R02448

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Letter of Transmittal

to: **Mr. Robert Schultz**
Alameda County Health Services, Env. Protection
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

from: **Pat Hoban**

re: **3004 Andrade Road, Sunol**

date: **August 11, 2004**

Number of Copies	*Date of Documents*	*Description*
1	*July 21, 2004*	Workplan: Preliminary Subsurface Assessment of Contaminant Plume

Weber, Hayes and Associates
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July 21, 2004

Alameda County Health Care Services Agency (ACHCSA)
Environmental Health Services, Environmental Protection
To the attention of: **Robert Schultz**
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Subject: **Workplan: Preliminary Subsurface Assessment of Contaminant Plume**
3004 Andrade Road, Sunol

This draft workplan describes proposed work tasks designed to provide preliminary on and off-site assessment of a fuel release, with an emphasis on determining subsurface flow paths, originating at the Sunol Tree Gas Station site, located at 3004 Andrade Road in Sunol. Weber, Hayes and Associates (WHA) prepared this workplan on behalf of Alameda County Environmental Health (ACEH). ACEH is managing the characterization and cleanup of this fuel release under a grant from the State Petroleum Underground Storage Tank Cleanup Fund's Emergency, Abandoned, and Recalcitrant (EAR) Account because Murray Kelsoe, the Responsible Party, has not complied with directives for investigation and cleanup of soil and groundwater at his site. WHA will implement the workplan on behalf of Alameda County.

MTBE contamination from this fuel release was detected in February 2003 in the drinking water well at the T Bear Ranch property which is located approximately 550 feet downgradient from the Sunol Tree Gas Station. This domestic water supply well provides water to four residences and horses boarded at the T Bear Ranch facility. The work tasks presented in this workplan are designed to address data gaps presented in the initial Site Conceptual Model (web-link: Sunol SCM). Specific work tasks include:

- Soil coring and subsurface mapping at and downgradient of the site will be conducted to identify stratigraphic variation and preferential pathways for contaminant transport. The soil coring will include critical logging of subsurface soil conditions including identification of clay layers and potential shallow shale beneath and in vicinity of the fuel release site. At least two deep soil cores will be obtained to confirm deeper geologic conditions including the potential presence of shallow shale bedrock, and determine lithologic continuity between the fuel leak site and the downgradient T Bear Ranch site.

    - Discrete vertical groundwater sampling and installation of temporary piezometers will be completed to assess the contaminant plume. The initial scope of work is designed to identify potential water bearing zones, the degree of connectivity between the water bearing zones, and hydraulic gradients. Water quality testing will provide additional information on contaminant concentrations in the key water bearing zones identified in the field, underlying the source location (Sunol Tree Gas Station site) and the impacted T Bear Ranch site.

- o Limited geophysical data (T Bear Well) and on-site probes (Sunol Tree Gas Station site) suggest there is potential for multiple water bearing zones. The geophysical data suggests potential water bearing zones may be located at about 25 ft bgs and a second higher permeability zone is located at about 38 ft bgs. Sunol Tree Gas Station borings, which have elevations approximately 5-10 feet above the T Bear water well location, contained groundwater at 16-19 ft bgs. It is currently unclear how the petroleum hydrocarbons and MTBE are migrating laterally (i.e., via interbedded sands and silts between 10 and 25 ft bgs or via a deeper higher permeability zone). If unconfined groundwater conditions are encountered, this potential scenario will be evaluated.

- o Soil and water concentrations will be compared with CRWQCB SF Bay Area Region Screening Levels to assess potential pathway threats to receptors (eg. contaminant vapor transport impact to surface; contaminant water transport to surface waters).

- Continuous transducer monitoring of the effects of production well pumping (T Bear Ranch well) will be conducted to obtain preliminary alluvial aquifer data including transmissivity, capture zone, and lateral hydraulic gradients

- A neighborhood walkthrough will be conducted to search for undocumented water supply wells that could be affected by the plume. Nearby water supply wells will be sampled/re-sampled to determine any impacts.

PROPOSED SCOPE OF WORK: This workplan describes proposed work tasks designed to obtain subsurface data on soil lithology and shallow groundwater flow regimes. Some additional water quality data will be collected from drilling locations to measure the magnitude of a dissolved gasoline plume originating from the Sunol Tree Gasoline station. The generated data will also provide subsurface information for effective sighting and design of a potential replacement water supply well for the T Bear Ranch. Tasks will include:

1) The drilling of approximately six to seven soil cores at locations around and downgradient of potential sources at the Sunol Tree Gas Station such as the former USTs and dispensers. Soil and groundwater contamination at both dispenser/product piping locations as well as at the USTs during closure sampling (April 2002) and subsequent exploratory on-site drilling (Nov 2002). The sampling will obtain stratigraphic information, identify key water bearing zones for dissolved contaminant migration, and get data on the magnitude and extent of the release.

2) The conversion of three to four of the borings into temporary piezometers to provide accurate groundwater flow direction (see Proposed piezometer and Driven Probe Locations, Figure 1).

A description of proposed field methodology is included in Appendix A that includes GeoProbe SOPs for dual tube coring and pre-pack piezometers installations.

Specific tasks to be completed include:

- Preparation of this workplan describing a network of shallow water monitoring points, designed to calculate shallow groundwater flow direction, obtain site-specific soil stratigraphy and water quality data to depths of up to 60 feet, and map the distribution of MTBE in the shallow aquifer. The piezometer network has been positioned based on an evolving, site-specific SCM (see Figure 1).

- Preparation of a *Site Health and Safety Plan* in accordance with OSHA standards (Appendix A). Pre-drilling services will include obtaining all appropriate permits, confirming the location of subsurface utilities with the property owner, contracting a driven probe/drilling rig, and coordinating fieldwork schedules with ACHCSA and Zone 7 Water Agency staff for inspection.

- Installation of up to four temporary piezometers for obtaining groundwater elevations and aquifer pumping data (PZ-1-PZ-4, see Figure 1). If time and budget are available, we will install dual piezometers at 2 locations (PZ-1, PZ-2) to monitor vertical gradients from a second, deeper saturated zone (see Dual Piezometer Detail, Appendix A). Following development and surveying, we will collect groundwater elevation data from all available monitoring zones, for a minimum of three events (approximate monthly intervals).

- Soil coring with a GeoProbe Direct Push sampling rig to obtain continuous cores without generating abundant soil cuttings. We will attempt to continuously core borings to depths of 20 feet below the first saturated sand unit at a minimum of two off-site locations (PZ-1, PZ-2) and if possible at 2 on-site locations (DP-2, DP-3, see Figure 1). These borings are estimated to have total driven probe coring depths of 50-60 feet. We will be using GeoProbe's Dual Tube Soil Sampling System for the inspection and logging of soil stratigraphy. The Dual Tube system is designed to seal off the outside strata while coring in order to minimize the potential for cross-contamination. The Dual Tube Sampling System will also be used to obtain discrete water samples at depth, again to minimize the potential for vertical cross contamination. A potential drawback of the Dual Tube Sampling System occurs when flowing sand conditions crop up, usually when drilling to extended depths in saturated material. The flowing sands can block and/or bind the sampling barrel thereby preventing further coring. Additional details on GeoProbe's Dual Tube drilling and sampling procedures are included in Appendix A.

- Time permitting, all borings will be continuously cored using 4-foot long sample tubes. If the efficiency of drilling decreases, we will core at 5-foot intervals once general site stratigraphy is obtained. An experienced, registered geologist (Aaron Bierman) will carefully log each of the borings, and record potential volatile organic vapor detections using an Organic Vapor Analyzer (OVA) calibrated for benzene. We will attempt to obtain two water samples at each location. The following table presents rationale for boring/piezometers locations.

TABLE 1
Drilling and Sampling Details

Boring ID#	Location	Sampling	
		Soil	Groundwater
PZ-1	- Approx 150' downgradient of potential sources (dispensers/USTs) - Positioned at the T Bear Ranch property line	0	- 1 at first encountered groundwater, and - 1at each of the next one-to-two, lithologically-separate, saturated zones (if encountered)
PZ-2	- Approx 550' downgradient of potential sources - Positioned 20 ft from the T Bear Ranch well	0	
PZ-3	Sidegradient	0	- 1 sample from each of the first two, separate saturated zones
PZ-4	Approx 150' downgradient of potential sources (dispensers/USTs);	0	
DP-1	Approx 160' downgradient of potential sources (dispensers); Positioned at the T Bear Ranch property line	0	
DP-2	Immediately Downgradient of Potential Source – Dispensers	3	- 1 at first encountered groundwater, and - 1at each of the next one-to-two, lithologically-separate, saturated zones (if encountered)
DP-3	Immediately Downgradient of Potential Source – USTs	3	

NOTE 1: If coring reveals initial groundwater is encountered in confined or semi-confined conditions, the initial groundwater sample will be obtained within the confined zone. If coring reveals unconfined, water table conditions, the initial water sample will be obtained from the soil-water interface.

NOTE 2: Similarly, piezometer screens will be positioned across first saturated soils in confined or semi-confined conditions while screens will be placed across the soil-water interface in unconfined, water table conditions.

- The temporary piezometers are primarily designed to monitor groundwater levels in first saturated soils (see notes in Table 1, above). If time and budget are available, a second deeper piezometer will be installed at 2 of the drilling locations (PZ-1, and PZ-2). See Appendix A for a detail of the dual piezometers construction. Note that specific screen elevation and length will be based on the elevation of encountered saturated strata. The horizontal distance between the dual piezometer set will be approximately 5 feet and the shallow well will be positioned up- or cross-gradient from the deeper well to avoid detecting impacts from the annular seal of the deeper well. The vertical distance between the top of the sand pack for the deeper well, and the bottom of the screens for the shallow well will be no more than 10 feet if installed in a single saturated unit.

- A transducer will be installed in PZ-2 to continuously monitor the effects of groundwater pumping in the T Bear well.

- Soil samples will be obtained primarily for logging purposes. Selected soil samples from on-site driven probe locations (DP-2, DP-3) will be chosen for chemical analysis based on their location relative to the potential sources (dispensers, USTs), saturation and stratigraphy (see Figure 1 for sampling plan specifics). Soil samples for chemical analysis will be collected in clean soil sample sleeves (acrylic/brass), capped and sealed with tape. Groundwater samples will be collected from discrete, saturated soil zones using a dual tube groundwater profiler having an exposed screen interval of 2 feet (Appendix A). Groundwater samples will be carefully dispensed into appropriate sample bottles (HCl–acidified VOAs). All samples will be placed in a blue-ice chilled cooler for transport to the laboratory with the appropriate chain of custody documentation. A complete description of proposed field methodology is included in Appendix A.

- Approximately 6 soil and 14-18 groundwater samples will be submitted for laboratory analysis of selected chemical compounds based on observed field conditions. Selected lab analyses will include: Total Petroleum Hydrocarbons as gasoline, and the fuel constituent compounds of benzene, toluene, ethylbenzene, xylenes (BTEX), and fuel oxygenates including MTBE and TBA). Groundwater samples will be tested on a 72-hour rush turnaround to assist with expedited decision-making.

- If access is granted, we will also sample water from nearby water supply wells (i.e., well #G1, at 3111 Andrade Road, #A2, at 3220 Andrade Road, see Figure 1).

Following receipt of analytical results, a summary report will be prepared and update to the Site Conceptual Model completed. Data submitted will include detailed geologic cross-sections, groundwater flow contours for each identified flow zone, maps with isocontours of detected contamination for each groundwater zone, and recommendations for installation of a groundwater monitoring network and other expedited characterization work needed to complete the site delineation. The report will include copies of all drilling logs, field sheets, and laboratory results. This report will:

1) evaluate the need for and (if necessary) plan boring transect(s);
2) identify additional sampling needs required to define the groundwater plume;
3) propose criteria (locations, number of wells and screening intervals) for a water quality monitoring network; and
4) evaluate potential locations and screen intervals for a replacement production well for the T Bear Ranch.

Toward these goals, WHA will use the piezometers installed during the current phase of work to determine hydraulic gradients in and between the various water bearing zones. Depending on the measured gradients and on the groundwater analytical data, WHA will evaluate the need for transect(s) of appropriately spaced borings that may be necessary to identify and define petroleum hydrocarbons and MTBE in groundwater. Following any necessary subsequent phases of work, the gradients and additional lithologic and analytical data from any transect(s) or additional borings will be the basis for location and screening of future wells. All work and reports will be conducted by and/or under the direct supervision of an engineering geologist registered in the State of California.

LIMITATIONS: Our service consists of professional opinions and recommendations made in accordance with generally accepted geologic principles and practices. This warranty is in lieu of all others, either expressed or implied. The analysis and conclusions in this report are based on sampling and testing which are necessarily limited. Additional data from future work may lead to modifications of the options expressed herein.

If you have any questions or comments regarding this workplan, please contact us at our office.

Respectfully submitted,

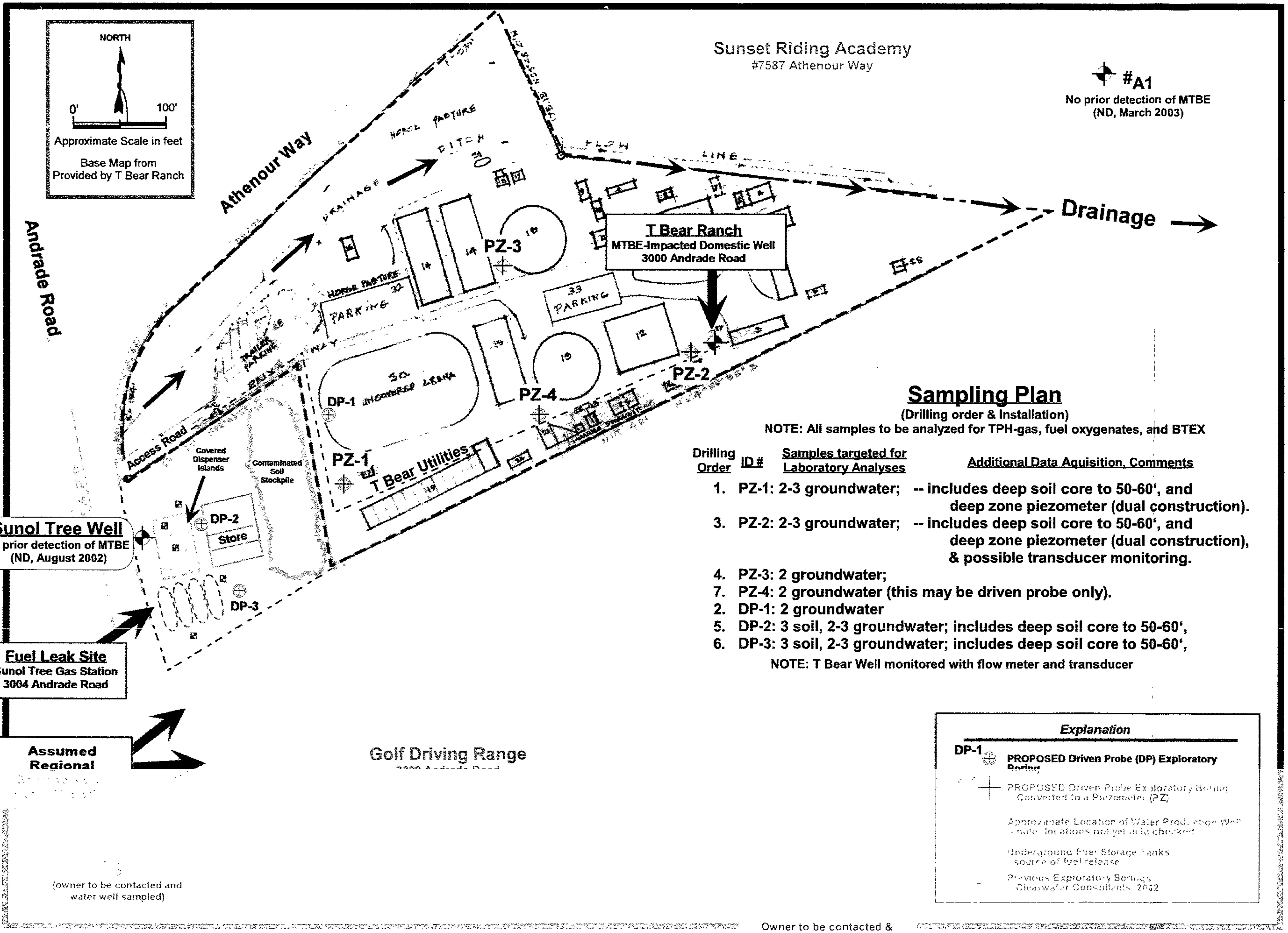
WEBER, HAYES AND ASSOCIATES
A California Corporation

Aaron Bierman
Registered Geologist #7490

Patrick Hoban
Senior Geologist

Joseph Hayes
Certified Engineering Geologist #1629
Certified Hydrogeologist #373

Attachments: Figure 1: Site Map & Proposed Piezometer Locations
Appendix A: Dual Piezometer Detail, *Site Health and Safety Plan for Drilling Program*, and Field Methodology



Sampling Plan

(Drilling order & Installation)

NOTE: All samples to be analyzed for TPH-gas, fuel oxygenates, and BTEX

Drilling Order	ID #	Samples targeted for Laboratory Analyses	Additional Data Aquisition, Comments
1.	PZ-1:	2-3 groundwater;	-- includes deep soil core to 50-60', and deep zone piezometer (dual construction).
3.	PZ-2:	2-3 groundwater;	-- includes deep soil core to 50-60', and deep zone piezometer (dual construction), & possible transducer monitoring.
4.	PZ-3:	2 groundwater;	
7.	PZ-4:	2 groundwater (this may be driven probe only).	
2.	DP-1:	2 groundwater	
5.	DP-2:	3 soil, 2-3 groundwater; includes deep soil core to 50-60',	
6.	DP-3:	3 soil, 2-3 groundwater; includes deep soil core to 50-60',	

NOTE: T Bear Well monitored with flow meter and transducer

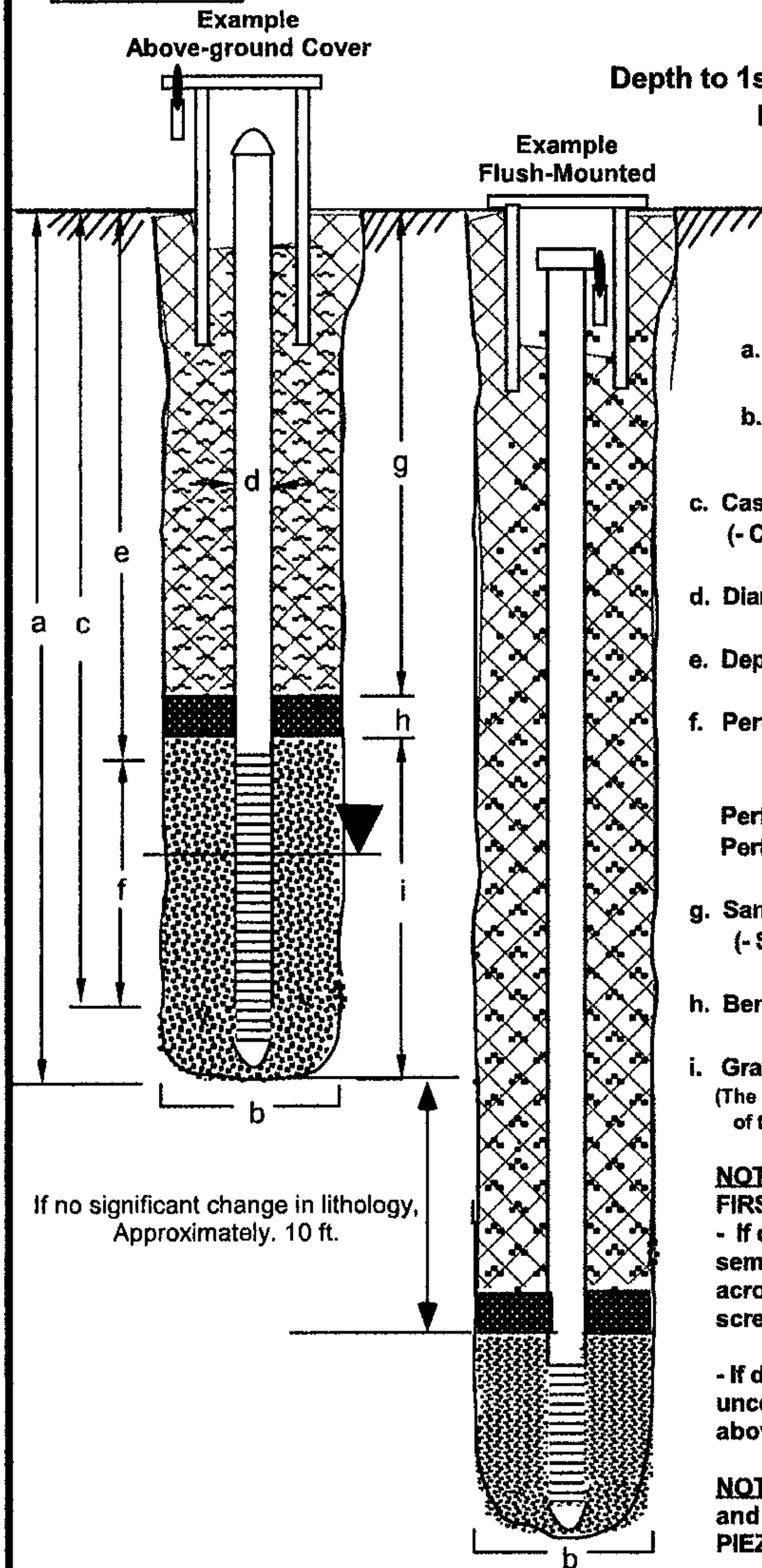
FIGURE 1
Job # 23027

WORKPLAN
PIEZOMETER & DRIVEN PROBE LOCATIONS
SUNOL TREE GAS STATION
3004 Andrade Road
Sunol, Alameda County

Weber, Hayes & Associates
Hydrogeology and Environmental Engineering
120 Westgate Drive, Watsonville, Ca. 95076
(831) 722 - 3580 (831) 662 - 3100

DUAL PIEZOMETERS DETAIL:
Sunol Tree Gas Fuel Release
(NOT TO SCALE)

Location: 3000-3004 Andrade Road
Depth to 1st Groundwater: 7-19 feet (to be determined)
Drilling Method: Driven Probe
Surface Finish: Above ground cover (3"x4') or Flush-Mounted Christy Box (traffic-rated)



EXPLORATORY BORING

a. Total Depth:	Site specific, based on strata and saturation.
b. Diameter	3.25-inch Probe Rod

WELL CONSTRUCTION

c. Casing length (- Casing material =Schedule 40 PVC)	12-30 feet (site specific)
d. Diameter	0.75- inch diameter
e. Depth to top of perforations	5-20 feet (site specific)
f. Perforated length	shallow piezometer: 7.5 feet deeper piezometer: 2.5 feet
Perforated interval from:	varies (site specific)
Perforation type/size	Machine slotted- 0.010 inch
g. Sanitary seal (- Sanitary seal material = Cement Slurry)	Ground surface to top of bentonite
h. Bentonite seal:	2 feet.
i. Gravel pack (#3 Monterey sand):	Varies (site specific)

(The sand pack will extend from an elevation of 2 feet above the top of the perforated well screen section to the base of the borehole.)

NOTE #1: The SHALLOW PIEZOMETER will target the FIRST-ENCOUNTERED saturated zone.
- If drilling indicates this saturated zone is confined or semi-confined, screened section will be positioned across the first saturated strata using a 2.-foot length of screen.

- If drilling If drilling indicates the first saturated zone is unconfined the initial screen interval will extend 2.5' above and 5' below groundwater

NOTE#2: Dual piezometers will be installed it time and budget is available (Figure 1). The DEEPER PIEZOMETER will target the SECOND saturated zone.

APPENDIX A

FIELD METHODOLOGY & WELL SPECIFICATIONS

1. **Driven Probe Field Methodology (including GeoProbe protocols)**

2. **Site Health and Safety Plan for Drilling Program**

3. **Piezometer Well Installation, Development & Sampling (if necessary)**

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(831) 722-3580 (831) 662-3100
Fax: (831) 722-1159

SITE SAFETY PLAN FOR A DRILLING PROGRAM

(July 19, 2004)

Job Name & #:
Sunol Tree Gas Station Release - #23027
Drilling & Sampling Program

Site Location:
3000-3004 Andrade Road, Sunol

Date field investigation is planned:
July2004

Type Of Facility/Current Usage Of Property
Commercial & Residential

Contractors/Subcontractors On Site
Enprob Environmental Probing
*Contact: **Mr. Denis Ott***

Client:
Alameda County (EAR Account)

Overseeing Regulatory Agency:
Alameda County Health Services Agency
Division of Environmental Health
*Contact: **Mr. Robert Schultz***
Phone Number: 510.567-6700

FIELD & SAMPLING PLAN

Work tasks are designed to obtain subsurface data on soil lithology and shallow groundwater flow regimes. Some additional water quality data will be collected from drilling locations to measure the magnitude of a dissolved gasoline plume originating from the Sunol Tree Gasoline station. The generated data will also provide subsurface information for effective sighting and design of a potential replacement water supply well for the T Bear Ranch. Tasks will include:

1) *The drilling of approximately six to seven soil cores at locations around and downgradient of the source (gas station tanks/dispensers) to obtain stratigraphic information, define preferred pathways for dissolved contaminant migration, and get data on the magnitude/extent of fuel contaminants.*

2) *The conversion of three to four of the borings into temporary piezometers to provide accurate groundwater flow direction (see Proposed piezometer and Driven Probe Locations, Figure 1). A description of proposed field methodology is included in Appendix A that includes GeoProbe SOPs for dual tube coring and pre-pack piezometers installations.*

Site Activities (Check those that apply)	
❑ Mapping	❑ Soil Excavation
✔ Drilling	❑ Tank Excavation
❑ Trenching	❑ Large Diameter Borehole
✔ Work in traffic area *heavy equipment*	❑ Above Ground Remediation

Is OSHA training for Hazardous Waste Operations required on this job? ❑ No ✔ Yes

Hazardous Substances Anticipated On The Site? ❑ No ❑ Possibly ✔ **Yes** *(petroleum fuel product)*

If hazardous substances are anticipated, please list below. Refer to the "Warning Concentrations" and "Health Effects" summaries stapled to this form for details on substances.

NAME (CAS #)	EXPECTED CONCENTRATION ❑ Water	HEALTH EFFECTS
▸ *Benzene (#71432)* ▸ *MTBE* ▸ *Gasoline*	▸ *ND (soil); 1.1 ppb (water)* ▸ *5.9 ppm (soil); 190 ppb (water)* ▸ *150 ppm (soil); 17,000 ppb (water)*	▸ *Carcinogen, headache, dizziness,* ▸ *Headache, dizziness,* ▸ *Headache, fatigue, eye irritation.*

Physical Hazards (Check and briefly describe source)

Noise: *Heavy equipment*
Traffic: *Drilling in construction zone, area to be flagged or coned*
Overhead Hazards: *none*
Excavation/Trenches: *No*
Underground Hazards: *Located by property owner representative/USA alert/Utility Service*

Level Of Protective Equipment (Check appropriate level): ❑ A ❑ B ❑ C ✔ D
(see Personal Protective Equipment requirements below).

Personal Protective Equipment (*R* = required, *A* = As needed)	
Hard Hat ***R***	Eyewear (type) *A*
Safety Boots ***R***	Respirator (type) *A (dust mask)*
Orange Vest *A*	Filter (type) *A (Particulate)*
Hearing Protection *A*	Gloves (type) *A nitrile, or cloth work gloves*
Tyvek Coveralls *A*	Other

Monitoring Equipment On Site	
Organic Vapor Analyzer ***HNu, if vapors apparent***	PID with lamp of ***10.2*** ev

Site Control Measures: *Flagging & barricades around work areas w/ foot traffic. Encapsulate/containerize any contaminated soils (Stockpiled or barreled).*

Decontamination Procedures: *Fresh water/ TSP water / fresh water rinse. Containment of wastewater and disposable suits/gloves.*

Hospital: ***VALLEY CARE MEDICAL CENTER***
5555 W LAS POSITAS BLVD, PLEASANTON, CA
Phone: *(925) 847-3000*

Paramedic Phone Number: *911*
Fire Department Phone Number *911*
Police Department Phone #: *911*

Emergency/Contingency Plans and Procedures: *Mobile Phone contact with emergency personnel.*

Site Hazard Information Provided By: *Patrick Hoban, Site Safety Officer* *Phone Number: (831) 722-3580*

Signature _______ 7/21/04 Date:

PLEASE INITIAL HERE AFTER TAILGATE MEETING AND SAFETY INSPECTION

_______ _______ _______ _______ _______

SBC Yahoo! Mail

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SBC YAHOO! Maps

Welcome, **pathoban@sbcgloba...**
[Sign Out, My Account]

Maps

Starting from: A Sunol, CA

Arriving at: B VALLEYCARE MEDICAL CENTER 5555 W Las Positas Blvd, Pleasanton, CA

Distance: 11.2 miles **Approximate Travel Time:** 15 mins

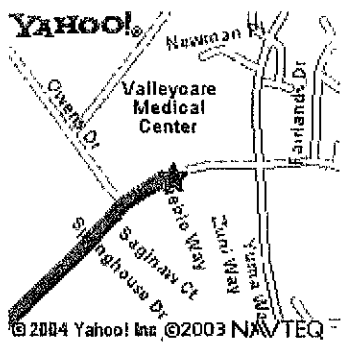
Your Directions

1.	Starting in **SUNOL, CA** on **MAIN ST** go towards **BOND ST** - go **0.2** mi
2.	Turn L on **NILES CANYON RD** - go **0.1** mi
3.	Bear R on **PALOMA WAY** - go **0.6** mi
4.	Continue on **CALAVERAS RD/PALOMA WAY** - go **0.1** mi
5.	**CALAVERAS RD/PALOMA WAY** becomes **CALAVERAS AVE/CALAVERAS RD/PALOMA WAY** - go **0.1** mi
6.	Take **CA-84 EAST/I-680 NORTH** towards **LIVERMORE/SACRAMENTO** - go **7.8** mi
7.	Take the **STONERIDGE DRIVE** exit - go **0.2** mi
8.	Turn R on **STONERIDGE DR** - go **1.8** mi
9.	Turn L on **W LAS POSITAS BLVD** - go **0.3** mi
10.	Turn R on **APACHE DR** - go < **0.1** mi
11.	Turn L on **W LAS POSITAS BLVD** - go < **0.1** mi
12.	Arrive at **VALLEYCARE MEDICAL CENTER**

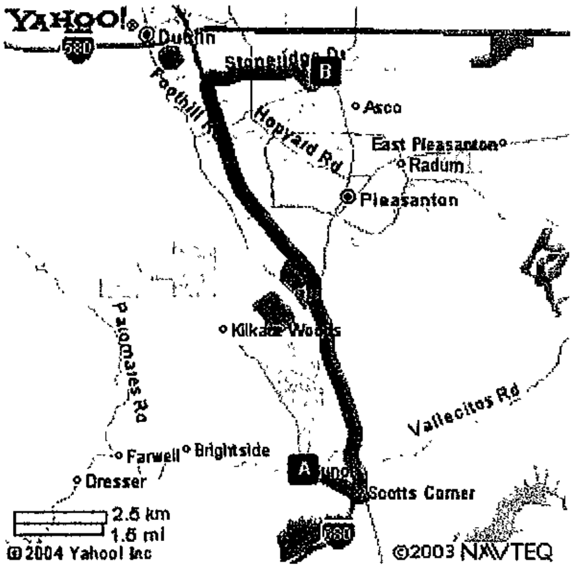
When using any driving directions or map, it's a good idea to do a reality check and make sure the road still exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an aid in planning.

Your Full Route

Your Destination



Address:
VALLEYCARE MEDICAL CENTER 5555 W Las Positas Blvd
Pleasanton, CA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Vallecitos Rd
Farwell
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2.5 km
1.5 mi
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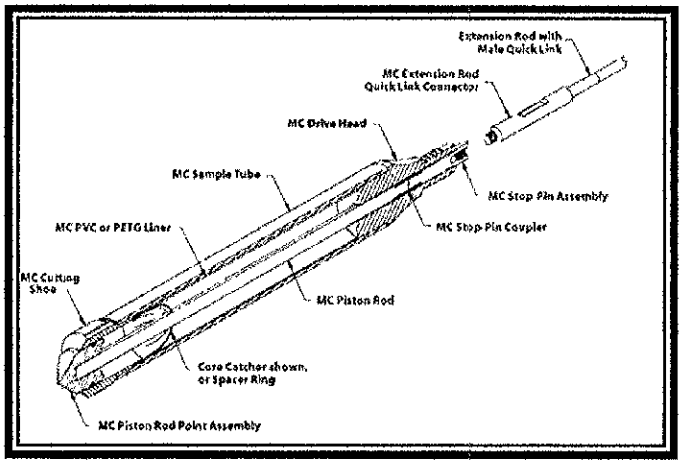
Field Methodology for Direct-Push Borings and Soil and Grab Groundwater Sampling

Direct push exploratory borings are "drilled" using a Geo-Probe rig which hydraulically drive and vibrate steel probes into the soil. No drill cuttings are produced (only soil cores). This sampling technology has the ability for either continuous or discrete sampling using a 4-foot long nickel-plated sampling probes fitted with clear acetate liners. During coring operations, the sampler remains open as it is driven into undisturbed soil over it's entire 4-foot sampling interval. Upon completion of drilling, all of exploratory the boreholes are grouted according to county regulations



The soil cores are logged by an experienced geologist using the Unified Soil Classification System (USCS), noting in particular, the lithology of the soils, moisture content, and any unusual odor or discoloration. Relatively undisturbed soil samples are obtained for both lithologic logging and laboratory analysis. A portion of individual soil cores are stored in a sealed plastic bags for field screening of hydrocarbon odors and/or volatile organic compounds by the PID. An Organic Vapor Analyzer (Photoionization Detector - PID) is for field screening soil samples for the presence of volatile organic compounds. Vapor readings in parts per million (ppm) are recorded on the boring logs. The PID is also used during drilling for monitoring the work area (site safety).

All drilling equipment is steam cleaned prior to arriving on-site to prevent possible transfer of contamination from another site. The sampling probe and all other soil sampling equipment is thoroughly cleaned between each sampling event by washing in a Liqui-Nox or Alconox solution followed by a double rinsing with distilled water to prevent the transfer of contamination.

<u>Samples Targeted for Laboratory Analysis</u>: Soil samples targeted for laboratory analysis are immediately protected at both ends with Teflon tape, sealed with non-reactive caps, taped, labeled, and immediately stored in an insulated container cooled with blue ice. A portion of the soil is placed in a baggie and the soil gas is measured using an HNu photoionization meter calibrated for benzene. Groundwater samples are collected after temporary casing is placed in the hole and four to ten borehole volumes are purged. Relatively representative groundwater samples are collected with individual disposable acrylic bailers and dispensed directly into containers specifically prepared for the analyses. Once collected, groundwater samples are immediately placed in ice chests cooled with blue ice. Soil and groundwater samples are transported to a State-certified laboratory under appropriate chain-of-custody documents in a timely manner.

GEOPROBE® DT21 DUAL TUBE SOIL SAMPLING SYSTEM

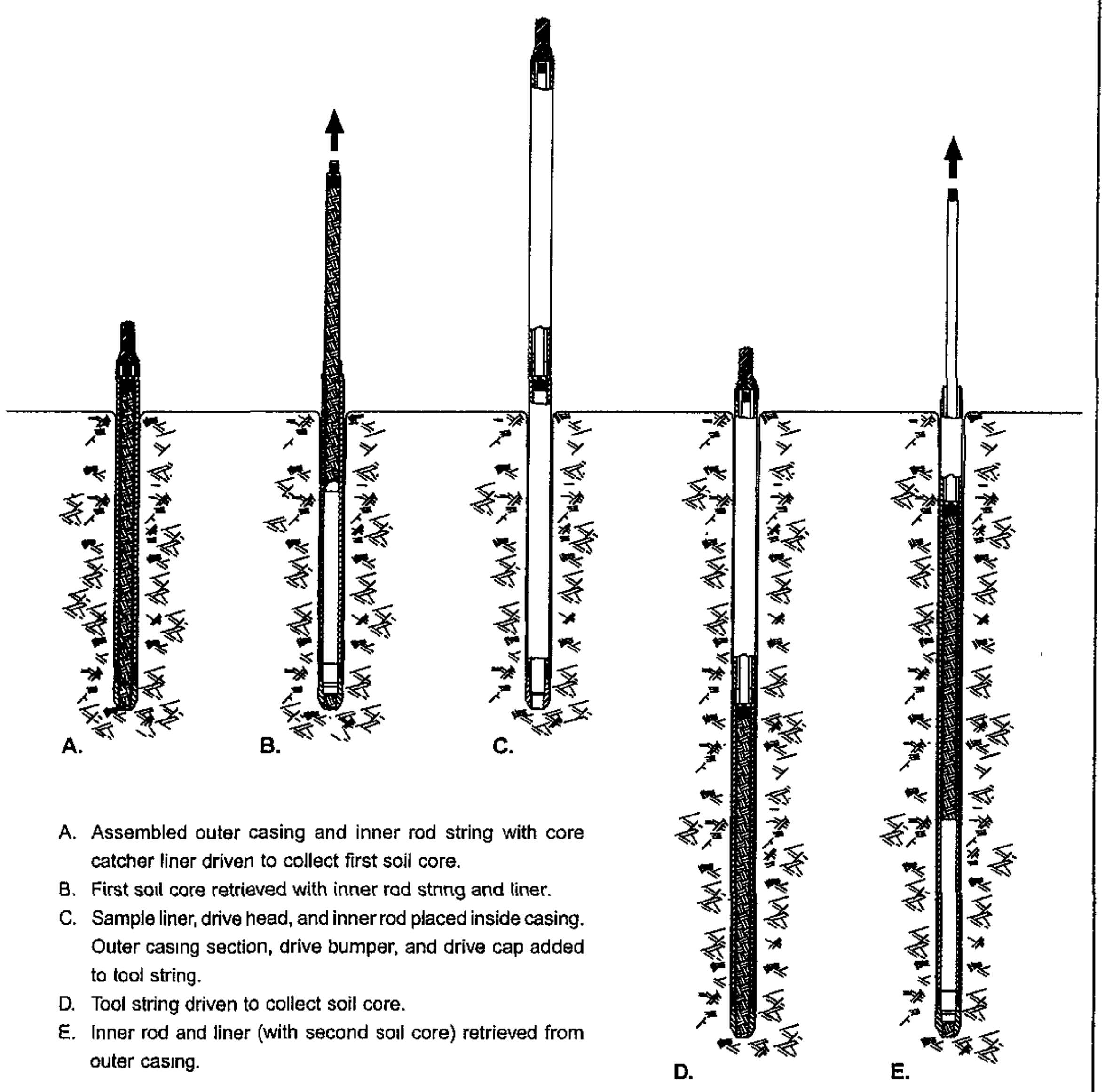
CONTINUOUS CORE SOIL SAMPLER

STANDARD OPERATING PROCEDURE

Technical Bulletin No. 982100

PREPARED: September, 1998

REVISED: June, 2002



A. Assembled outer casing and inner rod string with core catcher liner driven to collect first soil core.
B. First soil core retrieved with inner rod string and liner.
C. Sample liner, drive head, and inner rod placed inside casing. Outer casing section, drive bumper, and drive cap added to tool string.
D. Tool string driven to collect soil core.
E. Inner rod and liner (with second soil core) retrieved from outer casing.

OPERATION OF THE DUAL TUBE 21 SOIL SAMPLING SYSTEM

Geoprobe® and Geopobe Systems® are
Registered Trademarks of Kejr, Inc., Salina, Kansas

1.0 OBJECTIVE

The objective of this procedure is to collect a representative soil sample at depth through an enclosed casing and recover it for visual inspection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe®: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling, soil conductivity and contaminant logging, grouting, and materials injection.
* *Geoprobe® is a registered trademark of Kejr Engineering, Inc., Salina, Kansas*

Dual Tube 21 Soil Sampling System: A direct push system for collecting continuous core samples of unconsolidated materials from within a sealed casing of Geoprobe® 2.125-inch (54 mm) OD probe rods. Samples are collected and retrieved within a liner that is threaded onto the leading end of a string of Geoprobe® 1.0-inch (25 mm) OD probe rods and inserted to the bottom of the outer casing. Collected samples measure up to approximately 800 ml in volume in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core.

Liner: A 1.375-inch (35 mm) OD thin-walled, PETG tube that is inserted into the outer casing on the leading end of the inner rod string for the purpose of containing and retrieving core samples. Liners are available in two configurations; a simple open tube or a tube with a core catcher permanently attached to the leading end. Liner lengths include 25 inches (635 mm), 37 inches (940 mm), 40.4 inches (1026 mm), and 49 inches (1245 mm).

Core Catcher: A dome-shaped device positioned at the leading end of a liner to prevent loss of collected soil during retrieval of the liner and soil core. Flexible fingers at the top of the core catcher are pushed outward by soil entering the liner during advancement of the tool string. As the filled liner is subsequently retrieved, the fingers of the core catcher move back inward, effectively closing off the end of the liner and limiting soil loss. The core catcher designed for the DT21 system is made of PETG material and is permanently fused to the liner.

2.2 Discussion

Dual tube sampling gets its name from the fact that two sets of probe rods are used to retrieve continuous soil core samples from the subsurface. One set of rods is driven into the ground as an outer casing (Fig. 2.1). These rods receive the driving force from the hammer and provide a sealed casing through which soil samples may be recovered. The second, smaller set of rods are placed inside the outer casing with a sample liner attached to the leading end of the rod string (Fig. 2.1). These smaller rods hold the liner in place as the outer casing is driven to fill the liner with soil. The inner rods are then retracted to retrieve the full liner.

Standard Geoprobe® 2.125-inch OD probe rods provide the outer casing for the DT21 Dual Tube Soil Sampling System. A cutting shoe is threaded into the leading end of the rod string. When driven into the subsurface, the cutting shoe shears a 1.125-inch OD soil core which is collected inside the casing in a clear plastic liner.

The second set of rods in the DT21 system are standard Geoprobe® 1.0-inch OD probe rods. A sample liner is attached to the end of these smaller rods and then inserted into the casing. The 1.0-inch rods hold the liner tight against the cutting shoe as the outer casing is driven to collect the soil core. Once filled with soil, the liner is removed from the bottom of the outer casing by lifting out the 1.0-inch rods.

The outer, 2.125-inch probe rods provide a cased hole through which to sample. The main advantage of sampling through a cased hole is that there is no side slough to contend with. In addition, the outer casing effectively seals the probe hole when sampling through perched water tables. These factors mean that sample cross-contamination is eliminated. The DT21 sampling system is therefore ideal for continuous coring in both saturated and unsaturated zones.

A Solid Drive Tip (DT4070) can be placed on the leading end of the 1.0-inch probe rod string in place of a sample liner (Fig. 2.2). When installed in the outer casing, the drive tip firmly seats within the cutting shoe and effectively seals the tool string as it is driven into the subsurface. This enables the operator to advance the outer casing to the bottom of a pre-core hole or through undisturbed soil to reach the top of the sampling interval.

The DT21 system allows bottom-up grouting through the primary tool string. This means that a cement or bentonite grout mix can be pumped through the outer casing as it is withdrawn from the ground. This is in contrast to most other soil samplers which require driving a second set of tools back down the probe hole in order to deliver the grout mix.

An expendable cutting shoe enables the operator to install a Geoprobe® Prepacked Screen Monitoring Well through the outer casing of the DT21 Dual Tube System. After the collection of continuous soil cores to the desired depth, prepacked screens can be inserted to the bottom of the outer casing on the leading end of a PVC riser string. The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

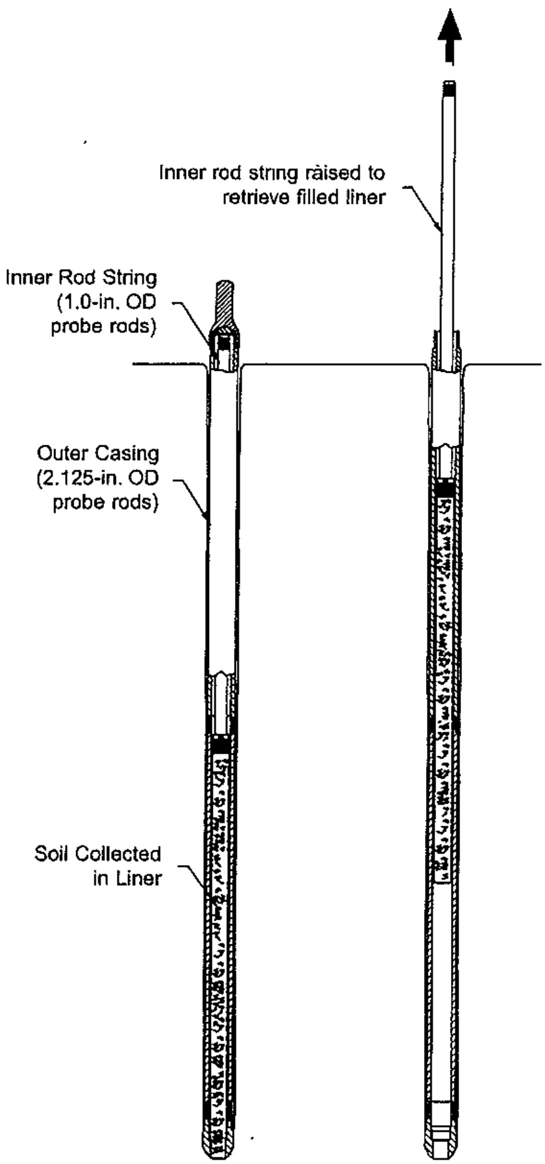


FIGURE 2.1
Outer Casing Driven With Liner

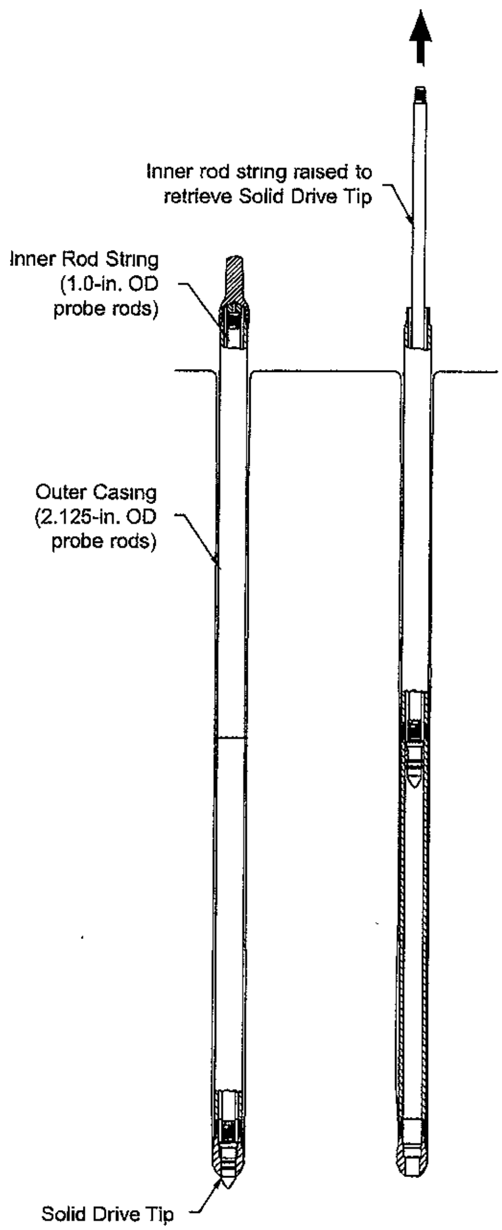


FIGURE 2.2
Outer Casing Driven With Solid Drive Tip

3.0 REQUIRED EQUIPMENT

The following equipment is used to recover samples with the Geoprobe® Dual Tube 21 Soil Sampling and probing systems. Note that the operator may choose to utilize 2.125-inch probe rods in lengths of 36 inches (914 mm), 1 meter, or 48 inches (1219 mm). It is not necessary to have all three rod lengths on-hand. Refer to Figure 3.1 for parts identification.

DUAL TUBE 21 SAMPLER PARTS	QUANTITY	PART NUMBER
DT21 Drive Bumper, Pkg. of 5	-1-	DT4010K
DT21 Threadless Drive Cap (1.0-inch probe rods)	-1-	DT4020
DT21 Cutting Shoe, Large, 2.375 in. OD	-1-	DT4030
DT21 Cutting Shoe, Small, 2.205 in. OD	-1-	DT4035
DT21 Expendable Cutting Shoe Holder	-1-	DT4040
DT21 Expendable Cutting Shoe, 2.375 in. OD	variable	DT4045
O-rings for Expendable Cutting Shoe, Pkg. of 50	variable	DT4045R
DT21 Liner Drive Head Assembly (1.0-inch probe rods)	-1-	DT4050
DT21 Rebuild Kit for Liner Drive Head	-1-	DT4051K
DT21 Rod Clamp Assembly (1.0-inch probe rods)	-1-	DT4060
DT21 Solid Drive Tip (1.0-inch probe rods)	-1-	DT4070
O-rings for Solid Drive Tip, Pkg. of 25	variable	DT4070R
DT21 Liners, PETG, 24-inch, Box of 50*	variable	DT4024K
DT21 Vinyl End Caps, Pkg. of 100 (50 pair)	variable	DT4026K
DT21 Liner, PETG, 36-inch, Box of 50*	variable	DT4036K
DT21 Liner, PETG, 1-meter, Box of 50*	variable	DT4039K
DT21 Liner, PETG, 48-inch, Box of 50*	variable	DT4048K
DT21 Liner With Core Catcher, PETG, 36-inch, Box of 50*	variable	DT4136K
DT21 Liner With Core Catcher, PETG, 1-meter, Box of 50*	variable	DT4139K
DT21 Liner With Core Catcher, PETG, 48-inch, Box of 50*	variable	DT4148K

GEOPROBE TOOLS AND EQUIPMENT	QUANTITY	PART NUMBER
Probe Rod, 1.0 inch OD x 36 inches*	variable	AT10B
Probe Rod, 1.0 inch OD x 39 inches (1 meter)*	variable	AT1039
Probe Rod, 1.0 inch OD x 48 inches*	variable	AT104B
Probe Rod, 1.0 inch OD x 24 inches*	variable	AT105B
O-rings for 2.125-inch Probe Rods	variable	AT2100R
Drive Cap (2.125-inch probe rods)	-1-	AT2101
Pull Cap (2.125-inch probe rods)	-1-	AT2104
Probe Rod, 2.125 inches OD x 36 inches*	variable	AT2136
Probe Rod, 2.125 inches OD x 39 inches (1 meter)*	variable	AT2139
Probe Rod, 2.125 inches OD x 48 inches*	variable	AT2148
MC Combination Wrench	-1-	AT8590
Rod Grip Pull System	-1-	GH3000K

ADDITIONAL TOOLS	QUANTITY
Hex Key, 3/32 in.	-1-
Utility Knife (with straight blade)	-1-
Pipe Wrench	-2-

* Match length of probe rods to desired liner length. Use 36-inch probe rods with 36-inch liners, 1-meter probe rods with 1-meter liners, and 48-inch probe rods with 24- and 48-inch liners. A 1.0 inch x 24 inches probe rod is also required when utilizing 24-inch sample liners.

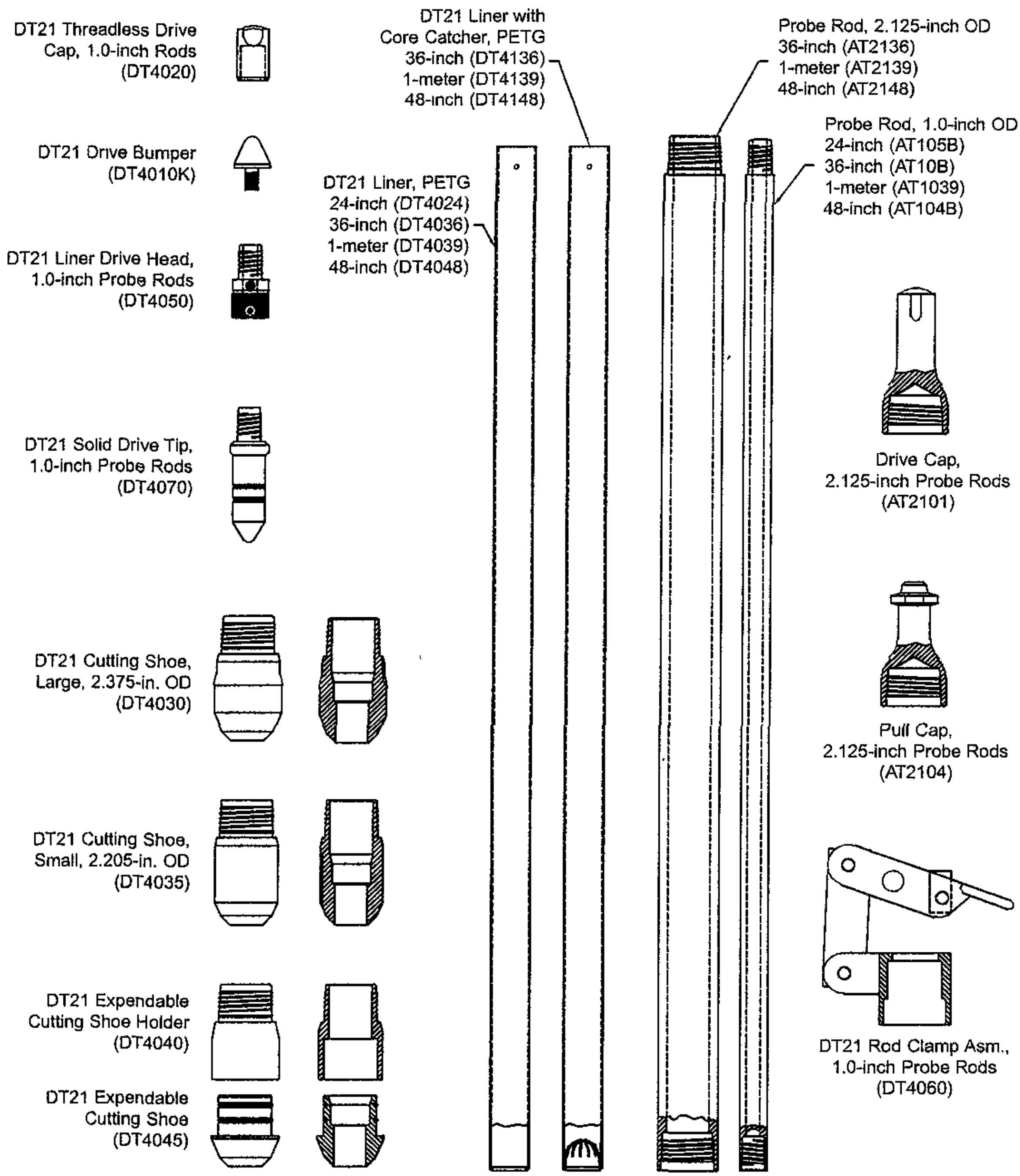


FIGURE 3.1
Dual Tube 21 Soil Sampling System Parts

3.1 Tool Options

Three major components of the DT21 Soil Sampling System are probe rods, sample liners, and cutting shoes. These items are manufactured in a variety of sizes to fit the specific needs of the operator. This section identifies the specific tool options available for use with the DT21 Dual Tube System.

Probe Rods

Standard Geoprobe® 1.0-inch (25 mm) OD and 2.125-inch (54 mm) OD probe rods are required to operate the DT21 Soil Sampling System. The specific length of rods may be selected by the operator. Available rod lengths are 36 inches (914 mm), 48 inches (1,219 mm), and 1 meter. Both rod sets (1.0-inch and 2.125-inch) must be of the same length.

Sample Liners

Sample liners are made of a heavy-duty clear plastic for convenient inspection of the soil sample. Lengths of 24 inches (610 mm), 36 inches (914 mm), 48 inches (1219 mm), and 1 meter are available with an OD of 1.375 inches (35 mm). Choose the liner length corresponding to the length of probe rods used (e.g. 36-inch liners with 36-inch probe rods).

The shorter length of the 24-inch liners helps to recover samples from flowing sands and highly expansive clays. These liners are used with 48-inch probe rods, but also require a single 1.0-inch x 24-inch probe rod.

Sample liners with integral core catchers are available in lengths of 36 inches (914 mm), 48 inches (1219 mm), and 1 meter. Utilize the core catcher liners when sampling flowing sands, non-cohesive soils, extremely dry soils, or any other materials that fall from the liner during retrieval. DT21 core catcher liners are used with the same equipment as open sample liners. No special tooling or adapters are required.

Cutting Shoes

Three cutting shoes are available for use with the DT21 Dual Tube System (Fig. 3.2). The DT21 Large Cutting Shoe (DT4030) and DT21 Small Cutting Shoe (DT4035) thread into the leading end of the 2.125-inch probe rods and are recovered after sampling. Dimensions for the large cutting shoe are 1.125 inches (29 mm) ID and 2.375 inches (60 mm) OD. The small cutting shoe also has an ID of 1.125 inches (29 mm) but the OD is only 2.205 inches (56 mm). To reduce side friction and make driving easier, the large cutting shoe (DT4030) is oversized to provide a small annulus between the outer casing and soil. By contrast, the small cutting shoe (DT4035) is for use in soil conditions where an annulus is undesirable.

The DT21 sampling system may also employ an expendable cutting shoe. In this arrangement, a DT21 Expendable Cutting Shoe Holder (DT4040) is threaded into the leading end of the outer casing. A DT21 Expendable Cutting Shoe (DT4045) is then inserted into the holder. Upon completion of soil sampling, the outer casing is withdrawn slightly. The expendable cutting shoe detaches from the holder, leaving an open casing through which a prepacked screen monitoring well may be installed. Dimensions for the expendable cutting shoe are the same as the large cutting shoe (ID = 1.125 in. (29 mm) and OD = 2.375 in. (60 mm)).

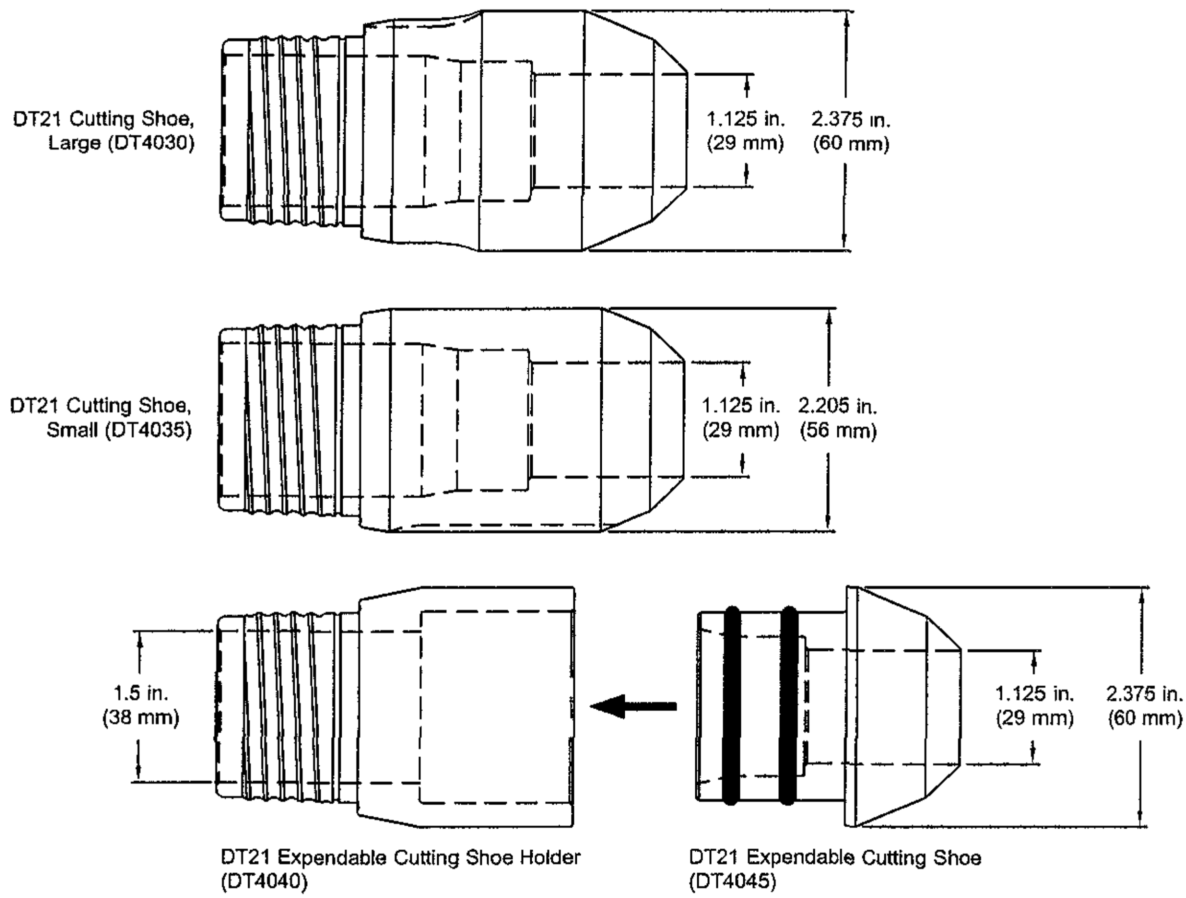


FIGURE 3.2
Cutting Shoe Options for the DT21 Dual Tube Soil Sampling System

4.0 OPERATION

4.1 Decontamination

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

4.2 Operational Overview

The DT21 Soil Sampling System is designed to collect continuous soil cores. Sampling may begin either from ground surface or a predetermined depth below ground. Once sampling begins, consecutive soil cores must be removed as the outer casing is advanced to greater depths

When sampling is to begin at the ground surface, the first soil core should be collected using a core catcher liner to maximize sample recovery (Fig. 4.1-A). This is especially true when the first core is composed of dry, loose soil. Upon removal of the first liner and soil core (Fig. 4.1-B), a new liner is inserted to the bottom of the outer casing on the end of an inner rod. A section of outer casing is added to the tool string (Fig. 4.1-C) and the entire tool string is driven to fill the liner with soil (Fig. 4.1-D). The filled liner is removed from the outer casing to retrieve the second soil core (Fig. 4.1-E). A new liner is then inserted to the bottom of the outer casing and the process is repeated over the entire sampling interval.

When the sampling interval begins at some depth below ground surface, a DT21 Solid Drive Tip is installed in the outer casing and the entire assembly is driven from ground surface directly through undisturbed soil (Fig. 4.2-A). This enables the operator to reach the top of the sampling interval without stopping to remove unwanted soil cores. Once the interval is reached, the solid drive tip is removed (Fig 4.2-B) and sampling continues as described in the preceding paragraphs (Fig. 4.2-C, Fig. 4.2-D, and Fig. 4.2-E).

NOTE: Once the first soil core is collected, the DT21 Solid Drive Tip cannot be reinstalled in the cutting shoe. Consecutive soil cores must be removed in order for the outer casing to be driven to greater depths.

Specific instructions for the assembly and operation of the DT21 Dual Tube Soil Sampling System are given in the following sections.

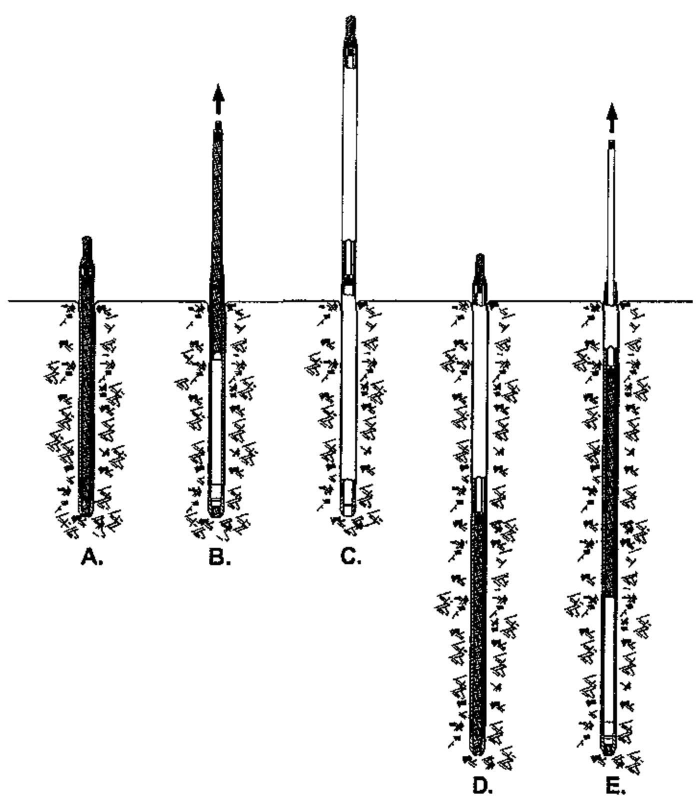


FIGURE 4.1
Continuous Core Sampling From Ground Suface with Dual Tube 21 System

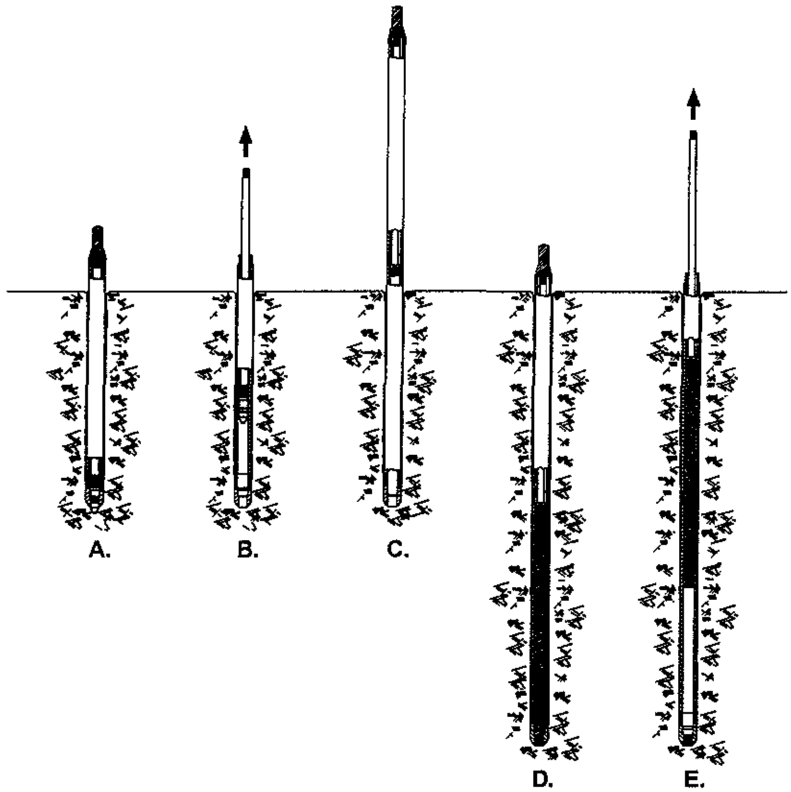


FIGURE 4.2
Outer Casing Driven Through Undisturbed Soil to Begin Sampling with DT21 System

4.3 Assembling and Driving the Outer Casing Using a DT21 Solid Drive Tip

If soil sampling is to begin at some depth below ground surface, the outer casing of the DT21 Dual Tube System can be driven to the top of the sampling interval with a DT21 Solid Drive Tip installed in the leading end. The solid drive tip seals the outer casing as it is driven to depth. Once the desired sampling interval is reached, the solid drive tip is removed to allow collection of the first soil core. This section describes assembling and driving the outer casing using the DT21 Solid Drive Tip.

1. If using a DT21 Large or Small Cutting Shoe (DT4030 or DT4035) install an O-ring (AT2100R) at the base of the threads as shown in Figure 4.3. If using an expendable cutting shoe, install an AT2100R O-ring on the DT21 Expendable Cutting Shoe Holder (DT4040) and two DT4045R O-Rings on the DT21 Expendable Cutting Shoe (DT4045) (Fig. 4.3).

2. Thread the DT21 Cutting Shoe or DT21 Expendable Point Holder into the leading end of a 2.125-inch OD Probe Rod (AT2136, AT2139, or AT2148). Completely tighten the cutting shoe or cutting shoe holder using a machine vise and MC Combination Wrench (AT8590) as shown in Figure 4.4.

3. Install an O-ring (DT4070R) in both grooves of the DT21 Solid Drive Point (DT4070) (Fig.4.5).

4. Thread the solid drive point into the female end of a 1.0-inch OD probe rod of the same length as the 2.125-inch probe rod (outer casing).

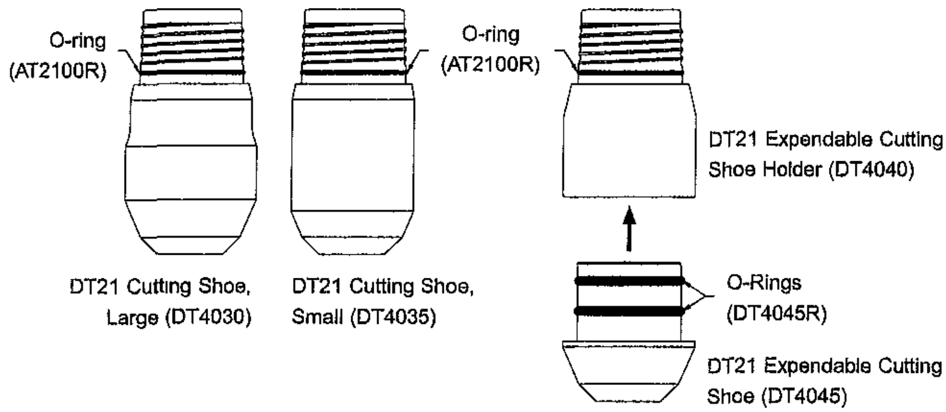


FIGURE 4.3
DT21 Cutting Shoes Utilize O-ring Seals

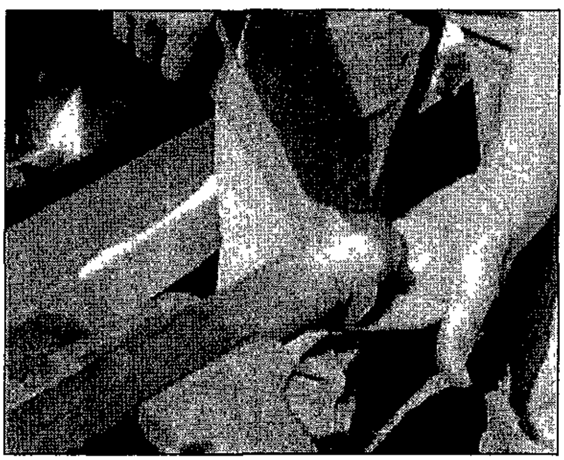


Figure 4.4. Place probe rod (outer casing) in vise and tighten cutting shoe with MC Combination Wrench.

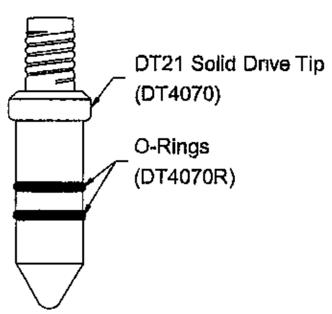


FIGURE 4.5
Solid Drive Point Utilizes Two O-Rings

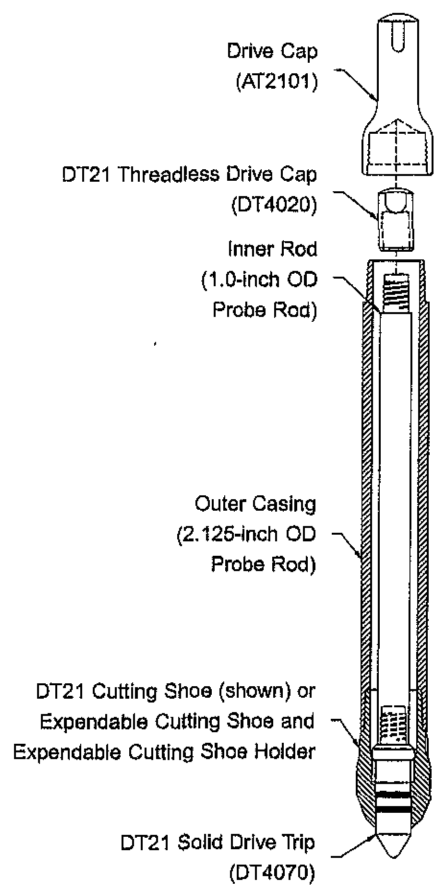


FIGURE 4.6
Outer Casing with Solid Drive Tip

5. Lubricate the O-rings on the solid drive point with a small amount of deionized water. Insert the point and probe rod into the outer casing until the point partially extends from the bottom of the cutting shoe.

6. Place a DT21 Threadless Drive Cap (DT4020) on top of the inner rod (Fig. 4.6). This drive cap is threadless for quick installation/removal, yet still provides protection for the probe rod threads.

7. Thread a Drive Cap (AT2101) onto the 2.125-inch probe rod (outer casing) (Fig. 4.6).

   NOTE: Current AT2101 Drive Caps are manufactured using a process that leaves an angled surface inside the cap (Fig. 4.7). This provides room for the Threadless Drive Cap (DT4020). Older AT2101 Drive Caps were manufactured using a process that leaves a flat surface inside the cap (Fig. 4.7). These older drive caps cannot be used with the DT21 Dual Tube System.

8. Place the assembled outer casing section under the direct push machine for driving. Position the casing directly under the hammer with the cutting shoe centered between the toes of the probe foot.

9. Lower the hydraulic hammer onto the drive cap and advance the outer casing into the subsurface.

10. Raise the hydraulic hammer and remove the drive cap from the outer casing and the threadless drive cap from the inner rod string.

11. Place an O-ring (AT2100R) on the outer casing section that extends from the ground (Fig. 4.8).

12. Thread a 1.0-inch probe rod onto the inner rod string. Place a 2.125-inch probe rod over the inner rods and thread it onto the outer casing (Fig. 4.9). Completely tighten the outer casing using a pipe wrench.

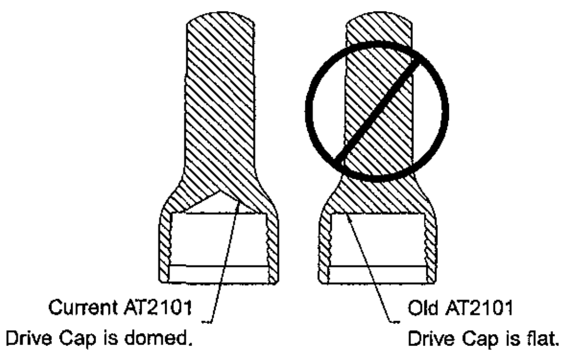


FIGURE 4.7
Comparison of AT2101 Drive Caps

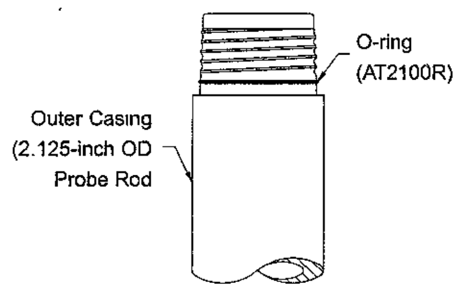


FIGURE 4.8
Outer Casing Joints are Sealed with O-Rings

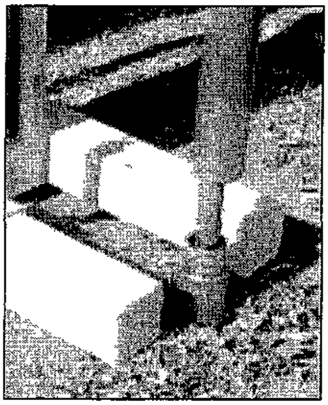


Figure 4.9. Place a 2.125-inch probe rod over the 1.0-inch rod and thread it onto the outer casing string.

Figure 4.10. The DT21 Rod Clamp Assembly holds the inner rod string while adding or removing 1.0-inch rods.

Figure 4.11. Raise the inner rod string using the probe hammer and a Rod Grip Pull Sytem if rods are too heavy to lift by hand.

13. Place the threadless drive cap on top of the inner rod. Thread the 2.125-inch drive cap over the threadless drive cap and onto the outer casing.

14. Lower the hydraulic hammer onto the drive cap and advance the outer casing into the subsurface.

    Repeat Steps 10-13 until the leading end of the outer casing is at the top of the proposed sampling interval. Continue with Step 15 to remove the DT21 Solid Drive Point for sampling.

15. Raise the hydraulic hammer and retract the probe derrick to provide access to the top of the tool string.

16. Unthread the 2.125-inch drive cap and remove the threadless drive cap from the inner rods.

17. Thread a 1.0-inch OD probe rod onto the inner rod string. Lift and remove the inner rods from the outer casing. The DT21 Solid Drive Point is removed from the leading end of the casing with the inner rods.

    NOTE: Hold the inner rod string with a DT21 Rod Clamp Assembly (DT 4060) while unthreading the retracted rods (4.10). Use the probe hammer and Rod Grip Pull System (GH3000K) to pull the inner rods if they are too heavy to lift comfortably by hand (Fig. 4.11).

The outer casing is now ready for sampling. Continue with Section 4.4 for more instructions.

4.4 Liner Drive Head Assembly

The main function of the DT21 Liner Drive Head Assembly (DT4050) is to connect a liner to the leading end of the inner rod string. This enables the inner rods to hold the liner tight against the cutting shoe to fill the liner with soil as the outer casing is driven. The inner rods are then used to retrieve the liner and soil core from within the outer casing.

The liner drive head assembly includes an internal check ball to improve sample recovery (Fig. 4.12) A considerable vacuum is created below the filled liner as it is lifted from the bottom of the outer casing. Because the inner rod string and liner drive head are hollow, atmospheric air can travel through the rods creating a positive pressure differential above the soil core during retrieval. The check ball seals the liner drive head to eliminate air flow into the liner which could otherwise push the soil sample out of the liner. The check ball also allows air to escape up through the liner drive head and inner rod string when lowering a new liner down the outer casing and as soil enters the liner during sampling.

Saturated conditions can also challenge sample recovery. Water enters the outer casing either from the saturated formation or is deliberately poured from the ground surface to keep flowing sands out of the casing. As with air in unsaturated formations, the check ball lets water pass through the liner drive head as a new liner is lowered to the bottom of the casing and during sampling as the liner is filled with soil. The check ball then seals the drive head during retrieval so that water draining from the inner rods does not wash the sample out the bottom of the liner. A drain hole located on the side of the liner drive head (Fig. 4.12) allows water to exit the inner rods and travel harmlessly along the outside of the liner.

The liner drive head assembly is made up of five parts as shown in Figure 4.13. The two 3/8-inch flat head socket cap screws are used to attach liners to the liner drive head. The longer 5/8-inch flat head socket cap screw holds the stainless steel check ball within the liner drive head. To disassemble the liner drive head for cleaning, simply unthread the 5/8-inch cap screw and remove the check ball.

Instructions for attaching a liner to the DT21 Liner Drive Head Assembly (DT4050) are given below.

1. Visually inspect the liner drive head assembly to ensure that the check ball moves freely within the drive head and the drain hole is unobstructed.

2. Place the liner drive head assembly in a machine vise so that either one of the 3/8-inch caps screws is on top as shown in Figure 4.14.

   NOTE: Only one 3/8-inch cap screw is used to attach a liner to the liner drive head assembly. Two 3/8-inch cap screws are included on the drive head to provide a backup in case one incurs thread damage. Either cap screw may be used to attach the liner.

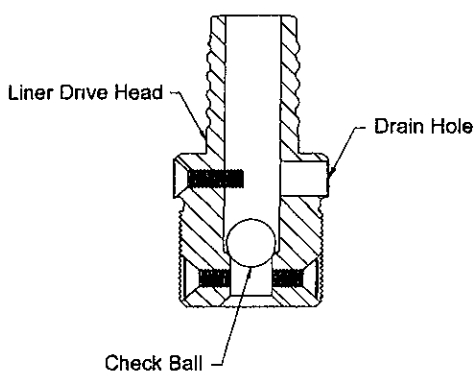


FIGURE 4.12
Cross-Section of Liner Drive Head

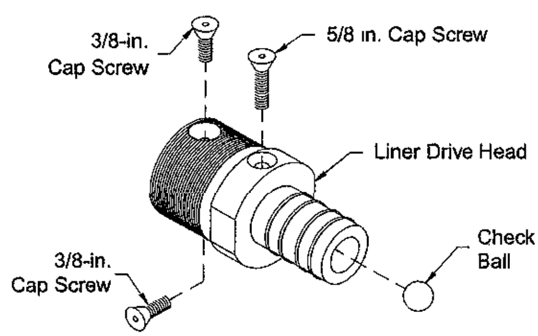


FIGURE 4.13
Liner Drive Head Assembly Components

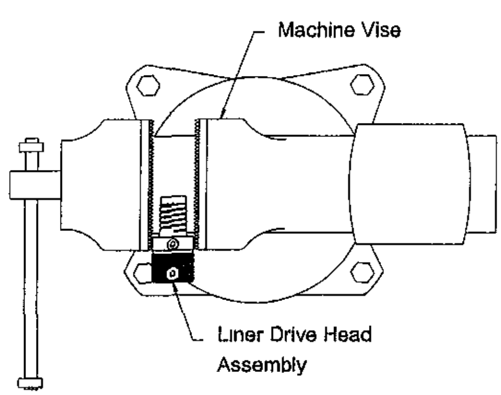


FIGURE 4.14
Place Liner Drive Head in Vise

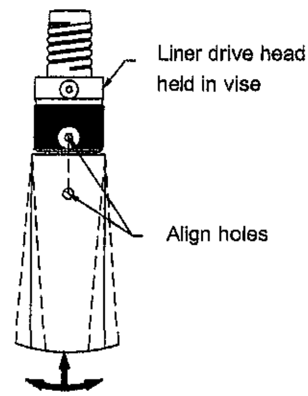


FIGURE 4.15
Push Liner Onto Liner Drive Head

3. Remove the 3/8-inch cap screw using a 3/32-inch hex key.

4. Place the open end of a DT21 Liner against the bottom of the liner drive head. Align the hole in the liner with the hole in the liner drive head as shown in Figure 4.15. Wiggle the free end of the liner back-and-forth while pushing the liner onto the drive head (Fig. 4.15).

   NOTE: Use the DT21 Liner that matches the length of your probe rods (36 inches, 1 meter, or 48 inches). The 24-inch DT21 Liners (DT4024K) are to be used with 48-inch probe rods only. One 1.0-inch x 24-inch probe rod (AT105B) is also required when using the DT4024K liners.

5. Thread the 3/8-inch cap screw through the liner and back into the liner drive head (Fig. 4.16). Tighten the cap screw with the 3/32-inch hex key.

The DT21 Liner is now attached to the DT21 Liner Drive Head Assembly (Fig. 4.17).

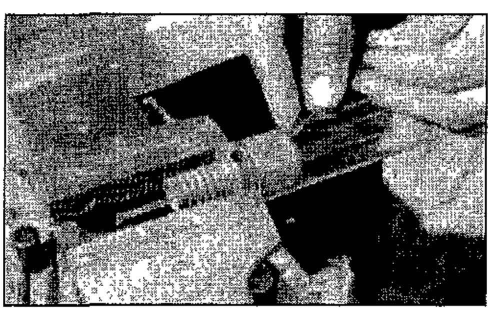


Figure 4.16. Thread cap screw into liner drive head to secure liner.

Figure 4.17. Liner attached to liner drive head and ready for sampling.

4.5 Soil Core Collection

This section describes collection of continuous soil core samples from within the sealed outer casing of the DT21 Dual Tube Soil Sampling System. The procedure is written for a sampling series that begins at the ground surface. If sampling is to begin after driving the outer casing through undisturbed soil using a DT21 Solid Drive Tip, skip ahead to Step 13 of this section.

1. Select a DT21 Large Cutting Shoe (DT4030), DT21 Small Cutting Shoe (DT4035), or DT21 Expendable Cutting Shoe (DT4045) and DT21 Expendable Cutting Shoe Holder (DT4040).

   If using a large or small cutting shoe, install an O-ring (AT2100R) at the base of the threads as shown in Figure 4.18. If using an expendable cutting shoe, install an AT2100R O-ring on the expendable cutting shoe holder and two DT4045R O-Rings on the expendable cutting shoe (Fig. 4.18).

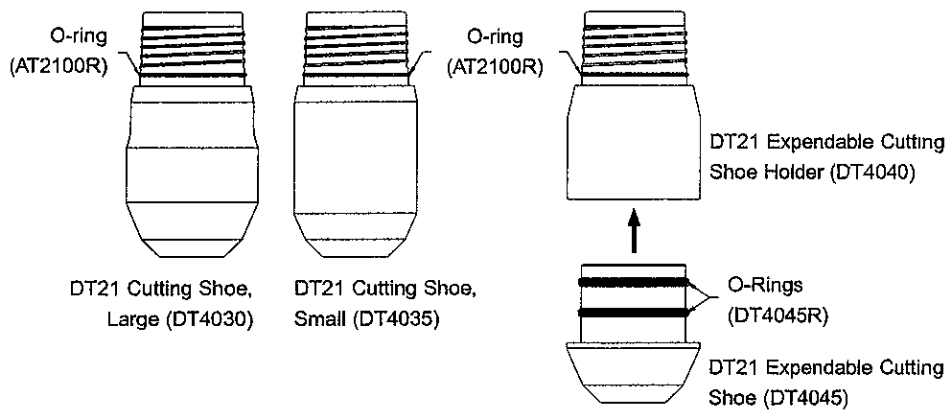


FIGURE 4.18
DT21 Cutting Shoes Utilize O-ring Seals

2. Thread the DT21 Cutting Shoe or DT21 Expendable Point Holder into the leading end of a 2.125-inch OD Probe Rod (AT2136, AT2139, or AT2148). Completely tighten the cutting shoe or cutting shoe holder using a machine vise and MC Combination Wrench (AT8590) as shown in Figure 4.19.

3. Attach a DT21 Liner Drive Head Assembly (DT4050) to a new liner as described in Section 4.4. A core catcher liner (DT4136, DT4139, or DT4148) is recommended for when the first soil core begins at ground surface as this configuration will provide maximum sample recovery.

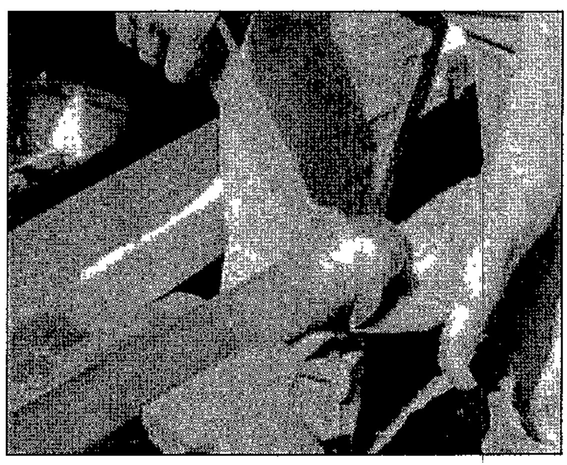


Figure 4.19. Place probe rod (outer casing) in vise and tighten cutting shoe with MC Combination Wrench.

4. Insert the liner and drive head into the 2.125-inch OD probe rod such that the core catcher contacts the cutting shoe as shown in Figure 4.20.

5. Place a DT21 Drive Bumper (DT4010K) on top of the liner drive head (Figure 4.20).

6. Thread a Drive Cap (AT2101) onto the 2.125-inch probe rod (outer casing) (Fig. 4.20).

NOTE: Current AT2101 Drive Caps are manufactured using a process that leaves an angled surface inside the cap (Fig. 4.21). Older AT2101 Drive Caps were manufactured using a process that leaves a flat surface inside the cap (Fig. 4.21). The older drive caps cannot be used with the DT21 Dual Tube System.

7. Place the assembled outer casing section under the direct push machine for driving. Position the casing directly under the hydraulic hammer with the cutting shoe centered between the toes of the probe foot.

8. Lower the hydraulic hammer onto the drive cap and advance the outer casing into the subsurface using continuous percussion.

9. Raise the hydraulic hammer and move the probe assembly back to provide access to the top of the tool string.

10. Remove the drive cap and drive bumper

11. Thread a 1.0-inch probe rod onto the liner drive head. Rotate the probe rod and liner assembly two or three revolutions to shear the soil core at the bottom of the liner. Lift the probe rod and filled liner from the outer casing to retrieve the first soil core.

12. Remove the filled liner from the liner drive head as described in Section 4.6. Prepare the soil core for subsampling or storage as specified by the project plan.

(Continue the procedure to collect the second soil core.)

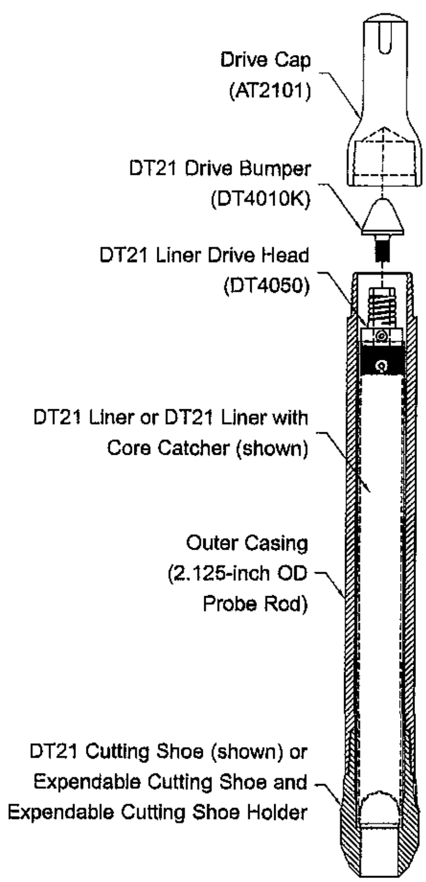


FIGURE 4.20
Outer Casing with DT21 Liner

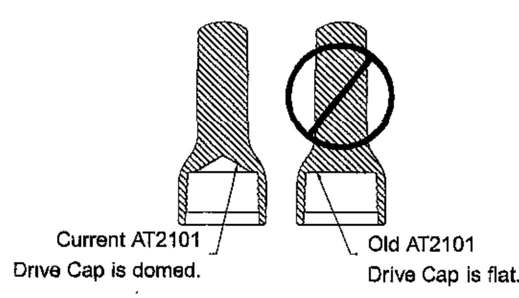


FIGURE 4.21
Comparison of AT2101 Drive Caps

13. Place an O-ring (AT2100R) in the groove just below the male threads on the top section of the outer casing (Fig. 4.22).

14. Thread a 1.0-inch probe rod onto an assembled DT21 Liner Drive Head (DT4050) and DT21 Liner (Fig. 4.23).

NOTE: A 1.0-inch x 24-inch Probe Rod (AT105B) is first threaded onto the DT21 Liner Drive Head Assembly (DT4050) if using a 24-inch DT21 Liner (DT4024K).

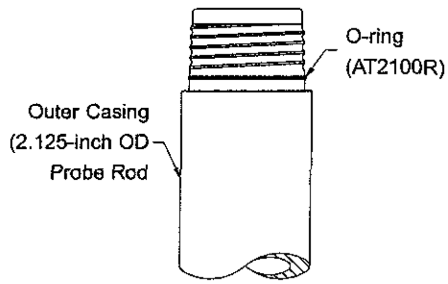


FIGURE 4.22
Outer Casing Joints are Sealed with O-Rings

Figure 4.23. Thread liner and liner drive head into 1.0-inch probe rod.

15. Insert the liner and probe rod into the outer casing (Fig. 4.24).

The inner rod will extend past the top of the outer casing if only one section of casing was previously driven into the ground. If the casing was driven to a greater depth, continue adding 1.0-inch probe rods until the last rod extends from the casing. Use the DT21 Rod Clamp Assembly to hold the inner tool string while adding rods if desired.

16. Place a 2.125-inch probe rod over the inner rods and thread it onto the outer casing (Fig. 4.25). Completely tighten the outer casing using a pipe wrench.

17. Place a DT21 Drive Bumper (DT4010K) on top of the inner rod as shown in Figure 4.26.

18. Thread a Drive Cap (AT2101) onto the 2.125-inch probe rod (Fig. 4.26). Completely tighten the drive cap with a pipe wrench. **(Refer to note in Step 6 regarding AT2101 Drive Caps.)**

19. Lower the hydraulic hammer onto the drive cap and advance the outer casing one liner length into the subsurface to collect the first soil core. Apply hammer percussion to the tool string as this helps move soil through the cutting shoe and into the liner for increased sample recovery.

20. Raise the hydraulic hammer and retract the probe derrick to provide access to the top of the tool string.

21. Unthread the drive cap and remove the drive bumper.

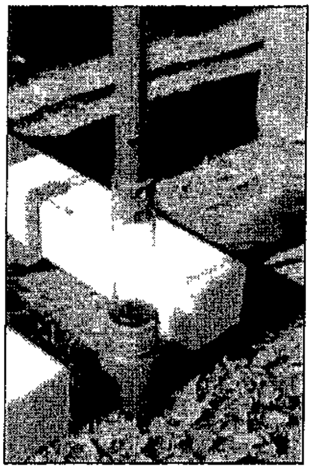


Figure 4.24. Lower liner to bottom of outer casing on leading end of inner rods.

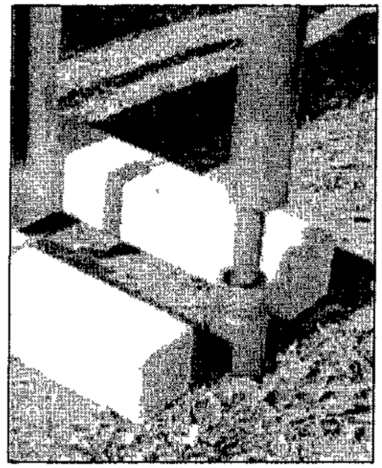


Figure 4.25. Place a 2.125-inch probe rod over the 1.0-inch probe rod and thread it onto the outer casing string.

Figure 4.26. Place a drive bumper on top of the inner rods and thread a drive cap onto the outer casing.

22. Thread a 1.0-inch probe rod onto the inner rod (Fig. 4.27). Rotate the inner rods two or three revolutions to shear the soil core at the bottom of the liner. Raise the inner rods to retrieve the filled liner.

NOTE: Hold the inner rod string with a DT21 Rod Clamp Assembly (DT 4060) while unthreading the retracted rods (Fig. 4.28). Use the probe hammer and Rod Grip Pull System (GH3000K) to pull the inner rods if they are too heavy to lift comfortably by hand (Fig. 4.29).

23. Remove the filled liner from the liner drive head as described in Section 4.6.

(Repeat Steps 13-23 to collect consecutive soil core samples.)

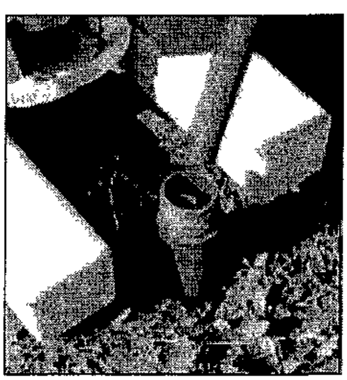


Figure 4.27. Thread a 1.0-inch probe rod onto inner rod string to retrieve filled liner.

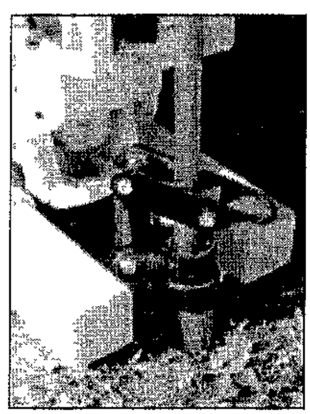


Figure 4.28. The DT21 Rod Clamp Assembly holds the inner rod string while adding or removing 1.0-inch rods.

Figure 4.29. Raise the inner rod string with the Rod Grip Pull System if rods are too heavy to lift by hand.

4.6 Removing the DT21 Liner Drive Head from a Filled DT21 Liner

The liner drive head assembly remains attached to the filled liner after retrieval from the outer casing (Fig. 4.30). In order to decontaminate the drive head for further sampling, it must first be removed from the filled liner. This process is easily accomplished using a machine vise and sharp utility knife.

Place the liner drive head in the machine vise such that the 3/8-inch cap screw threaded through the liner is positioned on top. Remove the cap screw with a 3/32-inch hex key.

Using a utility knife, score a line from the top of the liner to the bottom of the drive head (Fig. 4.31). Move the free end of the liner side-to-side until the top of the liner splits and releases from the drive head (Fig. 4.32). The soil core may now be prepared for storage or analysis according to project guidelines.

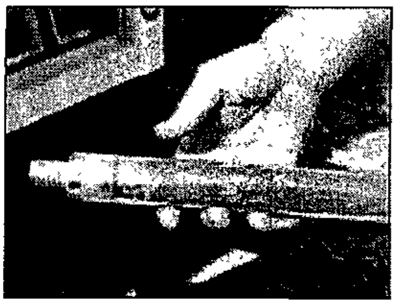


Figure 4.30. Liner drive head remains attached to filled liner after retrieval from outer casing.

Figure 4.31. Score a line from top of liner to base of liner drive head using a utility knife.

Figure 4.32. Move free end of liner back-and-forth to split liner and free it from the liner drive head.

4.7 Dual Tube Soil Sampling Tips

Saturated sands are the most difficult formations to sample with the DT21 system. Saturated conditions place positive pressure on the soil outside of the outer casing. When sampling in noncohesive formations (e.g. sands) below the water table, it may be necessary to add water to the outer casing to prevent formation heave. Adding water to the probe rods puts a positive head on the system and may keep formation material from flowing into the rods as the liner and soil sample are retracted. If a small amount of formation material is still drawn into the outer casing as the soil core is retrieved, the material may be displaced by slightly raising the outer casing while lowering the next new liner to depth. Water must be maintained within the outer casing during this process to overcome the hydraulic head imparted by the formation fluid.

DT21 core catcher liners will provide the best sample recovery in saturated noncohesive formations. Additionally, 24-inch open (no core catcher) liners may be used to collect samples under these conditions. The shorter sample interval may enhance sample recovery in sandy materials. Collecting a shorter sample will also minimize the vacuum created as the sample is retracted inside the rod bore. This may help minimize the heave of noncohesive materials into the rods.

DT21 core catcher liners will help considerably with sample recovery in non-cohesive soils and other materials that do not fill the liner diameter. Core catcher liners are not recommended for cohesive or expansive soils as the core catchers may actually inhibit soil movement into the liner.

Some clay materials will expand during sampling. Under these conditions, using a shorter sample interval (24-inch liners) may improve sample recovery by minimizing the wall friction as the material is sampled.

4.8 Outer Casing Retrieval

The outer casing of the DT21 Dual Tube System may be retrieved in one of three ways:

1. Casing pulled then probe hole sealed from ground surface with granular bentonite.

   The outer casing may be pulled from the ground with the probe machine and a Pull Cap (AT2104) or a Rod Grip Pull System (GH3000K) if the probe hole is to be sealed with granular bentonite from the ground surface (Fig. 4.33). This method is used for shallow probe holes in stable formations only. Such conditions allow the entire probe hole to be sealed with granular bentonite.

2. Casing pulled with probe hole sealed from bottom-up during retrieval.

   Bottom-up grouting should be performed during casing retrieval in unstable formations where side slough is probable. Such conditions create void spaces in the probe hole if granular bentonite is installed from the ground surface.

   A GS500 or GS1000 Grout Machine is used to deliver a sealing material (high-solids bentonite slurry or neat cement grout) to the bottom of the outer casing through flexible tubing. The grout mix is pumped through the tubing to seal the void remaining as the outer casing is retrieved (Fig. 4.34). This is an advantage of the DT21 Dual Tube System as other soil samplers require a second set of tools to deliver grout to the bottom of the probe hole. Contact Geoprobe Systems® for more information on bottom-up grouting with the GS500 and GS1000 Grout Machines.

3. Casing pulled with Geoprobe Prepacked Screen Well installed during retrieval.

   The final option is to install a 1.4-inch OD Geoprobe® Prepacked Screen Monitoring Well in the probe hole during retrieval of the outer casing. A DT21 Expendable Cutting Shoe Holder (DT4040) and a DT21 Expendable Cutting Shoe (DT4045) allow the operator to collect continuous soil cores as the outer casing is driven to depth. When sampling is complete, the outer rods are raised and the expendable cutting shoe is removed from the leading rod. This leaves an open casing through which a set of prepacked screens is lowered on the leading end of a PVC riser string (Fig. 4.35). The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

   Refer to *Geoprobe® 0.5-in. x 1.4-in. OD and 0.75-in. x 1.4-in. OD Prepacked Screen Monitoring Wells Standard Operating Procedure* (Geoprobe® Technical Bulletin No. 962000) for specific information on well installation.

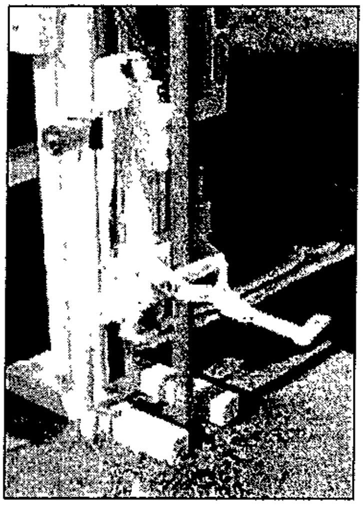


Figure 4.33 Outer casing may be retrieved with a pull cap or rod grip pull system if the probe hole is sealed with granular bentonite.

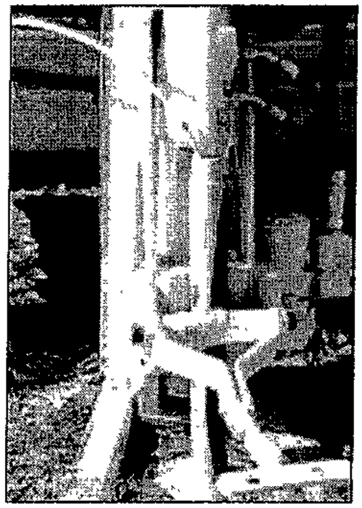


Figure 4.34. A grout machine and flexible tubing allow bottom-up grouting as the outer casing is retrieved.

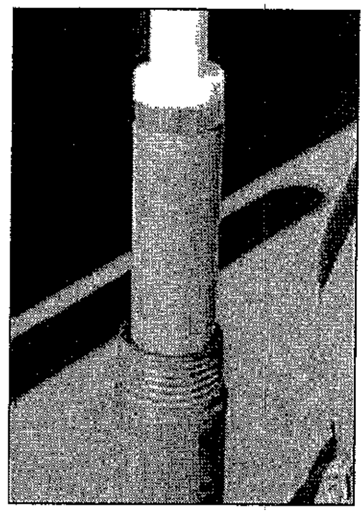


Figure 4.35. Geoprobe® prepacked screens may be installed through the outer casing when an expendable cutting shoe is used.

5.0 REFERENCES

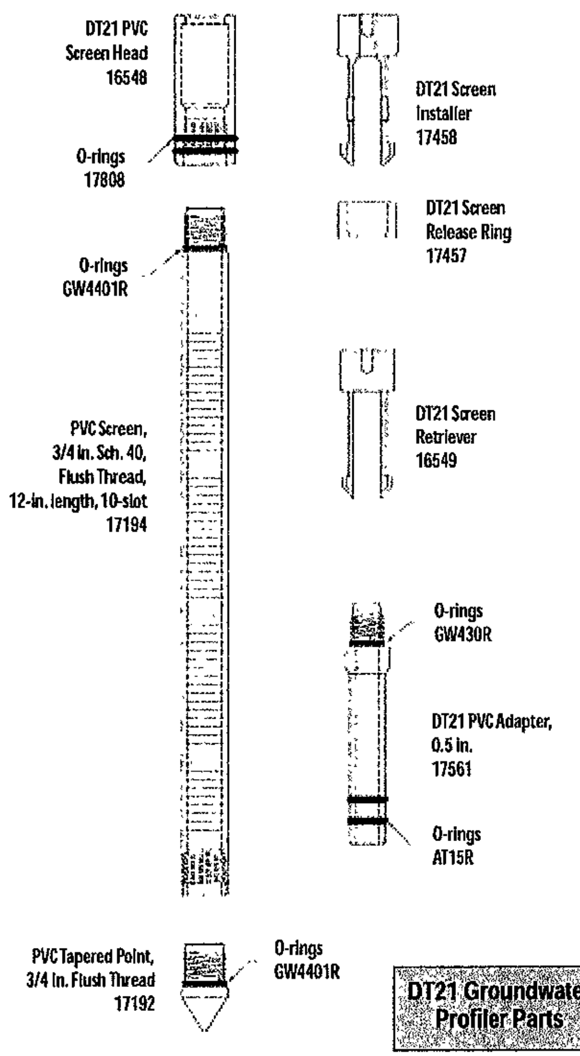
Geoprobe Systems®, *1998-99 Tools and Equipment Catalog*, 1997.

Geoprobe Systems®, *Geoprobe® 0.5-in. x 1.4-in. OD and 0.75-in. x 1.4-in. OD Prepacked Screen Monitoring Wells - Standard Operating Procedure.* Technical Bulletin No. 962000, 2002.

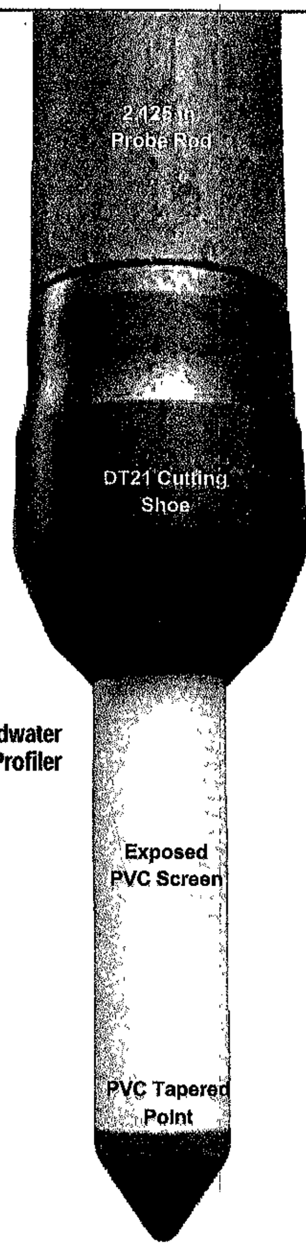
DT21 Groundwater Profiler

Geoprobe® Systems

Three tools in one! The Dual Tube 21 Groundwater Profiler allows you to retrieve soil samples, collect groundwater samples, and perform slug testing ... at multiple depth intervals ... in one probe push. This tool lets the field operator conduct detailed vertical profiles of groundwater contaminants with ease. You can also determine vertical and lateral variations in hydraulic conductivity to define preferential contaminant flow paths and optimize remedial system design. In one simple operation, drive dual tube rods to depth (either by soil sampling or with a solid drive point), then remove the inner rods so a 10-slot PVC screen (3/4 in. OD) can be inserted down the open outer casing. The screen head seats against the reduced ID of the cutting shoe, and O-rings provide a seal. The screen interval may be developed with the tubing check valve, and samples can be collected with the pneumatic bladder pump, if desired. This screen system is excellent for hydraulic conductivity (slug) testing. The DT Profiler is great for sampling at multiple depths and at deeper depths.



DT21 Groundwater Profiler Parts



DT21 Groundwater Profiler

Geoprobe® Systems

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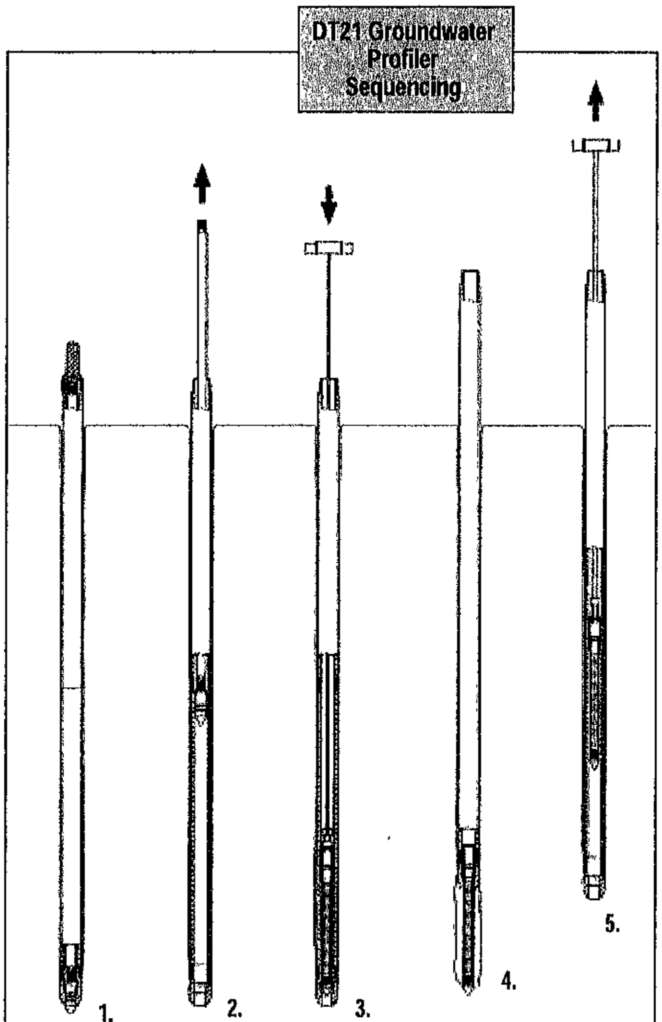
DT21 Groundwater Profiler

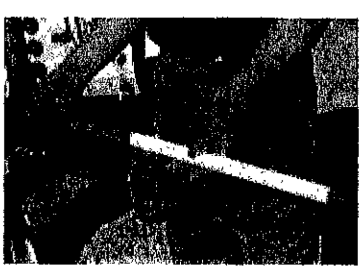
Collect groundwater samples and conduct slug tests at multiple depths.

- Conduct detailed vertical profiles of groundwater contaminants with ease.
- Determine vertical and lateral variations in hydraulic conductivity to define preferential contaminant flow paths and optimize remedial system design.
- Specially designed install and retrieve tools make for quick and easy installation and removal of PVC screen.
- Allows for groundwater sampling between collection of soil samples in amenable conditions (control of flowing sands is necessary in saturated non-cohesive formations).
- Adapter allows for connection of 0.5 in. PVC riser directly to the screen to isolate sampling from large rod diameter: minimizes purge volume.
- Use of 0.5 in. PVC riser allows for sample collection without contact with steel rods.
- Slug tests may be conducted through larger ID of the 2.125 in. rods for fast formations, or through the 0.5 in. PVC for slow formations.
- Slug tests easily conducted with Pneumatic Slug Test Kit from Geoprobe® Systems.
- Low cost PVC parts minimize expense of groundwater sampling.
- Operates with the same tools you use every day for DT21 Dual Tube soil sampling.



1. Advance outer casing to bottom of screen interval.
2. Remove inner rod string leaving the outer casing open.
3. Lower screen to bottom of casing and hold in place with extension rods.
4. Retract casing to expose screen to formation; remove extension rods.
5. Retrieve screen after development, sampling, and slug testing.

Repeat this sequence for the entire length of the probe push.

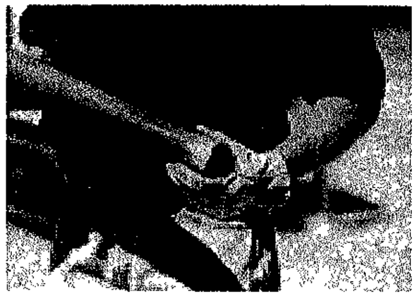


Geoprobe® engineers designed a simple system to install and retrieve the screen after sampling and testing is completed. The screen head has an internal groove. The bladed installation and retrieval tools latch into this groove to facilitate installing and recovering the screen repeatedly.

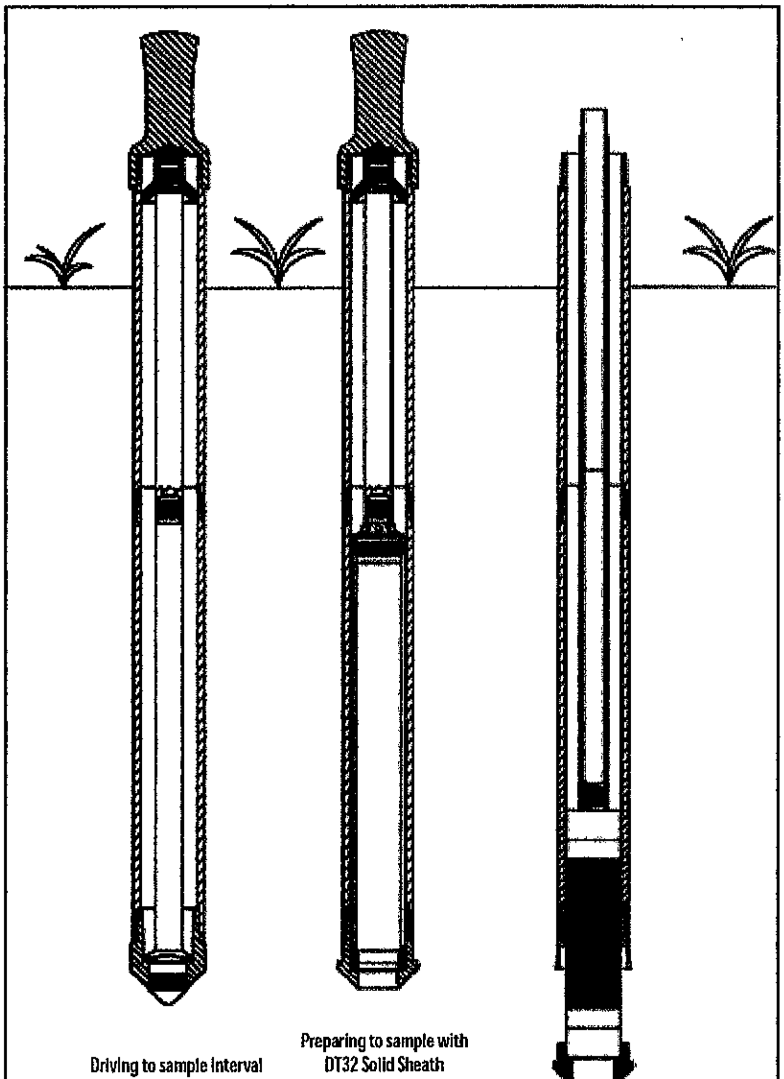
Geoprobe Systems

DT32 Soil Sampler

Designed specifically for use with the Geoprobe® GH60 Hammer



- Collects 1.85-inch diameter soil core
- Optional window sheath for use in swelling soils
- Optional expendable cutting shoe for prepack monitoring wells
- Uses 3.25 inch Probe Rods
- Core catcher for sampling loose soils
- Solid drive point for driving to discrete depths before sampling
- 4-foot and 5-foot sampling capacity

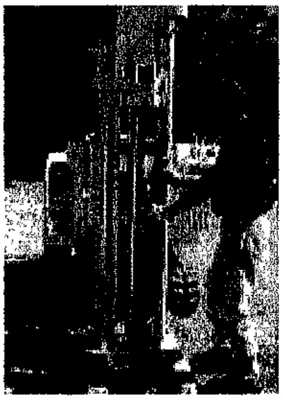


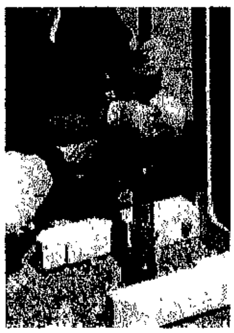
Driving to sample interval with DT32 Solid Drive Point

Preparing to sample with DT32 Solid Sheath

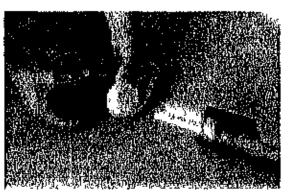
Setting a Prepack Well with DT32 Expendable Cutting Shoe

DT32 Soil Sampler

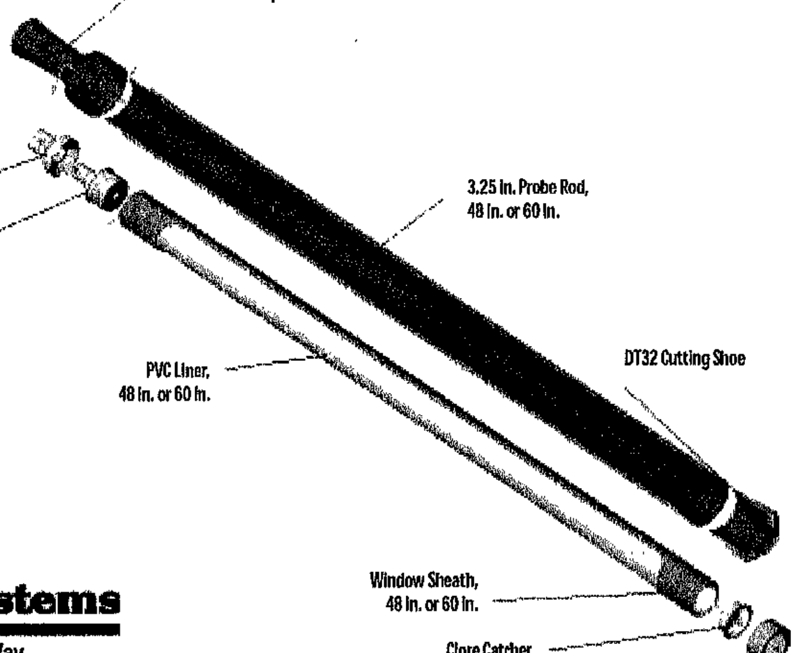




(Above) Sampling with the DT32 system. (Right) Filled DT32 liner visible through window sheath. (Below) DT32 Core Catchers help contain loose soils in liner.



DUAL TUBE 32 SAMPLER	PART NO.
Cutting Shoe, 3.75 in. OD	13338
Cutting Shoe, expendable, 3.75 in. OD	10305
Cutting Shoe, 3.5 in. OD	10299
Cutting Shoe Assembly, Expendable, 1.85 in. ID	13567
Cutting Shoe, (undersized) 1.7 in. ID	16437
Cutting Shoe Assembly, Expendable, (undersized) 1.7 in. ID	16671
Expendable Cutting Shoe Holder	10308
Solid Sheath, 60 in. (1525 mm) length	15142
Solid Sheath, 48 in. (1219 mm) length	15144
Window Sheath, 60 in. (1525 mm) length	12906
Window Sheath, 48 in. (1219 mm) length	12156
Window Sheath, 1 m. length	14023
Drive Head for Window Sheath	10212
Drive Cap, Centering	12943
Solid Drive Tip Assembly	13566
O-rings for Solid Drive Tip, Pkg. of 25	13942
Core Catcher Retainer	12182
Core Catcher Retainer Wrench	18277
PVC Liner, 60 in. (1525 mm) length, Box of 43	DT3260K
PVC Liner, 48 in.(1219 mm) length, Box of 43	DT3248K
PVC Liner, 1 m. length, Box of 43	DT3239K
Core Catcher, Pkg. of 25	13945



Monitoring Well and Piezometer Installation

1.0 PURPOSE AND SCOPE

1.1 This Standard Operating Procedure (SOP) describes the procedures to be used for installing monitoring wells and piezometers. Ground-water wells and piezometers will be installed to assess ground-water quality, potentiometric measurements and/or hydrogeologic characterization of the water table hydrostratigraphic units at the site.

2.0 RESPONSIBILITY

2.1 The Principal Investigator is responsible for ensuring that all project personnel are aware of this SOP. The project hydrogeologist and/or his/her designee will be responsible for ensuring that all monitoring well and piezometer installation will be performed in accordance with this SOP and the study protocol. The project hydrogeologist will review the proposed well designs, specifications, and installation procedures prior to well installation.

Well design, construction techniques, and construction materials will conform to state water well standards. In addition, all necessary permits and access agreements will be obtained prior to well installation form agencies having jurisdiction. A staff geologist will monitor well installation, observe the drilling activities, and prepare lithologic logs under the supervision of the project hydrogeologist.

3.0 EQUIPMENT

3.1 Field personnel will inspect equipment and materials as to their condition and suitability for the intended work. The equipment and materials used to construct monitoring wells and piezometers may be specified in the study protocol and generally includes the following:

- Threaded joint, two (2) inch diameter, Type 304L stainless steel casing with wire wrapped well screens (for wells)
- Threaded joint, two (2) inch diameter, Schedule 40 PVC casing with factory slotted well screen (for wells and piezometers)
- sand pack (*e.g.*, Monterey No. 3),bentonite, cement
- locking well box

4.0 PROCEDURE

4.1 It is anticipated that all monitoring wells proposed herein will constructed as single-cased wells. A geologist will supervise drilling and well installation and prepare a lithologic log of the sediments using the Unified Soil Classification System designations. The wells and piezometers at the site will be installed using a hollow-stem auger or other appropriate drilling method.

4.2 Selection of the sand pack and corresponding well-screen perforation size will be based on the particle size and distribution of sediments observed in lithologic samples collected within the screened interval.

4.3 The actual length of the perforated interval of the well casing to be installed will be determined in the field, based upon the depth and thickness of permeable sand and gravel deposits encountered, and intended future use of the well.

4.4 After the well casing has been placed in the completed borehole, the well annulus opposite the perforated casing interval will be backfilled with clean sand using a tremie pipe or other appropriate method, to a height of about two (2) feet above the well screen to increase the ground-water capture zone and isolate the perforated interval. A weighted sounding device will be used to check the depths and tops of each annular fill material. A four (4) foot bentonite seal will then be placed above the sandpack and charged with potable water. The remainder of the annulus will be filled to land surface with a cement/bentonite grout.

4.5 In shallow well installations, the bentonite seal may be reduced to allow finishing the annulus with cement grout. To protect the integrity of the monitoring wells, each well will be completed above grade encased in a monument well box with locking provisions mounted in a cement pad. Following completion of the well installation, each monitoring well will be surveyed for vertical control to the nearest hundredth (0.01) of a foot and for horizontal control to the nearest (1.0) foot by a state licensed surveyor.

4.6 All equipment inserted into the borehole (*e.g.*, auger, tools, and casing) will be steam cleaned prior to use. Potable water may be used to assist the drilling, but no lubricants or additives will be applied to the equipment.

5.0 LITHOLOGY

5.1 Each well boring will be drilled to an appropriate depth below ground surface using the hollow-stem auger, mud-rotary, air casing hammer or casing-driven method. Samples for lithologic description (and chemical and/or physical analysis, if needed) will be collected using the methodologies described in the appropriate SOPs. Lithologic logging of the borings will be conducted by a qualified soil scientist, geologist or engineer. A state-licensed subcontractor will be retained to perform drilling services.

5.2 Sediments (soils included) encountered during drilling will be examined and described by the site geologist, engineer, or field technician, who will maintain a complete record of the descriptions. Sediment descriptions will be in accordance with the Unified Soil Classification System. Sediments will be sampled for lithologic description at recommended minimum intervals of approximately two (2) feet. The boring log will contain the following information:

- borehole number and location
- sample depth
- sediment color
- sediment grain size
- relative percentage of grain sizes
- descriptive comments
- estimated moisture content
- depth where ground water was encountered during drilling
- observer's signature and date of activity

5.3 The project hydrogeologist will review the lithologic logs.

Well/Piezometer Development Procedures

1.0 PURPOSE AND SCOPE

1.1 This Standard Operating Procedure (SOP) describes well development procedures to be followed by field personnel.

2.0 INTRODUCTION

2.1 All monitoring wells will be developed (*e.g.*, cleared of fine-grained materials and sediments that have settled in or around the well during installation) to ensure the screen is transmitting ground water representative of the surrounding formation waters. Development will be accomplished by surging and evacuating well water by pumping or bailing. The well will be developed until it yields relatively sediment-free water. Development water will be handled according to the study protocol. All pump tubing and bailers used in the well for development will be constructed of non-reactive materials such as stainless steel, polypropylene, Teflon or rigid wall PVC.

3.0 PUMPING METHOD

3.1 When developing a well using the pumping method, new or clean decontaminated polypropylene tubing from the pump is extended to the screened portion of the well and will be moved up and down the screened interval until the well yields clear water. A procedure that may be used for well development entails surging and pumping ground water through the well screen using a centrifugal pump and/or a submersible pump. The centrifugal pump uses atmospheric pressure to lift water from the well and therefore can only be used where the depth to water is less than twenty feet. The submersible pump is attached to the end of the tubing that goes into the well, pushing the water to the surface, and is effective for all wells particularly where ground water is greater than twenty feet below land surface. The tubing or pump will be manually lifted and lowered within the screened interval to pull in fine sand and silt. To lift ground water from the well, the pump will be turned on forcing silty ground water up through the tubing. This surging and pumping routine will be repeated as many times as necessary within the well screen interval until the ground water is relatively clear.

3.2 Materials for monitoring well development using a pump include:

disposable gloves	field book
safety glasses	graduated pails
polypropylene tubing	pump (centrifugal, submersible, *etc.*)
power source (generator)	

3.3 A detailed procedure for ground-water well development with pumps will be as follows:

a. Don appropriate safety equipment.

b. All equipment entering each well will be decontaminated as specified in the decon-SOP.

c. Attach appropriate pump and lower tubing into well.

d. Start at bottom of well and surge well by raising and lowering the tubing at two-foot intervals in the screened interval of the well.

e. Turn on pump and observe fines being removed. If well runs dry then shut off pump and allow to recover.

f. Steps (d) and (e) will be repeated until the entire screen has been surged and ground water is relatively silt free.

g. Step (f) will be repeated until entire well screen has been developed.

4.0 BAILER-SURGE BLOCK METHOD

4.1 Materials for monitoring well development using a bailer or surge block include:

disposable gloves	polypropylene rope
safety glasses	graduated pails
bottom loading bailer	field book
surge block	

4.2 The procedure for developing a well using the bailer or surge block method is outlined below:

a. Bailers or surge blocks and new rope will be decontaminated as specified, if required.

b. Don appropriate safety equipment; place plastic sheeting around well.

c. Determine depth of well through examination of drilling log data and measure the rope at least ten (10) feet greater than the total depth of the well.

d. Secure one end of the rope to the well casing then secure the other end of the rope to the bailer or surge block. Test the knots and make sure the rope will not loosen. Check bailers/surge blocks to be sure all parts are intact and will not be lost in the well.

e. Lower bailer into well until bailer or surge block reaches total depth of the well.

f. Surge by raising and lowering the bailer or surge block at two-foot intervals, at least ten (10) times, then bail water until water begins to clear.

g. Lower the bailer or surge block back into well and repeat raising and lowering at an interval two (2) feet above the previously surged interval.

h. Repeat (f) through (h) until entire screen has been surged.

I. If silt is still in purge water after surging entire screen repeat (e) through (I).

j. Upon completion of surging of the well, remove the bailer or surge block and remove the rope from the well.

k. Secure lid and lock back on well.

l. Dispose of plastic sheeting and polypropylene rope in plastic garbage bags.

Monitoring Well or Piezometer Sampling

1.0 PURPOSE AND SCOPE

1.1 This Standard Operating Procedure (SOP) describes the procedures to be used for sampling monitoring wells.

2.0 RESPONSIBILITY

2.1 The principal investigator is responsible for ensuring that all project personnel are aware of this SOP. The principal investigator and/or his her designee will be responsible for ensuring that all ground-water sampling will be performed in accordance with this SOP and the study protocol.

3.0 EQUIPMENT

3.1 Equipment used for sampling monitor wells may include, but is not limited to:

- Field notes
- Either a bladder pump, whaler pump, peristaltic pump, centrifugal pump
- Either disposable Teflon, or high density polyethylene bailers, or reusable stainless steel bailer
- Disposable nylon cord / string / rope
- Plastic sheeting or plywood sheeting for covering well head
- Appropriate sample containers (voa vials, amber bottles, poly bottles)
- Latex (or equivalent) disposable gloves
- Two, five or ten gallon graduated buckets
- One, Gel-pack, 12-volt deep cycle marine battery
- Two, five gallon carboys of tap or spring water
- Two, five gallon carboys of distilled water
- Two squirt bottles, one with distilled water, one with tap water and soap.
- Liqui-nox biodegradable soap
- Socket set with wrench
- Water level indicator(s)
- Water Quality Meter(s) and associated calibration equipment, measure device
- Towels / rags
- plastic zip-loc bags (1-quart, 1-gallon and 2-gallon bags)
- Cooler with blue ice
- Plastic garbage bags
- 200 gallon poly drums or 55 gallon drums for purge water disposal
- Whisk broom
- Extra rubber gaskets for well vault
- Extra locking well caps

The type of sampling equipment will vary depending on use.

3.2 Fuel powered equipment, if required, will be placed downwind and away from the well to prevent any potential cross contamination.

4.0 PROCEDURE

4.1 Monitoring Well Purging and Water Quality Monitoring:

A) Record all site information: Project name and job number; sampling date; sample number; sample location; samplers name; recorders name; purge and sampling equipment to be used; analysis requested; well number; well diameter; laboratory used to analyze samples and; how samples are to be transported to laboratory.

B) Using a 9/16-inch or appropriate size socket wrench, loosen and remove the christy box manhole cover and determine/record the following observations:

Is water in the christy box?
If no, proceed to next step.
If yes, is the locking well cap secure?
If no, one can assume water migrated down well.
If yes, is water at the height of Top Of Casing (TOC)?
If yes, one can assume water migrated down well.
If no, one can assume there was either; 1)never enough water to fill up the christy box so that water could migrate down well or, there was enough water to fill up the christy box, and some of it migrated down well.

C) Using a water level indicator, measure depth to groundwater to hundredth of a foot (0.01) and well depth, if unknown (well completion depth information should be provided). Each measurement should be referenced to a fixed point marked permanently on the TOC - generally the north side of the TOC.

Decontaminate the water level indicator according to section 5.0 below.

NOTE: In wells with dedicated bladder pumps, use an access hole or lift up the well head assembly to allow access for water level indicator for obtaining measurement. If water level is below top of bladder pump and cannot be measured due to obstruction, record this observation in the field notes.

D) Calibrate Water Quality Meter using self-calibrating solution. Refer to owners manual of Water Quality Meter for calibrating instrument.

E) Calculate the height of water column using the formula:
well depth - depth to water.

F) Calculate volume of water in the well casing using the formula:
Volume: $V = (v= \pi r^2 L)$ x Height of Water Column;
where; V = volume of water in well in gallons,
v = casing volume, $\pi = 3.14$ (unitless), r = radius, and L = 1-foot.

G) Calculate gallons of groundwater to purge from well using the formula:
Volume of water in well (x) 3 (unitless).

NOTE: The rule is to purge at least 3 casing volumes or until water quality parameters stabilize, which ever come first.

H) Install the appropriate pump to the bottom of the well. Raise and lower the pump several times inside the well to surge the water column in the well.

I) Commence purging the monitoring well of groundwater while recording water quality parameters and total volume purged on the Groundwater Monitoring Well Sampling Information field sheet (attached). Field parameter measurements will be taken at appropriate intervals (every 0.5 to 1 gallon - depending on volume to purge) starting at time of purging.

NOTE: When using a dedicated bladder pump, follow guidelines in the appropriate SOP for this pumps operation.

J) To obtain water quality parameters, pour a small portion of the purge water into a appropriate cup that water quality parameter meter can be inserted into. Record the appropriate parameters: pH, Temperature, Conductivity, Dissolved Oxygen (D.O.), Oxygen Reduction Potential (ORP), and Turbidity. Refill the cup as necessary to continue monitoring water quality parameters.

K) Continue to monitor water quality parameters until the values from three (3) consecutive samples are within 15% of each other. Once water quality parameters are within 15% of each other, purging can stop. Remove pump, ensuring that no groundwater from the pump re-enters the well while removing the pump. A check valve is generally installed atop the pump. If no check valve is installed, make sure the pump remains on until it is completely pulled from the well and is decontaminated.

L) The groundwater in the well must recover to with 80% of its original static groundwater level prior to obtaining sample.

M) Calculate depth to groundwater for 80% well volume recovery by using the following formula:

Depth to GW for 80% well volume recovery = H_{wc} (x) 0.8 = ______ - (MW_{cd})
Where; H_{wc} = Original height of water column
Mw_{cd} = Monitoring well Completion Depth.

N) In cases where a well goes dry, the well will be allowed to recover to 80% after purging dry before sampling. Under certain conditions (*e.g.*, district requirements) more than one (1) dry purge may be necessary.

O) Collect samples in the order prescribed by study protocol, if specified.

NOTE: If using a dedicated bladder pump to collect samples, adjust the flow rate (if necessary) by decreasing the output pressure on the regulator to produce a steady stream without excessive splash or turbulence.

4.2 Collecting Samples

A) Volatile Organic Compound (VOC) and Semi-Volatile Organic Compound (SVOC) Samling: For VOC and SVOC sampling, use a bailer to obtain groundwater from the well which has recovered to within 80% of original static water level. DO NOT let the bailer free-fall to the groundwater table, rather, lower the bailer slowly and allow to fill. Once filled, remove the bailer and fill appropriate 40 ml VOA vials. If the groundwater sample is very turbid, decante groundwater into 1 liter amber bottle, let sample settle, and then pour into appropriate 40 ml VOA vials. Sample bottles for VOC's and SVOC's will contain pre-measured, concentrated hydrochloric acid, do not rinse bottle. Pour water into container *very* slowly to ensure that acid remains in bottle.

Water samples to be analyzed for volatile compounds will not be mixed or composited.

It is *critical* that no air space be left in the VOA's bottle, thus, sample water should be poured in the upright bottle until a meniscus forms at the bottle opening. The water should be poured gently down the edge of the sample vial to reduce turbulence, which could lead to volatilization. The vial cap should be screwed on squarely, with the Teflon septum contacting the sample to force excess water out of the bottle. The bottle should then be inverted and tapped gently to ensure that no bubbles have been trapped. If bubbles are present, additional sample will be added and the cap replaced. If after three (3) attempts bubbles still remain in the vial, the sample, vial, and septum will be discarded and the sample recollected into a fresh vial.

After obtaining sample(s), label bottle, and store sample bottle(s) on ice.

Record samples obtained on Chain Of Custody (COC) sheet.

Proceed to sample next constituent of concern or, if completed, dispose of bailer, and string/cord, replace well locking cap, secure well vault and mobilize to next monitoring well sampling location.

Pack, handle, and ship/transport samples carefully to laboratory, with chain of custody documentation.

B) Total Extractable Petroleum Hydrocarbon (TEPH): For TEPH sampling, use a bailer to obtain groundwater from the well which has recovered to within 80% of original static water level. DO NOT let the bailer free-fall to the groundwater table, rather, lower the bailer slowly and allow to fill. Once filled, remove the bailer and fill appropriate 1 litter amber bottles. If the groundwater sample is very turbid, decante groundwater into 1 liter amber bottle, let sample settle, and then pour into appropriate bottles. Sample bottles for TEPH will not contain pre-measured acid. Simply pour groundwater into appropriate container ensuring that enough sample has been obtained (generally two, 1-liter ambers).

Water samples to be analyzed for TEPH will not be mixed or composited.

After obtaining sample(s), label bottle, and store sample bottle(s) on ice.

Record samples obtained on Chain Of Custody (COC) sheet.

Proceed to sample next constituent of concern or, if completed, dispose of bailer, and string/cord, replace well locking cap, secure well vault and mobilize to next monitoring well sampling location.

Pack, handle, and ship/transport samples carefully to laboratory, with chain of custody documentation.

C) Metals Sampling: For metals sampling, use a bailer to obtain groundwater from the well which has recovered to within 80% of original static water level. DO NOT let the bailer free-fall to the groundwater table, rather, lower the bailer slowly and allow to fill. Once filled, remove the bailer and use a 0.45 micron filter (other pore size filter may be specified) to filter groundwater prior to placing groundwater sample in appropriate sample bottle. Filtering will effectively remove the fine particles which can affect the concentration of the parameter of interest. If no filter is available in the field, obtain sample and have sample filtered and acidified at laboratory. Sample bottles for metals will contain pre-measured, concentrated nitric acid, do not rinse bottle. Pour water into container *very* slowly to ensure that acid remains in bottle (if filter is conducted in field).

Generally, unfiltered samples are collected in conjunction with filtered samples.Water samples to be analyzed for metals will not be mixed or composited.

Confirm pH is less than two (2), then label, record in notebook, and store sample.

If pH is greater than two (2), add one (1) ml of additional acid to sample, shake, remove an aliquot, and measure. Continue to add acid until pH is less than two (2). Add an equal amount of acid to the equipment blank, if collected. Record amount of additional acid that was needed, label bottle, wrap bottles with paper towel, put in sealable plastic bag and place on ice.

Record samples obtained on Chain Of Custody (COC) sheet.

Proceed to sample next constituent of concern or if completed, dispose of bailer, and string/cord, replace well locking cap, secure well vault and mobilize to next monitoring well sampling location.

Pack, handle, and ship/transport samples carefully to laboratory, with chain of custody documentation.

5.0 DECONTAMINATION

5.2 Decontamination of Water level Indicator:

A) Prior to removing water level indicator from well, saturate a ra/shop towel with soapy water. Holding the water level indicator reel with one hand and the cage of the reel on your knee, commence rolling up the water level indicator while using the soapy rag in the other hand to gently clean the water level indicator line.

B) Once the water level indicator is completely rolled up, spray instrument with distilled water and capture all decontaminated water into bucket.

C) If necessary, place water level indicator instrument into a clean bucket and pour distilled water over instrument for final cleaning.

D) Remove water level indicator from bucket, let air dry. Instrument is ready for measuring of next monitoring well.

5.2 Decontamination of Monitoring Well Pump and Pump Column:

A) Place pump into a five or ten gallon bucket with five gallons of tap or spring water mixed with liqui-nox biodegradable soap. Using a rag, sponge, or wire brush, clean outside of pump, pump column and any other pump parts.

A) Turn pump on and off for approximately five minutes to circulate soapy water through pump.

B) After cleaning pump, remove pump and pump column and place in second five or ten gallon bucket with five gallons of distilled water. Using a rag, sponge, or wire brush, clean outside of pump, pump column and any other pump parts.

C) Turn pump on and off for approximately five minutes to circulate soapy water through pump back into soapy bucket so only clean distilled water comes out of pump. Once clean water is coming out of pump, replace nozzle so clean distilled water is pouring over pump into bucket. Let pump run for two minutes circulating clean distilled water.

D) Remove pump from bucket, let air dry, ready for purging of next monitoring well.

5.3 Decontamination of Water Quality Meter:

A) Once finished for the day, pour fresh distilled water into a bucket and stir probe in water. Let stand for several minutes. When completed remove probe and pour distilled water over probe and capture decontaminated water.

B) Let probe air dry, and pack away.