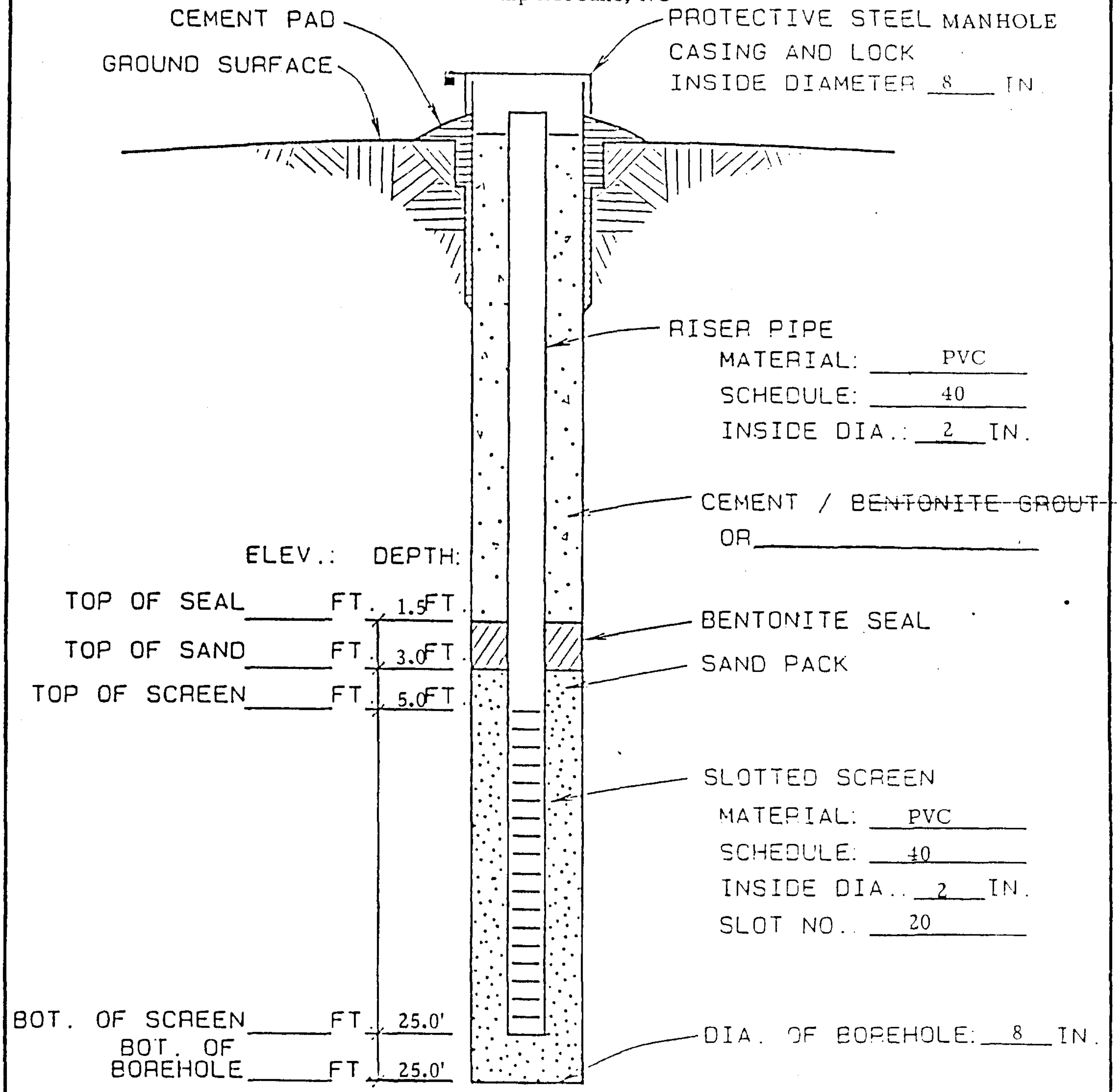
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-14



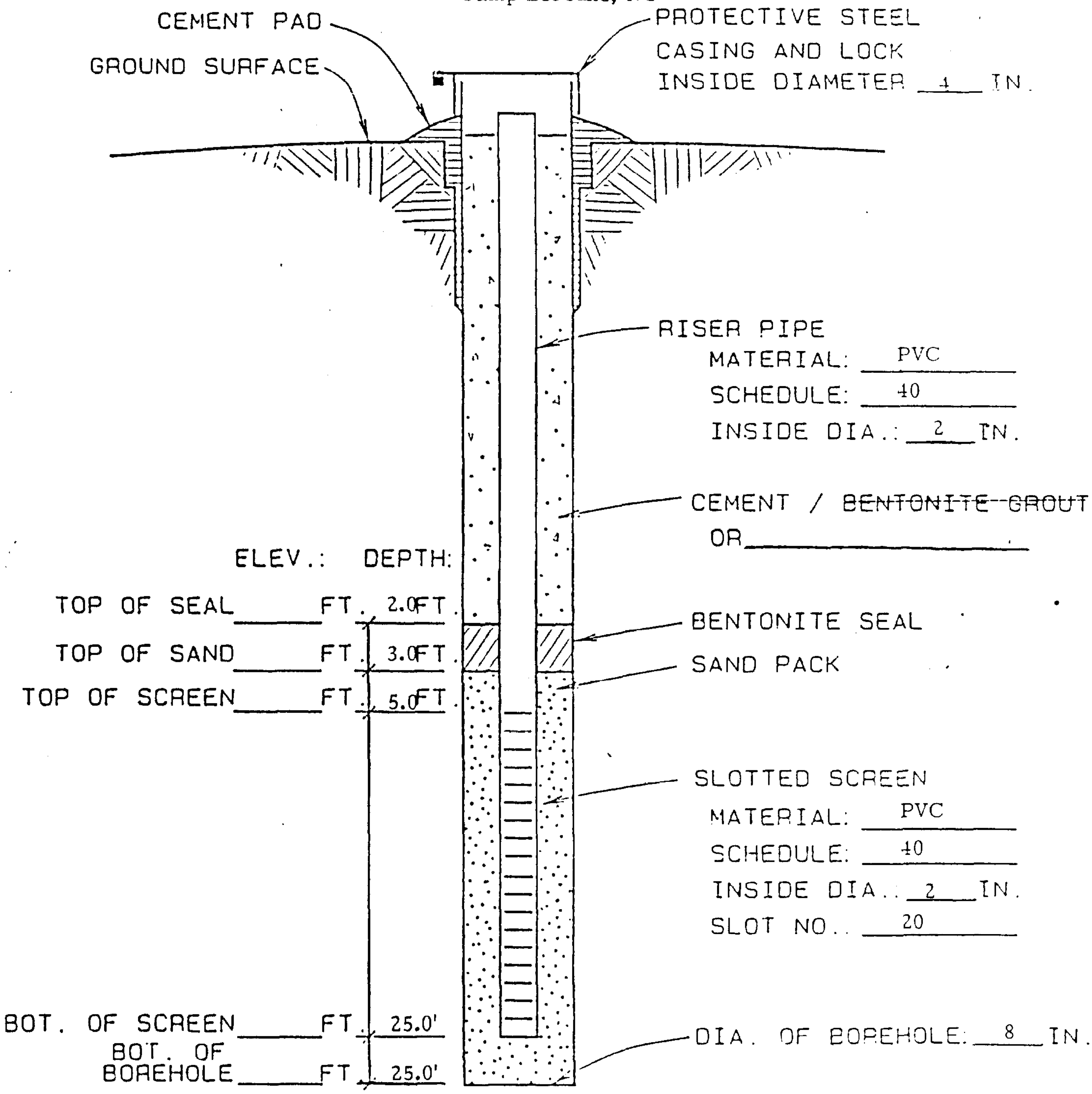
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-15



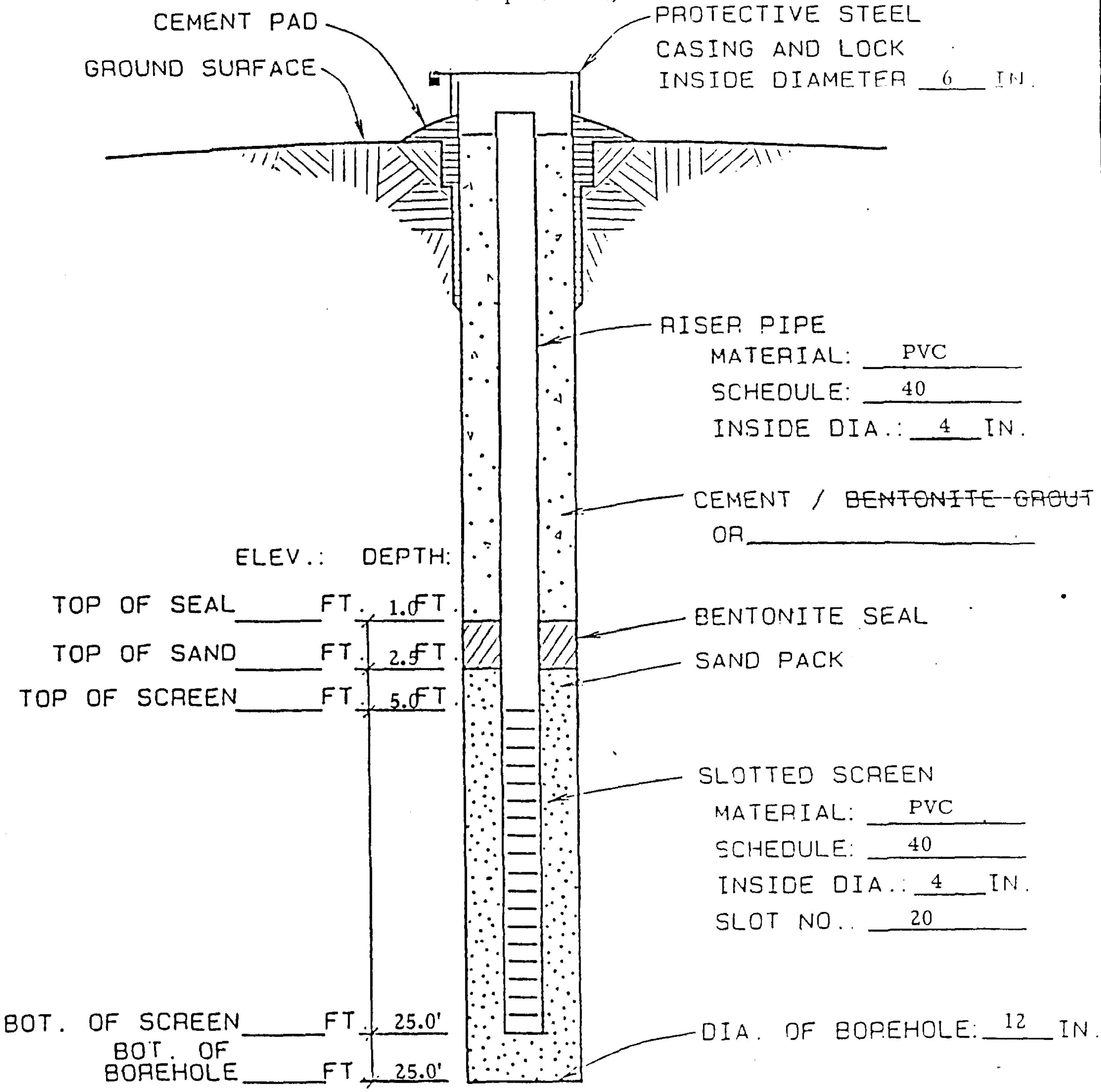
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-16



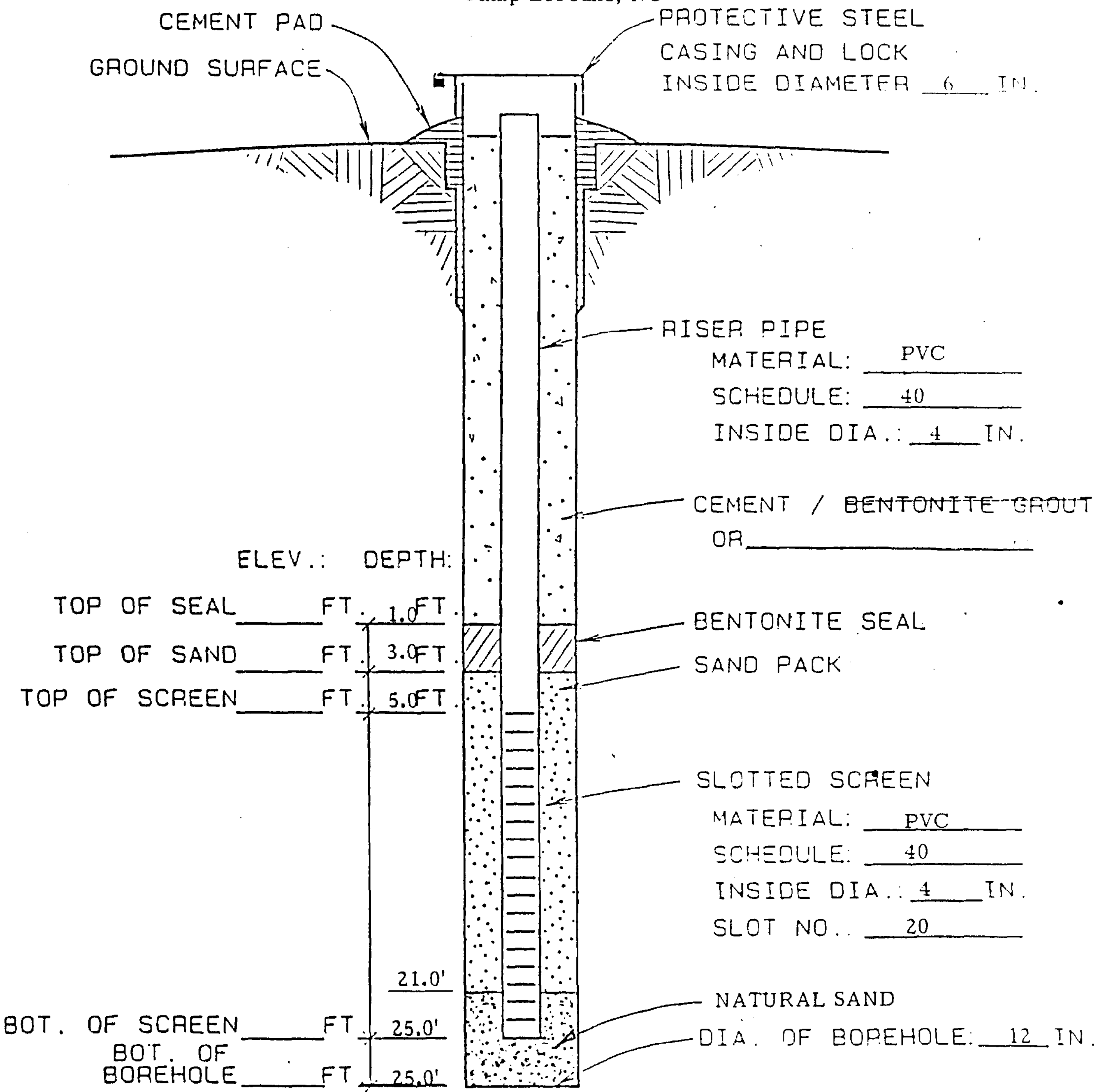
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-17



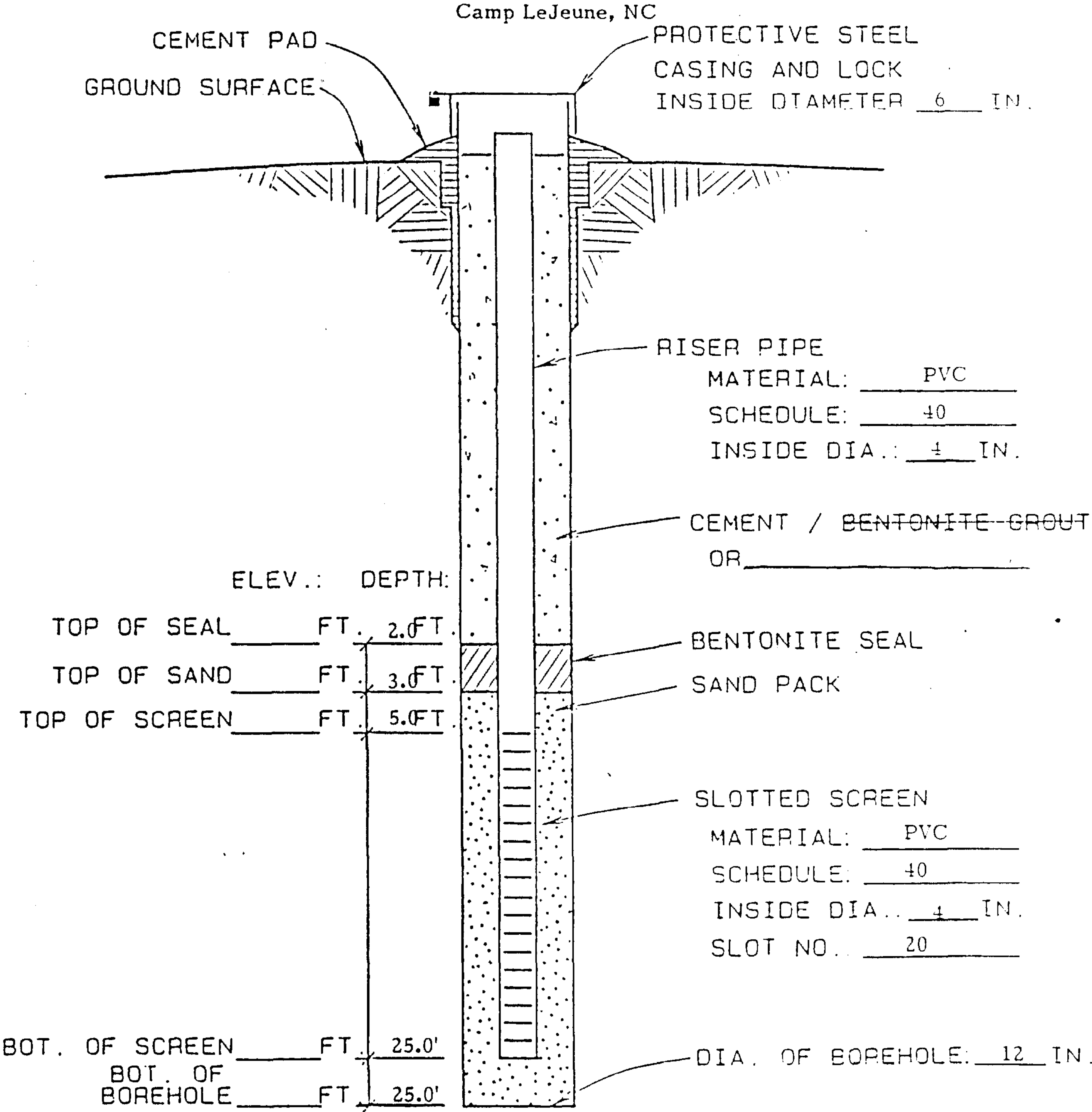
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-18



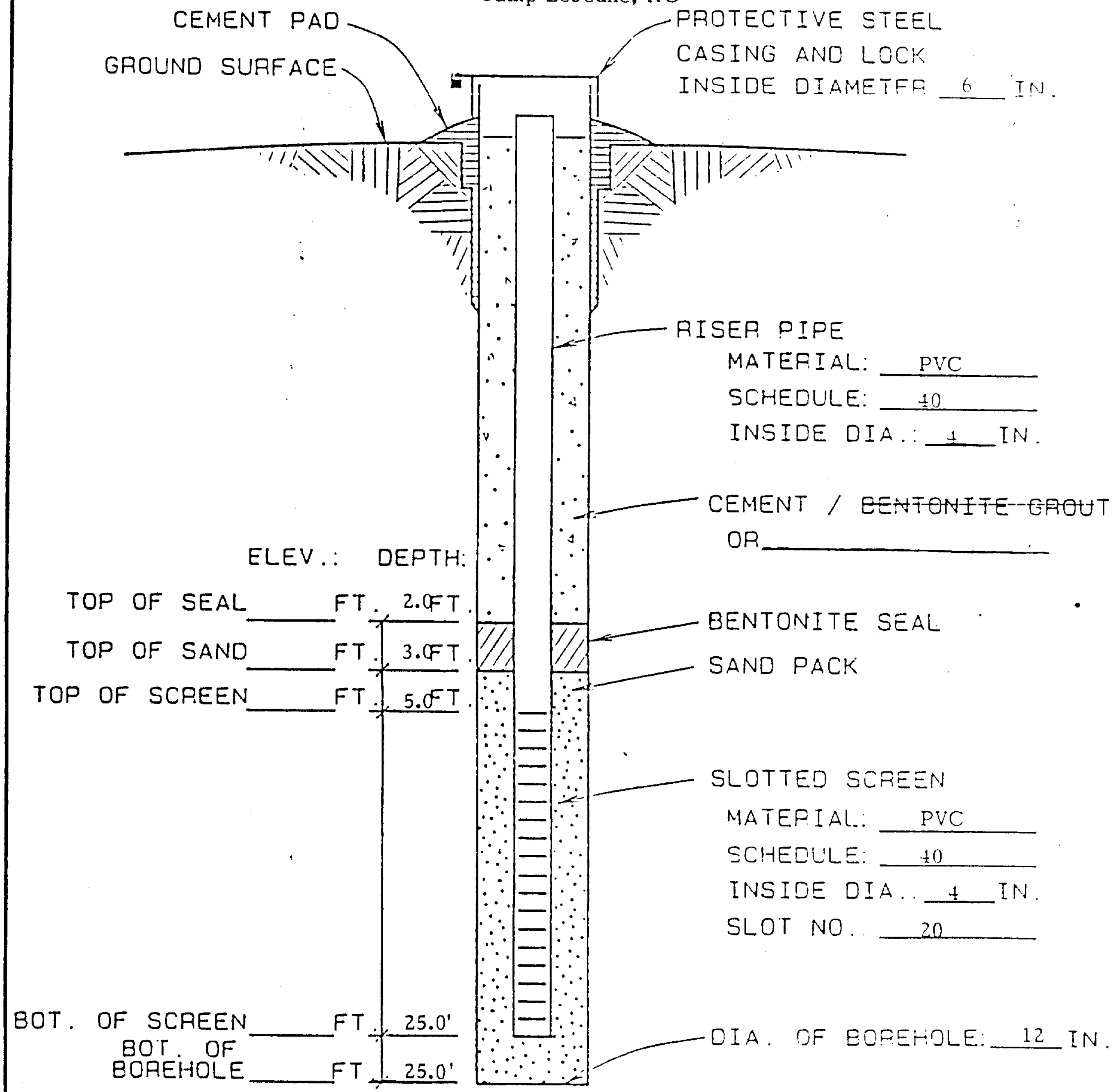
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-19



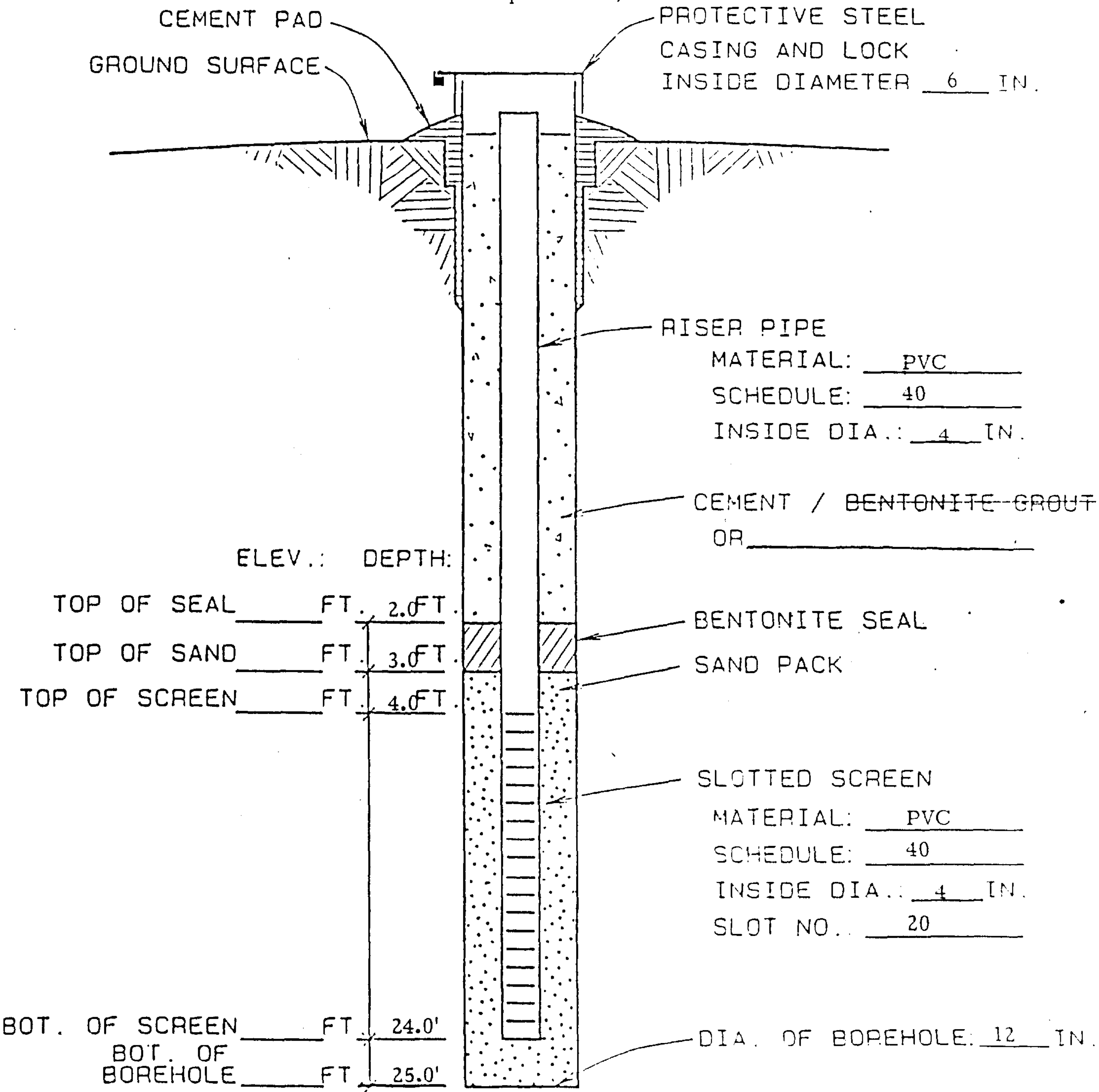
TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

3542.002.320

U.S. Navy
Hadnot Point Tank Farm
Camp LeJeune, NC

Well No. MW-20



TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

APPENDIX D

GROUND WATER SAMPLING PROTOCOL

The following procedures will be used to obtain representative ground water samples. To obtain representative ground water samples from wells containing only a few gallons of ground water, the bailing procedure is preferred (2" I.D. wells). To obtain representative ground water samples from wells containing more than a few gallons, the pumping procedure generally facilitates more rapid sampling (4" I.D. wells). Each of these procedures is explained in detail below.

Sampling Procedures (BAILER)

1. Identify the well and record the location on the Ground Water Sampling Field Log (copy attached).

2. Put on a new pair of disposable gloves.

3. Cut a slit in the center of a plastic sheet, and slip it over the well creating a clean surface onto which the sampling equipment can be positioned.

4. Using an electric well probe, measure the depth to the water table and the bottom of the well. Record this information in the Ground Water Sampling Field Log. Depth measurements will be taken before sampling starts so that this data is collected over the shortest period possible. This will allow for less data variability due to time.

5. Clean the well depth probe and rinse it with distilled water after use.

6. Compute the volume of water in the well, and record this volume on the Ground Water Sampling Field Log.

7. Attach enough polypropylene rope to a clear, LEXAN[R] bailer to reach the bottom of the well, and lower the bailer slowly into the well making certain to submerge it only far enough to fill one-half full. The purpose of this is to recover any oil film, if one is present on the water table.

8. Pull the bailer out of the well keeping the polypropylene rope on the plastic sheet or entirely off the ground if it is too windy to place a plastic sheet. The LEXAN[R] bailer can be used to observe the presence of any floating product layer and the physical appearance of the ground water.

9. Record the physical appearance of the ground water on the Ground Water Sampling Field Log.

10. If a floating product is observed, estimate its volume and note this on the Ground Water Sampling Field Log. The LEXAN[R] bailer should be used to collect a sample of any floating product layer into 40 ml vials for product

identification. After this sample is collected, or if no floating product is found, procede to the next step.

11. Attach the polypropylene rope to a clean, stainless steel bailer, lower the bailer to the bottom of the well, and agitate the bailer up and down to resuspend any material settled in the well.

12. Initiate bailing the well from the well bottom making certain to keep the polypropylene rope on the plastic sheet. All ground water should be poured from the bailer into a graduated pail to measure the quantity of water removed from the well.

13. Continue bailing the well throughout the water column and from the bottom until a sufficient volume of ground water in the well has been removed, or until the well is bailed dry. If the well is bailed dry, allow sufficient time for the well to recover before proceeding with the next step. Record this information on the Ground Water Sampling Field Log.

14. Remove the sampling bottles from their transport containers, and prepare the bottles for receiving samples. Inspect all labels to insure proper sample identification. Sample bottles should be kept cool with their caps on until they are ready to receive samples. Arrange the sampling containers to allow for convenient filling. Always fill the containers labeled "volatiles" (40 ml VOA bottles) first.

15. To minimize agitation of the water in the well, initiate sampling by lowering the stainless steel bailer slowly into the well making certain to submerge it only far enough to fill it completely.

16. If the sample bottle cannot be filled quickly, keep them cool with the caps on until they are filled. The vials labeled "volatiles" analysis should be filled from one bailer then securely capped. Add 0.2 ml of a mixture of 1 part A.C.S. reagent grade, concentrated hydrochloric acid (approximately 38%) to 1 part of organic-free water to each 40 ml VOA vial. This will adjust the pH to less than 2. Carefully fill the 40 ml VOA vials to minimize agitation. This is usually done by pouring the sample into a tilted VOA vial. Cap the VOA vial, turn it upside down, and check for air bubbles. If properly filled, there should be no visible air bubbles. Filter samples for metals analysis through a 0.45 micron filter and adjust the pH to less than 2 with A.C.S. reagent grade, concentrated (approximately 69-71%) nitric acid. Alternatively, metals samples may be filtered in the laboratory. If this option is selected, do not add the nitric acid preservative. Return each sample bottle to its proper transport container. Samples must not be allowed to freeze.

17. Record the physical appearance of the ground water observed during sampling on the Ground Water Sampling Field Log.

18. Begin the Chain of Custody Record.

19. Clean the bailer by washing it with a mild detergent, rinsing it with potable water, followed by a distilled water rinse. Store the bailer in a clean, dry place.

20. Replace the well cap, and lock the well protection assembly before leaving the well location.

21. Place the polypropylene rope, gloves, and plastic sheeting into a plastic bag for disposal.

Sampling Procedures (PUMP)

1. Identify the well and record the location on the Ground Water Sampling Field Log (copy attached).

2. Put on a new pair of disposable gloves.

3. Cut a slit in the center of a plastic sheet, and slip it over the well creating a clean surface onto which the sampling equipment can be positioned.

4. Using an electric well probe, measure the depth to the water table and the bottom of the well. Record this information in the Ground Water Sampling Field Log. As previously mentioned, all depth to water table and well depth measurements will be taken for all wells before sampling begins.

5. Clean the well depth probe and rinse it with distilled water after use.

6. Compute the volume of water in the well, and record this volume on the Ground Water Sampling Field Log.

7. Attach enough polypropylene rope to a clear LEXAN^R bailer to reach just below the surface of the water table, and lower the bailer slowly into the well making certain to submerge it only far enough to fill it one-half full. The purpose of this is to recover any oil film, if one is present on the water table.

8. Pull the bailer out of the well keeping the polypropylene rope on the plastic sheet. The LEXAN^R bailer can be used to observe the presence of any floating product layer and the physical appearance of the ground water.

9. Record the physical appearance (color, odor, turbidity, and presence of a floating product) of the ground water on the Ground Water Sampling Field Log.

10. If a floating product is found, follow the procedures in Step 10 of the "Bailer" section.

11. Prepare the pump for operation. Connect the dedicated polyethylene tubing to a delrin foot valve. Additional information on the pumps is attached. Each pump will be dedicated to a well and therefore not used to purge any other well.

12. Lower the pump to near the bottom of the well and pump the ground water into a graduated pail. Pumping should continue until sufficient well volumes have been removed or the well is pumped dry. If the well is pumped dry, allow sufficient time for the well to recover before proceeding with Step 13. Record this information on the Ground Water Sampling Field Log. The pump will be used to collect samples from any wells containing a floating product layer.

13. Remove the sampling bottles from their transport containers, and prepare the bottles for receiving samples. Inspect all labels to insure proper sample identification. Sample bottles should be kept cool with their caps on until they are ready to receive samples. Arrange the sampling containers to allow for convenient filling. Always fill the vials labelled "volatiles" (40 ml VOA vials) first. Filter samples for metals analysis and add nitric acid, as previously discussed in the "Bailer" section, to adjust the pH to less than 2. Alternatively, metals samples may be filtered in the laboratory. If this option is selected, do not add the nitric acid preservative. Preserve the volatiles samples with hydrochloric acid as previously discussed in the "Bailer" section.

14. To minimize agitation of the water in the well, initiate sampling using a gentle pumping action.

15. If the sample bottle cannot be filled quickly, keep them cool with the caps on until they are filled. Return each sample bottle to its proper transport container. Samples must not be allowed to freeze.

16. Record the physical appearance of the ground water observed during sampling on the Ground Water Sampling Field Log.

17. Begin the Chain of Custody Record.

18. If a bailer is used for sample collection, clean the bailer by washing it with a mild detergent, rinsing it with potable water., followed by a distilled water rinse. Store the bailer in a clean, dry place.

19. Replace the well cap, and lock the well protection assembly before leaving the well location.

20. Place the polypropylene rope, gloves, and plastic sheet into a plastic bag for disposal.

APPENDIX E

LABORATORIES, INC.

Laboratory Report

CLIENT NAVY

JOB NO 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED 4-20 & 21, 1988 DATE REC'D. 4-22-88 DATE ANALYZED 4-29 to 5-3, 1988

Description	MW#1	MW#2	MW#3	MW#4	MW#5	MW#6	MW#7	MW#8	MW#9	MW#10	MW#11	MW#12
Sample #	G7934	G7935	G7936	G7937	G7938	G7939	G7940	G7941	G7942	G7943	G7944	G7945
Petroleum Hydrocarbons and Solvents by Purge & Trap/GC												
BENZENE	19000.	29000.	<1.	<1.	<1.	600.	28000.	19.	<1.	51.	1.	19000.
TOLUENE	36000.	110000.	2.	↓	1.	1700.	26000.	1.	<1.	1.	1.	17000.
ETHYLBENZENE	3200.	11000.	<1.	↓	<1.	1600.	2800.	<1.	2.	9.	<1.	1500.
XYLENES	21000.	48000.	4.	2.	2.	7100.	12000.	<1.	8.	14.	1.	8400.
TRICHLOROETHENE	<1000.	<1000.	<1.	<1.	<1.	<100.	<1000.	<1.	<1.	<1.	<1.	<1000.
TETRACHLOROETHENE	<1000.	<1000.	4.	<1.	<1.	<100.	<1000.	<1.	<1.	<1.	<1.	<1000.
1,2-DICHLOROETHANE	1000.	<1000.	<1.	<1.	<1.	<100.	1000.	<1.	<1.	1.	<1.	2000.
MTBE	<10000.	<10000.	<10.	<10.	<10.	<1000.	<10000.	<10.	<10.	<10.	<10.	<10000.
TOTAL HYDROCARBONS	97000.	300000.	480.	16.	<10.	13000.	68000.	26.	92.	170.	<10.	50000.
COMMENTS	Gasoline	Gasoline	Gasoline	-	-	Gasoline	Gasoline	-	Gasoline	Gasoline	-	Gasoline

Methodology: Federal Register — 40 CFR Part 136, October 26, 1984

Units: mg/l (ppm) unless otherwise noted

Comments:

[illegible]

June 9, 1988

LABORATORIES, INC.

Laboratory Report

CLIENT NAVY JOB NO. 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED 4-20 & 21, 1988 DATE REC'D. 4-22-88 DATE ANALYZED 4-29 to 5-3, 1988

Description	MW#13	MW#14	MW#15	MW#16	MW#17	MW#18	MW#19	MW#20	Replicate	Wash Blank	Q C Trip Blank
Sample #	G7946	G7947	G7948	G7949	G7950	G7951	G7952	G7953	G7954	G7955	G7961
Petroleum Hydrocarbons and Solvents by Purge & Trap/GC											
BENZENE	2.	6.	4700.	28000.	11000.	24000.	21.	60.	12000.	<1.	<1.
TOLUENE	2.	<1.	18000.	28000.	13000.	42000.	150.	160.	35000.	↓	↓
ETHYLBENZENE	2.	<1.	2400.	1900.	2500.	1900.	53.	79.	2400.	↓	↓
XYLENES	8.	2.	13000.	12000.	9100.	12000.	130.	9[illegible].	11000.	↓	↓
TRICHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000.	<1.	[illegible]	<1000.	<1.	<1.
TETRACHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000.	<1.	<1.	<1000.	<1.	<1.
1,2-DICHLOROETHANE	<1.	<1.	<1000.	1800.	200.	<1000.	<1.	<[illegible].	<1000.	<1.	<1.
MTBE	<10.	<10.	<10000.	10000.	2800.	<10000.	<10.	<10.	<10000.	<10.	<10.
TOTAL HYDROCARBONS	23.	11.	43000.	79000.	42000.	96000.	640.	870.	62000.	<10.	<10.
COMMENTS	-	-	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	-	-

Methodology: Federal Register 40 CFR, Part 136, October 26 1984

Units mg/l (ppm) unless otherwise noted

Comments:

June 9, 1988

OBG LABORATORIES, INC.

Laboratory Report

CLIENT: NAVY JOB NO. 3543.004.517

DESCRIPTION: Camp Lejeune - Hadnot Pt.

DATE COLLECTED: 4-20-88 DATE REC'D.: 4-22-88 DATE ANALYZED: 6-3-88

Description	Sample #	Petroleum Identification		
MW-2 Product	G7956	Gasoline		
MW-7 Product	G7957	Gasoline		
MW-12 Product	G7958	Gasoline		
MW-16 Product	G7959	Gasoline		
MW-18 Product	G7960	Gasoline		

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

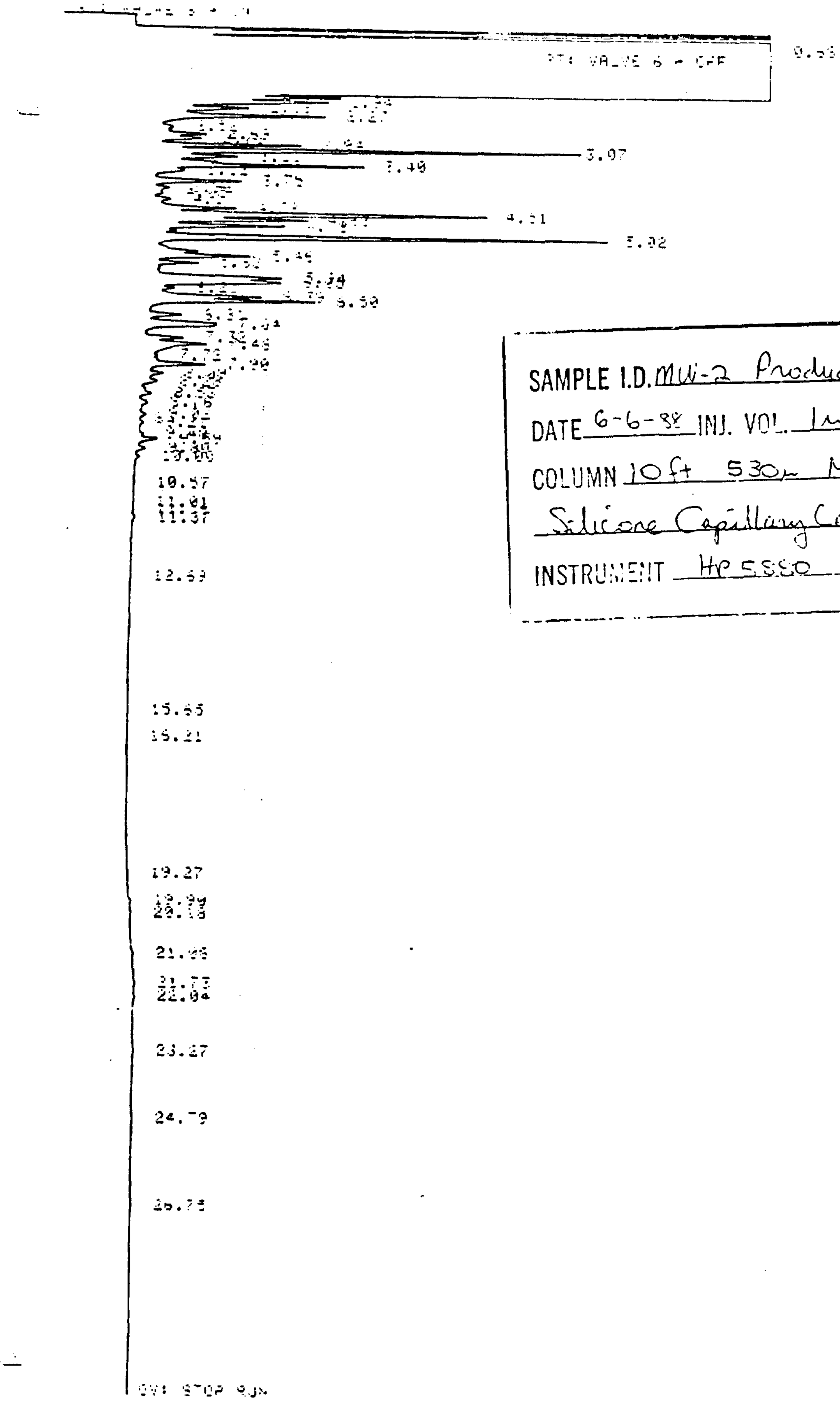
Units: mg/ℓ (ppm) unless otherwise noted

Comments:

Authorized:

Date: June 9, 1988

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY / 13221 / (315) 457-1494



SAMPLE I.D. MW-2 Product

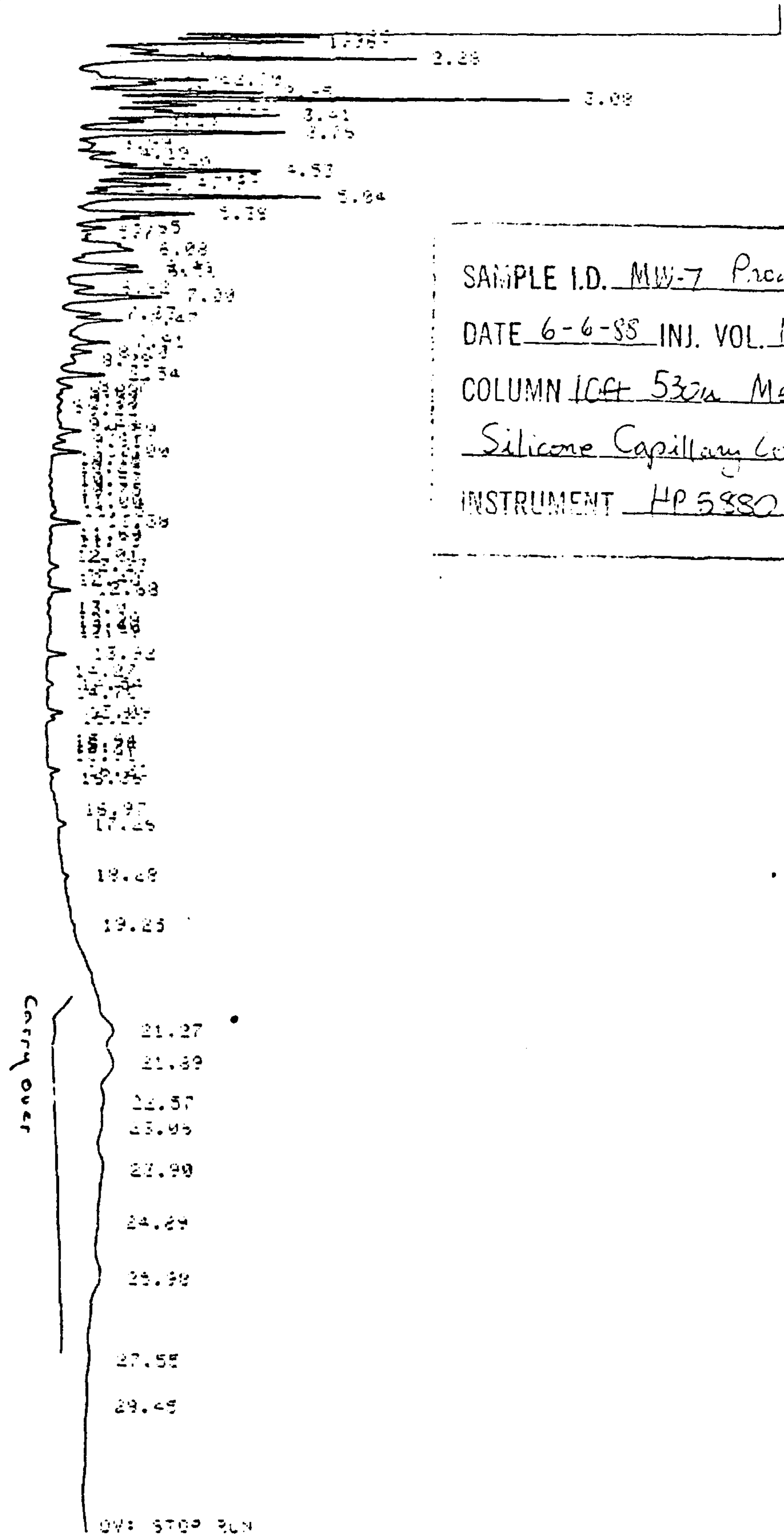
DATE 6-6-88 INJ. VOL. 1ul

COLUMN 10 ft 530u Methyl Silicone Capillary Column

INSTRUMENT HP 5880

[52] 5880A SAMPLER INJECTION 9 10:53 JUN 7, 1988
SAMPLE # : ID CODE :
12 07356
AREA %

RT	AREA	TYPE	AREA %
0.68	[illegible]	[illegible]	[illegible]



SAMPLE I.D. MW-7 Product

DATE 6-6-88 INJ. VOL. 1ul

COLUMN 10ft 530u Methyl Silicone Capillary Column

INSTRUMENT HP 5880

029

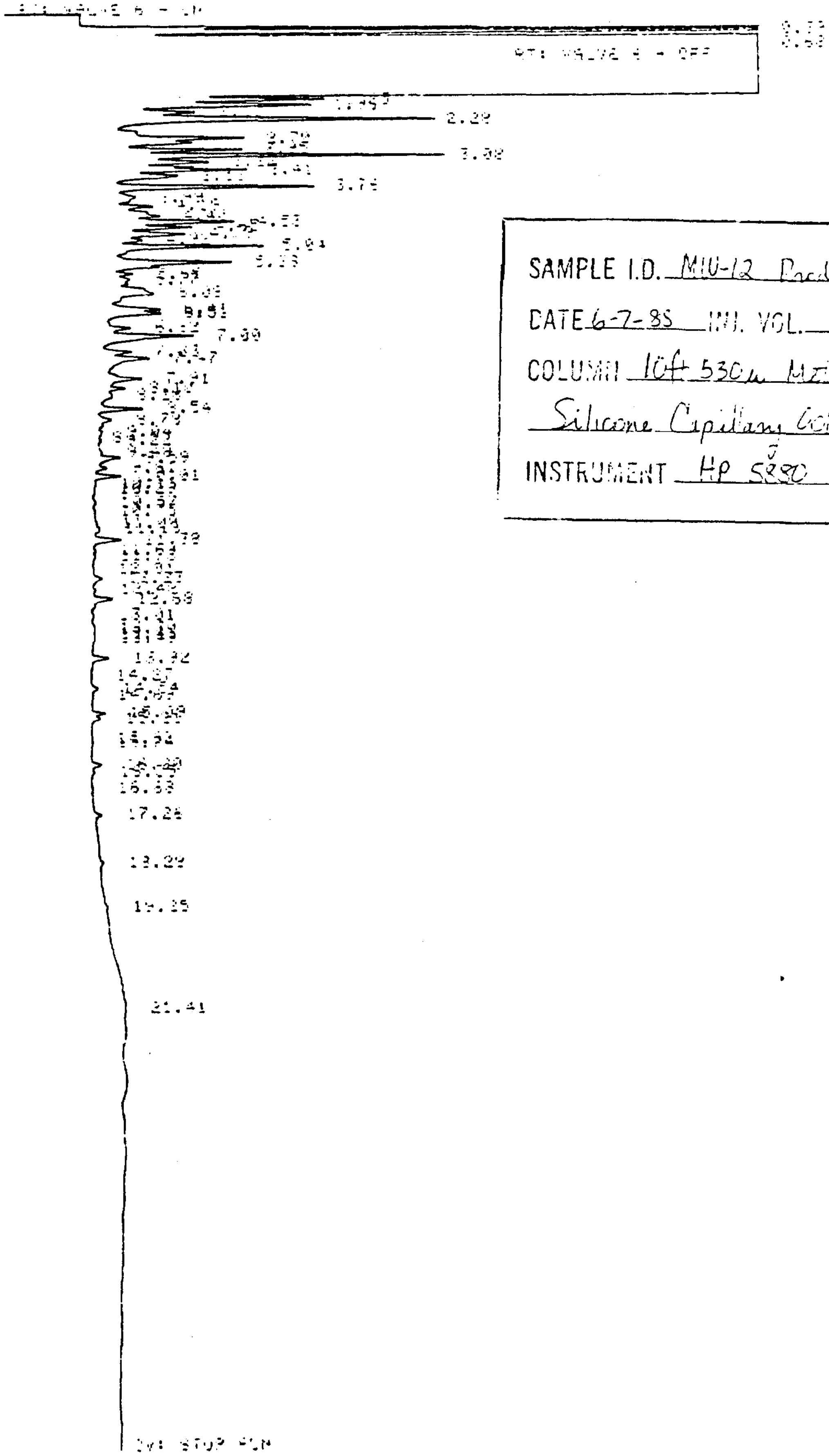
OV: STOP RUN

[HP] 58809 SAMPLER INJECTION @ 23:33 JUN 6, 1988

SAMPLE # : ID CODE :
13 G7957

AREA %

RT	AREA	TYPE	AREA %
0.39	1451.26	BB	0.011
0.68	12461300.00	SBB	99.353
1.85	119.23	BB	0.001
1.96	201.44	BB	0.002
2.13	47.13	BB	0.000



SAMPLE I.D. MIU-12 Product

DATE 6-7-88 INJ. VOL. 1ul

COLUMN 10ft 530u Methyl Silicone Capillary Column

INSTRUMENT HP 5880

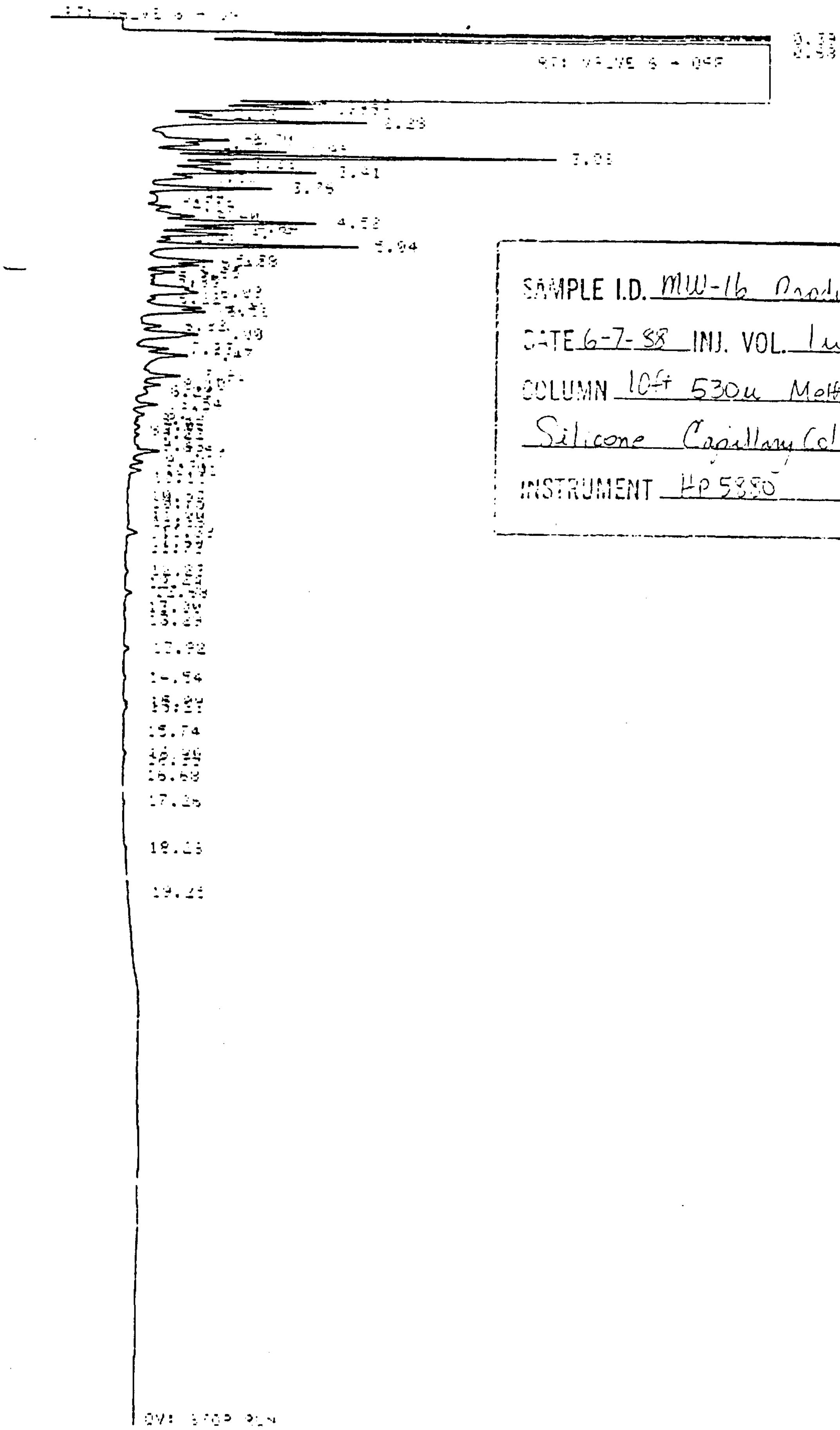
032

[HP] 5890A SAMPLER INJECTION @ 00:12 JUN 7, 1988
SAMPLE # : ID CODE :
14 67459

AREA %

RT	AREA	TYPE	AREA %
[illegible]	[illegible]	[illegible]	[illegible]

TOTAL AREA = [illegible]
MULTIPLIER = 1



SAMPLE I.D. MW-16 Product

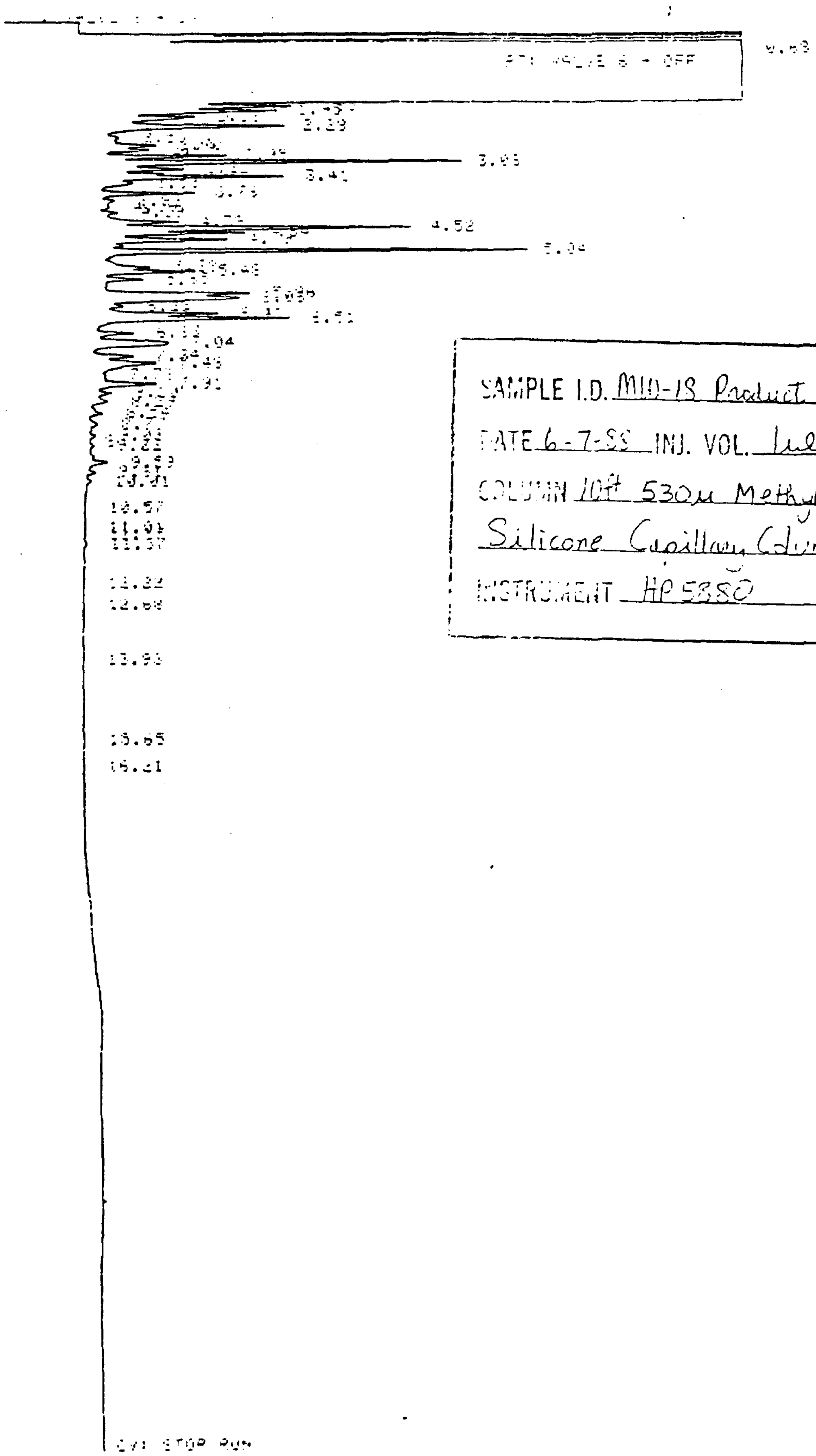
DATE 6-7-88 INJ. VOL. 1ul

COLUMN 10ft 530u Methyl Silicone Capillary Column

INSTRUMENT HP 5880

[HP] 5880A SAMPLER INJECTION # [illegible] JUN 7, 1988
SAMPLE # : ID CODE :

036



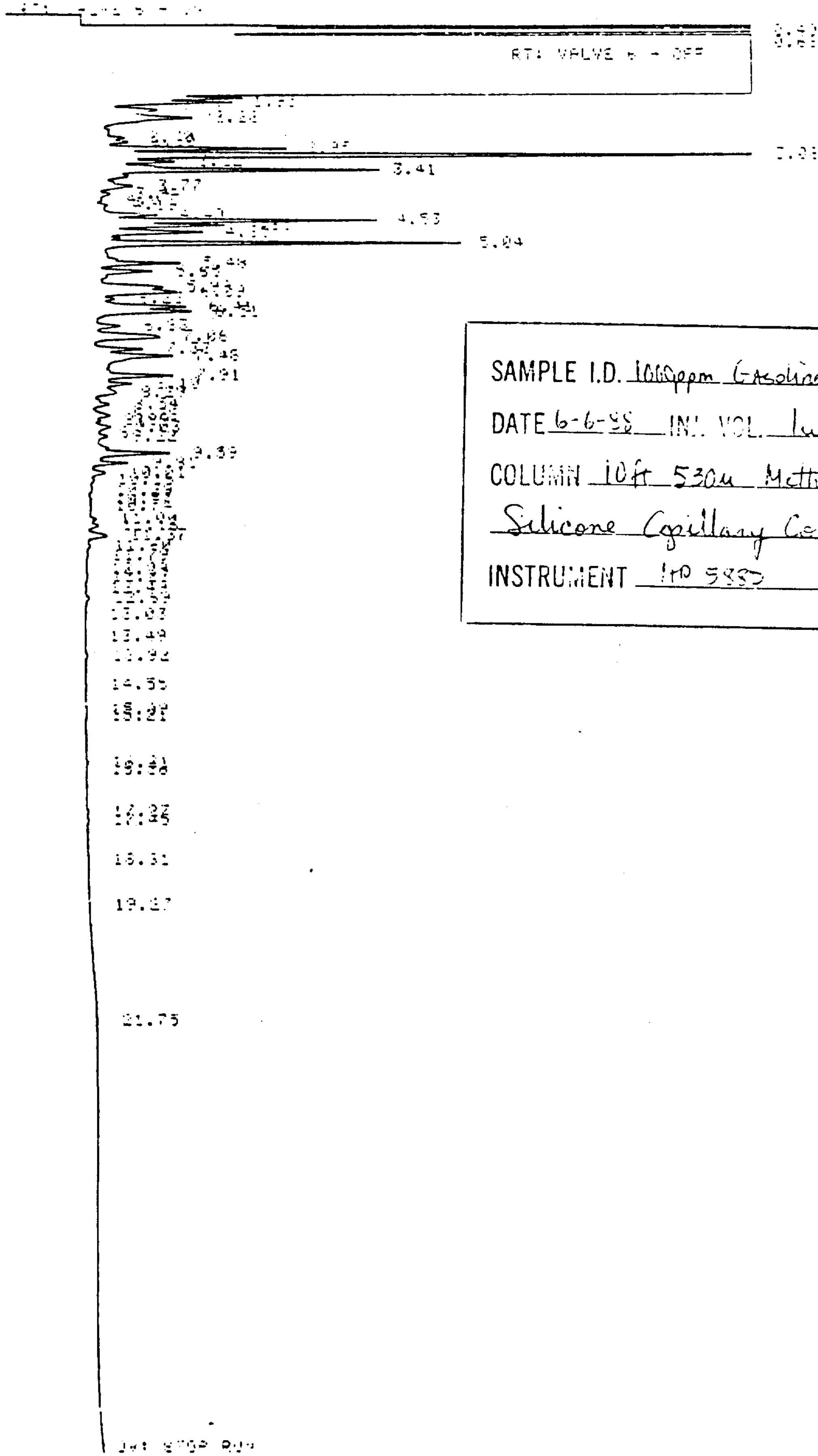
SAMPLE I.D. MID-18 Product
DATE 6-7-88 INJ. VOL. 1ul
COLUMN 10ft 530u Methyl Silicone Capillary Column
INSTRUMENT HP 5880

038

HP 5880A SAMPLER INJECTION @ 02:12 JUN 7, 1988
SAMPLE # : ID CODE :
17 GT250

AREA %

RT	AREA	TYPE	AREA %
0.68	1233@092.00	PBB	99.969
1.35	53.52	BB	0.004



SAMPLE I.D. 1000ppm Gasoline

DATE 6-6-88 INJ. VOL. 1ul

COLUMN 10ft 530u Methyl Silicone Capillary Column

INSTRUMENT HP 5880

009

010

[HP] 5880A SAMPLER INJECTION @ 17:33 JUN 6, 1988
SAMPLE # : ID CODE :
1000.345

AREA %

RT	AREA	TYPE	AREA %
0.40	5161.11	[illegible]	0.039
0.68	13445300.00	[illegible]	94.971

Laboratory Report

CBG LABORATORIES, INC.

CLIENT: NAVY   JOB NO: 3543.004 517

DESCRIPTION: Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED: 4-20 & 21, 1988   DATE REC'D: 4-22-88   DATE ANALYZED: 4-29 to 5-3, 1988

Description	MW#1	MW#2	MW#3	MW#4	MW#5	MW#6	MW#7	MW#8	MW#9	MW#10	MW#11	MW#12
Sample #	G7934	G7935	G7936	G7937	G7938	G7939	G7940	G7941	G7942	G7943	G7944	G7945
Petroleum Hydrocarbons and Solvents by Purge & Trap/GC												
BENZENE	19000.	29000.	<1.	<1	<1.	5,600	28000.	19.	<1.	51.	1.	19000.
TOLUENE	36000	110000	2.		1.	1700	26000.	1	<1.	1	1	17000
ETHYLBENZENE	3200.	11000.	<1.		<1.	1600.	2800.	<1.	2.	9.	<1.	1500.
XYLENES	21000.	48000	4.	2.	2.	7100	12000	<1	8.	14	1.	8400
TRICHLOROETHENE	<1000	<1000	<1.	<1	<1	<100	<1000	<1	<1	<1	<1.	<1000.
TETRACHLOROETHENE	<1000.	<1000.	4.	<1.	<1.	<100	<1000.	<1.	<1.	<1.	<1.	<1000.
1,2-DICHLOROETHANE	1000	<1000.	<1.	<1	<1.	<100.	1000.	<1.	<1.	1.	<1.	2000.
MTBE	<10000.	<10000.	<10.	<10	<10.	<1000.	<10000.	<10.	<10.	<10.	<10.	<10000
TOTAL HYDROCARBONS	97000.	300000.	480.	16.	<10.	13000.	68000.	26.	92.	170.	<10.	50000.
COMMENTS	Gasoline	Gasoline	Gasoline	-	-	Gasoline	Gasoline	-	Gasoline	Gasoline	-	Gasoline

Methodology: Federal Register — 40 CFR Part 136 October 26 1984

Units: mg/l (ppm) unless otherwise noted

Comments

Authorizing: [signature]

Date: June 9, 1988

CBG Laboratories, Inc.
Box 4942 ... Rd. Syracuse NY 1322.. 315-457-....

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OBG LABORATORIES, INC.

Laboratory Report

CLIENT NAVY JOB NO 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED 4-20 & 21, 1988 DATE REC'D. 4-22-88 DATE ANALYZED 4-29 to 5-3, 1988

Description	MW#13	MW#14	MW#15	MW#16	MW#17	MW#18	MW#19	MW#20	Replicate	Wash Blank	Q C Trip Blank
Sample #	G7946	G7947	G7948	G7949	G7950	G7951	G7952	G7953	G7954	G7955	G7961
Petroleum Hydrocarbons and Solvents by Purge & Trap/GC											
BENZENE	[illegible]	6.	4700.	28000.	11000.	24000.	21.	60.	12000.	<1.	<1.
TOLUENE	2.	<1.	[illegible]	28000.	13000	42000.	150.	160.	35000		
ETHYLBENZENE	2.	<1.	2400.	1900.	2500.	1900.	53.	79.	2400.		
XYLENES	8.	[illegible]	[illegible]	12000.	9100.	12000.	130.	96.	11000	↓	↓
TRICHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000	<1.	[illegible]	<1000.	<1.	<1.
TETRACHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000	<1.	<1.	<1000.	<1.	<1.
1,2-DICHLOROETHANE	<1.	<1.	<1000.	1800.	200.	<1000.	<1.	[illegible]	<1000	<1.	<1.
MTBE	<10.	<10.	<10000.	<10000.	2800.	<10000.	<10.	<10.	<10000.	<10.	<10.
TOTAL HYDROCARBONS	23.	11.	[illegible]	79000	42000	96000.	640.	870.	62000	<10.	<10.
COMMENTS	-	-	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	-	-

Methodology Federal Register — 40 CFR Part 136 October 26 1984 Units mg/l (ppm) unless otherwise noted

Comments

Authorized [signature]

Date June 9, 1988

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