FINAL

RCRA FACILITY INVESTIGATION WORK PLANS
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

ADDENDUM 2 (Revised)

ADDITIONAL INVESTIGATIONS AT CERTAIN OU 1, 6 AND 7 SWMUs

NAVAL STATION
ROOSEVELT ROADS, PUERTO RICO

CONTRACT TASK ORDER 0173

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Prepared For:

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1.0 INTRODUCTION

Naval Station Roosevelt Roads was issued a RCRA Permit to operate a hazardous waste storage facility in October, 1994. The permit contained provisions for "Corrective Action" at the Station in accordance with the Hazardous and Solid Waste Amendments (HSWA) of 1984. Among the varied requirements was one which mandated Phase I RCRA Facility Investigations (RFIs) at a number of Solid Waste Management Units (SWMUs) identified in the permit. Phase I RFIs are designed to be a screening tool to assess whether there may be an historical or ongoing release of hazardous waste or hazardous constituents from a unit.

The Station took the list of SWMUs and combined them into Operable Units (OUs) which addressed groups of SWMUs having similar location, use, or expected potential contaminants. Investigatory work for OUs 1, 6 and 7, which contain all the SWMUs requiring Phase I investigations, were undertaken in 1995 and 1996 and the results were provided to the EPA in a report entitled "RCRA Facility investigation Report for Phase I Investigations at Operable Units 1, 6 and 7, Naval Station Roosevelt Roads, Ceiba, Puerto Rico" (July 1996).

The results of the Phase I, coupled with EPA comments on the draft report received in November, 1996 indicated the need for additional investigations at some of the SWMUs because of evidence that releases to one or more environmental media had occurred. It is the purpose of this work plan addendum to provide details regarding the scope of, and rationale for, additional investigations at apparently affected sites.

The scope of investigatory work described in subsequent sections of this addendum only addresses the actual work elements at each site. All the other elements normally comprising Work Plans (e.g., Health and Safety Plan, Quality Assurance Project Plans) rely on the Final RCRA Facility Investigation Work Plan (Baker, September, 1995). All sampling will be conducted in accordance with the applicable SOP contained in Appendix B of the Data Collection Quality Assurance Plan. [Note: This document is Addendum 2 to the Work Plans. Addendum 1 addressed the Tow Way Fuel Farm (OU2) investigations.]

2.0 ADDITIONAL INVESTIGATIONS

2.1 Introduction

Section 2.0 provides details of the proposed additional investigations. Included in each discussion is a description of the site background and present status, details of the proposed investigatory scope, a detailed rationale which explains each element of the scope and a description of the intended data use.

The sites addressed in this work plan addendum are:

- SWMU 10 (Substation 90)
- SWMU 26 (Building 544 Area)
- SWMUs 31 and 32 (Public Works Yard)
- SWMU 46 (Pole Storage Yard Covered Pad)
- AOC C (Transformer Storage Pads)
- SWMU 13 (Pest Control Shop)
- SWMU 11/45 (Building 38 Cooling Water Tunnel)

In addition, a number of general considerations related to the overall investigations are discussed in this section.

2.2 SWMU 10 (Substation 2 - Building 90)

2.2.1 Site Background/Status

The soils in the area immediately adjacent to the substation were found to contain significant concentrations of PCBs. An Interim Corrective Measure (ICM) was performed at the site which consisted of contaminated soil removal. The ICM close-out report was provided to the EPA. Groundwater sampling was not a part of the initial investigations or the ICM. Based on the presence of a significant concentration of PCBs in the soil, the potential for groundwater to be impacted was apparent and, therefore, a groundwater sampling effort was included in the OU 1, 6 and 7 Phase I RFI. The sampling effort was not successful due to site subsurface conditions. Because the initial sampling program did not result in obtaining sufficient groundwater information, a new sampling program has been devised and is presented in this work plan addendum.

2.2.2 Additional Investigations

Scope

Three temporary monitoring wells will be installed at the site in the approximate locations shown on Figure 2-1. The borings will be made with six inch (nominal) diameter augers. Four inch PVC riser and screen will be lowered into the hole with the screen length sufficient to span across the water bearing zone. The hole will not be backfilled; however, a watertight bentonite seal will be installed at the collar of the well to prevent the inflow of any precipitation. After sampling, the PVC pipe and bentonite collar will be removed and the hole will be grouted from the bottom up using a cement/bentonite grout mixture.

A sample of groundwater will be extracted from each temporary well. No purging or development will be performed because of the expected small amount of groundwater infiltration. Each sample will be analyzed for VOCs, SVOCs, and PCBs. The order of sample collection will be PCBs first, VOCs second, and SVOCs last. It may be necessary to composite samples for PCBs and SVOCs due to the expected slow recharge of the well and the relatively large volume of sample required for these analyses. Upon verification of successful sample analysis, the casing will be removed from the temporary well and the boring will be backfilled with a mixture of drill cuttings and bentonite.

In the event that an insufficient quantity of groundwater is present to obtain samples for the various parameters, the well temporary casing will be removed and the hole will be advanced to a depth where groundwater supplies are adequate for sampling. A temporary two or four inch, PVC, well will be installed at the appropriate depth using the methodology previously described.

Rationale

Previous investigations at this site using Hydropunch® technology failed to retrieve sufficient groundwater for analysis. These investigations did, however, identify a water containing layer 6- inches to 1-foot thick at the approximate base of the soil column. Since this represents the first occurrence of groundwater below the spill zone, it represents the water most likely to show any effect from PCBs in the soil. It is the thought that, by using a relatively large diameter well and not developing or purging the well prior to sampling, sufficient water can be obtained to run the appropriate analyses. This is especially the case if a composite sample over time is taken. While this is not the ideal case, the results should be acceptable since it is really the PCB results which are desired and this analyte is least affected by the composite sampling technique.

The locations for the groundwater sampling points have been carefully selected to capture groundwater exiting the site. Groundwater flow is expected to be controlled by topography. The area is bordered to the north and west by very steep slopes. Any groundwater flow is expected to be to the south and southeast based on this topography; therefore, this is where the temporary wells have been located.

Data Use

The intent of the investigation is to assess whether PCBs have migrated to the groundwater from the soil. Analytical data will be reviewed to see if PCBs are present.

2.3 SWMU 26 (Building 544 Area)

2.3.1 Site Background/Status

Building 544, demolished in 1990, housed a vehicle maintenance operation for at least a portion of its existence. The RFA conducted in 1988 found approximately 25 drums at the rear of the building, some of which were seen to contain engine lubricating oil. The drums were removed in 1990 and the soil underlying the area where the drums were stored was moved approximately 20 feet and stockpiled.

A soil gas survey was conducted in the area where the drums were stored and where the soils are stockpiled. This survey did not detect significant levels of volatile organics. Surface soil samples taken at the site indicated the presence of arsenic and beryllium at some points above the residential risk-based concentration (RBC) and a variety of semivolatile constituents at low levels.

The Building 544 Area is located within the "Bundy" portion of the station. Bundy is a primary location for bachelor's quarters and, therefore, it is possible that the Building 544 Area could be used for base housing expansion at some point in the future. This fact, plus the EPA comments on the Draft OU 1, 6 and 7 RFI Report, leads to the conclusion that additional investigations are required at the site.

2.3.2 Additional Investigations

Scope

A total of 10 sampling locations have been selected to comprise the additional investigations (see Figure 2-2). Seven of the locations are within the SWMU and three are well outside the SWMU area and will serve as background sampling points.

Surface soil samples will be obtained at each location from the soil just below the root zone in accordance with the appropriate SOP as contained in the original approved RFI Work Plans (September, 1995). A boring will be advanced at each location with a hand auger to a depth of approximately three feet. The soil from approximately two and one-half to three feet will be retained and submitted for laboratory analysis.
Each sample collected will be subjected to analysis for:

- Arsenic
- Beryllium
- VOCs
- SVOCs
- PCBs

Rationale

The sampling density selected will result in samples being obtained on 30-foot centers at the most and, in many cases, much less (when considering the initial sampling points also). This will provide sufficient areal coverage and data quantity to characterize the surface and subsurface soils.

The presence of arsenic and beryllium above residential RBCs was noted by the EPA in their comments. While this is not disputed, the concentrations are likely the result of background conditions (based on work performed at other areas of the station) and do not represent a release from the SWMU. This area is relatively remote from other SWMUs and the area where background information was obtained; therefore, site-specific background data will be developed utilizing the three points indicated on Figure 2-2.

Data Use

The data from this investigation will be combined with that available from the first effort. A full Human-Health Risk Assessment (HHRA) will be performed using all the data. Arsenic and beryllium, should they continue to be detected, will be carried through the risk assessment; however, any risk posed by concentrations of these species which are statistically within background levels will be discounted.

2.4 SWMUs 31 and 32 (Public Works Yard)

2.4.1 Site Background/Status

The area is comprised of open parking/storage areas adjacent to Building 31 which houses the Station's Public Works Department. SWMU 31 was used for the management of waste vehicle oils and SWMU 32 contained numerous scrap batteries during the initial RFA. Neither area is presently utilized for waste management activities.

The draft Phase I report indicated that there was no unacceptable risk posed by the areas for continued industrial use. It is the Navy's intent to place a land-use restriction on the site limiting it perpetually to industrial uses. However, A.T. Kearney comments regarding the risk assessment for dioxin caused this to be recalculated with the result being that a slight risk to on-site workers was posed by the low level of dioxin present. It should be noted that no dioxin waste was managed at the site nor did waste burning take place. The result of the recalculated human health risk indicates the need to perform additional sampling at the site.

2.4.2 Additional Investigations

Scope

Eight surface soil samples are proposed at approximately the locations shown on Figure 2-3. The samples will be obtained from the zone 3 to 9 inches below the ground surface. Samples will be analyzed for dioxins only.

Rationale

The depth of sampling selected is designed to avoid the large gravel pieces that work their way to the surface when repeatedly traversed by vehicles. Sampling at this depth will allow the collection of a more representative soil sample.

The area of sampling includes the possible location of "previous uncontrolled storage," and the area immediately adjacent. It should be noted that dioxins were not found at SWMU 31 and 32 and was only detected at an unquantifiable level in sample 31SS02 and at measurable levels in sample 31SS04 which were both taken in the "uncontrolled storage" area. Samples taken between these locations did not contain detectable dioxin. Therefore, sampling is concentrated in the area where previous detection of dioxins occurred.

Data Use

The risk assessment indicated a slight risk to on-site workers was driven by the single sample taken at 31SS04. The data gathered in this additional sampling will be combined with that from the previous round and a new risk will be calculated.

2.5 SWMU 46 (Pole Storage Yard Covered Pad)

2.5.1 Site Background/Status

The site was originally listed as a SWMU based on the presence of electrical equipment and scrap on the pad during the initial RFA. The reinspection conducted in 1993 found the pad to be empty, however, it was kept as a SWMU because of its former use. Since that time, the pad has been upgraded with spill control measures and is being used for an under 90-day storage facility by the base operations support contractor.

Initial investigations at the site indicated relatively low levels of some semivolatiles, arsenic and Aroclor-1260. The arsenic is likely naturally occurring based on knowledge of background conditions. PCB is the major constituent of concern even though the concentrations are relatively low ranging from a maximum of 3.6 ppm to non-detect in the samples. This notwithstanding, the EPA has requested full characterization of the surface and subsurface soils in the area of the pad.

2.5.2 Additional Investigations

Scope

Fifteen additional surface soil samples are proposed at the approximate locations shown on Figure 2-4. Sampling methodology will be in accordance with the applicable SOP as provided in the Final RFI work plans. Combined with the initial investigation, the total number of surface soil samples will be 26.

Thirteen random locations have been selected for subsurface soil sampling. Emphasis was placed on obtaining subsurface samples near the pad. At each location, a hand auger will be advanced to three feet depth. The sample portion from two and one-half to three feet will be retained for laboratory analysis. Should insufficient sample volume be obtainable from this zone, the hole will be advanced another six inches.

Three additional surface soil samples will be obtained in the area formerly designated "Contaminated Soil Area". The samples will be taken from sites immediately north, east and west of the area as shown on Figure 2-4.

All the samples will be subjected to laboratory analysis for semivolatile organics, PCBs, arsenic and beryllium.

Rationale

The scope of the investigations is designed to fully characterize the surface and subsurface soils at the site as requested by the EPA. Having samples both close to and away from the pad will allow an assessment of contamination extent to be made and will identify any hot spots immediately adjacent to the pad. Also, the number of samples to be obtained will allow a full human health risk assessment to be calculated. It is the Navy's intent to place a "land-use restriction" on the site limiting it perpetually to industrial uses.

The analytical parameters selected are based on the findings of the initial investigation. Only those suites of analytes in which positive detections were seen are being repeated in these additional investigations.

Data Use

The data from the additional investigations will be combined with that from the initial work to form a unified database. This database will be utilized to perform a full human-health risk assessment. Both residential and industrial health risks will be assessed; however, the site will be restricted to industrial land use in perpetuity by the Navy.

2.6 AOC C (Transformer Storage Pads)

2.6.1 Site Background/Status

AOC C was originally included in the corrective action provisions of the RCRA permit based on the fact that numerous transformers and other electrical equipment were being stored on the pads prior to off-site disposal. There were oily stains noted both on and off the pads.

An initial investigation was performed which included 12 surface soil samples. PCBs were found in six of the 12 samples with the highest concentration of 5,200 ppm in one sample at the western end of the northernmost pad (see Figure 2-4).

During maintenance activities at the site, in preparation for the 1996 hurricane season, the soils in the vicinity of the pads was inadvertently stripped to a depth of up to approximately one foot and stockpiled nearby. This stockpile was rigorously characterized and, with the consent of the EPA, the pile was disposed in the base landfill. This action was taken based on the fact that the highest level of PCBs seen in the pile was 8.6 ppm.

The soils originally characterized in the OU 1, 6 and 7 investigations have been removed from the site; therefore, a recharacterization of the site is necessary. In addition, the EPA has indicated that, since there were significant concentrations of contaminants seen in the surface soil before it was removed, both the surface and subsurface soils need to be fully characterized.

2.6.2 Additional Investigations

Scope

Twenty-six surface soil samples will be collected at the approximate locations shown on Figure 2-4. It should be noted that 12 of the sample locations generally coincide with the points originally sampled. Sampling methodology will be in accordance with the applicable SOP contained in the Final RFI Work Plans.

Fourteen subsurface soil samples will be obtained using a hand auger at the locations shown on Figure 2-4. In each boring, cuttings from the zone between two and one-half and three feet will be retained for laboratory analysis. Should an insufficient volume of soil be available from this zone, the boring will be advanced an additional six inches to provide an acceptable quantity of sample.

Each sample will be analyzed for volatile and semivolatile organics, PCBs and Appendix IX metals.

Rationale

The areal distribution of sampling points will provide adequate coverage to detect releases and fully characterize the soil both near the pads and in the general area which could reasonably be expected to be affected by releases from the storage pads. It should be noted that subsurface samples are concentrated in the immediate vicinity of the pads as this is considered to be the area where extensive or repeated releases could have occurred which may have driven contamination deeper into the soil zone.

The analytical suites selected provide for analysis of all the constituents detected in the first round of sampling.

Data Use

The analytical data will be used to assess the areal and vertical extent of contamination, if any. A human-health risk assessment will be performed on the data for both the residential and industrial land-use scenarios. The residential scenario will only be provided for information since it is the Navy's intent to place a "land-use restriction" on this property that will relegate it to industrial use in perpetuity.

2.7 SWMU 13 (Pest Control Shop)

2.7.1 Site Background/Status

SWMU 13 has been subjected to three previous investigations each of which has further defined conditions at the site. It has been determined that there are no unacceptable risks posed by the surface soils at the site and, therefore, no additional characterization is required for this media. There is unacceptable risk posed by the sediments in the drainage ditch, especially in terms of the potential ecological receptors. Finally, although groundwater was sampled in the very early investigations, there is no detailed understanding of groundwater flow at the site nor has it been adequately demonstrated that groundwater is unaffected. Based on these conditions, additional investigations will be performed at the site addressing groundwater and sediments.

2.7.2 Additional Investigations

2.7.2.1 Sediment Investigation

Scope

A single surface sediment sample will be taken from the drainage ditch at the furthest possible point north of the site. The approximate proposed location of this sample is shown on Figure 2-5. This location will serve as a background point for data comparisons.

Deep sediment samples will be taken at the approximate locations shown on Figure 2-5. A boring will be advanced with a hand auger to a depth of three feet. The samples obtained from 1-1/2 to 2 feet and 2-1/2 to 3 feet will be retained for laboratory analysis.

Shallow sediment samples will be taken at the approximate locations shown on Figure 2-5. It should be noted that these samples will be taken on the side wall of the drainage ditch at a similar centerline position of a deep sediment samples. This strategy will provide information on the extent of contamination on a cross-sectional basis.

As can be seen on Figure 2-5, the drainage ditch enters a concrete headwall and goes underground at the south end of the large concrete pad. Little is known regarding this drainage system. It will be one of the efforts of this investigatory program to search for old drawings of the system and to physically walk the drainage ditch to attain an understanding of what happens to the drainage once it exits the site.

If the drainage resurfaces farther down, the surface sediments in the ditch will be sampled. If the drainage system does not reappear on the surface, the first catch basin downstream of the site will be accessed and a sample taken of the sediments, if any are present.

Analysis of all the sediment samples will be for volatile and semivolatile organics, Total Organic Carbon (TOC) and pesticides.

Rationale

The background sample is required for two reasons. First, it will be used as a point of comparison for downstream drainage samples to ascertain the effect on the drainageway sediments from the site. Second, the background sample will be used to assess the possibility that contamination is being imported to the site through flow in the drainage ditch.

Deep sediment samples are required to provide information about the depth of contamination. Samples will be obtained from the center of the ditch since this area is expected to be the most highly contaminated and has the most potential for exhibiting contamination at depth. The information obtained will be used in the analysis of possible corrective measures since it will provide details of the quantity of sediments/underlying soils that may be affected.

Sidewall sediment samples will be used to assess the extent of contamination away form the centerline of the drainageway.

Off-site ditch sediments will be sampled to see if contamination has migrated away from SWMU 13 via the drainage.

The analytical suites selected for this program (VOCs, SVOCs and pesticides) will be sufficient to adequately characterize the nature of site-related contamination. Their selection was based on the results of previous investigations in which only significant detections were members of these analytical groups.

Data Use

The information obtained from the sediment sampling program will be used to assess the extent of contamination knowledge of the extent of impact will allow the full analysis of remedial options. In addition, human-health and ecological risks will be reassessed to ascertain the extent of corrective measures required and to establish clean-up goals should remediation be required.

Downstream drainage sampling results will be used to determine whether contamination has migrated off-site and whether additional characterization or remedial work is warranted.

2.7.2.2 Groundwater Investigations

Scope

There are four existing monitoring wells at the site which were installed during the confirmation study. The condition of the wells will be assessed and, if apparently useable, the wells will be redeveloped and sampled as a part of this investigation. If any of the existing wells are found to be damaged beyond repair or are unusable for some other reason, these wells will be abandoned (grouted in place) and replaced.

Three new wells will be installed in the approximate locations shown on Figure 2-5. Soil samples will be obtained on 5-foot centers or less, as deemed appropriate by the field geologist. This sampling will only be for stratigraphic description and groundwater occurrence purposes; no samples will be retained for laboratory analysis. Once the boring is complete, a 2-inch diameter, PVC well will be installed. The well will be equipped with a 10-foot screen which will extend approximately eight feet into the uppermost water bearing unit.

The new monitoring wells will be developed and a groundwater sample will be obtained for laboratory analysis of volatile and semivolatile organics and pesticides.

One complete set of water level measurements will be obtained from all of the wells when they are in equilibrium (e.g., before development activities or a suitable period of time after sampling). These measurements will be used to prepare a potentiometric surface map for the site.

Rationale

There is significant pesticide contamination present in the drainage ditch and, while posing no human-health risk, there are also pesticides in site soils. Based on this, there is the possibility that contamination has migrated downward to the water table. It is for this reason that groundwater will be sampled.

The groundwater measurements will be used to construct a potentiometric surface map of the site. This will provide information regarding groundwater flow patterns and rates that could be used to predict contaminant migration direction and rate should any be detected.

The well locations have been selected to provide reasonably full coverage of the site. Existing well 18GW01 will serve as background. Groundwater flow, based on the topography, is expected to be toward the south or southeast. The wells have been located so as to not only monitor groundwater directly under the site, but also to intercept flow as it exits the site.

The groundwater analytes selected mirror those for sediment and are reflective of historical findings at the site.

Data Use

The data will be used to assess whether contamination has migrated to the groundwater.

2.8 SWMU 11/45 (Building 38 Cooling Water Tunnel)

2.8.1 Site Background/Status

The cooling water tunnels associated with Building 38 have been the subject of numerous studies over the past years. The most recent program was an Interim Corrective Measure designed to clean out the tunnels and remove them as a potential continuing release source. [Note: The Revised Final ICM close-out report will be available shortly.] During the cleaning of the tunnel interior, it became evident that the tunnels were not tight since a large quantity of water (apparently groundwater) was entering the tunnels. At one point where water inflow was particularly heavy (approximately five manways away from the building towards Puerca Bay), the ICM contractor dug a test pit to see if the cause of the inflow could be determined by looking at the outside of the tunnel. This proved to be a fruitless endeavor in terms of its goal, but did provide significant information regarding site conditions. When the subsurface soils near the tunnel were exposed they were found to be heavily oil stained. Based on this finding, an investigation of the soils surrounding the intake tunnel appears warranted. [Note: The tunnels have now been filled with concrete and do not contain water; therefore, they cannot act as a continuing release point.]

2.8.2 Additional Investigations

Scope

The soils surrounding the entire length of the intake tunnel leading to Puerca Bay from the building will be investigated using Geoprobe® technology. Geoprobe® borings will be made on approximately 50-foot centers along the tunnel as shown in concept on Figure 2-6. Borings will be staggered on both sides of the tunnel. A second and third set of borings will be made on 100-foot centers on both the north and south side of the tunnels. These lines of borings will be made approximately 50 feet away from the tunnel on each side.

Each boring will be advanced to a point a minimum of two feet below the tunnel invert or to the water table. The borings will be continuously sampled to the depth of the tunnel and the subsurface stratigraphy will be visually logged by the site geologist. The Macro sampling barrel will be used for all borings. This barrel uses a clear plastic sleeve in which to collect the sample in either two or four foot lengths depending on the ease of advance. Having the clear sleeve allows for visual examination of the entire length of the boring. Samples from any hole exhibiting contamination (either through visual, olfactory or instrumental [PID/FID] evidence) will be retained for laboratory analysis. Should no contamination be seen, a sample from every other boring, taken from the depth equivalent to the top of the groundwater table, will be submitted for laboratory analysis.

If contamination is evident in soil samples taken from the outer row of borings (i.e., those 50 feet away from the tunnel), another boring will be made 50 feet further away from the tunnel to assess subsurface conditions. This approach will continue until a boring is completed that has no evidence of contamination. All borings completed following this strategy (including the last "clean" boring) will be sampled and a portion retained for laboratory analysis.

Laboratory analysis will be performed on each sample for the following:

- Volatile organics
- Semivolatile organics
- PCBs
- Appendix IX metals
- TPH

In addition to subsurface soils, it appears prudent to also investigate groundwater in the vicinity of the tunnel. Temporary wells will be installed in every second boring. These wells will consist of three-quarter inch PVC screen and riser placed within the Geoprobe® hole. The screened interval will be long enough to extend well above the groundwater to ensure that any free product which may be present can enter the well. Each of the temporary wells will be sealed at the surface so that any precipitation cannot enter the well bore.

The temporary wells will be allowed to sit a minimum of 12 hours (and a maximum of 24 hours) prior to sampling. Prior to sampling, a clear, disposable bailer will be lowered into the hole very slowly and carefully. The bailer will be recovered before it is full to ascertain if any free product is present.

[Note: the use of an interface probe is not possible because its tip will not fit in three-quarter inch PVC. A larger well casing is not compatible with the Geoprobe® equipment.] No purging of the well will be performed in order to maintain a sufficient quantity of water for all the various laboratory analyses. Samples may be obtained by compositing multiple well volumes; i.e., the well may need to be evacuated multiple times over a period of some hours in order to obtain a sufficient volume for analysis. The order of sampling will be VOCs, SVOCs, PCBs, metals, TPH, and TOC.

Free product will be sampled at the rate of one sample per each four wells in which it is found (starting with the first well containing free product). The samples will be analyzed for VOCs, SVOCs, PCBs and Appendix IX metals.

Sediment sampling at the intake entrance in Puerca Bay was done as part of the Supplemental RI/FS performed at the site. The single sample obtained showed evidence of contamination potentially related to releases from the tunnel.

Based on this, an expanded sampling program is proposed as follows:

- One sediment sample will be collected at the mouth of the tunnel.

- A series of three samples will be taken in an arc approximately 50 feet away from the mouth of the tunnel.

- A series of three samples will be taken in an arc at a distance of approximately 100 feet from the tunnel mouth.

- Two samples will be taken 200 feet from the tunnel.

The proposed array of sampling points is shown on Figure 2-6. All samples will be obtained using a sampling dredge.

Analysis of the sediment samples will be for the same parameters as used for the tunnel soils with the addition of Total Organic Carbon.

Rationale

The planned array of borings will provide samples for an assessment to be made of the nature and extent of any contamination which may be found. Geoprobe® technology is proposed because it allows the rapid advancement of borings to obtain both soil and groundwater samples without the need to install permanent monitoring points. It is also financially attractive in that it allows many more sampling points to be accessed which provides for a cost-effective use of government funds.

The analytical suites proposed were selected based on the findings from previous sampling efforts. The potential contaminants which could have been released from the materials in the tunnel are all represented by these analytical suites.

The array of sampling point sin the Puerca Bay will provide sufficient information to assess the extent of release from the tunnel to the sediment.

Data Use

The data obtained from these investigations will be used to assess risk to human health and the environment posed by any contamination found in the subsurface soils, groundwater or sediments associated with the intake tunnel. In addition, the investigations have been carefully designed to provide sufficient information for the analysis of all possible remedial alternatives should a corrective measure study be necessary.

2.9 Miscellaneous Investigation Considerations

This section contains some miscellaneous investigations and related work that are required for the work proposed in the previous sections.

2.9.1 Surveying

All sampling locations will be flagged in the field and will be surveyed using established control. This surveying will be performed by the firm which did the previous work to ensure that the same level of survey quality and detail is attained.

2.9.2 Data Validation

All laboratory data generated by these investigations will be subjected to independent, third party, validation. The EPA Region II Data Validation SOPs agreed to prior to full approval of the original RFI workplans will be followed. The same firm which has performed data validation for the previous RFI steps will continue. This will ensure that the same techniques are followed and that an equivalent review of the data is performed.

2.9.3 Laboratory Analysis

All laboratory analyses will be performed in accordance with the methodologies contained in the approved Final RCRA Facility Investigation, Naval Station Roosevelt Roads, Puerto Rico (Baker, September, 1995) Work Plans.

2.9.4 Investigation Derived Waste (IDW)

The only investigation derived waste expected to be generated during this program will be at SWMU 13 where well installation, development and sampling will be performed. These wastes will be managed in accordance with the SOP contained in the Final Work Plans.

At SWMU 10 where temporary wells will be installed, the cuttings will be retained until groundwater is sampled. When the temporary well is abandoned, the cuttings will be mixed with powdered bentonite and use as boring backfill.

Wastes generated by hand augering are limited to very small amounts of cuttings. Likewise, Geoprobe® work produces little cuttings. Any cuttings which are remaining after this work will be mixed with powdered bentonite and returned to the hole from which they came. As much as possible, soils last out of the hole will be placed first thereby approximating original stratigraphy.

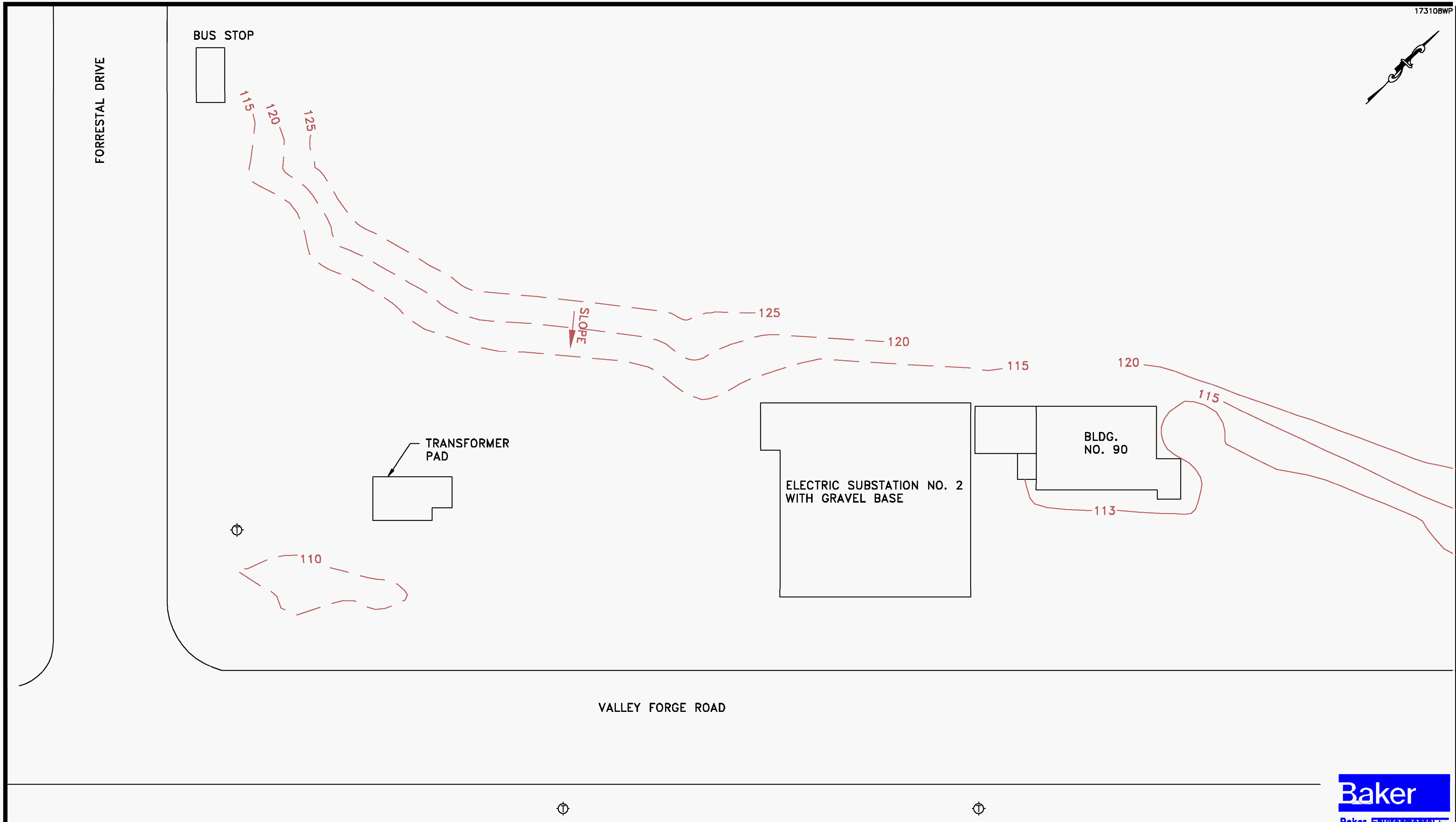
2.9.5 Standard Operating Procedures (SOPs)

All the SOPs required to complete the investigations described herein are provided in the Final RFI Work Plans (September, 1995) with the exception of the work involving the Geoprobe®. This SOP has been included as Appendix A.

3.0 SCHEDULE

Figure 3-1 shows the schedule for the additional RFI work described in Section 2.0.

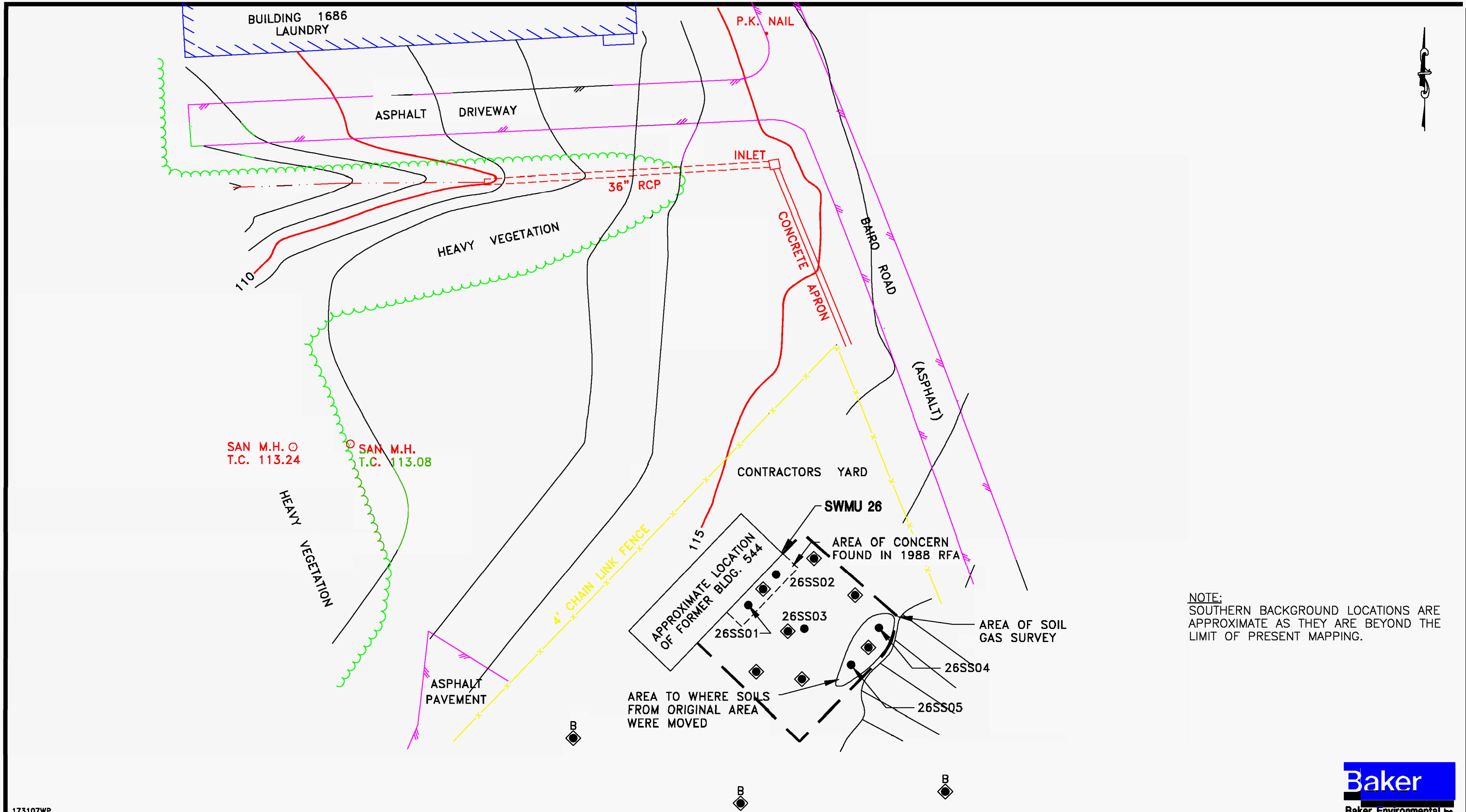
FIGURES



LEGEND

120 – CONTOUR LINE WITH ELEVATION
– BUILDING OR STRUCTURE
– PROPOSED TEMPORARY MONITORING WELL

FIGURE 2–1
PROPOSED ADDITIONAL INVESTIGSTIONS
SWMU 10 SUBSTATION 2/BUILDING 90
(revised 6/3/97)
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

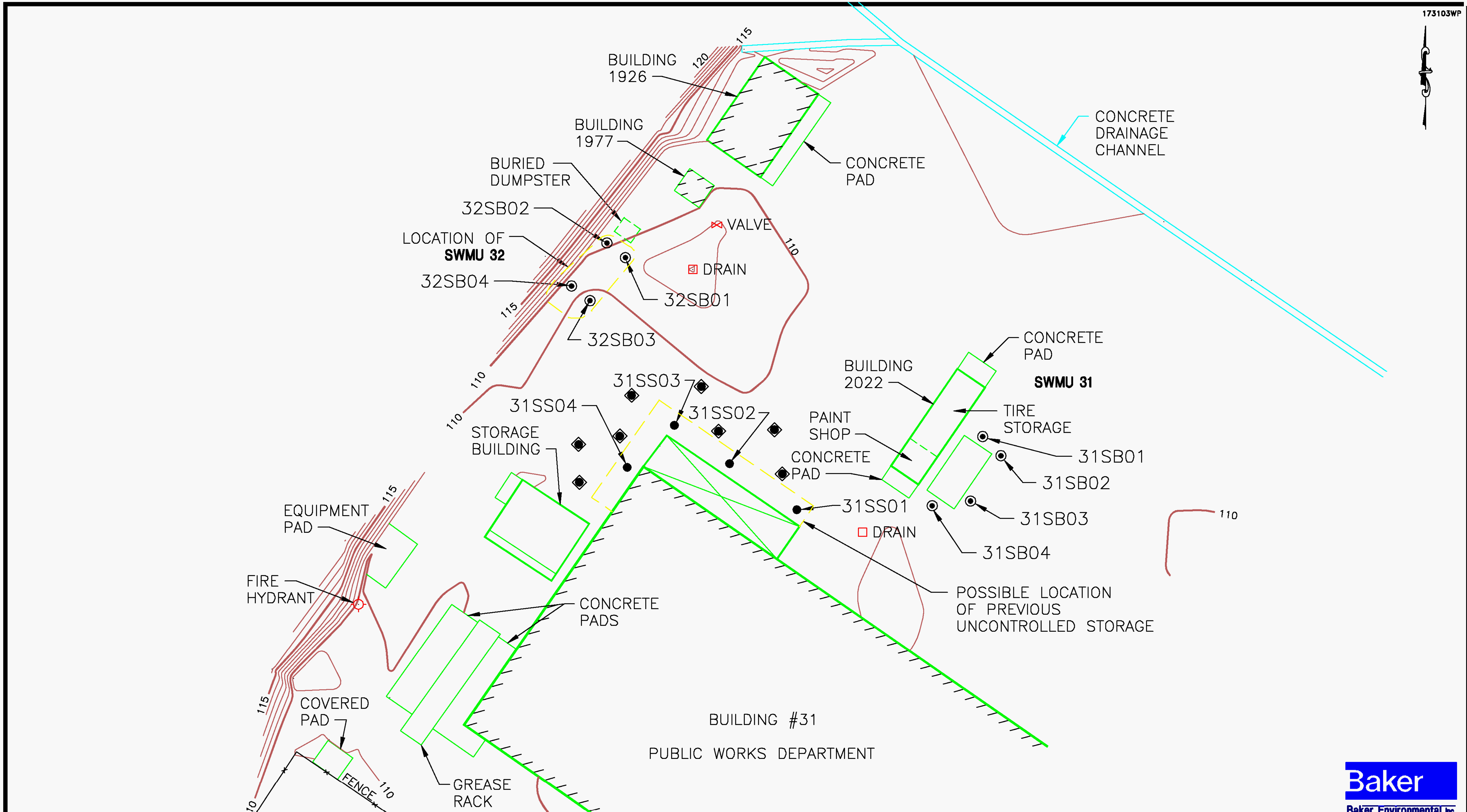
- ● PHASE I RFI SAMPLING LOCATION
- ◈ PROPOSED SOIL SAMPLING LOCATION
- B ◈ PROPOSED BACKGROUND SOIL SAMPLING LOCATION
- 110 SURFACE ELEVATION CONTOURS

50 0 25 50 100

1 inch = 50 ft.

FIGURE 2-2
PROPOSED ADDITIONAL INVESTIGATION
SWMU 26 – BUILDING 544 AREA
(REVISED 6/3/97)

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

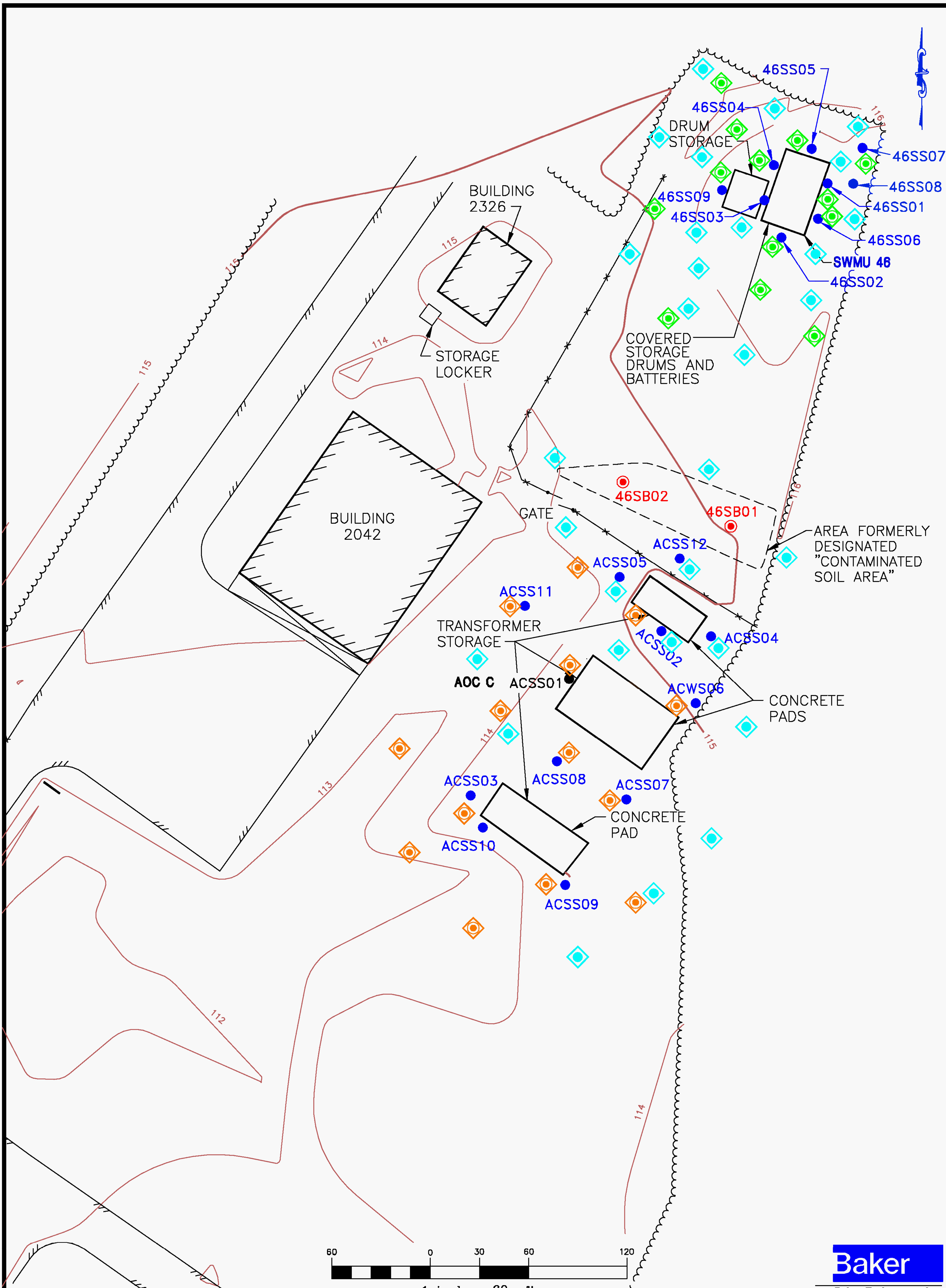
- PREVIOUS SOIL BORING LOCATION
- PREVIOUS SOIL SAMPLING LOCATION
- PROPOSED SOIL SAMPLING LOCATION
- 110 SURFACE ELEVATION CONTOUR

60 0 30 60 120

1 inch = 60 ft.

FIGURE 2-3
PROPOSED ADDITIONAL INVESTIGATIONS
SWMU 31 WASTE OIL COLLECTION AREA
SWMU 32 BATTERY COLLECTION BUILDING 31

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

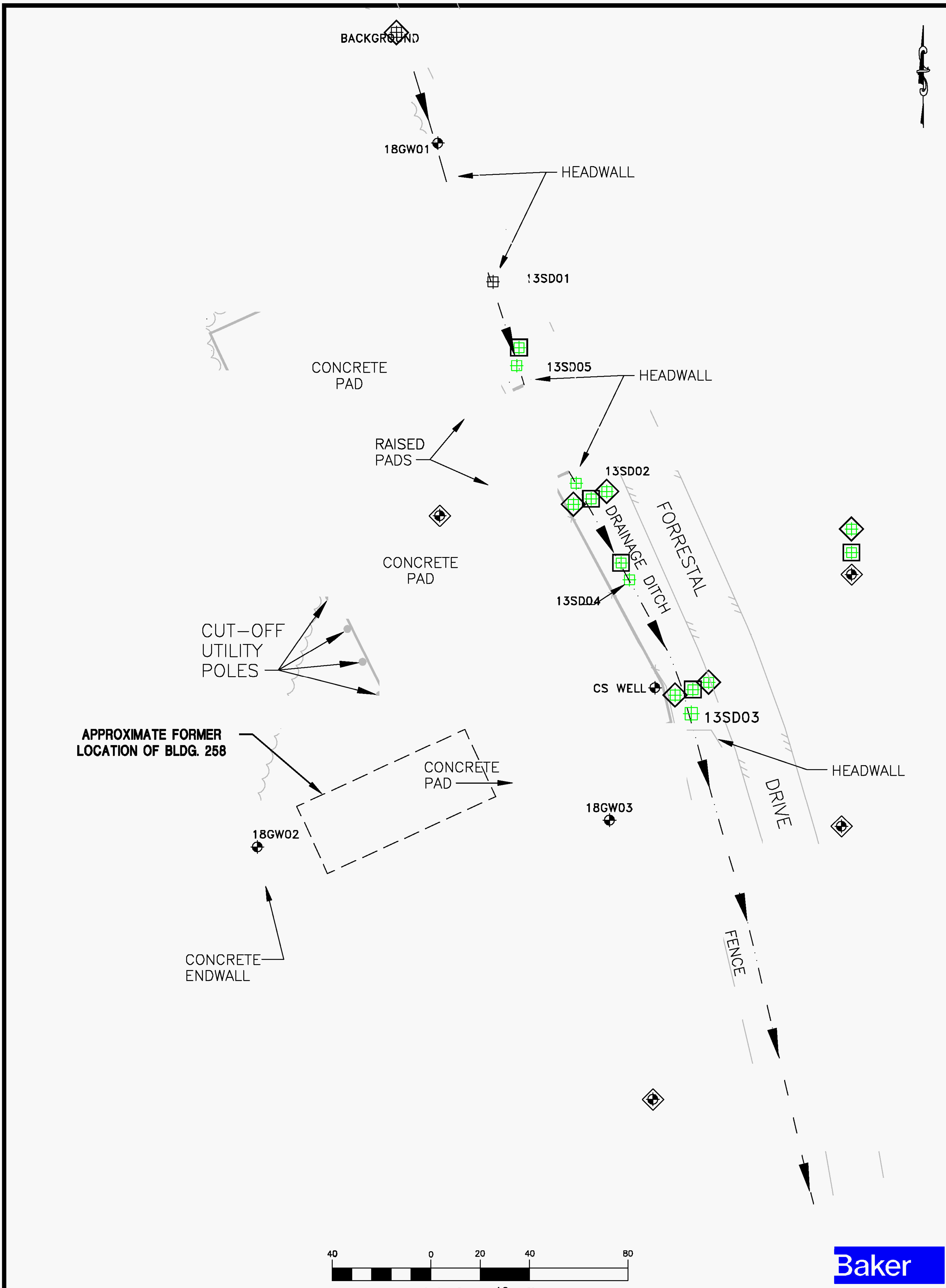


LEGEND

- PREVIOUS SOIL BORING LOCATIONS
- PREVIOUS SOIL SAMPLING LOCATIONS
- PROPOSED SUBSURFACE SOIL SAMPLING LOCATION
- PROPOSED SURFACE SOIL SAMPLING LOCATION
- PROPOSED SURFACE AND SUBSURFACE SAMPLING LOCATION
- 115 SURFACE ELEVATION CONTOUR

FIGURE 2-4
PROPOSED ADDITIONAL INVESTIGATIONS
SWMU 46 POLE STORAGE YARD
AOC C TRANSFORMER STORAGE PAD
(REVISED 6/3/97)

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



173105WP

Baker

Baker Environmental, Inc.

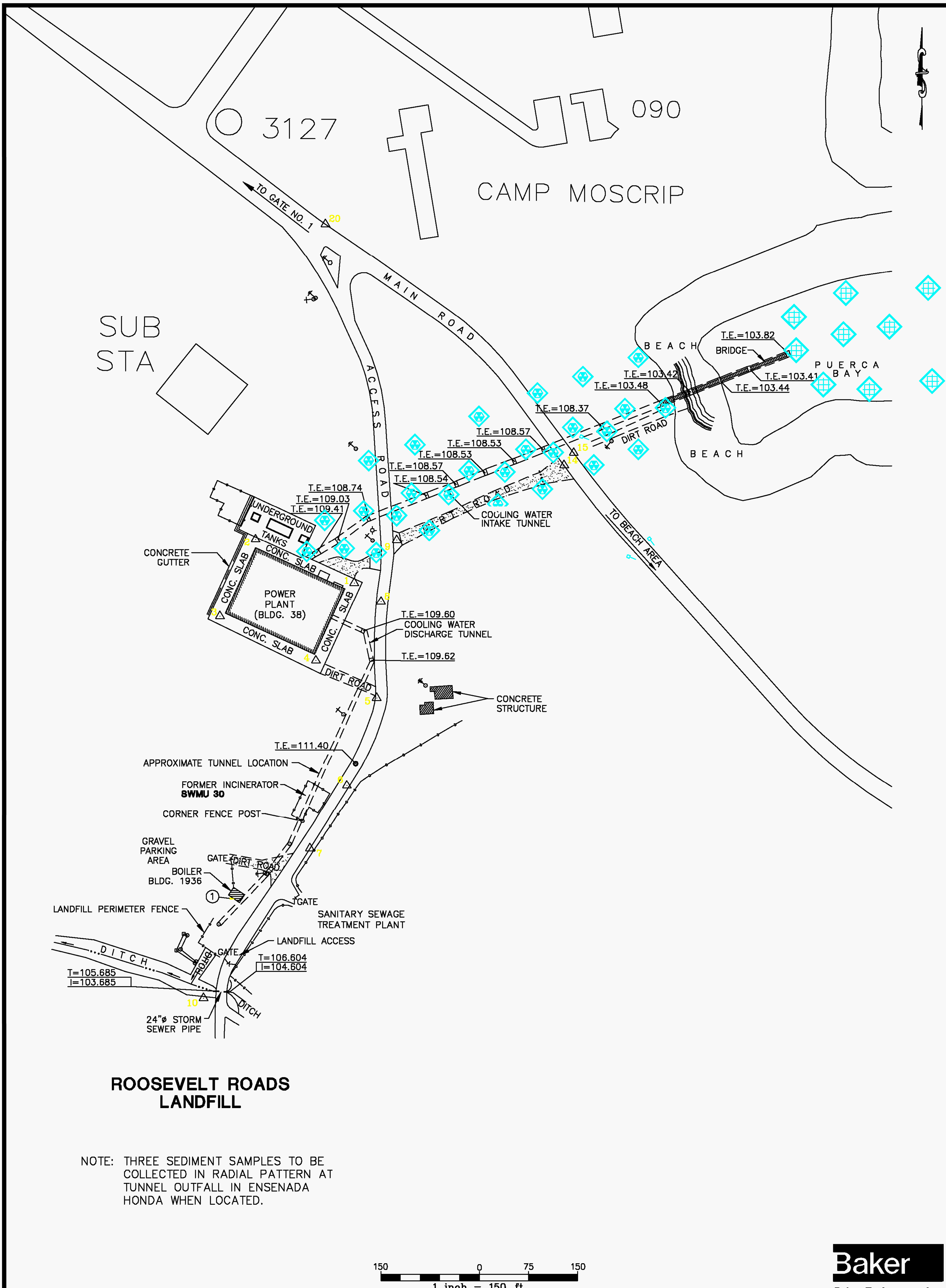
LEGEND

- EXISTING MONITORING WELL LOCATION (CONFIRMATION STUDY)
- PREVIOUS SEDIMENT SAMPLE LOCATION
- PROPOSED SEDIMENT SAMPLE LOCATION
- PROPOSED DEEP SEDIMENT SAMPLE LOCATION
- PROPOSED MONITORING WELL LOCATION
- DRAINAGE DITCH/SURFACE DRAINAGE FLOW DIRECTION

SOURCE: BAKER ENVIRONMENTAL, INC., MAY 1994

FIGURE 2-5
PROPOSED ADDITIONAL INVESTIGATIONS
SWMU 13
PEST CONTROL SHOP AND SURROUNDING AREAS

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



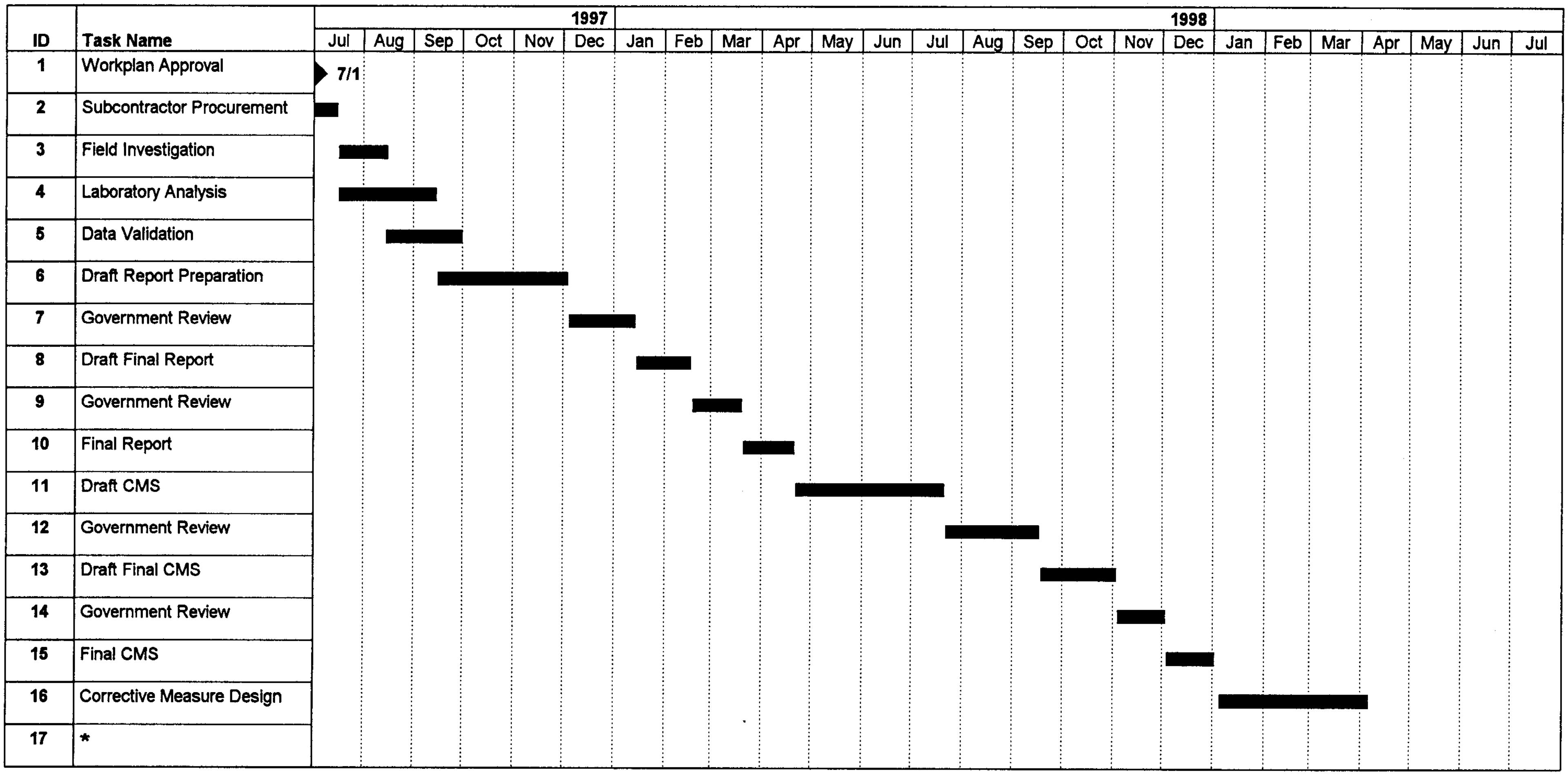
LEGEND

- T.E.=108.54 — MANHOLE LOCATION (WITH ELEVATION)
- CHAIN LINK FENCE
- ELECTRIC POLE
- ELECT. POLE WITH TRANSFORMER
- ELECTRIC POLE (CONC.)
- TELEPHONE POLE
- SANITARY SEWER MANHOLE
- FIRE HYDRANT
- CONTROL STATION
- SIGN
- GRAVEL
- PROPOSED GEOPROBE BORING LOCATION
- PROPOSED SEDIMENT SAMPLE LOCATION

FIGURE 2-6
PROPOSED TUNNEL SOILS AND PUERCA BAY SEDIMENT INVESTIGATIONS
RFI-SWMU 11/45

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

Figure 3-1
Revised Final RFI Workplans Addendum 2 - Project Schedule
Additional Investigations OU 1, 6 and 7 Naval Station Roosevelt Roads



* Additional schedule items to be determined base on scope of corrective measure.

APPENDIX A
STANDARD OPERATING PROCEDURE
GEOPROBE®

DIRECT-PUSH SOIL AND GROUNDWATER SAMPLING
TABLE OF CONTENTS

DIRECT-PUSH SOIL AND GROUNDWATER SAMPLING

1.0 PURPOSE

The purpose of this SOP is to describe the methods and procedures involved in conducting direct-push soil and groundwater sampling.

2.0 SCOPE

The methods described in this SOP are applicable to collection of direct-push soil and groundwater samples. Direct-push methods provide rapid means of collecting subsurface soil samples while minimizing surface disturbance and reducing the volume of soil cuttings generated. In addition, representative groundwater samples can be collected without installation of costly monitoring wells. This SOP does not include description of generic soil and groundwater sample collection procedures or decontamination requirements as these items are detailed in other SOPs. Rather, this SOP concentrates on requirements and procedures specific to direct-push sampling practices.

3.0 DEFINITIONS

Direct Push Refusal - Typically defined as penetration at a rate of less than one foot per minute.

Internal Friction Angle (Φ-value) - Resistance to shear failure

Hydraulic - Operated by the resistance offered or the pressure transmitted when a quantity of liquid is forced through a small orifice or tube.

Percussion - Operated by striking or banging.

Vadose Zone - Zone of aeration. Zone above the water table.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other methods to be used have been approved. The Project Manager is responsible for documenting procedures that deviate from those presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and describing the specific sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is also the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to properly execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and the Project Manager. Sampling personnel are responsible for the proper acquisition of direct-push soil and groundwater samples.

5.0 PROCEDURES

Prior to selecting sample locations, an underground utility search is recommended. The local utility companies or Plant utility personnel can be contacted and requested to mark the locations of their underground lines. Sampling plans or designs can then be devised accordingly. General Procedures are discussed in the following subsections. Detailed SOPs for specific equipment are typically available from the direct-push subcontractor or equipment manufacturer.

5.1 Equipment

Direct-push sampling devices typically consist of a 1-inch outside diameter (O.D.) stainless-steel probe that is mounted to the back of a cargo van, pick-up truck, or utility van. The probe or core barrel is pushed through the soil zone using a combination of the vehicle's static weight and hydraulic hammer percussion. Hydraulic pumps that are belt-driven by the vehicle's engine are used to power the probing device. The force applied by the static weight of the vehicle is controlled by the total weight of the vehicle, the distance from the probe to the vehicle, and the weight distribution of the vehicle.

The probing device may be advanced to depths of 20 feet in fine-grained soils with low internal friction angles (i.e., low Φ-values). Beyond the maximum depth achievable using only the static weight of the vehicle, the probe is advanced using a combination of the vehicle's static weight and hydraulic percussion hammering. Percussion hammering is also required to penetrate resistive layers such as hard pan, dense sands, gavels, frozen strata and fill material. Probes typically cannot penetrate competent bedrock or cemented soils. Refusal is defined as penetration at a rate of less than one foot per minute.

Many of the carrier vehicles are equipped with mobile laboratory units with a wide range of analytical capabilities. Commonly used carrier vehicles and sampling equipment are shown in Attachment A. Typically, selection of vehicle type is based on the following factors:

- Availability
- Cost
- On-site analytical capabilities
- Site access
- Soil conditions
- Required depth

In the event that vehicle access to sampling locations is precluded by site conditions (trees, brush, terrain, swamps, etc.) manually operated portable units are available.

Certain direct-push sampling methods require the use of standard auger drill rigs and drill rods in lieu of carrier vehicles and probe rods.

5.2 Soil Sampling

There are two general methods of collecting subsurface soil samples via direct-push methods: (1) Small quantity sampling; and (2) Large quantity sampling.

Small quantity samples are collected by disengaging an expendable point from the bottom of the probe, retracting the probe rods upward approximately 3 to 6 inches, and re-driving the rods. The sampler is filled with soil that has collapsed into the hole or soil cut from the wall of the hole. This method is not recommended as removing the sample from the probe can be difficult, recovery is limited to a small quantity of soil and sample disturbance may be excessive.

Large quantity sampling entails attaching a sampling device to the bottom of the probe rods and pushing the device through the desired sample interval. A drive point, which is attached to a piston rod inside of the sample collection tube, is affixed to the bottom of the sampler. Above the desired sample interval, the sampler is pushed through the soil with the point intact at the bottom of the sampler to prevent soil from entering the sampler. Once the desired sample interval is reached, a stop pin is removed from the probe rods allowing the point to retract through the sampler as the device is pushed downward and soil enters the sampler. Soil samples may be collected at continuous intervals until the total depth is achieved.

A variety of samplers are available that yield samples ranging from 8 inches to 4 feet in length and 0.96 to 2.125 inches in diameter. Sampling sleeves constructed of brass, acetate, Teflon™ or plastic may be inserted into select samplers to facilitate sample handling and visual inspection, maintain sample integrity, and meet regulatory requirements.

An SOP for a commonly used direct-push soil sampling device is presented as Attachment B.

5.3 Groundwater Sample Collection

There are several types of devices available for collecting groundwater samples via direct-push methods.

One commonly employed method entails advancing a probe rod to the desired depth and disengaging an expendable tip (by methods discussed above) thus allowing groundwater to migrate into the probe. Groundwater samples then are collected by inserting small-diameter flexible tubing with a bottom check valve through the probe rod and into the zone of saturation. The tube is oscillated vertically creating a momentum pumping action to draw water into the tubing. In areas of shallow groundwater within relatively permeable strata, this action may be sufficient to convey water to the surface. Where depth to groundwater is excessive or the strata is of relatively low permeability, groundwater may be conveyed to the ground surface by filling as much of the tubing as practical (by the momentum pumping method) and retrieving the tubing to the ground surface.

Slotted well points may also be driven to the desired depth and sampled via small diameter tubing as discussed above or by means of a small diameter bailer. A drawback associated with this method is that the screen is not shielded as it penetrates through the vadose zone and may be exposed to contaminants present in soils present above the zone of interest. Operating procedures for a commonly used well point groundwater sampler is presented as Attachment C.

Protective sheathes or outer rods are available that are placed around direct-push groundwater sampling well points and retracted as the sampler is installed at the desired depth. These devices typically are available to evacuate groundwater samples by either bailing or by retrieving the sampling tool once it has filled with ground water.

The bailing method is typically used when the water-bearing layer to be sampled is relatively thin, if it is necessary to sample the upper portion of a layer (e.g., when floating contaminants are present), or when a large volume of sample is required. A sacrificial plastic screen (typically 4.5 feet long) with a bottom cone is inserted into the protective outer rod and secured with an O-ring to hold the screen inside of the outer casing and prevent soil particles or water from entering the screen as the device penetrates the strata. The apparatus, which is attached to a string of drill rods is hydraulically pushed from either the ground surface or from the bottom of a borehole to the desired interval. A standard auger drill rig is typically required to push and retrieve the apparatus. Once the desired depth is achieved, the protective outer rod is retracted. The sacrificial point and screen section are held in place by overburden pressure and soil friction, and the screen is exposed to the surrounding formation. Groundwater samples are acquired by passing a small diameter bailer through the drill rods into the screen.

Groundwater sample collection via sampler removal entails installing the sampler a minimum of 5 feet below the groundwater surface and subsequently retracting the sampler to separate the unit from the expendable bottom drive point. Once the bottom point has been separated from the sampler, groundwater is free to enter the sampler and is retained inside of the sampler via a bottom check valve. The full sampler is then retrieved to the surface. This method typically yields slightly over 1 Liter of groundwater sample.

A user's guide for a commonly used sheathed groundwater sample collection screen point is presented in Attachment D.

Each of the sampling devices discussed above must be driven a minimum of 3 to 5 feet below the groundwater surface. With the exception of the sampler removal method, peristaltic pumps may be used to convey the groundwater samples to the surface.

Factors influencing the selection of direct-push groundwater sampling method include:

- Cost
- Availability
- Depth to groundwater
- Soil conditions
- Permeability and thickness of water-bearing zone
- Sample site access
- Regulator preferences
- Sample volume requirements
- Analytical parameters

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records kept by the direct-push subcontractors will vary between firms . The Baker Representative's field log book will also serve as a quality assurance record and shall include at a minimum the following information: Project name and identification number; date; field personnel; name of subcontractor; equipment; names of drilling/operating personnel; weather; site conditions; sample times and locations, and documentation of pay items (footage, samples collected, clearing, etc.).

Project plans should include QA/QC specific requirements for the collection of direct-push soil and groundwater samples.

7.0 REFERENCES

1. Christy, Thomas M., and Stephen C. Spradlin. The Use of Small Diameter Probing Equipment for Contaminated Site Investigation. Geoprobe Systems. Salina Kansas.

2. Cordry, Kent E. HydroPunch User's Guide. Edition 070193. QED Ground Water Specialists, Ann Arbor Michigan.

3. Eastern Research Group, Inc. Subsurface Characterization and Monitoring Techniques: A Desk Reference Guide. Volume I: Solids and Ground Water. Prepared for Center for Environmental Research Information, US Environmental Protection Agency. May 1993.

4. Geoprobe AT Series Large Bore Soil Sampler Standard Operating Procedured (SOP). Technical Bulletin No. 93-660. September 21, 1993.

ATTACHMENT A

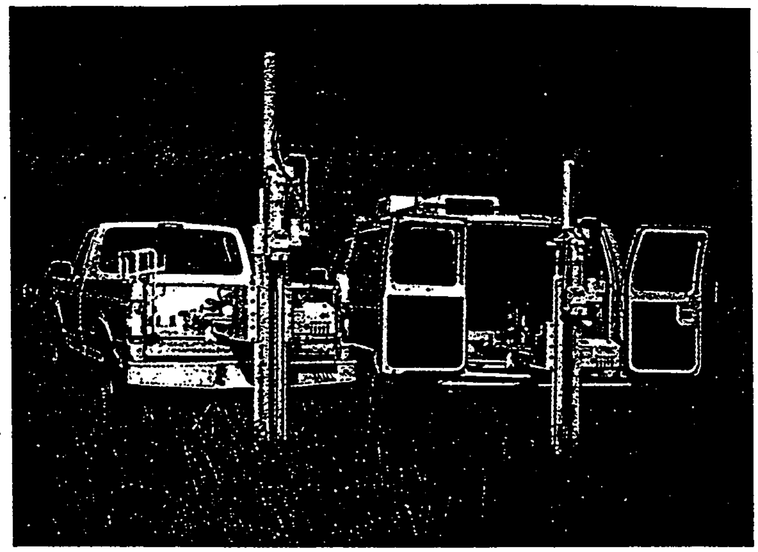
INTRODUCTION TO GEOPROBE SYSTEMS

Introduction – Geoprobe Machines

What is a Geoprobe?

A Geoprobe is a hydraulically-powered, percussion/probing machine designed specifically for use in the Environmental Industry. The first Geoprobe was built for the Environmental Protection Agency in 1988.

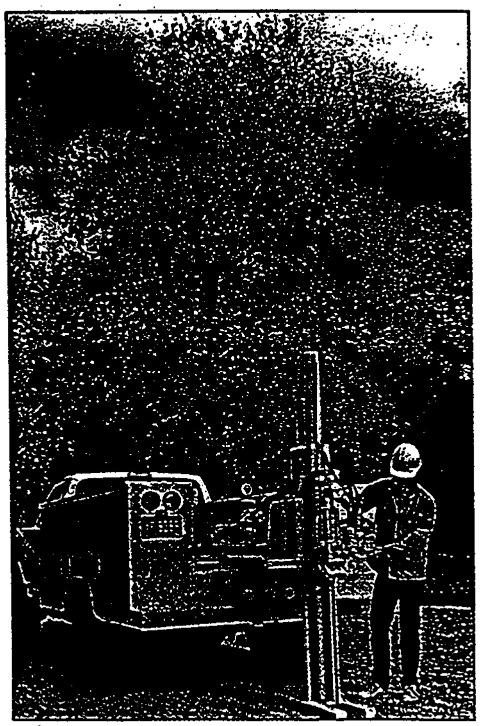
Soil probing techniques can be thought of as a subcategory of what are commonly referred to as "Direct Push" techniques. Direct push refers to tools and sensors that are inserted into the ground without the use of drilling to remove soil and make a path for the tool. A Geoprobe relies on a relatively small amount of static (vehicle) weight combined with percussion as the energy for advancement of a tool string.



Geoprobe Model 5400 (left) and Model 4200
The Newest Models from the Originators of Percussion Soil Probing.

Using a Geoprobe, you can drive tools to obtain continuous soil cores or discrete soil samples. You can drive samplers to obtain groundwater samples or vapor samples. You can insert permanent sampling implants and air sparging points. You can drive a conductivity sensor probe to map subsurface lithology. In fact, the Geoprobe has been used to perform all of these functions to depths of 100 feet (30 m) or more.

You will find Geoprobe equipment on four continents and places in between. You will find it used in UST investigations, property audits, Superfund sites, remediation projects, and research. Its uses are as diverse as its users.



The Geoprobe is a hydraulically-powered soil probing machine which uses static force and a percussion hammer to advance small diameter sampling tools into the subsurface to collect soil cores, groundwater samples, and soil gas samples.

How does a Geoprobe work?

Soil probing equipment is typically used for site investigations to depths of 30 to 60 feet (9 to 18 m). However, this range is elusive and constantly increasing as better probing equipment is produced. Geoprobe soil probing equipment has been used to depths exceeding 100 feet (30 m) in many areas of the United States.

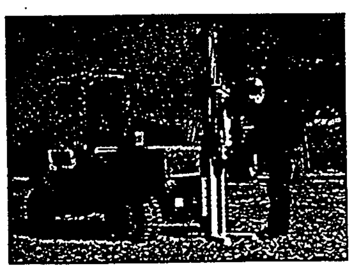
- It's hydraulically powered either from a vehicle or an auxiliary engine.
- It utilizes static force and the dynamic percussion force of the awesome GH-40 Soil Probing Hammer to advance small diameter sampling tools.
- It rearranges particles in the subsurface by application of weight and percussion to advance a tool string and produces no cuttings in the process.
- It can drill through surface pavements 12 inches (305 mm) or more in thickness and probes beneath them.
- It can be used for collecting soil cores, groundwater samples, and soil gas samples. A probing tool is also available to make continuous logs of soil conductivity and probe penetration rates.

Introduction – Geoprobe Machines

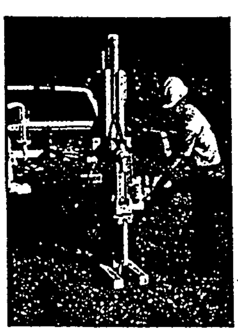
The Geoprobe Benefits . . .

Geoprobe equipment has redefined the way sites are investigated in the Environmental Industry. In many areas of the country, Geoprobe machines and tools have displaced traditional drilling methods as the preferred mode of collecting subsurface samples. There are numerous reasons why Geoprobe techniques have found such wide acceptance in the field. Among these reasons are the following:

- No cuttings are produced during the sampling process.
- Probing is fast: typical penetration rates are from 5 to 25 feet (2 to 8 m) per minute.
- Mobilization is quick and economical.
- The sampling process is fast; 20-40 sample locations per day.
- Probing machines are easy to operate and relatively simple to maintain.
- Probing tools create small diameter holes which minimize surface disturbance.
- Geoprobes fold compactly and store in cargo vans or truck toppers where the unit and tools can be locked and secured.
- Geoprobe machines have lower capital costs and are more economical to operate than rotary drilling machines.
- Geoprobes can be used to sample all subsurface media including soil, groundwater, and soil gas.



Taking soil samples with the Geoprobe Model 4220 Mule.



Sampling procedures produce no cuttings.

Geoprobe Model 4200 (left) and Model 5400.

What types of Geoprobe Machines are there?

There are five Geoprobe Models:

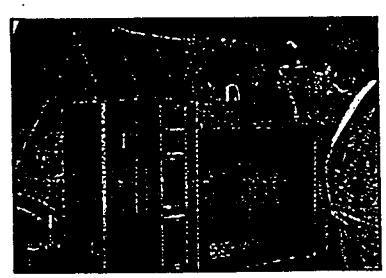
- Model 5400 (page 1.1)
- Model 4200 (page 1.5)
- Model 540U (page 1.9)
- Model 420U (page 1.13)
- Model 4220 (page 2.1)

What about Mobile Laboratories?

There are several options available:

- Custom built to suit your project requirements.
- Can be built to complement the soil probing system on the same vehicle or built as an independent unit.
- Can be built on a vehicle or a trailer.

See page 3.1 for details.



Geoprobe can custom design a mobile laboratory to work in conjunction with your soil probing

What about Training?

We offer complete training on all soil probing and laboratory systems sold. See pages 1.17 and 3.10 for information.

How can I Purchase a Geoprobe?

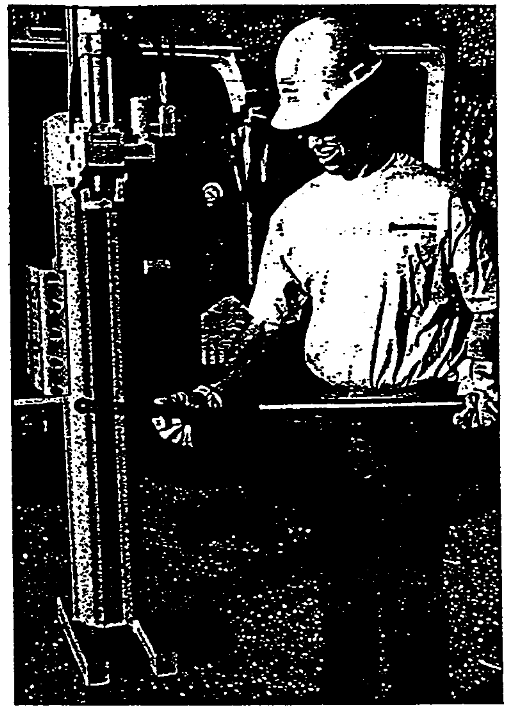
Tips and guidelines on purchasing a complete system are provided on page 14.1. We've seen to the details so you don't have to.

Large Bore Soil Samplers

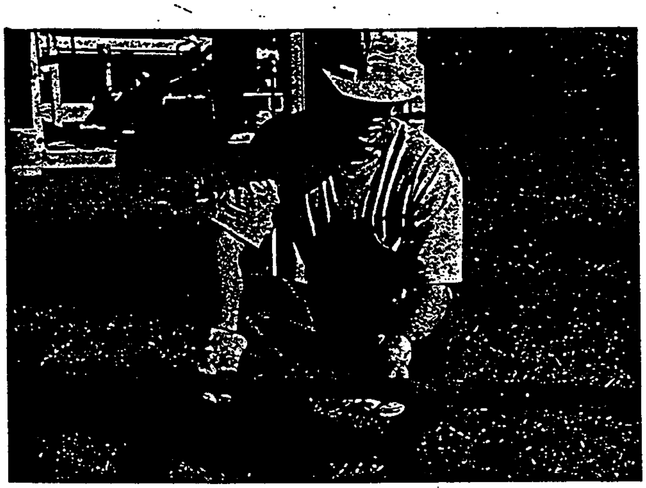
A Closed Piston Sampler for Soil Sampling at Discrete Depths

- Patented design* allows samplers to remain completely sealed while driven to depth.
- Large Bore Sampler recovers 22-inch long x 1.0625-inch diameter (559 mm x 27 mm) core, 320 mL in volume to depths of over 60 feet (18 m).
- Samplers are pushed or driven to depth.
- Generates no cuttings during sampling.
- Liners are available in CAB (clear plastic), brass, stainless steel, and PTFE (Teflon®).

Find a detailed description of the Large Bore Sampler and a list of parts beginning on page 6.2. Operating instructions are provided in Appendix A.



A discrete soil sample is obtained using the Large Bore Soil Sampler.



The Macro-Core Soil Sampler can now be used in an open tube or closed piston configuration.

Macro-Core® Soil Samplers

Open Tube Sampling from Ground Surface or Closed Piston Sampling for Sample Retrieval at Discrete Depths

- Macro-Core Samplers recover 45-inch long x 1.5-inch diameter (1143 mm x 38 mm) core, 1303 mL in volume.
- Samplers are pushed or driven.
- Generates no cuttings during sampling.
- Sample with an open tube or with a closed piston system to depths exceeding 30 feet (9 m).
- Liners are available in PETG (clear plastic), stainless steel and PTFE (Teflon®).

A complete description of the Macro-Core sampler and a complete list of parts begins on page 5.11. Operating instructions are provided in Appendix B.

* U.S. Patent No. 5,186,263.

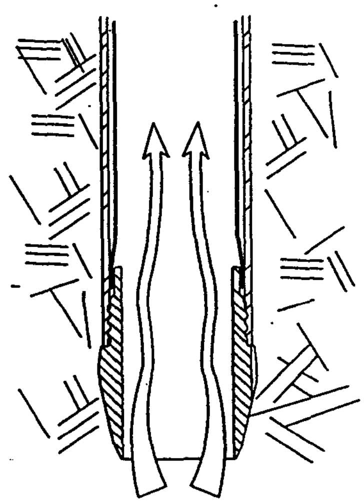
Soil Sampling Tools – Large Bore Soil Sampler

Large Bore Soil Sampling System . . .

Soil samplers that remain completely sealed while being pushed or driven to depth.

Typical Applications: Retrieval of Discrete Soil Samples at Depth Using Driven Probes

- Soil Sampling Beneath UST Sites
- Studies of Chemical Dissipation with Soil Depth
- Pesticide Studies
- Hazardous Waste Site Investigations
- Property Transaction Surveys
- Chemical Carryover/Residue Studies

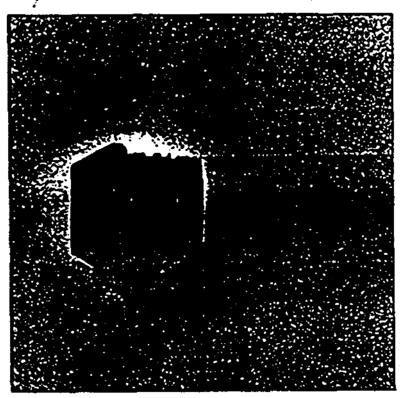


Geoprobe soil samplers feature liners that fit over the end of the cutting shoe. This feature, which was pioneered by Geoprobe, allows soil to flow into the liner without lodging behind the liner.

The Large Bore (LB) Soil Sampler is used primarily as a discrete interval sampler; that is, for the recovery of a sample at a prescribed depth. In certain circumstances, it is also used for continuous coring. The Large Bore Sampler recovers a 22-inch long x 1.06-inch diameter (559 mm x 27 mm) core. Maximum core volume is 318 mL.

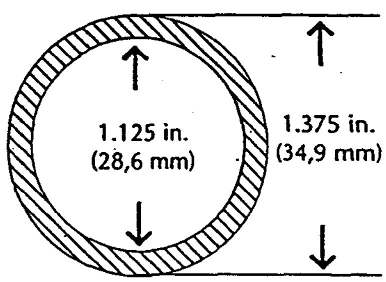
Liners for the Large Bore Sampler are available in CAB (clear plastic), brass, stainless steel, and PTFE (Teflon®).

Geoprobe's Large Bore Soil Sampler is perhaps the most popular direct push soil sampler in the United States today. It has achieved this status by solving problems for field investigators. Think of the possibilities: You need to determine the distribution of contaminants at depth (i.e., 10, 20, and 30 feet (3, 6, and 9 m)) — the Large Bore is your tool! Simply drive it to depth, open it, and recover a core. Easy driving, fast operation, minimal disturbance, no cuttings.



Pre-flared liners snap over interior end of cutting shoe. (Large Bore CAB liner shown here)

Suppose the project requires definition of contaminant concentration at a specific depth across the site. This is where the LB shines! You can complete multiple sampling points across the site. The speed and economic advantages offered by this sampler have allowed site investigators to increase the number of samples they obtain to define site conditions. It has also allowed them to develop a better understanding of subsurface conditions and contaminant distribution.



Actual size of Large Bore Sample Tube. The Large Bore Sampler gives an ample I.D. for core recovery while maintaining a small O.D. for ease of driving.

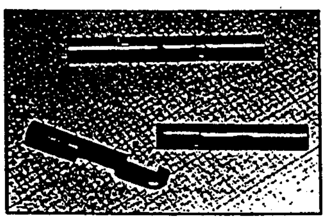
Soil sample recovered using the Geoprobe Large Bore Soil Sampler.

A unique soil sampling system designed for use with Geoprobe probing tools.

Geoprobe's Large Bore Soil Sampler can be used with either manually driven probe rods or Geoprobe hydraulic soil probing machines.

Unlike split-spoon samplers, the Large Bore Sampler remains completely sealed while it is pushed or driven to the desired sampling depth.

A piston stop-pin at the top end of the sampler is removed by means of extension rods inserted down the inside diameter of the probe rods after the sampler has been driven to depth. This enables the piston to retract into the sample tube as it is driven to recover a sample.



Stop-pin removal on the LB Sampler is now faster than ever thanks to the new Extension Rod Quick Links (AT-694K).

• GEOPROBE SOP AVAILABLE •

For complete instructions on the operation of this sampler, please request Geoprobe's Large Bore Soil Sampler SOP (Technical Bulletin No. 93-660).

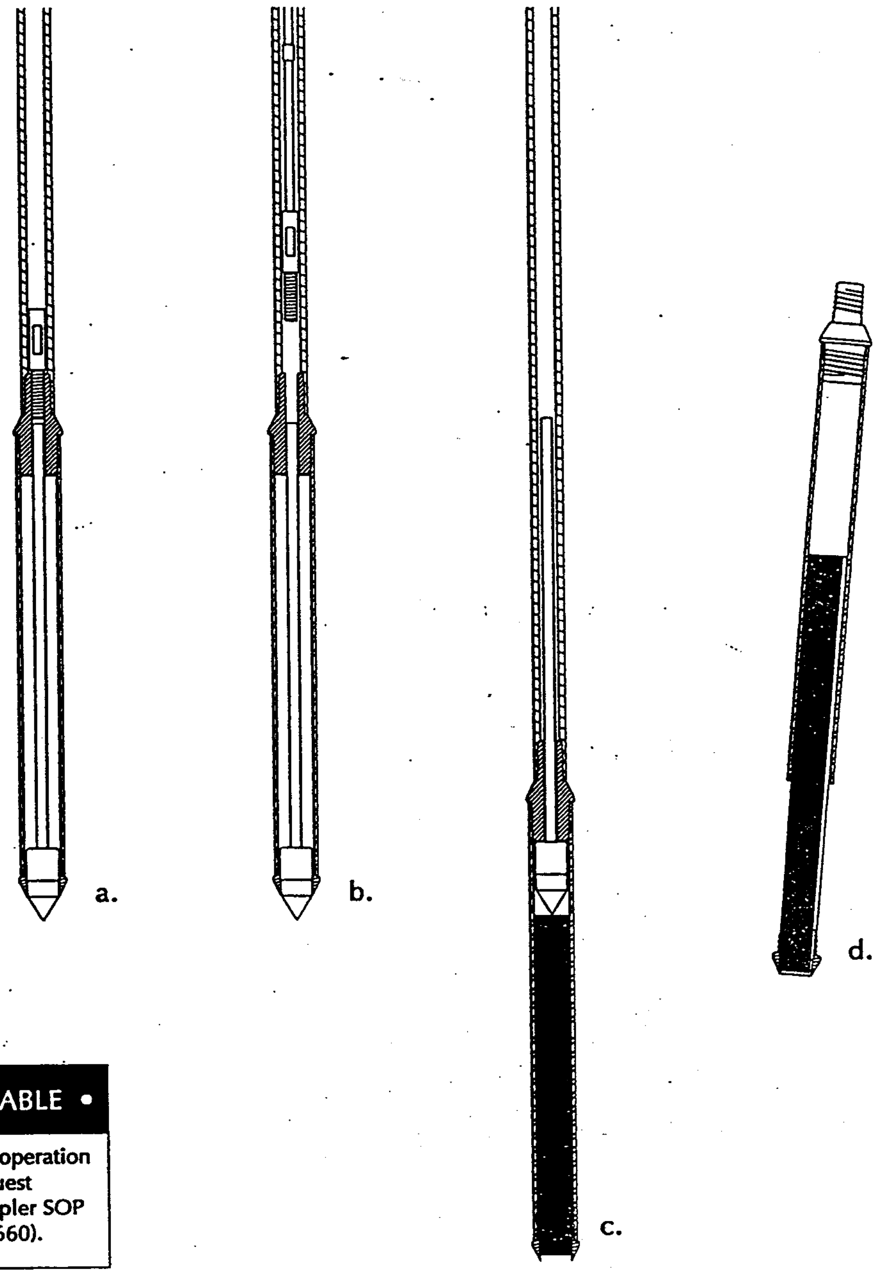


Figure 1. Driving and Sampling with the Large Bore Soil Sampler.
a. Driving the Sealed Sampler b. Removing the Stop-Pin
c. Collecting a Sample d. Recovering Sample in Liner

ATTACHMENT B

GEOPROBE AT-660 SERIES LARGE BORE SOIL SAMPLER STANDARD OPERATING PREOCEDURE

GEOPROBE AT-660 SERIES LARGE BORE SOIL SAMPLER

Standard Operating Procedure (SOP)

Technical Bulletin No. 93-660

PREPARED: 9/21/1993

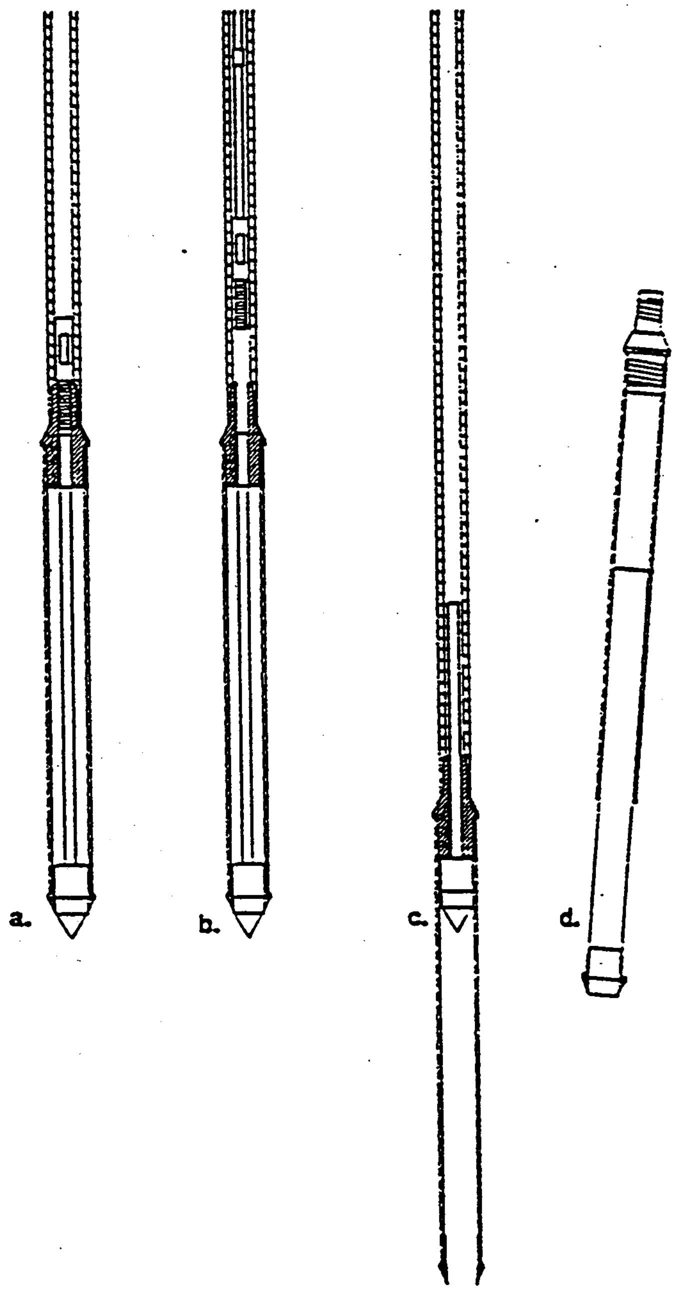


Figure 1. Driving and Sampling with the Large Bore Soil Sampler.
a. Driving the Sealed Sampler b. Removing the Stop-pin
c. Collecting a Sample d. Recovering Sample in Liner

1.0 OBJECTIVE

The objective of this procedure is to collect a discrete soil sample at depth and recover it for visual pection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe*: A vehicle-mounted, hydraulically-powered, soil probing machine that utilizes static force and percussion to advance small diameter sampling tools into the subsurface for collecting soil core, soil gas, or ground water samples.
**(Geoprobe is a registered trademark of Kejr Engineering, Inc., Salina, Kansas.)*

Large Bore Sampler: A 24-inch long x 1-3/8-inch diameter piston-type soil sampler capable of recovering a discrete sample that measures up to 320 ml in volume, in the form of a 22-inch x 1-1/16-inch core contained inside a removable liner.

Liner: A 24-inch long x 1-1/8-inch diameter removable/replaceable, thin-walled tube inserted inside the Large Bore Sampler body for the purpose of containing and storing soil samples. Liner materials include brass, stainless steel, Teflon, and clear plastic (either PETG or cellulose acetate butyrate).

2.2 Discussion

In this procedure, the assembled Large Bore Sampler is connected to the leading end of a Geoprobe brand probe rod and driven into the subsurface using a Geoprobe machine. Additional probe rods are connected in succession to advance the sampler to depth. The sampler remains sealed (closed) by a piston tip as it is being driven. The piston is held in place by a reverse-threaded stop-pin at the trailing end of the sampler. When the sampler tip has reached the top of the desired sampling interval, a series of extension rods, sufficient to reach depth, are coupled together and lowered down the inside diameter of the probe rods. The extension rods are then rotated clock-wise (using a handle). The male threads on the leading end of the extension rods engage the female threads on the top end of the stop-pin, and the pin is removed. After the extension rods and stop-pin have been removed, the tool string is advanced an additional 24 inches. The piston is displaced inside the sampler body by the soil as the sample is cut. To recover the sample, the sampler is recovered from the hole and the liner containing the soil sample is removed. The operation is illustrated in Figure 1.

3.0 REQUIRED EQUIPMENT

The following equipment is required to recover soil core samples using the Geoprobe Large Bore Sampler and driving system. (Figure 2.) Note that the sample liners for the Large Bore Sampler are available in four different materials. Liner materials should be selected based on sampling purpose, analytical parameters, and data quality objectives.

Large Bore Sampler Parts	Quantity	Part Number
STD Piston Stop-pin, O-ring	1	AT-63, 63 R
LB Cutting Shoe	1	AT-660
LB Drive Head	1	AT-661
LB Sample Tube	1	AT-662
LB Piston Tip	1	AT-663
LB Piston Rod	1	AT-664
LB Clear Plastic Liner	variable	AT-665
LB Brass Liner	variable	AT-666
LB Stainless Steel Liner	variable	AT-667
LB Teflon* Liner	variable	AT-668
LB Cutting Shoe Wrench	1	AT-669
Vinyl End Caps	variable	AT-641
Teflon* Tape	variable	AT-640 T

**(Teflon is a Registered Trademark of E.I. du Pont de Nemours & Co.)*

Geoprobe Tools	Quantity	Part Number
Probe Rod (3 foot)	variable	AT-10 B
Probe Rod (2 foot)	1	AT-10 B
Probe Rod (1 foot)	1	AT-10 B
Drive Cap	1	AT-11 B
Pull Cap	1	AT-12 B
Extension Rod	variable	AT-67
Extension Rod Coupler	variable	AT-68
Extension Rod Handle	1	AT-69

Optional		
LB Manual Extruder	1	AT-659 K
Extension Rod Jig	1	GW-469
LB Pre-Probe	1	AT-146B

Additional Tools

Vise Grips
Open Ended Wrench (3/8-inch)
1-inch or Adjustable Wrench

4.0 OPERATION

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the soil sampling system according to project specific requirements. A clean, new liner is recommended for each use. Parts should also be inspected for wear or damage at this time.

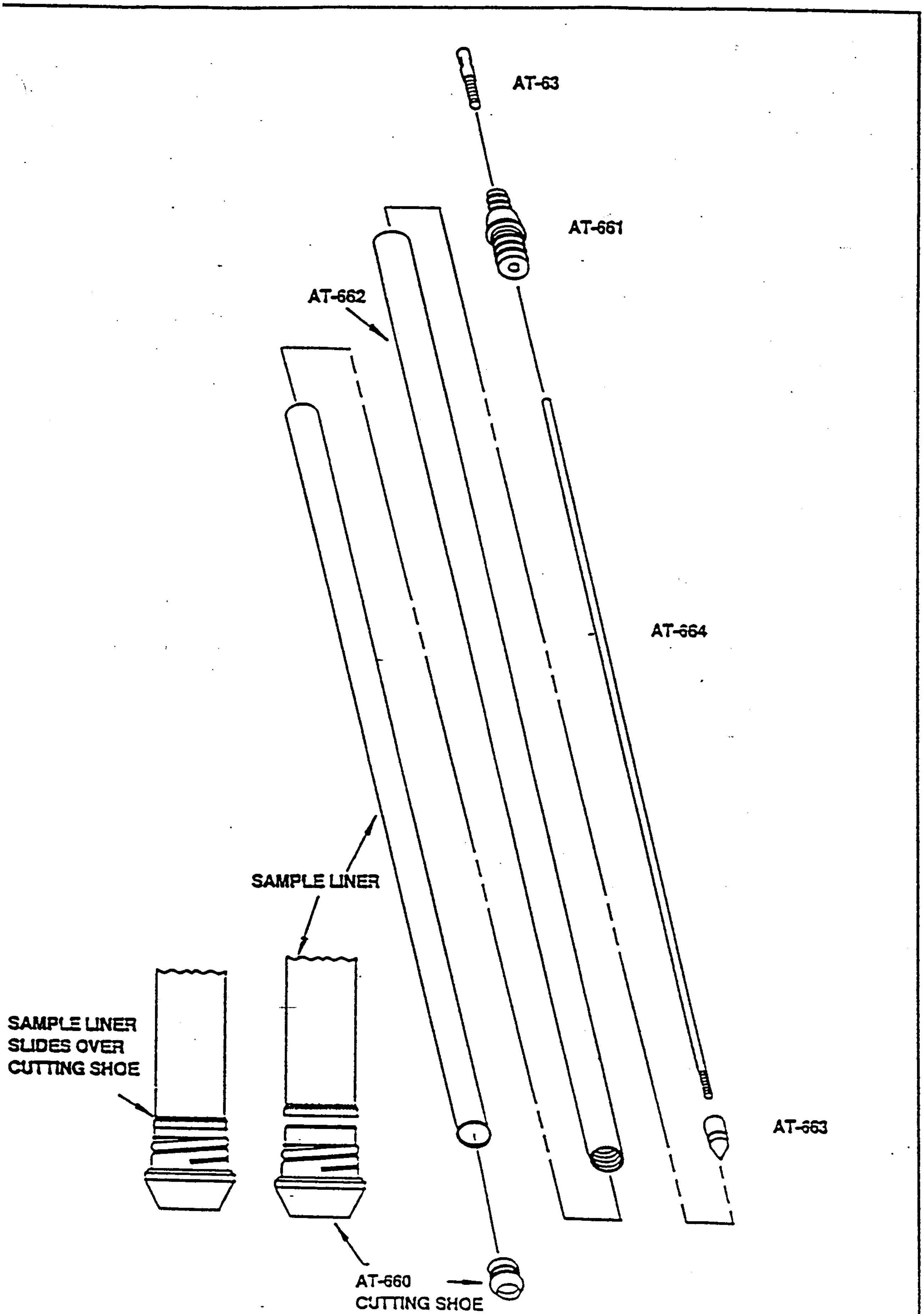


Figure 2. Large Bore Sampler Parts

4.2 Assembly

1. Install a new AT-63R O-ring into the O-ring groove on the AT-63 Stop-pin.

2. Seat the pre-flared end of the LB Liner (AT-665, -666, -667, or -668) over the interior end of the AT-660 Cutting Shoe. (Figure 3.) It should fit snugly.

3. Insert the liner into either end of the AT-662 Sample Tube and screw the cutting shoe and liner into place. If excessive resistance is encountered during this task, it may be necessary to use the AT-669 LB Shoe Wrench. Place the wrench on the ground and position the sampler assembly with the shoe end down so that the recessed notch on the cutting shoe aligns with the pin in the socket of the wrench. (Figure 4.) Push down on the sample tube while turning it, until the cutting shoe is threaded tightly into place.

4. Screw the AT-664 Piston Rod into the AT-663 Piston Tip. Insert the piston tip and rod into the sample tube from the end opposite the cutting shoe. Push and rotate the rod until the tip is seated completely into the cutting shoe.

5. Screw the AT-661 Drive Head onto the top end of the sample tube, aligning the piston rod through the center bore.

6. Screw the reverse-threaded AT-63 Stop-pin into the top of the drive head and turn it counter-clockwise with a 3/8-inch wrench until tight. Hold the drive head in place with a 1-inch or adjustable wrench while completing this task to assure that the drive head stays completely seated. The assembly is now complete.

4.3 Pilot Hole

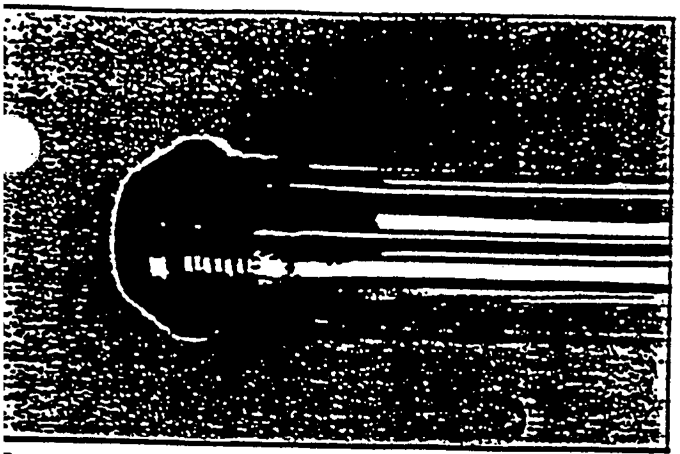
A pilot hole is appropriate when the surface to be penetrated contains gravel, asphalt, hard sands, or rubble. Pre-probing can prevent unnecessary wear on the sampling tools. A Large Bore Pre-Probe (AT-146B) may be used for this purpose. The pilot hole should be made only to a depth above the sampling interval. Where surface pavements are present, a hole may be drilled with the Geoprobe using a Drill Steel (AT-32, -33, -34, or -35, depending upon the thickness of the pavement), tipped with a 1.5-inch diameter Carbide Drill Bit (AT-36) prior to probing. For pavements in excess of 6 inches, the use of compressed air to remove cuttings is recommended.

4.4 Driving

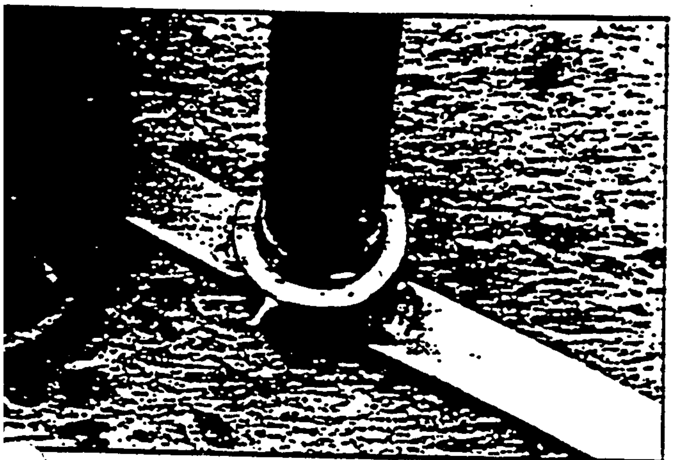
1. Attach an AT-106B 1-foot Probe Rod to the assembled sampler and an AT-11B Drive Cap to the probe rod. Position the assembly for driving into the subsurface.

2. Drive the assembly into the subsurface until the drive head of the LB sample tube is just above the ground surface.

3. Remove the drive cap and the 1-foot probe rod. Secure the drive head with a 1-inch or adjustable wrench and re-tighten the stop-pin with a 3/8-inch wrench. (Figure 5.)



igure 3. Liner fits snugly over interior end of cutting shoe.



e 4. Using the AT-669 Cutting Shoe Wrench to attach
utting shoe.

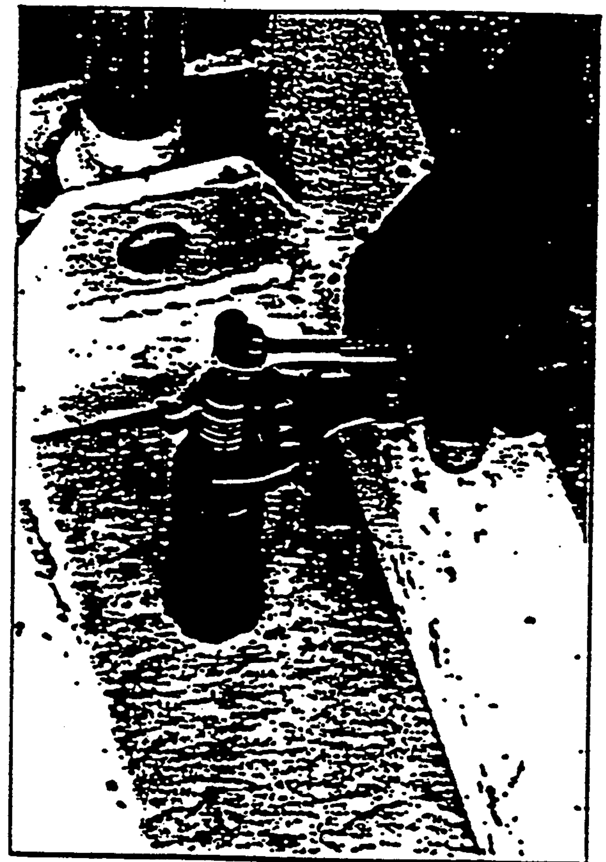
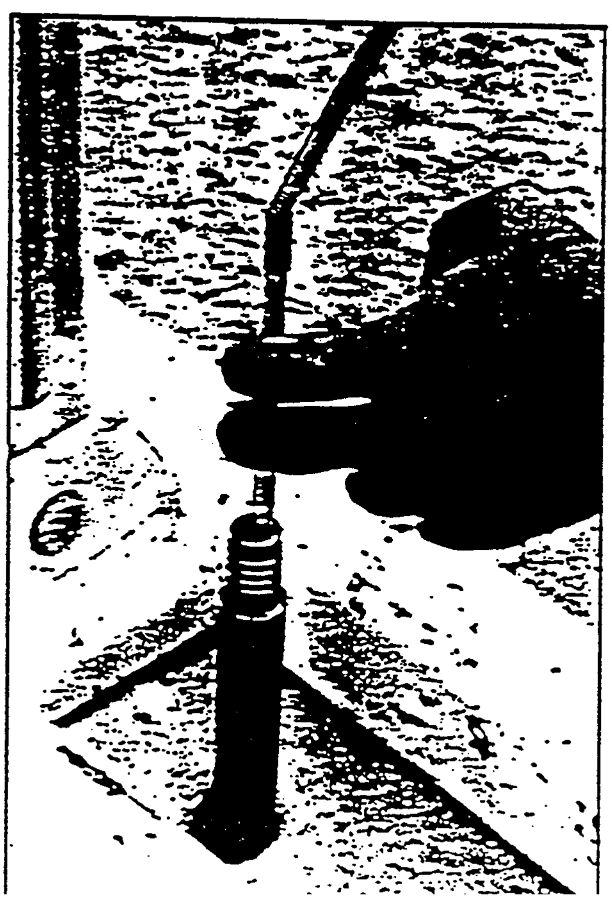
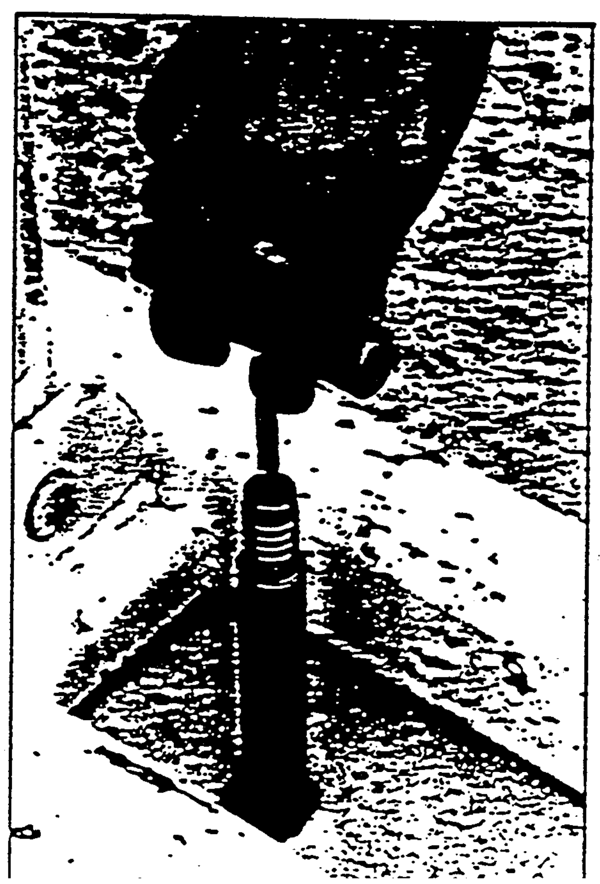


Figure 5. Tightening the Stop-pin.





4.4 Driving (continued from page 5)

4. Attach an AT-105B 2-foot Probe Rod and a drive cap, and continue to drive the sampler into the ground. Attach AT-10B 3-foot Probe Rods in succession until the leading end of the sampler reaches the top of the desired sampling interval.

4.5 Preparing to Sample

1. When sampling depth has been reached, position the Geoprobe machine away from the top of the probe rod to allow room to work.

2. Insert an AT-67 Extension Rod down the inside diameter of the probe rods. Hold onto it and place an AT-68 Extension Rod Coupler on the top threads of the extension rod (the down-hole end of the leading extension rod should remain uncovered). Attach another extension rod to the coupler and lower the jointed rods down-hole. (Figure 6.)

3. Couple additional extension rods together in the same fashion as in Step 2. Use the same number of extension rods as there are probe rods in the ground. The leading extension rod must reach the stop-pin at the top of the sampler assembly. When coupling extension rods together, you may opt to use the GW-469 Extension Rod Jig to hold the down-hole extension rods while adding additional rods.

4. When the leading extension rod has reached the stop-pin down-hole, attach the AT-69 Extension Rod Handle to the top extension rod.

5. Turn the handle clockwise (right-handed) until the stop-pin detaches from the threads on the drive head. (Figure 7.) Pull up lightly on the extension rods during this procedure to check thread engagement.

6. Remove the extension rods and uncouple the sections as each joint is pulled from the hole. The Extension Rod Jig may be used to hold the rod couplers in place as the top extension rods are removed.

7. The stop-pin should be attached to the bottom of the last extension rod upon removal. Inspect it for damage. Once the stop-pin has been removed, the sampler is ready to be re-driven to collect a sample.

4.6 Sample Collection

1. Reposition the Geoprobe machine over the probe rods, adding an additional probe rod to the tool string if necessary. Make a mark on the probe rod 24 inches above the ground surface (this is the distance the tool string will be advanced).

2. Attach a drive cap to the probe rod and drive the tool string and sampler another 24 inches. Use of the Geoprobe's hammer function during sample collection may increase the sample recovery in certain formations. Do not over-drive the sampler.

4.7 Retrieval

1. Remove the drive cap on the top probe rod and attach an AT-12B Pull Cap. Lower the probe shell and close the hammer latch over the pull cap.

2. With the Geoprobe foot firmly on the ground, pull the tool string out of the hole. Stop when the top (drive head) of the sampler is about 12 inches above the ground surface.

3. Because the piston tip and rod have been displaced inside the sample tube, the piston rod now extends into the 2-foot probe rod section. In loose soils, the 2-foot probe rod and sampler may be recovered as one piece by using the foot control to lift the sampler the remaining distance out of the hole.

4. If excessive resistance is encountered while attempting to lift the sampler and probe rod out of the hole using the foot control, unscrew the drive head from the sampler and remove it with the probe rod, the piston rod, and the piston tip. Replace the drive head onto the sampler and attach a pull cap to it. Lower the probe shell and close the hammer latch over the pull cap and pull the sampler the remaining distance out of the hole with the probe machine foot firmly on the ground.

4.8 Sample Recovery

1. Detach the 2-foot probe rod if it has not been done previously.

2. Unscrew the cutting shoe using the AT-669 LB Cutting Shoe Wrench, if necessary. Pull the cutting shoe out with the liner attached. (Figure 8.) If the liner doesn't slide out readily with the cutting shoe, take off the drive head and push down on the side wall of the liner. The liner and sample should slide out easily.

4.9 Core Liner Capping

1. The ends of the liners can be capped off using the AT-641 Vinyl End Cap for further storage or transportation. A black end cap should be used at the bottom (down end) of the sample core and a red end cap at the top (up end) of the core.

2. On brass, stainless steel, and teflon liners, cover the end of the sample tube with AT-640T Teflon Tape before placing the end caps on the liner. (Figure 9.) The tape should be smoothed out and pressed over the end of the soil core so as to minimize headspace. However, care should be taken not to stretch and, therefore, thin the teflon tape.

4.10 Sample Removal

1. Large Bore Clear Plastic and Teflon Liners can be slit open easily with a utility knife for the samples to be analyzed or placed in appropriate containers.

2. Large Bore Brass and Stainless Steel liners separate into four 6-inch sections. The AT-659K Large Bore Manual Extruder may be used to push the soil cores out of the liner sections for analysis or for transfer to other containers. (Figure 10.)

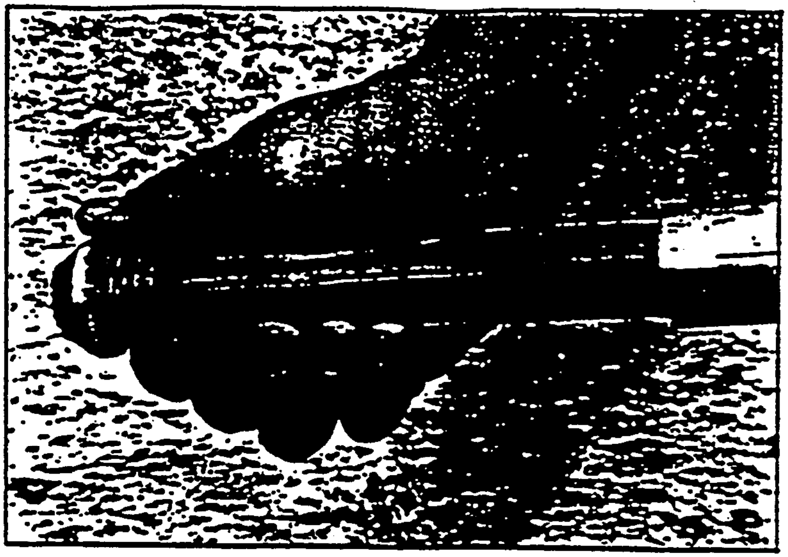


Figure 8. Removing the liner to recover the Sample.

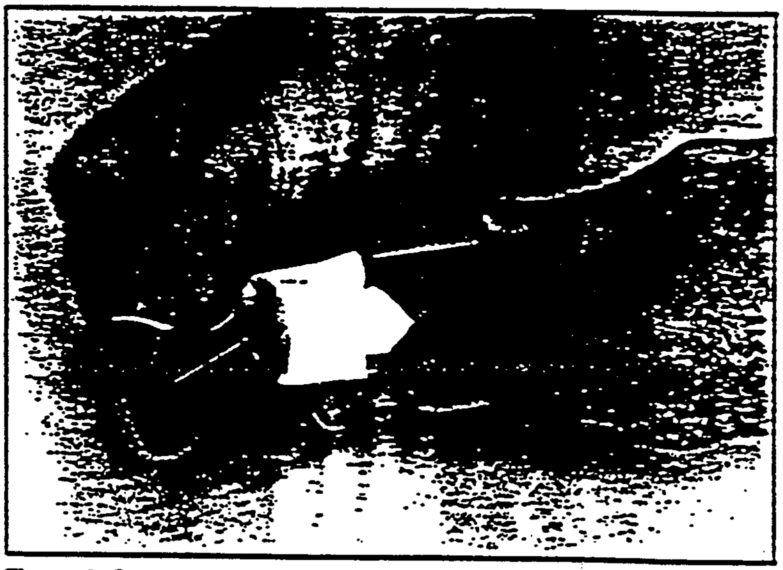


Figure 9. Covering the liner end with Teflon tape for capping.

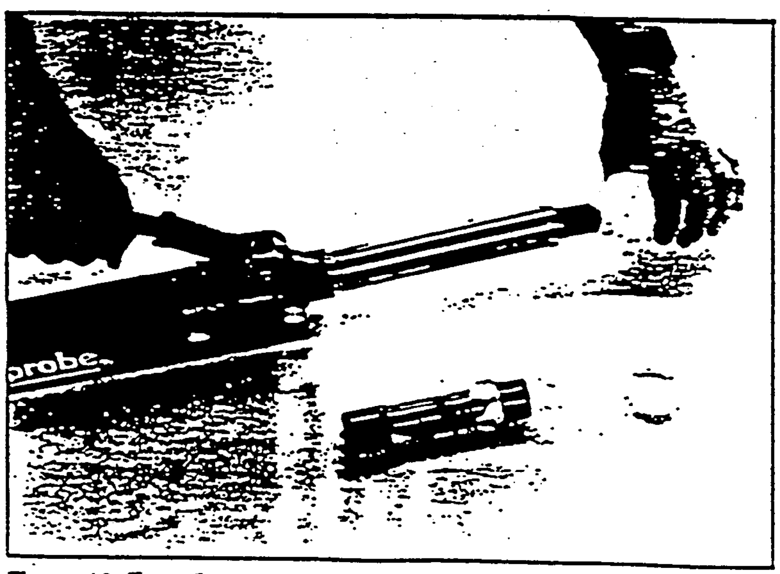


Figure 10. Extruding a sample in a metal liner using the AT-659K manual extruder.

5.0 REFERENCES

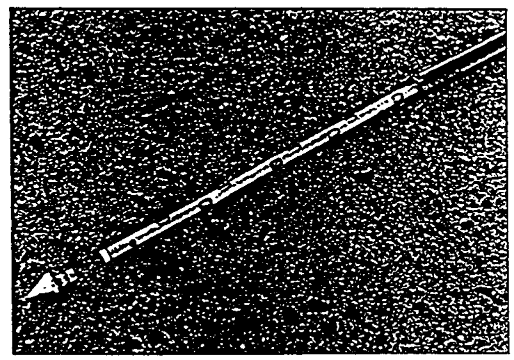
Geoprobe Systems, August 1993, "1993-94 Equipment and Tools Catalog".

ATTACHMENT C

SCREEN POINT GROUNDWATER SAMPLER COLLECTION

Appendix C:

Screen Point Ground Water Sampler Operation



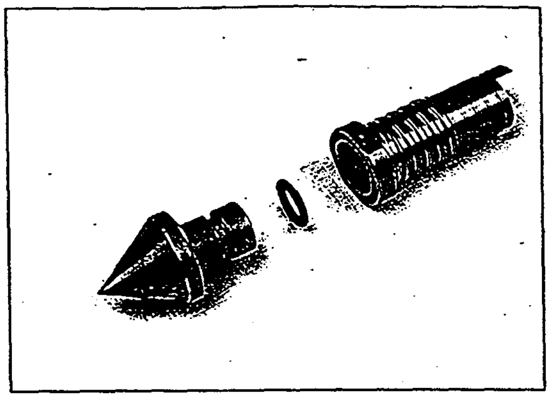
After the Screen Point Ground Water Sampler is driven to depth, the rods are retracted and the screen insert is pushed out into the formation.

Screen Point Ground Water Sampler – Operation

Assembly

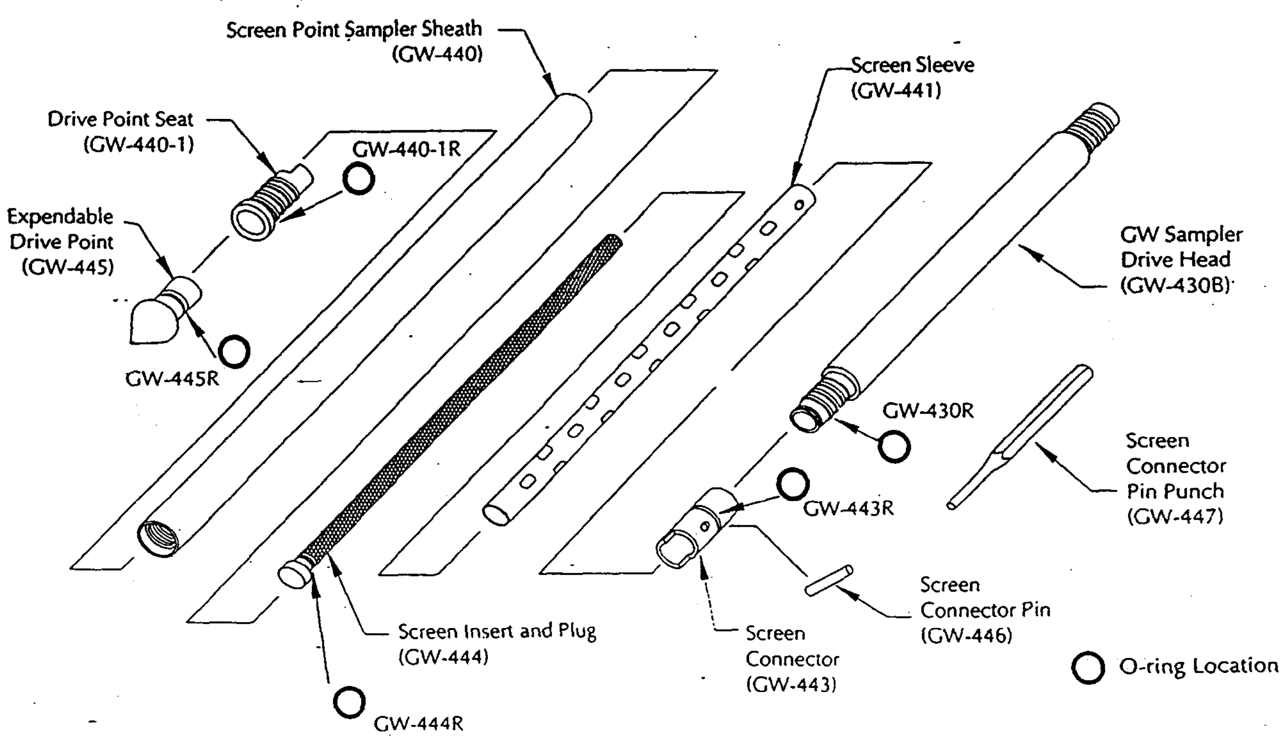
Clean all parts thoroughly before assembly. An uncontaminated screen insert should be used for each new sample. It is recommended that new O-rings be installed at each O-ring location prior to each sample. O-ring numbers correspond to the individual part numbers. After O-rings have been installed, follow these steps:

1. Push the Screen Insert and Plug into the Screen Sleeve from the bottom. The bottom end has one drain hole (Figure 1).
2. Push the Screen Connector over the top end of the Screen Sleeve and push the Screen Connector Pin into place (Figure 2). It has a loose fit so use your thumb and forefinger to hold it in place.
3. Insert the Screen Sleeve, Screen Connector first, halfway into the Sampler Sheath (either end is okay) (Figure 3).
4. Slide the Drive Point Seat over the end of the screen assembly that protrudes from the Sampler Sheath (Figure 4). Thread it in until tight using a 7/8-in. wrench.
5. Push the screen assembly just far enough into the Sampler Sheath that an Expendable Drive Point (GW-445) can be pushed into place in the Drive Seat (Figure 5).
6. Screw the Drive Head with the O-ring end first into the open end of the Sampler Sheath (Figure 6).



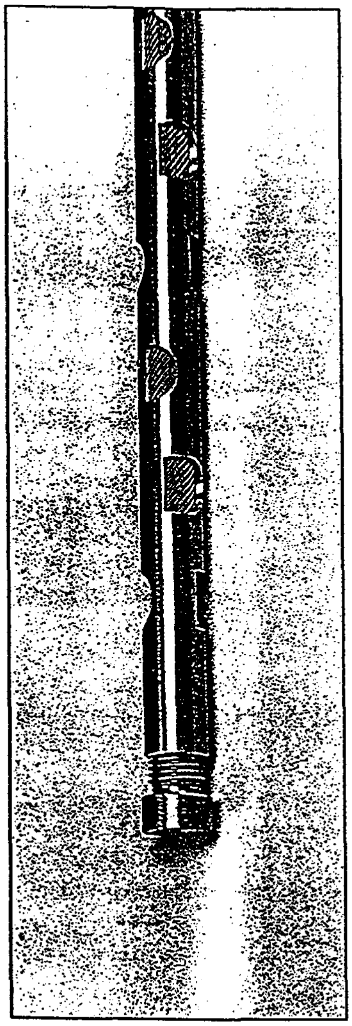
New O-rings should be used at each O-ring location prior to each sample. Shown here is the Expendable Drive Point (GW-445), O-ring (GW-445R), and Drive Point Seat (GW-440-1).

NOTE: These parts must be assembled so as to allow free movement of the screen assembly inside the Sampler Sheath. There should be no internal binding. The assembled sampler is now ready to be driven into the subsurface. Wetting the O-rings with a small amount of distilled water will aid in free movement of the parts.



▲ Screen Point Sampler (GW-440K)

Screen Point Ground Water Sampler – Operation



Wire mesh stainless steel Screen Insert inside stainless steel Screen Sleeve. Screen Insert has 0.145-mm pore openings which filter out sediment.

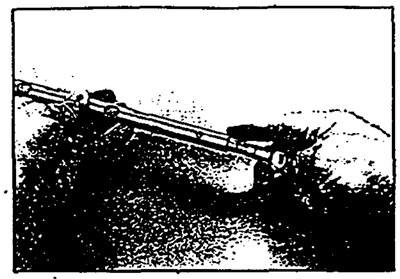


Figure 1. Push the Screen Insert and Plug into Screen Sleeve.

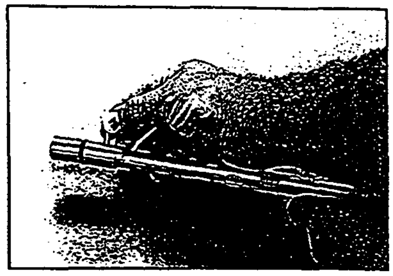


Figure 2. Push the Screen Connector Pin into place.

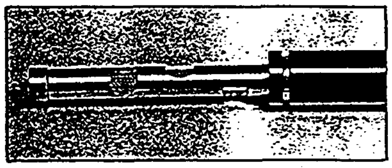


Figure 3. Insert Screen Sleeve halfway into Screen Point Sampler Sheath.

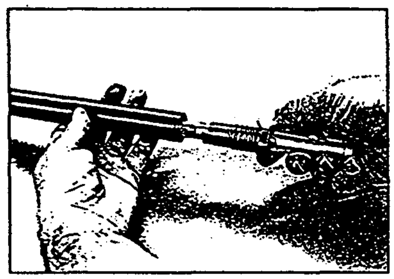


Figure 4. Slide Drive Point Seat over end of Screen Sleeve and screw into Sampler Sheath.

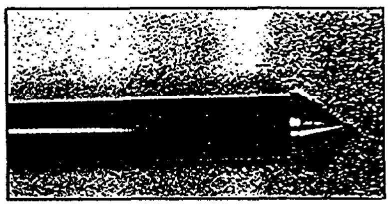


Figure 5. Insert Expendable Drive Point into Drive Point Seat.

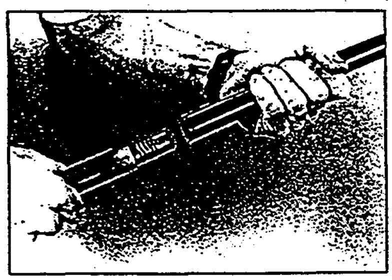
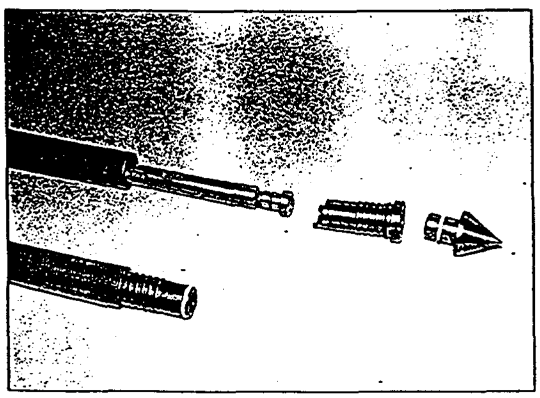


Figure 6. Screw O-ring end of Drive Head into top of Sampler Sheath.



Partially assembled Screen Point Sampler (GW-440K).

Screen Point Ground Water Sampler – Operation

Probing

Place a drive cap on the assembled sampler and drive it into the subsurface (Figure 1). Continue driving by adding Geoprobe probe rods until the sampler tip has been driven about one foot (1225 mm) below the target sampling depth (Figure 2). Once that depth has been reached, disengage the expendable drive point by replacing the drive cap with a pull cap and pulling the rods back a distance of about 2 ft. (1 m) (Figure 3).

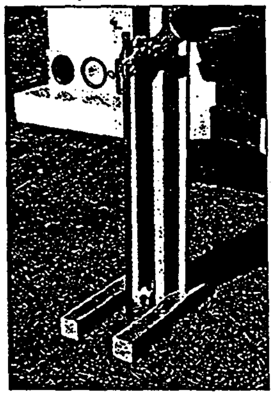


Figure 1. Assembled Screen Point Sampler is driven to depth.

Exposing the Screen

In stable formations, the screen assembly may be pushed out into the open borehole by lowering 3/8-in. tubing affixed with a PRT Adapter (TB-25L and PR-25S) to the top end of the screen assembly (Figure 4). The threads on the PRT adapter are engaged with the threads on the Screen Connector by pushing gently downward on the tubing and rotating it counterclockwise. When properly connected, the screen assembly can be pushed out of the Sampler Sheath by pushing down on the tubing. A water sample can be drawn through the tubing.

In unstable formations, the screen assembly may have to be pushed out of the Sampler Sheath by means of extension rods coupled together and inserted down the inside of the probe rods (Figure 5). The leading end of the extension rods should be equipped with an extension rod coupler to protect the threads on the Screen Connector. A steady push is sufficient. Excessive hammering on the rods should be avoided. After pushing the screen into the formation, the extension rods need to be removed in order to begin sampling.

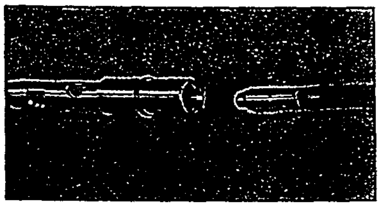


Figure 4. PRT-Adapter (PR-25S) inserted in tubing (TB-25L) prior to connection down-hole with Screen Connector.

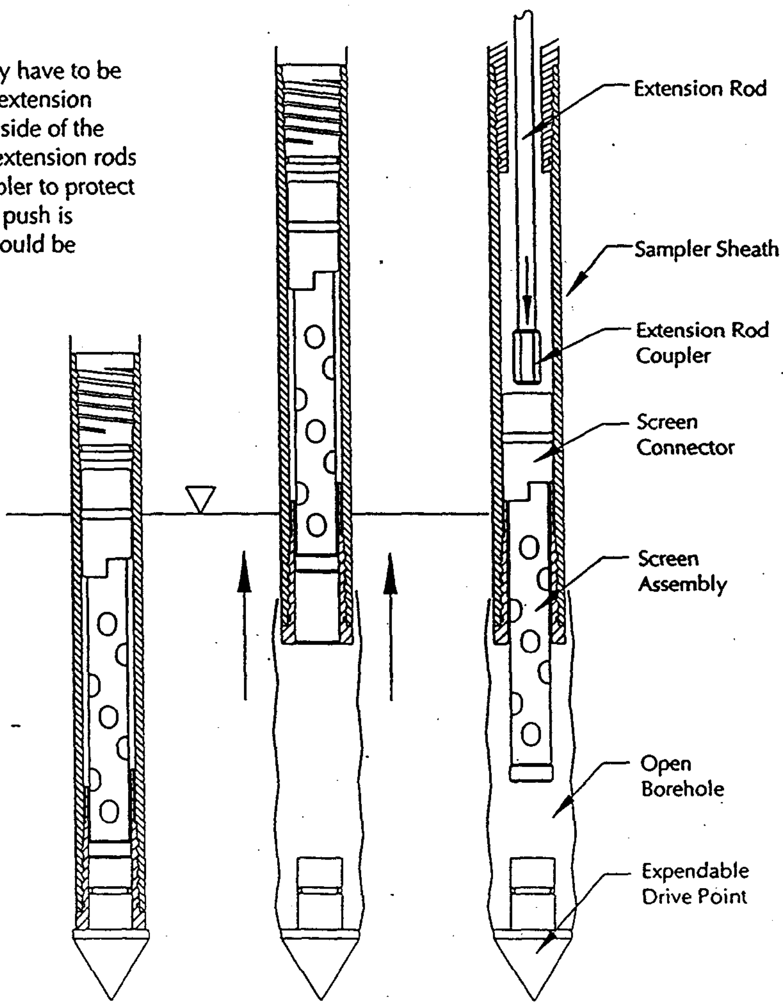


Figure 2. Sample Depth is Reached.

Figure 3. Pull Back Sampler 2 ft. (1 m).

Figure 5. Push Out Screen Assembly with Extension Rods.

Sampling

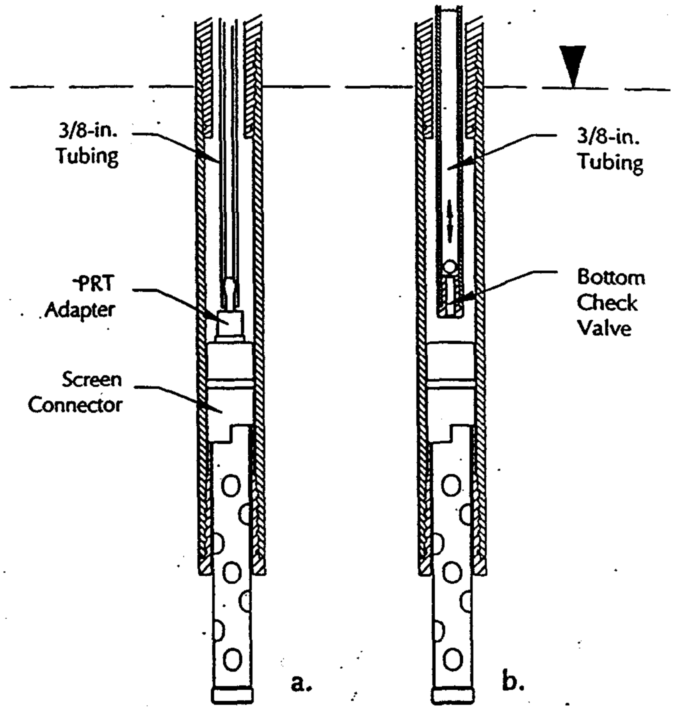
Water sampling may be accomplished by using 3/8-inch tubing and a stainless steel PRT adapter as previously described (TB-25L and PR-25S). Once the PRT adapter has made connection with the Screen Connector, a vacuum may be applied to the top of the tubing (Figure 6a). This may be done with a peristaltic pump (Figure 7) or by using a vacuum pump with an in-line trap.

If the PRT system is not used, the same tubing equipped with a Tubing Bottom Check Valve (GW-42) may be used (Figures 8 and 9). The tubing is oscillated up and down and the water sample is pushed upward into the tubing as the ball repeatedly lifts and seats (Figure 6b). The tubing will begin to feel heavier as it fills with several feet of water. It can then be lifted out of the probe rods, cut, and the water poured into a vial for analysis. This same tubing/check valve arrangement has been used to pump multi-liter samples from the probe rod.

Removal

When the sampling procedure is finished, the probe rods and sampler may be extracted. If the PRT system is used, remove the tubing by pulling up firmly on it until it disconnects from the PRT adapter down-hole. The PRT adapter will remain attached to the Screen Connector.

After the sampler has been recovered, examine all parts for wear, damage, or contamination. Thoroughly clean all parts, replace all O-rings, and prepare for the next sample.



Figures 6a and 6b. Sampling options.

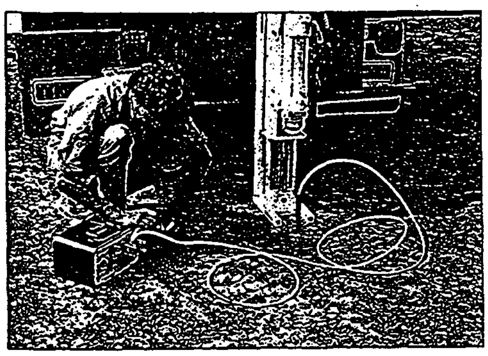


Figure 7. Using a peristaltic pump to collect a groundwater sample using the Screen Point Sampler.

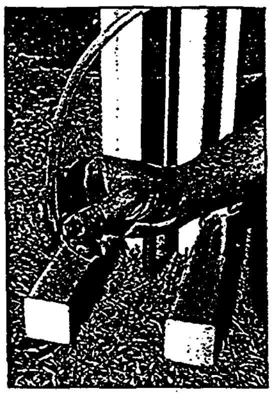


Figure 8. Tubing Bottom Check Valve and Check Ball are installed onto Tubing . . .

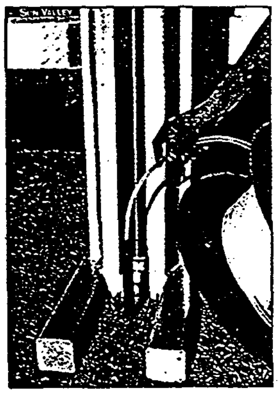
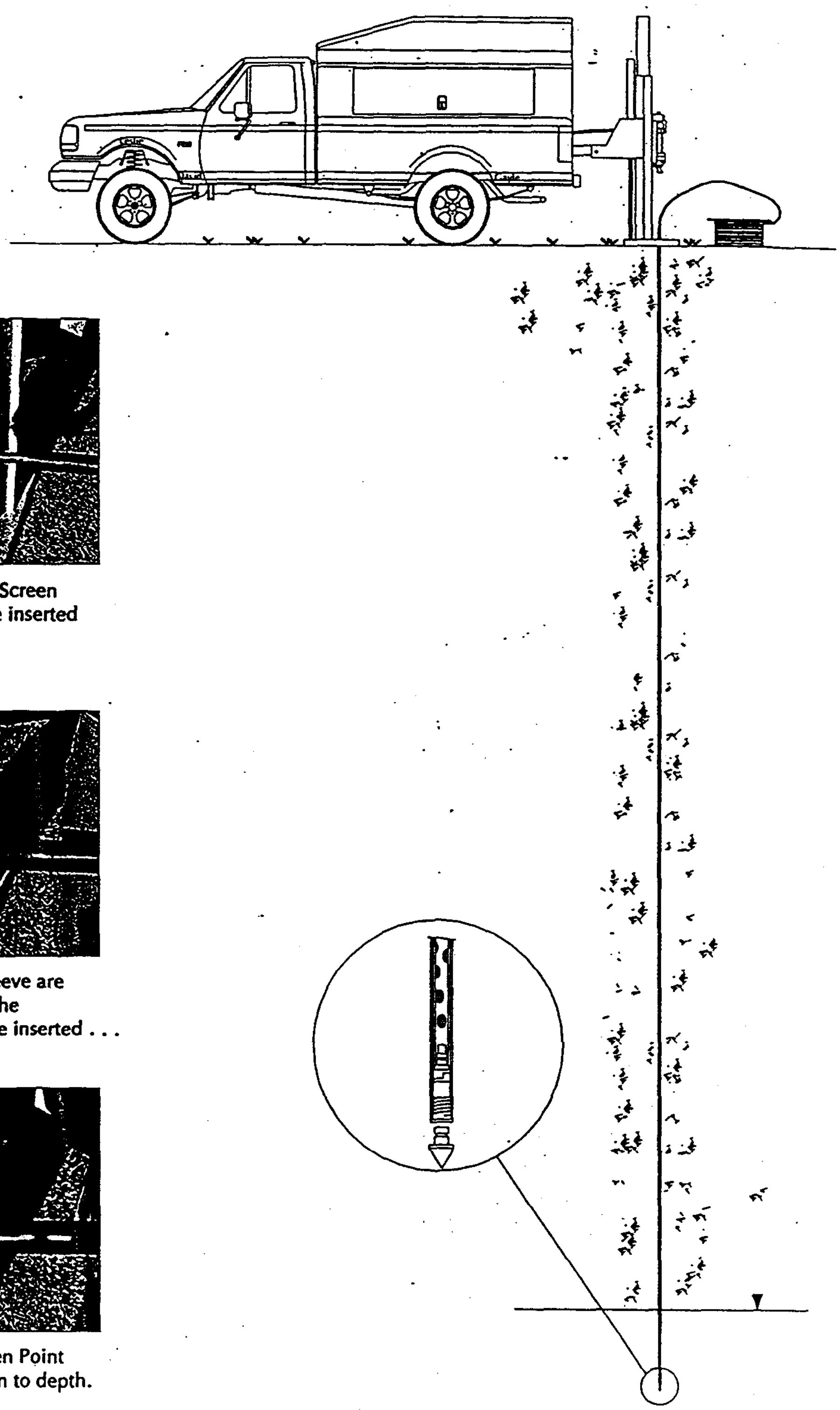
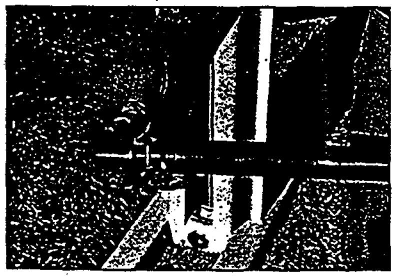


Figure 9. . . . and are then fed through the diameter of the probe rods to retrieve the water sample.

Screen Point Ground Water Sampler – Operation



An Expendable Drive Point, Screen Insert, and Screen Sleeve are inserted into Sampler Sheath . . .



. . . the Screen Insert and Sleeve are inserted just far enough for the Expendable Drive Point to be inserted . . .

. . . and the assembled Screen Point Sampler is ready to be driven to depth.

Screen Point Sampler at depth using Tubing Bottom Check Valve system for retrieving groundwater sample.

ATTACHMENT D

HYDROPUNCH USER'S GUIDE

HYDROPUNCH USER'S GUIDE

by

Kent E. Cordry

EDITION NO. 070193

QED

Ground Water Specialists™

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HYDROPUNCH USER'S GUIDE

by

Kent E. Cordry*

QED GroundWater Specialists

I. INTRODUCTION

HydroPunch II (HP-II) is a specialized field screening tool that is capable of collecting a representative ground water sample without requiring the installation of a ground water monitoring well. The tool is a drive sampler used to obtain ground water samples.

The HydroPunch system is protected by patents 5,146,998 and 5,046,568 with others pending. Any reproduction of the tool or components for resale as well as for in-house use is strictly prohibited.

The HydroPunch provides a fast, inexpensive method to determine the presence or absence of ground water contamination and, if present, to define the vertical and horizontal extent of the contamination. **The HydroPunch is not intended to replace monitoring wells but is used to reduce the number of monitoring wells needed to complete the hydrogeologic investigation.** HydroPunch samples enable the user to determine if long term monitoring wells are needed and, when needed, to optimize the location of the wells. While a monitoring well can collect hundreds of samples from a single location, a single HydroPunch can collect hundreds of samples from different locations. In short, the tools enable the user to get away from using monitoring wells to locate monitoring wells. A summary of the advantages of using the HydroPunch for site screening as opposed to the traditional approach of installing monitoring wells follows is outlined in Table 1 on the following page.

Other Screening Systems (general)

Prior to the availability of the HydroPunch the only field screening tools available to define the extent of ground water contamination consisted of various geophysical systems and soil gas analysis. Unfortunately, developing a correlation between the results of the soil gas or geophysical investigation and concentrations of contaminants in the ground water, is difficult, if not impossible, unless site and contaminant conditions are ideal. By comparison, the HydroPunch provides a physical sample of the ground water. This sample can be directly correlated with concentrations found in a monitoring well installed at the same location.

This manual has been prepared by Kent E. Cordry, the inventor of the HydroPunch, to aid your use of this tool. If you have any questions or suggestions

TABLE 1

HYDROPUNCH ADVANTAGES

Speed
HydroPunch samples can be collected in one-half to one-tenth the time it takes to install, develop, purge and sample a monitoring well and the samples are available immediately for analyses, not days, weeks or months later as is the case with monitoring wells.

Economy
Since samples can be collected at a much faster rate using the same equipment as well installation methods, the user realizes a substantial reduction in cost. Well development or purging is not necessary prior to sampling, consequently there is no need to containerize and dispose of excess water. Costs for projects can be one-half to one-tenth the cost of installing monitoring wells to obtain the same geochemical data.

Quality
Numerous technical papers have been published which compare HydroPunch samples to monitoring wells completed at the same locations. The results indicate a strong correlation between the monitoring wells and the HydroPunch samples. Findings thus far suggest that the HydroPunch samples minimize volatization at low levels of VOC contamination. This probably is because the HydroPunch collects a sample from a discrete zone with a minimum of aeration and agitation of the sample.

Environmental Impact
Since a permanent well is not installed, the disturbance to the surrounding environment is minimized during HydroPunch sampling, especially if the HydroPunch is pushed or driven from the surface to collect the sample. The low environmental impact is extremely valuable when tracking off-site plumes or when sampling needs to be as unobtrusive as possible.

Safety
The HydroPunch is a one time sampling system. Once the sample has been collected and the HydroPunch removed, the remaining hole can be effectively sealed from the bottom up by means of pressure grouting. This eliminates cross-contamination of aquifers as well as the need for well abandonment (necessary if wells are improperly constructed

Well points and screened hollow stem augers are sometimes used for site screening, but both share a common problem. The intake screens of the [illegible] are exposed as they are being advanced permitting outside contamination to enter and subsequently be carried down to the sample zone. As a result, large quantities of water need to be removed during development and purging prior to sampling. Even after development and purging are completed, there is no way to be positive that all contamination from the overlying zones has been removed. When a screened auger is used, an additional problem is that the auger does not seal itself in the borehole. The loose fit within the borehole permits contamination to enter the sample zone from above via the annulus between the flights of the auger and the wall of the borehole.

II. HOW THE HYDROPUNCH SYSTEM WORKS

1. General Information

The HydroPunch is designed to be pushed or driven into the aquifer either from the ground surface or from the bottom of a drilled borehole. Typically this is accomplished by using a drill rig or a cone penetrometer rig. The tool utilizes an air-tight and water-tight sealed intake screen and sample chamber which is isolated from the surrounding environment as the tool is advanced.

The shape and smooth exterior surface of the HydroPunch prevent the downward transport of contamination [as] the tool is advanced. As the tool is pushed deeper into the soil it cleans itself as the soil particles are displaced to the side and adhere to the surrounding soil material. As the soil is displaced, it compacts into the walls of the hole. This not only cleans the tool as it moves downward but also produces a very tight annular seal around the tool. The tight seal enables the HydroPunch to collect a very discrete sample from a specific depth by sealing off ground water from above and below the zone to be sampled. It should be noted that in fine grained materials with very thin water bearing zones, the compression of the soil particles displaced by the HydroPunch may sometimes lower the permeability of the material to a degree where ground water samples may not be collected in a reasonable amount of time (i.e. < 1 hour). Handling conditions like this will be covered later in more detail.

When the desired depth for collection of a ground water sample is reached, the HydroPunch is opened by pulling back on the body of the tool. Soil friction holds the drive cone in place as the body moves back. Once the O-ring seal between the drive cone and the body of the tool is broken, ground water flows from the surrounding formation into the sample chamber. No foreign materials (i.e. gravel pack, drilling fluid or cuttings) are introduced, minimizing the possibility of outside contamination. As the sample is collected, the drive cone and the sample chamber are tightly sealed against the borehole walls. This "packer" effect isolates the intake from ground water above and below and results in a very discrete vertical sample interval. Once open, the HydroPunch fills from the bottom with no aeration and minimal agitation of the sample.

When HP-II is used in the water sampling mode, the sample is collected and transported to the surface within the body of the tool. As the tool is pulled upward, increased hydrostatic head within the tool closes a lower and upper check valve which retains the sample within the body of the HydroPunch. Once at the surface, the HydroPunch is inverted and the sample is decanted through a top discharge valve and tubing.

When the HP-II is used in the hydrocarbon sampling mode, the tool is connected to the surface using a hollow drive pipe of large enough inside diameter (I.D.) to permit the passage of a thin bailer. The sample is collected by lowering the bailer from the surface through the drive pipe and retrieving the sample. This configuration permits sampling of floating contaminants and also allows an unlimited quantity of sample to be collected.

III. OPERATION: HYDROPUNCH II

HP-II is a durable tool intended to be used primarily by drilling contractors. The diameter of the tool is approximately 2-inches O.D. with a wall thickness of 1/4-inch. The heavy-duty construction of the HP-II greatly increases its rigidity; however, its large diameter limits its effective depth when pushed from the surface with cone rigs. HP-II can be water sampling. In the hydrocarbon mode, samples, including floating product, can be collected at the very top of the aquifer. In addition, an unlimited quantity of sample can be collected by additional pumping or bailing. In the water sampling mode, the sample is collected from 5 feet or more below the water table (to assure adequate hydrostatic pressure), a cone is lost each time the tool is used.

1. Hydrocarbon Mode Sampling with HydroPunch II

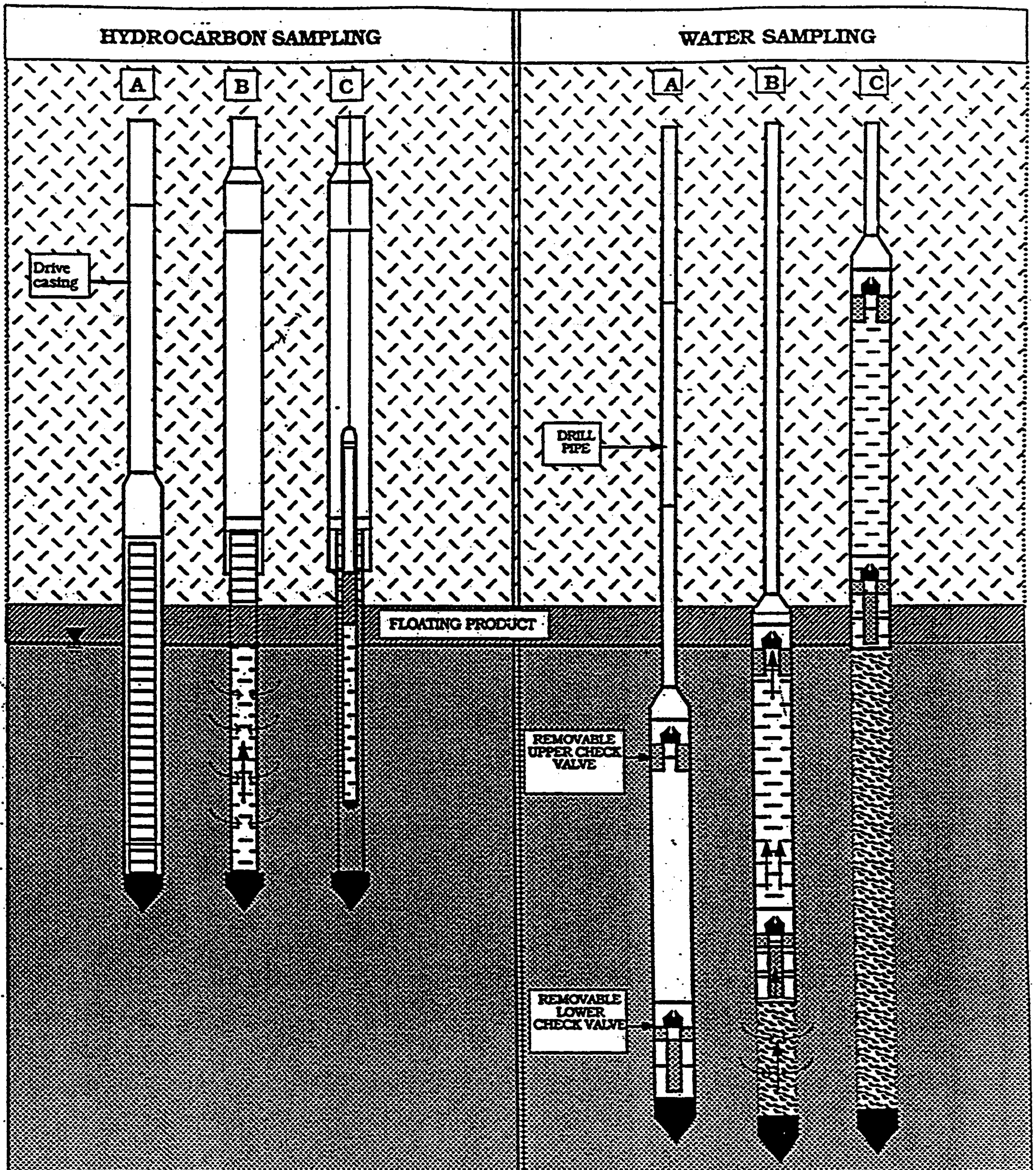
The HP-II is used in the hydrocarbon mode when: 1) a sample of floating product is needed, 2) a ground water sample must come from the uppermost portion of the aquifer, 3) the water bearing strata are very thin, or 4) a large volume of sample is required (Figure 1).

In this configuration the check valves are removed from the body of the tool. A sacrificial screen (approximately 4-1/2 feet long) is attached to a disposable cone. The screen and internal parts of the tool are sealed from the exterior by an O-ring seal at the base of the cone when the tool is in the closed position. The screen is large enough in diameter to permit a small bailer to pass through it. The screen, with the cone attached, is inserted into the body of the HP-II until the O-ring on the cone is seated in the body. When the HP-II has been advanced to the desired sample depth, the body is pulled back. Soil friction holds the cone in position while the screen telescopes out of the body of the tool. The drive casing (typically NW rod) is approximately the same I.D. as the HP-II. This permits a small I.D. bailer to be lowered through the casing and the body of the HP-II into the screened zone for sample collection. Since no material has been introduced into the sample zone, the screen does not need to be purged prior to sample collection.

2. Ground Water Mode Sampling with HydroPunch II

The HP-II is used in the ground water sampling mode when a sample can be collected from 5 feet or more below the top of the water table and when 1.2 liters of sample volume is adequate. In this mode a lower check valve with an attached filter screen is inserted in the bottom of the tool and an upper check valve is placed in the top of the body. A disposable point is inserted into the drive shoe. The tool is pushed or driven into the undisturbed soil to the desired sampling depth either from the surface or from the bottom of a drilled borehole (Figure 1). The body of the tool is then pulled back about 2 feet. Soil friction holds the drive cone in place. Once the O-ring seal on the cone is broken, ground water flows into the open end of the HP-II through the intake screen, past the lower check valve, into the sample chamber, and finally out the upper check valve. When open, the HydroPunch fills from the bottom with no aeration and minimal agitation of the sample. When the tool is full, the sample is collected by pulling the tool toward the surface. This increases the hydrostatic pressure.

FIGURE 1
HYDROPUNCH II



LEGEND: HYDROCARBON SAMPLING

[A] HydroPunch II closed while being driven into position.

[B] Tool opened and 4-1/2 foot screen telescopes into position for collection of hydrocarbon or water sample at the top of the aquifer.

[C] Hydrocarbon sample being collected using bailer lowered through drive casing.

LEGEND: WATER SAMPLING

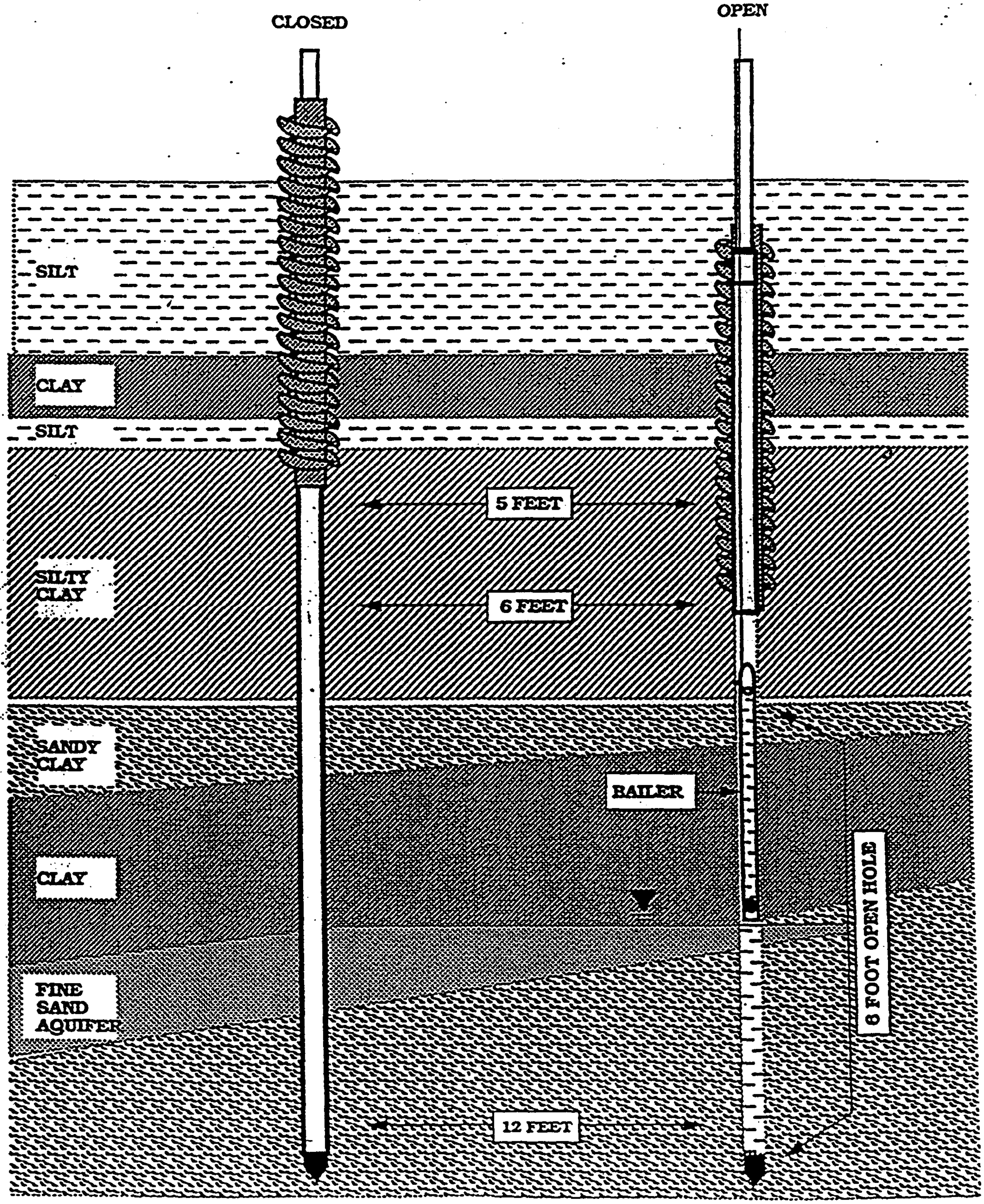
[A] HydroPunch II closed while being driven into position.

[B] Cone separated and tool open to collect sample.

[C] Check valves closed as sample is retrieved within body of the tool.

FIGURE 2

SAMPLING THIN WATER BEARING ZONES IN COHESIVE SOIL WITHOUT SCREEN



within the tool, closing the two check valves. At the surface the HP-II is inverted and the sample is decanted through an upper discharge valve and tubing into a sample container.

3. Field Procedures: Sampling with HydroPunch II

The hollow stem auger drilling system is by far the most prevalent drilling method used for environmental hydrogeologic investigations. The HP-II has been designed to be used with the auger drilling rig to collect ground water samples in much the same manner as soil samples are collected with drive samplers. Although the following section is targeted for hollow stem auger drilling, the same general guidelines apply to other drilling techniques.

HYPOTHETICAL SAMPLING PLAN

The following is a brief description of the typical sampling procedures for collecting a sample at the top of the aquifer using the HP-II in the hydrocarbon mode, and collecting a second sample 15 feet below the top of the aquifer using the same tool in the water sampling mode.

HYPOTHETICAL GEOLOGY

The first sample is collected from a thin (3 foot thick) aquifer of fine, clean sand occurring 10 feet below ground surface. The first water bearing zone is sandwiched between a very low permeability, sandy clay extending from the surface to 20 feet. At 20 feet below ground surface the sandy clay overlies a very clean medium grained sand aquifer about 40 feet thick. The second sample is to be collected from this second aquifer. (Figure 3)

SAMPLING IN HYDROCARBON MODE

The first sample will be collected using the HP-II in the hydrocarbon mode.

TIP: Because the HydroPunch must be pushed into undisturbed material in the zone to be sampled, the drilling procedure must stop somewhere above the sample point. Consequently, it is very helpful to have some idea of the depth at which the sample is to be collected. If little is known of the site hydrogeology, it is often a very good idea to use the initial boring as a pilot boring to determine: 1) exactly where the water bearing zones are, 2) the permeability of the sample zone, 3) the density of the soil, and 4) other relevant factors.

1. The hydrocarbon mode was selected because a sample is needed as close to the top of the aquifer as possible and, with only a 3-foot thick upper aquifer, it is the only mode that can assure that a full sample will be collected. In order to collect a sample in the <u>water sampling mode,</u> the HydroPunch intake has to be a minimum of 5 feet below the top of the water table for the tool to fill. At this site the intake screen would be open and in the confining layer below the aquifer resulting in an extremely slow fill time or no sample.
2. The contractor augers to 9 feet (one foot above the water table).
3. To prepare the HP-II for sampling, a disposable 4-1/2-foot polypropylene screen is pushed over the barbed end

O-ring is on the cone.) The screen and cone are inserted into the drive shoe end of the HP-II. (Note: In this mode internal check valves are not used—refer to assembly sheet in the Field Guide.)

4. To make sure the point and screen do not accidentally open as the tool is lowered inside the hollow stem auger, an exterior rubber sleeve is stretched over the cone and bottom of the drive shoe. The sleeve frictionally holds the cone in place and additionally provides a grit seal for the O-ring on the drive cone. When the tool reaches the bottom of the borehole and pushing or driving commences, the sleeve will peel back and slide up the body of the HydroPunch. It does not contact the water being sampled. Once the sleeve is in position the drive rods (typically NW rod) are attached to the upper subassembly of the HydroPunch and the tool is lowered downhole as additional casing is added.

TIP: It is very helpful to have a length of the drive pipe in a 2 foot and a 3 foot section, as well as standard 5 foot sections. The short sections enable the driller to have a manageable casing height above the top of the augers after the tool has been driven into place and opened.

5. Once the tool rests on the bottom of the borehole, it will be driven or pushed four feet from the bottom of the augers (at 9 feet) to 13 feet. The drive casing is marked at the surface so the exact depth the tool is driven/pushed and retracted is known.
6. At this point the user needs to know the three most important rules of HydroPunch use (see Table 2, left).
7. It was determined from the blow count during soil sampling that the soil density will require that the HydroPunch be driven into position using a 140-lb. hammer. If the material had been soft, the HydroPunch could have been pushed from the bottom of the augers using the hydraulic downfeed on the drill rig. The HydroPunch will typically require 2 to 4 times as many blows to advance the same distance as a

TABLE 2
DRILLER'S RULES

1) **DO NOT SET THE HYDROPUNCH DOWN ON THE BOTTOM OF THE BOREHOLE AND THEN PICK IT UP.**
THIS WILL OPEN THE TOOL, RUIN THE SAMPLE INTEGRITY AND, IF IT IS DRIVEN AFTER BEING OPENED, MAY DAMAGE THE HYDROPUNCH.
BE CAREFUL NOT TO BACKHAMMER WHEN DRIVING FOR THE SAME REASON.

2) **NEVER PULL THE HYDROPUNCH BACK FURTHER THAN IT IS PUSHED OR DRIVEN INTO THE UNDISTURBED SOIL.**
TO EFFECTIVELY ISOLATE THE SAMPLE FROM OUTSIDE CONTAMINATION, THE BODY OF THE HYDROPUNCH MUST REMAIN IN THE HOLE IT MADE DURING DRIVING OR PUSHING.

3) **ALWAYS ACCURATELY MEASURE THE DISTANCE THE TOOL IS PUSHED OR DRIVEN AND THE DISTANCE PULLED BACK.**

2-inch split barrel sampler. The reason for this is that all soil is displaced to the side with the advance of the HydroPunch whereas, when utilizing a split barrel sampler, the majority of the soil passes into the sampler.

TIP: Where soil conditions permit, it is preferable to push, rather than drive, the tool into position. Pushing allows very accurate control of the depths the tool is advanced and retracted, is easier on the driller, and is frequently quicker than driving. If the tool is to be pushed into position, it is best to make sure that the driller has an adapter which will enable him to push and retract the drive pipe before he gets into the field.

If soils are soft enough to enable the HP-II to be pushed from the surface into the sample zone, a considerable amount of time can be saved. When the HP-II is used in this manner, no drill cuttings are generated and there is no handling of the augers, etc. The only major activity is to add casing as the tool is being rapidly pushed into the ground. If pushed from the surface, sampling time can often be cut in half.

8. To drive the HydroPunch in the hydrocarbon mode the contractor will need an adapter to go from the drive casing (typically NW rod) to the thread on his drive hammer. Although the adaptors are readily available, it is best to make sure the contractor has one prior to mobilizing to the site. As mentioned earlier, the casing should be marked in one-foot increments to monitor the driving process.
9. The driller commences driving and continues until the tool has been advanced four feet. During driving the driller is very careful to make sure that he does not inadvertently backhammer the HydroPunch. If the tool is backhammered it will between the screen and body of the tool, destroying sample quality, if a sample can be collected at all. The tool may also be damaged if it is driven without the cone attached. When the sample depth is reached, in this case 13 feet, the tool is allowed to set for a few seconds prior to being pulled back. This permits the formation to expand around the cone and increases the soil friction on the cone. The tool is then pulled back about three feet, extending the screen from 13 feet to 10 feet. During pull back the driller is careful not to pull back more than the four feet that the tool was driven. (Drillers Rule 2) Also, the driller must not pull back further than the length of screen attached to the cone, in this case 4-1/2 feet.

TIP: If the aquifer material is very loose and does not pull the cone from the drive shoe during retraction, it is helpful to use the drive hammer to backhammer for the initial pull back. The upward snap on the tool during the backhammering process is often enough to separate the cone and pull the screen from the body.

10. When the tool has been retracted the full distance, the casing is clamped into place to assure it does not slide back down over the exposed screen. Chain type vise grips work well for this. Disconnect the hammer or remove the adapter from the drive pipe and check to see if the screen is filling with ground water.

TIP: With HP-II there is rarely a problem with the cone detaching and the screen not being exposed to the formation. Should the tool be used in a formation where there is a problem, it is helpful to measure the inter-

polypropylene screen and drive cone left from the previous sample, pull the cutter head of the auger to a point above the top of the screen, then lower the center bit into position and drill through the screen and cone. This procedure ensures that the screen and cone are drilled to the side, carried up the flights of the augers and do not become jammed in the hollow stem of the lead auger.

3. The HydroPunch is prepared for water sampling by inserting the stainless steel plug with the upper check valve into the top of the tool, reed valve pointing up. The upper subassembly going from the HydroPunch thread to the AW box is threaded over the upper check valve holding it in place. (Note: Detailed assembly instructions can be found in the Field Guide.)
4. Next, the inlet assembly is unthreaded from the screen cartridge sleeve and the short stainless steel screen is threaded onto the lower portion of the inlet assembly. The inlet assembly with the screen attached is threaded back into the screen cartridge sleeve. As with the upper check valve assembly, the cartridge sleeve is inserted into the bottom of the HydroPunch body with the reed valve pointed up and the drive shoe threaded onto the body to hold the cartridge sleeve in place.
5. Insert the cone without the polypropylene screen attached, into the end of the drive shoe making sure that the O-ring is on the cone. As in the hydrocarbon mode, stretch the rubber sleeve over the cone and body of the tool to make sure that the cone does not separate as the tool is low-
6. For collecting the second sample in the ground water sampling mode, the HydroPunch can be advanced using a wireline downhole hammer. When the tool reaches the bottom of the drilled borehole, the cable used to raise and lower the hammer is marked with the hammer in the down position.
7. Again the three Drillers Rules apply (Table 2). Since sampling is well below the top of the aquifer the tool is only driven a few feet into the undisturbed soil below the borehole. The distance the tool is driven is closely monitored by watching the marks on the cable as the tool is advanced. Once again the contractor must be careful not to hammer upward while driving the tool (Drillers Rule #1).
8. When the HydroPunch reaches its final depth, in this case driven three feet below the bottom of the augers (23 feet below surface), the hammer is gently pulled to its up position and the cable marked to monitor the pull back procedure.
9. The HydroPunch is backhammered one foot. As soon as the tool moves upward the cone separates from the body which allows the formation water to flow through the intake screen, past the lower check valve assembly, into the sample chamber and finally out the upper check valve.
10. Essentially the open HydroPunch becomes a dual check valve bailer

TABLE 3

STEPS IN PREPARING THE HP-II FOR SAMPLING

THE HYDROCARBON MODE

STEPS

1) Make sure O-rings are on each end of HP-II body

2) Thread drive shoe on one end of the body and the NW rod adapter on the other end. (The NW rod thread has a larger inside diameter than the AW rod adapter.) Make sure that both fittings are tightened by hand as much as possible.

3) Push the barbed end of the drive cone into the 4-1/2-foot long polypropylene screen.

4) Insert the screen into the drive shoe end of the HP-II and seat the O-ring and cone in the drive shoe.

5) Stretch rubber retainer sleeve over the cone and body to hold the cone in place as the tool is lowered downhole.

6) Attach HP-II to NW rod(or other drive casing) using appropriate adapter. Be sure that drive casing is thoroughly cleaned before attaching the HydroPunch.

THE GROUND WATER MODE

STEPS

1) Insert stainless steel plug with upper check valve into the top of tool

2) Upper subassembly from HP-II thread to AW box is threaded over upper check valve

3) Inlet assembly is unthreaded from screen cartridge sleeve

4) Thread short stainless steel screen onto lower portion of inlet assembly

5) Inlet assembly with screen attached is threaded back into screen cartridge sleeve

6) Insert cartridge sleeve into bottom of HP-II body

7) Thread drive shoe onto body to hold cartridge sleeve in place

8) Insert cone (without screen attached) into end of drive shoe. Make sure O-ring is on cone.

9) Stretch rubber sleeve over cone and body of tool to hold cone in place as tool is lowered downhole.

After a period of time, based on the estimated formation permeability, the tool is pulled back to the surface. As the tool is retrieved the hydrostatic head changes, closing both check valves and trapping the sample within the body of the tool.

11. At the surface the upper subassembly (AW adapter) is unthreaded. The reed valve barb is unthreaded from the disk and the discharge assembly is threaded into the disk. The HydroPunch is then inverted and the sample discharged through the discharge assembly into a sample container.

TIP: If the HydroPunch is used in a sand formation and the material has a tendency to flow into the augers, always sound the interior prior to lowering the tool into the augers. Driving the HydroPunch through a sand plug in the bottom of the augers is almost impossible. As the tool is driven sand is compressed into the space between the HydroPunch and the inside wall of the augers, greatly increasing the resistance to driving. This sometimes results in damage to the tool and will occasionally lock the HydroPunch inside of the augers.

Solutions to this problem include 1) the use of one way sand catchers or trap valves in the bottom of the augers, 2) filling the augers with drilling mud, and 3) drilling using mud rotary drilling techniques. A simple method that can be used at most sites is to drill to just above the sample zone with the augers and then back the augers out to a point where the sand is no longer inside. The HydroPunch can often be easily driven or pushed through the zone disturbed by the drilling process and then an additional distance into the undisturbed formation to the sample point. HydroPunches have been pushed through as much as 35 feet of collapsed sand in a borehole to collect a sample from the undisturbed material below the drilled portion.

FIGURE 3
HYPOTHETICAL FIELD INVESTIGATION

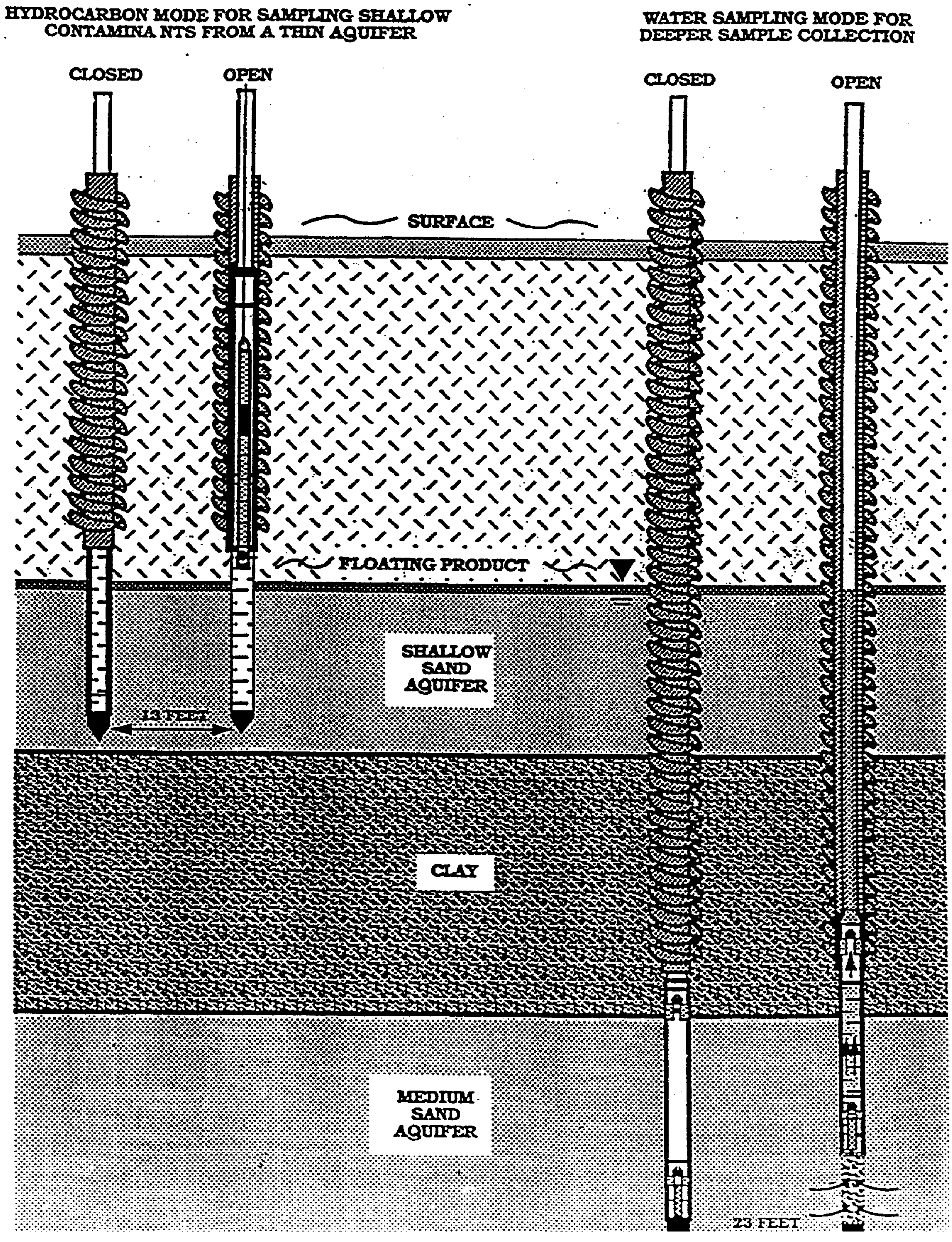


FIGURE 4
GROUND WATER MODE ASSEMBLY INSTRUCTIONS

A. Place O-rings (2) in groove on sleeve cartridge assembly (1) and in groove on inlet (3.)
Thread open end of screen (4) onto threaded portion of inlet (3.) Push reed valve (5) over barb on

B. Thread inlet and screen assembly into sleeve cartridge assembly.

C. Place large O-rings (2) on each end of HydroPunch body (6.) Insert complete assembly into body of to

D. Thread drive shoe (7) onto body. Place O-ring on drive cone (8) and push into end of drive shoe.

E. Place O-ring in groove on check disc (9.) Thread modified barb (10) into check disc (9).
Push reed check valve (5) over modified barb 10 and thread S.S. Barb.

F. Insert check disc assembly into body of tool (6).

G. Thread AW adapter (11) onto body. Stretch rubber retainer sleeve (12) over cone and body

H. To discharge sample, remove AW adapter from top of body.

I. Unthread modified barb from check disk (10) and thread barb from discharge kit (14). Attach discharge tube (15) to barb. Slide pinch clamp (16) over tube and pinch shut. Invert the tool and open pinch clamp to discharge sample.

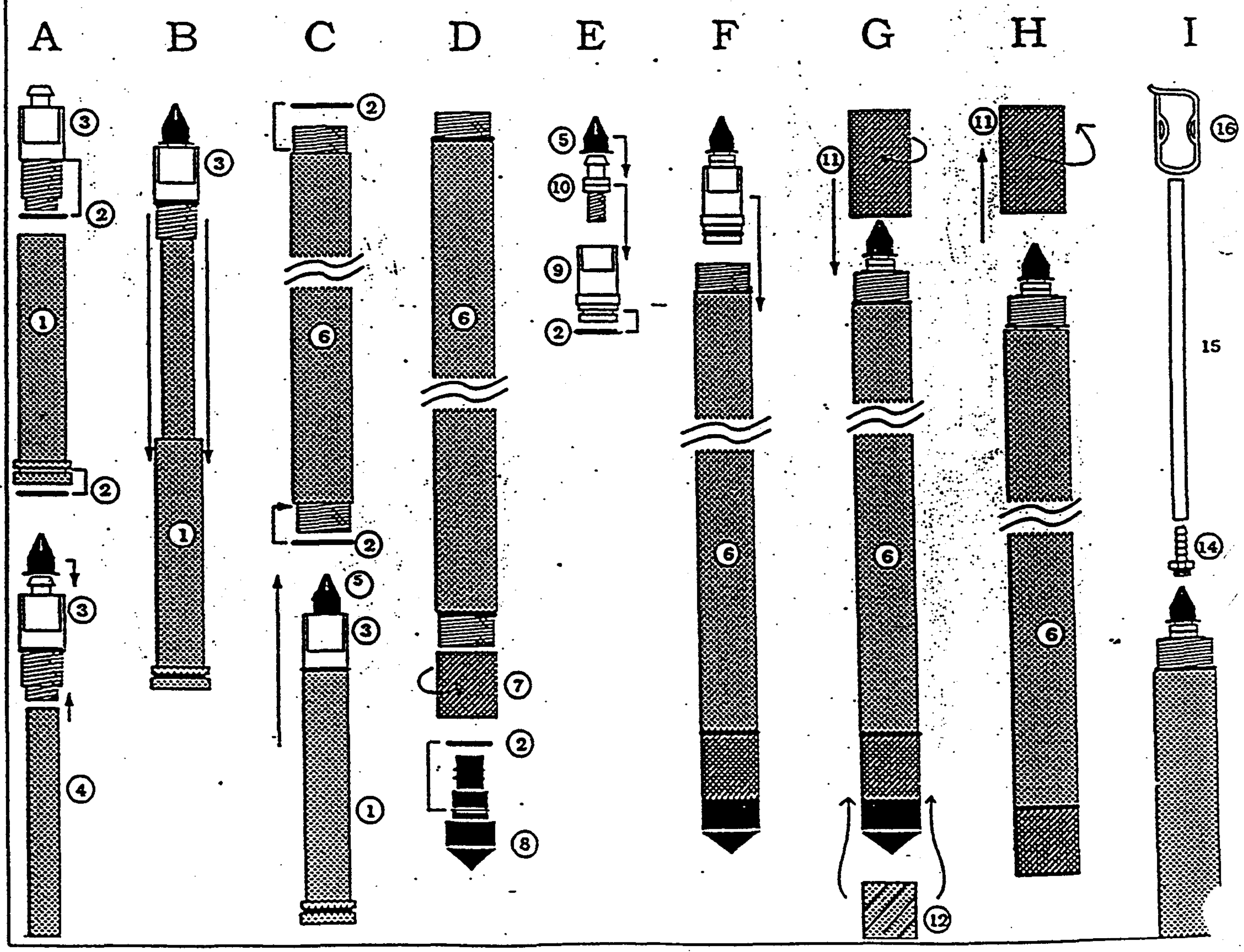


FIGURE 5
HYDROCARBON MODE ASSEMBLY INSTRUCTIONS

A. Place O-rings (1) on each end of HydroPunch II (HP-II) body (2).

B. Thread drive shoe (3) onto one end of body (2) and NW rod adapter (4) onto other end. Tighten both fittings by hand as much as possible. (NOTE: The NW rod adapter has a larger inside diameter than the AW rod adapter which is used in the Ground Water mode).

C. Push the barbed end of the drive cone (5) into the 4-1/2 foot long polypropylene screen (6).

D. Insert the screen (6) and drive cone (5) assembly into the drive shoe end of the HP-II and seat the O-ring and cone in the drive shoe.

E. Stretch rubber retainer sleeve (7) over cone and body to hold cone in place when tool is lowered downhole.

F. Attach HP-II to NW rod (or other drive casing) using appropriate adapter. (NOTE: Be sure drive casing is thoroughly cleaned before attaching to the HydroPunch.)

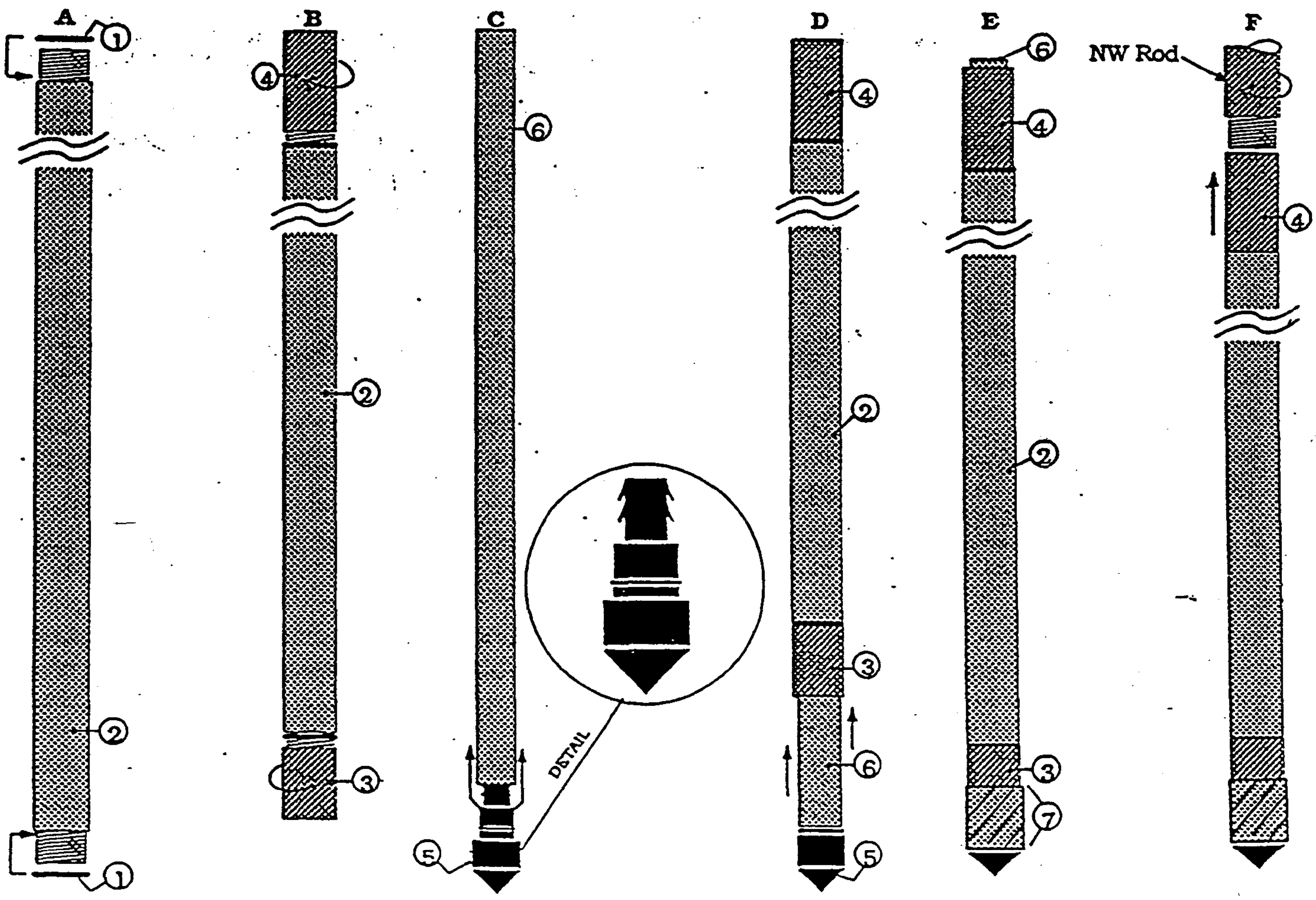


TABLE 4A
HYDROPUNCH II—WATER SAMPLING MODE
BASIC OPERATING PROCEDURES

STEP #	PROCEDURE	COMMENTS
1	Drill to a point just above the desired sample depth.	If site conditions permit pushing the tool from the surface to the sample point, omit steps 1 & 3.
2	Attach assembled HP-II to the drive rod or downhole hammer.	Be sure to use the rubber retainer sleeve to hold the cone onto the drive shoe if the tool is lowered downhole.
3	Lower the tool to the bottom of the borehole.	*Once on the bottom of the hole, DO NOT PICK UP THE TOOL.* (Drillers Rule 1)
4	Drive or push the HP-II a minimum of one foot past the bottom of the borehole to the final sample point.	1. If pushing or driving the HP-II from the surface, advance the tool directly to the selected sample depth. 2. Remember that when sampling in the water mode, the bottom of the HP-II must be at least 5 feet below the water table to collect a full sample. 3. WHEN DRIVING OR PUSHING, CAREFULLY COUNT AND MARK THE ROD OR CABLE SO YOU KNOW EXACTLY WHERE THE END OF THE TOOL IS.
5	When the final depth has been achieved, pull back on the drive rods or hammer to pull the cone out of the body of the tool, permitting ground water to enter the HP-II.	DO NOT PULL THE TOOL BACK FURTHER THAN IT HAS BEEN DRIVEN *(Drillers Rule 2).* For example, if the tool is driven or pushed 2-1/2 feet, do not pull the tool back more than 2 feet. A minimum of 6 inches of the body of the tool needs to be in the driven hole to provide a good annular seal.
6	Clamp the drive casing at the surface.	This prevents the body of the HP-II from sliding back down to the bottom of the hole and plugging with soil.
7(a)	If hollow drive rods are used to advance the tool, a water level indicator can be lowered down the rods to determine when the tool is full.	The rods must be watertight.
7(b)	If hollow drive rods are not used, wait approximately 20 minutes for the first sample.	Adjust the fill time based on the quantity of sample and the estimated permeability of the formation.
8	Pull the HP-II to the surface, unthread the upper sub-assembly.	
9	Unthread the upper check valve and replace it with the discharge assembly.	
10	Invert the tool, open the pinch clamp and decant the sample.	
11	Disassemble the HP-II while it is wet.	Water lubricates the parts which reduces the potential for galling.
12	Decontaminate the tool according to your cleaning protocol.	

TABLE 4B
HYDROPUNCH II—HYDROCARBON SAMPLING MODE*
BASIC OPERATING PROCEDURES

STEP #	PROCEDURE	COMMENTS
1	Drill to a point just above the desired sample depth. If sampling floating product, be sure to stop drilling above the top of the aquifer.	If site conditions permit pushing the tool from the surface to the sample point, omit steps 1 & 3.
2	Attach assembled HP-II to the drive casing.	Be sure to use the rubber retainer sleeve to hold the cone onto the drive shoe if the tool is lowered downhole
3	Lower the tool to the bottom of the borehole.	*Once on the bottom of the hole, DO NOT PICK UP THE TOOL.* (Drillers Rule 1)
4	Drive or push the HP-II a minimum of one foot (3 to 5 feet is better) past the bottom of the borehole to the final sample point.	1. If pushing or driving the HP-II from the surface, advance the tool directly to the selected sample depth. 2. When driving or pushing, carefully count and mark the casing so you know exactly where the end of the tool is.
5	When the final depth has been achieved, pull back on the drive casing to pull the cone and screen out of the body of the tool, permitting ground water to enter the HP-II.	1. DO NOT PULL THE TOOL BACK FURTHER THAN IT HAS BEEN DRIVEN *(Drillers Rule 2).* For example, if the tool is driven or pushed 3-1/2 feet, do not pull the tool back more than 3 feet. 2. A minimum of 6 inches of the body of the tool needs to be in the driven hole to provide a good annular seal. 3. Additionally, since the screen is 4-1/2 feet long, the tool cannot be pulled back more than 4-1/2 feet without separating the screen from the body.
6	Clamp the drive casing at the surface.	This prevents the body of the HP-II from sliding back down over the exposed screen.
7	Disconnect the drive casing from the hammer (or push adapter) and check to see if tool is filling.	A mirror to reflect light down the casing or a water level indicator can be used.
8	When an adequate volume of water has filled the tool, lower a small diameter bailer through the drive casing to collect the sample.	There is no need for development or purging prior to sample collection.
9	After completing sample collection, pull the drive casing and the HP-II to the surface. The cone and screen will normally stay downhole.	Should the screen be recovered, do not attempt to reuse it. It cannot be decontaminated and, if reused, will likely affect the integrity of subsequent samples.
10	Disassemble the HP-II while it is wet.	Water lubricates the parts which reduces the potential for galling.
11	Decontaminate the tool according to your cleaning protocol.	In the Hydrocarbon mode, the drive pipe as well as the tool and bailer need to be thoroughly decontaminated.

*Prior to using HP-II in the hydrocarbon mode, be sure the drive casing is thoroughly decontaminated. In this mode, the casing contacts the sampling bailer and is in communication with the sample chamber.

V. TROUBLESHOOTING

As with all drilling/sampling methods, occasional problems will arise with the use of the HydroPunch. Most of these problems relate to obtaining an inadequate sample for analysis. Because of the simple and robust construction of the HP-II, the majority to the problems are directly related a site's unique hydrogeologic conditions and few problems are the result of mechanical malfunctions of the tool. The following discussion breaks the problem areas into two groups: mechanical malfunction and hydrogeologic problems. The mechanical area will be addressed first.

MECHANICAL PROBLEMS

Drive Cone Does Not Separate From Body

1. In rare instances the cone will fail to separate from the body of the tool during the pull back procedure. This usually occurs when very fine sand manages to work its way between the cone and the drive shoe as the tool is being driven. The sand grains "sand lock" the cone in the drive shoe. The problem can be alleviated by making sure the rubber exterior sleeve is used over the cone and the drive shoe. Using this sleeve ensures that sand will not enter until the driving process begins. Once the drive or push commences, make sure the tool is not lifted or accidently backhammered as it is being advanced. The upward motion may slightly separate the cone from its seat and the subsequent hammering may drive sand into the seal area.

2. In very loose formations, such as extremely loose, quicksand-like material, there may not be enough soil friction for the cone to separate if it is pulled back in the normal fashion. In these situations, initiate the pull by a sharp backhammer; the sudden shock and upward motion of the tool will separate the cone from the body of the HydroPunch.

3. The <u>most common cause of cones not separating</u> is the result of utilizing homemade sleeves instead of the sleeves provided with the HP-II. The substitute material stretches as the tool is being driven and works itself between the cone and the seat in the drive shoe. When this happens the cone will almost always lock in position making it extremely difficult to pull free, even using wrenches and a vise. To prevent this from occurring, always use the sleeves provided with the tool.

Drive Cone Separates Too Soon

1. The most common cause of early cone separation is the result of the tool being pulled back prematurely by backhammering or being picked up after being placed on the bottom of the borehole. See DRILLERS RULE #1 (Table 2). *Be careful.*

2. When lowering the tool down an open borehole always use the exterior rub-

ber friction sleeves provided with the tool to make sure the cone stays in place.

Leaking Check Valve

1. The check valves in the HydroPunch are designed to handle grit saturated water and consequently do not usually leak to the degree where there is a critical loss of sample. Often, if the water is extremely sediment laden, the sediment itself will collect on the check valve and seal the sample in the tool. If a leak does occur, it is almost always very slow. The best way to correct the problem is to retrieve the tool and decant the sample as rapidly as possible.

HYDROGEOLOGY RELATED PROBLEMS

Sample Collection from Low Permeability Aquifers and Thin Water Bearing Zones

1. As the HydroPunch is driven or pushed into position, the soil is displaced to the side and compacts into the walls of the hole. The process cleans the tool as it moves downward and also produces a very tight annular seal around the tool. The consolidation of the soil particles around the tool can also result in a reduction of the permeability of the soil. The tight seal and reduced permeability enables the HydroPunch to collect a very discrete sample from a specific depth by sealing off ground water from above and below the zone to be sampled.

   In some fine grained silts and clays with very thin water bearing zones, the compression of the soil particles may lower the permeability of the saturated zone to a degree where ground water samples may not be collected in a reasonable amount of time (i.e., < 1 hour). It is important to remember that the HydroPunch collects a very discrete sample from a fairly short sample interval (usually less than 5 feet) versus a monitoring well which normally collects from an interval of 10 feet or more. Consequently, fill times are usually longer than that of a monitoring well completed in the same formation.

2. When sampling thin (< 5 feet) water table aquifers, it is important to know the exact location of the saturated zone. If detailed site hydrogeologic information is not available, it is best to start the investigation at the site with a pilot boring to accurately identify the target zone. Once the HydroPunch has been driven or pushed into position, the annular seal is so effective that missing the water bearing zone by inches can make the difference between a dry hole and the tool filling in minutes. If the water bearing zone is thin and has less than 5 feet of head the HP-II must be used in the hydrocarbon sampling mode. The HP-II in the water sampling mode will not have

mum) to fill.

When working with thin water bearing zones or low permeability aquifers in cohesive soils (soils where the hole will stand open after the drilling tools are removed), the HydroPunch can be used in the hydrocarbon sampling mode without attaching the polypropylene screen to the cone (Figure 2). This enables the intake interval to be any length desired. A hypothetical example would be: A 6 inch thick water bearing silty sand layer occurs between 7 and 10 feet below the surface at a site. The layer is over and underlain by a very low permeability silty clay. To maximize the possibility of intercepting the thin water bearing zone, the HydroPunch is pushed or driven from 5 feet to 12 feet (or if the soil is soft, the tool is advanced from the surface to 12 feet). Because the formation will stand open and no screen is used, the HydroPunch can be pulled back from 12 feet to 6 feet leaving an open hole between the cone (12 feet) and the bottom of the tool (6 feet). The open hole serves as the intake screen and intercepts the water bearing layer. The portion of the hole in and below the saturated zone will collect water. A bailer is lowered into the open hole for sample collection. Frequently thinly bedded water bearing formations occur at shallow depths in soft, cohesive soils. These conditions make pushing the tool easy and investigations frequently can be accomplished by pushing or driving from the surface.

Intrusion of Drilling Mud or Outside Ground Water

1. There is the possibility that outside fluid will be forced into the sample chamber, if the HydroPunch is used in the water sampling mode in: 1) a mud filled borehole, or 2) is used to collect a sample from a deep aquifer and, during retrieval is pulled back through an upper aquifer with a higher hydrostatic head.

   As an example, assume the tool is lowered into a mud filled borehole and is driven 3 feet into the underlying formation for a sample. The water table for the aquifer is 30 feet and the sample was collected at 40 feet. When the HydroPunch is filled with sample it has 10 feet of head above the sample (the depth the tool is below the top of the aquifer). The borehole has about 40 feet of drilling mud in it. When the HydroPunch is pulled from its hole and exposed to the drilling mud in the borehole, the mud, having much higher hydraulic head (40 feet vs. 10 feet), displaces the sample in the tool and forces it up the drive pipe. The same process can occur when the tool is retrieved from a low head deep aquifer through a borehole filled with water from a shallow aquifer with a higher head.
2. To prevent this from occurring two things can be done:

a) The tool can be used in the hydrocarbon sampling mode. In this configuration the sample is collected prior to the intake being exposed to the fluid in the borehole.

b) A barbed adapter is available which attaches to the top check valve of the tool in the water sampling mode. This adapter enables thin tubing (usually 1/8 inch vinyl) to be attached to the check valve. By using a special crossover adapter, the tubing can be run from the upper check valve, through the wall of the crossover adapter and up along side the drive pipe. The tubing vents the HydroPunch to the surface. This configuration provides two capabilities: 1) As the tool fills with sample the air is displaced from the body and is forced up the tubing and discharged at the surface. By monitoring the air discharged (this can be as simple as holding the end of the tube in a cup of water and watching the rate the air bubbles out) the fill rate can be measured and when the tool is filled can be determined. When the tool is filled and ready to be retrieved, apply enough pressure (usually compressed air or nitrogen) to the tubing to compensate for the head of mud in the borehole. The pressure closes the upper check valve which in turn prevents the lower check valve from opening as the tool is pulled through the drilling mud.

VI. SCHEDULING (General Guidelines)

As with all drilling projects, HydroPunch sampling rates are dependent upon site conditions, depth of sampling, equipment available and personnel experience. However, some general guidelines can be used. Based on a sample depth of 30 feet or less and easy drilling or pushing conditions, rough sampling rates outlined in Table 6 may be used. The slow first day rates reflect set up time and getting a feel for the tool and the site, particularly if no hydrogeologic information is available.

TABLE 6

SCHEDULING GUIDELINES

DAILY SCHEDULE	NUMBER OF SAMPLES COLLECTED: Inexperienced Crew	Experienced Crew
First Day	3 Samples	3 - 8 samples
Following Days	4-10 Samples *(depending on depth of sample and drilling rate)*	5 - 10 samples *(depending on depth of sample and drilling rate)*

TABLE 5

TROUBLESHOOTING GUIDE

MECHANICAL PROBLEMS

PROBLEM	CAUSE	SOLUTION
Drive Cone Does Not Separate from Body	1) Very fine sand has worked its way between cone and drive shoe as tool is being driven.	a) Make sure the rubber exterior sleeve is used over the cone and drive shoe b) Make sure tool is not lifted or accidently backhammered as it is being advanced
	2) In very loose formations there may *not* be enough soil friction to separate the cone as it is pulled back	a) Initiate pullback by a sharp backhammer. The sudden shock & upward motion will cause separation.
	3) Utilizing a "homemade" sleeve instead of the sleeve provided with the HydroPunch	a) Use the sleeves provided with the tool
Drive Cone Separates Too Soon	1) Tool is pulled back prematurely or was picked up after being placed on bottom of borehole	a) Drillers Rule#1 (Table 3)
	2) Rubber friction sleeve was not used	a) Always use rubber sleeves provided with the tool
Leaking Check Valve	1) Sediment clogs on check valve	a) Retrieve tool and decant sample as rapidly as possible

HYDROGEOLOGY RELATED PROBLEMS

PROBLEM	CAUSE	SOLUTION
No Sample Due to Low Permeability Conditions	In some fine-grained silts & clays or formations with very thin water bearing zones, the compression of soil particles may lower permeability of saturated zone causing the collection of ground water samples to take a longer period of time than "normal" (>1 hour). In some low permeability conditions, sample collection may not be possible.	Many low permeability conditions occur in fine-grained cohesive soils. Often these soils will "stand open" after the drilling tools are removed. If the HydroPunch hole stands open, it is possible to use the tool in the HydroCarbon mode without a screen attached to the cone. This permits the open area to be as long as possible—not limited to the 5-foot screen length. The long open hole provides a greater intake area and a collection sump for the sample. The increased intake reduces the time required for the tool to fill.
Intrusion of Drilling Mud or Outside Ground Water	If the HydroPunch is used in the water sampling mode in a mud filled hole or is retrieved through a zone with a higher head than the sample zone, the foreign fluid will displace the sample in the HydroPunch.	1. Vent tubing can be run from the top check valve of the HydroPunch to the surface. The tubing vents the tool while filling. After the tool is filled, gas pressure is applied to the tube which seats the check valves. This prevents outside fluid from entering as the tool is withdrawn. 2. Use the tool in the HydroCarbon mode and collect the sample before the tool is withdrawn through the fluid.