NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE GENERAL SPECIFICATION

MONITORING WELL

(No.)

CODE 353

SCOPE

This specification shall consist of installing and developing a well, or wells, designed and installed to obtain representative groundwater samples and hydrogeologic information. Construction and installation shall be conducted in a safe and skillful manner by a well driller licensed by the Oklahoma Water Resources Board (OWRB) meeting both the OWRB Rules and Regulations and Oklahoma Department of Agriculture, Food, and Forestry – Agricultural Environmental Management Services minimum criteria for monitoring wells. Safety and health regulations shall be observed and appropriate safety measures used.

All structures shall be constructed according to plans furnished by the Natural Resources Conservation Service (NRCS) and in accordance with the NRCS's engineering standards for this practice, as well as local building codes, state laws and regulations and current industry standards. Any deviation from the approved drawings and specifications must be approved by an NRCS engineer or representative prior to construction.

PUBLIC AND PRIVATE UTILITIES

Utilities are defined to be public or private, overhead and underground power or communication lines, and any pipelines The landowner\operator\contractor shall conduct their own search and discovery for utilities in order to lessen or avoid potential damages, injuries or loss of life. During planning, the landowner\operator should complete an OK-ENG-45 UTILITIES INVENTORY FORM to document known utilities in order to comply with State law prior to any ground disturbance and return it to a USDA-NRCS representative.

QUALITY CONTROL

Quality Control of all materials and construction procedures is the responsibility of the landowner/operator and contractor. NRCS will make periodic review(s) of the work for the benefit of the agency which will include the final construction check.

MATERIALS

All materials and construction shall be in accordance with applicable NRCS standards and specifications. Materials used for the construction of monitoring wells must not chemically react with the groundwater and must not leach substances into the groundwater. Avoid quick-setting cements containing additives that may leach from the cement and influence the chemistry of water samples collected from the monitoring well.

Plastic Pipe. The pipe shall be as uniform as commercially practicable in color, opaqueness, density, and other specified physical properties. It shall be free from visible cracks, holes, foreign inclusions, or other defects. The dimensions of the pipe shall be measured as prescribed in ASTM D 2122.

Unless otherwise specified, plastic pipe shall conform to the requirements listed in this specification and the applicable reference specifications in the table below, in addition to any requirements shown on the drawings.

Poly vinyl chloride (PVC) pipe	**Specification**
Plastic pipe - Schedules 40, 80, 120	ASTM D 1785
	ASTM D 2466
Pressure rated pipe - SDR Series	AWWA C 900
	ASTM D 2241
Plastic drain, waste, and vent pipe and fittings	ASTM D 2665
Joints for IPS PVC pipe using solvent weld cement	ASTM D 2672
Composite sewer pipe	ASTM D 2680
Type PSM PVC sewer pipe and fittings	ASTM D 3034
Large-diameter gravity sewer pipe and fittings	ASTM F 679
Smooth-Wall Underdrain Systems for Highway, Airport, and Similar Drainage	ASTM F 758
Profile gravity sewer pipe and fittings based on controlled inside diameter	ASTM F 794
Corrugated sewer pipe with a smooth interior and fittings	ASTM F 949
Pressure pipe, 4-inch through 12-inch for water distribution	AWWA C 900
Water transmission pipe, nominal diameters 14-inch through 36-inch	AWWA C 905

Fittings and joints - Fittings and joints shall be of a schedule, SDR or DR, pressure class, external load carrying capacity, or pipe stiffness that equals or exceeds that of the plastic pipe. The dimensions of fittings and joints shall be compatible with the pipe and measured in accordance with ASTM D 2122. Joint and fitting material shall be compatible with the pipe material. The joints and fittings shall be as uniform as commercially practicable in color, opaqueness, density, and other specified physical properties. Fittings and joints shall be free from visible cracks, holes, foreign inclusions, or other defects.

Fittings and joints shall conform to the requirements listed in this specification, the requirements of the applicable specification referenced in the ASTM or AWWA specification for the pipe, fitting, or joint, and the requirements shown on the drawings.

Solvents - Solvents for solvent welded pipe joints shall be compatible with the plastic pipe used and shall conform to the requirements of the applicable specification referenced in the ASTM or AWWA specification for the pipe, fitting, or joint.

Gaskets - Rubber gaskets for pipe joints shall conform to the requirements of ASTM F 477, Elastomeric Seals (Gaskets) for Jointing Plastic Pipe.

Well Screens - The well screen shall be of the specified type and size, and the size and pattern of the screen openings shall conform to the details shown on the drawings. Each screen shall be equipped with a bottom plug of the same material as the screen. Use only commercially available factory well screens with a minimum SDR-21 rating.

Aggregates for Drainfill and Filters. Drainfill and filter aggregates shall be sand, gravel, or crushed stone or mixtures thereof. Aggregates shall be composed of clean, hard, durable, mineral particles free from organic matter, clay balls, soft particles, or other substances that would interfere with the free-draining properties of the aggregates.

Coarse aggregate may be crushed limestone or other material that has limestone particles included. Aggregates from crushed limestone shall be thoroughly washed and screened to remove limestone dust, limestone fines, and fine soil particles. Limestone shall not be used for fine aggregates except in combination with other material, such that not more than 5 percent of the portion finer than the No. 4 sieve shall be limestone.

Aggregates shall be tested for soundness according to ASTM Method C88 and shall have a weighted average loss in 5 cycles of not more than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used.

Drainfill and filter aggregates shall conform to the specified grading limits after being placed or after being compacted when compaction is specified. Grading shall be determined by ASTM Method C136. The percentage of material finer than the No. 200 sieve shall be determined by the method in ASTM Designation C117.

Drainfill and filter aggregates shall be stored and handled by methods that prevent segregation of particle sizes or contamination by mixing with other material.

Bentonite Backfill. The bentonite shall be a natural occurring, high purity, dust free, sodium bentonite with high swelling, free flowing, montmorillonite properties, conforming to API Standard #13A for non-treated Bentonite. Drilling-grade non-treated bentonite clay, is composed principally of the mineral smectite, which is dried and ground, but not chemically treated. It can also contain accessory minerals, such as quartz, mica, feldspar and calcite.

High swelling is defined as the ability of 2 grams of bentonite, when mechanically reduced to pass a #100 sieve, to swell when added gradually to 100 ml of distilled water to a volume of 16 ml or greater. The colloid content of the bentonite shall exceed 85% as measured by evaporating the suspended portion of a 2% solution after 24 hours of sedimentation. The dry fine content of the bentonite shall be 85% minimum passing a #20 sieve, and 15% maximum passing a #200 sieve. The bentonite supplier shall provide manufacturer or testing certification for the bentonite.

Cement Grout. The cement grout shall consist of a mix ratio of one (1) 94 pound sack of cement to a maximum of six (6) U.S. gallons of water. The cement and water must be mixed to the proper consistency as recommended by the cement manufacturer before the mixture is installed around the casing. A maximum of fifty percent (50%) aggregate by dry weight may be added to the Portland cement to form the cement grout, provided the aggregate is a size that will not create a potential to cause bridging in the annular space. A maximum of twenty percent (20%) percent bentonite may be added to the slurry, which bentonite shall be pre-hydrated to the manufacturer's recommended consistency. Pre-hydration requires that the bentonite be properly mixed with the recommended amount of water before the mixture is installed.

CONSTRUCTION

Flowing and non-flowing groundwater wells, including monitoring wells are to be constructed in a manner as to prevent waste and to prevent contamination of groundwater by pollution material either entering the ground around the casings or tubing, or entering the fresh groundwater from pollution sources below the ground, or by entering the fresh well water by leaking wells, casing pipe fittings, pumps, or well seals.

Location and depth of wells. The plan location and depth of each well shown on the drawings are based on design estimates. The final depth and location of the components of each well will be determined in the field based on the basis of the examination of the well log and samples recovered during drilling.

When required, each waste retention structures shall have sufficient numbers of groundwater monitoring wells up gradient and down gradient in the direction of groundwater flow. All monitoring well locations shall be approved by the regulatory authority on a case by case basis.

Monitoring wells shall be drilled through the first aquifer encountered, but need not extend more than fifty (50) feet below the bottom of the waste retention structure unless otherwise specified in this specification or on the drawings. One down gradient monitoring well shall be drilled to the first aquifer encountered or the first impermeable layer, but need not extend more than one hundred (100) feet below the bottom of the waste retention structure. No monitoring well shall be installed more than one hundred and fifty (150) feet from the crown of the outer berm.

If no groundwater is encountered during the drilling operation, the bore hole shall be left open for at least forty eight (48) hours but not over thirty (30) days for the aquifer to recharge the bore hole. Thereafter, the bore hole shall be either developed into a monitoring well or plugged according to Oklahoma Water Resources Board requirements.

Drilling. Unless otherwise specified, the wells shall be drilled vertically by a rotary drilling procedure. The diameter of each well shall be adequate to permit the placement of the specified thickness of filter material.

Installing casing and screen. Ensure all materials used in construction, development, and sealing are free of contaminants prior to installation. The well shall be cased with a temporary casing of a type

that has sufficient thickness to retain its shape and maintain the true section throughout its total depth of the borehole, and is removable in a manner that does not disturb the filter, well screen, or casing.

A minimum of two (2) inch diameter PVC casing shall be used with a sealing cap on the bottom. The casing shall consist of minimum SDR-21 rated casing with a minimum SDR-21 rated factory screen in the saturated zone, or the bottom ten (10) feet if no groundwater is encountered.

The riser, consisting of the casing pipe, well screens, couplings, and fittings, shall be measured and inspected as it is assembled and placed in the well. Spiders or other centering devices shall be attached to the assembled casing in sufficient numbers to center it within the well and to accurately maintain its position during the placement of the filter material.

Before the casing is placed, filter materials shall be placed at the bottom of the well to the elevation specified for the bottom of the well screen. The casing shall be placed in the well in such a manner as to avoid shock and to prevent damage to any of its components. The relief outlet or top of the riser shall be securely maintained at the designated elevation during the placement of the filter material.

Placing filter/drainfill. The perforated zone shall be gravel or sand packed originating at the bottom of the screen and extending to two (2) feet above the top of the screen, and otherwise as appropriate for the installation. The filter material shall be placed by tremie, or by another approved method. At the initial placement operations, the tremie shall rest on the bottom of the well and be filled with filter material. The tremie and the temporary casing shall be raised in increments of not more than 2 feet, allowing the filter material to flow from the bottom of the tremie. The top surface of the filter material in the tremie shall be maintained above the water surface at all times. The top surface of the filter material in the well shall be maintained a minimum of 2 feet above the bottom of the casing as the casing is raised.

Backfilling. After the well has been developed, the annular space around the riser pipe above the filter material shall be filled as follows:

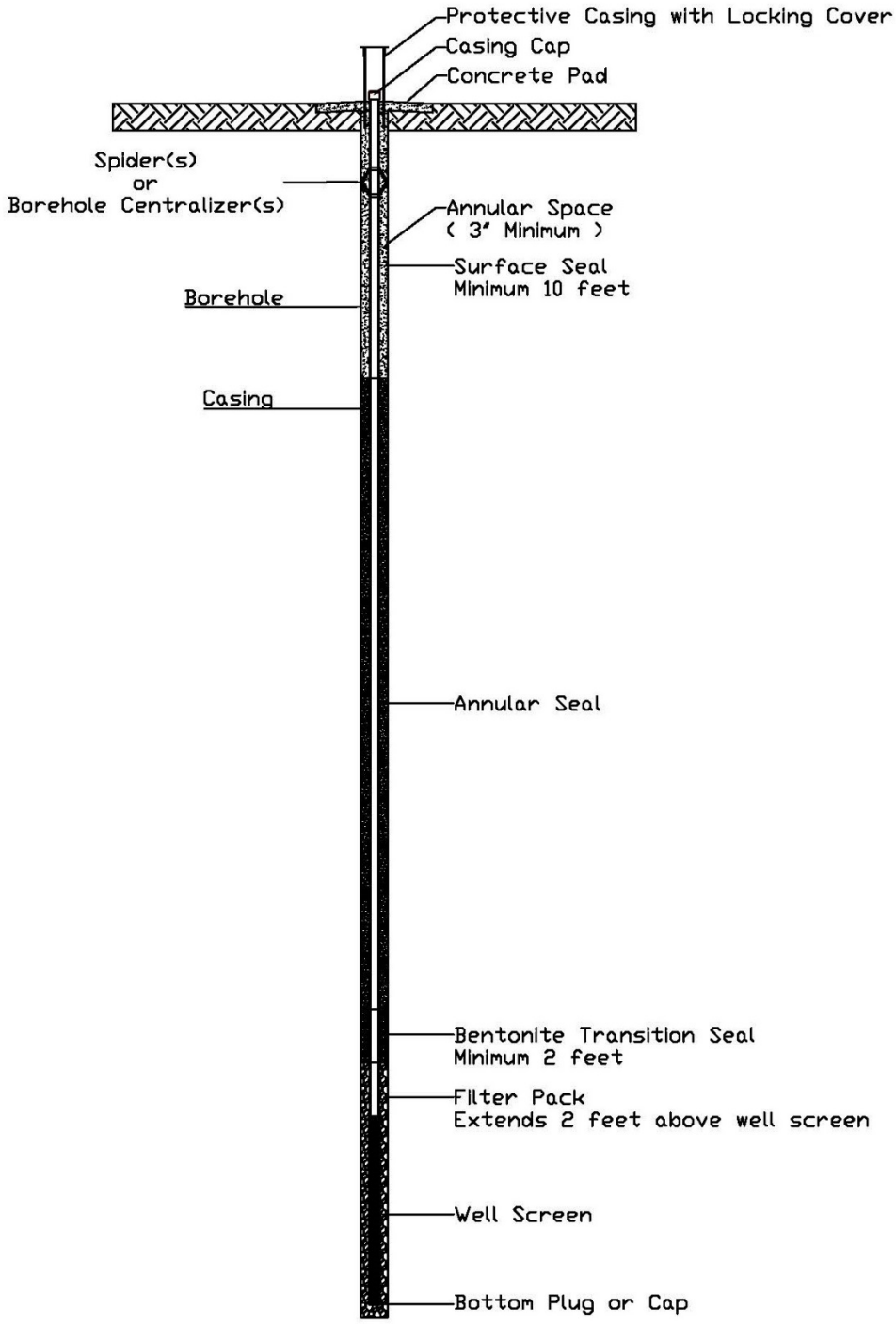
1. Backfill shall be placed in layers not to exceed 12 inches in thickness, and each layer shall be tamped firmly into place. The temporary casing shall be withdrawn in increments as the backfill is placed.
2. Bentonite shall be placed in the annular space of the well above the gravel or sand pack for an interval of at least two (2) feet to form an impermeable seal.
3. A cement grout or a mixture of bentonite and cement shall be placed in the annular space of the well above the bentonite seal to prevent seepage from entering behind the pipe and causing hydrologic connection.
4. A surface seal of at least the top ten (10) feet of the annular space shall be filled with type A cement.

Completion. A concrete apron, minimum of four (4) inch thickness and extending out two (2) feet from the casing shall be installed at the surface to prevent seepage of rain water into the bore hole. The apron shall be sloping away from the casing to avoid percolation of rain water.

A lockable protective cap shall be placed on top of the casing, which shall be a metal protective casing extending two (2) feet above the concrete apron and one (1) foot into the apron. The well shall remain securely capped and locked at all times, except during sampling events.

Within thirty (30) days of installation, a copy of the Oklahoma Water Resources Board approved Multi-Purpose Completion Form shall be submitted. A copy must also be submitted to the regulatory authority when required.

CROSS SECTION VIEW OF A TYPICAL MONITORING WELL



Well Development. A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to re-establish the natural hydraulic flow conditions of the formations which may

have been disturbed by well construction, around the immediate vicinity of each well. A new monitoring well should be developed until the column of water in the well is free of visible sediment, and the pH, temperature, turbidity, and specific conductivity have stabilized.

The following development procedures, listed in approximate increasing order of the energy applied to the formation materials, are generally used to develop wells:

1. Bailing
2. Pumping/overpumping
3. Surging
4. Backwashing ("rawhiding")
5. Jetting
6. Compressed air (with appropriate filtering): airlift pumping and air surging

These development procedures can be used, individually or in combination, in order to achieve the most effective well development. In most cases, over-pumping and surging will adequately develop the well without imparting undue forces on the formation or well materials. Except when compressed air is being used for well development, sampling can be initiated as soon as the ground water has reached equilibrium, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well. Wells developed with stressful measures may require as long as a 7-day interval before sampling. In particular, air surge developed wells require 48 hours or longer after development so that the formation can dispel the compressed air and restabilize to pre-well construction conditions. Because of the danger of introducing contaminants with the airstream, the possibility of entraining air in the aquifer, and the violent forces imparted to the formation, air surging is the least desired method of development and should only be used where there is a specific need for the procedure. Air-lift pumping is permissible where an eductor pipe is used and several well volumes of water are removed from the well by other by pumping means after air-lift pumping.

ADDITIONAL CONSTRUCTION DETAILS

Refer to the appropriate approved design plans for site specific additional items of work and construction details.