Energy and Environment Cabinet
Department for Environmental Protection
Division of Water

GROUNDWATER PROTECTION PLAN FOR WATER WELL DRILLERS

July 2011

Introduction

Administrative regulation 401 KAR 5:037 established the requirement to prepare and to implement groundwater protection plans for activities that have the potential to pollute groundwater. The purpose ofa groundwater protection plan is to ensure protection for all current and future uses of groundwater and to prevent groundwater pollution.

401 KAR 5:037 specifically requires the Natural Resources and Environmental Protection Cabinet to prepare a generic groundwater protection plan for water wells. This document establishes the minimum acceptable groundwater protection practices for the construction, installation, and abandonment of water wells. Any driller who does not prepare their own groundwater protection plan should implement the provisions of this generic plan.

The requirements of this generic groundwater protection plan do not supersede or in any way exempt any water well or water well driller from other federal or state regulatory requirements to which they may be subject. In addition, no water well may be constructed or modified contrary to the provisions of 401 KAR 6:310, Water Well Construction Practices and Standards.

I. Identification of Activities Covered by this Groundwater Protection Plan

This generic groundwater protection plan pertains to those activities that occur during well installation, construction, and abandonment that have the potential to pollute the groundwater. Activities to be addressed by the well driller include: well installation, construction, and abandonment.

II. Identification of Practices Selected to Protect Groundwater

A. Siting Considerations

When locating a well, the driller shall consider existing and/or potential pollutant sources occurring near the proposed well location. In establishing minimum lateral distances to locate a well from potential pollutant sources, the driller shall consider these factors:

1. character and location of the sources of the pollutants;
2. hydrogeology of the area;
3. depth of the aquifer;
4. direction of groundwater flow; and
5. effects on groundwater flow patterns from the pumping of the well.

The minimum 1ateral distances given in Table C of401 KAR 6:310 shall apply for the specific sources of pollutants listed.

The construction of wells in locations subject to a 100 year flood event should be avoided. If this is not possible, then watertight construction of the well is imperative. The well casing shall end no less than two (2) feet above the 100 year flood elevation. Alternate construction methods should have an approved variance from the Division of Water.

B. Decontamination

Decontamination procedures essentially consist of washing and rinsing equipment that contacts geologic formation material or groundwater. Contaminated material that adheres to the surface of drilling and sampling equipment may be transferred via the equipment from one borehole to another and/or vertically within a borehole from a contaminated zone to an uncontaminated zone.

Decontamination procedures are designed to prevent this cross-contamination. Decontamination measures should be conducted at all sites as a quality control measure. However, it is especially important if the well's intended use is for monitoring purposes.

An appropriate decontamination area at a particular site should be selected based on the ability to:

1. control access to the decontamination area,
2. control or contain residual material removed from the surfaces of the drilling and formation sampling equipment, and
3. store clean equipment to prevent recontamination before use.

The decontamination area should be located an adequate distance away from the drill rig to avoid contamination of clean equipment by airborne lubricating oil or hydraulic fluids from the drill rig. Once the equipment is clean, it should not be placed directly on the ground surface. At a minimum, the equipment should be placed on top of plastic ground sheeting.

To comply with the decontamination requirement, drillers must ensure that all down- hole equipment arrive "clean" at the drill site or be "cleaned" down gradient of the drill site. "Clean" shall mean washed with potable water, washed with phosphate free soap and rinsed with potable water, or steam cleaned using potable water.

Contaminated material removed from the surfaces of equipment and cleaning solutions and/or wash water used during decontamination procedures may require containment and proper disposal. If nonhazardous contaminants are involved, provisions for the disposal of wash water may not be required. However, equipment exposed to potentially hazardous materials (or suspected to be hazardous) requires provisions for catchment and proper disposal of the contaminated material and wash water. The catchment should be properly floored to prevent infiltration of contaminants into the groundwater *(e.g.,* temporary trenches lined with plastic sheeting).

C. Other Drill-site Groundwater Protection Practices

The driller shall ensure the following requirements are fulfilled at each drill site:

1. All oil leaks from hydraulic lines, transmission, air compressors, etc. shall be prevented from polluting the ground surface by using absorbent material or 4 mil or greater plastic sheeting in combination with absorbent material. All materials must be properly disposed of in a permitted landfill.

2. All water from well pump tests or well development shall not erode the ground surface or cause a pollutant discharge into any drainage feature.
3. Pits dug for monitoring well completion water or re-circulating fluids at sites with potential contamination shall be lined to prevent infiltration into the groundwater.
4. No pollutant *(e.g.,* oil, solvents, sewage, surface runoff: non-potable water) shall be introduced into the borehole
5. No finished well shall be left open for future installation of down-hole well equipment. A cap or sanitary seal must be installed on the finished well.

D. <u>Well Design Considerations for Proper Well Installation</u>

1. Well Casing

Casing is installed in a well to provide access from the surface of the ground to some point in the subsurface. The casing, associated seals, and grout prevent borehole collapse and inter-zonal hydraulic communication. Access to a particular hydrogeologic zone is through the casing and into either an open borehole or the screened intake.

The driller must consider the following factors when selecting the appropriate casing for a particular water well:

a. The stress to which the pipe will be subjected;
b. The corrosiveness of the water; and
c. Manufacturers' specifications for installation.

Minimum standards for steel and plastic casing, listed in 401 KAR 6:310, Tables A and B, respectively, shall be followed.

2. Well Intakes/Screens

The hydraulic efficiency of a well intake depends primarily on the amount of open area available per unit length. Increased open area also permits easy flow of water from the formation into the well and allows for effective well development. The amount of open area is controlled by the type of well intake and opening size.

The intake should be surrounded by materials that are coarser and have higher permeability than the natural formation material. This allows groundwater to flow freely into the well from the adjacent formation material while reducing the entrance of fine-grained material into the well.

In a naturally developed well, formation materials are allowed to collapse around the well intake after it has been installed in the borehole. The high-permeability envelope of coarse materials is developed adjacent to the well intake in situ by removing the fine-grained materials from natural formation materials during the well development process.

The artificial introduction of coarse, graded material into the annular space between a centrally positioned intake and the borehole serves a variety of purposes. Similar to a naturally-developed filter pack, the primary purpose of an artificial filter pack is to work with the well intake to filter out fine materials from the formation surrounding the well. In addition, the artificial filter pack stabilizes the borehole and reduces settlement of materials above the well intake. Introduction of material coarser than the natural formation materials also results in an increase in the effective diameter of the well and thereby increases the amount of water that flows toward the well. An artificial filter pack is advised for the following geologic situations:

a. the natural formation is uniformly fine-grained;
b. a long screened interval is required and/or the intake spans highly stratified geologic materials of widely varying grain sizes;
c. the formation in which the well intake is placed is a poorly cemented sandstone;
d. the formation is a fractured or solution-channeled rock through which particulate matter can travel;
e. the formation consists of shales or coals that act as constant sources of turbidity; or
f. the diameter of the borehole is significantly larger than the diameter of the screen.

3. Filter Pack Design

Artificial filter pack design factors include:

a. filter pack grain size;
b. screen slot size and length;
c. filter pack length;
d. filter pack thickness; and
e. filter pack material type.

Selection of filter pack grain size and well screen size depends on the geologic formation. Filter pack material size is selected on the basis of the finest formation materials present.

The size of the well intake opening is selected after the filter pack grain size has been specified. The opening size is selected based on its ability to hold back between 85-100% of the filter pack materials. The driller shall select screens or perforated/slotted casing consistent with the requirements of 401KAR 6:310 Section 6(3) and Section 7(3).

The filter pack should extend from the bottom of the well screen to approximately 2-5 feet above the top of the well screen, provided the interval above the well screen does not result in cross-connection with an overlying zone. Extending the filter pack above the screen allows for settlement of the filter pack material that occurs during well development. It also allows a sufficient buffer between the well screen and the annular seal above.

The filter pack must be thick enough to surround the well intake completely but thin enough to minimize resistance caused by the filter pack to the flow of water into the

well during development. Filter packs are recommended to be at least 2-4 inches thick. Filter pack materials should be chemically inert and have well-rounded grains *(e.g.,* clean, well-rounded quartz sand).

4. Annular Seal Design

An annular space is produced when well casing is installed in a borehole. This space provides a pathway for downward movement of water and/or contaminants unless it is adequately sealed. An annular seal placed above the filter pack between the borehole and the well casing serves several purposes:

a. to provide protection against infiltration of surface water and potential contaminants from the ground surface down the borehole annulus;
b. to seal off discrete sampling zones, hydraulically and chemically; and
c. to prohibit vertical migration of water and possible cross-contamination.

If the sealing material is not properly formulated and installed, or if it cracks or deteriorates after emplacement, permeability in the vertical direction can be significant. Infiltration can also result if sealing materials bridge in the annular space.

A satisfactory annular seal results in a complete filling of the annular space and envelopes the entire length of the well casing to ensure no vertical migration can occur within the borehole. Materials used for an annular seal should:

a. be capable of emplacement from the surface;
b. hydrate or develop sufficient set strength within a reasonably short time;
c. provide a positive seal between the casing and the adjacent formations;
d. be chemically inert to formations or fluids with which it may come in contact;
e. be permanent, stable and resistant to chemical or physical deterioration; and
f. be sufficiently impermeable to fluids to ensure that the vertical permeability of the casing/borehole system is lower than that of surrounding formations.

The annular seal may consist of several different types of permanent, stable, low permeability materials including pelletized, granular, or powdered bentonite, neat cement grout, or a combination of both. The most effective seals are obtained by using expanding materials that will not shrink away from either the casing or borehole wall after curing or setting.

5. Surface Completions and Protective Measures

There are two types of surface completions: above-ground and flush-to-ground. Their purpose is to prevent surface runoff from entering and infiltrating down the well annulus and to protect the well from accidental damage or vandalism.

Regardless of the completion type selected, a surface seal of concrete surrounding the well casing should always be installed. The annular space between the casing and the borehole at the surface should be filled. The surface seal may be an extension of the

annular seal installed above the filter pack or it may be a separate seal emplaced on top of the annular seal. Because the annular space near the land surface is large and the surface material surrounding the borehole is disturbed by drilling activity, the surface seal should extend at least two feet away from the well casing at the surface. The surface seal must extend below the frost line to prevent potential well damage due to frost heaving. Also, the surface seal should slope away from the well to prevent surface runoff from ponding and entering around the casing.

a. <u>Above-Ground Completion</u>

In this type of well completion, a protective casing should be installed around the well casing by placing the protective casing into the concrete surface seal while it is still wet. The protective casing should be anchored below frost depth into the concrete surface seal. The protective casing should be fitted with a locking cap to prevent unauthorized entry into the well.

Both the inner well casing and the outer protective casing should be vented to prevent the entrapment of any potentially explosive gases. Also, the outer protective casing should have a drain hole just above the top of the concrete level in the space between the protective casing and well casing. The drain allows any trapped water to exit and drain away from the well casing.

In high traffic areas or areas where heavy equipment is in use, additional protection such as bumper guards is suggested.

b. <u>Flush-to-Ground Completion</u>

According to 401 KAR 6:350, this type of surface completion is only allowed for monitoring wells. It is usually used in high traffic areas *(e.g.,* parking lots) where an above ground completion would be disruptive.

In this type of completion, a protective structure is installed around well casing that has been cut off below grade. Because of the potential for surface runoff to enter the protective structure and/or well, this type of completion must be carefully designed and installed. For example, the bond between the concrete surface seal and the protective structure, as well as the seal between the protective structure and the removable cover must be water tight. Expanding cement is suggested for the concrete to attain a tight bond to the protective structure. In addition, the installation of a flexible o-ring or gasket at the point where the cover fits over the protective structure will help achieve a good seal. In areas where significant amounts of runoff occur additional safeguards to manage drainage may be necessary to diminish entry of surface runoff or contaminants.

E. <u>Well Abandonment</u>

Unplugged or improperly plugged abandoned wells pose a serious threat to groundwater. These wells serve as a pathway for surface pollutants to infiltrate into the subsurface and present an opportunity for various qualities of water to mix. The objectives of an abandonment

procedure are to eliminate physical hazards, prevent groundwater contamination, conserve aquifer yield and hydrostatic head, and prevent intermixing of subsurface waters.

The purpose of sealing an abandoned well is to prevent further disturbance to the hydrogeologic conditions within the subsurface. The seal should prevent vertical movement within the borehole and confine the water to the original zone of occurrence.

1. Well Abandonment Considerations

Selection of the appropriate method for abandonment is based on the information compiled for each well. Factors that must be considered are:

a. casing material;
b. casing condition;
c. diameter of the casing;
d. quality of the original seal;
e. depth of the well;
f. well plumbness;
g. hydrogeologic setting; and
h. presence of contamination and the zone(s) where contamination occurs.

2. Well Abandonment Procedures

Well abandonment procedures involve filling the well with grout. The well may be filled completely or seals placed in appropriate zones and the well only partially filled with grout. Completely filling the well reduces the possibility of borehole collapse and shifting of seals.

Wells can be abandoned either by removing the casing or by leaving all or part of the casing in place and cutting the casing off below ground level. Because the primary purpose of well abandonment is to eliminate vertical fluid migration along the borehole, the preferred method of abandonment involves casing removal. If the casing is removed and the borehole is unstable, grout must be simultaneously emplaced as the casing is removed to prevent borehole collapse and an inadequate seal. When the casing is removed, the borehole can be sealed completely and there is less concern about channeling in the annular space or inadequate casing/grout seals. However, if the casing is left in place, the casing should be perforated and completely pressure grouted to reduce the possibility of annular channeling.

If the casing is in poor condition, the interval adjacent to the water bearing zone can be ripped or perforated with casing rippers, and the casing filled and pressure grouted. The top portion of the casing should be pulled so a watertight seal is attained in the upper 15-20 feet of the well. The driller shall fill the uppermost 5 feet of the well with clay or an impermeable material appropriate for the intended land use.

In situations where the use of permanent and/or temporary bridges is necessary, the driller shall follow the specific requirements of 401 KAR 6:310 Section 11(4)(a).

3. Grouting Procedures

All materials used for grouting should be clean and stable. Potable water should be used and should be free from oil and other contaminants. Grout should be applied in one continuous grouting procedure from bottom to top to prevent segregation, dilution and bridging of the sealant. The end of the tremie pipe should always remain immersed in the slurry of grout throughout the emplacement procedure. The driller shall use the procedures and materials for preparing cement grout listed in 401 KAR 6:310 Section 3.

To ensure the borehole was properly grouted, records should be kept of the calculated volume of the borehole and the volume of grout used. Any discrepancies should be noted and explained. This information should be kept on file with other well documentation records. A concrete cap should be placed on top of the sealed well, if applicable to land use.

4. Clean-up and Documentation

After abandonment is completed, a proper site cleanup should be performed, For example, any pits should be backfilled and the area should be left clean. Accurate documentation of all procedures and materials used should be recorded. The following is a list of the type of information typically recorded for well abandonment:

a. name of property owner;
b. address of owner/property;
c. well location (map or descriptive);
d. AKGWA number (if applicable);
e. type of well installation method and date;
f. purpose of well;
g. diameter of well;
h. depth of casing;
i. depth to rock;
j. depth to water;
k. formation type;
l. material overlying bedrock;
m. materials and quantities used to fill well in specific zones and method used;
n. casing removed or left in place;
o. name of firm doing work’
p. signature of person doing work; and
q. address and phone number of firm.

Note that for a 'water well to be considered properly abandoned, the procedures and materials used must be consistent with the requirements of 401 KAR 6:310 Sections 3 and 12. A monitoring well must be consistent with the requirements of 401 KAR 6:350 Sections 1 and 11.

Complete the following sections to execute this generic groundwater protection plan.

III. General Information

NAME: _____
(Well Driller)

ADDRESS: _____

_____

COUNTY: _____

PHONE#: _____

Name of person responsible for implementing this Groundwater Protection Plan:

_____

WELL AKGWA Number(s) (include all wells at a given site)

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

IV. Schedule of Implementation of Groundwater Protection Practices

Selected Practices	Schedule (weekly, monthly, etc.)
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(Attach additional pages if needed)

V. Description of Employee Training Required for Groundwater Protection Plan Implementation

_____

_____

_____

_____

VI. Schedule of Necessary Employee Training

Training Required	Schedule (weekly, monthly, etc.)
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

VII. Schedule of Regular Inspections Confirming Groundwater Protection Practices are in Place and Functioning.

Selected Practices	Inspection Schedule
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

*Keep all inspection records on file with your groundwater protection plan.

VIII. Certification of Groundwater Protection Plan

To the best of my knowledge, the groundwater protection practices I have selected and will implement according to the schedule given herein are adequate to protect groundwater from .pollution associated with the installation, construction, and/or abandonment of this well.

_____ _____

Driller's Signature Date Date