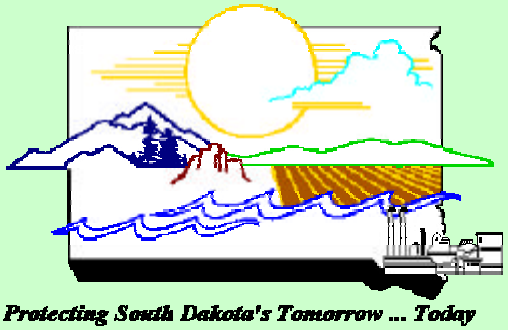
South Dakota Wellhead Protection Guidelines



Department of Environment and Natural Resources
Division of Environmental Regulation
Ground Water Quality Program

April 1995

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Seven Components of Wellhead Protection
South Dakota Wellhead Protection Guidelines
Steps for Wellhead Protection Development

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PURPOSE

Having good quality, safe drinking water at a reasonable cast is something that most people take for granted, especially if their water comes from a public water supply system. To ensure that the water supply is safe, and to avoid costly treatment or relocation of their supply, the local community must be aware of the activities that could adversely impact their water source. A program designed to help communities address potential sources of contamination of their ground water is called wellhead protection. Wellhead protection involves the protection of ground water supplies by eliminating or controlling sources of pollution to the surface and sub-surface area surrounding a water well or wellfield.

The purpose of this document is to provide information and guidance to communities on how to develop local wellhead protection programs. This document specifies the components necessary for a complete program, describes these steps to follow to develop the program, and reveals the process through which the local wellhead protection program can receive concurrence from the South Dakota Department of Environment and Natural Resources (DENR) that the local program is complete and adequate.

SEVEN COMPONENTS OF WELLHEAD PROTECTION

Seven components are recommended for a wellhead protection program to be considered adequate and complete by DENR, and the federal Environmental Protection Agency (EPA). These seven components to be addressed by the local program include the following:

Component 1: Specify Duties of State and Local Governments. This component identifies all state and local entities that may have a role in the protection of the water supply. Specifics for this component are described in **Guidelines 1 and 4** of this document.

Component 2: Delineate Wellhead Protection Areas. This component describes the wellhead protection area, which is the specific area around the well or wellfield that is to be protected for ground water quality. The wellhead protection area can be delineated according to a method or combination of methods described in these guidelines **(Guideline 2)** or another technically sound method approved by DENR. The areal extent of a wellhead protection area and locations of individual wells are best illustrated on a topographic map at a 1:24,000 scale (a standard United States Geological Survey topographic quadrangle).

Component 3: Identify Potential Contaminant Sources. Potential contamination sources in the wellhead protection area are to identified and included in this element of the Wellhead Protection document. Information for each source, such as the street address and legal location, the physical, chemical and biological properties of the potential contaminants, the distance from the well/wellfield, and the nature of the contaminant, should be included. This component is described in **Guideline 3** of this document.

Component 4: Develop Management Approaches. This component describes the management approaches that can be adopted and implemented to protect the water supply. Various management methods are available and are described in **Guidelines 1, 4, and 5.**

Component 5: Develop Contingency Plans. Despite adequate protection measures, emergencies may happen that threaten the public water supply; this component details emergency procedures and alternate water sources in the event of service interruption, water quality problems or threat of water quality problems. **Guideline 5** of this document describes the development of the contingency plan.

Component 6: Plan for New Wells. A complete wellhead protection program includes plans for the development and use of new wells. This component describes the precautions to be taken to prevent contamination in the event or expansion of current water use by the water supplier, and identifies the delineation method to be used for the new supply. **Guideline 6** of this document assists local governments with plans for new wells.

Component 7: Implement Public Participation. This component describes the methods of public involvement, communication and education in the development and implementation of a wellhead protection program. The local government should show the extent to which the public was involved in the wellhead protection program development. **Guideline 7** describes areas for public participation.

SOUTH DAKOTA WELLHEAD PROTECTION GUIDELINES

This document consists of seven guidelines designed to assist local communities in the development and implementation of local wellhead protection programs. The guidelines were required by the 1989 South Dakota Legislature when they passed Governor George S. Mickelson's Centennial Environmental Protection Act. These guidelines, described in South Dakota Codified Law 34A-3A-17, mirror the components noted above that are necessary to have an adequate program. Figure 1 illustrates the process a local agency would initiate to receive Sate concurrence. Guideline 7, although not in this State environmental law, was added to this document to address all the above described components. The guidelines and a summary of their objectives are listed below:

Guidelines specifying roles of state agencies and local governments. Guidelines specifying the duties of the Department and local governments in developing and implementing the wellhead protection program, including activities by privately owned water systems.

Guidelines for determining the extent of wellhead protection areas.
Guidelines for determining the extent of wellhead protection areas. Factors for consideration may include, but are not limited to, the once of depression, the area of influence, the zone of contribution and the recharge and discharge boundaries;

Guidelines for determining all potential and actual pollution sources.
Guidelines for determining all potential and actual pollution sources which may have an adverse effect on public health;

Guidelines for management of a wellhead protection program.
Guidelines for a wellhead protection program to protect public water supplies from new and existing facilities which may be potential or actual pollution sources. The guidelines cover the various regulatory and non-regulatory measures that are available to the local community to help protect their water supply. Ground water protection measures conducted by state and federal agencies are also included. These guidelines include, but are not limited to: land use restrictions, the design of new facilities and modification of existing facilities, DENR approval or denial under existing authority of plans and specifications for new facilities or modifications to existing facilities, siting criteria for new facilities, operation maintenance criteria, land acquisition, pollutant release containment and cleanup, technical assistance and education training;

Guidelines for developing contingency plans for pollution containment, clean up, and provisions for alternate water sources.
Guidelines for developing contingency plans for natural disasters, pollution release containment, cleanup and the provision of alternative drinking water supplies for each public water system in the event of well or wellfield pollution.

Guidelines for siting new wells.
Guidelines for taking into consideration potential sources of pollution when siting new wells for public water supplies;

Guidelines for pubic participation
Guidelines for including the local citizens in all facets of wellhead protection program development and

implementation.

STEPS FOR WELLHEAD PROTECTION DEVELOPMENT

The seven components which are closely correlated with statutory guidelines can be completed in five major steps in the wellhead protection program development process:
(Information will be presented in each individual guideline describing how the component can be satisfied in a step by step process)

Step 1: Form a community planning team/local task force
(Components 1 and 7)

Step 2: Define the land area to protected
(Component 2)

Step 3: Identify and locate potential contaminant sources
(Components 3 and 7)

Step 4: Manage the protection area
(Components 4 and 7)

Step 5: Plan for the future
(Components 5,6, and 7)

Although the steps and components are progressive, public participation should occur throughout the process so the public will own their protection program and will support any regulatory changes necessary to accomplish wellhead protection.

In South Dakota the wellhead protection program is voluntary for communities, rather than a regulatory requirement imposed by the state or federal government. If an individual community decides to implement a wellhead protection program and desires State concurrence with the program, the State will require a formal plan which includes all the wellhead protection program components that are discussed in this guideline document. DENR will evaluate the submittal to determine whether the proposed plan adequately addresses the component requirements. If the proposal is acceptable, DENR will indicate it "concurs" with the wellhead protection program plan. The proposal can receive partial concurrence from the state if DENR determines that some of the components have been adequately addressed while others have not. DENR will work with the local community to get all the components completed.

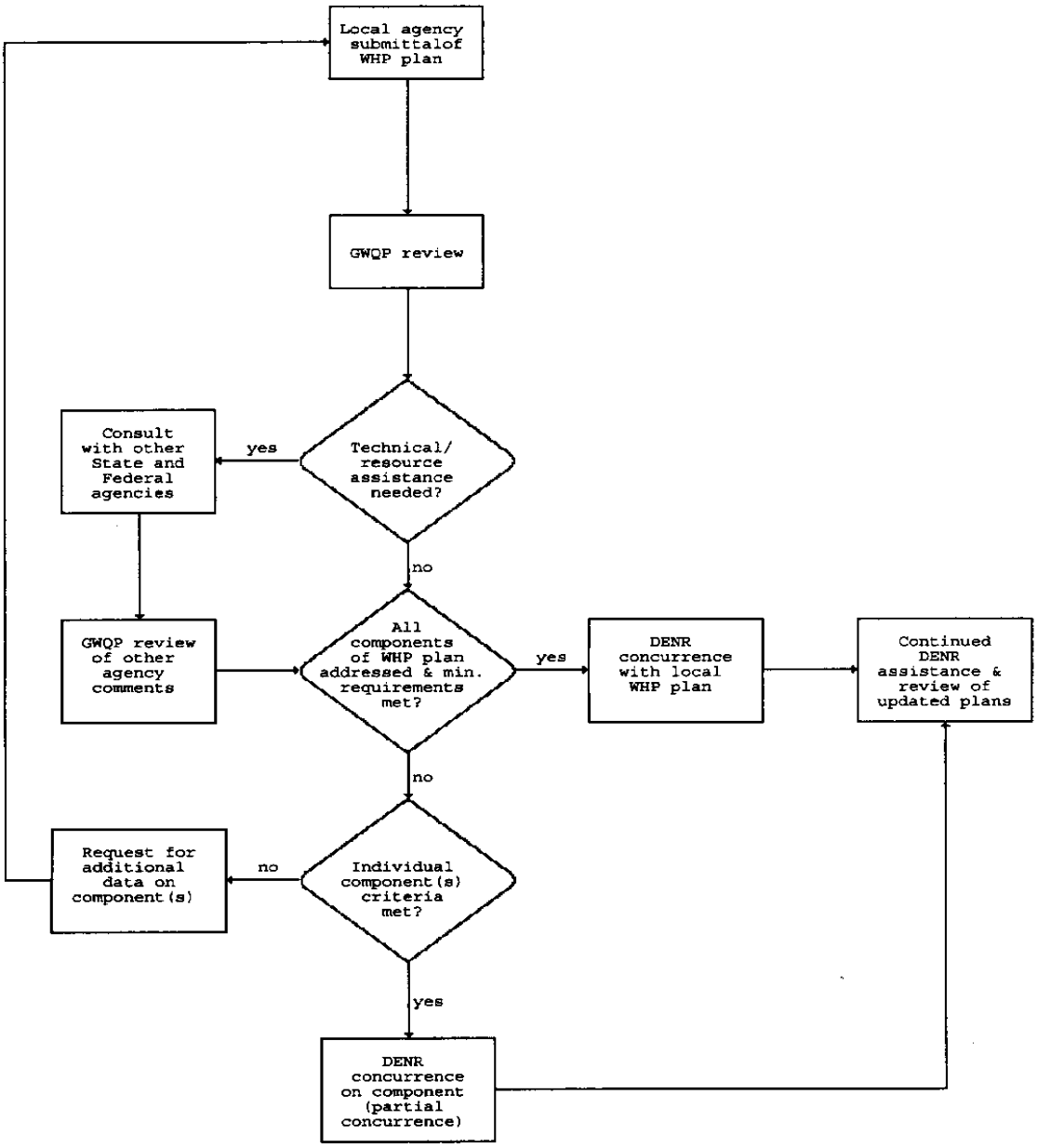


Figure 1. State Concurrence Procedure for Local WHP Programs.

1. GUIDELINES SPECIFYING ROLES OF STATE AGENCIES AND LOCAL GOVERNMENTS

INTRODUCTION

An initial step in developing any community program involves forming a group of concerned individuals or a local task force who will evaluate what the particular needs of the community are, plan how those needs can be met, and determine who is responsible for meeting those goals. This process involves gathering input from a broad spectrum of the local community, and requesting guidance from any state or federal agency that may be involved. Discussed below are the roles of the State and local governments in developing a wellhead protection (WHP) program for a public water supply. The main federal agency involved in WHP is the Environmental Protection Agency (EPA), which requires the states to develop and administer a State WHP program.

A. WHAT ARE THE STATE GOVERNMENT ROLES?

The Department of Environment and Natural Resources (DENR) was given the responsibility by the 1989 South Dakota Legislature to develop the State Wellhead Protection Program and to insure implementation at the state level. The wellhead protection program resides in the **Ground Water Quality Program** within the Division of Environmental Regulation. A detailed DENR organizational chart is shown in Figure 2.

The following describes the roles and services provided by DENR in regard to wellhead protection activities.

Division of Environmental Regulation

Ground Water Quality Program

- Assist local governments in general wellhead protection development.
- Provide minimum wellhead protection area delineations.
- Hold informational meetings.
- Provide guidance documents and technical information.
- Help identify contaminant sources.
- Review the local wellhead protection plans.

Drinking Water Program

- Assist with the monitoring waiver program.
- Monitor public water supply sampling programs.

South Dakota Geological Survey

- Provide information on aquifer characteristics and vulnerability.
- Provide other technical assistance in regard to South Dakota geology and/or hydrology

Division of Water Rights

- Assist with placement of new public water supply wells.
- Provide technical assistance concerning area geology/hydrology.

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

ORGANIZATIONAL CHART

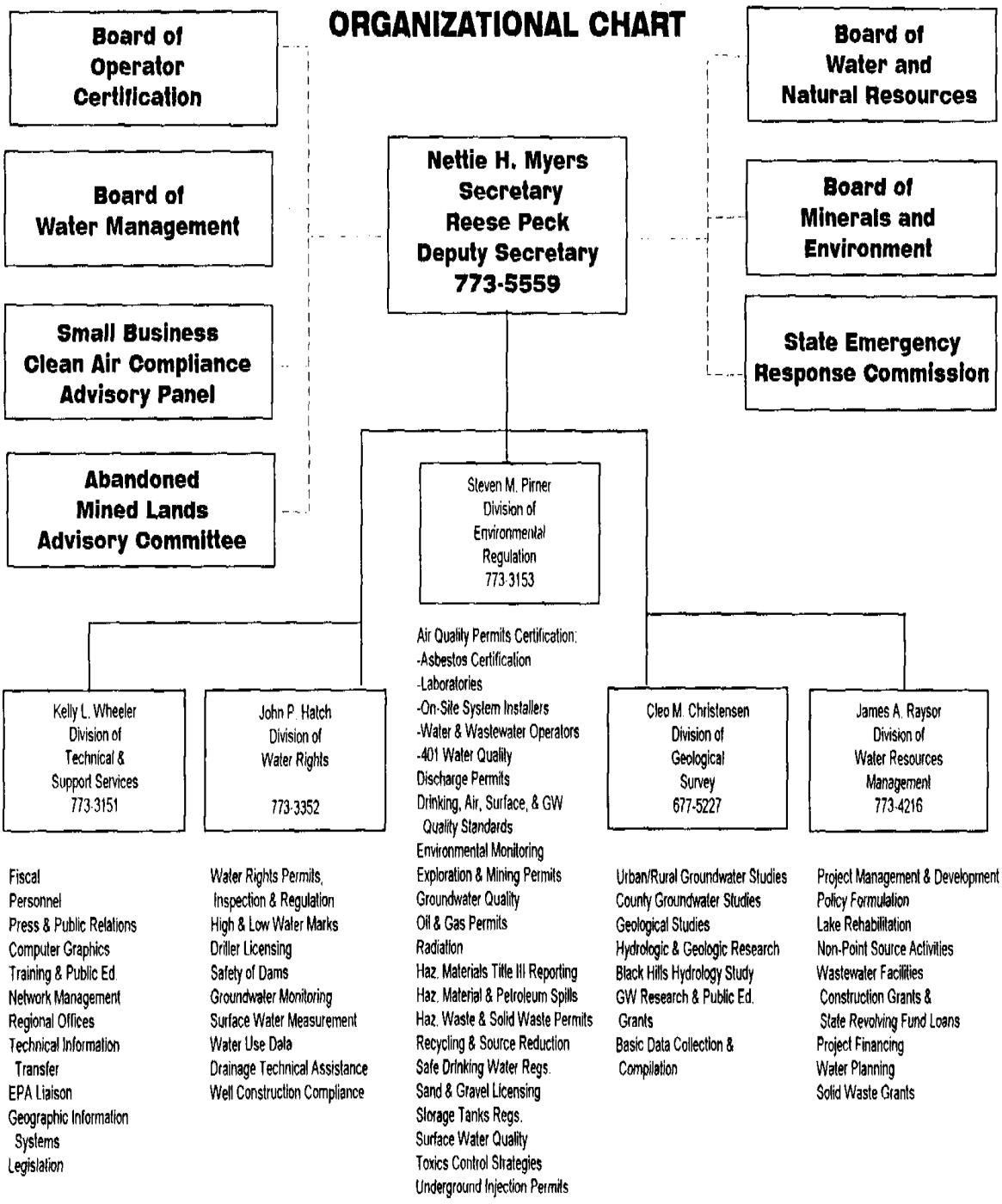


Figure 2. DENR Organizational Chart.

Other state agencies such as the **Department of Agriculture** and **Department of Health** may provide additional technical assistance in the areas of agricultural practices and public health, respectively. The address and phone numbers of the main environmental contacts within state government are shown in Appendix 1.

Other agencies or groups that may be of assistance for information or technical support include: water development districts, universities, United States Department of Agriculture, United States Geologic Survey, regional planning agencies, county associations, local emergency planning commissions, and the EPA.

State roles also include activities not directly related to wellhead protection program review or assistance, but do address pollution prevention. South Dakota is involved in regulatory contamination prevention activities through review of facility designs, siting restrictions, discharge permit requirements, ground water quality standards, and clean-up requirements for spill sites. The state agencies that regulate ground water protection also provide technical assistance and education to communities and citizens to help them manage their water resources. A discussion of the various regulatory and non-regulatory programs provided by the State can be found in the guideline regarding management of a wellhead protection program.

WHAT ARE THE LOCAL GOVERNMENTS ROLES?

Because the program is voluntary, and the fact that municipalities and counties are authorized by South Dakota Codified Law to adopt ordinances for the protection of ground water supplies, the management of the local wellhead protection program is the responsibility of local government. The initial step for a local community developing a wellhead protection program is to form a community planning team or local task force to initiate the wellhead protection planning process. It is important to insure that as many community interests are represented on the planning group as can be reasonably accommodated. This does not mean they should all be on the task force, which must remain a manageable size, but their ideas and concerns need to be addressed. The following groups, which certainly are not inclusive of all possible interests, can be represented on a wellhead protection program development task force: business and industry representatives; farmers; elected officials; local government agencies such as health, planning, & natural resources; emergency response personnel; the public water supplier; fire and police departments; legal representatives; water associations; scientists and engineers; environmental groups; and land developers.

It is important for the local community to pick the task force and a major spokesperson at an early stage of the process to develop the community goals for the program based on all the varied interests. For example, the goal of protecting the public water supply may be an easy goal to ascribe to, but setting the guidelines to achieve that goal (economic development vs. land use restrictions) may be much more difficult.

The public will need to be kept informed of task force progress as the goals and objectives of the wellhead protection program are developed. This will help educate them about wellhead protection and gather support for the program. It will also be beneficial to hold public meetings during plan development to gather input. Along with meetings, the committee may send out flyers, questionnaires, etc. to keep the public informed. This public support will be very important when the community conducts the contaminant source inventory, and develops the specific management plans.

Local public water supply officials must coordinate with the municipal or county government in development of the wellhead protection plan. The public water supply is also responsible for maintaining monitoring and pumping records, updating system changes, and emergency response as necessary to maintain water quality in the water supply system.

Local wellhead protection program enforcement can be achieved through regulatory and non-regulatory methods. Techniques such as ordinances, permits, licenses, fines, management plans, inspections, compliance reports and ground water monitoring can be used to meet zoning, operating, performance and construction

standards within wellhead protection areas. These various management techniques are discussed in more detail in Section 4, dealing with management of a wellhead protection program.

SUMMARY

The development of a local wellhead protection program in South Dakota is voluntary, and an understanding of the roles and responsibilities of the local agency in protecting their water supply verses what protection activities will be handled by the State is very important in developing the plan. Including the public in all stages of the planning and implementation process is essential if the program is to succeed.

The dependance of citizens on ground water, the vulnerability of the well or wellfield, and the potential sources of contamination vary with each public water supply. Therefore, WHP needs vary accordingly across the state. Local governments are responsible for initiating, developing, and implementing a WHP plan for their water supply; however, the DENR staff as well as other state and federal agencies are available for assistance during various stages of WHP plan development. To receive State support and have an effective and efficient WHP plan, the local community must adequately address all seven components in their submitted document.

ROLES AND RESPONSIBILITY ITEMS TO BE CHECKED IN THE LOCAL DOCUMENT SUBMITTED TO DENR

The following items will need to be addressed to determine whether the requirements for completion of Component 1 have been met.

- Has a task force or similar organizing/managing group been formed to plan the wellhead protection program?
- Are all the various interests of the local community represented on the task force?
- Are the roles the different local agencies will play in wellhead protection documented?
- Are the State roles understood, and the local activities coordinated with them?

2. GUIDELINES FOR DETERMINING THE EXTENT OF WELLHEAD PROTECTION AREAS

INTRODUCTION

The second step in the development of a local wellhead protection program is to identify the land area surrounding your well or wellfield which you need to protect. This wellhead protection area will consist of a zone around your well which would include land overlying the aquifer, and may include drainage areas outside the aquifer where surface runoff could carry contaminants over and then into the aquifer at a location near the well or well field. Ground water recharge areas that are some distance from the well may also need protection if they contribute water to the well. There are numerous methods which may be used to define or delineate a wellhead protection program area. This guideline includes the information required to complete Component 2 of a wellhead protection program.

GROUND WATER CONTAMINANT MECHANISMS

There are two major types of ground water bearing rock formations (aquifers) in nature. The unconfined aquifers, also known as water table aquifers, are essentially in direct hydrogeologic connection with the land surface an are generally more vulnerable to contamination than the confined aquifers. The confined aquifers, also known as artesian aquifers, occur between two less permeable materials and are under pressure greater than atmospheric pressure. Due to the presence of impermeable material above and below confined aquifers, they are generally less vulnerable to contamination from the land surface directly around the well. Confined aquifers may be vulnerable at the recharge area or can be threatened by contaminants moving around and down the wellbore of poorly sealed wells. The type and thickness of less permeable overlying materials (overburden) and the distance to the water table also have a bearing on the potential for moving a contaminant to the ground water.

Ground water contamination may occur when contaminants enter the ground water from underground sources such as storage tanks, injection wells or septic systems, or when precipitated water carries contaminants through the soil column. Contamination may also occur from surface spills if the porous media is very near the surface. Contaminants released into a porous medium will generally follow the local or regional gradient and may reach the drinking water supplies.

The timing and degree of ground water contamination depends on site geology and contaminant characteristics. Contaminants that are lighter than water such as petroleum products, tend to float on the surface of the aquifer while contaminants that are heavier than water such as brine, tend to sink. Migration of contaminants that are heavier than water is controlled by gravity. Sometimes these contaminants may move against the direction of ground water flow. The potential pathway for contaminants moving into and through the ground water are depicted in Figure 3.

Vulnerability of wellhead areas depends on aquifer sensitivity in addition to chemical toxicity, solubility of contaminants and if any contaminants are in the area. Sensitivity can be thought of as the natural susceptibility of the geologic formation or material to contamination. A shallow, unconfined sand and gravel aquifer with the high water table is very sensitive to contamination because contaminants can reach the water quickly and with little reduction in the amount that will enter the water. Vulnerability of a water supply is based upon the sensitivity of the aquifer and the presence and properties of a contaminant, as noted above. For example, a public water supply well may be located in a very sensitive aquifer but it is not vulnerable if no contaminants are present. The amount of protection required, which influences the size of the wellhead protection area and the restrictions placed on facilities, may vary because of the variation in aquifer sensitivities. Variations in individual public water supply wellhead delineation methods and criteria can reflect these different levels of protection, as can the resources (funding and personnel) available for management of a wellhead protection plan at the local level. Where shallow unconfined aquifers are involved, larger surface areas may need to be protected than if the wells are located in deep, confined aquifers. The surficial glacial aquifers east of the Missouri River, alluvial aquifers throughout the state, bedrock aquifers exposed at or near the surface, and bedrock aquifers that are highly fractured near the surface are the most vulnerable to contamination from activities at the land surface, and have the greatest need for wellhead protection.

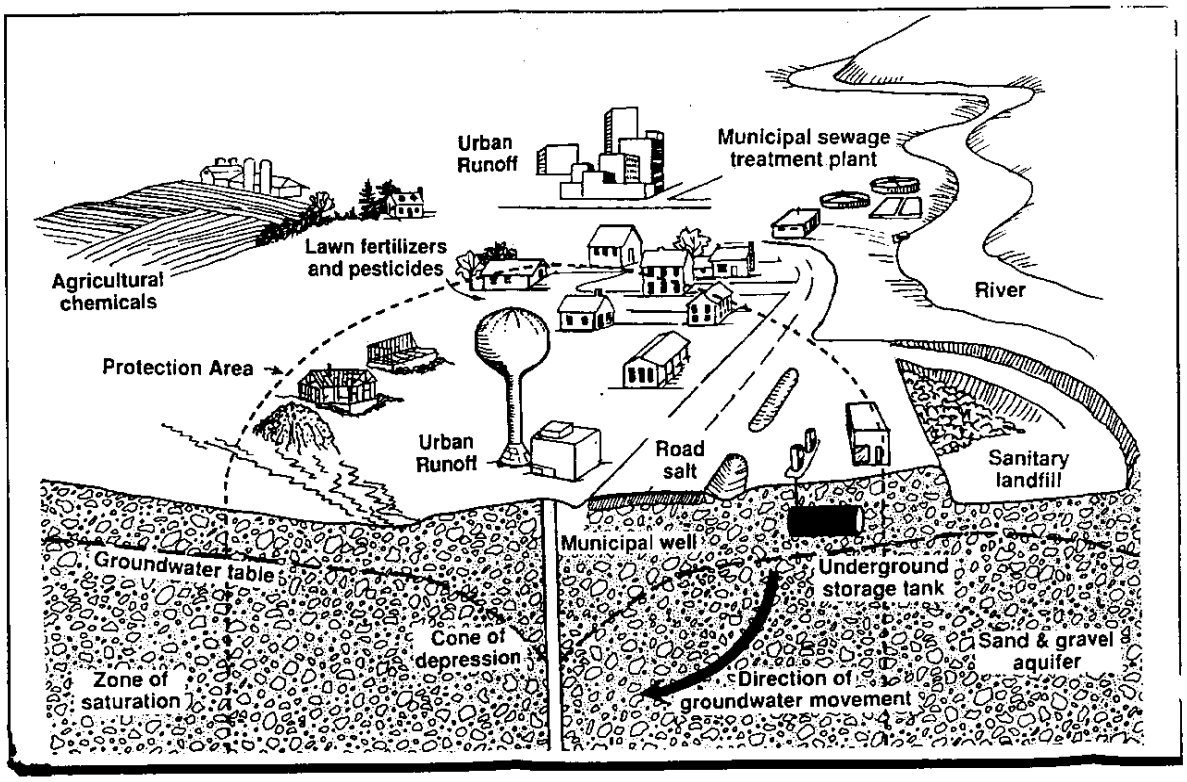


Figure 3. Potential Sources of Contamination and Pathways of Contaminants.

WELLHEAD PROTECTION AREA DELINEATION CRITERIA

Choosing appropriate criteria and thresholds are decisions used in wellhead protection are delineation to define the level of protection. Criteria measures such as distance, drawdown, time-of-travel, flow boundaries, and assimilative capacity are the factors that affect the likelihood of contaminants reaching the well or well field. The thresholds are the limits for the criteria, thus a limit on the desired protection. The threshold is the number corresponding with the selected criteria, such as a 10 year time-of-travel. These concepts are discussed below and defined in the glossary.

The actual criterion and threshold selected should be based on technical considerations, overall protection goals, and other policy considerations. For example, a community may wish to protect their wellfields from any contaminants that could reach their well(s) within 10 years of entering the aquifer. The criterion chosen would be time-of-travel, while the threshold used in this case would 10 years. If the community would decide to protect against any contamination within three miles of their wellfield, the criterion used would be distance and the threshold limit on that criterion would be three miles.

The most common criteria are:

- DISTANCE CRITERION
  A radial or horizontal distance from the well is selected as the real extent of the wellhead protection area. The criterion may or may not have a technical hydrogeological basis (may be arbitrary) and thus may under or over protect the well.

- DRAWDOWN CRITERION
  This criterion concerns the vertical extent to which the pumping well will lower the water table (or potentiometric surface) of an aquifer. This is used to delineate the boundaries of the zone of influence and is dependent on the pumping rate, the aquifer medium and water table gradient..

- TIME-OF-TRAVEL (TOT)
  The criterion bases the wellhead protection are boundary in the time required for contaminants to reach the water supply. Time of travel (TOT) is the estimated time it will take for a contaminant to reach a well from the point of release into the aquifer. The less permeable the medium, the more travel time will be required to impact the water supply.

- FLOW BOUNDARIES
  The mapping of physical and/or hydraulic boundaries of an aquifer can be used as an effective tool for certain wellhead protection delineations. The criterion is best suited for shallow, unconsolidated and fractured or karst aquifers where recharge and discharge areas and aquifer boundaries are clearly identified.

WELLHEAD PROTECTION AREA DELINEATION THRESHOLD

The wellhead protection area must be delineated according to a method or combination of methods described below or another technically sound method available from future research/studies. The locally selected delineation criteria and thresholds for individual wells are expected to be site specific because of the variable characteristics of the state's aquifers. The wellhead protection area must be delineated on a topographic map, 1:24,000 scale if available, and all public water supply wells must be included on the map.

- Unconfined Aquifer: For all unconfined and semi-confined aquifers, the initial wellhead protection area must extend a minimum of one radial mile (both upgradient and downgradient) from the well or to the 10 year time-of-travel boundary calculated by using the calculated fixed radius or analytical method until detailed hydrogeologic information has been gathered for further more accurate and efficient delineation. Using a one-mile radius based on an arbritary fixed radius delineation method will, in all likelihood, overprotect in the downgradient direction, and would therefore be beneficial to develop a more precise wellhead protection area to reduce the size of the downgradient area needing protection.

- Confined Aquifer: At a minimum, a delineated wellhead protection area must have a 500-foot arbitrary radius for confined aquifers greater than 100 feet deep. Deep wells instaled in confined aquifers near recharge area of wells that are poorly constructed also need more stringent protection. A confined aquifer less than 100 feet deep will be considered as an unconfined or semi-confined aquifer, until sufficient hydrogeologic information is furnished to the DENR which would indicate that these aquifers are sufficiently protected, and, therefore, require less stringent protection than unconfined aquifers.

PROTECTION MEASURES: The criteria and threshold values appropriate for unconfined, confined or semi-confined aquifers should be determined on a case-by-case basis due to variable geology across the state, but a minimum threshold value is defined as a 10 year time-of-travel or 1 mile radial distance. There are a number of methods and various levels of protection being used across the nation, depending on hydrogeology, local standards and available resources. Some of the common levels of protection and criteria are as follows:

- Use of a three-zone system - Zone A is the area most immediate to the wells and requires the highest degree of protection from potential contaminants; Zone B is an intermediate zone and requires a lesser degree of protection than zone A. Zone C may refer to protecting the outermost portion of the wellhead protection area. This could refer to an area that is contributing drainage to the wellfield area, but is not directly over the aquifer. In general, if a community decided to use a 10 year time-of-travel as its delineation criterion/threshold, then the delineated are depending on the nature of the contaminants. In many cases the 10 year time-of-travel is considered Zone A, and aquifer or vulnerable areas outside it are considered zones B and C. Some times this type of zonal partition may lead to over or under protection.

The entire 10 year time-of-travel zone must be protected, and all seven program components must be addressed in this zone. Additionally, if the area beyond the 10 year time-of-travel area is considered to be a potential recharge or run-off area and may impact the community's water supply, then this area should also be protected from contamination, but may not need to be protected as stringently.

- Small communities with few financial or personnel resources may initially want to adopt the adopt the arbitrary fixed radius method to protect their water supplies.

- Other communities may use hydrogeological mapping such as recharge-discharge boundaries for delineation. Communities with wells in narrow alluvial or outwash aquifers often use this method.

- In areas where the aquifer is the sole source of water to a community, the whole shallow aquifer under its jurisdiction can be mapped and protected to a higher level than normally would occur, but the most vulnerable area near the wellfield would still need the most stringent protection.

In all cases, the area chosen for protection should be based on the best hydrogeological information available and based on the community's management resources and public acceptance of the protection measures.

WELLHEAD DELINEATION METHODS

There are six common methods that can be used to determine wellhead protection areas. Generally, the more complex the method the more expensive and difficult it is to use and the more data needed to determine the protection area. For instance, to use complex delineation methods like numerical modeling, a large amount of highly accurate hydrogeological data must be collected in the field. This may require additional financial resources for hiring technical personnel and purchasing field instruments.

Any method chosen must be technically sound for the individual conditions of the public water supply and must be defensible if the wellhead protection area is challenged by those impacted by the possible land use restrictions. A brief explanation of each method is provided in the following paragraphs. Figure 4 shows some of the hydrologic relationships between a pumping well, ground water movement and the aquifer areas which can contribute to the well. Contamination found within the zone of contribution could impact the well. Examples and more detailed information can be found in the EPA document "Guidelines for Delineation of Wellhead Protection Areas" June 1987.

Arbitrary fixed radius is the simplest method for wellhead protection area delineation and may be acceptable to define an initial wellhead protection area until a more sophisticated approach can be adopted. Specific technical information is not necessary for this method. The method involves drawing an arbitrary circle around the well, (Figure 5). The size of the circle depends on the public water supply needs, the location of potential pollution sources, and the ability of the local government to manage the area. The Ground Water Quality Program defines the minimum initial protection area as a one mile radial distance (both upgradient and downgadient) from the public water supply well or fields, until an advanced delineation method is used. Any smaller or larger protection zone that is later chosen must be shown to be technically sound. An arbitrary fixed radius may be appropriate under certain conditions for wells over 100 feet deep with a relatively thick low permeability layer to protect the aquifer from surface sources of contamination. This method may not provide adequate protection for shallow wells in surficial aquifers.

Advantage: It is an easy, fast and inexpensive method and is suitable for initial delineation (1-mile radius minimum).

Disadvantage: Does not take site specific hydrogeologic information into consideration and thus may not be reliable for effective or complete wellhead protection. Over or under protection may occur in some directions from the well. Generally, it may underprotect in the upgradient direction, and overprotect in the downgradient direction. For example, an industry located two miles upgradient may not be included in any management or land use restrictions, and contamination from that facility may reach the wellfield. An industry ¾ mile downgradient may have additional restrictions placed on its

operation, but any contamination leaking from it to the ground water may not be pulled back to the pumping well, and thus may not be endangering the public water supply.

Calculated fixed radius is a circle drawn around a well, the size of which is calculated using aquifer, well and pumping rate information (Figure 6). The area of the circle is related to the volume of water drawn down into the well in a specified time based on aquifer characteristics: saturated thickness, well depth, screen length, and pumping rate. A minimum 10 year time-of-travel should be used to calculate the cone of influence.

Advantage: The method is simple to apply, easily verifiable and requires a limited amount of hydrogeologic data. This method can also be related to time-of-travel criteria.

Disadvantage: It can not be applied where contaminant transport is an important factor. It will usually overprotect downgradient of the well and underprotect upgradient because the local groundwater gradient is not considered. The effect of gradient is to move ground water, and any contaminants carried in it, toward the well(s) under the force of gravity moving the water "downhill". This method only accounts for water drawn into the well by pumping.

Simplified variable shapes is a method which uses analytical models to create standardized shapes dependent on aquifer type (Figure 7). An appropriate shape is applied for specific hydrogeologic and pumping conditions. For example, a wellhead delineation for one community can be imposed directly over other communities' public water supply without performing another delineation as long as the hydrogeology of the sites are similar and effective pumping capacities of both public water supplies are the same.

Advantage: Once the standardized shapes have been created for an aquifer based on hydrogeologic information, the shapes can be used where similar hydrogeology and water demands exist. Thus it is relatively fast and requires limited site-specific information. It offers more efficient protection than the fixed radius method.

Disadvantage: The method can lead to over or under protection, if hydrogeologic conditions differ from standard shaped sites. It does not use site specific hydrogeological information. If standardized forms are not already developed, cost may higher than expected.

Analytical methods define wellhead protection areas by solving mathematical ground water flow equations to delineate the area of contribution to a pumping well. This includes the area surrounding a pumping well that supplies water to recharge the well. This area may include surface water as well as ground water (Figure 8). Aquifer characteristics are used to calculate the most down-gradient distance the well draws from (the stagnation point), and the width of the area of contribution. Site specific hydrogeologic information is necessary for each well site including transmissivity, porosity, hydraulic gradient, hydraulic conductivity and saturated thickness of the aquifer. This method can be applied to aquifers with a sloping or flat water table and is especially applicable with time of travel criteria. Various computer models, including EPA's wellhead protection area (2.2) models, are capable of delineation based on this method. Thus, this method is one of the most useful one for communities to use.

Advantage: The analytical delineation is site specific and is more accurate than all the methods except numerical modeling. It requires a limited number of site specific hydrogeologic parameters and provides reliable wellhead protection area designations.

Disadvantage: The method is not reliable where the ground water gradient is high and variable geology causes the water to flow in different directions in the wellhead protection area

Hydrogeologic Mapping may be accomplished if sufficient hydrogeologic information is available. Investigation of an aquifer through surface observations and evaluation of subsurface data to indicate geologic changes, can be used to identify the aquifer boundaries and other areas possibly contributing water to the aquifer. Hydrogeologic mapping is used to identify aquifer and flow boundaries (Figure 9). Many of these aquifer boundaries have been mapped and are available in county reports prepared by the United Sates and

South Dakota Geological Surveys. Hydrogeologic mapping is especially well suited for narrow, shallow glacial and alluvial aquifers as well as bedrock aquifer recharge areas. When used alone in some aquifers, or in conjunction with other methods in other aquifers, hydrogeologic mapping is suitable for wellhead protection area delineation in areas of South Dakota. This method may be more applicable where surface features control the ground water flow and recharge-discharge balance in aquifers.

Advantage: Good for small, shallow and geologically variable aquifers.

Disadvantage: Requires specialized knowledge of geologic mapping, flow boundaries, recharge-discharge zones and groundwater divides. This method is less suited for large and deep aquifers.

Numerical flow/transport modeling can be used to delineate wellhead protection areas. A wide variety of numerical models are available from commercial and technical organizations. When hydrogeologic and boundary conditions are complex, numerical flow/transport models are useful. The accuracy of such models is dependent on the accuracy of the input data. Permeability, porosity, specific yield, saturated thickness, recharge rates, flow direction, flow rate and hydrologic boundaries are needed for modeling. If this method is selected for wellhead protection area delineation, the model should be technically acceptable for the site, and the parameters characteristic of the aquifer being modeled must be used. Often site specific data are available from aquifer tests using the well or wellfield or from a DENR study completed for a city water supply. If site specific information is not available, an aquifer test can provide the parameter values needed. To successfully delineate a wellhead protection area, the model must be calibrated with well or wellfield specific data. Numerical modeling can provide a high degree of accuracy and can be applied to nearly all hydrogeologic settings.

Advantage: These methods are very accurate and can be applied to almost all hydrogeologic settings.

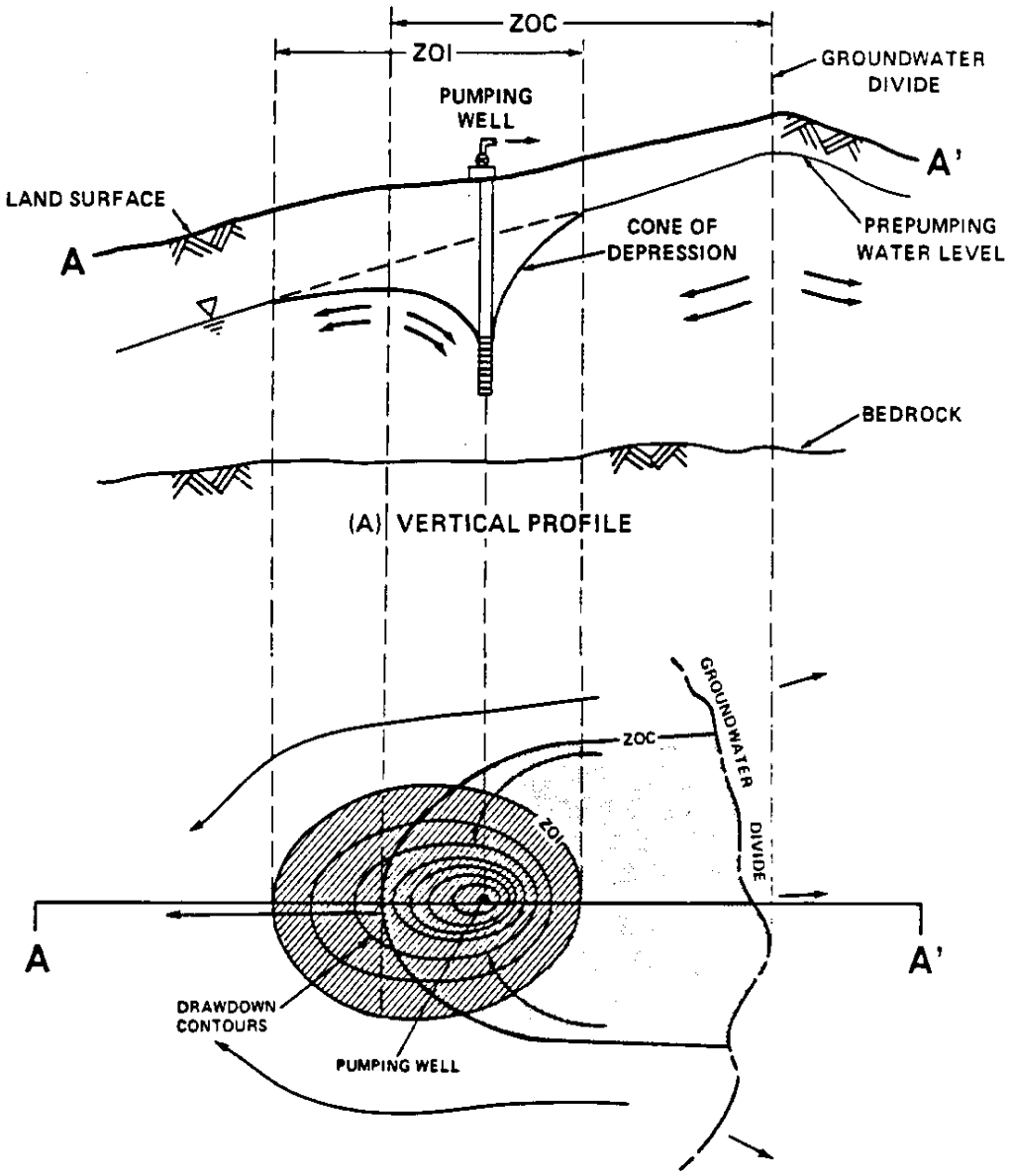
Disadvantage: It is expensive, and requires a high degree of technical expertise and a significant amount of site specific hydrogeologic information.

In the selection of a wellhead protection area delineation method, a local community must consider the degree of aquifer vulnerability and what resources are available to conduct the delineation. DENR is available to assist local communities in delineating wellhead protection areas, but the Department's involvement is restricted to evaluating hydrogeologic data that are presently available. DENR can make recommendations to a community, but the final delineation is the responsibility of the community. If additional information is needed (such as gathering site parameters via an aquifer test) to refine the delineation, the local community may want to hire a consulting firm to help.

The majority of the required hydrogeological information (e.g.; transmissivity, storativity, gradient, thickness, flow velocity) can be estimated by qualified individuals conducting an aquifer test. The delineation method should be easy to understand, defensible, and relevant to the program's overall goal.

Since time of travel is, in part, a function of the hydraulic conductivity and gradient, the criterion may have an effect on the basic shape of the wellhead protection area. Any major discrepancies in assumed effective porosity will cause changes in the calculated upgradient distance. The DENR believes that using only geological logs for delineation purposes is not a reliable method. The initial minimum delineation requirements can be modified after submission of individual site specific well and aquifer data to the DENR for review, which may help formulate a more accurate delineation area.

WHPA TERMINOLOGY: POROUS MEDIA AQUIFER



NOT TO SCALE

Figure 4. WHPA Terminology.

METHODS: ARBITRARY FIXED RADIUS

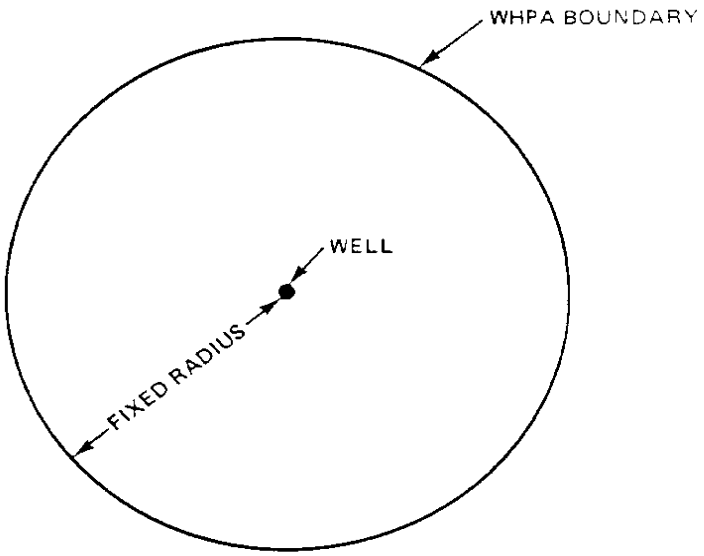
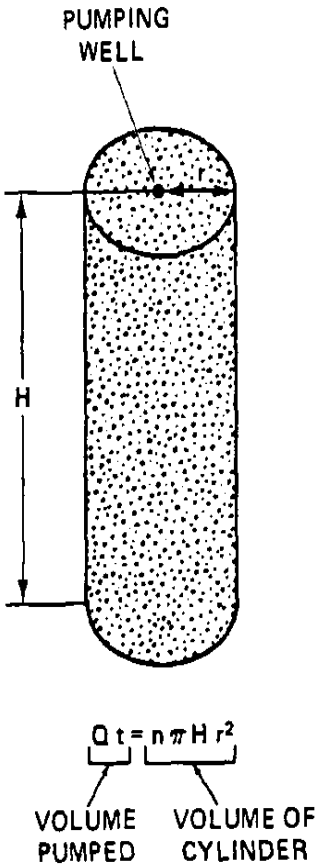


Figure 5. Arbitrary Fixed Radius.

METHODS: CALCULATED FIXED RADIUS



$$r = \sqrt{\frac{Q\,t}{\pi\, n\, H}}$$

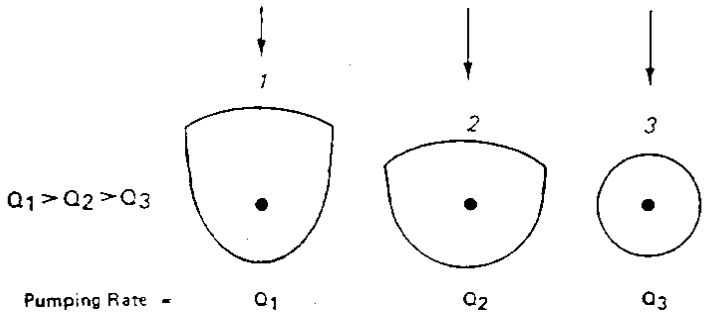
WHERE
Q = Pumping Rate of Well
n = Aquifer Porosity
H = Open Interval or Length of Well Screen
t = Travel Time to Well

(Any consistent system of units may be used.)

Figure 6. Calculated Fixed Radius.

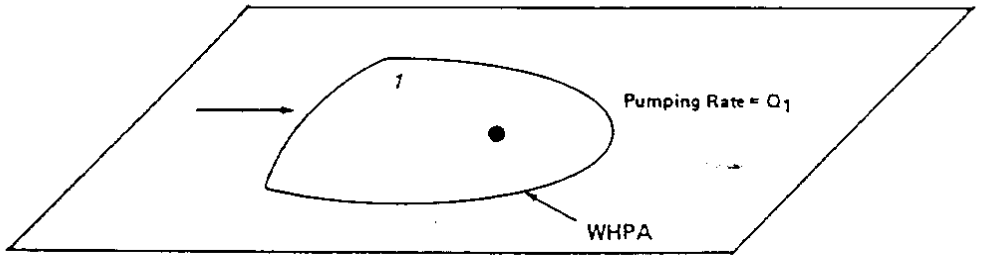
WHPA Delineation Using Simplified Variable Shapes Method

STEP 1: DELINEATE STANDARDIZED FORMS FOR CERTAIN AQUIFER TYPE



-Various standardized forms are generated using analytical equations using sets of representative hydrogeologic parameters.
-Upgradient extent of WHPA is calculated with TOT equation; downgradient with uniform flow equation.

STEP 2: APPLY STANDARDIZED FORM TO WELLHEAD IN AQUIFER TYPE



-Standardized form is then applied to well with similar pumping rate and hydrogeologic parameters.

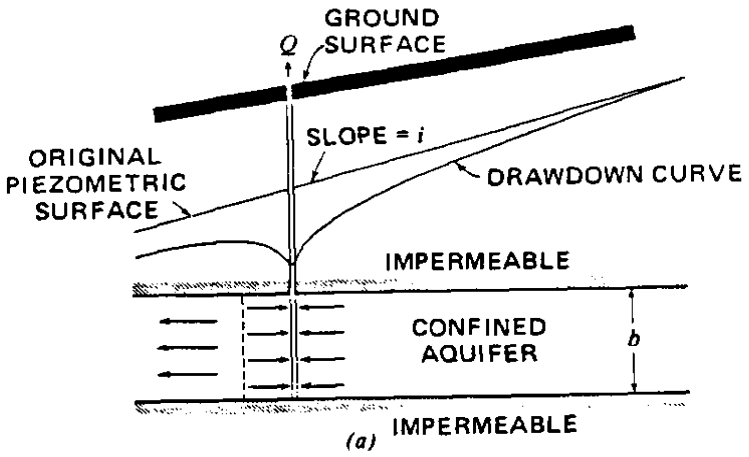
LEGEND:

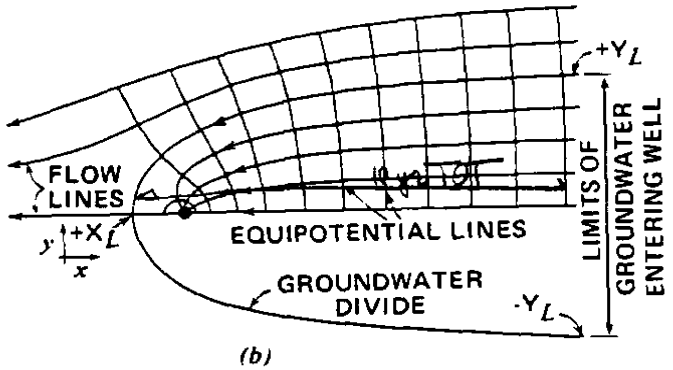
- Pumping Well
- Direction of Ground-water Flow

Figure 7. Simplified Variable Shapes.

NOT TO SCALE

METHODS: ANALYTICAL TECHNIQUES





$$-\frac{Y}{X} = \tan\left(\frac{2\pi Kbi}{Q}\,Y\right)$$

UNIFORM-FLOW EQUATION

$$X_L = -\frac{Q}{2\pi Kbi}$$

DISTANCE TO DOWN-GRADIENT NULL POINT

$$Y_L = \pm\frac{Q}{2Kbi}$$

BOUNDARY LIMIT

LEGEND:

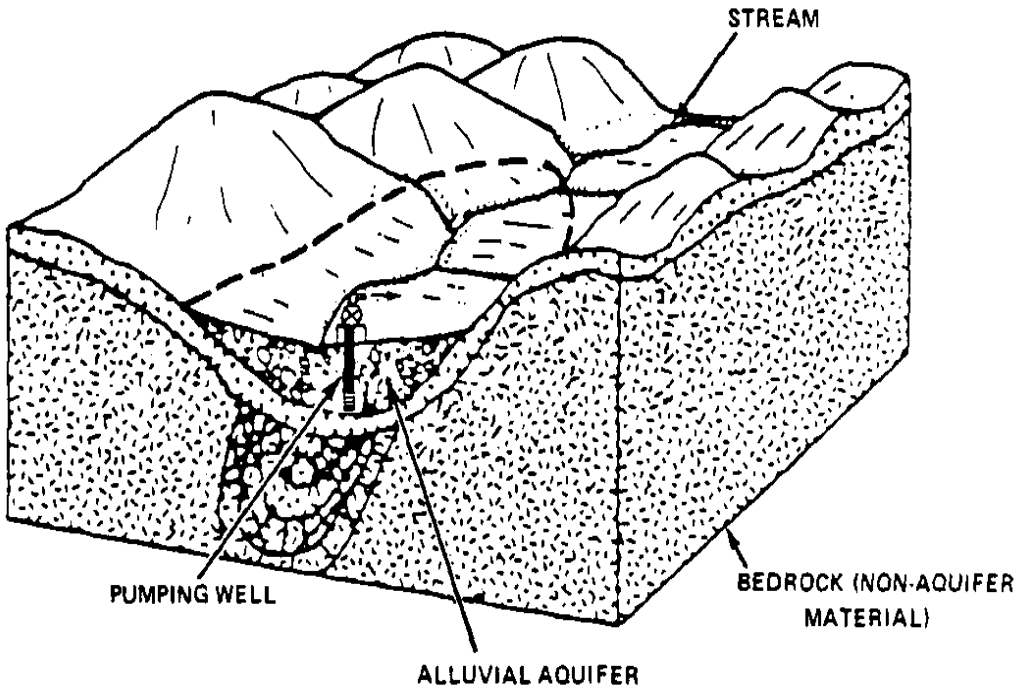
● Pumping Well

Where:
Q = Well Pumping Rate
K = Hydraulic Conductivity
b = Saturated Thickness
i = Hydraulic Gradient
π = 3.1416

SOURCE: Todd, 1980

Figure 8. Analytical Methods.

METHODS: HYDROGEOLOGIC MAPPING



Primary WHPA Boundary Drawn as Contact Between Aquifer and Non-Aquifer Material

NOTE: A secondary protection zone could be delineated based on the larger area of recharge derived from surface runoff, and inferred from topography and basin boundaries.

Figure 9. Hydrogeological Mapping.

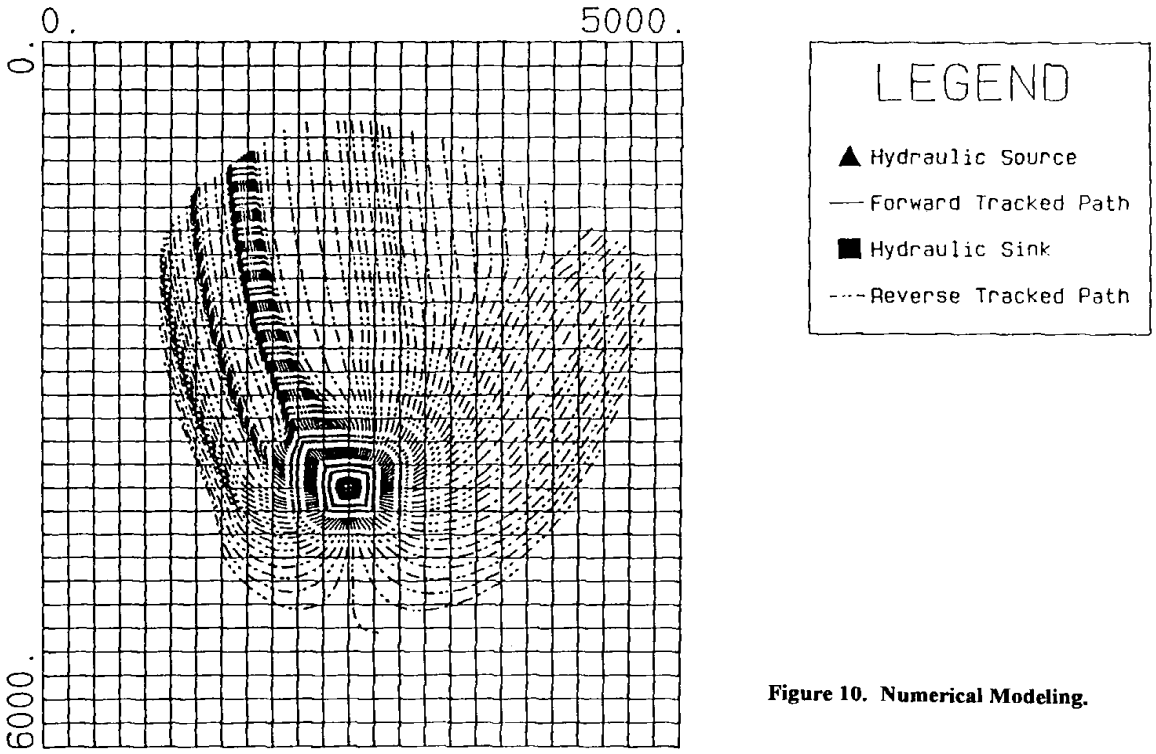


Figure 10. Numerical Modeling.

SUMMARY

Following the formulation of the local wellhead protection task force the local community must decide on the area around their wellfield that they feel requires protection. DENR has defined the minimum level of protection as a one-mile radius around the well, or a 10 year time-of-travel analysis. The local community can alter that type of protection if it can show through additional technical information that a different level of protection is warranted. DENR can assist with delineation by analyzing available data. The importance of establishing an adequate wellhead protection area can not be overemphasized, as it forms the basis for all the future activities of a wellhead protection program, such as source inventory, management, land use restrictions, and emergency contingency planning.

DELINEATION ITEMS TO BE CHECKED IN THE LOCAL DOCUMENT SUBMITTED TO DENR

The following items need to be addressed to complete Component 2, the delineation of the wellhead protection area. This information will assist the local community in determining if their delineation adequately protects the wellfield.

- Is aquifer type identified (confined, unconfined, fractured)?

- Are aquifer characteristics known (transmissivity, storativity, thickness, porosity)?
- Are current and future pumping rates included (the pumping rate and aquifer characteristics affect the zone of influence)?
- Are well depths and screened intervals known?
- Delineation method proposed (is method technically sound and feasible)?
- Is delineation method applicable to area hydrogeology?
- Is delineation threshold protective (over or under-protection)?
- Can method/threshold be modified?
- Is source of hydrogeology information documented?
- Is the wellhead protection area at least a mile radius or 10 year time-of-travel?
- Is wellhead protection area illustrated on 1:24,000 scale map?

3. GUIDELINES FOR DETERMINING ALL POTENTIAL AND ACTUAL POLLUTION SOURCES

INTRODUCTION

Following the formation of the local task force to develop the wellhead protection plan and defining the area around the well that needs protection, an inventory of what contaminant sources are located within that designated area should be conducted. This step will complete Component 3 of a wellhead protection program. To have an effective wellhead protection plan, the local community should inventory all potential and actual sources of contaminants which may have an adverse effect on public health if found in the water supply. An inventory of the number, type and location of existing facilities that may impact groundwater, can provide local officials with an understanding of the potential for contamination of the public water supply wells. A general understanding of what contaminants are produced at these source facilities is essential for setting protection priorities to adequately protect the water supply with the resources available to the community.

It is important to consider past land uses in the wellhead protection area, as some uses may have had a greater impact on groundwater quality than the existing activities. These uses are often masked by present uses. For example, an old gasoline station that may have had leaking underground storage tanks may no longer be present, and the station site is now the site of some other type of facility.

In addition to the contaminant sources being identified, the public water supply wells must be maintained to ensure contamination does not occur at the wellhead itself through surface runoff and seepage around the casing. Wells must be adequately sealed at the surface, must not be in an area susceptible to runoff or flooding, and should be protected against unauthorized access by fencing or a locked shed or small housing unit over the wellhead. A covering over the well also protects any monitoring or gaging equipment from the weather and is useful during any maintenance work. For complete well construction requirements, see the regulations written in Administrative Rules of South Dakota, Chapter 74:02:04.

WHAT ARE POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION?

Before attempting the inventory of your contaminant sources, you need to be familiar with the types of facilities or operations that may produce ground water contaminants. The main categories of potential pollutant sources in South Dakota include wastewater treatment systems, on-site waste disposal systems, land application of wastes, livestock feedlots and waste storage, chemical storage (including petroleum) facilities, fertilizer and pesticide storage and application, businesses and industries using hazardous materials, road salt and de-icing sand, and landfills and dumps. Government agencies have produced lists of potential sources of ground water contamination. Tables 1 identifies possible contaminant sources, and defines the categories based upon the type of operation that may produce the contaminants.

Contaminant sources within a local wellhead protection area may also contain any business or activity that uses any of the potential contaminants found in Table 2, even if the facility or activity is not listed in Table 1. This potential list of contaminants is included to show the difficulty in determining what facility operations do pose a threat to groundwater, as the list of chemicals that may impact ground water is very extensive, and it is not always readily apparent which facilities use these chemicals. Appendix 2 reveals the types of chemicals or products that can be found at many of the sources, and this information will help correlate the potential source with the chemicals produced. Appendix 3, which shows a list of household products that contain a number of these potentially harmful chemicals, will also be useful in the inventory.

To help manage the source identification, local governments may tailor their inventory to reflect local priorities and perceptions of problems. The table, although not inclusive of all sources, shows a list of facilities and sites which may be identifiable sources of contamination for local inventories. It should be emphasized that not all the sources identified will necessarily be a threat to ground water, but they should all be documented as being in the wellhead protection area. A general methodology to follow in conducting a contaminant source inventory is described below.

HOW DOES A COMMUNITY CONDUCT A CONTAMINANT SOURCE INVENTORY?

An inventory of potential sources and contaminants within the wellhead protection area as described in Tables 1 and 2, and Appendices 2 and 3 is necessary for proper wellhead protection management and planning. The extent and focus of an inventory can vary from town to town depending on specific local concerns, resources available and location of the water supply. Inventory information should include the potential source by name and location by street address and/or legal location based on Township-Range-Section-Quarter identification.

Information on the general physical, chemical or biological constituents produced by the potential contaminant sources is essential to adequately protect your water supply. It is important to know what problems can result from leaks in such sources as underground storage tanks, feedlots, wastewater treatment facilities, or landfills. In the first two cases it may be fairly easy to identify the contaminants associated with a particular tank or an animal feedlot, but it is not the case with a sewage treatment facility or landfill. The tables and appendices noted above will be helpful in this regard as will state and federal agencies that have information on these facilities. It should be stressed that a detailed knowledge of the contaminants is not necessary, but gathering as much information about the potential contaminants produced by these facilities will help in the protection effort.

There are various methods available to conduct a source inventory, methods which range from compiling a list of contaminant sources or activities from a simple review of telephone directories, to gathering information on quantity and quality of facility discharges, and creating map overlays of sources and locating them on geographic information system (GIS) computer data bases. Regardless of the complexity of the inventory, the following steps are recommended for conducting the inventory.

Step 1. Enlist a source inventory team - The number of individuals required to conduct the inventory will depend upon the size and location of the wellhead protection area. If the wellhead protection area is small, and in an area with few contaminant sources or the sources are all of the same type, the personnel needs will be much less than if an extensive wellhead protection area is located in a city industrial area. Many communities that have done contaminant source inventories have enlisted the help of volunteers to conduct area surveys while the local officials heading the wellhead protection effort set up the survey and help train the volunteers. In some communities retired individuals have volunteered to help, and were trained to do the surveys. Their knowledge about past land uses can be very helpful in assessing risks to the community water supply. Another possibility is for students to be hired to do these surveys during summer months. Other volunteers or the government entity developing the wellhead protection program may be able to do the assessment. A major responsibility in developing a wellhead protection program is to sell the idea to your local community by promoting protection of their water supply and gathering local support for the inventories.

Step 2. Develop an information data base - After developing a team for the work, but before actually inventorying what contaminant sources are in your area, it is very helpful to develop a method to handle the information that you will collect. It is important to be able to integrate the location of the wellhead protection area with the known potential contaminant sources in the area. This will require a good base map from which to work, so you can identify the potential problems. It would be difficult to over-emphasize the importance of a good base map, as all your management activities related to the wellhead protection area depend upon the relationship between the area you wish to protect and the activities within that area that may be a potential pollution problem. Some large scale maps you may wish to consider are community plat maps, or city street, water or sewer maps. In many instances it may be useful to transfer the information to United States Geological Survey (USGS) topographic maps (1:24,000 scale, or 7.5 minute series). The 1:24,000 USGS topographic map is required by the DENR Drinking Water Program for communities submitting contaminant source information when applying for Phase 11/V monitoring wavers. These maps are often converted to a digital, computer based format for use in Geographic Information Systems, where different kinds of information can be presented on one map by overlaying the various pieces of information (wellhead protection area, contaminant sources, zoning areas, the physical landscape and political boundaries) on the map. It must be noted that in order to correlate the wellhead protection area delineation with contaminant source inventory, the information must be placed on the same base map. Although other maps as noted above can be used for the

Table 1. Potential Contaminant Sources

Agricultural

Animal burial areas
Animal feedlots
Chemical application (e.g. pesticides, fungicides, and fertilizers)
Chemical storage areas
Irrigation
Manure spreading and pits

Commercial

Airports
Auto repair shops
Boat yards
Construction areas
Car washes
Cemeteries
Dry cleaning establishments
Educational instutions (e.g., labs, lawns, and chemical storage areas)
Gas stations
Golf courses (chemical application)
Jewelry and metal plating
Laundromats
Material transports (trucks and railroads)
Medical institutions
Paint shops
Photography establishments/printers
Railroad tracks and yards/maintenance
Research laboratories
Stormwater drains, retention basins,
Road deicing operations (e.g., road salt)
Road maintenance depots
Scrap and junkyards
Storage tanks and pipes (above-ground, below-ground, underground)

Industrial

Agricultural drainage wells
Asphalt plants
Automobile service station disposal wells
Chemical manufacture, warehousing, and distribution activities
Construction excavations
Detonation Sites
Electrical and electronic products and manufacturing
Electroplaters and metal fabricators
Foundaries
Industrial process water disposal wells
Machine and metalworking shops
Manufacturing and distribution sites for cleaning supplies
Mineral extraction disposal wells
Mining (surface and underground) and mine drainage and waste piles
Oil and gas disposal wells
Petroleum products production, storage, and distribution centers
Pipelines (e.g., oil, gas, coal, slurry)
Radioactive Disposal Sites
Septage lagoons and sludge
Storage tanks (above ground, below-ground, underground)
Toxic and hazardous spills
Wastewater disposal wells
Wells- operating and abandoned (e.g., oil, gas, water supply injection, monitoring, and exploration)
Wood preserving facilities

Residential

Fuel storage systems
Furniture and wood strips and refinishers
Household hazardous products
Household lawns (chemical application)
Septic systems, cesspools, water softners
Sewer lines
Swimming pools (e.g., chlorine)

Waste Management

Fire training facilities
Hazardous waste management units (e.g., landfills, land treatment areas, surface impoundments, waste piles, incinerators, treatment tanks)
Municipal incinerators
Municipal landfills
Municipal wastewater and sewer lines
Open burning sites
Recycling and reduction facilities

(Source: US-EPA 1989, Wellhead Protection Programs: Tools for Local Governments. EPA 440/6-89-002

TABLE 2

POTENTIAL CONTAMINANTS

Arsenic
Barium
Cadmium
Chromium
Copper
Cyanide
Fluoride
Lead
Mercury
Nitrate as N
Nitrite
Selenium
Silver
Endrin
Lindane
Methoxychlor
Toxaphene
2,4-D
2,4,5-TP Silvex
Trihalomethanes
Fecal Coliform Bacteria
Radium 226 and 228
Gross Alpha
Trichloroethylene
Carbon tetrachloride
Vinyl-chloride
1,2-Dichloroethane
Benzene
1,1-Dichloroethylene
1,1,1-Trichloroethane
para-Dichlorobenzene
Total Hydrocarbons
Polychlorinated biphenals (PCBs)
Chloride
Sulfate
Total dissolved solids (TDS)
1,3-Dichloropropene
Diquat
Epichlorohydrin
Ethylene dibromide (EDB)

Acetone
Acrylamide
Adipates
Alachlor
Aldicarb
Atrazine
Bromobenzene
Bromodichloromethane
Bromoform
Bromomethane
Butyle acetate
Carbofuran
Chloramben
Chlorodane
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
o-Chlorotoluene
p-Chlorotoluene
Dalapon
DCPA
Dibromochloropropane
Dibromomethane
Dicamba
m-Dichlorobenzene
o-Dichlorobenzene
1,1-Dichloroethane
cis1,2-Dichloroethylene
trans1,2,-Dichloroethylene
Dichloromethane
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
1,1-Dichloropropene
Dinoseb
Endothall
Ethylbenzene
Fonofos

Table 2 (continued)

Glyphosate	Heptachlor
Heptachlor epoxide	Hexachlorocyclopentadiene
Methyl ethyl ketone	Methylene chloride
Monochlorobenzene	Napthalene
PAH's (Polynuclear aromatic hydrocarbons)	
Parathion	Pentachlorophenol
Phenol	Phthalates
Phorate	Picloram
Simazine	Sulfone
Sulfoxide and aldicarb	Styrene
2,3,7,8-TCCD (Dioxin)	Trichlorobenzene
1,1,2-Trichloroethane	1,2,3-Trichloropropane
Trifluralin	1,1,1,2-Tetrachloroethane
PCE	Toluene
Xylene	

initial source inventory, the final product should be combined with the delineation boundary on the 1:24,000 USGS topographic maps.

The large volume of information you may be able to gather about contaminant sources will need to be recorded in a way that allows you to easily work with the data. Use of a computer to store this information would be very beneficial, but a good data filing system will be sufficient in many cases.

Step 3. Compile the existing data - Local, state and federal offices often have a substantial amount of information concerning facility operations in a community, which could provide data on historical, current or potential contaminant sources. A search of documents such as:

construction permits	assessors files
real estate title searches	zoning records
telephone directories	business licenses
aerial photographs	maps and plats
discharge permit records	disposal permits
environmental spill files	emergency plans
environmental impact studies	NRCS and CFSA records
other historical records	

will help describe and locate possible contaminant sources. The majority of these records can be found in the local communities.

One valuable source of information concerning possible contaminant sources is the Emergency Planning and Community Right to Know Act of 1986 which was passed as Title III of the Superfund Amendments and Reauthorization Act (SARA). SARA Title III requires communities to identify facilities which store substances on EPA's Extremely Hazardous Substances List or on the Hazardous Materials List as defined by the Occupational Safety and Health Administration. This act also requires communities to develop a plan and procedures for responding to releases from those facilities. The groups involved with these plans are the State Emergency Response Commissions and Local Emergency Planning Committees. This information will be very valuable to your overall inventory. However, since this is not a complete list of facilities that store material which may impact groundwater, there is a need for the source inventory noted earlier. The SARA Title III activities are administered by the DENR's Ground-Water Quality Program. The SARA Title III information will be readily available to the wellhead protection programs for their use. Personnel from the Ground-Water Quality Program working in the wellhead protection and SARA Title III programs will play an active role in local contingency planning as well as provide information for your source inventory.

Data concerning environmental permits or studies usually can be found in State records at the Department of Environment and Natural Resources' offices. Other possible sources of contamination regulated by the DENR in conjunction with EPA are listed below:

- underground and above ground petroleum storage tanks (excluding fuel oil tanks)
- underground injection control wells (automotive service station and industrial disposal drainfields, septic systems, drainage wells)
- wastewater treatment facilities
- feedlots
- landfills
- mining operations
- other industrial facilities

Agricultural chemical facilities which are regulated by the South Dakota Department of Agriculture also may impact ground water if releases occur, at which time DENR becomes involved in any cleanup required.

In addition to regulating these types of facilities to prevent contamination from occurring (through permits, inspections, performance and construction standards through review of plans and specifications), clean up of actual groundwater contamination is also required. The DENR and South Dakota Department of Agriculture can provide location and contaminant information to the local wellhead protection programs regarding these

contaminated sites. This information will also be valuable to local communities who are proposing to install new drinking water wells, and wish to be sure no contamination is present in their future wellhead protection area. This topic will be discussed in more detail in a later guideline.

Step 4. Field Verification and Surveys - Once you have compiled and mapped possible sources of contamination from known facilities you will then want to verify these sources and identify any others which were not previously noted as being in the wellhead protection area. The best way to do this would be through some type of survey. Listed in Appendix 4 is an example of a survey form that could be used to do your inventories. The survey formats can include:

- windshield surveys to visually identify sources and locations simply by driving through the wellhead protection area and recording and mapping identifiable contaminant sources.

- mail or telephone surveys which can be used to contact a large number of people at a low cost. Although more people may respond when calling, it is more expensive and time consuming than sending out a mail survey questionnaire asking about knowledge of possible contaminant sources.

- door to door surveying in the wellhead protection area will take additional time and effort, but it is a good method to use to insure the public is informed about ground water contamination, and may be the best way to increase the likelihood that contaminant sources will not be missed.

- personal interviews with people that have lived in the area a long time and have a knowledge of past and present land use activities are often useful to help locate possible sources. Interviews with individuals that work in business and/or industry can also help locate and describe possible contaminant sources.

Except for possibly the windshield survey, these surveys will be an intrusion on the people who are contacted. It is very important that the community is informed ahead of time about the upcoming environmental survey. The local media and law enforcement agencies, community leaders, and others should be informed of the planned activities. Public meetings should also be held to promote wellhead protection, explain the program objectives, and describe why a contaminant source inventory is important. Making contact with the owners or operators of possible contaminant sources prior to sending them a questionnaire or interviewing them concerning their operation will be very important. These actions will help alleviate citizen concerns when they receive these survey questions or see individuals working in the neighborhoods.

Step 5. Prioritizing inventory results - Once the surveying has been completed, the local water managers and community officials have the difficult task of deciding which facilities pose more of a threat to the water supply. This depends upon such factors as the toxicity of the material produced, the quantity of the material on hand, how it is used and stored, its distance from the wellfield, how often it is used, containment procedures, degree of existing regulatory control on the facility, past history of any problems, and so forth. Your local fire department, emergency and disaster services people, water department, and the state and federal environmental agencies discussed earlier can assist in this prioritization.

Table 3 shows a ranking system adapted from an EPA document indicating which types of land use "in general" pose a greater risk of contaminating ground water. The local wellhead protection officials will have to use all the criteria noted above when ranking contaminant threats, as this table is only a general guide. For example, an underground storage tank that is 1/2 mile from the public water supply well, is double walled and has early detection monitoring wells around it, may be less of a threat than a residence with a septic system that is across the street and upgradient from the well.

This prioritization information will be used extensively in assessing your management options regarding how the wellfield area will be protected from contamination, and will be important in developing your wellhead protection contingency plan regarding emergency procedures for water supply disruption.

Table 3
Land Uses and Their Relative Risk to Ground Water

LEAST RISK

A.
1. Land surrounding a well or reservoir, owned by a water company.
2. Permanent open space dedicated to passive recreation.
3. Federal, state, municipal, and private parks.
4. Woodlands managed for forest products.
5. Permanent open space dedicated to active recreation.

B.
1. Field crops: pasture, hay, grains, vegetables.
2. Low density residential: lots larger than 2 acres.
3. Churches, municipal offices.

C.
1. Agricultural production: dairy, livestock, poultry, nurseries, orchards, berries.
2. Golf course, quarries.
3. Medium density residential: lots from 1/2 to 1 acre.

D.
1. Institutional uses: schools, hospitals, nursing homes, prisons, garages, salt storage, sewage treatment facilities.
2. High density housing: lots smaller than 1/2 acre.
3. Commercial uses: limited hazardous material storage and only sewage disposal.

E.
1. Retail commercial: gasoline, farm equipment, automotive, sales and services; dry cleaners; photo processor; medical arts; furniture strippers; machine shops; radiator repair; printers; fuel oil distributors.
2. Industrial: all forms of manufacturing and processing, research facilities.
3. Underground storage of chemicals, petroleum.

GREATEST RISK

4. Waste disposal: pits, ponds, lagoons, injection wells used for waste disposal; bulky waste and domestic garbage landfills; hazardous waste treatment, storage and disposal sites.

SOURCE: USEPA (1993), Wellhead Protection: A Guide for Small Communities, EPA 625/R- 93/002

Step 6. Update of source inventory - One important aspect of the contaminant source inventory process is the need to upgrade and refine the information gathered during the survey. New facilities may move into the area or may change locations, others may move from the wellhead protection area, or operational changes may occur in existing facilities. These changes in land use in the wellhead protection area must be monitored, and the contaminant source map and data base periodically updated to reflect these changes and keep the inventory current. It may be beneficial to update the inventory as a new business or industry locates in the wellhead protection area or closes down. Status changes involving taxing, zoning, property transfers, utility needs or other activities are all indicators that may show a change in business activities.

At a minimum, the source inventory must be upgraded every 2 years in order to maintain an adequate inventory. If the changes occurring in the wellhead protection area are frequent, it may be beneficial to upgrade it more often than that. For your wellhead protection program to be acceptable to the State, the source inventory plan, results and upgrades must be submitted to the DENR for review.

What are the Benefits of Conducting A Source Inventory?

- The most obvious benefit is, of course, the protection of your community water source from contamination, and the resulting protection of the citizens' health.

- The cost of cleaning up area ground water in most cases far exceeds the cost of preventing the contamination from occurring in the first place. A knowledge of where potential contaminant causing facilities are located in relation to the public water supply is essential to helping local governmental agencies manage threats to their water supply, to prevent groundwater contamination which could require expensive treatment or abandonment of the water supply and costly development of a new one.

- Recent federal drinking water rules (Phase II/V) administered by the Environmental Protection Agency (EPA) have placed some stringent requirements on public water supplies regarding monitoring of potentially harmful chemicals in their systems. The EPA may allow waivers (reductions) to monitoring frequency or to the number of parameters sampled, if the state has an approved waiver program. DENR has received EPA approval for the state waiver program. This waiver is intended to assist public water supplies which are able to show that some of the regulated Phase II/V chemicals do not pose a major threat to the water supplies. An integral part of this is an acceptable inventory of all contaminant sources in the wellhead protection area, which helps indicate what chemicals in the Phase II/V rules are not a threat to a particular wellfield, and therefore the requirements for monitoring may be reduced.

SUMMARY

An inventory of the potential sources of contamination located within the wellhead protection area is an integral part of the process necessary to protect your public water supply from contamination. The type of source inventory conducted by your community will be based on the nature of the threats to the water supply, and the resources (time, money and personnel) available to you, but each community should strive to conduct the most complete inventory it can. Once this information is complete you can then proceed to manage the wellhead protection area with a better understanding of the threats to the water supply and how to balance water protection efforts while maintaining the economic base in the community.

SOURCE INVENTORY CHECK LIST FOR THE SUBMITTAL DOCUMENT:

The following questions will assist the local wellhead protection sponsor in determining whether the requirements for component 3 have been met.

- Are potential sources of contaminants identified?

- Are the locations of the sources documented, and mapped on the wellhead protection area?
- Are the potential sources prioritized for management options?
- Are the physical or chemical contaminants associated with the potential sources identified?
- Is the potential source list easily modified/upgraded, and is a time frame for updating included?
- Has all the necessary information required for State concurrence with the local plan been submitted to the DENR?

4. GUIDELINES FOR MANAGEMENT OF A WELLHEAD PROTECTION PROGRAM

INTRODUCTION

After the local community has determined what specific area must be protected around the wellfield and has located and categorized the potential contamination sources within the wellhead protection area, they must then proceed to step 4 of the plan which is to properly manage their wellhead protection program. This process encompasses a number of the components required for an adequate program, but relates primarily to Component 4 which addresses the need for local controls to prevent contamination in the wellhead protection area via land use restrictions, as well as construction, performance, operation and maintenance standards. Communities may also provide ground water protection through activities such as land acquisition, ground water monitoring, and public education activities.

The state also assists in contamination prevention through state regulations regarding review of facility designs, permitting requirements for discharge facilities, siting restrictions, ground water quality standards, resource management plans, and clean up requirements for spill sites. Federal laws such as the Clean Water Act, Safe Drinking Water Act, and Federal Insecticide, Fungicide and Rodenticide Act, were enacted to protect the nation's surface and ground water, and gave rise to many of the state regulations noted above. Both state and federal agencies that regulate ground water protection are also involved in providing pubic education and technical assistance to communities and citizens to help them manage their ground water resources.

Management of the wellhead protection area is generally the most difficult aspect of the wellhead protection program to formulate and administer. It is, however, essential to a successful wellhead protection program, because defining the area that needs protection and identifying the potential sources of contamination in that area are of little value if measures to protect the ground water are not implemented. The local communities must determine what resources are available to them for implementing the management plan and what other factors may affect how it is designed, before developing the actual program and applying the protection measures.

WHAT ARE THE MAJOR MANAGEMENT CONSIDERATIONS?

Prior to implementing any management measures such as zoning or land acquisition, the local community will need to consider a number of factors that will influence the scope of the management plan. These factors, which relate to available resources, local support, legal authority and finances, may affect the ability of the local community to carry out their management goals.

The management information presented in this guideline must be tempered with the understanding that to be able to conduct all the management activities discussed is an idealized situation which few communities would have the resources to undertake, and the DENR does not expect or require that all these activities be included in every community plan.

- **Available Resources**

  One factor which will affect the local community's level of management is whether it has a sufficient number of qualified people available to their wellhead protection program to conduct the work. Ideally, individuals are needed who may be required to design and evaluate zoning regulations, review facility design and operating standards, conduct inspections, do ground water monitoring, and assist in public education activities. To have enough staff with the desired technical background as well as sufficient time to address ground water concerns, will require an adequate financial commitment by the taxpayers in the community. The wellhead protection staff will have to evaluate what can realistically be accomplished given the constraints of time, personnel and money that undoubtedly affect all local governments.

- **Local Support**

  Getting local support for your wellhead protection program is crucial to its success. Without support of the community, it will be difficult to develop and implement any wellhead protection management plans (for example: pass land use controls, allocate sufficient tax money for wellhead protection, collect fees or fines), and any voluntary programs that are initiated will be ineffective. Therefore, it is very important that the public is informed about, and included in, any wellhead protection program that is proposed. The public should be involved in the decision making process from the beginning of the program, and it is particularity important that they have a say in how the program will be managed. Therefore, public education and promotion of wellhead protection must be an integral part of the work of the local wellhead protection committee.

- **Legal Authority**

  Prior to developing and implementing a management program, the community must be certain they have the legal authority to carry out all the aspects of it. In general, local communities have the authority to protect the health, safety and welfare of their citizens which would include ground water protection, but the power to take certain actions may be limited by local, state and/or federal regulations, the language of the enabling laws, and specific court rulings. There is a limit to the community's ability to regulate private property, and this property cannot be taken without just cause or without just compensation for the taking.

In some cases where specific state or federal legislation has been passed on an issue, their rulings will take precedence over any local regulation, which cannot conflict with state or federal laws. This primarily concerns areas where the local laws would be less stringent than state or federal laws (for example, the county could not pass a law to allow an 80 mile per hour speed limit). In most cases however, local regulations can be more stringent than state or federal laws (most environmental regulations are this way), but there may be instances where this is not true. States may reserve the authority to regulate in certain areas. For example, in South Dakota the state restricts the authority of local communities to regulate pesticide use. A review of the local legal authority in your community by an attorney well versed in this type of law may be very beneficial.

- **Financial Considerations**

  One very important aspect of the entire wellhead protection program is determining what financial resources are needed and are available to the community, not only to implement the management plan, but also to complete the other components of the program (delineation, source inventory, contingency plan, etc.). Questions that must be addressed concerning your financing include: whether the funding source is stable and can be relied on year after year, does the public or the potential polluter pay for wellhead protection, how costly is the program to administer, and is it an equitable and politically acceptable system?

  Listed below are some of the financial options that can be used to support your wellhead protection program. There are various combinations of these that can be used depending upon resources available, public support and community philosophy.

  Taxes - Some of the generalized taxes levied at the local level include property and sales taxes, which the local communities can use to support wellhead protection activities and provide broad based benefits. Excise taxes, which apply only to the sale or exchange of certain goods and services, are additional sources of funds that may be used. Examples of excise taxes include real estate transfer taxes, taxes on liquor, tobacco, water or sewer use, hotels and restaurants, or taxes on water equipment or lawn fertilizers. An excise tax can be a general tax or can relate to possible pollution activities or wellhead protection beneficiaries. In many cases the above taxes are placed in a general fund where competition for the funds may be intense, and therefore using these taxes as a funding source is not always reliable in the long term.

  Fees - These generally involve charging a user for use of a product or service. Two popular fees include access and service fees. An example is charging an access fee for getting hooked up to the

water or sewer system, and a service fee involves paying a fee for the amount of water used or sewage discharged. Another fee which may be imposed is an impact fee in which developers pay a fee (often associated with building permits) to local governments to help finance public facilities or activities in the development area. These activities include building sewers, water systems and roads, or conducting ground water monitoring. Other fees which may be collected include permit, inspection and monitoring fees assessed to facilities that are potential pollution sources. With this type of funding mechanism, there is a correlation between the use of a product and the cost of using that product, and these fees can be used to recover costs of an environmental program.

Fines & Penalties - This form of funding is designed to encourage careful facility operations and help pay for any specific environmental damage caused by a facility, rather than to raise revenue for general environmental protection. An upfront environmental bond has been used in some instances to insure that a business or industry has sufficient resources to pay for any cleanup activities that may be required due to a contaminant release from that facility.

Capital Financing - Long range capital investments in wellhead protection can include issuing long-term tax exempt bonds or borrowing from area banks to finance such projects as land purchases.

Grants - Grants from local agencies or the state or federal government may also be available to help in wellhead protection. There are a variety of agencies which may be sources for financial support or may partially fund specific activities. The interested communities would need to contact the local sources directly, or to check with local branch offices of larger organizations. The DENR can help locate the proper contacts for possible financial assistance from regional agencies. Financial assistance may be available through the following sources:

Water Development Districts;
South Dakota Department of Environment and Natural Resources;
South Dakota Department of Agriculture
Community Development and Planning
City Government
County Government
Regional planning agencies
U.S. EPA Region VIII
US Geological Survey
USDA Soil Conservation Service
USDA Consolidated Farm Service Agency
USDA Rural Development Association

The type of funding available from the sources listed above depends on the availability of resources and in some cases the potential contaminant source(s) of concern.

Private Donations - Additionally, donations (such as land) or investments from private sources may defray the costs of managing your wellhead protection program.

The above management considerations need to be addressed prior to and in conjunction with development of a management strategy for the wellhead protection program, to insure the program can be carried out as designed. The following section describes the various management controls available to local communities to help them protect their water supplies.

WHAT MANAGEMENT TOOLS ARE AVAILABLE TO PROTECT YOUR WATER SUPPLY?

There are three major types of management strategies for protecting the public water supply area: regulatory, non-regulatory, and legislative. Regulatory options may include zoning, subdivision control and health regulations. Non-regulatory options include actions such as land acquisition, collection of hazardous waste, and water quality monitoring. Legislative options may be used by communities in cases where a wellhead

protection area encompasses more than one jurisdictional area, requiring actions to establish where the local authority lies. South Dakota Codified Law Chapter 1-24 under the Joint Power Act allows public agencies (such as counties, townships, or water development districts) to jointly exercise any governmental power they could exercise individually. A list summarizing various wellhead protection tools and some considerations for each action is found in Appendix 5. Not all these tools will be applicable for a particular community.

The prevention of ground water contamination is a more cost-effective means of environmental protection than is future remediation of the ground water. To meet this prevention goal requires an understanding of the threats to the water supply. The major concern in protecting wells and wellfields is the accidental release of pollutants to the environment from facilities (including residential homes) storing, using or handling potential pollutants, and from facilities that generate a waste that contains potential pollutants. Facilities with a potential to pollute groundwater must be sited, designed, and operated to reduce that potential or to strictly control the waste generated by the facility. Numerous state and federal regulations and guidelines have been developed which address these concerns. Government agencies also provide public education and technical assistance programs & documents which help communities learn what they can do on a regulatory or non-regulatory basis to prevent ground water contamination.

Local governments may also enact stringent requirements and may pass local zoning ordinances to protect wellhead protection areas. Any facility involving collection, handling, manufacture, use, storage, transfer or disposal of potentially harmful solid or liquid materials or wastes needs to be addressed through restrictions, permits, or performance and construction standards. Local governments may prohibit or place restrictions on a business using potentially harmful chemicals in a wellhead protection area. They may also promote voluntary citizen efforts to protect ground water and employ non-regulatory methods as will be described later.

Listed below are descriptions of the various management tools available to local governments to protect their public water supplies. Also described will be the State and federal management practices, emphasizing regulations and permits applicable to facilities with potential to pollute groundwater. Conditions where legislative action is necessary will also be discussed.

LOCAL REGULATORY MANAGEMENT TOOLS

Through South Dakota Codified Law 9-12-17 and 7-18-20, local governments have authority to zone, monitor, regulate and require remedial activities within established wellhead protection areas. Local managers may use various techniques for differential management of each zone if primary and secondary wellhead protection areas are established.

The following are methods that local governments can use:

> **Zoning.** Zoning is a land use restriction that can be placed on activities that would endanger ground-water supplies. These regulations consist of dividing an area (primarily municipalities) into districts and applying land-use regulations uniformly throughout the district. Zoning is usually regarded as dividing land into specific regions for residential, commercial, open or industrial use. Zoning laws can be used to site new commercial and industrial businesses and regulate land use within wellhead protection areas, and therefore is much more useful in controlling new development rather than affecting existing facilities. Zoning may also be used to control lot size for residential development, limiting the number of units within a wellhead protection area to limit, for example, the amount of waste disposed through septic systems. Developmental restrictions typically include: 1) type of land use, 2) density of development, 3) placements of structures on lots, 4) street frontage, and 5) parking. For environmental concerns, restricting the type of land use in the wellhead protection area is generally the most effective zoning regulation. Overlay zoning is often used to place land use restriction on top of existing zoning laws. The overlay districts must have a particular area (as a wellhead protection area) where they apply.
>
> Other qualifications can be placed on a zoned area to aid in ground-water protection, including special permitting, industry paid monitoring, transfer of development rights, performance standards and clustering. Incentives through taxes or other means may also be considered to influence the siting of

new facilities. A mechanism should be in place that will allow the local community to update the zoning regulations in instances where the wellhead protection area delineation is refined or new public water supply wells are drilled.

Health and Nuisance Laws. Health and nuisance laws are adopted by local governments to protect public health, and can be used to relocate operations or insure compliance with existing construction and operating procedures. Often these regulations are contaminant source specific, such as placing a nitrogen loading standard in an area with septic systems or requiring that the septic systems be inspected for operational efficiency before a real estate transaction can occur, requiring that all abandoned wells be sealed, or requiring a specific type of industry to do ground water monitoring. There is a broad range of possible contaminant sources that can be regulated based on the authority given to local communities to protect the public's health; however, as noted earlier, the enabling legislation and legal authority to carry out these restrictions must be thoroughly reviewed prior to implementing the rules.

Subdivision Ordinances. These ordinances are not as broad as zoning regulations, and only apply when land is actually divided for sale or development. One main thrust of subdivision regulation is to control development to ensure that industrial growth does not out pace local infrastructure such as roads, sewers, schools, and fire protection. Subdivision ordinances enable local governments to direct the development of undeveloped land. This type of control is often used in rural areas to set the minimum size of the lots for sale, and to specify the amount of land in the division that must be set aside for open space. As with zoning, these ordinances work best for planning new developments rather than with existing ones. Subdivision regulations typically address water supply, ground water recharge, septic or sewer systems, and surface drainage requirements such as stormwater ponds, wetlands or infiltration basins. Many counties in South Dakota have subdivision regulations in effect.

Site plan review. The purpose of a site plan review is to determine whether a proposed development project is compatible with existing land uses, is designed and constructed to standards, and meets any other regulatory requirements. As noted, reviews of site plans are useful to insure that other rules or regulations (as zoning requirements) are being followed, but it also requires that the time and technical expertise be available at the local level to conduct the review.

Design and Operating standards. Design and operating standards requirements for potential contaminant sources within the wellhead protection area are a useful tool to protect public water supplies. These standards are used to regulate the design, construction and operation of various land use activities. Standards for chemical storage, wastewater treatment systems, waste disposal wells, and septic systems are examples of systems that may be controlled. Current agricultural best management practices should be used for agricultural chemical application. South Dakota Department of Agriculture, DENR and federal design and operating standards and regulations are in place for many potential sources (such as for underground storage tanks), and local communities should be aware of these standards before adding their own. As with the site plan review, which may include reviewing the design and operating standards, a knowledge of the facility operation or requirements is necessary to evaluate these standards.

Performance/construction standards. Standards for performance and/or construction can be used when potential pollution sources are allowed in a wellhead protection area. These standards are usually set up to establish a threshold beyond which the impact of a use or activity is not acceptable. Examples of this type of standard are to limit the nitrogen loading to ground water, or to be certain that facility effluent meets the allowable ground water quality standards. This type of standard requires verification through monitoring or a knowledge of the contaminant loading that is put into the environment. State standards in the form of regulations or guidelines are in place for most potential sources. Local governments may set their own standards if they are at least as stringent as state or federal requirements, but do not conflict with other regulations.

Source prohibitions. Source prohibitions, where the storage or use of dangerous material is prohibited from a wellhead protection area, can be a valuable method for protecting against ground-

water contamination. The prohibition can be against certain specific contaminants or activities in the wellhead protection area. The prohibited activities may include junk yards, industrial shops, livestock feedlots or landfills. Prohibited contaminants include various solvents, heavy metals, or petroleum products.

Caution must be taken to insure that restrictions imposed on uses do not violate state or federal regulations, or impede in areas where these agencies have jurisdictional control. An example is restricting agricultural chemical use in wellhead protection areas where the South Dakota Department of Agriculture has jurisdiction. The South Dakota Department of Agriculture would have to be contacted prior to any planned restrictions, and be petitioned to designate the area for special use controls. It should also be noted that although the local community may have the authority to impose source prohibitions in an area, this action is fairly stringent and is a course of action that may receive a lot of opposition. A phase-in of the restrictions over time may be more desirable.

Regulatory Land Acquisition. In some instances the local government entity has the authority to exercise the right of eminent domain and condemn property that may present a serious environmental problem. This method of control is also one that can generate a lot of local opposition, and it should only be used if the situation is serious and other methods have failed.

The regulatory methods available to local communities are valuable tools to protect their local water supply. Not all the methods noted above are applicable to all communities. Public support, legal authority, cost to local business/industry vs. benefits, and the financial and human resources available to the community must all be taken into account when developing these requirements.

STATE AND FEDERAL REGULATORY MANAGEMENT TOOLS

The state and federal governments are also empowered to enforce environmental regulations designed to protect ground water. These regulations include some of the same tools available to local governments including siting criteria, design operating standards, performance standards (maximum allowable contaminant levels in ground water), clean up requirements, etc.

These regulations are, in most cases, the primary protection against ground water contamination in the state. However, neither the state nor the federal government can impose land use controls. It is very important for the local wellhead protection program staff to have a good understanding of the various state and federal regulations and guidelines to help them develop their own management plan.

REGULATORY PROGRAMS

Following is a listing of regulations that directly or indirectly pertain to activities, facilities, or operations in the wellhead protection program. Be advised these descriptions are only highlights of some of the regulations; the regulatory cites are given if a detailed description is desired.

Individual and small on-site wastewater systems (Administrative Rules of South Dakota (ARSD) 74:03:01)
All wastewater systems must be designed, constructed and monitored according to the regulations. There are minimum lot size, design type, total capacity, holding area and geological requirements under the regulation. Drainages must not enter wastewater systems, and flow capacity of the wastewater system must be evaluated properly according to location and its impact to the environment.

Underground injection control (ARSD 74:03:11 and 12)
Under this program, all underground sources of drinking water are protected from contamination from waste disposal via injection. South Dakota has been delegated enforcement authority by EPA for Class II wells which are oil and gas production related injection wells. South Dakota has banned

wells used for injection of hazardous waste. Other types of injection wells are regulated by EPA at this time. Class V wells are the most prominent type of injection wells in the state, and include such systems as septic tanks, industrial disposal wells, automotive disposal wells, agricultural drainage wells, cesspools, and reinjection wells.

Underground storage tanks (ARSD 74:03:28)
Each tank must be designed, constructed and protected from corrosion, and must include overfill and release detection devices. The owner or operator of the underground storage tank system must submit installation plans and other relevant information to the DENR. There are specific cleanup requirements for releases to the soil or ground water from these tanks.

Above ground storage tanks (ARSD 74:03:30)
All above ground storage tanks must be supported on well drained, stable foundations. They must be protected from corrosion, must be capable of containing 110% of the tank volume in a secondary containment structure in case of a leak, and must also submit installation plans to the DENR. There are clean up requirements for releases from these tanks.

Bulk Fertilizer Storage (ARSD 12:44)
An individual may not construct a liquid bulk commercial fertilizer storage facility without secondary containment. All non-liquid fertilizer materials must be covered and stored within a secondary containment structure. The quality of primary and secondary containment and volume restrictions are discussed in these regulations, which are administered by the South Dakota Department of Agriculture.

Some of the cited regulations include the following requirements: bulk commercial fertilizer facilities must not be located within 500 feet of a public water supply, leak detection and secondary containment of bulk commercial fertilizer storage tanks are required, and these facilities must construct mixing/loading pads. All significant releases of fertilizer to the environment must be reported to the Department of Agriculture and DENR. Fertilizer contaminated soils are removed to a concentration based on the normal fertilizer uptake rate of the major crops grown in the area. Ground water contamination must be cleaned up to DENR ground water quality standards.

Bulk Pesticide Storage (ARSD 12:56:13)
No individual may establish or operate a bulk pesticide storage facility without obtaining a permit. The South Dakota Department of Agriculture requires appropriate plans and specification for construction and operation of a bulk pesticide storage facility. Secondary containment and mixing/loading pads are required. Any significant release of pesticide must be reported to the Department of Agriculture and DENR. Pesticide contaminated soils are removed based on applicable application rates set forth by the manufacturer of the pesticide. Ground water contamination must be cleaned up to DENR ground water quality standards.

Solid waste disposal (ARSD 74:27)
DENR developed solid waste regulations that contain provisions for the proper permitting, collection, transportation, processing and disposal of solid waste in South Dakota. These rules are in full compliance with the federal Subtitle D landfill regulations, and are designed to protect the public's health and the environment, including surface and ground water.

Hazardous waste disposal (ARSD 74:28)
DENR has adopted the federal regulations for the generation, treatment, storage, transportation, and disposal of hazardous waste. A permit is not needed to generate, or transport hazardous waste, however, there are management standards that must be met in order to be in compliance with regulations. The regulations are designed to prevent the dumping of hazardous waste in a manner harmful to the environment.

Abandoned well plugging (ARSD 74:02:04:67-70)
There are various requirements for abandoning a well depending upon the well type, depth, and medium it is installed in. These requirements are discussed within the well construction standards.

Chemigation (ARSD 74:02:09)
These regulations pertain to requirements placed on irrigation systems that add pesticides or nutrients to the irrigation water (through the irrigation system) after the water has been withdrawn from the well. This method is usually used with center pivot irrigation systems. Requirements include check and relief valves and back flow preventers to stop any chemically ladened irrigation water from flowing back down the well to the aquifer, and set back requirements to keep the chemical tank away from the water source.

Well Construction Standards (ARSD 74:02:04)
Before drilling a well for which a water permit is required, the well owner must obtain a permit. The regulations require a minimum distance be maintained between it and another water well in the vicinity; and from other potential pollution sources such as a waste water treatment plant, bulk petroleum storage facility, landfill, pesticide facility, or hazardous waste site. Additionally, minimum grouting/packing standards, and construction and installation standards are also set forth under these regulations.

Ground water discharge permits (ARSD 74:03:16)
An owner or operator of a discharge facility may apply for a ground water discharge permit if certain requirements are met. Accidental leaks and spills or intentionally dumping may not, in general, be considered for a discharge plan. The effluent must conform with State ground water quality standards at compliance points. Water used in lawns, gardens or irrigation; application of fertilizers, herbicides, insecticides and fungicides used according to manufactures recommendations; permitted Class II UIC wells; and land application of livestock waste generally do not require a groundwater discharge permit. Discharges to ground water are not permitted within a designated wellhead protection area.

Ground-water quality standards (ARSD 74:03:15)
There are ground water quality standards for various contaminants. The standards include maximum allowable levels for such parameters as total dissolved solids, pH, various hydrocarbons, non-metals, heavy metals, solvents, and pesticides. No water with concentrations higher than ground water quality standards can be discharged or injected into the ground water without a permit. Existing contamination exceeding ground water standards must be cleaned up to the standards, which may be more stringent for wellhead protection areas than in other areas.

Bulk Chemical Storage Facilities (ARSD 74:03:36)
Facilities storing regulated substances must be a specific distance from a water well, and must be protected by secondary containment and corrosion control devices. To prevent future contamination, early monitoring systems should be installed. Pollution assessment, mitigation measures and contingency planning must be properly evaluated.

Soil Remediation Criteria (ARSD 74:03:32)
DENR requires remediation or removal of petroleum contaminated soils. The criteria for remediation are based on depth to the aquifer, type of soil, and chemical characteristics of the contaminant. Petroleum contaminated soils are removed or remediated based on quantitative standards set forth by the DENR.

Pesticide handling and use (Federal Insecticide, Fungicide and Rodenticide Act - FIFRA)
FIFRA regulates the registration and use of pesticides. This includes such things as pesticide use, handling, mixing and loading, registration, disposal and applicator certification and licensing. This act allows EPA to address ground water concerns about pesticides on a national level, and through cooperative agreements with the states, to pass on that authority to a more local level. The South Dakota Department of Agriculture has delegated authority to administer the FIFRA program in South Dakota. State management plans for agricultural chemical use are administered under this act.

CERCLA and RCRA (EPA)

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as Superfund, is designed to clean up the country's most contaminated sites based on degree and type of hazard to the public. Currently there are more than 1200 contaminated sites on EPA's clean-up list, three of them are located in South Dakota. The Resource Conservation and Recovery Act (RCRA) deals with all hazardous waste generated by a facility. These wastes must be transported and disposed of according to state/federal regulations. The DENR has delegated authority to administer portions of RCRA in South Dakota.

SARA Title III (EPA)

The emergency planning and Community Right-to-Know Act of 1986 contained in Title III of the Superfund Amendments and Reauthorization Act (SARA), requires facilities which use, store or release listed extremely hazardous substances, or Operational Safety and Health Administration (OSHA) hazardous substances, to report to federal, state and local authorities. This information is used to develop emergency response plans for handling releases of these materials. All information collected or developed through this program is available to the public upon request.

Animal waste management systems (Soil Conservation Service standards 312 and 425; and South Dakota National Pollution Discharge and Elimination Systems ARSD 74:03:17-26, and Solid Waste Disposal Permits ARSD 74:27).

These standards and regulations refer to State and federal requirements placed on designed livestock manure handling systems in which all necessary components are installed for managing liquid and solid organic waste, including run-off and seepage from concentrated waste areas, in a manner that does not degrade air, soil, or water resources. The requirements include design and installation specifications for storage of animal or other organic agricultural wastes. Agricultural waste ponds generally must have a leakage factor of 10^{-7} centimeter per second (1/16th inch per day) or less, and waste should not be stock piled.

FACILITY REQUIREMENTS

In addition to State and federal requirements, a local unit of government could adopt specific requirements or standards for facilities in a wellhead protection area. Standards can be evaluated for facilities such as underground storage tanks, above ground storage tanks, wastewater facilities, landfills and feedlots. Some of the specific requirements discussed below include release detection, containment systems, new facility siting requirements, construction and maintenance requirements, and a contingency plan for release detection and clean-up.

- **Release Detection**

  Release detection will provide initial identification of a problem; allowing maximum effort and time to stop a potential contaminant from reaching the public water supply. Release detection can be through a mechanical mechanism such as a gauge or meter, or through accurate inventory records. Any gauge or meter must be sensitive enough to note a change in conditions beneath a tank, containment system or facility. A release detection system is required by state regulations for several types of facilities such as underground and above ground storage tanks.

  In the case of dry chemicals, release detection may be for the facility as a whole or for a secondary containment system. For liquid chemicals, release detection could be on the primary storage tanks, the secondary containment system or the facility. Release detection for primary storage would be through inventory records, internal systems designed to detect any changes in substance level, such as in-tank monitors capable of continuous monitoring, and connected to an external alarm or external systems designed to detect any release. For secondary containment systems, monitoring wells, collection systems or moisture sensitive devices would be appropriate. A facility could also be required to do periodic monitoring of soils and/or ground water.

- **Containment Systems**

  Containment systems, often referred to as secondary containment systems, are excellent ways to reduce environmental impacts from accidents and equipment failure. A containment system must be adequate to contain a leak to prevent contamination from impacting ground and surface waters.

  A secondary containment system may consist of a combination of double-walled tanks and bottoms, dikes, liners, pads, ponds, impoundments, curbs, ditches, sumps, receiving tanks or other equipment capable of containing the substance stored. Construction must be in accordance with codes of practice developed by nationally recognized associations or independent testing laboratories. The secondary containment should include the following:

  - Be of sufficient size to hold 110% of the largest container stored plus the volume of all other substances within the containment system;
  - Be of a material compatible with the substance to be contained;
  - Be adequately sealed at all times to not allow leakage out of the containment. An impermeability of at least 10^{-6} centimeter per second is needed;
  - Be designed and installed to control storm water and be kept free of accumulated precipitation and potential contaminants;
  - Have no outlets, such as pipes, hoses, valves or drains other than those designed to control liquid movement into tanks or other containers for disposal or reuse; and
  - Be constructed to meet the impermeability requirements for the operational life of the system being contained.

- **New Facility Siting**

  Facilities producing, handling or storing large quantities of wastes or other potential contaminants that could adversely affect health and the water supply must be sited to minimize the impact to groundwater and wells. For example, hazardous waste disposal sites, landfills, chemical manufacturers, and feedlots should not be located over shallow aquifers if it can be avoided. In the case of other facilities that produce, handle or store potential contaminants, the allowable quantity of contaminant material could be determined on a case by case basis through a permit process, or taken from the Superfund Amendment and Reauthorization Act (SARA) Title III reportable quantity list.

- **Operation and Maintenance**

  Adequate storage facilities for the substance(s) handled should be available, such as providing inside storage for dry chemicals. Plans and specifications for facilities of concern in wellhead protection areas should be prepared by a licensed professional engineer to ensure adequate construction in regard to stresses, loading, waste quantity, seepage rates, and climatic conditions such as freezing, thawing and precipitation. Additional requirements are:

  - There must be compatibility of construction materials with the substance stored;
  - Above ground storage tanks, under ground storage tanks and underground piping must be cathodically protected;
  - Underground storage tanks and piping should be double walled;
  - Above ground storage tanks must have secondary containment as described in the containment section of this chapter;
  - Mixing/loading pads must be constructed for filling sprayer tanks with fertilizer, and/or pesticides within the wellhead protection area.
  - Overfill control through tank gauging during transfer, along with detection devices independent of other gauging equipment should be included;
  - Proper maintenance should be conducted to avoid any environmental contamination from the substances handled or stored during aging of the facility. This will include sealing of all cracks and joints in secondary containment systems and mixing/loading pads, periodic checking of all seals on above ground piping, routine maintenance on leak detection systems, periodic inspection for stress, leaks or other signs of potential problems on above ground storage tanks;

- **Contingency Plan for Release Containment and Clean Up**
  As part of a wellhead protection program, any facility using, handling or storing hazardous substances discussed in Guideline 3 of this document should have a prepared plan in conjunction with local government entities for immediate containment of any leak or spill. The facility in a wellhead protection area should have a contingency plan on file with local emergency response authorities. This plan would include clean-up of the spill as well as provisions to protect the public water supply. If a release is detected the facility response must include:

  - Stopping any further release;
  - Immediate containment, do not allow runoff from the site;
  - Removal and proper disposal of the contained substance. Released material should be removed from a secondary containment system within 24 hours. Contaminated soils should be excavated, or otherwise remediated, treated and disposed of properly.
  - Notification of the local and state authorities;
  - A timely investigation and report of any additional impacts to surface or ground water; and
  - Work with DENR to complete required corrective action measures.

In addition to cleaning up a release, any spill from mixing, loading, or unloading must be contained. A method must be developed to eliminate runoff or wash water from carrying any spilled substance off the facility site.

LOCAL NON-REGULATORY MANAGEMENT TOOLS

The discussion of regulatory measures addresses one aspect of management that can be used to protect a public water supply. Listed below are non-regulatory activities that can be used to help manage a wellhead protection area.

- **Land Acquisition**
  If the circumstances warrant, the local community may be able to condemn property for environmental protection. As this is a rather drastic step, the community may desire to undertake negotiations to purchase the property from a willing seller. Obtaining ownership of portions of the land in a wellhead protection area may be more effective or less costly in protecting the water supply than applying numerous zoning controls on the land, as the land can be managed to protect the water supply without the pressures to allow more intense economic development.

  Land purchasing is often an expensive undertaking for the community so they may wish to prioritize the lands that are of the most concern. If the land area is in an industrial expansion area, purchasing outright may be justified, but if the land is in a more rural area, some form of land use controls may be sufficient. However, because of the cost it may be more feasible to purchase the rural land than the more expensive industrial property. Purchases may take these forms:

  - Outright Purchase - It affords the most control to the local community, but often is the most expensive.
  - Donation - This may be accomplished if the owner is so inclined, but some type of tax breaks may be an incentive for this type of purchase.
  - Conservation Easement - This is a control method where the community may purchase an easement to the land rather than acquire ownership, but the easement holder has the right to prevent the owner from taking specific actions on the property covered by the easement. For example, the easement holder may require that the owner leave a strip of land as open space or pasture land, rather than develop the land or place it in cropped agriculture.

- **Ground Water Monitoring**

  A ground water monitoring program consists of regular sampling of the water in wells to determine the presence and concentrations of particular contaminants. The community may wish to develop their own

monitoring program to evaluate the effectiveness of source controls, measure compliance with drinking water standards, and provide advance warning of contamination that may be moving toward the water supply. Such a program would provide information on whether the management program needs revision (whether protection measures are working), or if some contaminant clean up action was needed. Although a monitoring program can be expensive, it may be cost effective if the measures prevent the water supply from being contaminated, which could then involve an extended costly clean up effort or relocation of the water supply wells.

Installation and sampling of monitoring wells require technical expertise, personnel, time and money, and the community may wish to consider having area environmental firms involved with the work. Part of the planning effort would involve deciding what type of monitoring program best fits the local situation, as they may wish to do general sampling in the wellhead protection area, or concentrate on sampling around certain high risk facilities.

To avoid duplication of effort, the monitoring program should be coordinated with the other on-going monitoring efforts in the area. Ground water monitoring may be required of some facilities as part of state or federal regulations (wastewater treatment facilities or landfills), or because a contaminant release has been detected (as found at a number of service stations with petroleum underground storage tanks). As described earlier, local governments may require some facilities to conduct their own ground water monitoring around their operation as part of the local regulations. Additionally, to achieve compliance with the drinking water standards, public water supply operators must also sample their system's drinking water for a number of possible contaminants.

- **Water Conservation**

  This method can be helpful to public water supplies by reducing the total water consumed from the aquifer, thus possibly reducing the inflow of contaminants to the system and helping with aquifer recharge to insure an adequate water supply. This conservation effort can be conducted on a voluntary basis through public education (low flow showers, toilets, more efficient irrigation systems, reduced lawn watering and vehicle washing), but in instances where that does not work, the local communities do have the authority to implement water use restrictions.

- **Hazardous Waste Collection Days**

  A number of household and farm chemicals have the potential to impact ground water if not disposed of properly. The type of materials can include pesticides, gasoline, solvents, paints & paint thinners, waste oil, and fertilizers. Improper disposal may allow these chemicals to leach to the area ground water through direct infiltration to the aquifer, or through the storm sewers, septic systems, sanitary sewer or landfill.

  A centralized location, preferably not in the wellhead protection area, can be established where the local citizens can bring their hazardous household or farm material on specific days. The planned collection activities must be promoted and advertised far enough in advance to increase the likelihood that the program will be a success. A licensed hazardous waste collection firm would have to be hired to haul the waste to a proper disposal area.

  The main drawback to this effort is the high cost of having the hazardous material collected, categorized and disposed of. There is an additional concern about legal liability for the community to be sure the material has been disposed of properly. Increased public awareness of the need for ground water protection may be one of the main benefits of conducting a hazardous waste collection day.

- **Plug Abandoned Wells**

  Abandoned wells can provide an open conduit for contamination on the land surface to run down the inside or outside of the well casing and contaminate an aquifer. If any of these wells are located near the public water supply wells, they should be considered a threat to the water supply. A project to

locate and properly plug abandoned wells located in the wellhead protection area may be a worthwhile preventative measure.

Depending upon the type and depth of the well, plugging can also be expensive. A correctly conducted source inventory should have located the abandoned wells in the wellhead protection area. You may wish to prioritize the abandoned wells as to their threat to the water supply wells, and the cost of plugging.

- **Best Management Practices**

Use of best management practices is usually used in reference to agricultural practices, but it can also relate to business, industry, and hom1eowners. This term refers to practices that will reduce possible impacts to the environment. Agricultural best management practices can include: soil tests to determine the amount of nitrogen present in the soil to avoid over application of fertilizer, pest scouting to establish the approximate level of insect pests, disease or weeds to prevent over application of pesticides, a recommendation to not applying fertilizer on frozen ground so runoff will be reduced, and so forth. A system designed to assess possible contamination sources on the farmstead itself and address ways to remedy the problems is called Farm-A-Syst. This program, which is relatively new, is a voluntary program where a farmer can assess possible environmental problems on his farmstead and then works through government agencies (primarily the Cooperative Extension Service) to fix the problem, and learn ways to prevent future concerns. The community can contact the county extension agent for more information.

Various industries can alter their practices to help reduce the pollution potential of their operations. Three ways they can target pollution prevention are to 1.) reduce their source of contamination by attempting to reduce the amount of waste generated, 2.) recycle as much of the waste product as feasible and 3.) treat the waste produced to reduce its toxicity and make it less harmful. The first option is the most desirable environmentally and possibly economically, because reducing the amount of waste produced through cleaner procedures may also save handling and disposal costs. Treating the waste tends to be the most costly, but in some instances may be the most feasible alternative.

The general public can also use better management of their own activities to avoid pollution, such as not over applying lawn chemicals or returning used oil to collection facilities. Initiation of these types of activities is based on providing public education to better inform people of what they can do to prevent ground water contamination, as noted below.

- **Public Education**

Educating the public as to the importance of ground water protection, and indicating various things that individuals and business/industry can do to protect it, are key elements in any ground water protection program. Public education is important for regulatory as well as non-regulatory management tools, as many of the actions noted above begin with public education. The management effort will be ineffective if you do not have the support of the citizens in the community.

There are a number of different means available to get the message out to the public. These include:

Informational meetings	Questionnaires
Press releases	Newsletters
Brochures	Video tapes
Demonstration Projects	Advertisements
Community events	Posters
Ground water protection signs	

The focus of these communication efforts is to make the public aware of what operations or activities can cause contamination, convince them of the need for ground water protection, and indicate ways to

prevent ground water contamination. These preventative methods could include: taking used oil to a collection center, not overapplying fertilizer or pesticides on lawns, conserving water, not pouring hazardous chemicals down drains, plugging abandoned wells, using best management practices when applying farm chemicals or storing or applying manure, and so forth.

STATE AND FEDERAL NON-REGULATORY MANAGEMENT TOOLS

State and federal activities in this area are primarily public education, and technical and financial assistance. Development of the State wellhead protection program document and this guideline document are examples of how state government assists local communities in protecting ground water in essentially a non-regulatory manner. The DENR and South Dakota Department of Agriculture are involved in developing best management practices for agricultural non-point source contaminant problems which will be used to develop state management plans. The United States Natural Resources Conservation Service and Extension Service also assist in developing best management practices for farmers. Other federal agencies such as the United States Geological Survey and Environmental Protection Agency do a great deal of research into ground water quantity and quality, and produce numerous reports and present information to the public on the hazards of certain chemicals or practices.

The DENR presently conducts ground water monitoring studies to assess the impacts of pesticides and fertilizer on shallow aquifers. The state has also promoted and conducted hazardous waste collection days, delegated some funds for well plugging activities.

MULTI-JURISDICTION TOOLS

A final management tool that may be needed concerns a wellhead protection area that may straddle several jurisdictional areas. Several governmental units may want to establish multi-jurisdiction cooperation on a regional basis to mange and coordinate ground water issues including wellhead protection

SDCL 1-24 (Joint Exercise of Government Powers) allow public agencies to jointly exercise any governmental powers that they could exercise individually. The term “Public agency” includes counties, townships, school districts, drainage districts, and other political subdivisions of the State as well as federal agencies, agencies or political subdivisions of other states, and Indian tribes. There are statutory requirements for the contents of the agreement (duration, membership/composition, purpose, methods of acquiring and holding property) and other statutory formalities.

The South Dakota Water Development Districts are examples of regional districts involved in ground water protection. These entities are often a valuable source of information and assistance when planning your management strategies. Communities will need to coordinate activities with other counties, districts, Indian tribes or other states should your wellhead protection zone cross these political boundaries. In these instances you will need to also work closely with your state agencies to coordinate these efforts.

SUMMARY

The process of managing potential contaminant sources in the wellhead protection area is the most important aspect of ground water contamination prevention. It is also the most difficult and time consuming of the required components. The difficulty lies in balancing the fundamental right of private property ownership with the responsibility of protecting the citizens of the community from possible ground water contamination. The local wellhead protection staff must evaluate why certain land areas need protection from various surface activities, determine the risk of pollution and its impact on the community, identify critical areas within the program and evaluate the program's success. Management of the wellhead protection area also involves knowledge of your personnel and financial resources. You must be aware of the legal authority available to your community to require the desired land use changes, taxes or fees. The regulatory management tools, such as zoning and compliance standards, are the most often used means of environmental protection at all levels of government, but are not always the most popular. Non-regulatory management tools are often more popular because they do not involve regulatory requirements, but are often more expensive for the local community to

administer. Gaining local support through public education and input must be part of the ongoing process of management plan development if your program is to succeed.

Continuing education of the public water supply staff is important for wellhead protection. This can be attained by attending and organizing various seminars related to wellhead protection or discussing the problems and successes of program implementation with the other local, state and federal agencies. Because the wellhead protection area delineation area may be refined as new information becomes available, new potential contaminant sources will enter and old sources leave the wellhead protection area, and new public water supply wells are added to the system (or old wells removed), the management strategy must be updated. This can occur as the situation warrants, but should be done at least every two years, to be sure that public water supply protection remains adequate.

MANAGEMENT ITEMS TO BE CHECKED IN THE LOCAL DOCUMENT SUBMITTED TO DENR

- Does your agency have adequate personnel with the required expertise to conduct your management program?
- Are there sufficient financial resources available?
- Has the determination of legal authority to carry out all the aspects of the management plan been discussed?
- Has the public been included in the development of your management program?
- Have all relevant state and federal regulations been reviewed to avoid enacting conflicting or duplicating ordinances?
- Is there a mechanism in place to easily update community ordinances?

5. GUIDELINES FOR DEVELOPING CONTINGENCY PLANS FOR POLLUTION CONTAINMENT, CLEAN UP, AND PROVISIONS FOR ALTERNATE WATER SOURCES

INTRODUCTION

Using management tools addressed previously, the local communities can proceed to step 5 which is to plan for future developments in the wellhead protection area. One problem which will be a continuing concern is what can be done to prepare for a possible large scale disruption of the water supply because of a natural disaster or environmental spill which contaminates or threatens to contaminate the public water supply. A wellhead protection program contingency plan is designed to ensure that a local community can react quickly and efficiently to a disruption in their drinking water supply. A contingency plan should be developed by public water supply and/or local government officials to detail emergency procedures and identify alternate water sources to be used in the event of service interruptions or curtailment due to water quality or water quantity problems. Keeping the contingency plan current is essential for using it successfully in a water supply emergency. By incorporating a method to update the plan periodically ensures that it will be kept current as practices change in the community and wellhead protection area. The contingency plan should be a dynamic document which will provide coordination of and the efficient and effective response to a threatened public water supply.

WHAT MUST BE ADDRESSED IN A CONTINGENCY PLAN?

The contingency plan anticipates potential service disruptions to a public water supply which affects all the citizens using that supply, not just those living within the wellhead protection area. The contingency plan outlines standard operating procedures to use during a public water service disruption. All vital information relevant to a water supply emergency is contained in this plan, which should be accessible to all emergency response personnel. The contingency plan must address the following elements:

- Purpose and Development of Contingency Plan;
- Background Information;
- Relationship of the Plan to Other Emergency Response Plans;
- Duties and Responsibilities for Emergency Response;
- Short and Long term Water Supply Replacement;
- Logistical Support Services;
- Financial Resources;
- Public Communication/Relations
- Prevention and Training

A local contingency plan may need to include the initiation of specific actions to decrease contaminant concentrations or other appropriate actions once water quality parameters rise to a specific level but before exceeding ground water quality standards. These activities include:

- State, local and public water supply responsibilities and agreements for evaluation of monitoring, testing, and inspections;

- State, local and public water supply responsibilities during various types and phases of contamination events such as health threat assessment, public communication, notification, short- and long- term containment and cleanup;

- Public water system chain-of-command;

- Contacts and telephone numbers for notification of local and state authorities; and

- Notification of the public served by the public water supply of the problem and alternative water supply.

CONTINGENCY PLAN ELEMENTS

- **Purpose and Development of Contingency Plan**

  The first contingency plan requirement states the purpose and goals of the plan and how it relates to overall wellhead protection. The individuals and method used for plan development should also be discussed. This first section may also include a brief explanation on how the document is organized, how to locate specific information and a brief statement describing what information is contained in the water supply contingency plan. This plan should be placed on file with local planners and emergency response personnel and must include measures for preventing hazardous materials from contaminating a surficial aquifer or surface waters should flood, fire, natural disaster or equipment failure occur. Since the contingency plan is a dynamic document, procedures must be developed to update the document and be certain those who will implement the plan are kept informed of any changes to it. It is suggested the contingency plan be updated every two years at a minimum for smaller communities and more frequently for larger communities or as warranted due to changing needs.

- **Background Information**

  Information gained from completion of the inventory of potential and existing contaminant sources is valuable background information for contingency planning because the public water supply will have a record of owner names, addresses and telephone numbers of the main potential contaminant sources, as well as information on the types and volumes of contaminants at these facilities. This information is helpful for future emergencies in wellhead areas. Each facility that handles or stores potential pollutants may also be required to have an individual contingency plan to prevent groundwater contamination caused by a release or disaster at their plant.

  To effectively develop a contingency plan, background information on the water supply and system characteristics is also needed. An exhaustive description of the aquifer is not necessary but a brief evaluation of the aquifer characteristics is needed. Descriptive water system information such as water source location(s) (a good generalized map would be useful), water distribution information, water rights restrictions, average daily use, and treatment capacity and limitations can also be included. A brief sketch of the distribution system detailing where pumps, valves and storage tanks are located should also be included in the contingency plan. The background information, which will aid in the further development of the contingency plan, should be located where it can be referenced by emergency personnel.

- **Relationship of the Plan to other Emergency Response Plans**

  It is important to understand the workings of the present emergency and disaster response plans to be certain the response to an emergency goes smoothly, and there is minimal delay, confusion or duplication of effort in the response. he local emergency planning committee (LEPC) is a good source of information to aid in the development of the contingency plan. The LEPC has on file the county emergency response plan which outlines a contingency plan for each pollutant stored within the county that is listed under SARA Title III (a description of this program is given in Section 2, which covers how to conduct a contaminant source inventory). If possible, it may be advantageous to have a representative from the water department placed on the LEPC. This would allow for the two local entities to work together in developing contingency plans that would complement each other.

  The State of South Dakota, Division of Emergency Management, (605) 773-3231, maintains a 24-hour telephone hotline to provide emergency assistance and advice in the event of a disaster. Additionally, each potential case of environmental contamination must be reported to the Ground-Water Quality Program Spill Coordinator at (605) 773-3296. The person responsible for the spill is then required to initiate clean-up action based upon specific State environmental clean-up standards.

- **Duties and Responsibilities for Emergency Response**

There are basically two types of water supply emergencies, which require notification of different groups of emergency responders. The first type of emergency, which is usually more serious, involves chemical spills, vandalism, fires, natural disasters and other emergencies that require an immediate response from other agencies besides the water department. The second type of emergency includes water main breaks, power outages and mechanical equipment failure that require immediate attention from the local water department. For each specific emergency, (i.e. contamination, flood, vandalism, water main break) a procedure must be developed to adequately address the response of emergency personnel.

To minimize confusion during a water supply emergency, it is important to identify beforehand the chain of command and who has overall responsibility for making decisions. In those counties or municipalities where sufficient technical expertise and support services exist to act on emergencies, it is strongly recommended that a city or county designate an on-scene coordinator or incident commander whose role is clearly defined. In the case of an emergency, the on-scene coordinator will keep the party responsible for the contamination, the public water supply manager, and local, state and federal agencies informed of all activities.

Other factors to consider are whether other agencies or groups have precedence during certain types of emergency situations. For example, if the fire department responds to an emergency they are required to have an incident commander on scene. Who will provide support functions in advisory roles or communications? Does anyone have the authority to override a decision made by the incident commander? All of these questions must be addressed in the contingency plan. A flowchart would be useful to show the relationship of all the various groups and agencies to the incident commander or on-scene coordinator and identify exactly where everyone fits into the overall response and chain of command.

In the event of an emergency, notification of emergency personnel must be initiated. A notification roster is one way of contacting all these individuals. The roster will contain the names of all emergency personnel, their titles, and phone number(s) where they can be reached. If emergency personnel carry a pager, also include this in the roster. The state emergency management team noted earlier should be an integrated part of the response plan.

Many public water supplies use a roster based on the pyramid notification procedure where everyone is responsible for notifying two others on the list starting from the top. If a person is unable to notify the next person, contact the other individual on the list, but note the initial caller is still responsible for contacting the missing person. Another approach is to have one or two people responsible for contacting all emergency personnel. It is up to the individual public water supply to determine which notification method is most logistically feasible, but the method must be clearly spelled out for all the individuals involved.

- **Long and Short Term Water Supply Replacement**

One question that must be answered if there is a water supply disruption is: Where will the water system obtain its water if an emergency should take place? According to the EPA, there are five categories from which alternative water supplies are available. They include a supply from within the system (standby wells or wellfield), a supply from an outside system (neighboring community or bottled water), modification or reduction of water use (restrictions) and aquifer restoration (spill clean-ups). In determining an alternate water source or combination of sources, consider all possibilities and make a selection which best fits the water systems characteristics. Cost will also be a major consideration. Under most conditions aquifer restoration or remediation will be the most expensive alternative, which emphasizes how important it is to prevent pollution problems from occurring rather than trying to clean them up after the damage has been done.

When evaluating water source alternatives, consider the following criteria. Is the alternative technically and logistically feasible? Is it a reliable source of water? Are there any political considerations in selecting a particular alternate water source? Finally, what is the cost of one alternative over another? These criteria will aid in the decision making process by eliminating some options.

Having an additional water source within the community available for emergencies, or simply one that is from another aquifer or surface water that is regularly used by the community, will reduce your dependence on a sole vulnerable aquifer source. The extra water source may be somewhat expensive to maintain if it is not needed, but the costs of getting the water from outside sources or through aquifer restoration may be much higher. Getting enough bottled water or water from neighboring communities may not be feasible in all instances. Placing restrictions on water use in emergencies is a valuable tool available to communities as it can be accomplished quickly and inexpensively. It is often only a partial solution, because it may not reduce the water use as much as needed, and/or it may not always be politically acceptable if the restrictions are perceived by the community as too strict for the type of disruption experienced. It should be kept in mind that short term solutions such as hauling water may be a cost effective means of supply in the short term, but would not always be a viable solution over an extended period of time.

- **Logistical Support Services**

  During a crisis, logistical information about equipment and personnel will be passed back and forth between the incident commander and emergency response personnel. A list of available clean-up and emergency equipment should be prepared before an emergency arises to aid the incident commander in determining what material resources are available and where they can be located. The equipment list will identify each piece of equipment, the quantity, housing location, and capacity of the equipment as well as any qualified operators. The equipment list should include all heavy earth moving equipment, pumps, generators, hand tools, safety equipment, lab and sampling supplies.

  Additional equipment may be required due to the size of an emergency or limited equipment at the disposal of the public water supply. It may be necessary to enter into contractual agreements with other entities to provide additional equipment and services that the public water supply may not be able to provide. Entities to look for that have equipment and supplies and will possibly enter into a contractual agreement include consulting firms, contractors, other municipalities and private analytical labs. These agreements need to be in place prior to an actual emergency. One other source of assistance that may be utilized in some emergency situations is the National Guard. The National Guard can assist in emergencies if all local resources have been exhausted and the Governor authorizes their use. Depending upon the circumstances, the state may ask reimbursement for the assistance of the National Guard.

- **Financial Resources**

Any water supply emergency will be expensive to manage and correct. How expensive depends on the severity of the emergency and resources consumed. Is there a short term need for water conservation or alternate supply, or will the emergency require development of an entirely new water source? To help pay for a water supply emergency, several sources should be investigated. Local communities may have a "reserve fund" that can be tapped for small emergencies, but larger emergencies require more resources. Some state and federal agencies may provide assistance with grants and low interest loans but these may be contingent on the type of emergency. For example, the Federal Emergency Management Association may provide assistance after a natural disaster when the county has been declared a disaster area. Identification of potential funding sources before an emergency arises will help a community be more financially prepared for such a water supply disruption.

- **Public Communication/Relations**

After a public water supply emergency has occurred, how the incident information is presented to the public becomes very important. An effective message will be prompt, frequent, accurate and provide credible information. The message will minimize confusion and gain the public's support and cooperation in implementing any emergency procedures. Educating the public about the wellhead protection program and the water system will help the public understand the issues involved during a water supply emergency. Several methods of education include brochures, water-bill mailings, public forums or press articles which pertain to emergency response procedures. Education is part of building and maintaining public confidence.

The EPA offers the following guidelines when presenting information about a water disruption event.

- Notify the public as soon as possible after the discovery of a problem. The spokesperson should be someone from water personnel not state or federal personnel.
- Choose a spokesperson likely to communicate clearly with the public and to inspire confidence.
- Public anger and frustration are more likely to arise than panic. Avoid defensive postures and speculative responses in the face of negative reactions. It is better to admit ignorance than to speculate.
- Do not raise false hopes concerning the remedial time-frame or attempt to trivialize problems involved in responding to a serious water supply disruption.
- If the incident is substantial, failure to convey adequate information to the public could be particularly polarizing. A person from the "public" should be allowed to observe the operation which would provide a gesture of openness and respect.

Information to include in the message to the public includes the following list:

- Federal and state notification requirements
- Water supply system information
- Contaminant identification
- Water use restrictions
- Boil orders
- Conservation
- Impact on water supply
- Alternative supplies
- Risk Assessment
- Action taken and planned
- Duration of the incident
- Future public communication
- Source of contamination

Continue to inform the public with progress reports after the initial notification of a water emergency. The progress reports indicate to the public that the water emergency is being adequately addressed. The progress reports should include information that is required by law (i.e., notification of exceeding maximum contaminant levels, which are the maximum legal allowable concentrations of a contaminant that can be present in drinking water), the status of any water use restrictions, time frame for remedial measures, options under consideration, costs and sources of funding and investigation results.

- **Prevention and Training**

  During the development of the plan, there may be areas which need to be addressed which may prevent or mitigate water disruption emergencies. For example, the background check of the distribution system may reveal methods that can be used to completely isolate a contaminated well from the system and avoid the need to shut down the entire system if there is a problem. The community may be able to manage with some temporary water use restrictions, rather than require a short term alternate water source. Other items to look for include unregulated land uses which could potentially contaminate the aquifer, shortage of equipment and trained personnel or the lack of mutual aid response agreements with neighboring communities. A time frame should be set up to address all of the above identified issues.

  Training local emergency responders to deal with a variety of emergencies makes the actual emergency response go smoothly and with little confusion. The training, which is an ongoing need, may take several forms such as reviewing the water supply contingency plan, identifying the various hazardous materials in the wellhead protection area, learning how to contain and mitigate a spill and providing full scale mock emergencies. New emergency responders will need complete training while veterans require periodic refresher courses.

SUMMARY
The contingency plan prepares the local community for water supply emergencies that range from natural disasters to contamination, and provides a pre-planned response for emergency personnel to follow. Some of the planning items that need to be addressed include: understanding your water distribution system, coordinating with other response plans, developing a response command structure, identifying equipment, funding & alternate water supplies, and keeping the public informed of the plan elements. By preparing in advance, all emergency personnel will know their role in an emergency, providing for an organized and efficient response.

CONTINGENCY PLANNING ITEMS TO BE CHECKED IN THE LOCAL DOCUMENT SUBMITTED TO DENR

The information submitted in conjunction with the above guideline will satisfy component 5 concerning contingency planning. Component 1, 4 and 7 are also addressed through this planning operation.

- Are the short and long term supply sources identified?
- Are coordination procedures and contact persons clearly identified?
- Has the public been adequately informed of their responsibility during an emergency?
- Is a response document addressing all the necessary items completed and available for all emergency response personnel?

6. GUIDELINES FOR SITING NEW WELLS

INTRODUCTION

As part of an ongoing wellhead protection program, new public water supply wells may be proposed for the community which must be protected against potential contamination to the same extent that existing wells are. Wellhead protection areas should be delineated for all proposed wells and appropriate contaminant source identification made to reduce future problems, and a management plan developed to address the identified contaminants. Managing the future wellfield area for ground water protection prior to its installation and operation will help reduce future costs or contamination problems, and protect the investment of the new wells. Listed below are siting criteria for locating new wells in future wellhead protection areas.

NEW PUBLIC WATER SUPPLY WELL SITING CRITERIA

New public water supply wells in South Dakota must meet State well construction standards including restrictions on locating near potential contaminant sources as listed in Administrative Rules of South Dakota 74:02:04:24. Restrictions include locating public water supply wells in shallow aquifers no closer than 150 feet horizontally from any pollution source, 500 feet from a wastewater treatment plant, or 1000 feet from a landfill or wastewater stabilization pond. Other restrictions are also noted in this regulation.

The Ground Water Quality Program reviews proposed sites for new public water supply wells through notification by the DENR's Water Rights Division and/or the Drinking Water Program. It is recommended a community with a wellhead protection program notify the Ground Water Quality Program of their intentions to drill new wells. The review for the new well(s) must be consistent with the State wellhead protection program and include a review of the hydrogeological data, any spills/releases in the area, and any other applicable information. Communities with wellhead protection programs that have met all the applicable criteria and apply to the Division of Water Rights for a new water permit, will be notified that wellhead protection areas are to be delineated and their protection programs updated so the new wells also meet all the wellhead protection criteria.

The goal of installing any new well is to maximize yield while minimizing the cost and risk of contamination. To achieve this goal, the community must first select a site and begin compiling information consistent with State wellhead protection program guidelines. A site may have been selected through a "future use permit" available from the DENR Water Rights Division, which gives the community the right to withdraw, at a future date, a specific amount of water from an aquifer at a predetermined location. An alternate site selection may be desirable if the primary site encounters water quality problems or is a high risk for contamination. If possible, the alternate site should also be located in the future use area to save time and effort in finding a new site and obtaining the necessary permits should an alternate site have to be used.

The wellhead protection area delineation is the next step in siting a new well using the delineation guidelines established in guideline 2. The initial delineation should be conservative to estimate the maximum area that may need to be protected to determine if the site location is acceptable, and then be followed up with a more detailed delineation to be used in the management of the wellhead protection area. The recommended interim protection distance of 1 mile or 10 year time-of-travel for unconfined and semiconfined aquifers, and 500 feet for confined aquifers will also be applied to new well sites.

After the initial delineation, the public water supply should conduct an inventory of potential contaminant sources (see guideline 3) prior to final selection of the well site to minimize future contamination possibilities. This inventory will be used to assess the risk of contamination to the proposed well. If a potentially high risk is determined an alternate site should be used before wells are installed.

Management plans consistent with the wellhead protection plan should be enacted as soon as a commitment to the site is made, which may include some type of protection measures for the future use area. This may involve buying the land around the proposed site to manage it for wellhead protection. The site could be kept in an undeveloped state where crop farming or commercial, residential or industrial development are restricted. Short of purchasing the land, the local governing body may pass ordinances that restrict land use activities in

the future supply well area. The main goal is to prevent the area from becoming contaminated prior to the well becoming operational.

SUMMARY

This guideline encourages the public water supply to be proactive in siting new wells rather than reactive when problems develop. Thoroughly evaluating a proposed well site beforehand, including delineating a wellhead protection area, conducting a contaminant source inventory, and developing a management strategy for the area, will help identify any potential problems that may arise or determine that the proposed site is not suitable and an alternate site should be selected.

NEW WELLS ITEMS TO BE CHECKED IN THE LOCAL DOCUMENT SUBMITTED TO DENR:

Information submitted under this guideline will satisfy component 6.

- Have you notified the Ground Water Quality Program concerning the location of your proposed well(s) prior to drilling/developing the site?

- Has a site assessment been conducted for the proposed well(s), including a wellhead protection area delineation and an inventory of possible contaminant sources?

- Have management options been explored for the new well area prior to the well's installation and operation?

7. GUIDELINES FOR INCLUDING PUBLIC PARTICIPATION

INTRODUCTION

Public participation is the last component in a wellhead protection program, but is one facet of wellhead protection which should be included from the initial planning through managing of the program. The public will determine the extent of the restrictions that can be imposed on land use in the area, whether money will be allocated to the program, and whether voluntary contamination reduction measures will be followed. It is vitally important to keep the public informed and encouraged to participate in the development of the wellhead protection program if it is to be successful.

PUBLIC INVOLVEMENT IN WELLHEAD PROTECTION

Public participation is strongly encouraged during the development of the wellhead protection program. The wellhead protection program is a local plan that meets the needs of the community in protecting their public water supply. A wellhead protection program developed for one community may not work for another because the needs of the communities are different. Public participation will provide opportunities for citizens to voice their concerns, make recommendations and provide feedback as the wellhead protection program develops into a process that adequately protects the water supply while not being overly restrictive. Input should be obtained from a wide range of groups which include, but are not limited to: state and local agencies, water development districts, businesses, industry, farmers, scientists and engineers, environmental groups and any interested citizens.

There are many avenues for public participation during the development of the wellhead protection program. Public meetings where wellhead protection is discussed are a good format for public involvement. Potential contaminant source identification via the inventory surveys discussed earlier can involve significant public participation. Because managing the wellhead protection area most closely impacts the citizens of the community, their input at this stage of the process is very important. Public participation also promotes public education about wellhead protection and increases awareness of where the community obtains its water supply, what are the potential sources of contamination that can affect a well, and how do their activities affect ground water.

Examples of public participation at the state level include the annual Groundwater Quality Conference, public meetings, presentations, newsletters, press releases and providing technical assistance.

SUMMARY

This guideline emphasizes how important public participation is in the development of a wellhead protection program. By involving the public during the development of the wellhead protection program, adequate protection is provided that still meets the private needs of the citizens. Their involvement in the process should ensure that the program is acceptable to the majority of the citizens, and will enhance the smooth operation of the program.

PUBLIC PARTICIPATION CHECK LIST FOR THE SUBMITTAL DOCUMENT:

Information submitted under this guideline will fulfill component 7 requirements.

- How was the public involved in the wellhead protection planning and implementation process?
- What committee(s) were set up to prepare a wellhead protection program? Who attended these meetings?
- What organizations were involved in the development of the wellhead protection program?
- Were all groups with differing points of view allowed to have input?

- What information methods were used to involve the public in the program development and decision making?

SUMMARY

The wellhead protection program guidelines discussed in this document are designed to assist local communities in developing a program that will protect their water supply from contamination, and assist them in designing an emergency response to a water supply disruption from contamination or natural disaster. This program has been strongly recommended at the state and national level because it has been shown that prevention of contamination is much less costly than clean-up of the ground water contamination or being forced to develop a new water source.

In South Dakota this program is voluntary, and each community must decide if they believe a wellhead protection program is warranted for the protection of their water supply. In this regard, the support of the citizens in the community is essential if such a program is to be successful; therefore the public must be informed of the program plans throughout the entire process.

If a community wants to develop a wellhead protection program, DENR is ready to assist in getting started. All seven components of wellhead protection need to be addressed for an adequate program, although DENR can give partial concurrence to a local program in an effort to initiate protection measures. DENR will continue to work with communities as long as needed to reach full program development and DENR concurrence.

The water supply protection needs, and personnel and financial resources of the various communities in South Dakota can be quite different. Some public water supplies withdraw large volumes of water from shallow, vulnerable aquifers, while other communities may have one well that is hundreds of feet deep. Additionally, one community may have a large staff with expertise in wellhead protection activities, while another may have one individual who is the sole person in the community water department. These differences will be reflected in the type of wellhead protection program that can be developed at the local level, and the type of document that will be submitted to the DENR.

Effective implementation of the wellhead protection program, whatever its level of sophistication, is the key to its success. Protection of area ground water is a worthwhile goal for any community, and developing a manageable wellhead protection program will be very helpful in attaining that goal.

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ACRONYMS

ARSD:	**Administrative Rules of South Dakota**
CEPA:	**Centennial Environmental Protection Agency**
CERCLA:	**Comprehensive Environmental Response, Compensation and Liability Act**
CFSA:	**Consolidated Farm Service Agency**
DENR:	**Department of Environment and Natural Resources**
EPA:	**Environmental Protection Agency**
FIFRA:	**Federal Insecticide, Fungicide, and Rodenticide Act**
LEPC:	**Local Emergency Planning Commission**
NRCS:	**Natural Resources Conservation Service**
OSHA:	**Occupational Safety and Health Administration**
RCRA:	**Resource Conservation and Recovery Act**
SARA:	**Superfund Amendments and Reauthorization Act**
SDCL:	**South Dakota Codified Law**

GLOSSARY

Alluvium: A general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope.

Aquifer: A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield sufficient, economical quantities of water to wells and springs.

Aquifer Test: A test to determine hydrologic properties of an aquifer, involving the withdrawal of measured quantities of water from, or addition of water to, a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition.

Cone of Depression: A depression in the groundwater table or potentiometric surface that has the shape of an inverted cone and develops around a well from which water is being withdrawn. It defines (in cross-section) the area of influence of a well.

Confined Aquifer: An aquifer bounded above and below by confining units of distinctly lower permeability than the aquifer media; or one containing confined ground water. An aquifer in which ground water is under pressure significantly greater than atmospheric and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the aquifer itself.

Confining Unit: A hydrogeologic unit of relatively impermeable material, bounding one or more aquifers. This is a general term that has replaced aquitard, aquifuge, and aquiclude and is synonymous with confining bed.

Contaminant: An undesirable substance not normally present, or an usually high concentration of a naturally occurring substance, in water, soil, or other environmental medium.

Contamination: The degradation of natural water quality as a result of man's activities. There is no implication of any specific limits, since the degree of permissible contamination depends upon the intended end use, or uses, of the water.

Criteria, Wellhead Protection Area: Conceptual standard that forms the basis for wellhead protection area delineation. Wellhead protection area criteria can include distance, drawdown, time-of-travel, assimilative capacity, and flow boundaries.

Discharge Area: An area in which ground water is discharged to the land surface, surface water, or atmosphere.

Drawdown: The vertical distance ground water elevation is lowered, or the amount pressure head is reduced, due to the removal of ground water. Also the decline in potentiometric surface caused by the withdrawal of water from a hydrogeologic unit.

Freshwater: Water containing a small quantity of total dissolved solids (generally less than 1000 mg/L).

Ground Water: The water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.

Ground Water Divide: Ridge in the water table, or potentiometric surface, from which ground water moves away at right angles in both directions. Line of highest hydraulic head in the water table or potentiometric surface.

Hydraulic Conductivity (K): Proportionality constant relating hydraulic gradient to specific discharge, which for an isotropic medium and homogeneous fluid, equals the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

Hydraulic Gradient (i): Slope of a water table or potentiometric surface.

Infiltration: The downward entry of water into soil or rock.

Permeability: Ability of a porous medium to transmit fluids under a hydraulic gradient.

Porosity (n): Ratio of the total volume of voids available for fluid transmission to the total volume of a porous medium. Also the ratio of the volume of the voids of a soil or rock mass that can be drained by gravity to the total volume of the mass.

Public Water Supply System: System for provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves at least 25 individuals daily or at least 60 days out of the year.

Pumping Test: A test that is conducted to determine aquifer or well characteristics. A test made by pumping a well for a period of time and observing the change in hydraulic head in the aquifer. A pump test may be used to determine the capacity of the well and the hydraulic characteristics of the aquifer. Also called aquifer test.

Pumping Rate: The rate at which the water is withdrawn from the well.

Radius of Influence: The radial distance from the center of a well bore to the point where there is no lowering of the water table or potentiometric surface (the edge of its cone of depression).

Recharge Area: Area in which water reaches the zone of saturation by surface infiltration. An area in which there are downward components of hydraulic head in the aquifer. Infiltration moves downward into the deeper parts of an aquifer in a recharge area.

Semiconfined: An aquifer that has a "leaky" confining unit and displays characteristics of both confined and unconfined aquifers.

Threshold: A quantitative number used with a wellhead protection area criteria for delineation purposes.

Time-of-Travel (TOT): The time required for a contaminant to move in the saturated zone from a specific point to a well.

Till: An unsorted and unstratified mixture of clay, silt, sand, gravel and boulders deposited by glaciers.

Transmissivity (t): Rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Unconfined Aquifer: Conditions in which the upper surface of the zone of saturation forms a water table under atmospheric pressure.

Wellhead Protection Area: A designated area around a public water supply well(s) that is to be protected from contaminants that may adversely affect human health.

Wellhead Protection Program: A program to protect wellhead protection areas within a State's jurisdiction from contaminants that may have any adverse effects on the health of persons (SDWA, subsection 1428(a)).

Zone of Influence: An area from where water can move to the well due to drawdown in the pumping well. The extent of the influence is directly dependent on aquifer properties.

Zone of contribution: An area from where water can move to the pumping well due to the drawdown influence of the pumping well, and the regional gradient of the water table. The extent of zone of contribution is directly dependent on the aquifer properties.

APPENDIX 1

Addresses and Phone Numbers of State Environmental Contacts

Ground Water Quality Program
Department of Environment and Natural Resources
Division of Environmental Regulation
Joe Foss Building
Pierre, SD 57501
(605) 773-3296

Waste Management Program
Department of Environment and Natural Resource
Division of Environmental Regulations
Joe Foss Building
Pierre, SD 57501
(605) 773-3153

Point Source Control Program
Department of Environment and Natural Resources
Division of Environmental Regulation
Joe Foss Building
Pierre, SD 57501
(605) 773-3351

Drinking Water Program
Department of Environment and Natural Resources
Division of Environmental Regulation
Joe Foss Building
Pierre, SD 57501
(605) 773-3754

South Dakota Geological Surey
Department of Environment and Natural Resources
Ackley Science Center - USD Campus
Vermillion, SD 57069
(605) 677-5227

Division of Water Rights
Department of Environment and Natural Resources
Joe Foss Building
Pierre, SD 57501
(605) 773-3352

Sioux Falls Regional Office
Department of Environment and Natural Resources
1108 W. Bailley
Sioux Falls, SD 57104
(605) 339-6697

Rapid City Regional Office
Department of Environment and Natural Resources
2050 West Main, Suite 1
Rapid City, SD 57702
(605) 394-2229

Northeast Lakes Regional Office
Department of Environment and Natural Resources
913 5th Street SE
Watertown, SD 57201
(605) 882-5111

Department of Agriculture
Division of Regulatory Services
Joe Foss Building
Pierre, SD 57501
(605) 773-3375

Department of Health
Health Protection Program
Andreson Building
Pierre, SD 57501
(605) 773-3361

APPENDIX 2

Potential Sources of Ground Water Contamination

Source	Health, Environmental, or Aesthetic Contaminant[1,2,3]
NATURALLY OCCURRING SOURCES	
Rocks and soils	*Aesthetic Contaminants:* Iron and iron bacteria; manganese; calcium and magnesium (hardness) *Health and Environmental Contaminants:* Arsenic; asbestos; metals; chlorides; fluorides; sulfates; sulfate-reducing bacteria and other microorganisms
Contaminated water	Excessive sodium; bacteria; viruses; low pH (acid) water
Decaying organic matter	Bacteria
Geological radioactive gas	Radionuclides (radon, etc.)
Natural hydrogeological events and formations	Salt-water/brackish water intrusion (or intrusion of other poor quality water); contamination by a variety of substances through sink-hole infiltration in limestone terrains
AGRICULTURAL SOURCES	
Animal feedlots and burial areas	Livestock sewage wastes; nitrates; phosphates; chloride; chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests on livestock; coliform[4] and noncoliform bacteria; viruses
Manure spreading areas and storage pits	Livestock sewage wastes; nitrates
Livestock waste disposal areas	Livestock sewage wastes; nitrates
Crop areas and irrigation sites	Pesticides;[5] fertilizers;[6] gasoline and motor oils from chemical applicators
Chemical storage areas and containers	Pesticide[5] and fertilizer[6] residues
Farm machinery areas	Automotive wastes;[7] welding wastes
Agricultural drainage wells and canals	Pesticides;[5] fertilizers;[6] bacteria; salt water (in areas where the fresh-saltwater interface lies at shallow depths and where the water table is lowered by channelization, pumping, or other causes)
RESIDENTIAL SOURCES	
Common household maintenance and hobbies	*Common Household Products:*[8] Household cleaners; oven cleaners; drain cleaners; toilet cleaners; disinfectants; metal polishes; jewelry cleaners; shoe polishes; synthetic detergents; bleach; laundry soil and stain removers; spot removers and dry cleaning fluid; solvents; lye or caustic soda; household pesticides;[9] photochemicals; printing ink; other common products *Wall and Furniture Treatments:* Paints; varnishes; stains; dyes; wood preservatives (creosote); paint and lacquer thinners; paint and varnish removers and deglossers; paint brush cleaners; floor and furniture strippers *Mechanical Repair and Other Maintenance Products:* Automotive wastes;[7] waste oils; diesel fuel; kerosene; #2 heating oil; grease; degreasers for driveways and garages; metal degreasers; asphalt and roofing tar; tar removers; lubricants; rustproofers; car wash detergents; car waxes and polishes; rock salt; refrigerants
Lawns and gardens	Fertilizers;[5] herbicides and other pesticides used for lawn and garden maintenance[10]
Swimming pools	Swimming pool maintenance chemicals[11]
Septic systems, cesspools, and sewer lines	Septage; coliform and noncoliform bacteria;[4] viruses; nitrates; heavy metals; synthetic detergents; cooking and motor oils; bleach; pesticides;[9,10] paints; paint thinner; photographic chemicals; swimming pool chemicals;[11] septic tank/cesspool cleaner chemicals;[12] elevated levels of chloride, sulfate, calcium, magnesium, potassium, and phosphate
Underground storage tanks	Home heating oil
Apartments and condominiums	Swimming pool maintenance chemicals;[11] pesticides for lawn and garden maintenance and cockroach, termite, ant, rodent, and other pest control;[9,10] wastes from onsite sewage treatment plants; household hazardous wastes[8]

SOURCE: US EPA, Wellhead Protection: A Guide for Small Communities, EPA 625/R-93/002

Potential Sources of Ground Water Contamination (continued)

Source	Health, Environmental, or Aesthetic Contaminant[1,2,3]
MUNICIPAL SOURCES	
Schools and government offices and grounds	Solvents; pesticides;[9,10] acids; alkalis; waste oils; machinery/vehicle servicing wastes; gasoline and heating oil from storage tanks; general building wastes[13]
Park lands	Fertilizers;[6] herbicides;[10] insecticides[9]
Public and residential areas infested with mosquitoes, gypsy moths, ticks, ants, or other pests	Pesticides[5,9]
Highways, road maintenance depots, and deicing operations	Herbicides in highway rights-of-way;[5,10] road salt (sodium and calcium chloride); road salt anticaking additives (ferric ferrocyanide, sodium ferrocyanide); road salt anticorrosives (phosphate and chromate); automotive wastes[7]
Municipal sewage treatment plants and sewer lines	Municipal wastewater; sludge;14 treatment chemicals[15]
Storage, treatment, and disposal ponds, lagoons, and other surface impoundments	Sewage wastewater; nitrates; other liquid wastes; microbiological contaminants
Land areas applied with wastewater or wastewater byproducts	Organic matter; nitrate; inorganic salts; heavy metals; coliform and noncoliform bacteria;[4] viruses; nitrates; sludge;[14] nonhazardous wastes[16]
Storm water drains and basins	Urban runoff; gasoline; oil; other petroleum products; road salt; microbiological contaminants
Combined sewer overflows (municipal sewers and storm water drains)	Municipal wastewater; sludge;[14] treatment chemicals;[15] urban runoff; gasoline; oil; other petroleum products; road salt; microbial contaminants
Recycling/reduction facilities	Residential and commercial solid waste residues
Municipal waste landfills	Leachate; organic and inorganic chemical contaminants; wastes from households[8] and businesses;[13] nitrates; oils; metals
Open dumping and burning sites, closed dumps	Organic and inorganic chemicals; metals; oils; wastes from households[8] and businesses[13]
Municipal incinerators	Heavy metals; hydrocarbons; formaldehyde; methane; ethane; ethylene; acetylene; sulfur and nitrogen compounds
Water supply wells, monitoring wells, older wells, domestic and livestock wells, unsealed and abandoned wells, and test hole wells	Surface runoff; effluents from barnyards, feedlots, septic tanks, or cesspools; gasoline; used motor oil; road salt
Sumps and dry wells	Storm water runoff; spilled liquids; used oil; antifreeze; gasoline; other petroleum products; road salt; pesticides;[5] and a wide variety of other substances
Drainage wells	Pesticides;[9,10] bacteria
Well pumping that causes interaquifer leakage, induced filtration, landward migration of sea water in coastal areas; etc.	Saltwater; excessively mineralized water
Artificial ground water recharge	Storm water runoff; excess irrigation water; stream flow; cooling water; treated sewage effluent; other substances that may contain contaminants, such as nitrates, metals, detergents, synthetic organic compounds, bacteria, and viruses
COMMERCIAL SOURCES	
Airports, abandoned airfields	Jet fuels; deicers; diesel fuel; chlorinated solvents; automotive wastes;[7] heating oil; building wastes[13]
Auto repair shops	Waste oils; solvents; acids; paints; automotive wastes;[7] miscellaneous cutting oils
Barber and beauty shops	Perm solutions; dyes; miscellaneous chemicals contained in hair rinses
Boat yards and marinas	Diesel fuels; oil; septage from boat waste disposal areas; wood preservative and treatment chemicals; paints; waxes; varnishes; automotive wastes[7]

Potential Sources of Ground Water Contamination (continued)

Source	Health, Environmental, or Aesthetic Contaminant[1,2,3]
Bowling alleys	Epoxy; urethane-based floor finish
Car dealerships (especially those with service departments)	Automotive wastes;[7] waste oils; solvents; miscellaneous wastes
Car washes	Soaps; detergents; waxes; miscellaneous chemicals
Camp grounds	Septage; gasoline; diesel fuel from boats; pesticides for controlling mosquitoes, ants, ticks, gypsy moths, and other pests;[5,9] household hazardous wastes from recreational vehicles (RVs)[8]
Carpet stores	Glues and other adhesives; fuel from storage tanks if forklifts are used
Cemeteries	Leachate; lawn and garden maintenance chemicals[10]
Construction trade areas and materials (plumbing, heating and air conditioning, painting, paper hanging, decorating, drywall and plastering, acoustical insulation, carpentry, flooring, roofing and sheet metal, wrecking and demolition, etc.)	Solvents; asbestos; paints; glues and other adhesives; waste insulation; lacquers; tars; sealants; epoxy waste; miscellaneous chemical wastes
Country clubs	Fertilizers;[6] herbicides;[5,10] pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests;[9] swimming pool chemicals;[11] automotive wastes
Dry cleaners	Solvents (perchloroethylene, petroleum solvents, Freon); spotting chemicals (trichloroethane, methylchloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate)
Funeral services and crematories	Formaldehyde; wetting agents; fumigants; solvents
Furniture repair and finishing shops	Paints; solvents; degreasing and solvent recovery sludges
Gasoline services stations	Oils; solvents; miscellaneous wastes
Golf courses	Fertilizers;[6] herbicides;[5,10] pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests[9]
Hardware/lumber/parts stores	Hazardous chemical products in inventories; heating oil and fork lift fuel from storage tanks; wood-staining and treating products such as creosote
Heating oil companies, underground storage tanks	Heating oil; wastes from truck maintenance areas[7]
Horticultural practices, garden nurseries, florists	Herbicides, insecticides, fungicides, and other pesticides[10]
Jewelry/metal plating shops	Sodium and hydrogen cyanide; metallic salts; hydrochloric acid; sulfuric acid; chromic acid
Laundromats	Detergents; bleaches; fabric dyes
Medical institutions	X-ray developers and fixers;[17] infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; dental acids; miscellaneous chemicals
Office buildings and office complexes	Building wastes;[13] lawn and garden maintenance chemicals;[10] gasoline; motor oil
Paint stores	Paints; paint thinners; lacquers; varnishes; other wood treatments
Pharmacies	Spilled and returned products
Photography shops, photo processing laboratories	Biosludges; silver sludges; cyanides; miscellaneous sludges
Print shops	Solvents; inks; dyes; oils; photographic chemicals
Railroad tracks and yards	Diesel fuel; herbicides for rights-of-way; creosote for preserving wood ties
Research laboratories	X-ray developers and fixers;[17] infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; solvents; infectious materials; drugs; disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach); miscellaneous chemicals

Potential Sources of Ground Water Contamination (continued)

Source	Health, Environmental, or Aesthetic Contaminant[1,2,3]
COMMERCIAL SOURCES (continued)	
Scrap and junk yards	Any wastes from businesses[13] and households;[8] oils
Sports and hobby shops	Gunpowder and ammunition; rocket engine fuel; model airplane glue
Above-ground and underground storage tanks	Heating oil; diesel fuel; gasoline; other petroleum products; other commercially used chemicals
Transportation services for passenger transit (local and interurban)	Waste oil; solvents; gasoline and diesel fuel from vehicles and storage tanks; fuel oil; other automotive wastes[7]
Veterinary services	Solvents; infectious materials; vaccines; drugs; disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach); x-ray developers and fixers[17]
INDUSTRIAL SOURCES	
Material stockpiles (coal, metallic ores, phosphates, gypsum)	Acid drainage; other hazardous and nonhazardous wastes[16]
Waste tailing ponds (commonly for the disposal of mining wastes)	Acids; metals; dissolved solids; radioactive ores; other hazardous and nonhazardous wastes[15]
Transport and transfer stations (trucking terminals and rail yards)	Fuel tanks; repair shop wastes;[7] other hazardous and nonhazardous wastes[15]
Above-ground and underground storage tanks and containers	Heating oil; diesel and gasoline fuel; other petroleum products; hazardous and nonhazardous materials and wastes[16]
Storage, treatment, and disposal ponds, lagoons, and other surface impoundments	Hazardous and nonhazardous liquid wastes;[16] septage; sludge[14]
Chemical landfills	Leachate; hazardous and nonhazardous wastes;[16] nitrates
Radioactive waste disposal sites	Radioactive wastes from medical facilities, power plants, and defense operations; radionuclides (uranium, plutonium)
Unattended wet and dry excavation sites (unregulated dumps)	A wide range of substances; solid and liquid wastes; oil-field brines; spent acids from steel mill operations; snow removal piles containing large amounts of salt
Operating and abandoned production and exploratory wells (for gas, oil, coal, geothermal, and heat recovery); test hole wells; monitoring and excavation wells	Metals; acids; minerals; sulfides; other hazardous and nonhazardous chemicals[16]
Dry wells	Saline water from wells pumped to keep them dry
Injection wells	Highly toxic wastes; hazardous and nonhazardous industrial wastes;[16] oil-field brines
Well drilling operations	Brines associated with oil and gas operations
INDUSTRIAL PROCESSES (PRESENTLY OPERATED OR TORN-DOWN FACILITIES)[18]	
Asphalt plants	Petroleum derivatives
Communications equipment manufacturers	Nitric, hydrochloric, and sulfuric acid wastes; heavy metal sludges; copper-contaminated etchant (e.g., ammonium persulfate); cutting oil and degreasing solvent (trichloroethane, Freon, or trichloroethylene); waste oils; corrosive soldering flux; paint sludge; waste plating solution
Electric and electronic equipment manufacturers and storage facilities	Cyanides; metal sludges; caustics (chromic acid); solvents; oils; alkalis; acids; paints and paint sludges; calcium fluoride sludges; methylene chloride; perchloroethylene; trichloroethane; acetone; methanol; toluene; PCBs
Electroplaters	Boric, hydrochloric, hydrofluoric, and sulfuric acids; sodium and potassium hydroxide; chromic acid; sodium and hydrogen cyanide; metallic salts
Foundries and metal fabricators	Paint wastes; acids; heavy metals; metal sludges; plating wastes; oils; solvents; explosive wastes

Potential Sources of Ground Water Contamination (continued)

Source	Health, Environmental, or Aesthetic Contaminant[1,2,3]
Furniture and fixtures manufacturers	Paints; solvents; degreasing sludges; solvent recovery sludges
Machine and metalworking shops	Solvents; metals; miscellaneous organics; sludges; oily metal shavings; lubricant and cutting oils; degreasers (tetrachlorethylene); metal marking fluids; mold-release agents
Mining operations (surface and underground), underground storage mines	Mine spoils or tailings that often contain metals; acids; highly corrosive mineralized waters; metal sulfides
Unsealed abandoned mines used as waste pits	Metals; acids; minerals; sulfides; other hazardous and nonhazardous chemicals[1,6]
Paper mills	Metals; acids; minerals; sulfides; other hazardous and nonhazardous chemicals;[1,6] organic sludges; sodium hydroxide; chlorine; hypochlorite; chlorine dioxide; hydrogen peroxide
Petroleum production and storage companies, secondary recovery of petroleum	Hydrocarbons; oil-field brines (highly mineralized salt solutions)
Industrial pipelines	Corrosive fluids; hydrocarbons; other hazardous and nonhazardous materials and wastes[1,6]
Photo processing laboratories	Cyanides; biosludges; silver sludges; miscellaneous sludges
Plastics materials and synthetics producers	Solvents; oils; miscellaneous organics and inorganics (phenols, resins); paint wastes; cyanides; acids; alkalis; wastewater treatment sludges; cellulose esters; surfactant; glycols; phenols; formaldehyde; peroxides; etc.
Primary metal industries (blast furnaces, steel works, and rolling mills)	Heavy metal wastewater treatment sludge; pickling liquor; waste oil; ammonia scrubber liquor; acid tar sludge; alkaline cleaners; degreasing solvents; slag; metal dust
Publishers, printers, and allied industries	Solvents; inks; dyes; oils; miscellaneous organics; photographic chemicals
Public utilities (phone, electric power, gas)	PCBs from transformers and capacitors; oils; solvents; sludges; acid solution; metal plating solutions (chromium, nickel, cadmium); herbicides from utility rights-of-way
Sawmills and planers	Treated wood residue (copper quinolate, mercury, sodium bazide); tanner gas; paint sludges; solvents; creosote; coating and gluing wastes
Stone, clay, and glass manufacturers	Solvents; oils and grease; alkalis; acetic wastes; asbestos; heavy metal sludges; phenolic solids or sludges; metal-finishing sludge
Welders	Oxygen, acetylene
Wood preserving facilities	Wood preservatives; creosote

[1]In general, ground water contamination stems from the *misuse and improper disposal* of liquid and solid wastes; the *illegal dumping or abandonment* of household, commercial, or industrial chemicals; the *accidental spilling* of chemicals from trucks, railways, aircraft, handling facilities, and storage tanks; or the *improper siting, design, construction, operation, or maintenance* of agricultural, residential, municipal, commercial, and industrial drinking water wells and liquid and solid waste disposal facilities. Contaminants also can stem from *atmospheric pollutants*, such as airborne sulfur and nitrogen compounds, which are created by smoke, flue dust, aerosols, and automobile emissions, fall as acid rain, and percolate through the soil. When the sources listed in this table are used and managed properly, ground water contamination is not likely to occur.

[2]Contaminants can reach ground water from activities occurring on the land surface, such as industrial waste storage; from sources below the land surface but above the water table, such as septic systems; from structures beneath the water table, such as wells; or from contaminated recharge water.

[3]This table lists the most common wastes, but not all potential wastes. For example, it is not possible to list all potential contaminants contained in storm water runoff or research laboratory wastes.

[4]Coliform bacteria can indicate the presence of pathogenic (disease-causing) microorganisms that may be transmitted in human feces. Diseases such as typhoid fever, hepatitis, diarrhea, and dysentery can result from sewage contamination of water supplies.

[5]Pesticides include herbicides, insecticides, rodenticides, fungicides, and avicides. EPA has registered approximately 50,000 different pesticide products for use in the United States. Many are highly toxic and quite mobile in the subsurface. An EPA survey found that the most common pesticides found in drinking water wells were DCPA (dacthal) and atrazine, which EPA classifies as *moderately toxic* (class 3) and *slightly toxic* (class 4) materials, respectively.

[6]The EPA National Pesticides Survey found that the use of fertilizers correlates to nitrate contamination of ground water supplies.

APPENDIX 3
Potentially Harmful Components of Common Household Products

Product	Toxic or Hazardous Components
Antifreeze (gasoline or coolants systems)	Methanol, ethylene glycol
Automatic transmission fluid	Petroleum distillates, xylene
Battery acid (electrolyte)	Sulfuric acid
Degreasers for driveways and garages	Petroleum solvents, alcohols, glycol ether
Degreasers for engines and metal	Chlorinated hydrocarbons, toluene, phenols, dichloroperchloroethylene
Engine and radiator flushes	Petroleum solvents, ketones, butanol, glycol ether
Hydraulic fluid (brake fluid)	Hydrocarbons, fluorocarbons
Motor oils and waste oils	Hydrocarbons
Gasoline and jet fuel	Hydrocarbons
Diesel fuel, kerosene, #2 heating oil	Hydrocarbons
Grease, lubes	Hydrocarbons
Rustproofers	Phenols, heavy metals
Car wash detergents	Alkyl benzene sulfonates
Car waxes and polishes	Petroleum distillates, hydrocarbons
Asphalt and roofing tar	Hydrocarbons
Paints, varnishes, stains, dyes	Heavy metals, toluene
Paint and lacquer thinner	Acetone, benzene, toluene, butyl acetate, methyl ketones
Paint and varnish removers, deglossers	Methylene chloride, toluene, acetone, xylene, ethanol, benzene, methanol
Paint brush cleaners	Hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones
Floor and furniture strippers	Xylene
Metal polishes	Petroleum distillates, isopropanol, petroleum naphtha
Laundry soil and stain removers	Hydrocarbons, benzene, tricholorethylene, 1,1,1-trichloroethane
Other solvents	Acetone, benzene
Rock salt	Sodium concentration
Refrigerants	1,1,2-trichloro-1,2,2-trifluoroethane
Bug and tar removers	Xylene, petroleum distillates
Household cleansers, oven cleaners	Xylenols, glycol ethers, isopropanol
Drain cleaners	1,1,1-trichloroethane
Toilet cleaners	Xylene, sulfonates, chlorinated phenols
Cesspool cleaners	Tetrachloroethylene, dichlorobenzene, methylene chloride
Disinfectants	Creosol, xylenols
Pesticides (all types)	Naphthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons
Photochemicals	Phenols, sodium sulfite, cyanide, silver halide, potassium bromide
Printing ink	Heavy metals, phenol-formaldehyde
Wood preservatives (creosote)	Pentachlorophenols
Swimming pool chlorine	Sodium hypochlorite
Lye or caustic soda	Sodium hydroxide
Jewelry cleaners	Sodium cyanide

Source: "Natural Resources Facts: Household Hazardous Wastes," Fact Sheet No. 88-3, Department of Natural Science, University of Rhode Rhode Island, August 1988.

Appendix 4
INVENTORY FORM

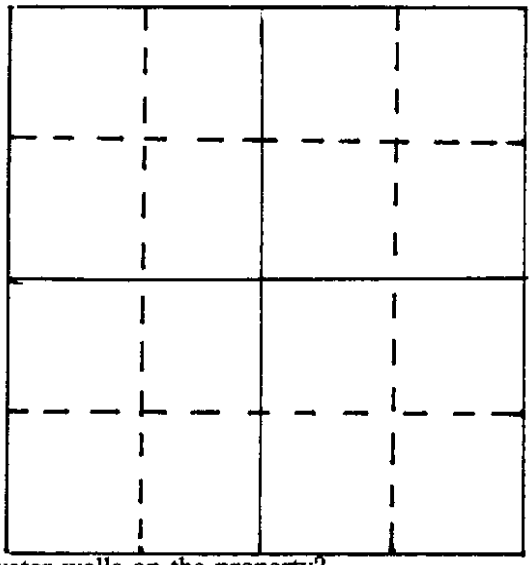
Location of PWS _____
Date of Inventory _____
Person Conducting Inventory _____
Map No. _____

Wellhead Protection Area Inventory Form

Public Water Supply _____
A. Property Owner Name _____
B. Property Owner Address _____
C. Property Owner Phone No. _____
D. County _____

Nature of Property

Residential _____ Commercial _____
Industrial _____ Agricultural _____
Gov't/Public _____ Other ( ) _____
Describe Property _____
_____
_____



Are there any water wells on the property? _____
If so, type (concrete, plastic, wood, etc) _____
Size (diameter) _____ Year Constructed _____
Depth _____ Use of Well _____
Abandoned ? _____

APPENDIX 4 (CONT.)

Potential Sources of Contamination

Check the potential sources listed below that you have identified at this site. For those checked, describe on the following page as best you can what the on-site contaminants are, or what particular type of facility is present.

Abandoned Well	---	Landfill	---
Above Ground Storage Tanks	---	Livestock Feedlot	---
Airport	---	Meat Packing	---
Animal Burial	---	Medical Facility	---
Auto Salvage	---	Mining Operation	---
Car Wash	---	Oil/Gas Well	---
Cemetery	---	Paint Shops	---
Cesspool	---	Pesticide Storage Facility	---
Chemical Storage Facility	---	Pipeline	---
Chemigation	---	Quarry	---
Construction Sites	---	Railroad	---
Dry Drainage Well	---	Research Institution	---
Dry Cleaners	---	Salt Piles or Storage	---
Dump	---	Service Station Disposal Well	---
Fertilizer/Pesticide Application	---	Septic Tank	---
Fertilizer Storage Facility	---	Sewage Plant Sludge Disposal	---
Floor Drain Disposal	---	Underground Storage Tank	---
Golf Course	---	Other	---
Grain Storage Bin	---		
Holding Pond/Lagoon	---		
Injection Well	---		

Where applicable and information is available, describe on-site contaminants for sources checked or elaborate on facility type. For example: type of product in underground storage tank (gasoline, heating fuel, waste oil); type of livestock feedlot (poultry, hogs, beef or dairy cattle); type of mining operation (gold mine, or sand and gravel mining); or type of chemical facility and products (metal plating, solvents, metals, etc).

_____

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APPENDIX 5
SUMMARY OF WELLHEAD PROTECTION TOOLS

	Applicability to Wellhead Protection	Land Use Practice	Administrative Considerations
Regulatory: Zoning			
Overlay GW Protection Districts	Used to map WHPAs. Provides for identification of sensitive areas for protection. Used in conjunction with other tools that follow.	Community identifies WHPAs on practical base/zoning map.	Requires staff to develop overlay map. Inherent nature of zoning provides "grandfather" protection to pre-existing uses and structures.
Prohibition of Various Land Uses	Used within mapped WHPAs to prohibit ground water contaminants and uses that generate contaminants.	Community adopts prohibited uses list within their zoning ordinance.	Requires amendment to zoning ordinance. Requires enforcement by both visual inspection and on-site investigations.
Special Permitting	Used to restrict uses within WHPAs that may cause ground water contamination if left unregulated.	Community adopts special permit "thresholds" for various uses and structures within WHPAs. Community grants special permits for "threshold" uses only if ground water quality will not be compromised.	Requires detailed understanding of WHPA sensitivity by local permit granting authority. Requires enforcement of special permit requirements and on-site investigations.
Large-Lot Zoning	Used to reduce impacts of residential development by limiting numbers of units within WHPAs.	Community "down zones" to increase minimum acreage needed for residential development.	Requires amendment to zoning ordinance.
Transfer of Development Rights	Used to transfer development from WHPAs to locations outside WHPAs.	Community offers transfer option within zoning identifies areas where development is to be transferred "from" and "to".	Cumbersome administrative requirements. Not well suited for small communities without significant administrative resources.
Cluster/PUD Design	Used to guide residential development outside of WHPAs. Allows for "point source" discharges that are more easily monitored.	Community offers cluster/ PUD as development option within zoning ordinance. Community identifies areas where cluster/PUD is allowed (i.e., within WHPAs)	Slightly more complicated to administer than traditional "grid" subdivision. Enforcement/inspection requirements are similar to "grid" subdivision.
Growth Controls/Timing	Used to time the occurrence of development within WHPAs. Allows communities the opportunity to plan for wellhead delineation and protection.	Community imposes growth controls in the form of building caps, subdivision phasing, or other limitation tied to planning concerns.	Generally complicated administrative process. Requires administrative staff to issue permits and enforcement growth control ordinances.

	Applicability to Wellhead Protection	Land Use Practice	Administrative Considerations
Performance Standards	Used to regulate development within WHPAs by enforcing predetermined standards for water quality. Allows for aggressive protection of WHPAs by limiting development within WHPAs to an accepted level.	Community identifies WHPAs and established "thresholds" for water quality.	Complex administrative requirements to evaluate impacts of land development within WHPAs.
Regulatory: Subdivision Control			
Drainage Requirements	Used to ensure that subdivision road drainage is directed outside of WHPAs. Used to employ advanced engineering designs of subdivision roads within WHPAs.	Community adopts stringent subdivision rules and regulations to regulate road drainage/runoff in subdivisions within WHPAs.	Requires moderate level of inspection and enforcement by administrative staff.
Regulatory: Health Regulations			
Underground Fuel Storage System	Used to prohibit underground fuel storage systems (UST) within WHPAs. Used to regulate USTs within WHPAs.	Community adopts health/ zoning ordinance prohibiting USTs within WHPAs. Community adopts special permit or performance standards for use of USTs within WHPAs.	Prohibition of USTs requires little administrative support. Regulating USTs requires moderate amounts of administrative support for inspection followup and enforcement.
Privately Owned Wastewater Treatment Plants (Small Sewage Treatment Plants)	Used to prohibit Small Sewage Treatment Plants (SSTP) within WHPAs.	Community adopts health/ zoning ordinance within WHPAs. Community adopts special permit or performance standards for use of SSTPs within WHPAs.	Prohibition of SSTPs require little administrative support. Regulating SSTPs requires moderate amount of administrative support of inspection follow-up and enforcement.
Septic Cleaner Ban	Used to prohibit the application of certain solvent septic cleaners, a known ground water contaminant, within WHPAs.	Community adopts health/ zoning ordinance prohibiting the use of septic cleaners containing 1,1,1-Trichloroethane or other solvent compounds within WHPAs.	Difficult to enforce even with sufficient administrative support.
Septic System Upgrades	Used to require periodic inspection and upgrading of septic systems.	Community adopts health/ zoning ordinance requiring inspection and, if necessary, upgrading of septic systems on a time basis (e.g., every 2 years) or upon title/ property transfer.	Significant administrative resources required for this option.

	Applicability to Wellhead Protection	Land Use Practice	Administrative Considerations
Toxic and Hazardous Materials Handling Regulations	Used to ensure proper handling and disposal of toxic materials/waste.	Community adopts health/ zoning ordinance requiring registration and inspection of all businesses within WHPA using toxic/hazardous materials above certain quantities.	Requires administrative support and on-site inspections.
Private Well Protection	Used to protect private onsite water supply wells.	Community adopts health/ zoning ordinance to require permits for new private wells and to ensure appropriate well-to-septic-system setbacks. Also requires pump and water quality testing.	Requires administrative support and review of applications.
Non-Regulatory: Land Transfer and Voluntary Restrictions			
Sale/Donation	Land acquired by a community with WHPAs, either by purchase or donation. Provides broad protection to the ground water supply.	As non-regulatory technique, communities generally work in partnership with non-profit land conservation organizations.	There are few administrative requirements involved in accepting donations or sales of land from the private sector. Administrative requirements for maintenance of land accepted or purchased may be substantial, particularly if the community does not have a program for open space management.
Conservation Easements	Can be used to limit development within WHPAs.	Similar to sales/donations, conservation easements are generally obtained with the assistance of non-profit land conservation organization.	Same as above.
Limited Development	As the title implies, this technique limits development to portions of a land parcel outside of WHPAs.	Land developers work with community as part of a cluster/PUD to develop limited portions of a site and restrict other portions, particularly those within WHPAs.	Similar to those noted in cluster/PUD under zoning.
Non-Regulatory: Other			
Monitoring	Used to monitor ground water quality within WHPAs.	Communities establish ground water monitoring program within WHPA. Communities require developers within WHPAs to monitor ground water quality downgradient from their development.	Requires moderate administration staffing to ensure routine sampling and response if sampling indicates contamination.

	Applicability to Wellhead Protection	Land Use Practice	Administrative Considerations
Contingency Plans	Used to ensure appropriate response in cases of contaminant release or other emergencies within WHPA.	Community prepares a contingency plan involving wide range of municipal/ county officials.	Requires significant up-front planning to anticipate and be prepared for emergencies.
Hazardous Waste Collection	Used to reduce accumulation of hazardous materials within WHPAs and the community at large.	Communities, in cooperation with the state, regional planning commission, or other entity, sponsor a "hazardous waste collection day" several times per year.	Hazardous waste collection programs are generally sponsored by government agencies, but administered by a private contractor.
Public Education	Used to inform community residents of the connection between land use within WHPAs and drinking water quality.	Communities can employ a variety of public education techniques ranging from brochures detailing their WHPA program, to seminars, to involvement in events such as hazardous waste collection days.	Requires some degree of administrative support for programs such as brochure mailing to more intensive support for seminars and hazardous waste collection days.
Legislative:			
Regional WHPA Districts	Used to protect regional aquifer systems by establishing new legislative districts that often transcend existing corporate boundaries.	Requires state legislative action to create a new legislative authority.	Administrative requirements will vary depending on the goal of the regional district. Mapping of the regional WHPAs requires moderate administrative support, while creating land use controls within the WHPA will require significant administrative personnel and support.
Land Banking	Used to acquire and protect land within WHPAs.	Land banks are usually accomplished with a transfer tax established by state government empowering local government to impose a tax on the transfer of land from one party to another.	Land banks require significant administrative support if they are to function effectively.

Source: Jon Witten, *Wellhead Protection Program Workbook*, U.S. Environmental Protection Agency, September 1989.