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Standard Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers[1]

This standard is issued under the fixed designation D6725/D6725M; 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 practice is based on recognized methods by which direct push monitoring wells may be designed and installed for the purpose of detecting the presence or absence of a contaminant, and collecting representative groundwater quality data. The design standards and installation procedures herein are applicable to both detection and assessment monitoring programs for facilities.

1.2 The recommended monitoring well design, as presented in this practice, is based on the assumption that the objective of the program is to obtain representative groundwater information and water quality samples from aquifers. Monitoring wells constructed following this practice should produce relatively turbidity-free samples for granular aquifer materials ranging from gravels to silty sand.

1.3 Direct push procedures are not applicable for monitoring well installation under all geologic and soil conditions (for example, installation in bedrock). Other rotary drilling procedures are available for penetration of these consolidated materials for well construction purposes (Guide D5092). Additionally, under some geologic conditions it may be appropriate to install monitoring wells without a filter pack (**1, 2**)[2]. Guide D6724 may be referred to for additional information on these and other methods for the direct push installation of groundwater monitoring wells.

1.4 The values stated in either inch-pound units or SI units presented in brackets are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.5 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this standard.

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 limitations prior to use.*

1.7 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgement. Not all aspects of this practice 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 the 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4043 Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques
D4044 Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers
D4104 Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)
D4448 Guide for Sampling Ground-Water Monitoring Wells

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

D4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well) (Withdrawn 2010)[4]
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5092 Practice for Design and Installation of Groundwater Monitoring Wells
D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock
D5521 Guide for Development of Groundwater Monitoring Wells in Granular Aquifers
D5785 Test Method for (Analytical Procedure) for Determining Transmissivity of Confined Nonleaky Aquifers by Underdamped Well Response to Instantaneous Change in Head (Slug Test)
D5786 Practice for (Field Procedure) for Constant Drawdown Tests in Flowing Wells for Determining Hydraulic Properties of Aquifer Systems
D5787 Practice for Monitoring Well Protection
D5881 Test Method for (Analytical Procedure) Determining Transmissivity of Confined Nonleaky Aquifers by Critically Damped Well Response to Instantaneous Change in Head (Slug)
D5912 Test Method for (Analytical Procedure) Determining Hydraulic Conductivity of an Unconfined Aquifer by Overdamped Well Response to Instantaneous Change in Head (Slug) (Withdrawn 2013)[4]
D6001 Guide for Direct-Push Groundwater Sampling for Environmental Site Characterization
D6026 Practice for Using Significant Digits in Geotechnical Data
D6067 Practice for Using the Electronic Piezocone Penetrometer Tests for Environmental Site Characterization
D6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
D6282 Guide for Direct Push Soil Sampling for Environmental Site Characterizations
D6285 Guide for Locating Abandoned Wells
D6286 Guide for Selection of Drilling Methods for Environmental Site Characterization
D6542 Practice for Tonnage Calculation of Coal in a Stockpile
D6634 Guide for Selection of Purging and Sampling Devices for Groundwater Monitoring Wells
D6724 Guide for Installation of Direct Push Groundwater Monitoring Wells
D6771 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (Withdrawn 2011)[4]
D6914 Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices
D7242 Practice for Field Pneumatic Slug (Instantaneous Change in Head) Tests to Determine Hydraulic Properties of Aquifers with Direct Push Groundwater Samplers
D7352 Practice for Direct Push Technology for Volatile Contaminant Logging with the Membrane Interface Probe (MIP)
D7929 Guide for Selection of Passive Techniques for Sampling Groundwater Monitoring Wells

3. Terminology

3.1 *Definitions*—For common definitions of terms in this standard, refer to Terminology D653.

3.2 *Definitions:*

3.2.1 *tremie pipe, n*—in wells, a small-diameter pipe or tube that is used to transport filter pack materials and annular seal materials from the ground surface into an annular space. (D5092).

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *dual tube systems, n*—a system whereby inner and outer tubes are advanced independently or simultaneously into the subsurface strata.

3.3.1.1 *Discussion*—The outer casing tube is used for borehole stabilization. The inner rod system is used for sampler recovery and insertion of other devices.

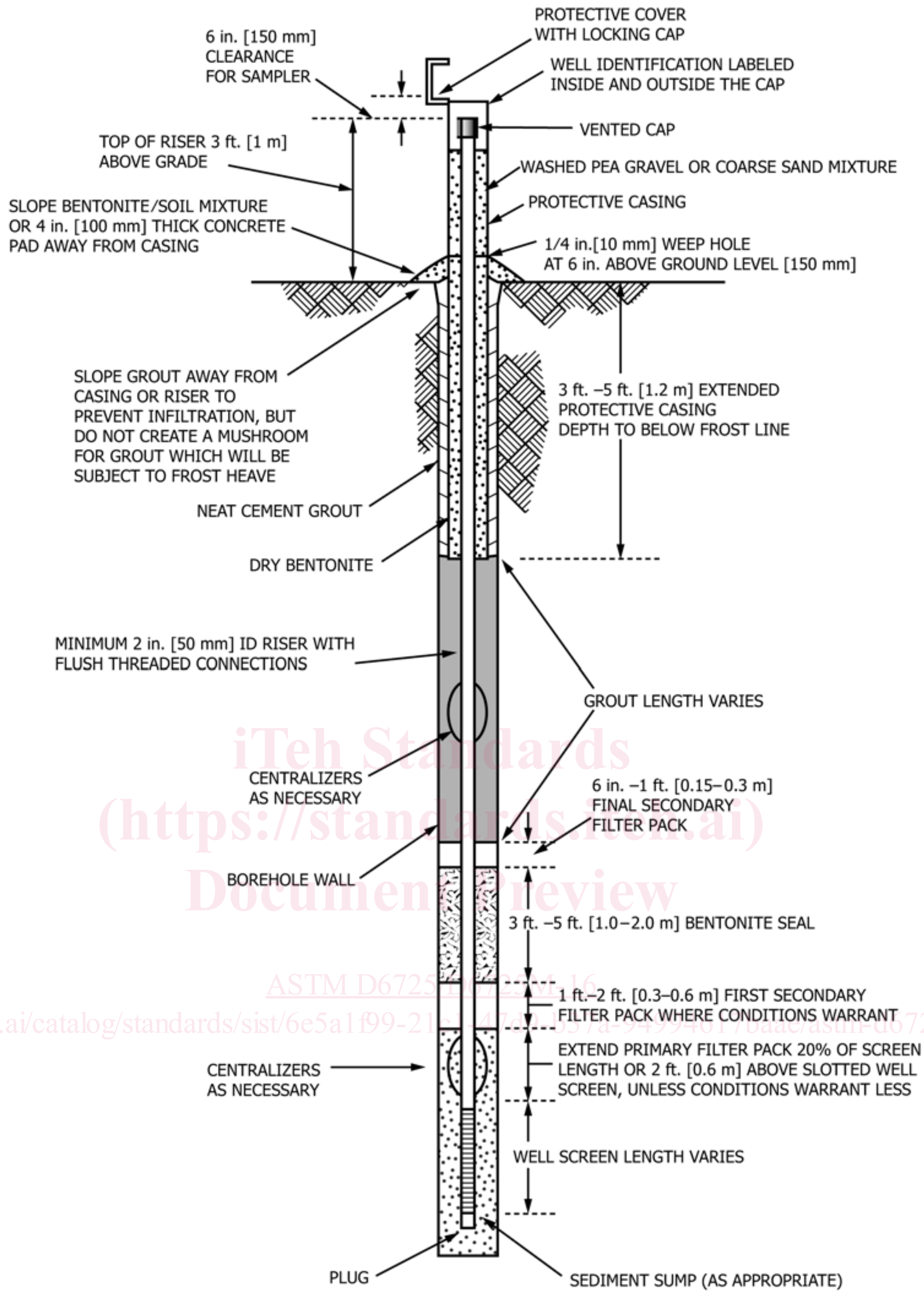
3.3.2 *prepacked screen*—a manufactured well screen that is assembled with a slotted inner casing and an external filter media support. The external filter media support may be constructed of a stainless steel wire mesh screen or slotted PVC that retains filter media in place against the inner screen. The filter media is usually composed of graded silica sand.

4. Summary of Practice

4.1 This practice provides information for installing a prepacked screen monitoring well using direct push techniques. When constructed following this Standard Practice the direct push installed monitoring wells can meet most local regulations and environmental guidelines (**2-5**) for well construction (Fig. 1) and protection of the aquifer and groundwater resources.

4.2 Initially the outer casing tube of the dual tube system is advanced to depth using direct push methods. The monitoring well is constructed inside the casing with prepacked well screens and riser pipe. The casing tube is retracted to set the well at the desired depth in the formation. Bottom up tremie installation of the annular seal and grout is conducted through the outer casing as it is retracted. This grouting method is advised to obtain the highest integrity well construction. Commonly available types of above ground or flush mount well protection are installed to physically protect the well and prevent tampering (D5787). The small diameter wells may be developed using bailers, peristaltic pumps, bladder pumps or an inertial check valve system (D6542). The inertial check valve and tubing system is especially effective when used for development in medium to coarse-grained aquifers. This development method simultaneously surges and purges fines from the screen interval. Slug testing of the wells (D7242) can be conducted to determine local aquifer properties and verify that development has been successful. Low flow (D6771) and other sampling techniques (D4448, D7929) may be used to obtain representative water quality samples. Clear and accurate documentation of the well construction is advised.

[4] The last approved version of this historical standard is referenced on www.astm.org.



NOTE 1—This well design is consistent with most regulatory requirements promulgated prior to development of direct push techniques (after Practice D5092)

FIG. 1 Specifications for Conventional Monitoring Wells Installed with Rotary Drilling Methods.

5. Significance and Use

5.1 This practice is intended to provide the user with information on the appropriate methods and procedures for installing prepacked screen monitoring wells by direct push methods. The monitoring wells may be used to obtain representative water quality samples for aqueous phase contaminants or other analytes of interest, either organic or inorganic (**3**, **6-8**). The monitoring wells may also be used to obtain information on the potentiometric surface of the local aquifer and properties of the formation such as hydraulic conductivity or transmissivity.

5.2 Use of direct push methods to install monitoring wells can significantly reduce the amount of potentially hazardous drill cuttings generated during well installation at contaminated sites. This may significantly reduce cost of an environmental site investigation and groundwater monitoring program. Minimizing generation of hazardous waste also reduces the exposure hazards to site workers, local residents, and the environment.

5.3 Direct push methods for monitoring well installation are limited to use in unconsolidated formations such as alluvial/stream sediments, glacial deposits, and beach type sediments. Direct push methods are generally successful at penetrating clays, silts, sands and some gravel. Deposits such as soils with thick caliche layers, or glacial tills with large cobbles or boulders may be difficult or impossible to penetrate to the desired depth. Direct push methods are not designed for penetration of consolidated bedrock such as limestone, granite or gneiss.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

Practice D3740 was developed for agencies engaged in the laboratory testing and/or inspection of soils and rock. As such, it is not totally applicable to agencies performing this field practice. However, user of this practice should recognize that the framework of Practice D3740 is appropriate for evaluating the quality of an agency performing this practice. Currently there is no known qualifying national authority that inspects agencies that perform this practice.

6. Site Characterization and Well Placement

6.1 *Characterization*—Understanding the project goals as well as the subsurface geology, hydrogeology, and contaminant distribution at a site is necessary before installation of monitoring wells can be completed successfully. Steps in a site characterization program may include investigating site history, literature search, site reconnaissance, and field investigation and sampling efforts. The field investigation may include completion of borings to collect soil and groundwater samples and to determine the groundwater flow direction. Geophysical methods may also be applied to obtain an understanding of the subsurface geology. Several ASTM standards are available for use in conducting the site characterization and sampling efforts; these include water sampling Guide D6001, soil sampling Guide D6282, cone penetrometer Practice D6067, slug testing Test Method D4044 and Practice D7242, standard penetration Test Method D1586, and membrane interface probe (D7352). Other important sources of information include local agencies having responsibilities for groundwater protection and regulation. A list of geological surveys are included in Guide D6285. Depending on site conditions, when direct push methods are used for site characterization (for example, D6001 and D6282) it may be possible to complete the site characterization and monitoring well installation activities in one mobilization. Practice D5092 provides further details on site characterization necessary for successful installation of monitoring wells and development of a site conceptual model.

6.2 *Well Placement*—The well location, depth and length of screen interval should be based on project requirements, information obtained during the site characterization activities and background research. In general at least one well is placed at a depth and location considered to represent undisturbed background water quality conditions. The length and depth of the screened interval for the background well(s) should reflect those of the wells installed hydraulically down gradient of the site. Information obtained during site characterization regarding local hydrogeology, water level(s), contaminant distribution, and groundwater flow direction should be used to determine appropriate well placement. If multiple aquifers separated by aquitards are present beneath the site monitoring wells with screened intervals at multiple depths may be needed at each location. The purpose for installation should be considered in selecting the locations of the monitoring wells. Purposes may include detection monitoring, long term monitoring, or data collection to determine the presence, extent, and concentrations of potential contaminants. Guidance on selection of well locations, screen lengths and intervals are found m several references, some of which are: (**1, 3-5, 9-15**).

7. Monitoring Well Construction Materials

7.1 *General*—The materials that are used in the construction of a prepacked screen monitoring well should not measurably alter the chemistry of the groundwater sample(s) to be collected when appropriate sample collection methods are used. Ideally, PVC should not be used when monitoring for neat organic solvents that are PVC solvents (**16**). While conventional steel materials (for example, carbon steel or galvanized steel) are not suitable for use under most groundwater monitoring conditions stainless steel has been found to perform well in most corrosive environments, particularly under oxidizing conditions (**11**). In most cases Type 304 stainless steel will perform satisfactorily for many years (**17, 18**). Under highly corrosive and reducing conditions Type 316 stainless steel will perform better than Type 304 stainless steel (**11**). The prepacked screens and well casing used in the well construction should be delivered from the manufacturer to the field site in a clean state sealed in protective wrapping. Any other equipment used in the well construction process (for example, casing, measuring tapes, grout hoses, other down hole tools) that could impact the resultant water quality should be cleaned and decontaminated following appropriate methods (Practice D5088) prior to use in the well installation. Additional guidance and information on well construction practices can be obtained from Practice D5092. Always verify compliance with local regulations by contacting the appropriate regulating agency or organizations.

7.2 *Water*—In general, little water is used in the construction of direct push installed prepacked screen wells other than in preparation of annular seal and grout mixtures. However, there are situations that may require addition of water to the well or borehole during installation. One of the most common situations that may require addition of water is under drilling conditions where formation blow-in may occur. Under these conditions (most often saturated sands) water must be added to the boring to prevent blow-in and assure that the well is properly installed at the desired depth. When water is used in the well installation and construction process (to prevent blow-in, or mix grout) water of known quality (generally potable water) that will not adversely affect the sample must be used to ensure that the sample integrity will not be compromised. The volume of water added to each well must be documented.

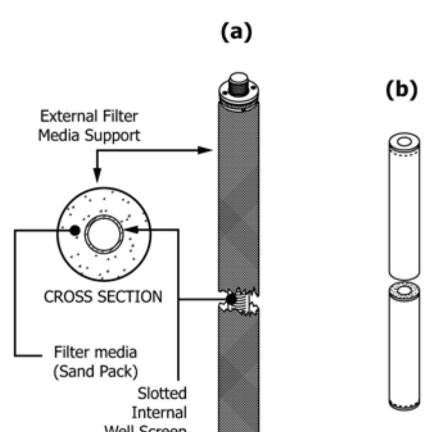
7.3 *Prepacked Screen*—There are three primary components of the prepacked well screen (Fig. 2). These are the internal well screen, the external filter media support, and the contained filter media (sand pack). Some prepack screens are assembled with the internal PVC screen as an integral part of the assembly (Fig. 2a). Alternatively, some prepack screens are available as sleeves or jackets (Fig. 2b) that may be installed over factory available casing. The components used in construction of the prepacked well screen must not adversely affect the groundwater quality so that representative samples may be acquired. Subsurface conditions, including but not limited to site geology, geohydrology, groundwater chemistry, and the analytes to be monitored must be considered to assure that the prepacked well screens are compatible with the system to be monitored. A sump may be attached to the base of the screen to capture any fines entering the well. The bottom of the screen or sump must be sealed with a plug constructed of compatible material. The prepacked well screen must be of sufficient strength to withstand the forces and stress of installation and development without being damaged or otherwise compromised. Some of the prepacked well screens are packed with filter media by the manufacturer. Other prepacked screens are shipped without filter media and are packed in the field with acceptable filter media materials just prior to installation.

7.3.1 *Internal Well Screen*—The most common material used for construction of this component is polyvinyl chloride (PVC). Other materials (for example, stainless steel or fluoropolymers) may be used where and when appropriate. Routinely used internal well screen diameters include nominal 0.5-in., 0.75-in., and 1.0-in. [15, 25, 50 mm] PVC. For optimum performance of the well the screen slot size should be determined relative to the grain size analysis of the stratum to be monitored and the gradation of the filter pack material. For further details on the selection of screen slot size refer to Practice D5092. The most widely available slot size is 10 slot, 0.010-in. [0.25 mm] in the prepacked well screens. The slot size used for the internal well screen should retain at least 90 % of the filter media.

7.3.2 *External Filter Media Support*—The purpose of the external filter media support is twofold. The primary purpose is to retain the filter media around the internal well screen as the screen is being placed in the boring. Additionally the external filter media support assures accurate and complete placement of the filter pack media in the desired screen interval. Emplacement of the filter media in this fashion eliminates problems with formation collapse against bare screen or bridging and creation of voids around the bare screen as when gravity installation of the filter media is conducted. One of the most common materials used for construction of this screen component is a stainless steel wire mesh. Slotted PVC, fluoropolymers or other compatible materials may be used for construction of this screen component when and where appropriate. The external diameter of the prepacked screen ranges from about 1.4- to 3.0-in. [35 to 75 mm], depending on the inner well screen diameter and the inside diameter of the probe rods used to advance the boring.

7.3.3 *Filter Media*—The filter media or gravel pack most commonly consists of uniformly graded siliceous particles washed and screened to have the appropriate particle size distribution. Refer to Practice D5092 for details on the selection of appropriate grain size distribution for the filter media. One of the most widely used grain size distributions for prepacked screen well filter media is 20-40 grade silica sand. However, finer grained formations may require finer sand gradation (see Practice D5092).

7.3.4 *Sump*—The sump is usually constructed of a length of well casing material ranging from a few inches in length to several feet [1 m] in length depending on the well design and formation characteristics. It is attached to the base of the well screen and is plugged at the bottom. The sump provides a space



NOTE 1—The internal well screen is usually constructed of Schedule 40 or 80 PVC (a) with a factory cut 0.010 in. slots while some are available with 0.25 slots. The external filter media support is usually constructed with stainless steel wire cloth with pore size of approximately 0.011 in. and graded silica sand or equivalent material is used for the filter media. Some prepacked screens are available as sleeves or jackets (b) that slide over factory available slotted PVC.

FIG. 2 Typical Prepacked Well Screens.

for fine sediments entering the well to settle without obstructing a portion of the screen interval and interfering with recharge or sampling activities. The sump also allows for the collection of dense nonaqueous phase fluids (DNAPLs) at locations where they are present.

7.4 *Casing or Riser*—The well casing should be made of clean, new materials that will not alter the quality of the water samples being collected. Most casing or riser is made of PVC but other materials (for example, stainless steel, fluoropolymers, etc.) may be appropriate in some situations. The inside diameter and wall thickness of the casing should match that of the internal well screen of the prepacked well. Threaded and flush jointed casing fitted with o-rings of appropriate material are generally recommended for the casing. Glued or solvent welded joints are not recommended as the glues and solvents generally contain hazardous chemicals that can cause contamination of the groundwater to be sampled. The casing and casing joints must be of sufficient strength to withstand the forces of installation and development. Further information on the selection of appropriate casing materials can be found in Practice D5092 and (**1**, **10-12**, **15**, **17-21**).

7.5 *Grout Barrier*—The grout barrier serves to prevent the annular sealants from entering into the screen interval resulting in the alteration of the water chemistry, because common annular sealants and grouts (for example, bentonite and Portland cement) can have a significant impact on the local groundwater chemistry a grout barrier is emplaced immediately above the screened interval. The grout barrier may be constructed by gravity or tremie installation of fine sand or by installation of a mechanical or modular barrier.

7.5.1 *Gravity or Tremie Installation*—The grout barrier may be constructed with silica sand having the same or finer gradation than the materials used in the filter media. When the filter media is course-grained use of a finer grained grout barrier is recommended. The grout barrier usually extends 1 to 2 ft [1 m] above the top of the screened interval. The granular material used for the grout barrier may be poured through the annular space in the well for installation or placed through a tremie tube if conditions permit (see 9.4.1).

NOTE 2—Slowly add the barrier material to prevent bridging and to allow time for the material to settle through the water column.

7.5.2 *Modular Barriers*—Some direct push well systems offer the option of installing a modular grout barrier (see 9.4.1). This modular barrier is assembled with the screen and casing and lowered into the well annulus. When the outer casing is retracted this modular barrier expands and creates a seal above the prepacked screen. These modular barriers are constructed with polyurethane foam covered with a polyethylene sleeve. These modular barriers are not recommended for use below the water table because of potential for absorption and desorption of some contaminants.

7.6 *Annular Seal and Grout*—The annular seal and grout are prepared of materials that will eliminate or at least reduce the potential for surface or up-hole water (or fluids) from moving down the well annulus. This is important because these fluids could significantly alter the water quality or cause cross contamination in the zone being monitored.

7.6.1 *Annular Seal*—Regulations may recommend the use of sodium bentonite in construction of the annular seal immediately above the grout barrier. Recent research on sealing methods shows that bentonite seals are not effective above the water table and that a minimum of 20 % solids mix should be used for grouting (Practice D5092). Different sealants may be needed when subsurface geology, chemistry of the groundwater, or high concentrations of contaminants are present. When present in high concentrations, some organic contaminants can cause desiccation and cracking of bentonite seals resulting in cross contamination of the well and potential migration of contaminants to a previously clean aquifer. Efforts should be taken in the site characterization program to determine if these conditions may exist at the site. Annular seals may be installed by gravity or tremie methods and modular seals are available for some prepacked well systems.

7.6.1.1 *Gravity and Tremie Installations*—Bentonite chips, granules, or pellets may be used to construct the annular seal when the field conditions and size of the well annulus permit. Gravity or tremie installation of these dry bentonite materials is most successful when the top of well screen is at or near the water table. Use of a small diameter tremie tube and grout pump with bentonite slurries may provide the most reliable method of placing the annular seal (Fig. 4). Bentonite slurries ranging from 20 to 30 % solids by weight are required. Check the local regulations to verify compliance. A side port tremie tube may be used to reduce the jetting of the slurry into the grout barrier.

7.6.1.2 *Modular Seals*—These seals are constructed with paper sleeves containing bentonite attached to a segment of blank casing. This modular seal (Fig. 3) is placed above the grout barrier (modular) and prepacked screens to provide an annular seal.

7.6.2 *Grout*—There are two primary types of grout slurry used in monitoring well construction. These are bentonite grouts and cement grouts. The grout slurries should be mixed until smooth to prevent clogging of the tremie tube. Local regulations for grout compositions and density vary considerably and these regulations should be reviewed to assure compliance. Additional information on grouting requirements is provided in Practice D5092 and (**22**).

7.6.2.1 *Bentonite Grout*—Some bentonite powders contain additives to accelerate the gelling of the slurry and increase viscosity. For the smaller diameter direct push installed monitoring wells where a small well annulus may require the use of small diameter tremie tubes these additives may cause clogging of the tremie tube. The use of bentonite powders (200 mesh) without additives is commonly used for grout when small diameter tremie tubes are advised. In general bentonite slurry densities of 20 to 30 % solids by weight are required by regulation. A 20 % solids by weight bentonite slurry may be prepared by adding 2.0 lb [0.9 kg] of bentonite powder to 1 gal [3.8 L] of clean water (D5092). Bentonite grouts are recommended for use only in the saturated zone as dessication may occur in the unsaturated zone compromising the integrity of the seal (**22**). Additional information on grout mixtures is provided in Practice D5092 and regulations should be consulted.