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Standard Guide for
Installation of Direct Push Ground Water Monitoring Wells[1]

This standard is issued under the fixed designation D 6724; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide describes various direct push ground water monitoring wells and provides guidance on their selection and installation for obtaining representative ground water samples and monitoring water table elevations. Direct push wells are used extensively for monitoring ground water quality in unconsolidated formations. This guide also includes discussion of some groundwater sampling devices which can be permanently emplaced as monitoring wells.

1.2 This guide does not address the single event sampling of ground water using direct push water samplers as presented in Guide D 6001. The methods in this guide are often used with other tests such as direct push soil sampling (Guide D 6282) and the cone penetrometer test (Guide D 6067). The present guide does not address the installation of monitoring wells by rotary drilling methods such as those presented in Practice D 5092. Techniques for obtaining ground water samples from monitoring wells are covered in Guide D 4448.

1.3 The installation of direct push ground water monitoring wells is limited to unconsolidated soils and sediments including clays, silts, sands, and some gravels and cobbles. Penetration may be limited, or damage may occur to equipment, in certain subsurface conditions; some of which are discussed in 5.5. Information in this guide is limited to ground water monitoring in the saturated zone.

1.4 This guide does not purport to comprehensively address all of the methods and issues associated with monitoring well installation. Users should seek input from qualified professionals for the selection of proper equipment and methods that would be the most successful for their site conditions. Other methods may be available for monitoring well installation, and qualified professionals should have flexibility to exercise judgement concerning alternatives not covered in this guide. The practice described in this guide is current at the time of issue; however, new, alternative, and innovative methods may become available prior to revisions. Therefore, users should consult with manufacturers or producers prior to specifying program requirements.

1.5 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgement. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 4448 Guide for Sampling Ground Water Monitoring Wells[3]

D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[2]

D 5088 Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites[2]

D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers[2]

D 5254 Practice for Minimum Set of Data Elements[2]

D 5299 Guide for Decommissioning Monitoring Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities[2]

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock[2]

D 5474 Guide for Selection of Data Elements for Ground Water Investigation[2]

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[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 11.04.

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D 5521 Guide for Development of Ground Water Monitoring Wells in Granular Aquifers[2]

D 5730 Guide for Site Characterization for Environmental Purposes with Emphasis on Soil, Rock, the Vadose Zone, and Ground Water[2]

D 6001 Guide for Direct Push Water Sampling for Geoenvironmental Investigations[4]

D 6067 Guide for Electronic Cone Penetrometer Testing for Environmental Site Characterization[4]

D 6282 Guide for Direct Push Soil Sampling for Environmental Site Characterization[4]

D 6286 Guide for Selection of Drilling Methods for Environmental Site Characterization[4]

D 6452 Guide for Purging Methods for Wells Used for Groundwater Quality Investigations[4]

D 6564 Guide for Field Filtration of Ground Water Samples[4]

D 6634 Guide for the Selection of Purging and Sampling Devices for Ground Water Sampling Wells[4]

3. Terminology

3.1 Terminology used within this standard is in accordance with D 653.

4. Summary of Guide

4.1 This guide provides information to be used by experienced ground water professionals for investigation of the subsurface and ambient ground water conditions.

4.2 This guide outlines a variety of field methods for installing direct push ground water monitoring wells. Installation methods include: (*1*) soil probing using combinations of dynamic (percussion or vibratory) driving with, or without, additions of static (constant) force; (*2*) static force from the surface using hydraulic penetrometer or drilling equipment; and (*3*) incremental drilling combined with direct push methods. Methods for installation of annular seals and annular grouts are also discussed as well as abandonment grouting.

4.3 This guide addresses considerations for selection and use of direct push well systems and installation techniques that may be classified into two main categories; exposed screen techniques and protected screen techniques. In exposed screen techniques, the screened casing may serve as the drive rod, or may surround a drive rod that is removed following installation. In protected screen techniques, the well may be advanced along with a protective outer casing, or may be lowered into a driven casing that is subsequently removed. Alternatively, the screen, riser, and a retractable shield may be driven simultaneously and all remain in the ground.

4.4 The interval to be tested is determined in advance by prior investigation, or by soil or water sampling during direct push driving. A screen section, either protected or unprotected, is connected to riser pipes and either driven on the outside of, or placed inside of direct push rods. With some monitoring well designs, it may be necessary to add sand pack and seals to isolate the screened test zone as the rods are retracted. The top of the installation is usually completed in a manner consistent with regulatory requirements. The well can be developed to remove mobile sediments. Water levels can be measured, and water samples are taken as required in the sampling plan.

5. Significance and Use

5.1 The direct push ground method is a rapid and economical procedure for installing ground water monitoring wells to obtain representative ground water samples and location-specific hydrogeologic measurements. Direct push installations may offer an advantage over conventional rotary drilled monitoring wells (Practice D 5092) for ground water investigations in unconsolidated formations because they reduce disturbance to the formation, and eliminate or minimize drill cuttings. At facilities where contaminated soils are present, this can reduce hazard exposure for operators, local personnel, and the environment, and can reduce investigative derived wastes. Additionally, smaller equipment can be used for installation, providing better access to constricted locations.

5.2 Direct push monitoring wells generally do not extend to depths attainable by drilling. They are also typically smaller in diameter than drilled wells, thereby reducing purge water volumes, sampling time, and investigative derived wastes. Practice D 5092 monitoring wells are used when larger diameters and/or sample volumes are required, or at depths to which it is difficult to install direct push wells. Direct push monitoring wells should be viable for monitoring for many years.

5.3 Prior to construction and installation of a direct push well or any other type of ground water well the reader should consult appropriate local and state agencies regarding regulatory requirements for well construction in the state. A regulatory variance may be required for installation of direct push monitoring wells in some states.

5.4 To date, published comparison studies between drilled monitoring wells and direct push monitoring wells have shown comparability **(1, 2, 3, 4, 5)**. However, selection of direct push monitoring wells over conventional rotary drilled wells should be based on several criteria, such as site accessibility and penetrability, stratigraphic structure, depth to groundwater, and aquifer transmissivity.

5.5 Typical penetration depths for installation of ground water monitoring wells with direct push equipment depend on many variables. Some of the variables are the size and type of the driving system, diameter of the drive rods and monitoring well, and the resistance of the earth materials being penetrated. Some direct push systems are capable of installing ground water monitoring wells to depths in excess of 100 feet, and larger direct push equipment, such as the vibratory sonic type drill (Guide D 6286) are capable of reaching much greater depths, sometimes in excess of 400 ft. However, installation depths of 10 to 50 feet are most common. Direct push methods cannot be used to install monitoring wells in consolidated bedrock (for example, granite, limestone, gneiss), but are intended for installation in unconsolidated materials such as clays, silts, sands, and some gravels. Additionally, deposits containing significant cobbles and boulders (for example, some glacial deposits), or strongly cemented materials (for example, caliche) are likely to hinder or prevent penetration to the desired monitoring depth.

[4] *Annual Book of ASTM Standards*, Vol 04.09.

5.6 For direct push methods to provide accurate ground water monitoring results, precautions must be taken to ensure that cross-contamination by "smearing" or "drag-down" (that is, driving shallow contamination to deeper levels) does not occur, and that hydraulic connections between otherwise isolated water bearing strata are not created. Similar precautions as those applied during conventional rotary drilling operations (Guide D 6286) should be followed.

5.7 There have been no conclusive comparisons of effectiveness of sealing between drilled monitoring wells and direct push monitoring wells. As with drilled monitoring wells, sealing methods must be carefully applied to be effective.

5.8 Selection of direct push monitoring wells versus conventional rotary drilled monitoring wells should be based on many issues. The advantages and disadvantages of the many available types of driving equipment and well systems must be considered with regard to the specific site conditions. Specific well systems and components, as well as direct push driving equipment, are described in Section 7.

5.9 *Advantages*:

5.9.1 Minimally intrusive and less disturbance of the natural formation conditions than many conventional drilling techniques.

5.9.2 Rapid and economical.

5.9.3 Smaller equipment with easier access to many locations.

5.9.4 Use of shorter screens can eliminate connections between multiple aquifers providing better vertical definition of water quality than long well screens.

5.9.5 Generates little or potentially no contaminated drill cuttings.

5.9.6 Less labor intensive than most conventional drilling techniques.

5.10 *Disadvantages*:

5.10.1 Cannot be used to install monitoring devices in consolidated bedrock and deposits containing significant cobbles and boulders.

5.10.2 Small diameter risers and screens limit the selection of useable down-hole equipment for purging and sampling.

5.10.3 Difficulty installing sand pack in small annular space if gravity installation of sand pack is used.

5.10.4 Difficulty installing grout in same annular space unless appropriately designed equipment is used.

6. Pre-Installation Considerations

6.1 *Site Characterization*—Successful installation of direct push ground water monitoring wells must be preceded by appropriate site characterization activities. These activities may include reconnaissance, research, conceptual model development, exploratory field investigations, and confirmation and re-evaluation of any existing flow models.

6.2 For the installation to be successful, it is imperative that the target aquifer be located accurately. As with any well installation, the geologic conditions must be understood and the stratigraphy must be known. Although direct push wells can monitor thinner aquifers, with more precision, they may be ineffective is incorrectly placed. In thicker aquifers, and when seeking dense non-aqueous phase liquids, screens may need to be located in the bottom of the water-bearing stratum. Wells placed without determination of nearby geologic conditions can be ineffective and possibly dangerous. Geologic investigations should look for perched aquifers and use installation methods which will avoid any crosscontamination of the unit.

6.3 Environmental site characterization approaches are described in Guide D 5730. Proper site characterization for monitoring well placement is reviewed in Practice D 5092 on Monitoring Well Design.

6.3.1 *Characterization Tools*—In geologic settings amenable to the use of direct push ground water monitoring wells, other direct push methods and tools can likely also be used to effectively characterize the site. For example, the Cone Penetrometer Test (CPT) (Guide D 6067) is an effective tool for mapping stratigraphy and locating target layers. Other sensors, such as electrical conductivity and optical detectors have been placed on CPT and other direct push systems. Direct push soil sampling (Guide D 6282) and water sampling (Guide D 6001) can be used in advance to locate strata of concern. Direct push characterization experience at a site can guide the user in well design or device selection.

6.3.2 *Sampling During Installation*—Many direct push systems can take soil or water samples as part of the well installation process. For example, two-tube systems described in direct push soil sampling Guide D 6282 can be used to collect soil samples while driving. When the target aquifer is reached, the well screen system can be installed in the casing. Sampling data taken prior to well installation can confirm the target stratum has been reached.

6.3.3 *Sampling Systems*—There is a wide variety of direct push ground water sampling systems which can also be used for ground water monitoring. Direct push water sampling Guide D 6001 describes exposed screen versus protected screen samplers. Guide D 6282 describes the differences in two-tube and single-rod direct push soil sampling systems.

6.4 *Access and Clearances*—The selection of driving equipment should consider the accessability of the installation site. The site should be surveyed for accessibility. Utility clearances may be required. Certain driving methods are incompatible with nearby hazards (for example, flammables). Also check for overhead utility lines during the site survey.

6.5 *Well Size Selection*—Driving resistance can govern the selection of an appropriate well diameter. Driving resistance can be evaluated by direct push testing on the site prior to well installation. Larger diameter monitoring wells may be easy to install on soft or loose ground sites. Smaller diameter monitoring wells may facilitate deeper installation on sites that are more resistant to penetration, but also present additional considerations for use as discussed below.

6.5.1 The availability of appropriate well development and sampling equipment for use in small-diameter monitoring wells may be limited. Many conventional down-hole pumps for purging and sampling are too large for use in small-diameter screens and risers.

6.5.2 Small diameter monitoring wells, because they are generally less rigid than larger diameter monitoring wells, require special attention during backfilling to maintain vertical alignment. This may include the use of centralizers.

7. Direct Push Wells Systems and Components

7.1 *Drive Rod and Casing*—In some instances the well itself may serve as the drive rod. Otherwise, it either surrounds the well casing or is contained within it diuring installation, and is then removed. Direct push drive rod is typically constructed of steel in threaded sections. Lengths of 3.3 ft or 5 ft are common. The diameter selected will depend on the driving resistance of the soil and well size considerations. Consult experienced area contractors or qualified manufacturers to select the appropriate diameters for the site. Drive rods used inside of casings range from 0.5 to 1.25 in. in diameter. Outer drive casings of up to 4.5-in. diameter have been used at relatively soft or loose soil sites allowing installation of 2-in. screen/riser assemblies. The most common casing sizes are 2 to 3 in. Large drive rods can be advanced with large vibratory drills (Guide D 6286). Threaded sections can be outfitted with o-ring seals or PFTE tape to reduce ground water infiltration. Drive casings are equipped with expendable steel or aluminum drive points that are left in the bottom of the well.

7.2 *Well Screen and Riser Pipe*—Slotted PVC with flush-joint riser pipe is commonly used in the installation of direct push monitoring wells. Sizes range from ½ in. to 2 in. (Schedules 40 and 80). Other riser screen and riser materials such as stainless steel, polyethylene, or PTFE may be used. PVC is preferred due to its low cost and because it is relatively inert. Selection of well material should consider possible material interactions with the contaminant being monitored. While PVC and Stainless steel are commonly used in most monitoring wells without any problem, there are extreme environmental conditions that could lead to failure of these materials. PVC should not be exposed to neat organic solvents (that is, pure products) that are PVC solvents or swelling agents or to extremely high concentrations of these chemicals (approaching a saturated solution) **(5, 6, 7, 8, 9, 10)**. Although there is very little data on the expected life of steel well casings **(11)**, stainless steel is reported to perform well in most environments **(11, 12, 13)**. Stainless steel should be avoided in extremely corrosive conditions, which may include water high in chlorides, low in pH, high in dissolved solids or high in dissolved oxygen **(14, 15, 16, 17)**. As screen and riser pipe may contain chemical residue from manufacturing, the screen and riser should be cleaned prior to installation. Threads of the riser pipe can be sealed with O-rings or by using PTFE tape.

7.2.1 Slotted (PVC) or wire-wrapped (steel) well screen is normally supplied with slot widths of 0.01 or 0.02 in. The screen can be wrapped with stainless steel wire mesh of 0.006 in. opening. The selection of slot size depends on the formation grain size distribution and if a sand pack will be needed to reduce turbidity. Practice D 5092 provides slot size and sand pack selection criteria.

7.2.2 A sediment trap may be specified. If the riser is lifted and needs to be pushed back into place, pointed sediment traps are useful.

7.3 *Sand Pack*—The use of sand packs assists in reducing turbidity and the amount of well development required to obtain low turbidity samples. Monitoring wells without sand packs will likely yield more turbid water, which may impact the results of some chemical analyses. However, a filter can be as thin as several grain diameters to be effective. Improving well yield is not the purpose of the sand pack; yield is controlled by the formation. For monitoring of metals, filtering of samples (Guide D 6564) may be required for samples with elevated turbidity levels.

7.3.1 *Sand Pack Selection and Size Range*—Formations of clean sands and gravels (that is, less than 5 % fines) may not require a sand pack. For soil containing appreciable fines, use of a sand pack should be considered. The gradation requirement depends on the particle size distribution in the target aquifer. Refer to Practice D 5092 for criteria on sand pack design.

7.3.2 *Pre-packed Screens*—Pre-packed screen systems are intended to ease the installation of sand in direct push cased monitoring wells by carrying it with the casing. The prepack sections use hollow stainless steel screen casings to accommodate the slotted riser. A screen opening of 0.006 in. is typical.

7.4 *Seals*—In addition to the sand pack, a seal above the screen is needed. Current state regulations and EPA guidance documents **(18, 19, 22)** require the installation of annular seals and grouting of the well annulus to prevent potential cross contamination along the well bore and the possibility of surface water or chemical spills from contaminating the monitored aquifer(s). Sealing is necessary to prevent infiltration of surface runoff and to maintain the hydraulic integrity of confining layers. The sealing required depends on the formation, well type, and installation technique (Section 8). Several methods can be used to assure a seal above the screened zone. Most completion methods with cased systems use tremie grout placed as the casing is withdrawn. The grout can be bentonite or cement similar to that specified in Guides D 6001, D 6282, and Practice D 5092. A typical well completion diagram is shown on Fig. 1. A grout barrier of fine to medium sand is used to protect the sand pack or screened interval from infiltration of grout, which can change the local water chemistry. Practice D 5092 addresses this subject.

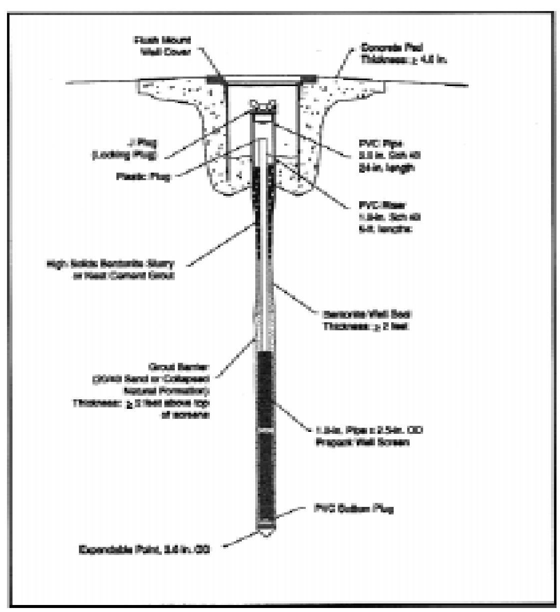

FIG. 1 Example of a Completed Direct Push Monitoring Well (20)

7.4.1 Mechanical techniques can also be used to create an effective seal. For example, Fig. 2 depicts a solid metal sleeve left in the ground, and Fig. 3 shows modular expandable foam and bentonite sleeves used above the screened interval. Rubber wiper seal may also be used. Whether this barrier is formed by the addition of fine to medium sand, by collapse of the surrounding formation, or mechanically, the materials employed must be chosen to be compatible with the local groundwater conditions and contaminants of interest.

7.5 *Modular Well Systems*—The most recent developments have been towards the use of modular components for placing sand pack and seals. Pre-packed screens can be used with most drive systems. The screens are stainless steel wire mesh filled with sand of different gradations. Fig. 3 shows the use of these modular sand packs.

7.6 *Other Variations*—Numerous innovations have been developed for ground water monitoring through direct push well systems. For example, multiple screened sections can be completed in one installation, and sampling of multiple zones can be performed by using packers or sampling ports for ground water extraction. Another recent development has been the use of everting flexible sock system liners to seal the borehole and isolate a water sampling interval **(21)**.

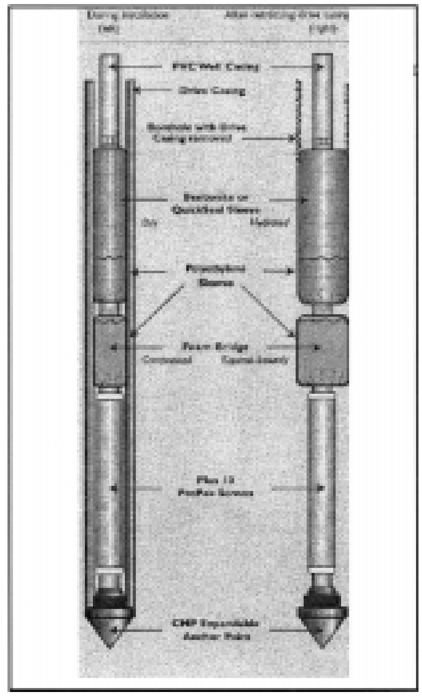

FIG. 3 Direct Push Well with Modular Sealing Components

8. Installation Techniques

8.1 There are several techniques for installing direct push monitoring wells. Techniques can be broadly classifieds into two categories: exposed screen techniques, and protected screen techniques. Each of the systems described hereafter may require a unique installation procedure. Regardless of the choice of techniques and systems, a written operating procedure should be developed which allows some flexibility in response to field conditions. Project sampling plans and standard operating procedures should be consulted prior to installation.

8.2 *Direct Push Driving Equipment*—Direct push Guides D 6001 and D 6282 describe typical driving systems. Some systems are manual (slam bar, hand held electric or pneumatic hammers), static weight (cone penetrometers), percussion (hydraulic hammers, air hammers, electric hammers), and vibratory systems. In some cases, direct push monitoring wells may be installed in combination with rotary drilling.

8.3 *Exposed Screen Techniques*—One method of installing direct push wells is to advance a screen and riser of constant diameter that remain in direct contact with the formation during installation. The riser may be driven either alone or by using a mandrel rod inside the screen and riser (Fig. 4). Because the well screen is exposed to soil during driving, development by surging or jetting will be necessary to remove sediment from the screen slots (see Guide D 5521 for well

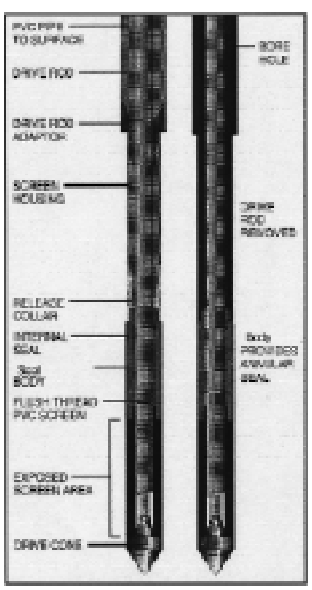

FIG. 2 Example of a Steel Seal Body Above the Screen

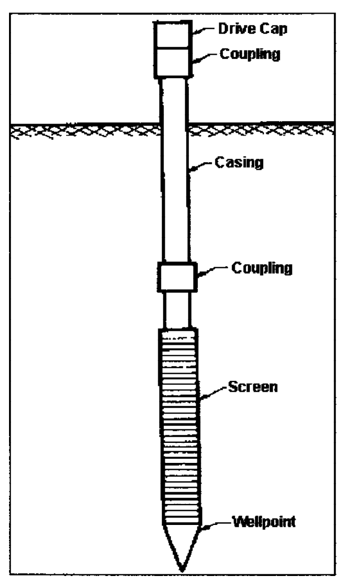

FIG. 4 Example of an Exposed-Screen Driven Well Point (11)

development methods). When installing exposed screen monitoring wells the slotted screens may become clogged with fine-grained materials if any are present in the penetrated formation. If the zone penetrated with the slotted screens is contaminated the materials trapped in the screens may be contaminated and result in cross contamination of the screened interval. Additional development may be required to remove the material clogged in the screens. Failure to remove such material may bias sample quality.

8.3.1 *Driven or Jetted Wellpoints*—As is commonly practiced in other hydrology applications (for example, construction site dewatering), well points can be jetted or driven (hammer or vibration) through sands. Fig. 4 shows this simple type of installation. At many saturated sand sites, the well point can be quickly driven using vibrators or vibratory hammers. Well points are generally 2 to 3 in. diameter and constructed of slotted or wire-wrapped steel or stainless steel. Slot widths of 0.01 to 0.02 in. are typical. These monitoring wells perform well in clean, coarse to medium sand deposits, but they do not have a sand pack and will yield sediment in soils containing fines. The use of jetting will reduce effective sealing above the screen. Installation by jetting with water or other fluids is not recommended for environmental water quality monitoring wells, as injection of large volumes of fluids into the local formation will result in significant alteration of the local ground water geochemistry.

8.3.2 *Mandrel-Driven Screen and Riser*—Fig. 5 shows a section of poly vinyl chloride (PVC) screen and riser that is driven using inner steel CPT rods. A drive tip slightly overreams the hole to reduce friction on the riser pipes. Through experience, the drive tip diameter can be optimized to assure good sealing above the screen. With this type of installation, rigorous development to remove possible cross-contamination must be performed. A combination of mechanical surging and continuous withdrawal of the well water is effective for this purpose. See Guide D 5521 for well development guidance.

8.4 *Protected Screen Techniques*—Protected screen techniques do not allow the well screen to come in contact with the formation until the screened section is at the target installation depth. The well is driven inside of a protective outer casing, or lowered down into the casing once it has been driven to the desired depth. A variety of sand pack and sealing approaches are available, as discussed in subsequent sections. There may be difficulty in installing sand pack or grout in the annular space that is created. However, the use of pre-packed well screens facilitates the quick and accurate placement of the sand pack. Additionally, new grouting technology allows for efficient and accurate placement of seals and grout by the bottom-up tremie method recommended by EPA guidance **(11, 18, 19)** and most state regulatory agencies.

8.4.1 *Single Rod Wells*—Guide D 6001 describes rod-driven water samplers which can be driven and left in place as monitoring points without backfilling. Fig. 6 shows a typical rod-driven water sampler. If the drive rod is smaller in diameter than the sampler body, surface infiltration can be prevented by grouting the annular space above the sampler body. Otherwise, the only seal will be between the formation and that portion of sampler body above the screen. If the annulus between the drive rod and soil remains unsealed, such installations are satisfactory only for monitoring the uppermost portions of surficial aquifers, and where potential contamination by infiltration from above is not a concern. Most conventional direct push water samplers of this type are typically not left in the ground for long periods due to equipment expense. However, low-cost versions of these samplers are available and can be used for long-term installations.

8.4.2 *Two-Tube Systems*—Many protected screen direct push monitoring wells are installed by first advancing the outer tube to the bottom of the desired screen interval. Then the screen(s) and riser are assembled and lowered through the open bore of the probe rods. Following this, the outer tube is retracted while the screen(s) and riser remain in place. The grout barrier, annular seal and grout are then installed by appropriate methods. With non-percussive driving systems the screen and riser may be advanced along with the protective casing without risking damage. Monitoring wells installed using a two-tube system are similar to rotary monitoring wells (Practice D 5092) in that they can contain a sand pack, seal, and annulus sealing to the surface. The well assembly may

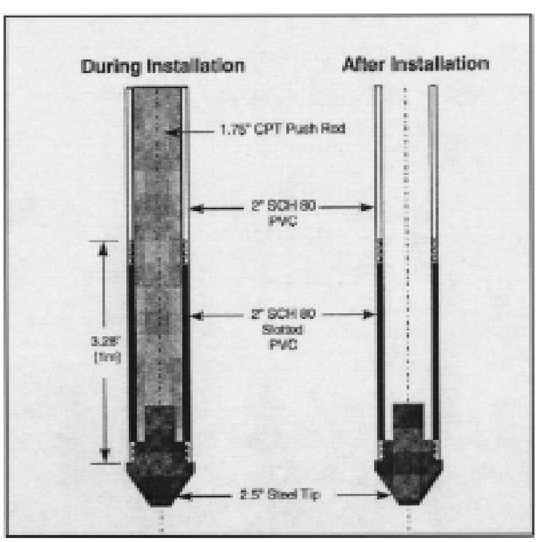

FIG. 5 Mandrel-Pushed Screen and Riser

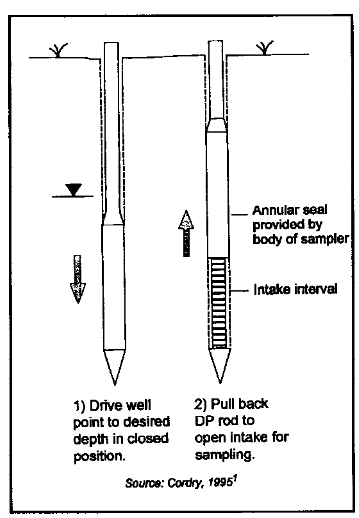

FIG. 6 Typical Rod Driven Water Sampler (23)

include a pre-fabricated sand pack or other modular components as illustrated in Fig. 7. By using the protective casing, the well can be installed through multiple aquifers. The well may be lowered down into the casing following driving and prior to casing withdrawal, or the bottom end may be attached to an expendable push point, which remains in the ground upon retraction of the drive rods and acts as an anchor. The casing provides a positive temporary seal and allows for control of sand pack and permanent seal placement as it is retracted. Two-tube systems also allow for soil or ground water sampling along the way. However, they must be checked for standing water in the outer tube which, if not drained, may impact sample quality. Typical well diameters are from one-half to two inches.

8.4.3 *Filter Packs and Seals*—In a surficial aquifer it may be appropriate to allow the formation to collapse back in against the screen and riser without adding a sand pack. In this case the surface completion method must provide adequate protection against infiltration by surface runoff. Otherwise, sand pack and seals, if not provided by pre-packed or modular construction (7.3.2 and 7.5, respectively), can be placed by tremic or pouring methods, or by pumping.

9. Installation Procedure

9.1 *Decontamination of Materials*—Well components and installation equipment may require decontamination before and/or after well installation. Consult Practice D 5088 for decontamination procedures. If the well is to be used for water chemistry testing, at least one rinseate sample of the well material will be required following decontamination and prior to installation.

9.2 *Installation*—Drive the direct push monitoring well in accordance with the standard operating procedures developed for the push system and/or monitoring well (8.1). Record all assembly lengths and rod or casing lengths, and any unusual driving conditions as the push progresses on the well completion log (Fig. 8). Record water levels if required (see Test Method D 4750). For cased systems in sand below the water

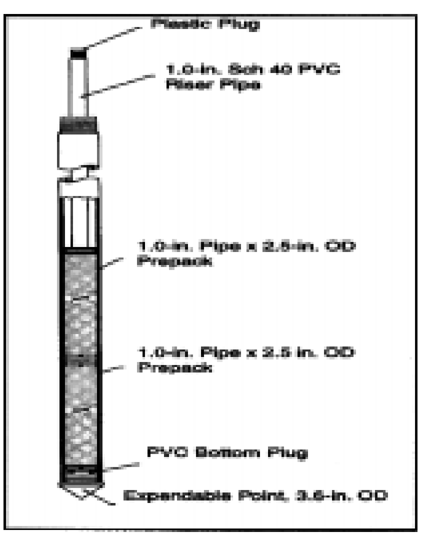

FIG. 7 Example of Prepacked Screens Installed After the Drive Casing is in Position (20)

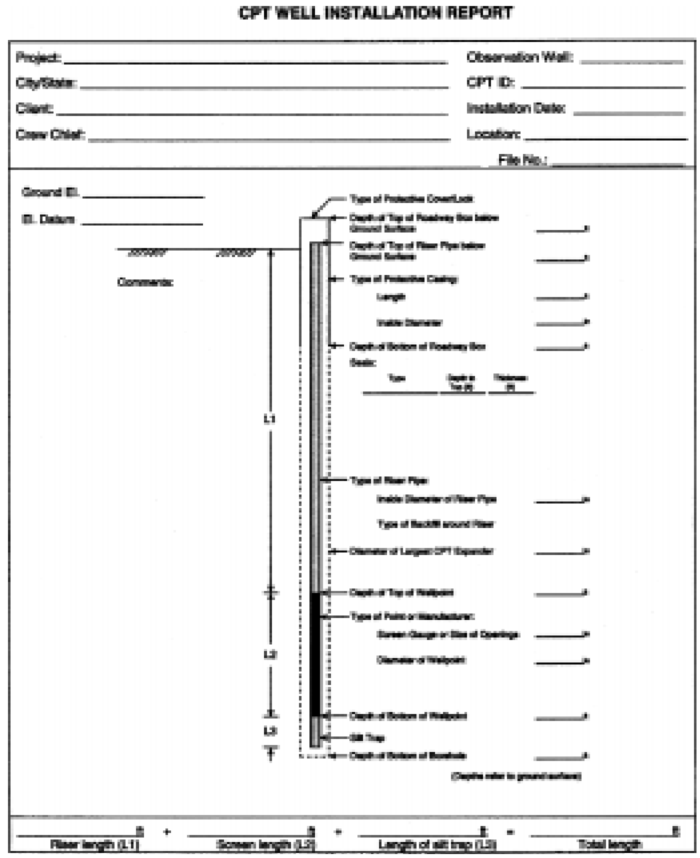

FIG. 8 Example of a Direct Push Well Completion Report

table, it may be necessary to fill the casing with clean water to prevent sand heaving. With cased systems, it may be necessary to check for ground water infiltration using a water level meter prior to detaching the expendable tip. This check is imperative in conditions of contaminated perched water.

9.3 *Centralizers*—For small diameter casings (less than half the size of the borehole created), the use of centralizers prevents deflections of the riser during backfilling of the annular space. Riser deflection can later interfere with the free passage of bailers and other equipment through the casing. Centralizers may also assist in sealing procedures by keeping the riser in a consistent position within the borehole.

9.4 *Sealing*—Procedures for sealing direct push monitoring wells are similar to those in Practice D 5092. Direct push sealing considerations and procedures are also addressed in sampling Guides D 6001 and D 6282. Groundwater that has entered the cased system may cause difficulty in placing seal materials by the gravity-pouring method. New grouting equipment allows for efficient and effective installation of well seals and grout (20 to 30 % solids bentonite) by bottom-up tremie methods with tremie tubes as small as 0.25-in. inside diameter. Depth to the top of seal materials can be periodically checked using rods or weighted tape lowered into the annular space.

9.5 *Surface Completion*—Well capping details vary from simple to detailed, similar to rotary drilled monitoring wells. After the final height of the riser is established, record the elevation of the top of the riser pipe.

9.6 *Well Development*—Direct push monitoring wells are developed using procedures similar to those in Guide D 5521.

Typically, the well can be developed 48 hours after installation to allow surface concrete to set.

9.7 *Purging*—Purging may be required prior to sampling. Bailers, bladder pumps, peristaltic pumps, vacuum pumps, and inertial pumps utilizing check valves are often used for purging and sampling. Guidance on their selection and use is provided in Guides D 5521, D 6492, and D 6634. The low-flow sampling procedure is recommended when sampling for volatile organic compounds **(24)**.

9.8 *Sampling*—Direct push monitoring wells are sampled using methods similar to those for rotary drilled wells. Sampling should be in accordance with Guide D 4448. Smaller diameter risers may limit the choice of applicable sampling methods. Typical samplers for small diameter wells include bailers, peristaltic pumps, and inertial pumps. However, new bladder pumps are available in sizes down to ½-in. diameter.

9.9 *Maintenance*—Monitoring wells that will be used for sufficiently long that biofouling or silt accumulation will be a concern may require periodic maintenance. Maintenance practices might include disinfection, acid treatment, and redevelopment and purging. However, using acid on stainless steel systems is not recommended because of problems with corrosion, and both disinfection and acid treatment are discouraged for environmental water quality monitoring wells as these practices may significantly alter the local chemistry.

9.10 *Abandonment/Decommissioning*—Direct push sampling wells may require removal or closure either at the end of their service life or if an installation attempt is unsuccessful (for example, equipment breakage or failure to reach target depth). The closure and plugging of such wells should be done in accordance with Practice D 5299. relative to techniques for direct push wells. It may be sufficient to fill the screen and riser with an impermeable grout, or if plugging the well is not acceptable, the casing may be removed by rotary over-drilling using a hollow stem auger.

10. Field Report and Project Control

10.1 Record and report information as required in the sampling plan and as noted in Section 8 on the well installation. An example of a well completion report form is shown on Fig. 8.

10.2 Report any subsurface investigation data that are required in the sampling plan and consult Guide D 5434 on logging of subsurface investigations.

10.3 If the well data are to be used in a Geographic Information System, consult Guide D 5254 on minimum data elements for documenting a ground water sampling site.

10.4 Well development events may require a separate report of monitored ground water conditions during development.

10.5 A field notebook should be kept to document all activities relevant to the work plan. Activities include sampling events and conditions that occur during installation, development, and sampling as part of a quality assurance program.

10.6 If samples are obtained during the installation, as with two-tube soil sampling Guide D 6282, record and report the sample intervals and the data that are required.

10.7 If water samples are acquired during the push (Guide D 6001), record the purge watcr volumes and any monitored water quality indicators.

10.8 Record and report the depth of the push, and details such as effective screen length, effective seal lengths, backfilling and sealing methods. As the well is completed, ensure that all necessary installation information is recorded.

11. Keywords

11.1 direct push; ground water; monitoring well; site investigation

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