

**STATE OF NEVADA**  
**WELLHEAD PROTECTION PROGRAM**



**STATE OF NEVADA**  
**DIVISION OF ENVIRONMENTAL PROTECTION**  
**BUREAU OF WATER POLLUTION CONTROL**

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Sixth Revision – with minor revision May 2007

**STATE OF NEVADA**  
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**GUIDE**

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## DISCLAIMER

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the State of Nevada. The Nevada Division of Environmental Protection (NDEP) believes that the models mentioned in this document may be very useful for wellhead protection program implementation, and NDEP utilizes several of these models. However, NDEP does not select, endorse, or approve their use over any other equivalent approach. Since various ground water modeling software packages are continually updated, improved, and re-released, there may be many models capable of facilitating wellhead protection area delineations.

## **I. INTRODUCTION**

This is the sixth revision to the “State of Nevada Wellhead Protection Program” guidance document. Revisions have been made to reflect program refinements. This document is based on the Nevada “Comprehensive State Ground Water Protection Program” (updated March 1998) developed by the Nevada Division of Environmental Protection (NDEP) and approved by the U.S. Environmental Protection Agency. Periodic revisions to this guidance document are made at the discretion of NDEP.

The Wellhead Protection Program for the State of Nevada is administered by the NDEP Bureau of Water Pollution Control (BWPC). The primary goal of the program is the protection of public drinking water supplies by the implementation of contaminant source control at the community level. It must be realized that it requires much less effort and money to protect drinking water supplies than to clean them once contamination has occurred.

This document is designed to provide guidance on the development and implementation of a Wellhead Protection Plan (WHPP). Sections III through XI provide guidance for the development of the seven elements of a WHPP. Section XII outlines the minimum requirements of a State endorsed / State funded WHPP. WHPPs that obtain State endorsement are a top priority to receive financial assistance for implementation and source management projects. Scientific terms are defined when used in this document. A glossary of hydro geologic terms can be found in Appendix A.

Drinking water for approximately 90% of Nevada's population is supplied by public water systems (PWSs). Ground water is utilized by approximately 90% of the PWSs. A PWS is defined as a system that has at least 15 service connections or regularly serves an average of at least 25 individuals daily with a minimum of 60 service days per year. As of April 2007, Nevada had 565 ground water-dependent PWSs. Of these 565 systems, 199 are classified as community systems (serving year-round residents), 102 are classified as non-transient/non-community systems (serves at least 25 individuals 6 months of the year, such as schools), and 264 are non-community systems (e.g. restaurants, parks).

Outreach activities by the State will target those public ground water supplies that appear most susceptible to contamination and which would affect the greatest population. In that context, ground water-dependent community water suppliers will be given first priority with respect to State outreach activities to encourage Wellhead Protection Plan development. Additionally, the State will prioritize requests for assistance based on the extent to which the proposed WHPP addresses the seven elements of a WHPP and meets the criteria for a State endorsable WHPP, in conjunction with an estimate of the vulnerability of the water supply.

## **II. PROGRAM BACKGROUND AND GOALS**

The Wellhead Protection Program is mandated by the Safe Drinking Water Act (SDWA) enacted in 1974 by the federal government to ensure safe public drinking water supplies and to protect underground sources of drinking water from contamination. These provisions for protecting ground water were strengthened by the 1986 Amendments (Section 1428) to the SDWA. These amendments mandate that each State develop a Wellhead Protection Program for the purpose of protecting ground

water that serves as a source for public drinking water supplies. Although the law specifies certain elements which must be addressed in a State's wellhead protection program, States are allowed the flexibility to develop programs that meet their particular needs. At the federal level, the requirements of the SDWA are administered by the U.S. Environmental Protection Agency.

The Nevada Wellhead Protection Program is one component of the Nevada Comprehensive State Ground Water Protection Program (CSGWPP). The purpose of the CSGWPP is to provide comprehensive protection for ground water within Nevada, through the coordination and integration of all State and federal agencies that manage ground water in Nevada.

### **III. SCOPE OF THE NEVADA WELLHEAD PROTECTION PROGRAM**

To fulfill the above goals and requirements, the State has outlined a multi-faceted, voluntary Wellhead Protection Program that is operative on both the State and local levels. The objective of the program is to develop guidelines that will facilitate community involvement in development of Wellhead Protection Plans (WHPPs), and provide technical assistance whenever possible.

It is Nevada's belief that effective WHPPs must be developed and administered by local government (e.g. county commission, city council, town board) in conjunction with the public water suppliers (public or private entities). A local WHPP should be a long-term commitment on the part of the community to protect its drinking water sources. Because the needs, abilities, and jurisdictional authorities vary among rural and populous communities, the State plan allows for flexibility in developing wellhead protection activities.

In accordance with EPA guidelines, a complete WHPP for both State and local levels will address the following seven minimum elements:

- Formation of a Wellhead Protection Team, and definition of the roles and responsibilities of the team and team members.
- Delineation of wellhead protection areas.
- Contaminant source inventories.
- Contaminant source management strategies.
- Plans for siting of new wells.
- Contingency planning.
- Public participation.

Each of these elements is discussed in detail in subsequent sections of this guidance document.

Because participation in Nevada's wellhead protection program is voluntary, the State does not have the authority to require plan development. However, the State can assist communities in all aspects of their wellhead protection activities. Section XII outlines the seven elements that a community WHPP must include in order to be endorsed by the State. Additionally, the State will prioritize requests for financial assistance based on the extent to which the proposed WHPP addresses the elements outlined in Section XII.

#### **IV. ELEMENTS OF A WELLHEAD PROTECTION PLAN**

The seven essential elements of a Wellhead Protection Plan (WHPP) are briefly described below.

WHPP Team formation and definition of roles and responsibilities - Suggestions regarding who should be involved in the Team and in local WHPP development and implementation are provided in Section V of this document. The Nevada Division of Environmental Protection (NDEP) will attempt to facilitate interaction between the local community and State or federal agencies when requested.

Delineation of wellhead protection areas (WHPAs) - General recommendations are contained in Section VI. Detailed guidance can be found in the “Wellhead Protection Area Delineation Recommendations” (NDEP, August 1995) available from NDEP (775-687-4670). NDEP can provide technical assistance in completing WHPA delineations.

Inventory of contamination sources - Guidelines for conducting contaminant source inventories on a community scale are outlined in Section VII. NDEP can aid in the development of inventory lists and survey forms that are appropriate for a specific community. General inventory check lists are available from NDEP.

Selection and implementation of contaminant source management strategies - Approaches to managing actual and potential sources of contamination within a wellhead protection area are discussed in Section VIII. A list of suggested management strategies is available from NDEP.

Plans for new well siting - Water rights, siting of new wells, and related drilling activities are regulated by the Nevada Division of Water Resources. Guidance with respect to the siting of new wells is provided in Section IX.

Contingency plans - Guidance for the development of contingency plans is provided in Section X.

Public participation - The State encourages public participation in all elements of community WHPPs. Recommendations for obtaining public participation are provided in Section XI.

#### **V. DEVELOPING A WELLHEAD PROTECTION PLAN**

The State Wellhead Protection Program is designed as a flexible program that will guide and facilitate Wellhead Protection Plan (WHPP) development at the local level. Any local government, public water supplier, or community organization may develop and initiate a WHPP. A complete community WHPP will address the following seven elements:

- Formation of a Wellhead Protection Team
- Delineation of wellhead protection areas (WHPAs).
- Contaminant source inventories.



- Contaminant source management strategies.
- Plans for siting of new wells.
- Contingency planning.
- Public participation.

A successful WHPP will necessitate involvement of a number of entities throughout the planning and implementation phases. The following activities are recommended to garner the participation and support of all jurisdictional authorities.

1. All governmental agencies with jurisdictional authority over land use must be identified.

- a. If the wellhead protection area (WHPA) is likely to overlap Federal, State, tribal, county, or city land, the WHP Team should secure the cooperation of the appropriate land manager.
- b. If a private organization or group of concerned citizens is initiating the WHPP, that group should first contact the appropriate local governing body (e.g. town board, city council, or county commission), and Federal land manager if applicable, to generate political support. Participation by a representative of the local governing body with authority over land use zoning is strongly encouraged: controlling the land use within WHPAs is the most powerful source management strategy.
- c. The cooperation of the appropriate authority / land owners must be secured before management of potential contaminant sources developed, adopted, and implemented. It is common that the public water system has the water rights, but does not own the land where the wells and wellhead protection area are located.

2. The WHPP should be developed by the WHPP Team.

- a. The wellhead protection goals for the community must be defined.
- b. WHPAs consistent with State guidelines, local protection goals and hydrogeologic information should be delineated.
- c. Base maps with information on well locations, delineated WHPAs, current and historical land use, the community or county master plan, and existing and proposed zoning designations should be assembled at a scale appropriate to the community size and complexity of data.
- d. Inventories of actual and potential sources of contamination within the WHPAs should be conducted and compiled on maps that are clear, accurate and consistent with base maps. These potential contaminant sources may be from historical, existing, or planned activities.
- e. Perceived risks to water supply should be evaluated.
- f. Appropriate management options for the WHPAs should be selected, developed and implemented with the cooperation of all involved and affected local, State, and Federal agencies.

4. Each agency represented on the WHPP Team should implement the aspects of the WHPP for which it has the delegated responsibility. For example, the public water supplier may be responsible for the contingency planning and new well siting elements, a private organization or group of concerned citizens may have responsibility for contaminant source inventories and public education, and the county and/or city may be responsible for other aspects of WHPA management.

If the State is providing financial assistance to a community or water system, the WHPP Team will be required to develop a complete WHPP that addresses the seven elements of a WHPP according to the requirements outlined in Section XII. The WHPP Team will also be required to provide financial accountability and progress reports to the State. However, if the State is not providing program funding, the NDEP Bureau of Water Pollution Control can still provide technical and programmatic assistance.

5. Sources of Ground Water and Wellhead Protection Information. There are many government and research agencies involved in ground water and wellhead protection. A list of some of these agencies and a brief description of their activities can be found in Appendix B.

## **VI. DELINEATION OF WELLHEAD PROTECTION AREAS**

A wellhead protection area (WHPA) is the area on the ground surface which must be managed in order to protect the ground water below. This area is delineated by defining the area around a well that contributes water to the well. Therefore, an understanding of the hydrogeology of the drinking water aquifer is helpful in the delineation of the WHPA.

This section provides an overview of Nevada hydrogeology, a description of the 6 wellhead protection area delineation methods, and guidelines for selecting and applying a delineation method. For a more detailed discussion of wellhead protection area delineation methods, contact the NDEP Bureau of Water Pollution Control for a copy of the “Wellhead Protection Area Delineation Recommendations” (NDEP, August 1995).

It should be noted that the concepts of wellhead protection should also be applied to springs that are utilized as drinking water sources. A spring protection area should be delineated using the guidelines for WHPA delineation. A potential contaminant source inventory should be completed for the spring protection area, and it should be managed in a manner similar to that for a WHPA. The spring should also be included in contingency plans. Since more wells than springs are utilized for drinking water supply in Nevada, the remainder of this guidance document will refer to wells. However, springs are also implied.

### **Nevada Hydrogeology**

Most of Nevada lies within the Basin and Range physiographic province, which is characterized by isolated, long, narrow, roughly parallel mountain ranges and broad, intervening, nearly flat valleys

and basins. Nevada has been divided into 14 major hydrographic regions that contain 256 hydrographic areas and sub areas.

Hydrogeologic conditions in Nevada vary according to the statewide distribution of three basic aquifer types: basin-fill, carbonate rock, and volcanic rock. The basin-fill aquifers supply most of the ground water currently withdrawn in Nevada. These aquifers consist of alluvial, colluvial, and lacustrine deposits, and are generally contained within closed basins. Some of the basin-fill aquifers in closed basins may contain naturally occurring, poor quality, saline waters. Basin-fill aquifers may or may not be hydraulically connected to aquifers in adjacent basins via inter-basin flow. An extensive carbonate rock terrain covers much of the eastern part of Nevada, and carbonates comprise much of the stratigraphy of the mountain ranges. A hydraulic connection between parallel basins has been documented in this terrain; flow is believed to be through the carbonate rock aquifers that separate the basins. Volcanic rock aquifers are located in several isolated sections of the State, but only a relatively small amount of ground water is withdrawn from them. Each of these aquifer types will have to be considered separately when delineating a WHPA.

## **Wellhead Protection Area Delineation Methods**

A WHPA should be conservative. It should include the surface and subsurface areas contributing water to the well. The goal is to provide protection from unexpected contaminant releases so that drinking water standards can be maintained at the well.

There are several criteria that may be used in the delineation of a WHPA. These criteria are physical features or parameters that need to be mapped, measured or calculated. Examples of criteria include time-of-travel for water from points in the aquifer to the well, distance from the well, and ground water flow boundaries. The values selected for these criteria are the thresholds. The selected criteria and thresholds will dictate the extent of the WHPA. For example, 3000 feet is a threshold that may be used with the distance criterion, and 10 years may be used with the time-of-travel criterion.

The criteria and thresholds utilized in WHPA delineation methods recommended by the U.S. EPA (“Guidelines for Delineation of Wellhead Protection Areas”, EPA, June, 1987) are briefly described below in order of increasing sophistication. State-endorsed plans must use Methods 4, 5, or 6 based on aquifer test, or equivalent, data.

1. The Arbitrary Fixed Radius Method uses the criterion of distance to define a circle of a specified radius around a well. The threshold distance, for the radius, should be selected based on typical aquifer and pumping conditions, which would result in a distance corresponding to a reasonable time-of-travel. While the use of the Arbitrary Fixed Radius Method is not preferred, it may be necessary in some cases. The State suggests that the method be used only as a preliminary WHPA delineation or as a last resort when sufficient data is not available for the use of any other method.

2. The Calculated Fixed Radius Method uses a specified time of travel threshold to define a radius around a well. An analytical equation is used to calculate the radius of the circle on the ground surface representing the water contributing to the well over a specified period of time.
3. The Simplified Variable Shapes Method uses analytic equations to define representative shapes by time of travel and flow boundary criteria for a particular aquifer. These shapes are then oriented with respect to the ambient ground water flow direction; shape size is determined by the quantity of water pumped from the well.
4. The Analytical Method uses a set of equations to define a time-related capture zone in an area having a sizable ambient ground water flow gradient. The equations consider hydrologic parameters specific to the area around the well.
5. Hydrogeologic Mapping uses flow boundary and time-of-travel criteria to define the area contributing water to the well. Geologic, geophysical, and dye tracing techniques may be utilized to determine flow boundaries such as ground water divides, impermeable structures and aquifer extent.
6. Numerical Flow and Transport Models are utilized by a number of computer programs that model ground water flow and solute transport. This method may be particularly useful in complex hydrologic situations, but requires a significant amount of detailed data and technical expertise.

### **Selection of a Wellhead Protection Area Delineation Method**

This section discusses State guidelines for selection of a WHPA delineation method. The WHPP Team is free to select any of these methods, or other methods that might better suit its needs. However, the delineation method selection must be based on sound technical rationale. Once WHPA delineations have been completed, they should be mapped on a scale that is clear, accurate and consistent with the land use and zoning maps for the community. It is requested that the WHPA maps be submitted to the NDEP Bureau of Water Pollution Control (BWPC). For a detailed discussion of WHPA delineation, the “Wellhead Protection Area Delineation Recommendations” (NDEP, August 1995) is available from the BWPC.

Each WHPA delineation portion of a Wellhead Protection Plan (WHPP) should include the following:

- \* A statement of the WHPA objectives, which may include definition of well/well field management areas or contaminant attenuation zones;
- \* The method, criteria, and threshold selected and the rationale for selection should be consistent with State guidelines;
- \* A summary of the WHPA delineation process;

- \* Community base maps depicting the WHPA.

When possible, a WHPA should be identical to the ground water capture zone of the well. Therefore, the ground water flow system around the well should be understood. It is recommended that regional and aquifer-specific information be considered. Hydrologic data may be obtained from sources listed in Appendix B.

The criterion, threshold, and method selected for delineating a WHPA must be appropriate for the hydrogeologic situation. For example, a shallow, unconfined aquifer is highly vulnerable to contamination originating at the ground surface. Therefore, WHPAs delineated for wells in this type of aquifer should be larger and more conservative. Municipalities may have certain constraints that must be considered when selecting a WHPA delineation method. These include limited finances, data availability, access to technical expertise, and complexity of the municipal supply and ground water systems. When possible, it is recommended that the most sophisticated method practicable be employed utilizing all available data. In this way, the most realistic and protective WHPA will be delineated.

Once the delineation method has been selected, the delineation criteria and thresholds must be evaluated and selected. Thresholds may vary depending on the contingency and management plans of a community. For example, one community may decide to protect a 5-year capture zone around its wells, while another may choose to protect the 10-year capture zone. Similarly, multiple time-of-travel capture zones may be delineated for a single well, with differential management applied in each capture zone. In other words, different management options would be implemented closer to the well than those implemented further from the well. For example, certain activities might be prohibited within the 5-year capture zone. However, those same activities might be permitted with the restriction of meeting specific performance standards within the area between the 5-year capture zone and the 10-year capture zone.

The BWPC recommends that, at a minimum, the WHPP Team delineate a WHPA of a 3000 foot area or a 10-year capture zone for shallow unconfined or semi-confined aquifers. In situations where the well is screened across multiple aquifers, one of which is an unconfined aquifer, the well should be considered to be in an unconfined aquifer.

For confined aquifers, a minimum WHPA of a 2500 foot radius or 10-year travel time capture zone is recommended. In addition to managing activities that could potentially contaminate the ground water within this WHPA, all wells either penetrating or reaching a depth close to the top of the confined aquifer should be surface-sealed or abandoned properly. [The State regulations governing the drilling, construction, and plugging of wells are found in Administrative Code (NAC) 534.280 - 534.450. A copy of these regulations is available from the State Division of Water Resources, (775) 897-4380]. In the case of a confined aquifer, the recharge area is often a large distance from the well. Therefore, a hydrogeologic study should be completed to determine the recharge area. The portion of the recharge area contributing water to the wells of interest should be identified. In this recharge area, a potential contaminant source inventory should be conducted, and management of potential threats to the water recharging the drinking water supply should be achieved. Contaminant source inventories and management strategies are discussed in Sections VII and VIII.

Fractured carbonate and bedrock aquifers must be considered differently. Water supplies from fractured rock aquifers may be particularly vulnerable to contamination because of high flow rates typical of fracture flow. Once contaminated, remediation is difficult and often ineffective in fractured rock aquifers. In addition, fracture flow directions and origins are often poorly understood. Currently, it is thought that a combination of hydrogeologic mapping and analytical or numerical methods might be appropriate for WHPA delineation in aquifers dominated by fracture flow. For more information, refer to the EPA technical assistance document entitled “Delineation of Wellhead Protection Areas in Fractured Rocks” (EPA, June 1991).

In some cases, it may be appropriate for a community to protect the entire aquifer from which its drinking water is pumped. For example, a community with many wells distributed throughout a relatively small hydrographic basin would benefit from this approach, termed aquifer protection. A hydrogeologic study must be completed to determine the extent of the aquifer as well as the recharge zones of the aquifer. Even though protective measures will be applied to the whole aquifer, it is suggested that WHPAs be delineated and differential management be applied. In addition, more protective management strategies might be implemented in the recharge zones of the aquifer.

## **VII. CONTAMINANT SOURCE INVENTORIES**

Once the wellhead protection area has been delineated, the actual and potential sources of ground water contamination within the area must be identified and managed to minimize the risk of contaminating the well. A sample listing of categories of potential contamination was developed by the EPA Office of Technology Assessment (OTA, “Protecting the Nation's Groundwater From Contamination”, October, 1984). It is important to address known soil and ground water contamination differently than potential sources, if actions have not started already upon review, contact NDEP to discuss necessary actions.

The categories are summarized as follows:

CATEGORY I - sources designed to discharge substances [for example, subsurface percolation (septic tanks), injection wells, floor drains not connected to the sanitary sewer system, land application].

CATEGORY II - sources designed to store, treat, and/or dispose of substances, with potential for discharge through unplanned releases (all types of landfills and disposal sites, surface impoundments, waste piles, non-waste stockpiles, above and below ground storage tanks, containers, graveyards, animal burial).

CATEGORY III - sources designed to retain substances during transport or transmission (pipelines, materials transport and transfer operations).

CATEGORY IV - sources discharging substances as a consequence of other planned activities [agricultural practices (irrigation, pesticide and fertilizer application, animal feeding operations), de-icing salts application, urban runoff, percolation of atmospheric pollutants, surface or underground mining or mine drainage].

CATEGORY V - sources providing conduits or inducing discharge through altered flow patterns (all types of exploration, production and monitoring wells, construction excavation).

CATEGORY VI - naturally occurring sources whose discharge is created and/or exacerbated by human activity (natural leaching, interaction between ground and surface water).

In addition to the items listed in the categories defined by EPA, any community conducting a contaminant source inventory for the purposes of wellhead protection should also consider the following actual and potential contaminant sources:

- Improperly abandoned wells of any type.
- Improperly sealed domestic, irrigation, or municipal wells.
- Filled or abandoned septic systems.
- Household gardening, lawn maintenance, non-commercial application of pesticides and fertilizers.
- Household hazardous wastes.

Although the potential sources outlined above do not represent a comprehensive list, they illustrate types of sources that should be considered in developing a contaminant source inventory. Standardized lists of potential contaminant sources have been extracted from various documents developed by EPA, and are available from the NDEP Bureau of Water Pollution Control.

Potential contaminant sources are often identified near public water supply wells as part of the Vulnerability Assessments conducted by the State Bureau of Safe Drinking Water and the public water systems in the State. Communities may use the Vulnerability Assessment data as a starting point for conducting their own inventory. If a Vulnerability Assessment has been conducted, the data is available from the Bureau of Safe Drinking Water.

### **Guidelines for Conducting Contaminant Source Inventories**

Check lists for conducting contaminant source inventories, and associated survey forms, are available through the NDEP Bureau of Water Pollution Control (BWPC). The BWPC can aid in the development of lists and survey forms which may be more appropriate to the specific community, as the concerns relevant to each public drinking water supply will vary between rural and populous communities.

Initial steps in conducting an inventory include a review of any documents that may indicate the location of current, historical, or proposed potential sources of contamination. Such documents may be telephone directories, business records (e.g. fuel oil deliveries), government records (State, county, municipal), historic records (defunct business activities, mine sites), and news articles. Additionally, land use data, assessors' maps and records, master plans, zoning maps, and aerial photographs may be useful. Information obtained through door-to-door, mail, or "windshield" surveys may also be useful, especially with respect to historical contamination. Any approach or combination of approaches chosen should

ensure that the inventories are complete and accurate, and that the information collected is properly located on a map. The map of the inventoried data should be at the same scale as the other maps developed, and should be easily overlain with maps of land use, zoning, and delineated wellhead protection areas.

The inventories should be updated regularly. The timing of each update will depend on the growth rate of the particular community. The responsibility for updating the inventories should be delegated to a specific member or members of the WHP Team (e.g. representative of city or county engineer, fire department, etc.).

For additional information, refer to the following documents published by the Office of Groundwater Protection, U.S. Environmental Protection Agency:

“Guide For Conducting Contaminant Source Inventories For Public Drinking Water Supplies” (EPA 570/9-91-014);

“A Review of Sources of Ground-Water Contamination From Light Industry” (EPA 440/6-90-005);

“Wellhead Protection Programs: Tools for Local Governments” (EPA 440/6-89002).

## **VIII. CONTAMINANT SOURCE MANAGEMENT STRATEGIES**

Following the delineation of wellhead protection areas (WHPAs) and the identification of actual and potential sources of contamination within them, an approach to managing those sources must be developed and implemented. The Bureau of Water Pollution Control (BWPC) recommends that a management plan be developed for all public water systems. However, because the degrees of need, financial resources, and control over land use activities vary by community, there is no model plan that can be followed uniformly. It is the responsibility of the Wellhead Protection Plan Team (WHPP Team) and the implementing agencies to assess the level of risk to the aquifer and the level of threat posed by various contaminant sources. Based on this evaluation, each community must balance the issues of potential threats, acceptable risk, and degree of management the community is willing to support. The WHPP Team will then define the levels of management that are deemed appropriate for the community's WHPAs. The protection employed will depend on the aquifer hydrogeology, and the resources available to the community.

Many types of industry, businesses, and land uses may have an impact on ground water quality. These activities must be identified before effective wellhead protection management options can be instituted. At a minimum, the WHPP Team should identify, locate, and map the past, present, and proposed operations that may represent a source of ground water contamination. The Team should also identify and map current and proposed land use zoning designations.

A variety of mechanisms are available to a local government for the management of contaminant sources within the WHPA. The following list is extracted from “Wellhead Protection Programs: Tools



for Local Governments” (Office of Groundwater Protection, U.S. EPA, April, 198, EPA 440/6-89002). Detailed explanations can be found in that publication.

1. Zoning Ordinances - Zoning ordinances typically are comprehensive land-use requirements designed to direct the development of an area where certain land uses may be restricted or regulated in WHPAs. Zoning ordinances are one of the most powerful tools for managing future contamination events that could impact ground water. WHPP Team participation from a representative of the local zoning authority is important.
2. Subdivision Ordinances - Subdivision ordinances are applied to land that is divided into four or more subunits for sale or development. The tool may be used for WHPAs in which ongoing development is a potential or current source of contamination, or there is inadequate well recharge.
3. Site Plan Review - Site plan reviews are regulations requiring developers to submit, for approval, plans for development occurring within a given area. This tool ensures compliance with regulations or other requirements made within a WHPA.
4. Design Standards - Design standards typically are regulations that apply to the design and construction of buildings or structures. This tool can be used to ensure that new buildings or structures placed within a WHPA are designed to minimize the potential for contaminant releases.
5. Operating Standards - Operating standards are regulations that apply to ongoing land-use activities to promote safety or environmental protection. Such standards can minimize the threat to the wellhead area from ongoing activities such as the application of agricultural pesticides or the storage and use of hazardous substances.
6. Source Prohibitions - Source prohibitions are regulations that prohibit the presence or use of chemicals or hazardous activities within a given area. Local governments have used restrictions on the storage or handling of large quantities of hazardous materials within a WHPA to reduce the threat of contamination.
7. Purchase of Property or Development Rights - This tool may be used to ensure complete control of land uses in or surrounding a WHPA. It may be preferred if regulatory restrictions on land use are not politically feasible and the land purchase is affordable.
8. Public Education - Public education often consists of brochures, pamphlets, or seminars designed to present wellhead issues and protection efforts to the public in an understandable fashion. This tool promotes the use of voluntary protection efforts and builds public support for a community's protection program.
9. Ground Water Monitoring - Ground water monitoring generally consists of sinking a series of test wells and developing an ongoing water quality testing program. This tool allows the Wellhead Protection Plan Team to monitor the quality of the ground water supply or the movement of a contaminant plume.

10. Household Hazardous Waste Collection - Residential hazardous waste management programs can reduce the quantity of household hazardous waste being disposed of improperly. These programs have been used in localities where disposal of household wastes in municipal landfills potentially threaten ground water.

Differential management, also termed phased management, may be implemented by utilizing corresponding multiple WHPAs and management zones. For example, a community may choose to delineate three zones around a well. Zone 1 would be a small WHPA (tens to hundreds of feet). The purpose of this smallest zone would be to prevent accidents and direct contamination of the spring collection area or the annulus of the well. Management options utilized within this zone might include source prohibitions. Zone 2 would be the next larger WHPA. Its purpose would be to allow sufficient time or distance from the wellhead for the reduction of concentration of most contaminants to levels below maximum contaminant levels (MCLs) before ground water reaches a well or spring. All sources of pathogenic microorganisms, such as septic tanks and drain-fields, should be excluded from this zone. Zone 3 would be the largest protection area delineated around a well. The purpose of this zone is to provide sufficient time for remediation or development of a new source of water if the drinking water aquifer becomes contaminated. Management options implemented in Zone 3 might include design standards, operating standards or ground water monitoring.

Land management strategies may be difficult to implement because of the potential for overlap among authorities for control of land use. This is of particular concern in Nevada, since approximately 85% of the land in Nevada is federally managed. This is most likely to affect management of WHPAs in rural communities where many public water supply wells are on land managed by the Bureau of Land Management. For this reason, the definition of jurisdictional authority at the outset of the WHPP, as outlined in Section V, is essential for effective implementation of management options. The NDEP Bureau of Water Pollution Control staff can provide assistance with land management and contaminant source control.

## **IX. CONTINGENCY PLANNING**

Even if a public water supplier/community chooses not to develop a Wellhead Protection Plan, the State of Nevada Administrative Code NAC 445A.66665 requires all water suppliers develop emergency/contingency plans that will detail the procedures to be followed in the event of water quality or quantity problems. The NAC requires this plan be submitted to the Bureau of Safe Drinking Water or the county health district office in which the public water system is located. It is expected the contingency plans developed for the various communities will differ depending on the size of the public water system and the population served, actual and perceived threats to the water supply, financial resources, and issues of local jurisdiction. With respect to contingency planning, the responsibility of the State Wellhead Protection Program is to provide guidance to local communities and public water suppliers. A more detailed discussion of contingency planning can be found in the "Guide To Ground-Water Supply Contingency Planning for Local And State Governments", Office of Ground Water Protection, U.S. EPA, May 1990 (EPA 440/690-003).

Elements to be included in a community or public water system contingency plan may address issues related to emergency response, rationing, decontamination, and source development.

Emergency Response Plans are short-term solutions to an immediate shut-down of supply, either due to quantity problems, response to contaminant threat, or natural disaster. Public water suppliers in Nevada work with the Nevada Division of Emergency Management (DEM) through county emergency management representatives if an emergency response is required. The DEM assists with short-term problems, such as spill response and coordinating the trucking of water to the afflicted community. However, the emergency response plans do not address the longer term problems presented by contaminated aquifers. The Nevada Emergency Response Commission may also be contacted for assistance with developing emergency response plans.

Rationing Plans should be outlined to ensure an adequate water supply in the event of water shortages due to drought, overuse, or contamination. A public water supplier or community may wish to define an "action level" in terms of water supply that would activate the Rationing Plan. The plan should identify all resources available to the water supplier, and may evaluate the following: alternate water supplies; emergency water supply equipment; communications systems; and technical and financial assistance. Additionally, conservation measures should be developed and implemented, as should public education initiatives and compliance actions.

Water Supply Decontamination Plans serve as an alternative to the abandonment of the drinking water source should a contamination event occur. Familiarity with potential sources of contamination in the wellhead protection area and the technology available to remediate contamination from each source will expedite action if an event occurs. If the water system management is familiar with remediation options and expenses, funding can be generated and dedicated in advance of a contamination event. This will also allow water managers to assess, in advance of an emergency, whether it is more appropriate for the community to remediate or to develop an alternate water supply.

Source Development Plans are important for any public water supply system, as existing supplies may become insufficient due to increased demand, water shortages, or contamination of supply. The information contained in Sections V through IX should be incorporated into any source development plan. Some suggestions for source development planning include:

- Estimate projected supply needs to determine when a new source will be needed.
- Identify undeveloped water sources that have potential for production and long-term water supply.
- Examine steps required to obtain water rights.
- Define protection areas around the proposed new well sites (see Sections VI and IX).
- Identify actual and potential sources of contamination in each proposed protection area (Section VII).
- Consider existing or proposed management options and degree of protection afforded for each new well site (Section VIII).
- Perform water quality studies to ensure that all parameters are below the Maximum Contaminant Levels for drinking water established by the Federal EPA.
- Evaluate financial needs and procure funding for water development projects.

## **Recommendations for Wellhead Protection Contingency Plans**

The State recommends all communities and public water suppliers develop contingency plans that address the topics listed below that may apply.

1. The purpose and relationship Contingency and Emergency Response Plans to the overall WHP Plan.
2. How and by whom the contingency plan was developed.
3. The relationship of the contingency plan to other state and local plans.
4. Identification of various duties and authorities, and the responsible person or position to carry out each duty.
5. Where, what, and how temporary alternate water supplies will be made available.
6. Identification of long-term water supply alternatives and related financial considerations.
7. Water supply disruption response procedures for aquifer contamination. A local contingency plan may include the initiation of specific actions to decrease contaminant concentrations after they have risen to a specific level but before they exceed Maximum Contaminant Levels for drinking water.
  - a. State, local and public water system (PWS) responsibilities for evaluation of monitoring, testing, and inspections.
  - b. State, local and PWS responsibilities during various types and phases of contamination events such as health threat assessment, short and long term containment and clean-up, public notification.
  - c. Public water system chain-of-command.
  - d. Contacts and telephone numbers for notification.
9. Water supply response procedures for disruption of service.
10. Background information on the water system such as system characteristics and potential sources of contamination or disruption.
11. A process for reviewing and updating the plan.

## **X. PLANS FOR NEW WELL SITING(S) AND PROTECTION OF THESE SITES**

Wellhead protection areas (WHPAs) should be delineated for all proposed wells and/or potential future well sites in the same manner as existing wells. If the local government or water system owns and/or controls the land of a future site, then protection and prevention measures should be put into place for these new “potential” well sites. Protection of the ground water at this site should not start after the well is constructed, it should start now. The only difference for these future sites from a plan for an existing well would be the delineations and potential contaminant source inventories will be completed prior to the construction of the wells. The WHPA delineation recommendations outlined in Section VI should also be followed for new wells. NDEP suggests placing these “protection areas” in the Wellhead Protection Plan and in any overlay districts with a note citing they are future sources of drinking water.

NDWR regulates the general construction of wells, but the construction of public water systems is overseen by the State Bureau of Safe Drinking Water, except in Clark and Washoe County where the County Health District has jurisdiction. Any construction or reconstruction of a public water system must be approved and permitted by a health officer, generally the Bureau of Safe Drinking Water (NAC 445A.65505-925). The horizontal distance from any possible source of pollution must be as great as practical, but no less than 150 feet. However, this distance is generally inadequate for good wellhead protection.

Proposals for new wells should be evaluated by the WHPP Team with respect to the guidelines for all of the WHPP elements. All new wells should also be incorporated into the WHPP. In addition, contingency plans should be modified to include new wells. Management practices being implemented at existing wells may be utilized for new wells or modified where appropriate.

Since a single well drawing water from more than one aquifer increases the vulnerability of the deeper aquifers, it is recommended that future wells not draw water from multiple aquifers. If it is necessary to draw water from multiple aquifers, it is recommended that the unconfined, or water table, aquifer not be utilized. This will take advantage of the natural protection provided by a confined system.

All new water wells and related drilling are regulated by the Nevada Division of Water Resources (NDWR) as specified in Nevada Administrative Code (NAC) 534.010 - 534.450. An Intent to Drill must be registered with NDWR prior to drilling and a permit must be obtained to drill or replace a water well within a water basin designated by the State Engineer. Since improperly constructed and sealed wells may act as conduits for contaminants to reach an aquifer, a seal around the well is required from the ground surface to a depth of 50 feet (NAC 534.380). Similarly, improperly abandoned wells may act as conduits for contaminants, and therefore, the plugging and abandonment of water wells is also regulated by NDWR (NAC 534.420 -534.427).

## **XI. PUBLIC PARTICIPATION**

Public participation is crucial to wellhead protection in Nevada since the programs must be initiated and implemented at the local level. The public can provide significant assistance in generating the momentum required to bring local programs to completion. Public participation may be in the form of a citizen advisory committee that would participate in the development of the program itself. Additionally, public participation may be encouraged in volunteer groups which would be a valuable asset in completing important tasks such as the inventory of actual and potential contaminant sources.

Successful wellhead protection in Nevada depends on the willingness of a community to regulate itself. Therefore, it is crucial that members of the community participate in the development and execution of the WHPP, either as active program leaders or as a result of educational outreach activities by the WHPP Team. It is the responsibility of the WHPP Team to create channels and opportunities for the public to communicate and contribute. In this way, barriers to successful WHPPs may be minimized, as the support of the community will be present at all phases of program development.

Ground water education activities are an importance part of a communities' wellhead protection program. A ground water presentation for the local public schools and professional organizations can be used year after year to raise the level of ground water awareness. Teach the community where their drinking water comes from, and how the water system works, and they will want to protect it!

## **XII. REQUIREMENTS OF STATE ENDORSED / STATE FUNDED WELLHEAD PROTECTION PLANS**

Below are the minimum *requirements* of both State endorsed and State financed Wellhead Protection Plans (WHPPs). WHPPs that receive State endorsement are a top priority for financial assistance for subsequent projects such as plan implementation and contaminant source management.

### **A. Formation of the Wellhead Protection Team**

1. Form the WHPP Team. Every effort should be made to include representatives of the public water system, city, county, state, and federal land managers, and a representative from the Nevada Division of Environmental Protection (NDEP). Representation from the local governing body with land use zoning authority (city and/or county) is strongly recommended.
2. Conduct meetings to outline the wellhead protection goals and define the responsibilities of each team member.
3. Prepare a WHPP Team member list with mailing addresses, telephone numbers, and name of lead contact person.

### **B. Delineation of Wellhead Protection Areas (WHPAs) and Recharge Areas**

1. A review and assessment of the Source Water Assessment Program (SWAP) report must be conducted as part of this task. The SWAP report may be obtained from NDEP Bureau of Safe Drinking Water.
2. Review references, well logs, pump test data, and available files (City, State, U.S.G.S.) and compile pertinent information and data for the wells, aquifers and springs.
3. The modular semi-analytical model (WHPA, US EPA, 1991), or equivalent model must be used to delineate the wellhead protection area(s).
4. Aquifer parameters to be used as model inputs must be derived from pump test data, or an equivalent approved by NDEP. A pump test is required for each general type of subsurface material screened by the water system wells (ie: basin-fill aquifer, carbonate rock aquifer, volcanic rock aquifer).
5. Outline the method, criteria, and threshold selected for the WHPAs and present the rationale for the selection. The final WHP Plan must include maps delineating the WHPAs. Maps must clearly and accurately depict these features at a scale that is consistent with the community's base maps.
6. In the text of the WHP Plan, identify the ground water recharge area(s) for the aquifer(s). In the appendix of the WHP Plan, include raw pump test data and field data sheets, and model assumptions and input data.

7. Discuss geologic and hydrogeologic susceptibility to contaminant infiltration in the WHPAs and the recharge areas
8. Prepare poster-sized print(s) of WHPA maps. Display the poster in water system offices. Distribute posters to community planning agencies for display and education.

C. Inventory of Contamination Sources

1. Perform an inventory of existing and potential contaminant sources within the WHPAs using available databases, such as records at the City, County, and State, and those observed during field activities. Listed sources should be ranked by estimated risk to ground water. **Begin by reviewing results from the SWAP report.**
2. Prepare a summary of data sources used to conduct contaminant source inventory.
3. Prepare a map or maps that depict existing or potential contaminant sources as well as land uses that may pose a potential threat. The scale of this map should be consistent with existing base maps and other maps being developed.
4. Prepare a map of current and proposed master plan and land use zoning designations.
5. Develop a schedule for updating contaminant source inventories, with the name, address and telephone number of the responsible WHPP Team member.

D. Selection and Implementation of Contaminant Source Management Strategies

1. Develop and document selected management strategies (both regulatory and non-regulatory) to be implemented for protecting WHPAs from potential contaminant sources including implementation schedule and rationale. Non-industrial zoning for WHPAs is strongly encouraged.
2. Compile documentation related to the management options, such as copies of proposed or enacted zoning changes, ordinances, design or operating standards, public education materials, etc.
3. Provide name, address and telephone number of the WHPP Team member responsible for source management and strategy revision, and a tentative revision schedule.
4. Prioritize and develop a schedule for implementing management strategies.

E. Contingency and Emergency Response Plans – The Plan must identify and prioritize short- and long-term threats to the system, develop response tailored to the specific situations, review resources available and/or needed, define response procedures and assign responsibilities. The short-term response procedures must:

1. Identify safe alternative sources of water and includes plan for water rationing, water supply decontamination, and emergency response. This section must fulfill the contingency plan requirements of Nevada Administrative Code 445A.66665.
2. List state and local response agencies and personnel, including contact information.
3. Outline activities for the restoration of services in the contingency that an emergency, including power failure, mechanical or electrical failure, natural or man-induced disaster, or water main breaks, reduces or threatens water supply.
4. Include the chain-of-command for personnel responsible for plan implementation. Identify staff responsible for implementing specific tasks, if available.

- F. Plans for New Well Siting – As part of the long-term Contingency Plan mentioned above, the following information must be included:
1. Prepare a map or maps depicting sites of future wells and their WHPAs.
  2. Document rationale for site selection.
  3. Identify resources needed to secure new site (if required)
  4. Develop tentative schedules for putting wells in use.
  5. Discuss plan for protection of the new site through various management strategies (WHPP development/implementation)
- G. Public Participation/Education
1. Propose public participation and education activities with implementation schedules. Development of a perennial groundwater presentation program for the community public schools is strongly encouraged.
- H. OPTIONAL/SUGGESTED ACTIVITIES:
1. Prepare mailings, advertisements and/or flyers for water users and businesses to encourage public participation and education.
  2. Develop wellhead protection messages to be included in water billings.
  3. Set appropriate wellhead protection signs at strategic locations.
  4. Present the WHPP at City Council meetings for assistance with land use zoning of WHPAs.
  5. Use State ground water protection logo and slogan: “Groundwater – protect it today, you may drink it tomorrow”. Logo and slogan available in electronic form from NDEP.



## Appendix A. GLOSSARY OF HYDROGEOLOGIC TERMS

**Aquifer.** A geologic formation, or group of formations, that contains water, and is capable of conducting useable amounts of water to wells and springs.

**Attenuation.** The decrease of contaminant concentration in ground water, through filtration, biodegradation, dilution, sorption, volatilization, and other processes.

**Basin-fill aquifer.** An aquifer located in a basin surrounded by mountains and composed of sediments and debris shed from those mountains (sediments are often predominantly sand and gravel with some clay).

**Bedrock.** A general term for solid rock that lies underneath soil and loose sediments.

**Capture zone.** The zone around a well contributing water to the well; the area on the ground surface from and beneath which a well captures water.

**Carbonate rock.** A rock consisting dominantly of calcium or magnesium carbonate minerals, such as limestone or dolomite.

**Confined aquifer.** An aquifer that is bounded above and below by geologic units of much lower permeability than the aquifer material, and is under pressure significantly greater than atmospheric.

**Contaminant.** An undesirable substance not normally present, or an undesirably high concentration of a naturally occurring substance.

**Criteria, WHPA.** Conceptual standards that form the basis for WHPA delineation. WHPA criteria can include distance, time of travel, and flow boundaries.

**Flow boundaries.** Anything which inhibits ground water flow, such as a ground water divide or an impermeable geologic unit.

**Fractured bedrock aquifer.** An aquifer composed of solid rock where most water flows through cracks and fractures in the rock instead of through pores. Flow through fractured rock is typically relatively fast.

**Ground water divide.** A ridge in the water table from which ground water moves away.

**Hydraulic gradient.** The change in hydraulic head (or pressure) with a change in distance in a given direction. Also used to describe the direction of slope of the water table.

**Hydrogeologic.** Relating to subsurface water, the geologic units through which subsurface water flows; also, relating to geologic aspects of surface water.

**Hydrologic.** Relating to the study of water in natural systems.

**Hydrographic.** A region or area defined by stream drainage boundaries.

**Impermeable.** Unable to transmit water.

**Permeability.** The ability of a geologic formation to transmit fluids.

**Recharge area.** The land surface area that allows water to percolate down through the soil and loose sediments to an aquifer.

**Saline/poor quality aquifer.** An aquifer containing water that is high in total dissolved solids, and is unacceptable for use as drinking water.

**Saturated thickness.** The thickness of the portion of the aquifer in which all pores, or voids, are filled with water. In a confined aquifer, generally the aquifer thickness. In an unconfined aquifer, the distance between the water table and the base of the aquifer.

**Semi-confined.** Conditions in which at least one of the bounding units of an aquifer conducts some measurable amount of water into or out of the aquifer.

**Solute transport.** The movement of dissolved substances through hydrogeologic units.

**Threshold, WHPA.** The value assigned to a criterion used to define the extent of the WHPA. For example, a 5-year threshold for a time of travel criterion.

**Time-of-travel.** The time required for a water molecule or contaminant to move through an aquifer from a specific point to a well.

**Transmissivity.** The rate at which water is capable of flowing through a particular geologic formation.

**Unconfined.** Conditions in which the upper surface of the aquifer is at atmospheric pressure and is expressed as a water table.

**Volcanic rock aquifer.** An aquifer composed of rock that originated from a volcano, such as basalt. This type of rock may or may not be very permeable.

**Water table.** The top surface of an unconfined aquifer above which pores, or voids, are filled with air at atmospheric pressure.

**WHPA (wellhead protection area).** The surface and subsurface area surrounding a well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field.

## **Appendix B. SOURCES OF GROUND WATER AND WELLHEAD PROTECTION INFORMATION**

**County Health Departments** - Often are the lead agency for emergency response. May have regulatory authority regarding public water systems and permitting.

**Desert Research Institute** - A source of water quality studies and general hydrogeologic information.

**Federal Emergency Management Agency (FEMA)** - A source of emergency management plans and public education about hazardous materials.

**Local Emergency Planning Agencies** - Emergency management and contingency plans, spill reporting and contaminant source identification.

**Nevada Department of Agriculture (DOA)** - The State office that administers the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The DOA's primary responsibility is to regulate the registration, use, storage, transportation and disposal of canceled and suspended pesticides. A State Management Plan for pesticides is being developed with the goal of protecting ground water from pollution.

### **Nevada Department of Conservation and Natural Resources**

**Division of Environmental Protection (NDEP)** - Part of the Department of Conservation and Natural Resources, NDEP is the State's lead agency for ground water protection in Nevada. It is the primary regulatory agency responsible for environmental permitting and enforcement activities in the State.

**Bureau of Safe Drinking Water (BSDW)** within NDEP— has primary enforcement authority for the supervision of public drinking water systems as authorized under the Federal Safe Drinking Water Act. BSDW is responsible for the monitoring and regulation of public drinking water systems, as well as the permitting of all individual domestic waste disposal (septic) systems throughout the State, with the exception of Washoe and Clark counties.

**Division of Water Resources – Water Planning Section** - Part of the Department of Conservation and Natural Resources, the Water Planning Section is a resource for information on water supply issues and general hydrogeologic data.

**Nevada Department of Military, Division of Emergency Management** - A State resource for emergency management and contingency planning.

**Nevada Emergency Response Commission** - A State agency providing Superfund Amendment and Reauthorization Act (SARA) chemical inventory databases, and contingency planning assistance.

**Regional and local planning agencies** - Resources for land use plans, master plans, zoning maps, siting of new facilities.

## **University of Nevada**

**Cooperative Extension** - Educational material, assistance with public education and public participation.

**Harry Reid Center for Environmental Research** - General information on geothermal resources.

**Nevada Library System** - Data pertaining to regional and site-specific geologic, hydrologic, soils, and engineering studies, as well as general hydrogeologic information.

**Nevada Emergency Response Commission** - Superfund Amendment and Reauthorization Act (SARA) chemical inventory databases, and contingency planning; information related to pesticide management, livestock waste management, assistance to ranchers and farmers with environmental protection practices.

## **U.S. Department of Agriculture**

**Forest Service** - May have primacy in land use regulation, access to contaminant source, hydrogeologic, and land use information.

**Intermountain Forest and Range Experiment Station** - Technical assistance with water quality data collection and analysis, especially for forested areas, or areas undergoing reforestation.

**Soil Conservation Service** - Maps, data relating to aquifer vulnerability, including soil, vegetation, and land use capabilities.

## **U.S. Department of the Interior**

**Bureau of Indian Affairs** - Information on management and use of tribal lands.

**Bureau of Land Management** - May have primacy in land use regulation, access to contaminant source, hydrogeologic, or land use information.

**Bureau of Mines** - Geologic information related to mineral resources, mining operations and closure.

**Bureau of Reclamation** - Water resources and water quality information related to BOR projects including the Newlands Project and various BOR dams and reservoirs.

**Geological Survey** - Water quality studies, general hydrogeologic information, ground water monitoring data.

**National Park Service** - May have primacy in land use regulation, access to contaminant source and land use information.

**U.S. Environmental Protection Agency, Region IX** - General information, financial support, technical assistance, public education and outreach.

**U.S. Public Health Service, Indian Health Service** - Information on public drinking water supplies on tribal lands, historic land uses and related potential contaminant sources.