FIELD PROCEDURE FP 3-3

DECONTAMINATION OF HAND TOOLS AND DRILLING EQUIPMENT

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Subject	Procedure No.	Rev.	
DECONTAMINATION OF HAND TOOLS AND DRILLING EQUIPMENT	FP 3-3	1	
	Issue Date	Effective Date	
	10/04/93	10/04/93	
	Supersedes Procedure Number	Rev.	Date
	630 FP 20	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide reference information on the proper decontamination of drilling equipment and hand tools used in conducting field investigations.

2.0 SCOPE

This procedure addresses decontamination of drilling equipment and hand tools only. Personal decontamination guidelines are present in the project-specific work plan. Decontamination of sampling equipment is described in Field Procedure FP 3-1 and decontamination of monitoring well construction materials is described in FP 3-2.

3.0 REQUIREMENTS

To ensure that chemical analysis results are reflective of the actual concentrations present at sampling locations, various drilling equipment and hand tools used in sampling activities must be properly cleaned and decontaminated. This will minimize the potential for cross-contamination between sampling locations, and the transfer of contamination off-site.

4.0 REFERENCES

4.1 HAZWRAP, July 1990. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1.

4.2 United States Environmental Protection Agency, December 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

4.3 USAEC, May 1993. *U.S. Army Environmental Center Guidelines for Implementation of ER 1110-1-263 for USAEC Projects.*

4.4 USATHAMA, January 1990. *U.S. Army Toxic and Hazardous Materials Agency Quality Assurance Program*, USATHAMA PAM 11-41.

4.5 United States Environmental Protection Agency, November 1986. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA SW-846, Third Edition.

4.4 United States Environmental Protect Agency, September 1986. *Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1.

5.0 DEFINITIONS

Negative Contamination - Occurs when the measured concentration of the analyte is artificially reduced as a result of volatilization, adsorption and related losses.

Positive Contamination - Occurs when the measure concentration of the analyte is artificially high due to leaching or the introduction of foreign matter into the sample.

Cross Contamination - Type of positive contamination caused by the introduction of part of one sample with a second sample during sampling or storage.

Detergent - Standard brand of non-phosphate laboratory-grade detergent such as Alconox or Liquinox.

Acid Solution - Made from reagent-grade acid and deionized water.

Solvent - Pesticide grade solvent.

Tap or Potable Water - Water from an approved municipal water treatment system.

Deionized Analyte-free Water - Ion free-organic water produced on-site from a Deionization Chamber equipped with a carbon filter.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for ensuring that decontamination procedures for all chemical sampling and field analytical equipment are established prior to the actual field effort and that personnel required to accomplish the task have been briefed and trained to execute the task.

6.2 Field Operations Leader

The Field Operations Leader is responsible for ensuring that project-specific plans and the implementation of field investigations are in compliance with this procedure.

7.0 EQUIPMENT

1. Portable High-Pressure Steam or Hot Water Generator
2. Insulated Gloves
3. Laboratory-Grade Non-Phosphate Detergent
4. Tap Water
5. Deionized Analyte-Free Water
6. Sheet Plastic
7. Pesticide-Grade Methanol
8. Scrub Brushes
9. Five- to 10-gallon Bucket.

8.0 PROCEDURE

All drilling equipment involved in field sampling activities will be decontaminated prior to drilling, excavation and sampling activities. Such equipment includes drilling rings, backhoes, down-hole tools, augers, and hand tools.

8.1 Steam Cleaning

Prior to drilling or leaving the site, equipment not directly utilized for sampling, will be decontaminated at a designated area. This includes drilling rigs, augers, backhoes, hand tools and down-hole tools. The decontamination area will be designed to contain decontamination wastes and waste waters, and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided that is connected to a holding tank. A shallow, above-surface tank may be used or a pumping system with discharge to a waste tank may be installed.

The location of the decontamination area will be identified in the project-specific work plan. Transport vehicles used on-site for personnel and/or equipment will be cleaned prior to leaving the site. Decontamination wastes will be collected and contained for eventual treatment on-site and/or disposal at an approved facility in accordance with the project-specific work plan.

8.2 Equipment Decontamination

Equipment that does not come into direct contact with the sample medium shall be decontaminated using a high-pressure steam or hot water cleaner. The drill rig, drill pipe, and all down-hole equipment will be steam cleaned prior to entering the site and will be decontaminated in accordance with this procedure before work is begun. The drill rig will be decontaminated prior to use on each site. All down-hole equipment will be decontaminated between each borehole. The following method may be utilized only with AEC approval.

- Wash with detergent (can be through steam cleaner).
- Steam clean using approved water source.
- Allow to air dry.
- Store tools, augers, etc. on plastic sheeting.

9.0 ATTACHMENTS

None.

FIELD PROCEDURE FP 5-1

MONITORING OF HOLLOW STEM AUGER DRILLING ACTIVITIES

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Subject	Procedure No.	Rev.	
	FP 5-1	1	Page 1 of 5
MONITORING OF HOLLOW STEM AUGER DRILLING ACTIVITIES	Issue Date	Effective Date	
	10/04/93	10/04/93	
	Supersedes Procedure Number	Rev.	Date
	630 FP 23	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to describe the methods and sequence of operations for recording field observations pertinent to the documentation of drilling activities.

2.0 SCOPE

This procedure applies to hollow stem auger drilling activities used to install monitoring wells, determine the type, thickness, and certain physical and chemical properties of the soil, water, and rock strata which underlie the site.

3.0 REQUIREMENTS

Complete documentation must be kept to ensure proper installation of monitoring wells, knowledge of geologic data, and contract compliance by the drilling subcontractor.

4.0 REFERENCES

4.1 HAZWRAP, July 1990. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1.

4.2 USAEC, May 1993. *U.S. Army Environmental Center Guidelines for Implementation of ER 1110-1-263 for USAEC Projects.*

4.3 USATHAMA, January 1990. *U.S. Army Toxic and Hazardous Materials Agency Quality Assurance Program*, USATHAMA PAM 11-41.

4.4 United States Environmental Protection Agency. *Manual of Water Well Construction Practices*, Office of Water Supply, USEPA, Washington, DC.

4.5 United States Environmental Protection Agency, September 1986. *Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1.

5.0 DEFINITIONS

Hollow stem auger drilling - consists of screwing augers with an open center into the ground. Cuttings are brought to the surface by the rotating action of the auger. Samples can be taken using split-spoon or thin wall tube samplers inserted through the hollow stem and driven into the substrata in advance of the auger.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader is responsible for ensuring that field personnel have been trained in the use of this procedure, and for verifying that auger drilling activities are being performed in compliance with the project-specific work plan. The Field Operations Leader should also determine the disposal methods for products generated by drilling, such as drill cuttings and well development water, as well as any specialized supplies or logistical support required for the drilling operations. These activities should be documented in the Site Logbook.

6.2 Field Geologist

The Field Geologist is responsible for monitoring drilling activities and documenting observations made during drilling in a bound Field Logbook. The Field Operations Leader will summarize these activities on the Daily Drilling Report (Attachment 9.1). The Field Geologist will also generate a detailed boring log for each test hole. This log shall include a description of materials, samples, method of sampling, blow counts, and other pertinent drilling and testing information that may be obtained during drilling in accordance with Field Procedure FP 7-3, Borehole Logging.

7.0 EQUIPMENT

1. Field Logbook
2. Drilling Subcontract
3. Daily Drilling Report (Attachment 9.1).

8.0 PROCEDURE

8.1 Prior to Arrival

Prior to arriving at the site, the Field Geologist will confer with the Field Operations Leader regarding the pertinent aspects of the drilling contract related to daily drilling activities.

8.2 Field Logbook

A Field Logbook will be kept by each Field Geologist and will be used to record at least the following information:

- Date
- Location
- Weather
- Drilling company
- Drill crew names and telephones numbers
- Descriptions of the material being drilled.

The Field Geologist will record, at a minimum, the following observations:

- Start and stop time of all drilling activities, including:
  - mobilization
  - drilling/reaming/augering
  - sampling
  - drill rig decontamination
  - cementing
  - geophysical well logging
  - any other relevant events.
- Footage for the above activities
- Type and quantity of drilling equipment (especially auger flights and drill stems)
- Conditions of drilling equipment; ensure that it has been cleaned and there are no equipment malfunctions or leaks that would impact the boring or well
- Problems causing delays during drilling activities
- Quantity and frequency that water was added to the borehole; the water must come from an approved source and a sample of the water must be collected from the hose used to introduce water into the borehole and analyzed for the same set of parameters as the water samples to be collected from the wells
- Lubricants (specific brand name) used on the downhole equipment; only vegetable- based petroleum-free lubricants are to be used.

8.3 Daily Drilling Report

A Daily Drilling Report (Attachment 9.1) will be completed at the conclusion of drilling activities for the day. This report is required to document the work conducted by the subcontractors and will be filled out as follows:

- Assign a unique number to the form
- Record the unique code assigned to the borehole in the upper right-hand corner of the form
- Record descriptive name of the project and the project number
- Record the current date
- Record the type of equipment used for drilling operation
- Record the diameter of the borehole
- Record the names of the Field Operations Leader and Field Geologist monitoring the drilling
- Record the name of the drilling company, the driller, and the driller's helper
- Check the box applicable to the activities accomplished during the day
- Circle the method(s) used (drilled, augered, cored, or reamed) for the type of work accomplished and record the start and stop depths (below surface level) in the blanks provided in the section title "Footage"
- Record the size, in inches, of bit(s) used
- Describe the type(s) of sample taken and the method(s) used; record the quantity either in feet, volume or number of samples logged
- Record the number of hours to the nearest tenth of an hour in the applicable box or boxes (stand-by-time is normally a delay caused by the contractor or the client; down time is a delay caused by the drilling subcontractor); comments should include, at a minimum, the following:
    - reason and start and stop times for standby or down time
    - explanation of "other" time
    - explanation of large deviations from planned progress
    - clear, concise comments relevant to any justification of work stoppage.
- Record the amount of material actually used by the subcontractor; comments include any necessary explanations for the amount recorded in the space provided
- Record the start and stop footage below the land surface in the space provided for

well construction information

- Record the casing material under "Casing Type"; enter Casing Size" in inches (specify O.D. or I.D.); check "Drain Hole" and "Stamped ID" in the space provided for well casing information
- Sign and date (Field Geologist) the form for verification of activities
- Have the driller verify the identified activities and sign the form; the driller receives a copy of the form daily
- Payment for standby hours and well acceptance must be approved by the Field Operations Leader or his designee. Sign and date (Field Operations Leader) in the space provided; this signature is required for payment of standby hours and well approval
- Distribute copies of the Daily Drilling Report to individuals designated by the Field Operations Leader.

9.0 ATTACHMENTS

9.1 Daily Drilling Report

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ATTACHMENT 9.1
FP 5-1

Daily Report

Time In: ____________ Log No.: ____________
Time Out: ____________
Protection Level: ____________ Date: ____________

Well I.D.: ______ ______ Boring or Drilling Method: ______ ______ Boring or Well Size: ______ ______

Supervisor/Geologist: ____________ Driller: ____________
Drilling Company: ____________ Helper: ____________

Daily Activities

- [ ] Mobilization
- [ ] Decontamination
- [ ] Setup
- [ ] Drilling/Augering/Coring
- [ ] E-logging (standby)
- [ ] Reaming
- [ ] Setting Surface Casing
- [ ] Well Installation
- [ ] Well Development
- [ ] Cleanup
- [ ] Standard Penetration Test
- [ ] Other (explain): ____________

Footage-Drilled/Augered/Cored: ______ ft to ______ ft Reamed: ______ ft to ______ ft

Bit Sizes: ____________ ____________

Sample Type: ____________ Quantity: ____________ SP Tests: ____________ (Quantity)

Time

Drill/Rig: ____________ hr
Decontamination: ____________ hr
Stand-by: ____________ hr
Well Development: ____________ hr
Down Time: ____________ hr
Other: ____________ hr
Explanation: ____________

Materials Used

Bentonite: ____________ bags
Cement: ____________ bags
Sand: ____________ bags
Bentonite: ____________ buckets
Other: ____________
Explain: ____________

Verification of Activities: ____________ Date: ____________
(Signature — Driller)

Well Type (Strata) [ ] Unconsolidated [ ] Other: ____________

Well Construction

Screen Setting: ____________ ft to ____________ ft BLS
Seal Setting: ____________ ft to ____________ ft BLS
Grout Setting: ____________ ft to ____________ ft BLS

Casing Type: ____________
Casing Size: ____________
Drain Hole: [ ] Yes [ ] No
Stamped ID: [ ] Yes [ ] No

Comments: ____________

Verification of Activities: ____________ Date: ____________
(Signature-Supervisory Geologist)

If Well Completed		
Footage Summary		
Unconsolidated:	______	ft
Bedrock:	______	ft
No. Samples:	______	ft
No. SP Tests:	______	ft
Other Dev (hrs):	______	ft

Approved for payment: Standby hours: ____________
Well accepted: [ ] Yes [ ] No

Field Manager ____________ Date ____________
(Signature)

Science Applications International Corporation

White: File Pink: Driller Yellow: Drilling Supervisor Goldenrod: Field Manager

FIELD PROCEDURE FP 5-2

MONITORING WELL INSTALLATION

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Subject	Procedure No.	Rev.	
	FP 5-2	1	Page 1 of 11
MONITORING WELL INSTALLATION	Issue Date	Effective Date	
	10/04/93	10/04/93	
	Supersedes Procedure Number	Rev.	Date
	630 FP 28	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to establish acceptable methods for proper monitoring well design and construction.

2.0 SCOPE

This procedure is applicable to the construction of semi-permanent monitoring wells at field investigation sites. The methods described herein include multiple options to account for the variety of conditions that may be encountered in the field. Specific monitoring well installation procedures proposed for use are described in the project-specific work plan.

3.0 REQUIREMENTS

The objectives for each monitoring well and its intended use must be clearly defined before the monitoring system is constructed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well construction, attention must be given to clearly documenting the basis for construction decisions, the details of well construction, and the materials used.

Siting of monitoring wells shall be performed after a preliminary estimation of the hydraulic gradients and groundwater flow direction. In most cases, these can be determined through review of geologic data and the site terrain. In addition, production wells or other monitoring wells in the area may be used to determine the flow direction. Monitoring well locations, objectives, and intended uses are described in the project-specific work plan.

4.0 REFERENCES

4.1 Driscoll, Fletcher, G. 1986. *Groundwater and Wells*, 2nd Edition, Johnston Division, St. Paul, Minnesota, pp. 1089.

4.2 HAZWRAP, July 1990. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1.

4.3 United States Environmental Protection Agency, September 1986. *Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1.

4.4 American Society of Testing and Materials, 1989. *Proposed Recommended Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers.* ASTM Subcommittee D18-2105 on Design and Installation of Groundwater Monitoring Wells.

4.5 USATHAMA, March 1987. *Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports.*

5.0 DEFINITIONS

Monitoring Well - A well which will provide for the measurement of total well depth, the collection of representative groundwater samples, the detection and collection of representative light- and dense-phase organics, and measurement of water levels and water flows.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for selecting the well casing and screen materials, the screen length and placement, and the filter pack and seal materials to be used for each monitoring well. The Project Manager should work in cooperation with the Field Operations Leader to ensure that all contract items are fulfilled and that the project is executed in a scientifically sound manner.

6.2 Field Operations Leader

The Field Operations Leader is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that monitoring well installation activities are performed in compliance with the contract. The Field Operations Leader will obtain the information necessary for the Project Manager to select screen size and well packing material and siting well installation locations.

6.3 Field Geologist

The Field Geologist is responsible for ensuring the well is installed according to the contract specifications and documenting the well completion. If notification of the driller does not result in corrective action, the Field Geologist will thoroughly document the driller's failure to follow procedures and notify the Field Operations Leader as soon as possible.

7.0 EQUIPMENT

1. Field Logbook and Indelible Ink Pens
2. Monitoring Well Construction Log and Soil Boring Log
3. Folding or Retractable Engineers Rule (calibrated to 0.01 foot)
4. Weighted Tape (calibrated to 0.01 foot)
5. Slot Size or Feeler Gauge
6. Water-Level Indicator
7. Copies of the Geotechnical Portion of the Statement of Work, Site Safety Plan, and AEC-approved Technical Plan
8. 10X Hand Lens.

8.0 PROCEDURE

8.1 Design Considerations

8.1.1 Monitoring Well Depth, Diameter, and Screen Length

- Standard well diameters are two, four, six, or eight inches. For most monitoring programs, a two- or four-inch diameter well is preferred. Smaller wells have a smaller volume of stagnant water, well construction costs are lower, and the water table stabilizes readily.
- In specifying well diameter, sampling requirements must be considered. A total of up to four gallons of water may be required for a single sample to account for full organic and inorganic analyses and split samples. The standing water in the monitoring well available for sampling after complete recharge is dependent on the well diameter as follows:

Casing Inside Diameter (inches)	Standing Water Depth to Obtain One Gallon Water (ft)	Total Depth of Standing Water For Four Gallons (ft)
2	6.13	25
4	1.53	6
6	0.68	3

- The borehole diameter should be at least four inches larger than the well riser pipe diameter.
- Wells constructed in the 100-year flood plain must be flood protected by either sealing the well or extending the well casing above the 100-year flood elevation.
- Monitoring wells shall contain only one screened interval per well. Separate boreholes will be drilled for cluster monitoring wells whose purpose is to monitor several intervals.

8.1.2 Riser Pipe and Screen Materials

- Schedule 40 PVC has sufficient tensile and compressive strength for wells up to 75 feet. Schedule 80 PVC generally will be used for wells greater than 50 feet.
- The inside diameter for schedule 80 PVC is smaller and may be an important factor when considering the size of bailers or pumps to be used for the sampling. Due to this problem, the minimum well pipe size recommended for schedule 80 is four inches I.D.
- All well construction materials must be decontaminated before using according to Field Procedure FP 3-2.
- Type 316L stainless steel or other alloys will be considered for use in sulfidic waters.
- Threaded, flush joint casing is required. No glues or solvents will be used in well construction.
- For deep wells, the screen must be chosen to withstand the column weight without collapsing. The screen shall pass no more than 10 percent of pack material on insitu aquifer material.
- The field geologist shall specify the combination of screen slot size and gravel pack gradation, based on the ASTM (ASTM, 1989) recommended screen slot size in the attached table. The approximate D-1, D-10, and D-30 of the formation will be determined. D-1, D-10, and D-30 are the particle diameters at which only 1%, 10%, and 30% of the sample, respectively, is finer than that particle size. The geologist will compare these values with the ranges in ASTM Table 1 (Attachment 9.6) and estimate which screen slot size and filter pack combination best fits the sample.
- Materials other than stainless steel, PVC, and Polytetrafluoroethylene (PTFE) will not be used in the construction of monitoring wells.

Screen lengths will generally be 10 feet long, except where the aquifer to be examined is less than 10 feet thick, where a particular contaminant layer is being screened, or specified by the statement of work. A five-foot screen length or less will be installed in these instances. Well screens shall be placed no more than three feet above the bottom of the drilled borehole.

8.1.3 Annular Materials

Material placed in the annular space between the borehole and well riser pipe includes a granular filter pack, when necessary, a bentonite seal, and/or cement grout. In general, all of these should be installed via a rigid tremie pipe placed in the annular space with the exception of bentonite pellets. The granular filter pack is usually a medium- to very coarse-grained uniform sand. The quantity of sand placed in the annual space is dependent upon the length of the screened interval but should always extend five feet above the top of the screen unless otherwise specified in the statement of work. The bentonite pellet seal will be a minimum of five feet thick while the bentonite slurry will be a maximum of five feet thick. A bentonite slurry shall be used only as a last resort. Slurry seals shall have a thick, batter-like (high viscosity) consistency. Care should be used when placing the filter pack above the screen to insure that the integrity of confining layers are maintained.

Bentonite expands by absorbing water and provides a seal between the screened interval and the rest of the annular space and formation. Cement grout is placed on top of the bentonite to the surface. The seal, whether all bentonite or bentonite capped with grout, prevents surface runoff from reaching the screened interval. Infilling with bentonite and grout also prevents hole collapse and subsidence around the well. A side-discharge, rigid tremie pipe shall be used to introduce bentonite slurry and grout from the bottom of the hole upward to prevent bridging and to provide a better seal. In some shallow holes, it may be more practical to pour the cement from the surface without using a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite seal. Grout generally is composed of two assemblages of material (i.e., a cement-bentonite grout or a neat cement grout). A cement-bentonite grout normally is a mixture of cement, bentonite, and water at a ratio of 20 parts Portland Type II or V cement, up to one part granular or flake-type bentonite, approximately five pounds, and up to eight gallons of water per 94-pound bag of cement. Neat cement is made up of one 94-pound bag of Portland Type II or V cement and up to eight gallons of water.

8.1.4 Protective Equipment

A protective steel casing will be placed over the top of the well the same day as initial grout placement around the well. This casing has a hinged cap and can be locked to prevent vandalism. A slide-on cap that fits loosely on the well riser will prevent unwanted material from entering the well and maintain atmospheric pressure as water levels rise or fall with the exception of wells installed to monitor gases. The top of the protective casing to the top of the well casing shall be no more than 0.2 feet. The protective casing has a larger diameter than the well and is set into the wet grout over the well upon completion. In addition, at least one ¼-inch hole is drilled just above the cement collar through the protective casing which acts as a drainage port for the flow of water which may enter the annulus during well development, purging, or sampling.

Four 3-inch diameter steel guard posts filled with cement will be placed around the protective steel riser pipe unless the wells are flush-mounted. The posts are generally six feet in total length and installed approximately three feet into the ground with independent concrete footings. A 0.5 foot by three feet by three feet concrete pad will be placed around the installed protective casing, unless otherwise specified in the statement of work. Fencing also will be installed, if applicable.

Protective casing which is level with the finished surface is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the well is placed four to five inches below the pavement and cemented to approximately six or seven inches below the pavement. A protective sleeve is set into the wet cement around the well with the top set level with the pavement. A locking gasket cap is placed on the well to seal out water and a manhole type lid placed over the protective sleeve. The top of the well resembles a small manhole. If the cement grout seal is effective and does not leak, the hole below the pavement will hold water. A drainage system may be required to direct pooled water away from the well head.

8.2 Monitoring Well Construction

8.2.1 Predrilling Activities

Underground utility maps for the immediate vicinity of the drilling site will be reviewed and proposed drilling locations will be staked in the field for inspection. Digging permits will then be obtained. No drilling will be done without the required digging permits.

8.2.2 Well Construction

- Once begun, well installation shall not be interrupted due to the end of the driller's work shift, darkness, weekend, or holiday.
- Inspect the screen to insure that no damage has occurred during shipment and decontamination. Also record the type and class of material and screen slot size. Check the slot size with a feeler gauge to insure that the screens are properly labeled.
- Prior to placing well materials in the borehole, place a backfill of filter pack material below the base of the screen not to exceed three feet. The filter pack will consist of chemically and texturally inert (e.g., clean quartz sand, or silica), and of appropriate size for the well screen and host environment.
- Assemble the well casing and screen, and place the material in the borehole. Ensure that each well is straight as possible and centered in the borehole. All screen bottoms shall be securely fitted with a threaded cap or plug with a maximum length of 0.5 feet.

  NOTE: All well screen, riser pipe, bottom plug, and cap will be threaded and flush jointed. No glues or solvents are to be used in monitoring well installation.
- Record the depth of the base of the well, the top of the screen, and the screen length in the monitoring well construction log.

8.2.3 Placement of Filter Pack and Annular Seal

- Place the monitoring well filter pack into the annulus between the well screen and the open borehole wall by slowly pouring filter pack material directly or pumping a sand slurry through a rigid tremie pipe. If the borehole will not stand open, place filter pack material directly into the annulus between the auger wall and the well casing and screen. Then gradually pull back the auger string in small increments, two feet at a time, to allow the sand to settle around the screen below the augers. Care will be taken to prevent filter pack material from bridging between the borehole wall or augers and the well screen and riser pipe. A weighted tape will be used periodically to verify the placement of the filter pack.

  NOTE: The filter pack material will be chemically and texturally inert (e.g., clean quartz sand, or silica) with particles that are of appropriate size.
- The filter pack material will be placed from the bottom of the well to five feet above the top of the screen. The depth to the top of the sand pack will be recorded. Note the amount (weight) and volume of sand used.
- For shallow wells ($\leq$35 feet), gravity feed bentonite pellets (not powder) onto the top of the filter pack to form the bentonite seal. Bentonite pellets are generally used and preferred. If a tremie pipe is used, slowly withdraw the pipe as the bentonite is added to ensure even placement around the annulus. Check the depth with a weighted tape. Pellet seals shall be a minimum of five feet thick as measured immediately after placement, without allowance for swelling.

- Follow manufacturer's specifications for hydration time. Record the depth to the top of the bentonite seal, the amount of bentonite used, the amount of water added for hydration, if applicable, and compare actual volume used with calculated volume on the Monitoring Well Construction Log.

  NOTE: The annular seal material must be chemically compatible with the well materials and contaminants and chemically inert so it does not affect the quality of groundwater samples. The permeability of annular seals will be one to two orders of magnitude less than the surrounding formation.

- Tremie a neat cement-bentonite grout above the bentonite seal by pumping it through a side-discharge, rigid tremie pipe and allow the grout to rise in the borehole annulus until undiluted grout flows out at the ground surface. If drill casing is still in the borehole, it will be pulled at this time, and more grout will be added to compensate for settling. Place the steel protective well casing into the fresh grout. After 24 hours, add more grout, if needed. This process will be repeated until firm grout remains at the ground surface.

  NOTE: Mix the cement and water first, and then add the bentonite (Reference 4.5). All prescribed portions of grout shall be combined in an above-ground, SAIC approved container and mechanically (not manually) blended to produce a thick, lump-free mixture throughout the mixing vessel.

8.2.4 Above Ground Well Completion

- Make a V-notch on the north side of the well casing with a file. The notch will be the point from which surveys and subsequent water level measurements will be measured. Ensure no filings or shavings enter the well.
- For wells that are completed above the ground surface, the steel protective casing should extend approximately 2.5 feet above the land surface. The protective casing should be equipped with a hinged, loose-fitting cap that can be locked to prevent unauthorized entry. Sufficient space must be allowed between the protective casing lid and the top of the well riser pipe for a well cap. The minimum size for a two-inch diameter well is four-inch diameter protective casing ,for a three-inch diameter well is five-inch diameter protective casing, for a four-inch diameter well is six-inch diameter protective casing, and for a five-inch diameter well is eight-inch diameter protective casing. The top of the protective casing to the top of the riser pipe shall be no more than 0.2 feet.
- Construct a 0.5 X 3 X 3 foot square concrete pad around the protective casing after the grout has finished settling. The pad shall slope away from the casing in all directions. Embed a brass surveyors pin in the concrete pad and stamp the well Identification Number in the pin, and on the top of the protective casing, and the inner casing.
- Drill a ¼-inch diameter drainage port into the side of the protective casing approximately 1/8 inches above the internal mortar collar to permit drainage.

- Install four 3-inch diameter by 6-foot long, concrete filled steel guard posts radially around the concrete pad. The guard posts will extend approximately three feet into the ground with independent concrete footings.

8.2.5 Flush Mount Completions

For wells that are completed flush with the land surface, install a well vault over the well riser pipe. The vault will be water-tight and equipped with a locking mechanism to prevent unauthorized entry. A system of drainage also should be installed. For flush-mount completions, the top of the well is 4- to 5-inches below ground surface and concreted to at least six inches below ground surface.

8.2.6 Monitoring Well Installations in Confined Aquifers

1. Advance an oversized borehole through unconsolidated surface deposits to a depth of 2- to 3-feet into the top of the confining bed. In general, the borehole should be 2 inches in diameter larger than the casing to be installed when a tremie is to be used.
2. Condition the borehole until the hole is cleaned of cuttings.
3. While performing Step 2, make-up the necessary length(s) of surface casing. Surface casing may be of mild or galvanized steel.
4. Pressure grout bentonite pellets or chips to fill the portion of the borehole in the confining bed. If the bentonite seal is to be set below the static water level, only pellets may be used. The bentonite should hydrate in the presence of groundwater, but approved potable or distilled water may be added, if needed.
5. Insert the surface casing into the borehole and push firmly into the bentonite seal in the confining bed.
6. Mix Portland cement and water to make a pumpable slurry.
7. Insert the tremie pipe into the borehole and begin pumping grout. Slowly withdraw the tremie pipe as the annulus fills to ensure even placement with no bridging
8. Allow grout to cure for 48 hours or longer before proceeding.
9. After grout has cured, rig up with a smaller diameter bit and proceed with drilling. Advance the borehole to the desired depth. The hole should be drilled a few feet deeper than necessary to allow for cave-ins during casing placement. If more than one aquifer will be encountered during drilling, the well must be cased in separate states to prevent cross-contamination. Steps 1 through 8 of this section should be followed for each separate aquifer that must be cased off. Cable tool follows similarly with a larger casing set at the confining layer prior to advancing.
10. Condition the borehole until the hole is cleaned of cuttings. Pull the drill string out of the borehole when no additional cuttings reach the surface. Check the hole depth with a weighted surveyor's tape.

11. Make up the casing string in manageable sections while conditioning the borehole. The casing and screen (if used) must be decontaminated in accordance with FP 3-2 before make-up. Tighten casing joints to the manufacturer's specifications.

12. Insert the first segment of the casing string and lower to a convenient height for adding the second casing segment. Chock the casing, add the second segment, then release the chock and lower the casing. Repeat this process until the full casing string is hanging in the well. Centralizers should not be placed anywhere on the well riser or screen that will be covered with the filter pack. The centralizers should be placed at 25 foot intervals. The casing string should be allowed to hang in the well rather than set on the bottom. Casing strings with Teflon® screens should never be set on the bottom because the weight of casing will significantly reduce the slot size and may collapse the screen.

13. Insert the tremie pipe so it is near the bottom of the screen and begin placing the filter material into the borehole. Slowly withdraw the tremie pipe so that the filter pack is placed evenly around the screen without bridging. A maximum of three feet of filter pack material may be spotted at the bottom of the hole, under the screen. The filter pack must be installed to five feet above the top of the screens. If the top of the screen is below the bottom of the confining layer, extend the filter pack to the confining layer, if appropriate. Develop the well according to FP 5-4 to settle the filter pack and, if used, remove slurry water.

14. If the filter pack was placed as a slurry, withdraw the tremie pipe, rinse with potable water, and dry before proceeding to add the bentonite seal. The potable rinsewater does not have to be contained. If the filter pack was installed dry, do not remove the tremie unless a larger diameter pipe is needed for installing the bentonite seal. Check the depth of the filter pack to ensure that it rises above the top of the screen.

15. Pour bentonite pellets onto the top of the filter pack. Bentonite pellets must be used for installations below the water table. The bentonite seal must extend two to three feet into the confining layer, if possible. Slowly withdraw the tremie pipe as bentonite is added to ensure even placement around the casing without bridging.

16. Hydrate the bentonite according to the manufacturer's specifications. Record amount of water used.

17. Mix Portland cement with powdered bentonite (as previously described) and water to make a pumpable slurry.

18. Tremie the grout into the annulus using a side-discharge tremie pipe. Slowly withdraw the tremie pipe as the annulus fills to ensure even placement. Grout the well to the surface.

19. After installing grout, dismantle and clean the tremie equipment.

8.2.7 Monitoring Well Completion and Borehole Records

The Field Geologist will record the lithology and complete a drilling record for all borings and send the original log to the Contracting Office within three working days after well installation.

See Section 9.0 Attachments for specific construction logs. Borehole logging will be in accordance with FP 7-3.

9.0 ATTACHMENTS

9.1 Standard Monitoring Well Construction

9.2 Monitoring Well Construction When Water Table is Near Land Surface

9.3 Monitoring Well Construction With Sealed Cap and Flush Surface Presentation

9.4 Monitoring Well Construction With Telescoped Casing

9.5 Monitoring Well Construction Logs:

- Standard
- Standard Flush Mount
- Double Cased
- Double Cased Flush Mount
- Open Hole
- Open Hole Flush Mount.

9.6 ASTM Table 1

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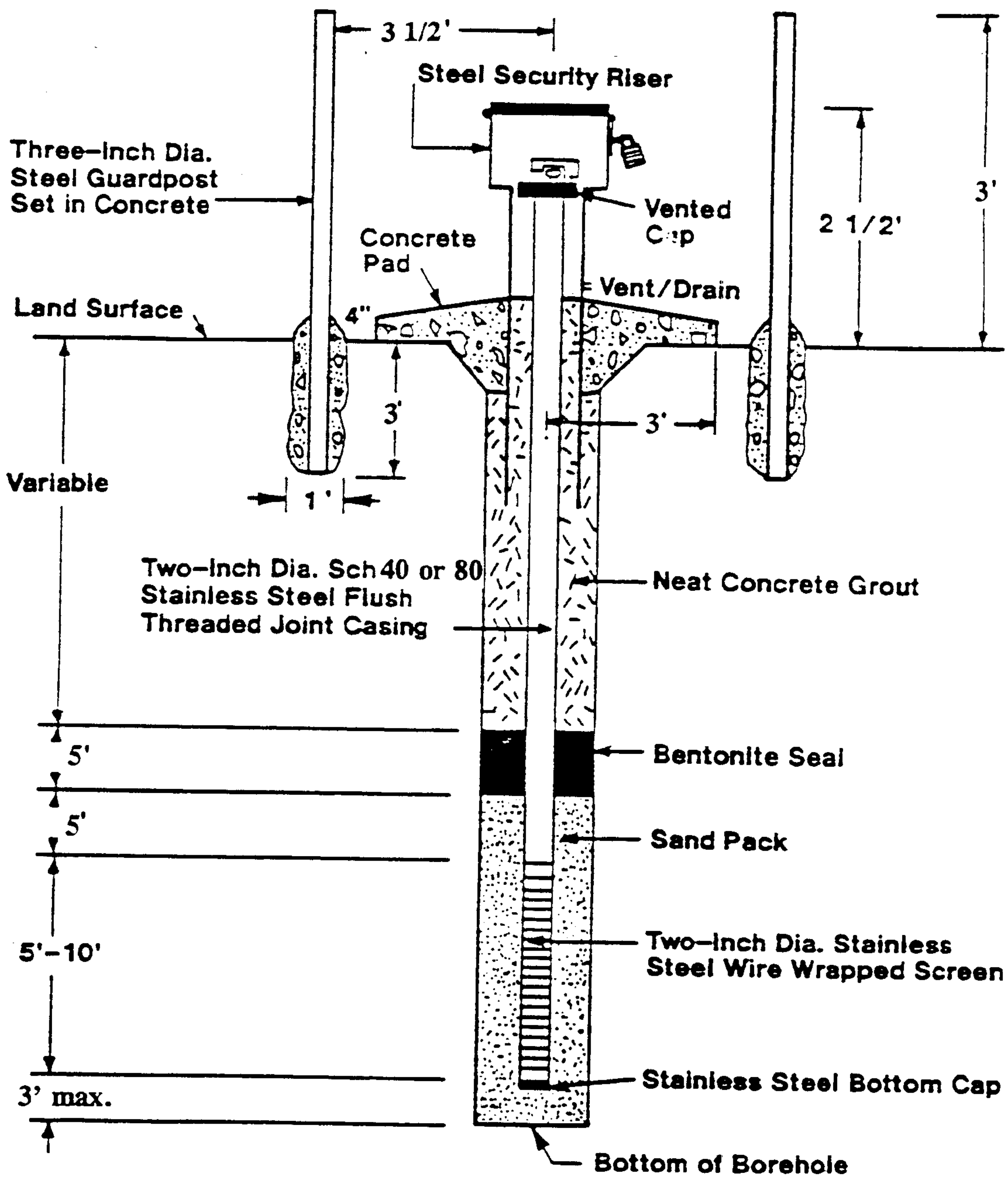
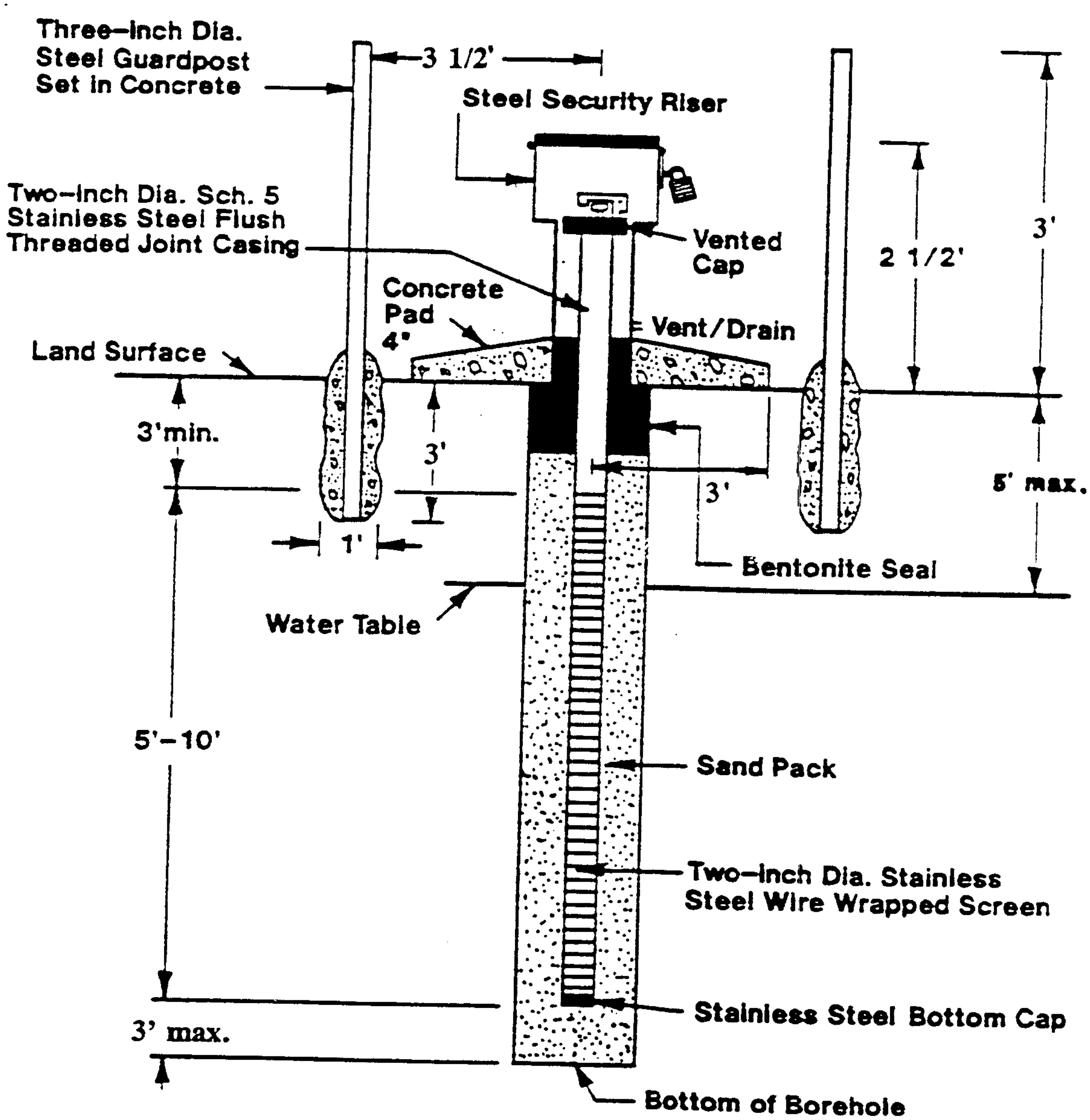
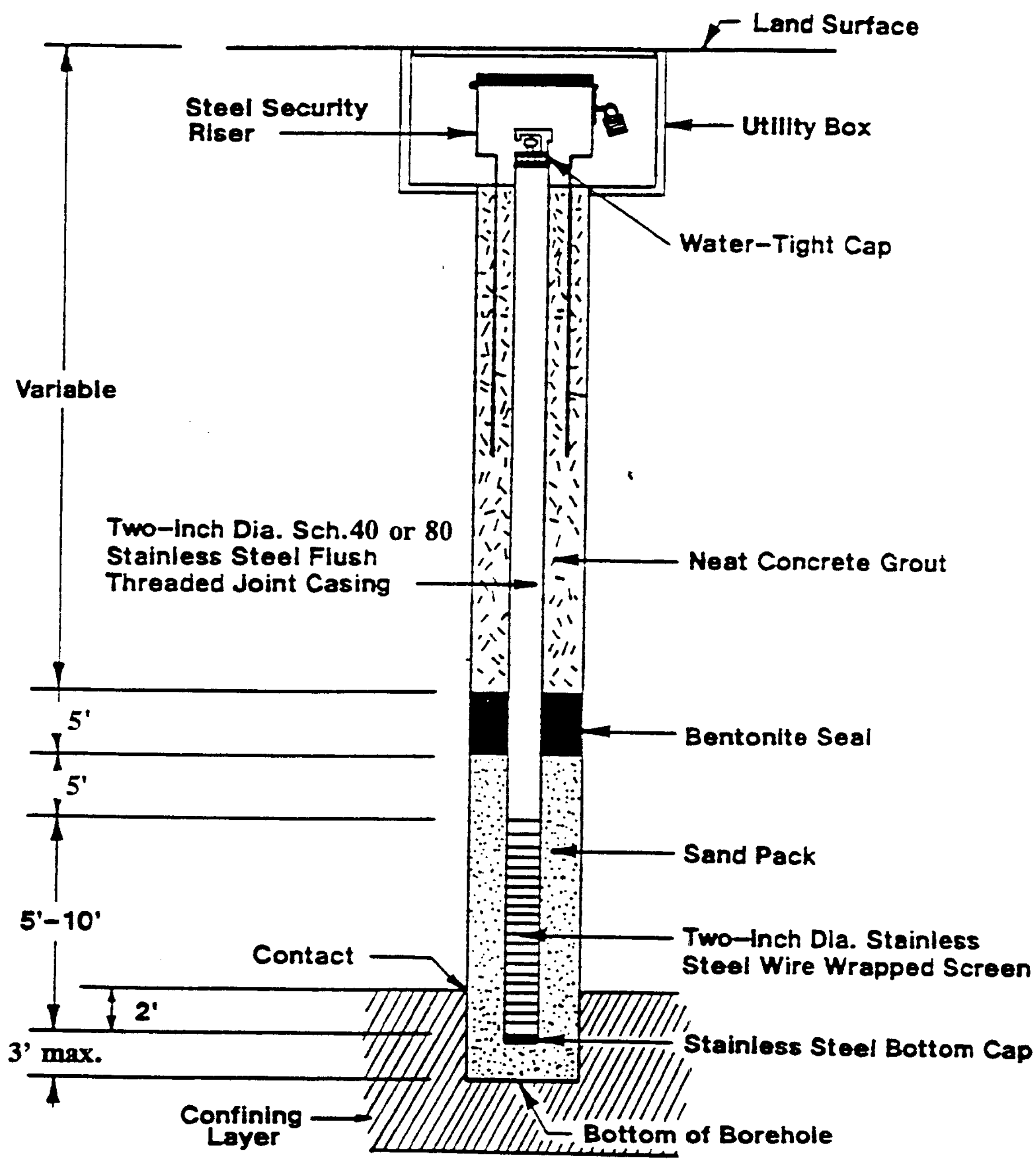


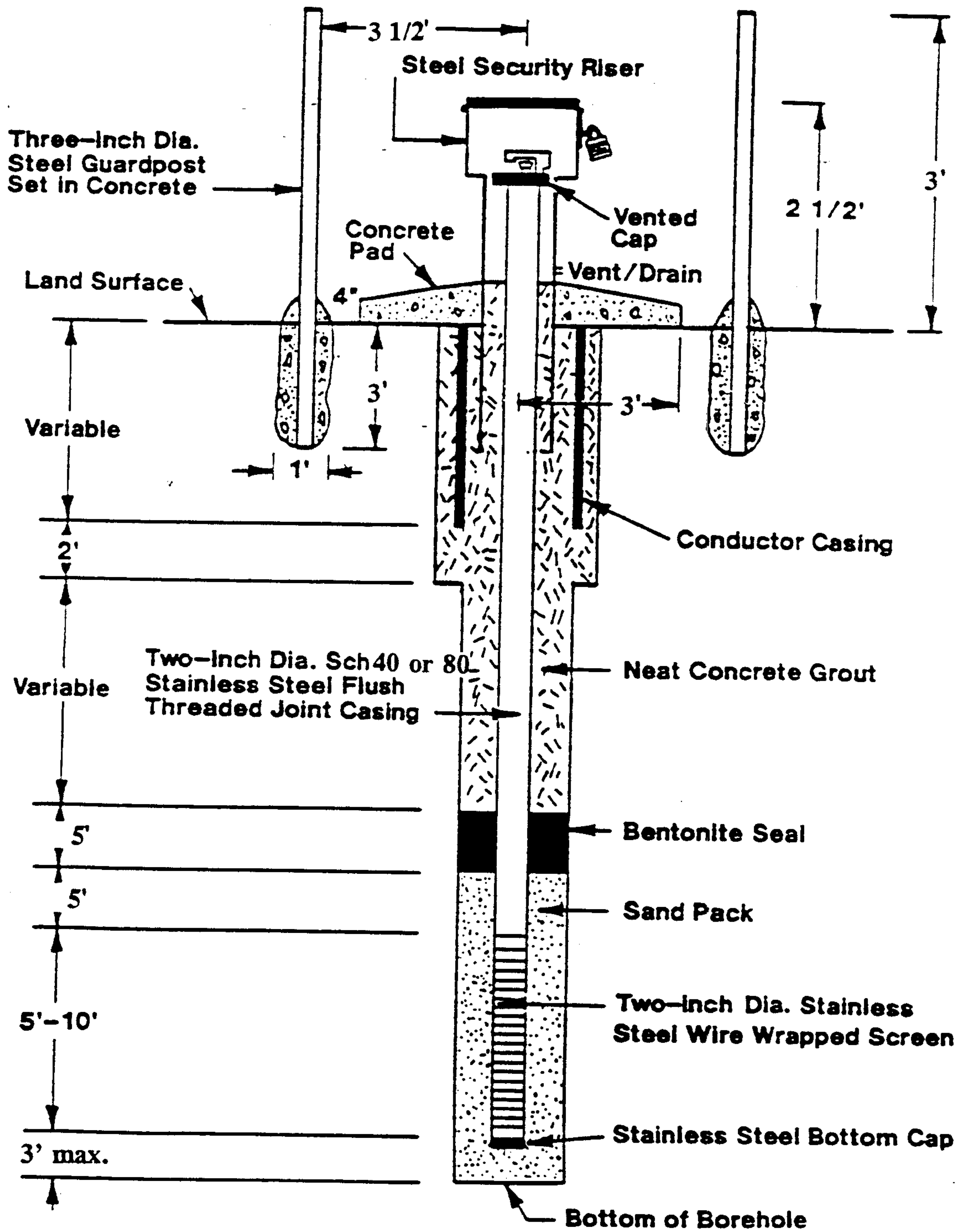
Typical Monitoring Well Construction.



Monitoring Well Construction When Water Table is Near Land Surface.



Monitoring Well Construction With Sealed Cap and Flush Surface Presentation.



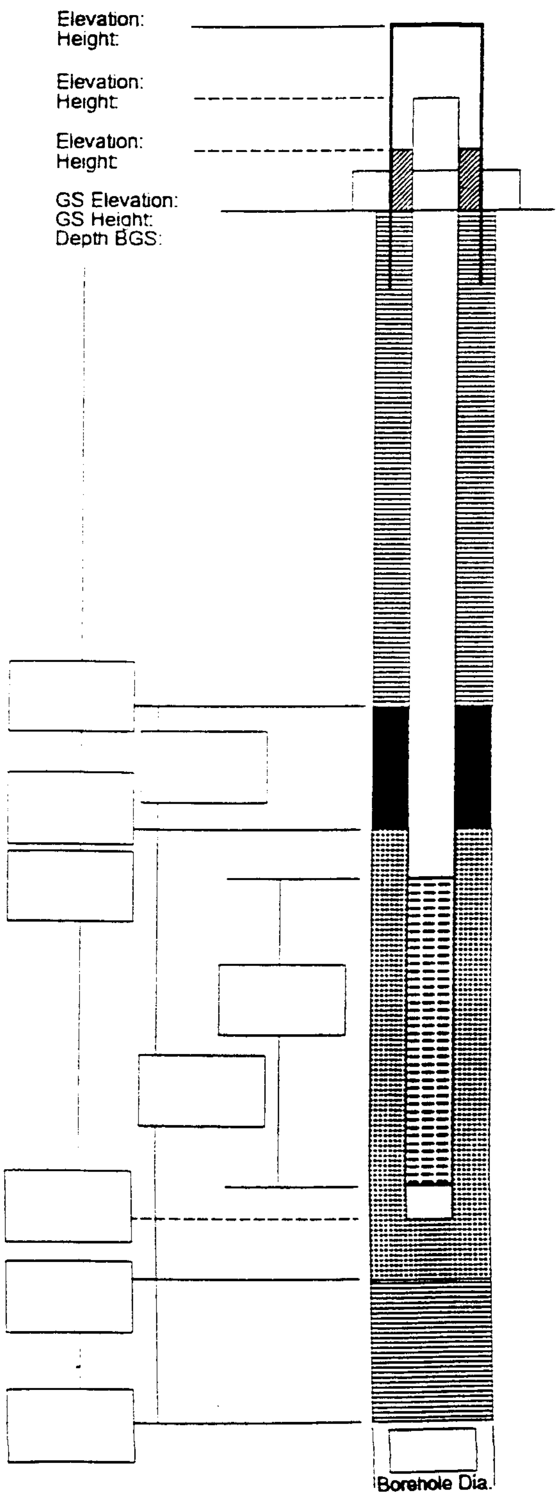
Monitoring Well Construction With Telescoped Casing.

ATTACHMENT 9.5
FP 5-2
9 Pages

MONITORING WELL CONSTRUCTION LOGS

- Standard
- Standard Flush Mount
- Double Cased
- Double Cased Flush Mount
- Open Hole
- Open Hole Flush Mount

MONITORING WELL CONSTRUCTION LOG - Standard		Rev: 4/92
Well No.:	Installation:	Site:
Project No.:	Client / Project:	
Drilling Contractor:	Driller:	
Comp. Start:	Comp. End:	
Built By:	Well Coord.:	



PROTECTIVE CGS Material Type	Length:
Diameter	Water Tight Seal( )
Depth BGS	Drainage Hole ( ) Height: Size:
GUARD POSTS( ) No.: Configuration:	Type
SURFACE PAD Composition & Size	
RISER PIPE Type	
Diameter	
GROUT Composition: Proportions :	
Interval	Tremied( )
CENTRALIZERS( ) Type: Depth(s)	
SEAL Type	
Source	
Setup / Hydration time	Vol. Fluid Added
Tremied( )	
FILTER PACK Type	
Amount Used	Tremied( )
Source	
Gr. Size Dist	
SCREEN	Type: Manufacturer:
Diameter ID:	OD:
Slot Size: Schedule / Thickness	
Interval BGS	
SUMP( ) Interval BGS	Bottom Cap( )
BACKFILL PLUG Material	
Setup / Hydration time	Tremied( )
WATER ADDED( ) Interval	Amount
Interval	Amount

MONITORING WELL CONSTRUCTION LOG - Standard			Rev: 4/92
Well No.:	Installation:		Site:
Project No.:	Client / Project:		
Drilling Contractor:		Driller:	
Comp. Start:		Comp. End:	
Built By:		Well Coord.:	

DRILLING EQUIPMENT

Rig Manufacturer:

Rig Model

DRILLING METHOD ( ) Auger ( ) Mud Rotary ( ) Air Rotary ( ) Cable Tool ( ) Other (Specify) ____________

Auger Type & Size:

Casing Size:

Bit Type and Size:

Hammer Weight and Percussion Method:

Rod Size:

Mud Mixture (Mud Rotary)
Air Filter Method (Air Rotary)

SAMPLING METHOD & NUMBER COLLECTED

( ) Split Spoon No.: ( )
( ) Grab Sample No.: ( )
( ) Misc. No.: ( )
( ) Shelby Tube No.: ( )
( ) Core Barrel No.: ( )

MATERIALS USED (TOTALS)

Sand: Bentonite Pellets:

GROUT
Bentonite: Cement:

SURFACE PAD MATERIALS

Screen (ft):

Riser (ft):

Misc:

MISC:

MONITORING WELL CONSTRUCTION LOG - Standard		Rev: 4/92
Well No.:	Installation:	Site:
Project No.:	Client / Project:	
Drilling Contractor:	Driller:	
Comp. Start:	Comp. End:	
Built By:	Well Coord.:	

Remarks:

MONITORING WELL CONSTRUCTION LOG - Standard Flush Mount			REV. 10/90
Well No.:	Installation:		Site:
Project No.:	Client/Project:		
HAZWRAP Contractor:		Drilling Contractor:	
Comp. Start:		Comp. End:	
Built By:		Well Coord.:	

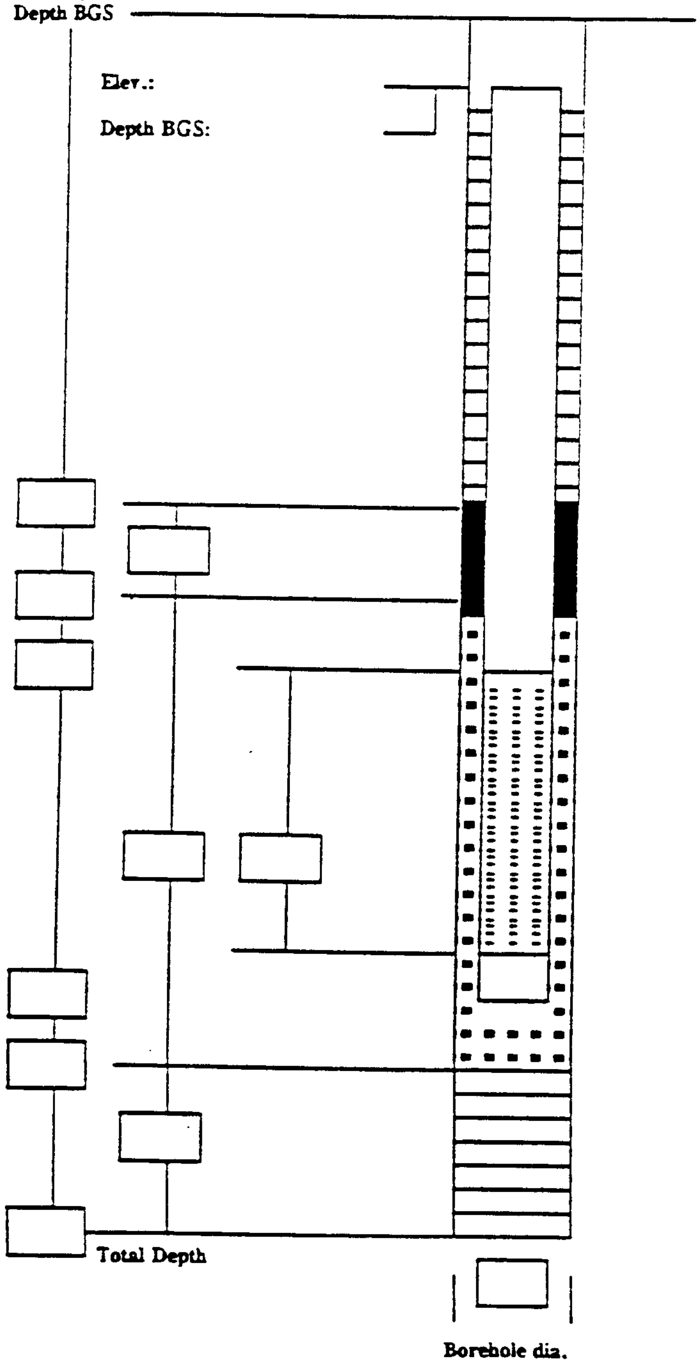
Elevation:

Height:

GS Elevation:

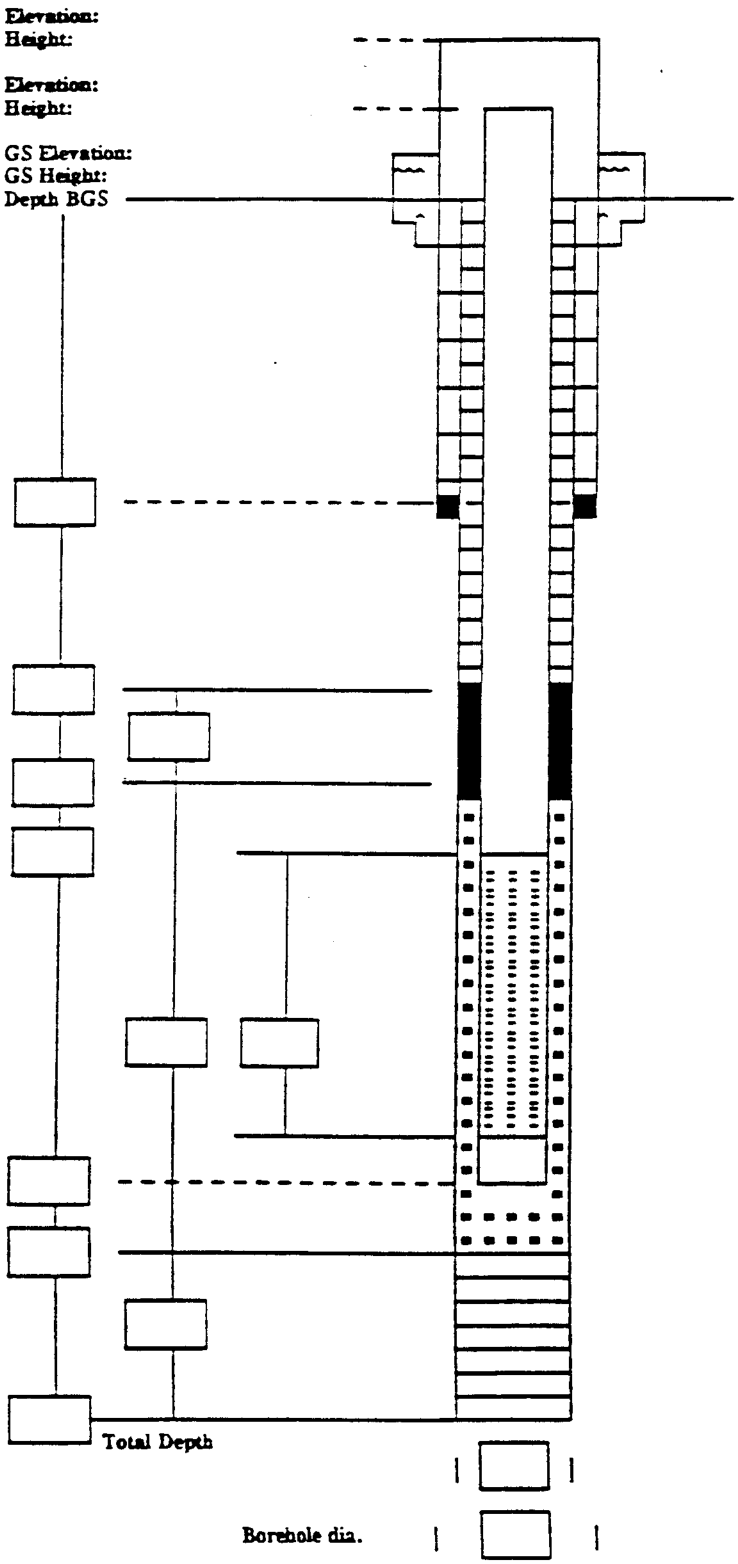
GS Height:

Depth BGS



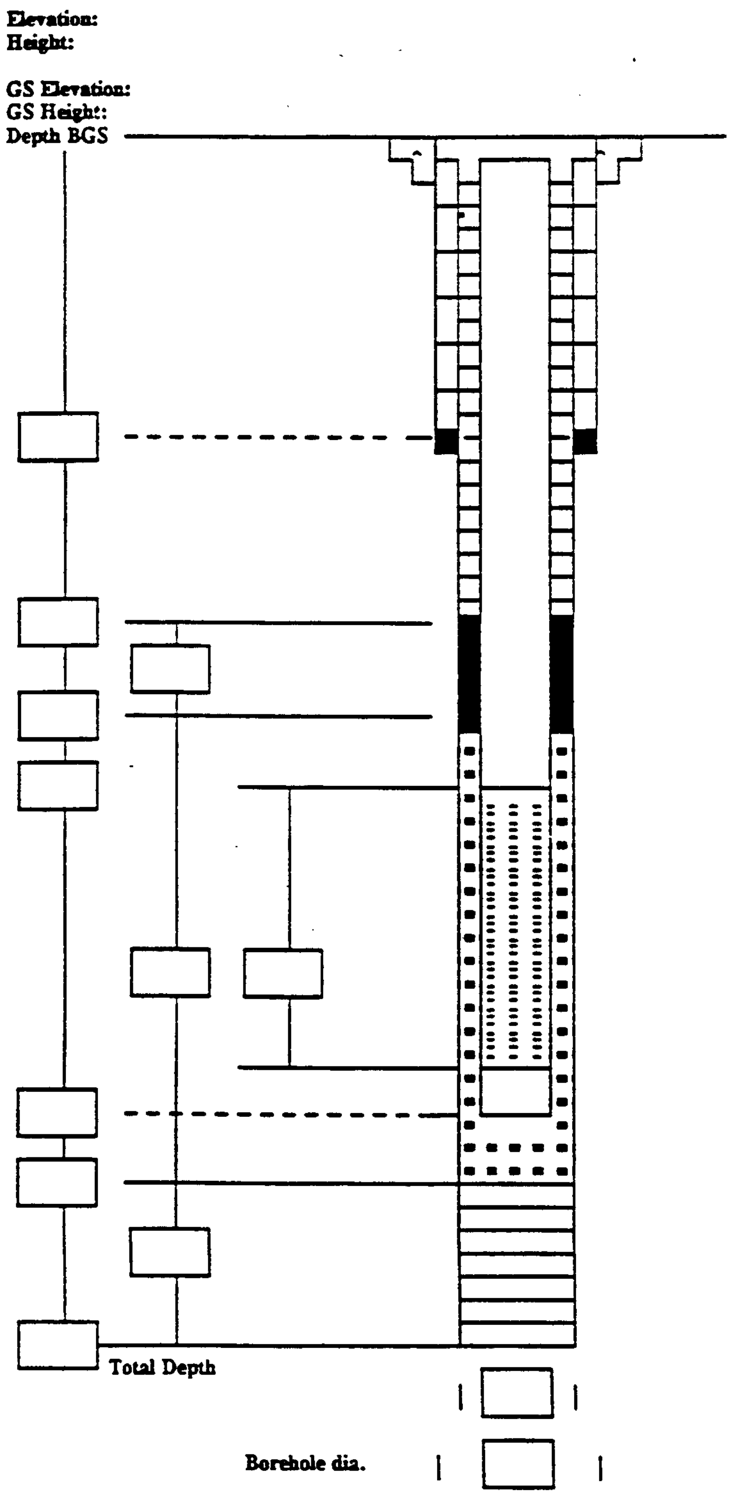
PROTECTIVE CGS Material Type		
Diameter	Water Tight Seal( )	
Depth BGS	Weep Hole ( )	
SURFACE PAD Composition & Size		
RISER PIPE Type		
Diameter		
GROUT Compositions & Proportions		
Interval	Tremied ( )	
CENTRALIZERS ( ) Depth(s)		
SEAL Type		
Source		
Setup/Hydration time	Vol. Fluid Added	
Tremied ( )		
FILTER PACK Type		
Amount Used	Tremied ( )	
Source		
Gr. Size Dist		
SCREEN Type		
Diameter		
Slot Size & Type		
Interval BGS		
SUMP ( ) Interval BGS	Bottom Cap ( )	
BACKFILL PLUG Material		
Setup/Hydration time	Tremied ( )	
WATER ADDED ( ) Interval	Amount	
Interval	Amount	
Interval	Amount	

MONITORING WELL CONSTRUCTION LOG - Double Cased		REV. 10/
Well No.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:	Drilling Contractor:	
Comp. Start:	Comp. End:	
Built By:	Well Coord.:	



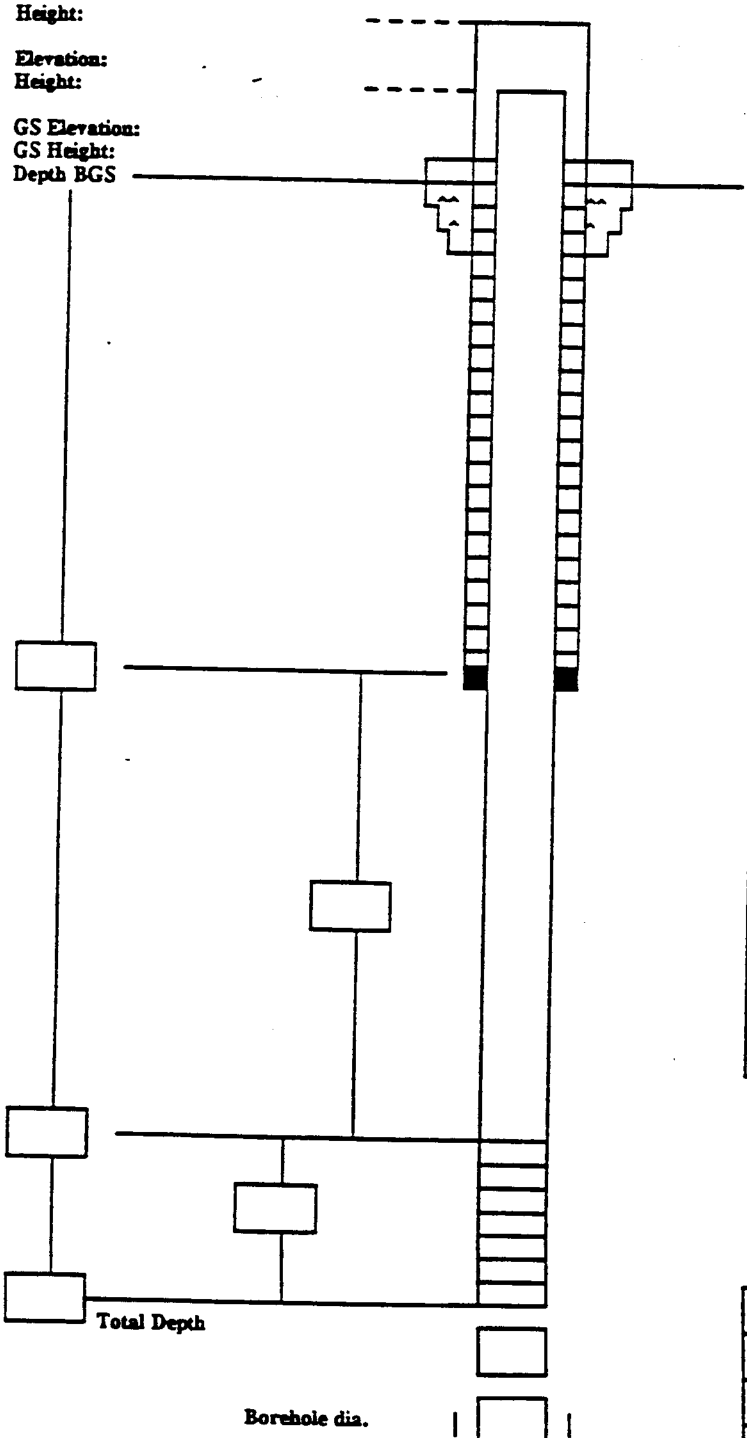
PROTECTIVE CGS Type:	
Diameter	Water Tight Seal( )
Depth BGS	Weep Hole ( )
GUARD POSTS ( )No.	Type
SURFACE PAD Composition & Size	
SURFACE CSG Type	
Diameter	Total Length
GROUT: Setup/Hydration Time	
Compositions & Proportions	
Interval BGS	Tremied ( )
RISER PIPE Type:	
Diameter	Total Length
GROUT Interval	Tremied ( )
Composition & Prop.	
CENTRALIZERS ( ) Depths	
SEAL Type	
Source	Tremied ( )
Setup/Hydration time	Vol. Fluid Added
FILTER PACK Type	
Amount Used	Tremied ( )
Source	
Gr. Size Dist	
SCREEN Type	
Diameter	
Slot Size & Type	
Interval BGS	
SUMP ( ) Interval BGS	Bottom Cap ( )
BACKFILL PLUG Material	
Setup/Hydration time	Tremied ( )
WATER ADDED ( ) Interval	Amount
Interval	Amount

MONITORING WELL CONSTRUCTION LOG - Double Cased Flush Mount		REV. 10/90
Well No.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:	Drilling Contractor:	
Comp. Start:	Comp. End:	
Built By:	Well Coord.:	



PROTECTIVE CGS Type:	
Diameter	Water Tight Seal( )
Depth BGS	Weep Hole ( )
SURFACE PAD Composition & Size	
SURFACE CSG Type	
Diameter	Total Length
GROUT: Setup/Hydration Time	
Compositions & Proportions	
Interval BGS	Tremied ( )
RISER PIPE Type:	
Diameter	Total Length
GROUT Interval	Tremied ( )
Composition & Prop.	
CENTRALIZERS ( ) Depths	
SEAL Type	
Source	Tremied ( )
Setup/Hydration time	Vol. Fluid Added
FILTER PACK Type	
Amount Used	Tremied ( )
Source	
Gr. Size Dist	
SCREEN Type	
Diameter	
Slot Size & Type	
Interval BGS	
SUMP ( ) Interval BGS	Bottom Cap ( )
BACKFILL PLUG Material	
Setup/Hydration time	Tremied ( )
WATER ADDED ( ) Interval	Amount
Interval	Amount

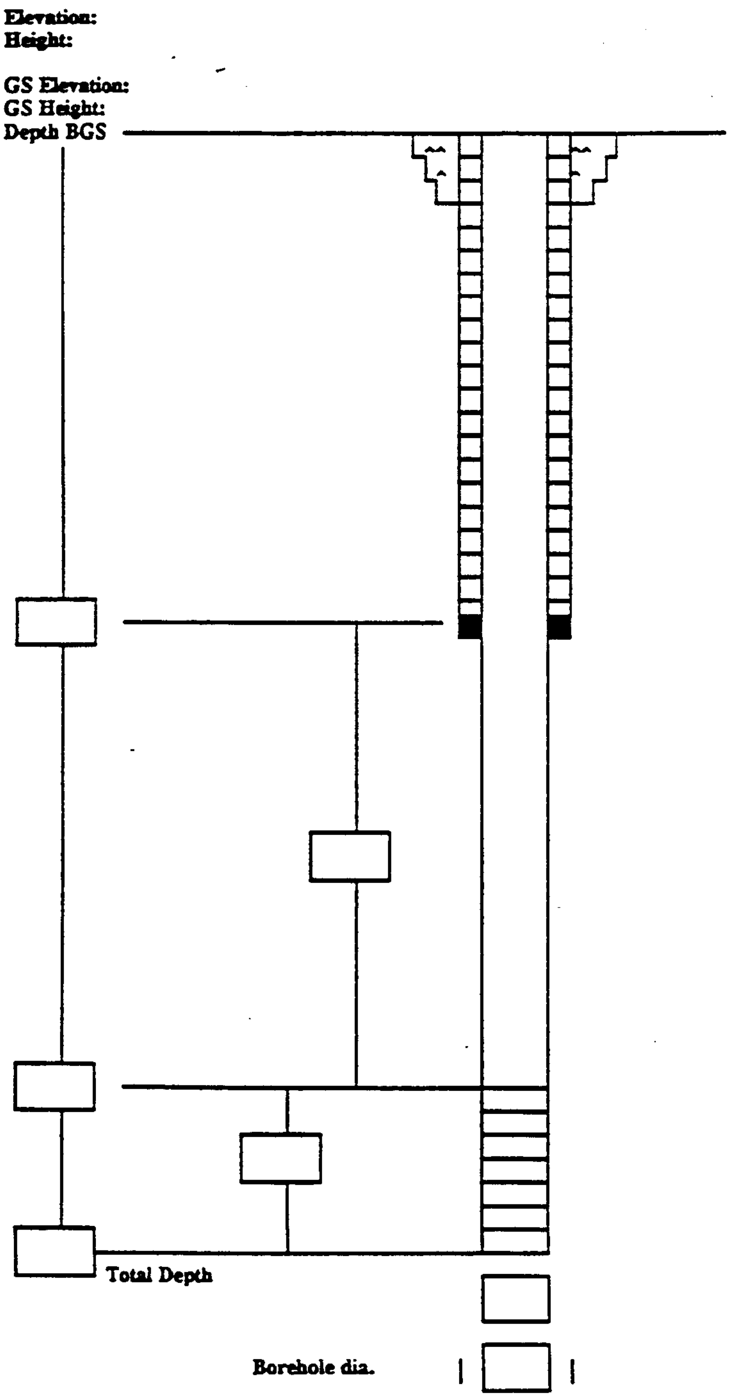
MONITORING WELL CONSTRUCTION LOG - Open Hole		REV. 10/
Well No.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:	Drilling Contractor:	
Comp. Start:	Comp. End:	
Built By:	Well Coord.:	



PROTECTIVE CGS	
Material Type	
Diameter	
Depth BGS	Weep Hole ( )
GUARD POSTS ( )	
No.	Type
SURFACE PAD	
Composition & Size	
RISER PIPE	
Type	
Diameter	
Total Length (TOC to TOS)	
GROUT	
Composition & Prop.	
Interval	
Tremied ( )	
CENTRALIZERS ( )	
Depth(s)	
WATER ADDED ( )	
Interval	Amount
Interval	Amount
Interval	Amount
Interval	Amount

BACKFILL PLUG
Material
Setup/Hydration time
Tremied ( )

MONITORING WELL CONSTRUCTION LOG - Open Hole Flush Mount		REV. 10/90
Well No.:	Installation:	Site:
Project No.:	Client/Project:	
HAZWRAP Contractor:	Drilling Contractor:	
Comp. Start:	Comp. End:	
Built By:	Well Coord.:	



PROTECTIVE CGS	
Material Type	
Diameter	Water Tight Seal ( )
Depth BGS	Weep Hole ( )
SURFACE PAD	
Composition & Size	
RISER PIPE	
Type	
Diameter	
Total Length (TOC to TOS)	
GROUT	
Composition & Prop.	
Interval	
Tremied ( )	
CENTRALIZERS ( )	
Depth(s)	
WATER ADDED ( )	
Interval	Amount
Interval	Amount
Interval	Amount
Interval	Amount

BACKFILL PLUG	
Material	
Setup/Hydration time	
Tremied ( )	

ASTM TABLE 1

RECOMMENDED (ACHIEVABLE) FILTER PACK CHARACTERISTICS FOR COMMON SCREEN SLOT SIZES

Size of Screen Opening mm(in)	Slot No.	Sand Pack Mesh Size Name(s)	1% Passing Size (D-1) mm	Effective Size (D-10) mm	30% Passing Size (D-30) mm	Range of Uniformity Coefficient	Roundness (Powers Scale)
0.125 (0.005)	5	100	0.09 - 0.12	0.14 - 0.17	0.17 - 0.21	1.3 - 2.0	2 - 5
0.25 (0.010)	10	24 - 40	0.25 - 0.25	0.4 - 0.5	0.5 - 0.6	1.1 - 1.6	3 - 5
0.50 (0.020)	20	10 - 20	0.7 - 0.9	1.0 - 1.2	1.2 - 1.5	1.1 - 1.6	3 - 6
0.75 (0.030)	30	10 - 20	0.7 - 0.9	1.0 - 1.2	1.2 - 1.5	1.1 - 1.6	3 - 6
1.0 (0.040)	40	8 - 12	1.2 - 1.4	1.6 - 1.8	1.7 - 2.0	1.1 - 1.6	4 - 6
1.5 (0.060)	60	6 - 9	1.5 - 1.8	2.3 - 2.8	2.5 - 3.0	1.1 - 1.7	4 - 6
2.0 (0.080)	80	4 - 8	2.0 - 2.4	2.4 - 3.0	2.6 - 3.1	1.1 - 1.7	4 - 6

ES Footnote: The 0.005 inch slot size is not commonly available. A 0.006 inch slot size is usually used in its place. The actual spacing of a 6 slot screen is commonly between 0.005 and 0.006 inch.

FIELD PROCEDURE FP 5-4

WELL DEVELOPMENT

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Subject	Procedure No.	Rev.	
	FP 5-4	1	Page 1 of 5
WELL DEVELOPMENT	Issue Date	Effective Date	
	10/04/93	10/04/93	
	Supersedes Procedure Number	Rev.	Date
	630 FP 12	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to define the requirements for developing monitoring wells to increase permeability and ensure that a representative sample of groundwater is obtained from the aquifer.

2.0 SCOPE

This procedure applies to development of wells by either the bailing or pumping techniques. The development water will be stored in appropriate containers, analyzed, and handled in accordance with the project-specific work plan.

3.0 REQUIREMENTS

The purpose of well development is to stabilize and increase the permeability of the filter pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. The selection of the well development method shall be made by a hydrogeologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation in which the well is screened. Any equipment introduced into the well during development shall be decontaminated in accordance with Field Procedure FP 3-1.

Each monitoring well will be developed by bailing or pumping. Centrifugal pumps will generally be used to develop shallow wells with high yield. Submersible or positive displacement pumps will generally be used to develop deep wells of low to high yield. Equipment availability or other circumstances may occasion the use of a submersible or positive displacement pump to develop a shallow high-yield well or hand pumps and bailers to develop any well. Physical and chemical parameters including temperature, pH, specific conductance and turbidity of the water will be measured during well development.

4.0 REFERENCES

4.1 Driscoll, Fletcher, G. 1986. *Groundwater and Wells*, 2nd Edition, Johnson Division, St. Paul, Minnesota, pp. 1108.

4.2 HAZWRAP, July 1990. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1.

4.3 United States Environmental Protection Agency, September 1986. *Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1.

4.4 USATHAMA, March 1987. *Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports*.

5.0 DEFINITIONS

Swabbing - Swabbing is a process in which a plunger-type device called a surge plunger or surge block, is moved up and down within the well screen to force groundwater to alternately flow in and out through the sand pack. This back and forth movement of water facilitates removal of fines from the formation immediately adjacent to the well while preventing bridging (wedging) of sand grains.

6.0 RESPONSIBILITIES

6.1 Field Operations Leader

The Field Operations Leader is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that well development activities are performed in compliance with the contract.

6.2 Field Geologist

The Field Geologist is responsible for withdrawing sufficient water to clarify the well, and for performing physical measurements such as pH, temperature, specific conductance and turbidity to ensure proper development. All data should be entered into the Field Logbook and on the Well Development Log (Attachment 9.1).

7.0 EQUIPMENT

1. Pumps
2. Pump Suction Lines

3. Swabbing Equipment (as necessary)
4. Bailers
5. Polypropylene Rope for Bailer Line (or approved equal)
6. Steel Retractable Engineer's Measuring Tape (calibrated to 0.01 foot)
7. Water Level Indicator
8. pH Meter
9. Specific Conductance Meter
10. Mercury Thermometer
11. Drums or Mobile Tanks to Contain the Development Water
12. Field Logbook
13. Plastic Sheeting
14. Aluminum Foil
15. Well Development Log.

8.0 PROCEDURE

8.1 Development

The development of wells will begin between 48 hours and seven days after internal mortar collar placement. During development, water from the entire water column shall be removed by periodically raising and lowering the pump intake. Well development shall be completed for 14 days before sampling occurs. The procedure includes:

- Open and check the condition of the well head. Check for organic vapors.
- Measure the water level in the well before development begins. Record the value to the nearest 0.01 foot in the Field Logbook. This measurement shall be repeated 24 hours after development.
- Measure the total depth of the well prior to development. Record the value to the nearest 0.1 foot in the Field Logbook.
- Measure the pH and specific conductance before development. Collect a sample per Section 8.2.
- Prepare the equipment for developing the well. For screened intervals longer than 10 feet, develop the well in two to three foot intervals from bottom to top.
- Continue development until water appears to run clear. A minimum of five well volumes plus five times any water used during the well installation shall be removed. Water used

for the well installation includes: measured amount of drilling fluid lost while drilling and any water used in filter pack placement.

- Sampling will be repeated until consistent measurements of pH, temperature, and specific conductance are achieved in three consecutive samples.
- Development will be considered complete when the three consecutive measurements, each separated by five minutes, have pH values within ± 0.1 units, temperature within ± 0.5 degrees Celsius, specific conductance within ± 10 micromhos per centimeter, and the well water is clear to the unaided eye.
- Should the recharge be so slow that the required volume cannot be removed in 48 hours, the water remains discolored, or excess sediment remains after the five volume removal; contact the Contracting Office for guidance.
- Measure the total depth of the well after development. Record the value to the nearest 0.1 foot in the Field Logbook.
- If requested, a one-pint water sample of the last water removed during development shall be obtain and given to the installation environmental coordinator within three working days of developing that well.
- The record of well development shall be submitted to the Contracting Office within three working days after development.

8.2 Groundwater Sampling

A pump or bailer will be lowered into the well. Water will be removed from the well at varying depths along the entire interval of the screen until the effluent begins to clear of suspended solids. A sample of the development water will be tested for clarity, pH, temperature, and specific conductance.

1. Temperature Measurement: The temperature of the water will be measured to within 0.5 degrees Celsius (°C) using a mercury thermometer. The measurement will also be used to calibrate the pH and conductivity meters.
2. pH Measurement: The pH of the water will be measured within 0.1 pH unit using a portable pH meter. The meter will be calibrated per FP 7-4.
3. Specific Conductivity Measurement: The specific conductivity of the water will be measured with a portable specific conductivity meter. The instrument will be calibrated per FP 7-5.
4. Turbidity: Turbidity will be measured with the unaided eye.

8.3 Development Methods, Restrictions, and Limitations

8.3.1 Overpumping and Backwashing

- This method develops the well by drawing the water level down at a given rate and then reversing the flow direction so water is passing from the well into the formation.
- Backwashing is accomplished by starting and stopping the pump intermittently.

8.3.2 Surging with a Surge Plunger

- A surge plunger (also called a surge block or swab) is approximately the same diameter as the well casing and is used to agitate the water.
- In formations with a low yield, a solid plunger is the most effective.
- In formations with a high yield, as valved surge plunger may be preferred, as they are designed to create grater inflow than outflow during surging.

9.0 ATTACHMENTS

9.1 Well Development Log

SAIC
An Employee-Owned Company

Well Development Form
(Field Sheet)

Project Name and Number: ______________________

Well Number and Location: ______________________

Development Crew: ______________ Driller (if applicable): ______________

Water Levels/Time: Initial: ____________ Pumping: ____________ Final: ____________

Total Well Depth: Initial: ____________ Final: ____________

Date and Time: Begin: ____________ Completed: ____________

Development: Method(s): ______________________

____

Total Quantity of Water Removed: ______________ gals

Date/Time and Pump Setting	Discharge Rate* and Measurement Method	Field Measurements				Remarks (Including Sand Production)
		Temp (°C)	Specific Conductivity (umhos/cm)	pH (Standard Units)	Turbidity	

*gallons per minute or bailer capacity

FIELD PROCEDURE FP 5-5

WELL PURGING - BAILING METHOD

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Subject	Procedure No.	Rev.	
	FP 5-5	3	Page 1 of 7
WELL PURGING - BAILING METHOD	Issue Date		Effective Date
	10/04/93		10/04/93
	Supersedes Procedure Number	Rev.	Date
	630 FP 13	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide general reference information on well purging by the bailing method prior to the sampling of groundwater wells. The methods and equipment described are for the purging of water samples from the saturated zone of the substrata.

2.0 SCOPE

This procedure applies to purging water from relatively low volume wells. Reference Field Procedure FP 5-6 Well Purging - Pumping Method for wells too voluminous for purging by the bailing method. The site hydrogeologist, geochemist, and risk assessment personnel shall define the objective of the groundwater sampling program in the project-specific work plan.

3.0 REQUIREMENTS

Methods for purging from completed wells include the use of pumps, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to purging and sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant.

4.0 REFERENCES

4.1 HAZWRAP, July 1990. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1.

4.2 USAEC, May 1993. *U.S. Army Environmental Center Guidelines for Implementation of ER 1110-1-263 for USAEC Projects.*

4.3 USATHAMA, January 1990. *U.S. Army Toxic and Hazardous Materials Agency Quality Assurance Program*, USATHAMA PAM 11-41.

4.4 United States Environmental Protection Agency, 1987. *Ground Water Handbook*, EPA/625/6-87/016.

4.5 United States Environmental Protection Agency, September 1986. *Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1.

5.0 DEFINITIONS

Bailer - A cylindrical section of Teflon® with a floating ball check-valve at the bottom. The bailer is submerged, the ball floats, and water enters from the bottom. As the bailer is raised, the ball settles on the bottom creating a seal, allowing retrieval of a quantity of trapped water.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for reviewing the purging procedures used by the field crew and for performing in-field spot checks for proper purging procedures.

6.2 Site Hydrogeologist or Geochemist

The Site Hydrogeologist or Geochemist is responsible for selecting and detailing the specific well purging techniques and equipment to be used, documenting these in the Field Logbook, and properly briefing the site sampling personnel.

6.3 Site Geologist

The Site Geologist is primarily responsible for the proper well purging techniques. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians). The Site Geologist will be responsible for purging of wells, performing necessary physical measurements and observations, and containment of purged water. The Site Geologist must record pertinent information including amount of water purged, pH, specific conductivity, temperature, and turbidity in the Field Logbook and on the Groundwater Sampling Form, Attachment 9.1.

7.0 EQUIPMENT

1. Bailers
2. Polypropylene Bailer Line (or approved equal)
3. Steel Retractable Engineer's Measuring Tape (Calibrated to 0.01 Foot)
4. Water Level Indicators
5. Swabbing Equipment (as necessary)
6. pH Meter
7. Specific Conductance Meter
8. Mercury Thermometer
9. HNu Photoionization Detector
10. Drums to Contain the Purge Water
11. Groundwater Sampling Form, Attachment 9.1
12. Field Logbook
13. Calculator
14. Plastic Sheeting.

8.0 PROCEDURE

8.1 General

- The amount of flushing a well should receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions.
- A well will not be purged until at a minimum five well volumes of water are removed.

8.2 Calculations of Well Volume

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to determine the volume of standing water in the well pipe and the volume of water in the filter pack below the well seal. The volume can be easily calculated by the following method. Calculations shall be entered in the Field Logbook:

1. Obtain all available information on well construction (location, casing, screens, etc.).
2. Determine well casing and borehole diameter.
3. Measure and record static water level (depth below ground level or top of casing reference point), using one of the methods described in FP 7-2.

4. Determine depth of well (if not known from past records) by sounding, using a clean, decontaminated weighted tape measure or water level indicator.

5. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

6. Calculate the volume of water in the casing and the volume of water in the filter pack (see Attachment 9.2).

$$Vc = \pi (di/2)^2(TD-H)$$

$$Vf = \pi [(dH/2)^2 - (do/2)^2] (TD - S \text{ or } H) (P)$$

If $S > H$ use S, if $S < H$ use H

$$Vt = (Vc + Vf) (7.48)$$

where:

Vc = volume of water in casing, ft^3

Vf = volume of water in filter pack, ft^3

Vt = total volume, gal

di = inside diameter of casing, ft

do = outside diameter of casing, ft

dH = diameter of borehole, ft

TD = total depth of well, ft

H = depth to water, ft, from ground surface

S = depth to base of seal, ft, from ground surface

P = estimated porosity of filter pack (for most Ottawa, Morie #1 sand or glass beads value is estimated at a range of 30 to 35%).

7. Determine the minimum number of volumes to be evacuated before sampling.

8.3 Specific Procedure for Well Purging by Bailing

- Work crew members must use either new disposable gloves or decontaminated reusable gloves.
- To prevent cross-contamination of wells, upgradient and background wells should be purged and sampled first.
- Measure background organic vapors in the air using the HNu meter.
- Open the well casing cover, remove the well cap, and sample the well head space for gaseous contaminants using the HNu photoionization detector (FP 2-2). If the organic vapor

concentration is equal to or greater than 1000 ppm, immediately recap the well and inform the Field Operations Leader.

- Measure the "depth to water" in the well in accordance with the water level measurement procedure and using well construction data (FP 7-2).
- Calculate the volume of water in the well. Record this information in the purge notebook and calculate the volume of water required to be purged. Normally, the well will be purged of five volumes of water.
- An initial measurement of purge water for physical parameters including pH, conductivity, temperature, and turbidity (description by unaided eye) shall be recorded on the Groundwater Sampling Form and in the Field Logbook.
- Remove protective foil from the bailer.
- To prevent bailer from becoming lodged in the well, the loose end of the rope will be cut short enough not to extend beyond the sloping portion of the bailer barrel.
- The bailer will be slowly lowered into the well to the desired level.

  NOTE: If resistance is encountered when lowering the bailer into the well, THE BAILER WILL BE WITHDRAWN FROM THE WELL and the Field Operations Leader informed.
- The rope will be secured to the protective casing of the well or to the Geologist's wrist.
- To prevent the introduction of foreign contaminants into the well, the bailing rope will not be allowed to contact the ground.
- The bailer will be withdrawn from the well and the purge water poured into the receptor drum or bulk container.
- The bailer will be lowered and a full bailer will be withdrawn repeatedly until the required minimum of five well volumes have been purged.
- Record total volume of water removed on the Groundwater Sampling Form (Attachment 9.1) and in the Field Logbook.
- Purging will continue until a minimum of five well volumes are removed.
- Chemical samples shall be obtained immediately after bailing is complete in accordance with FP 6-5.
- After obtaining chemical samples, a final measurement of purge water for physical parameters including pH, conductivity, temperature, and turbidity (description by unaided eye) shall be recorded on the Groundwater Sampling Form and in the Field Logbook.
- Whenever the receptor drum has become filled, the water shall be stored, analyzed and disposed of in accordance with the project-specific work plan.
- Decontaminate the bailers in accordance with FP 3-1 after purging is complete.
- Bailer shall not be left inside the well after purging is complete.

8.4 Purging of Low Recharge Wells

Purge rates should be at a value less than that indicated from the well development recharge rate recorded at the conclusion of well development. Under low recharge conditions, this rate will rarely exceed 1 liter/minute. This low purge rate will permit the water within the casing and borehole to exchange without pumping the well to dryness or appreciably depressing the static water level.

If the above condition cannot be met, the entire volume of water within the well casing and borehole should be removed at the rate determined above. If it already known that the well can be pumped down without appreciable recharge, the rate specified above should not be exceeded. Excessive pumping will only cause turbidity problems when eventual recharge and sampling begins. If possible, the wells should not be purged dry. This may result in aeration of the samples and possible alteration of the contaminant or the concentrations.

If the well does not recover to 90 percent of its static water level within six to eight hours, only one borehole volume need be removed. If the well recovers in less time, purge activities should be repeated at least one more time. At the conclusion of the initial purge activities, if significant fines have accumulated in the bottom of the well, these fines should be removed before the second purge activity.

Sampling from wells in which the static water level was not appreciably depressed is to occur immediately after purge activities are completed. Sampling from wells, in which the water was completely removed from the well or the recovery time is very slow, will occur when the water level has reached a point above the bottom of the screen such that a sufficient sample can be retrieved.

Care shall be used to minimize agitation that may cause turbid conditions when purging slow recharging wells. Where possible these wells should be purged with a peristaltic pump or bladder pump that allows for purge rates less than 0.5 liter/minute. Definition of a peristaltic pump can be found in FP 5-6.

8.5 Restrictions and Limitations

- Bailers are the simplest evacuation devices and offer several advantages:
  - few limitations on size and materials
  - no external power source required
  - inexpensive and dedicated to the well to reduce cross-contamination
  - easy to decontaminate.

- Limitations on the use of bailers include:
  - time consuming to remove stagnant water column
  - transfer of sample may cause aeration
  - use of bailer is physically demanding, especially in warm climates at protection levels above Level D.

9.0 ATTACHMENTS

9.1 Groundwater Sampling Form

9.2 Well Volume Calculation Definition Sketch

SAIC
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Sampling Form
(Field Sheet)

Project Name and Number: ______________________

Sampling Crew: ______________________

Sampling Point Number: ______________________

Sampling Location: ______________________

Sample Type: ☐ GW ☐ SW ☐ Soil ☐ SED ☐ Other: ______________________

Date and Time Sample Collected: ______________________

Weather Conditions: ______________________

Purging Information (if applicable):

Method: ______________________

Quantity of Water Purged: ______________________

Disposition of Purge Water: ______________________

Date and Time of Purging: Start: ____________ End: ____________

Comments: ______________________

Groundwater:

Date and Time Collected: ______________________

Sampling Depth: ______________________

Water Level: ______________________

Sampling Method/Equipment: ______________________

Field Measurements: pH ________ Temp: ________ Cond: ________ Alkalinity: ________

Date and Time Filtered (if applicable): ______________________

Comments: ______________________

Surface Water:

Date and Time Collected: ______________________

Collection Method: ______________________

Date and Time Filtered (if applicable): ______________________

Field Measurements: pH ________ Temp: ________ Cond: ________ Turbidity: ________

Comments: ______________________

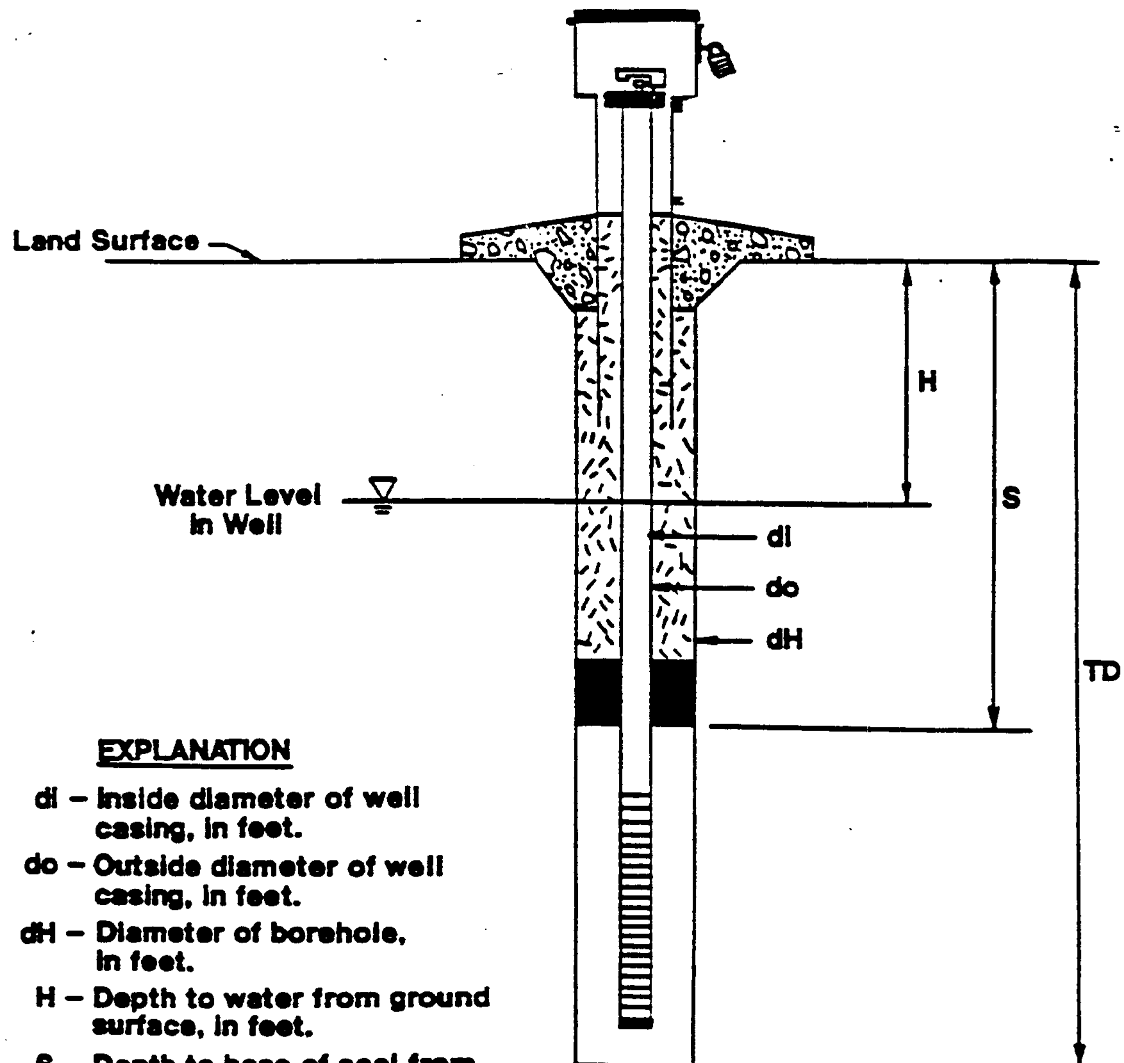
Soils/Sediment Sampling:

Date and Time Collected: ______________________

Sampling Depth: ______________________

Sampling Method: ______________________

Comments: ______________________



EXPLANATION

di – Inside diameter of well casing, in feet.
do – Outside diameter of well casing, in feet.
dH – Diameter of borehole, in feet.
H – Depth to water from ground surface, in feet.
S – Depth to base of seal from ground surface, in feet.
TD – Total depth of well, in feet.

Well Volume Calculation Definition Sketch.

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FIELD PROCEDURE FP 5-6

WELL PURGING - PUMPING METHOD

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Subject	Procedure No.	Rev.	
	FP 5-6	1	Page 1 of 6
WELL PURGING - PUMPING METHOD	Issue Date		Effective Date
	10/04/93		10/04/93
	Supersedes Procedure Number	Rev.	Date
	630 FP 14	0	
Acceptance - Program QA	Approval - Program Manager		

1.0 PURPOSE

The purpose of this procedure is to provide general reference information on well purging by the pumping method prior to the sampling of groundwater wells. The methods and equipment described are for the purging of water samples from the saturated zone of the substrata.

2.0 SCOPE

This procedure applies to purging relatively large volumes of water in a shallow to medium depth well. The site hydrogeologist, geochemist, and risk assessment personnel shall define the objective of the groundwater sampling program in the project-specific work plan.

3.0 REQUIREMENTS

Methods for purging from completed wells include the use of pumps, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to purging and sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant.

4.0 REFERENCES

4.1 HAZWRAP, July 1990. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1.

4.2 USAEC, May 1993. *U.S. Army Environmental Center Guidelines for Implementation of ER 1110-1-263 for USAEC Projects.*

4.3 USATHAMA, January 1990. *U.S. Army Toxic and Hazardous Materials Agency Quality Assurance Program*, USATHAMA PAM 11-41.

4.4 United States Environmental Protection Agency, 1987. *Ground Water Handbook*, EPA/625/6-87/016.

4.5 United States Environmental Protection Agency, September 1986. *Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1.

5.0 DEFINITIONS

None.

6.0 RESPONSIBILITIES

6.1 Project Manager

The Project Manager is responsible for reviewing the purging procedures used by the field crew and for performing in-field spot checks for proper purging procedures.

6.2 Site Hydrogeologist or Geochemist

The site hydrogeologist or geochemist is responsible for selecting and detailing the specific well purging techniques and equipment to be used, documenting these in the Field Logbook, and properly briefing the site sampling personnel.

6.3 Site Geologist

The Site Geologist is primarily responsible for the proper well purging techniques. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians). The Site Geologist will be responsible for purging of wells, performing necessary physical measurements and observations, and containment of purged water. The Site Geologist must record pertinent information including amount of water purged, pH, specific conductivity, temperature, and turbidity in the Field Logbook and on the Groundwater Sampling Form, Attachment 9.1.

7.0 EQUIPMENT

1. Gasoline or Electric Purge Pump
2. Power Source

3. Steel Retractable Engineer's Measuring Tape (Calibrated to 0.01 Foot)
4. Water Level Indicator
5. Swabbing Equipment (as necessary)
6. pH Meter
7. Specific Conductance Meter
8. Mercury Thermometer
9. HNu Photoionization Detector
10. Drums to Contain the Purge Water
11. Groundwater Sampling Form, Attachment 9.1
12. Field Logbook
13. Calculator
14. Plastic Sheeting.

8.0 PROCEDURE

8.1 General

- The amount of flushing a well should receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions.
- A well will not be purged until at a minimum five well volumes of water are removed.

8.2 Calculations of Well Volume

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to determine the volume of standing water in the well pipe and the volume of water in the filter pack below the well seal. The volume can be easily calculated by the following method. Calculations shall be entered in the Field Logbook:

1. Obtain all available information on well construction (location, casing, screens, etc.).
2. Determine well casing and borehole diameter.
3. Measure and record static water level (depth below ground level or top of casing reference point), using one of the methods described in FP 7-2.
4. Determine depth of well (if not known from past records) by sounding, using a clean, decontaminated, weighted tape measure or water level indicator.
5. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

6. Calculate the volume of water in the casing and the volume of water in the filter pack (see Attachment 9.2).

   $Vc = \pi (di/2)^2(TD-H)$

   $Vf = \pi [(dH/2)^2 - (do/2)^2] (TD - S \text{ or } H) (P)$

   If $S > H$ use S, if $S < H$ use H

   $Vt = (Vc + Vf) (7.48)$

where:

- Vc = volume of water in casing, ft^3
- Vf = volume of water in filter pack, ft^3
- Vt = total volume, gal
- di = inside diameter of casing, ft
- do = outside diameter of casing, ft
- dH = diameter of borehole, ft
- TD = total depth of well, ft
- H = depth to water, ft, from ground surface
- S = depth to base of seal, ft, from ground surface
- P = estimated porosity of filter pack (for most Ottawa, Morie #1 sand or glass beads value is estimated at a range of 30 to 35%).

7. Determine the minimum number of volumes to be evacuated before sampling.

8.3 Specific Procedure

- Work crew members must use either new disposable gloves or decontaminated reusable gloves.
- To prevent cross-contamination of wells, upgradient and background wells should be purged and sampled first.
- Measure background organic vapors in the air using the HNu meter.
- Open the well casing cover, remove the well cap, and sample the well head space for gaseous contaminants using the HNu photoionization detector (FP 2-2). If the organic vapor concentration is equal to or greater than 1000 ppm, immediately recap the well and inform the Field Operations Leader.
- Measure the "depth to water" in the well in accordance with the water level measurement procedure and using well construction data (FP 7-2).

- Calculate the volume of water in the well. Record this information in the Field Logbook and calculate the volume of water required to be purged. Normally, the well will be purged of five volumes of water and until the temperature, pH, and conductivity have stabilized.
- An initial measurement of purge water for physical parameters including pH, conductivity, temperature, and turbidity (description by unaided eye) shall be recorded on the Groundwater Sampling Form and in the Field Logbook.
- Lower the purge pump into the well until it is submerged.

  NOTE: If resistance is encountered when lowering the pump into the well, WITHDRAW THE PUMP FROM THE WELL and inform the Field Operations Leader.
- Direct the pump discharge hose into the receptor bucket and start the pump in accordance with the pump's operation manual. Record the total volume of water purged from the well. Collect a minimum of three samples during purging and note the clarity, pH, conductivity, and temperature measurements of the sample in the Field Logbook.
- Purging will continue until a minimum of five well volumes are removed.
- Chemical samples shall be obtained immediately after bailing is complete in accordance with FP 6-5.
- After obtaining chemical samples, a final measurement of purge water for physical parameters including pH, conductivity, temperature, and turbidity (description by unaided eye) shall be recorded on the Groundwater Sampling Form and in the Field Logbook.
- Whenever the receptor bucket is filled, dispose of the purge water in accordance with the project-specific work plan.
- Carefully withdraw the purge pump from the well and decontaminate the pump and hose in accordance with FP 3-1 after purging is complete.
- Dispose of all contaminated waste items in accordance with the project-specific work plan.

8.4 Well Purging by Pumping

8.4.1 Peristaltic Pumps

A Peristaltic pump creates a vacuum in a flexible polymer tube that is capable of drawing water out of a well from approximately 30 feet deep. The tubing runs through the pump's roller-bearing housing, which cyclically squeezes it, forcing water out the top and drawing water in the bottom. The pump sits at the surface, only the tubing is lowered into the well. The pump can draw water very slowly and steadily with a minimum of agitation, making it ideal for the development, purging and sampling of slow recharge wells less than 30 feet deep. Direction for the sampling of slow recharging wells can be found in FP 5-5.

8.4.2 Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources of these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, or impeller. Pumps are available for 2-inch diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet). Limitations of this class of pumps include:

- Low delivery rates
- Many models of these pumps are expensive
- Compressed gas or electric power is required
- Sediment in water may cause clogging of the valves or erode the impellers in some models
- Decontamination of internal components is difficult and time-consuming.

9.0 ATTACHMENTS

9.1 Groundwater Sampling Form

9.2 Well Volume Calculation Definition Sketch

SAIC
An Employee-Owned Company

Sampling Form
(Field Sheet)

Project Name and Number: ______________________

Sampling Crew: ______________________

Sampling Point Number: ______________________

Sampling Location: ______________________

Sample Type: ☐ GW ☐ SW ☐ Soil ☐ SED ☐ Other: __________

Date and Time Sample Collected: ______________________

Weather Conditions: ______________________

Purging Information (if applicable):

Method: ______________________
Quantity of Water Purged: ______________________
Disposition of Purge Water: ______________________

Date and Time of Purging: Start: __________ End: __________
Comments: ______________________

Groundwater:

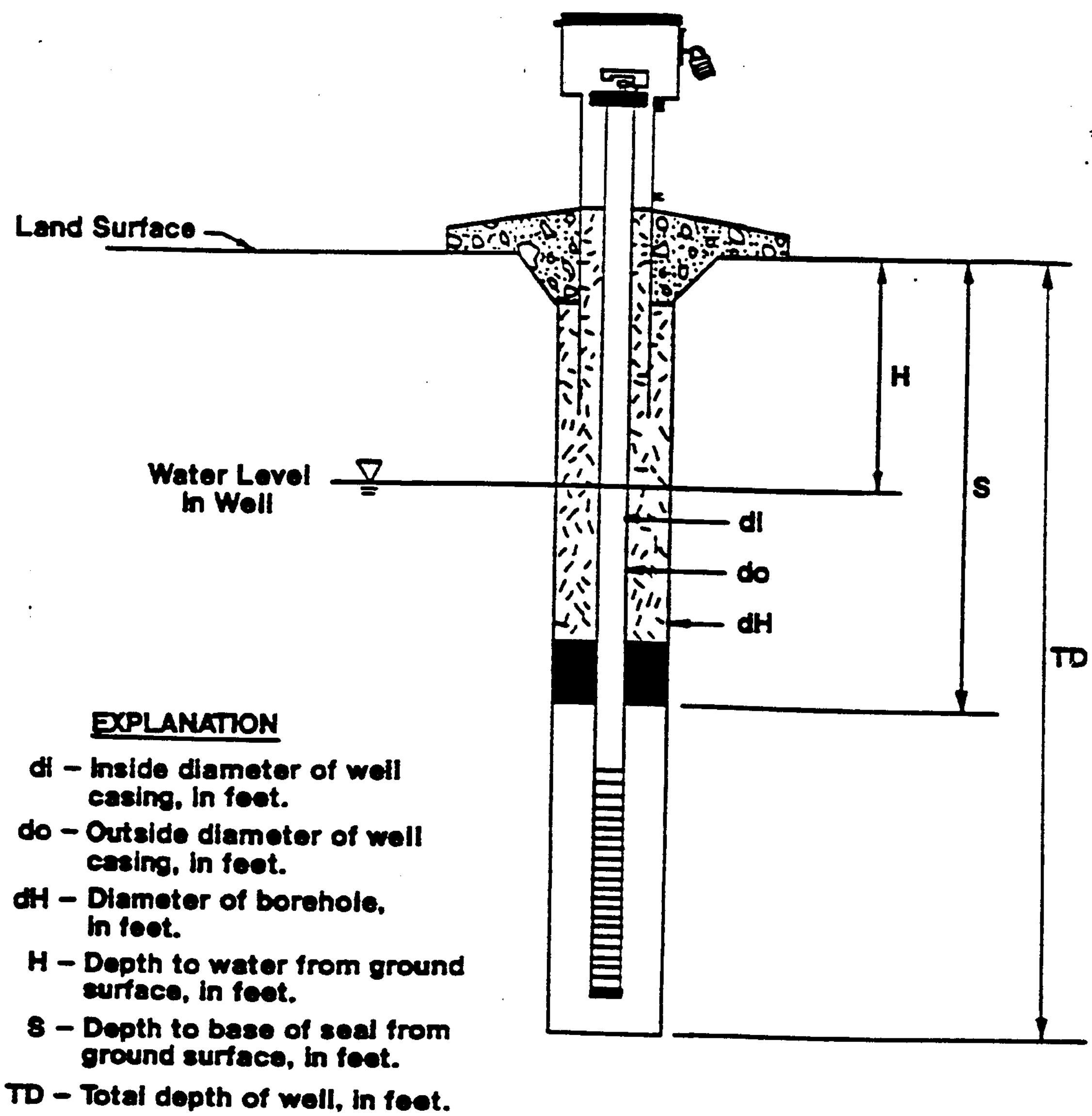
Date and Time Collected: ______________________
Sampling Depth: ______________________
Water Level: ______________________
Sampling Method/Equipment: ______________________
Field Measurements: pH ______ Temp: ______ Cond: ______ Alkalinity: ______
Date and Time Filtered (if applicable): ______________________
Comments: ______________________

Surface Water:

Date and Time Collected: ______________________
Collection Method: ______________________
Date and Time Filtered (if applicable): ______________________
Field Measurements: pH ______ Temp: ______ Cond: ______ Turbidity: ______
Comments: ______________________

Soils/Sediment Sampling:

Date and Time Collected: ______________________
Sampling Depth: ______________________
Sampling Method: ______________________
Comments: ______________________



Well Volume Calculation Definition Sketch.