

***Big Hole National Battlefield***  
**Public Water System**  
(PWS # MT 0001271)

***Source Water Assessment***

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# Table of Contents

<b>EXECUTIVE SUMMARY .....</b>	<b>I</b>
<b>INTRODUCTION.....</b>	<b>1</b>
PURPOSE.....	1
LIMITATIONS.....	1
<b>BACKGROUND .....</b>	<b>2</b>
THE COMMUNITY.....	2
GEOGRAPHIC SETTING .....	2
CLIMATE.....	2
GEOLOGIC AND HYDROGEOLOGIC SETTING.....	3
GENERAL DESCRIPTION OF THE SOURCE WATER .....	3
PUBLIC WATER SUPPLY .....	4
WATER QUALITY.....	4
<b>DELINEATION .....</b>	<b>5</b>
CONCEPTUAL MODEL AND ASSUMPTIONS .....	5
DELINEATION.....	5
LIMITING FACTORS .....	5
<b>INVENTORY .....</b>	<b>6</b>
INVENTORY METHOD .....	6
CONTROL ZONE INVENTORY RESULTS .....	7
INVENTORY REGION RESULTS.....	7
RECHARGE REGION INVENTORY RESULTS .....	8
INVENTORY UPDATE .....	8
INVENTORY LIMITATIONS .....	8
<b>SUSCEPTIBILITY ASSESSMENT .....</b>	<b>9</b>
HAZARD DETERMINATION.....	9
DISCUSSION OF SUSCEPTIBILITY .....	9
MANAGEMENT RECOMMENDATIONS.....	9
<b>REFERENCES.....</b>	<b>1</b>
<b>GLOSSARY.....</b>	<b>1</b>

## TABLES

TABLE 1. PERIOD OF RECORD MONTHLY CLIMATE SUMMARY WISDOM CLIMATE STATION .....	2
TABLE 2. SUMMARY OF POTENTIAL CONTAMINANT SOURCES IN THE INVENTORY REGION. 7	
TABLE 3. SUSCEPTIBILITY ASSESSMENT OF SIGNIFICANT POTENTIAL CONTAMINANT SOURCES.....	1

## Figures

[Figure 1. Vicinity Map and Well Locations](#)

[Figure 2. Geology of the Area](#)

[Figure 3. Land Use and Potential Sources of Contamination in the Protection Areas](#)

[Figure 4. Onsite Protection Area and Sources of Potential Contamination](#)

**Appendices**

APPENDIX A – Well Log

APPENDIX B – Concurrence Letter

## EXECUTIVE SUMMARY

This Source Water Delineation and Assessment Report (SWDAR) was prepared under the requirements and guidance of the Federal Safe Drinking Water Act and the US Environmental Protection Agency, as well as a detailed Source Water Assessment Plan developed by a statewide citizen's advisory committee here in Montana. The Department of Environmental Quality (DEQ) is conducting these assessments for all public water systems in Montana. The purpose is to provide information so that the public water system staff/operator, consumers, and community citizens can begin developing strategies to protect your source of drinking water. The information that is provided includes the identification of the area most critical to maintaining safe drinking water, i.e., the Inventory Region, an inventory of potential sources of contamination within this area, and an assessment of the relative threat that these potential sources pose to the water system.

As part of this assessment, three types of source water protection management areas were mapped for the Big Hole National Battlefield public water system. They are: the control zone, the inventory region, and the recharge region. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- Significant potential contaminant sources identified within the control zone include: the Onan generator. The control zone is delineated as a 100-foot radius around the well and all sources of significant potential contaminants should be excluded in this region.
- Significant potential contaminant sources identified within the inventory region include: sewage lines, lagoons, and grazing cattle. The inventory region should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. The inventory region was delineated based on a one mile radius around the wellhead.
- Potential contaminant sources identified within the recharge region include: Agricultural land. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage.

The Big Hole National Battlefield public water supply has a high susceptibility to the following potential contaminant sources: onsite sewage systems and low risk from the cattle. This provides a quick look at the existing potential sources of contamination that could, if improperly managed or released, impact the source water for Big Hole National Battlefield. The susceptibility analysis provides the community and the public water system with information on where the greatest risk occurs and where to focus resources for protection of this valuable drinking water resource.

The costs associated with contaminated drinking water are high, and prevention is preferable to treatment. Public awareness is a powerful tool for protecting drinking water. The information in this report will help increase public awareness about the relationship between land use activities and drinking water quality.

# INTRODUCTION

This Source Water Delineation and Assessment Report (SWDAR) was prepared for the Big Hole National Battlefield Public Water Supply (PWS) located in Beaverhead County. It was completed by Joe Meek of the Source Water Protection Program at the Department of Environmental Quality (DEQ) and intern Bethany Haines.

## PURPOSE

The primary purpose of this source water delineation and assessment report is to provide information that helps the Big Hole National Battlefield protect its drinking water sources. A major component of the Montana Source Water Protection Program is '*delineation and assessment*'. Delineation is the process of identifying areas that contribute water to aquifers or surface water bodies used as drinking water supplies. The delineated areas are referred to as source water protection areas. Assessment involves identifying and inventorying potential sources of contamination within the source water protection areas, and then determining the potential for contamination of drinking water by these sources. This report is intended to meet the technical requirements for the completion of a source water delineation and assessment report for the Big Hole National Battlefield public water system, as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (Public Law 104-182). The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protect public drinking water supplies from contamination.

## LIMITATIONS

This report was prepared to assess threats to Big Hole National Battlefield's public water supply, and is based on published information. The terms '*drinking water supply*' or '*drinking water source*' refer specifically to the source of the Big Hole National Battlefield public water supply, and not to any other public or private water supply. Also, not all potential or existing sources of groundwater or surface water contamination in the vicinity of the Big Hole National Battlefield public water supply are identified. Potential sources of contamination are considered only in areas that contribute water to the source of the public water supply.

The term '*contaminant*' is used in this report to refer to constituents for which maximum concentration levels (MCLs) have been specified under the national primary drinking water standards, and to certain constituents that do not have MCLs but are considered to potentially represent health threats.

# CHAPTER 1 BACKGROUND

## THE COMMUNITY

Big Hole National Battlefield is part of the Nez Perce National History Park. It is a memorial to the Nez Perce that camped for several days along the North Fork of the Big Hole River and fought the US Army in 1877. The site contains a visitor center that houses a small museum with exhibits from the Nez Perce and US military. The road to the actual battlefield is closed in late autumn due to snow. The visitor center remains open daily, and the battlefield is accessible to skiers or snowshoers. The road normally reopens in late April, but the exact date of reopening is weather dependent. There is no food service at the Battlefield. Big Hole National Battlefield is located ten miles west of Wisdom, Montana on state highway 43. The Big Hole National Battlefield public water supply provides water through two service connections that serve a few onsite homes and the visitor center for 100 transient persons, 7 workers, and 12 residential staff persons. Wastewater from Big Hole National Battlefield is handled by a sewage ponds located southwest of the well. About 60,000 visitors per year: highest June through September; lowest November through January.

## GEOGRAPHIC SETTING

The Big Hole National Battlefield is located in the Big Hole basin. The basin is a wide, high-altitude valley nearly surrounded by mountains – The Beaverhead Mountains to the west and Southwest, the Pioneer Mountains to the east, and the Anaconda Range to the north and northwest and the Big Hole Divide to the South (Kendy & Tresch, 1996). Big Hole National Battlefield is located in the Big Hole Watershed, U.S. Geological Survey (USGS) hydrologic unit code (HUC) No.10020004, which is located within the Upper Missouri River Watershed Management Region for Montana. The Big Hole Watershed extends from the Idaho Montana state border to follow the Big Hole River.

## CLIMATE

The climate of Big Hole Basin is typical of higher-elevation intermontane basins in southwestern Montana, with very cold, dry winters and mild summers. Based on climate data from the closest weather station located in Wisdom Montana (249067) the average maximum and minimum temperatures in this area are 78.3° F and 37.5° F in July and 26.6° F and 1.8° F in January. Annual total precipitation averages 11.82 inches. Rainfall occurs April through September with May and June being the wettest months. An annual average of 57.2 inches of snow is received in this area mainly November to April. See Table 1 for additional climate information.

**Table 1. Period of Record Monthly Climate Summary Wisdom Climate Station  
Wisdom (249067) 7/1/1948 to 6/30/2004**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	26.6	31.1	38.0	48.6	59.4	68.2	78.3	77.2	66.9	54.5	37.3	27.7	51.2
Average Min. Temperature (F)	1.8	3.7	10.4	20.8	28.6	35.8	37.5	34.4	27.3	20.4	12.2	3.5	19.7
Average Total Precipitation (in.)	0.69	0.52	0.69	0.92	1.66	1.90	1.09	1.08	0.97	0.77	0.77	0.76	11.81
Average Total Snow Fall (in.)	12.8	8.4	8.1	3.8	2.4	0.6	0.0	0.0	0.3	1.6	7.8	11.3	57.2
Average Snow Depth (in.)	9	10	8	1	0	0	0	0	0	0	1	5	3

Taken from Western Regional Climate Center, [wrcc@dri.edu](http://wrcc@dri.edu)

## **GEOLOGIC AND HYDROGEOLOGIC SETTING**

This section provides an overview of the geology and hydrology of the Big Hole National Battlefield area. The Big Hole basin is a partly glaciated, intermountain valley situated in southwestern Montana. The Big Hole River and its tributaries provide the primary source of water for ditch irrigation of abundant pasturelands in the basin (Levings, 1986). Nearly all domestic and stock wells obtain water from Tertiary and Quaternary sedimentary rocks underlying the valley floor. An adequate supply of the water for domestic-and stock-watering needs is generally available within the top 125 feet of the sedimentary basin and aquifer system, which may have as much as 1,000 feet thick (Levings, 1986).

Tertiary sediments crop out of pediments at the bases of the Anaconda Range and Pioneer Mountains. Glacial deposits mostly cover Tertiary sediments along the Beaverhead Mountain front. Tertiary sediments that fill the Big Hole Basin belong to the Renova Formation and the overlying Sixmile Creek Formation. Quaternary glacial deposits, including glacial till and glacial outwash, mantle Tertiary sediments along the western basin margin. Glacial till crops out as dissected terminal moraines overlying pediment gravels, and consists of the central basin are deposits of glacial outwash as much as 100 feet thick (Kendy & Tresch, 1996).

## **GENERAL DESCRIPTION OF THE SOURCE WATER**

Groundwater, apparently derived from Tertiary sediments, is the source of drinking water for the PWS ([Figure 2](#)). Groundwater in Tertiary sediments within the Big Hole Basin likely range unconfined to confined. For the purposes of this report, the aquifer is conservatively assumed to unconfined with a high sensitivity.

## **PUBLIC WATER SUPPLY**

The Big Hole National Battlefield serves a population of 19 employees, 12 of which reside in houses south of the visitor center. The Big Hole National Battlefield is classified as a non-transient non-community public water supply because of the nature of the population served. Water demand is approximately 2,805 gallons per day assuming 15 gallons per day per employee, 100 gallons per day per residing employees, 15 gallons per day per transient user (EPA, 1991).

The 2003 sanitary survey indicates the Big Hole National Battlefield has a single well. The well was drilled in 1965 to a depth of 250 feet below ground surface (bgs). The static water level is 76.67 feet bgs. The well lithology indicates the subsurface is made up of layers of unconsolidated gravel, sandstone, quartzite, sand, and clay. The well has a steel casing to a depth 250 feet bgs and is perforated from 200 to 245 feet bgs. The well log is in Appendix A. The well is located outside the east side of the visitor center. The single well pumps water into a 50,000 gallon buried storage tank. The water is disinfected through a hypochlorinator (uses household bleach) as it enters the storage facility. The system is pressurized by a 0-80 gpm variable frequency drive submersible pump that takes suction from the underground storage. A line shaft turbine pump with a capacity of 200 gpm is also available to provide some level of fire flow capacity. The system provides water to a few on-site homes and the visitor center.

## **WATER QUALITY**

Every PWS is required to perform regular sampling of their water supply to detect any contamination. The analytical parameters include: coliform bacteria and other pathogenic organisms, nitrates, metals, petroleum hydrocarbons, and other organic chemicals. The monitoring schedule depends on factors such as the size and source water of a PWS, the number of supplies (e.g. wells), and the population served. Each PWS has a specific monitoring program tailored to their system that follows the general protocols defined by DEQ for operation of a PWS. PWS monitoring schedules are available at: <http://nris.state.mt.us/wis/swap/swapquery.asp>.

The Big Hole National Battlefield PWS is routinely monitored for compliance with drinking water standards. Bacteriological monitoring occurs monthly. Nitrate can come from human or animal wastes but also occurs naturally. The highest level of nitrate-nitrogen detected in the Big Hole National Battlefield well in the last five years was 1.2 mg/l. The U.S. Environmental Protection Agency standard for maximum allowable nitrates is 10 mg/l. The PWS has tested free of coliform bacteria for the last five years (DEQ, BAC-T, 2001).

## CHAPTER 2 DELINEATION

This report delineates three source water management areas. The goal of source water management is protecting the source water by 1) controlling activities in the control zone, 2) managing significant potential contaminant sources in the inventory region, and 3) ensuring that major land use activities or other significant activities in the recharge region pose minimal threat to the source water.

### CONCEPTUAL MODEL AND ASSUMPTIONS

The Big Hole National Battlefield's well is drilled into semi-confined Tertiary sediments. The direction of groundwater flow beneath the site is presumed to be from the southeast towards the northwest along Big Hole River. The aquifer is conservatively treated as unconfined for the purposes of this report and recharge to the wells is primarily from infiltration of surface water and precipitation through the overlying sand and gravel.

The is considered to have **Moderate Source Water Sensitivity** to contamination. Sensitivity is defined as the degree of ease with which contaminants may migrate to the source water aquifer. This determination is according to the DEQ Source Water Protection Program criteria for ranking aquifer sensitivity (DEQ 1999).

### DELINEATION

Methods and criteria for delineating source water protection areas are specified in the Montana Source Water Protection Program (DEQ, 1999). The delineated management zones for the wells are shown on [Figure 3](#).

*Control Zone* – A 100-foot radius control zone is delineated for Big Hole National Battlefield's wells. All sources of potential significant contaminants should be excluded in this region.

*Inventory Region* – The method was modified from DEQ's Source Water Protection Program criteria for semi-confined non-transient non-community water systems PWS (DEQ, 1999); the inventory zone was delineated based on a one-mile radius circle around the well. This method was used due to the uncertain nature of ground water flow in the semi-confined aquifer and the relatively rural nature of the setting. All sources of potential contaminants are inventoried in this region.

*Recharge Region* –The recharge region for the Big Hole National Battlefield wells includes Jefferson River Valley material upgradient (northwest) of the PWS wells. The upgradient extent of the recharge region was limited to approximately the peaks of the nearby subbasin watershed. The goal of management in the recharge region is to maintain and improve the long-term quality of groundwater in the aquifer.

### LIMITING FACTORS

Delineation of the source water protection areas for the Big Hole National Battlefield PWS well is based on a simplified approach. The interaction of surface water with the bedrock aquifer is not understood and the changes in the flow regime under seasonal conditions are not known. The delineation was completed using conservative assumptions to help ensure that the inventory zone reflects the actual area where contamination to the system may occur.

## CHAPTER 3 INVENTORY

### INVENTORY METHOD

Significant potential contaminant sources in the source water management areas were inventoried to assess the susceptibility of Big Hole National Battlefield's proposed well to contamination, and to provide a foundation for source water protection planning. The inventory for Big Hole National Battlefield focuses on facilities or features that generate, use, store, or transport potential contaminants, as well as certain land uses in the inventory and recharge regions. It is important to remember that the sites and areas identified in this section are only potential sources of contamination to the drinking water. Contamination of drinking water sources is less likely when potential contaminants are properly used and managed.

The inventory focus is slightly different in each of the delineated management areas. The inventory for Big Hole National Battlefield focuses on all activities in the control zones for the well; certain types of facilities and land uses in the inventory region; and general land uses and large facilities in the Recharge Region. Information on facilities and land uses that are potential sources of regulated contaminants was obtained from a number of databases, described below. The process for completing the inventory included several steps, which are summarized as follows:

Step 1: Urban and agricultural land uses were identified from the U.S. Geological Survey's (USGS) Geographic Information Retrieval and Analysis System <<http://nris.state.mt.us/gis/datalist.html>>. Sewered and unsewered residential land uses were identified from boundaries of sewer coverage obtained from municipal wastewater utilities.

Step 2: The US Environmental Protection Agency's (EPA) Envirofacts System <<http://www.epa.gov/enviro/>> was queried to identify EPA-regulated facilities located in the management areas. This system accesses facilities listed in the following databases: Resource Conservation and Recovery Information System (RCRIS), Biennial Reporting System (BRS), Toxic Release Inventory (TRI), and Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) and the Permit Compliance System (PCS - for Concentrated Animal Feeding Operations with MPDES permits). The available reports were browsed for facility information including the Handler/Facility Classification to be used in assessing whether a facility should be classified as a significant potential contaminant source.

Step 3: Montana DEQ databases were queried to identify any of the following in the management areas:

- Underground storage tanks (USTs) <<http://www.deq.state.mt.us/UST/USTDownloads.asp>>
- Hazardous waste contaminated sites, above ground storage tanks (ASTs), landfills, and abandoned and active mines, including gravel pits <<http://nris.state.mt.us/gis/bundler/>>

Any information on past releases and present compliance status was noted.

Step 4: Major road and rail transportation routes were identified throughout the inventory region: <<http://nris.state.mt.us/gis/gisdata/lib/gisDataList.aspx>>.

Potential contaminant sources are designated to be significant if they fall into one or more of the following categories:

1. Large quantity hazardous waste generators.
2. Landfills.
3. Underground storage tanks.
4. Known groundwater contamination (including open or closed hazardous waste sites, state or federal Superfund sites, and leaking UST sites).
5. Underground injection well.
6. Major roads or rail transportation routes.
7. Cultivated cropland exceeding 20% of the inventory region.
8. Animal feeding operations.
9. Wastewater treatment facilities, sludge handling sites, or land application areas.
10. Septic systems.
11. Sewer mains.
12. Storm sewer outflows.
13. Abandoned or active mines

## CONTROL ZONE INVENTORY RESULTS

The control zone includes a back-up power supply (Onan generator) and associated fuel tank. The fuel supply for the generator is a potential source of contamination if there would be a fuel spill or leak. A provision for secondary containment that would capture a potential fuel spill would amend the problem.

Fields used for cattle grazing surround the Big Hole National Battlefield. Improper storage and management of animal wastes may impact drinking water supplies especially if the animals have access to the control zone. The well has a protective enclosure around the wellhead and a fence around the area; livestock is not considered a risk to the drinking water. The PWS should be vigilant to ensure that potential sources of contamination are excluded from the control zone and that positive drainage away from the well casing is maintained.

## INVENTORY REGION RESULTS

The inventory results for Big Hole National Battlefield's source water are summarized in Table 2 and are shown on [Figure 3](#). Big Hole National Battlefield utilizes at sewage lagoons that are west of the houses. The sewage lines and lagoons are a potential source of contamination if a break or leak were to occur.

Land uses within the inventory region include primarily undeveloped grassland. Septic system density within the inventory region is low and is not considered a risk to the PWS drinking water at this time. Additional point sources of potential pollutants (such as businesses or facilities listed on regulatory databases) were not identified in the inventory region.

**Table 2. Summary of Potential Contaminant Sources in the Inventory Region**

<i>Source Type</i>	<i>Potential Contaminants</i>	<i>Description/Concern</i>
<b>Land Use Cover (Step 1)</b>		
On site sewage system	Ongoing or catastrophic leakage of sewage into groundwater	If not properly designed, installed, and maintained, sewage lines can be a point source of effluent in groundwater.
<b>EPA Envirofacts Sites (Step 2)</b>		
None Identified		
<b>DEQ Databases (Step 3)</b>		
None Identified		
<b>Miscellaneous Others, including Step 4</b>		
Onan Generator	Leaching into groundwater	If a spill were to occur the fuel could impact ground water

Notes: Individual sites identified are evaluated in Chapter 4.

## **RECHARGE REGION INVENTORY RESULTS**

According to the 1992 National Land Cover dataset, the primary land uses in the recharge region are grassland, and agricultural. The percentage of agricultural land is considered a low risk to the drinking water supply. Grasslands are not considered potential sources of contamination unless there are significant grazing operations in the area. Additional sources of potential pollutions (such as businesses or facilities listed on regulatory databases) were not identified in the recharge region.

## **INVENTORY UPDATE**

To make this SWDAR a useful document for the years to come, the certified water system operator should review the inventory every year. Changes in land uses or potential contaminant sources should be noted and additions made as appropriate. The complete inventory should be submitted to DEQ every five years to ensure the source water delineation and assessment remains current.

## **INVENTORY LIMITATIONS**

This Source Water Delineation and Assessment Report is intended to meet the technical requirements for delineation and assessment as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 [U.S. Code Title 42, Chapter 6A, Subchapter XII, Part E, § 300j-13-(a) Source Water Assessment]. The following limitations should be noted:

- Not every source of contamination to the PWS well has been identified. Consideration was limited to potential sources of contamination within the inventory region. Additionally, sources of contaminants that are not regulated for were not inventoried or assessed.
- No site inspection was performed, and the inventory was developed from available sources of information, including DEQ files and NRIS.
- The potential contaminant sources described in the inventory are identified from readily available information. Consequently, unregulated activities or unreported contaminant releases may have been overlooked. The inventory is not exhaustive.
- Some management recommendations are fairly site-specific and can be implemented by the public water supply. However, other management options can only be implemented by federal, state, county or local governmental entities. When the latter options are mentioned, it is not implied or suggested that this public water supply should lead or spearhead the effort to implement the management option. It is assumed that representatives from this public water supply would participate in the public process sponsored by various governmental entities to develop and implement any of these management options.

# CHAPTER 4

## SUSCEPTIBILITY ASSESSMENT

### HAZARD DETERMINATION

The threat of contamination is referred to as *hazard*. The degree of hazard is determined either by the proximity of a potential contaminant source to a spring or well intake, potential contaminant migration pathways, or by the density of potential non-point contaminant sources.

### DISCUSSION OF SUSCEPTIBILITY

*Susceptibility* is the degree of likelihood for a public water supply to be impacted by inventoried contaminant sources, at concentrations that would pose a concern. Susceptibility is assessed to prioritize potential pollutant sources for local management, in this case the Big Hole National Battlefield PWS managers and operators. Alternative management approaches that could be used by the PWS managers and operators to reduce susceptibility are recommended in this chapter.

Susceptibility is determined by considering the hazard rating for each potential contaminant source relative to any contaminant barriers. Barriers to contamination are anything that decreases the likelihood that contaminants will reach a spring or well. Barriers can be engineered structures, management actions, or natural conditions. Examples of engineered barriers include spill catchment structures and leak detection for underground storage tanks. Emergency planning and best management practices (BMPs) are considered management barriers. Thick clay-rich soils, a deep water table or a thick unsaturated zone above the well intake are examples of natural barriers. No barriers were identified for the PWS.

A summary of the susceptibility assessment for Big Hole National Battlefield production well is provided in Table 4. This table only includes the potential contaminant sources (identified in Chapter 3) that were determined to present a significant potential risk to the drinking water supply. Therefore, this list is not exhaustive, and it is highly recommended that the PWS operator and community members familiar with the nature of businesses and land use in the area enhance the inventory through further research and local input.

### MANAGEMENT RECOMMENDATIONS

It should be noted that even small releases of some chemicals in close proximity to a public water supply well can have significant negative impact on water quality, and therefore are a significant threat to the public water supply. Steps can be taken to reduce the likelihood of releases in the source water for the PWS or in the vicinity of the sources. Management recommendations for protecting the Big Hole National Battlefield drinking water supply are detailed in the susceptibility table (Table 3). If these, and other, management recommendations are implemented; they may be considered additional barriers that will reduce the susceptibility of the intake to specific sources and contaminants.

**Table 3. Susceptibility Assessment of Significant Potential Contaminant Sources**

Potential Contaminant Source	Potential Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendations
<b>Inventory Region.</b>						
Big Hole National Battlefield's Sewage collection system and treatment lagoons	Pathogens, nitrates	Ongoing discharge or catastrophic leakage of sewage	<b>High</b>	<b>-Thick unsaturated zone -Depth of well intake -Certified Operator</b>	<b>Moderate to low</b>	Properly operate and maintain the on-site sewage system and distribution lines. Ensure proper operation and maintenance of onsite wells especially sampling schedule.
Onan Generator	VOCs, petroleum hydrocarbons	Spill at wellhead Contaminants leaching into groundwater	<b>High</b>	<b>None</b>	<b>Very High</b>	Install secondary containment that would capture a potential fuel spill.

**Notes:** VOCs - Volatile organic compounds (i.e. solvents, fuel components)      SOCs - Synthetic Organic Compounds (i.e. pesticides, herbicides, plasticizers)  
 UST - Underground Storage Tank      LUST - Leaking Underground Storage Tank  
 BMPs - Best Management Practices      DEQ- Montana Department of Environmental Quality  
 RR - Recharge Region

## REFERENCES

- Kendy, Eloise and R.E. Tresch, Geographic, 1996, Geologic, and Hydrologic Summaries of Intermontane Basins of the Northern Rocky Mountains, Montana, U.S. Geological Survey, Water-Resources Investigations Report 96-4025.
- Levings, Julianne, 1986. Water Resources of the Big Hole Basin, Southwestern Montana: Montana Bureau of Mines and Geology Memoir 59, 72p.
- Montana Bureau of Mines and Geology, 2004. Groundwater Information Center, lithologic well logs. <http://mbmaggwic.mtech.edu/>
- Montana Department of Environmental Quality Public Water Supply Section, 2004. Safe Drinking Water Information System (SDWIS).
- Montana Department of Environmental Quality, 1999. Montana Source Water Protection Program. <http://www.deq.state.mt.us/ppa/p2/swp/index.asp>
- Montana Department of Environmental Quality Underground Storage Tank Program web site. <http://www.deq.state.mt.us/Rem/tsb/iss/USTDownloads.asp>
- Montana Natural Resources Information Interactive Map website. 2004. <http://nris.state.mt.us/interactive.html>
- United States Census Bureau, 2000. [http://factfinder.census.gov/home/saff/main.html?\\_lang=en](http://factfinder.census.gov/home/saff/main.html?_lang=en)
- United States Environmental Protection Agency “Envirofacts Data Warehouse and Applications”. <http://www.epa.gov/enviro/>
- United States Environmental Protection Agency, 1991, Protecting Local Groundwater Supplies Through Wellhead Protection, EPA 570/9-91-007, 18 p.
- United States Geological Survey. 1992. National Landcover Dataset, Montana. 30-meter electronic digital landcover dataset interpreted from satellite imagery. <http://nris.state.mt.us/nsdi/nris/nlcd/nlcdvector.html>
- Various Authors, 1999-2004. Correspondence in DEQ’s PWS files regarding the Big Hole National Battlefield Water Supply.
- Western Regional Climate Center Montana Climate Summaries. [wrc@dri.edu](mailto:wrc@dri.edu)

# GLOSSARY

**Acute Health Effect.** A negative health effect in which symptoms develop rapidly.

**Alkalinity.** The capacity of water to neutralize acids.

**Aquifer.** A water-bearing layer of rock or sediment that will yield water in usable quantity to a well or spring.

**Barrier.** A physical feature or management plan that reduces the likelihood of contamination of a water source from a potential contaminant source

**Best Management Practices (BMPs).** Methods for various activities that have been determined to be the most effective, practical means of preventing or reducing non-point source pollution.

**Biennial Reporting System (BRS).** An EPA database that contains information on hazardous waste sites. The data can be accessed through the EPA Envirofacts website.

**Chronic Health Effect.** A negative health effect in which symptoms develop over an extended period of time.

**Class V Injection Well.** Any pit or conduit into the subsurface for disposal of waste waters (e.g. dry well). The receiving unit for an injection well typically represents the aquifer, or water-bearing interval.

**Coliform Bacteria.** A general type of bacteria found in the intestinal tracts of animals and humans, and also in soils, vegetation and water. Their presence in water is used as an indicator of pollution and possible contamination by pathogens.

**Comprehensive Environmental Cleanup and Responsibility Act (CECRA).** Passed in 1989 by the Montana State Legislature, CECRA provides the mechanism and responsibility to clean up hazardous waste sites in Montana.

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).** Enacted in 1980. CERCLA provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

**Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS).** A database that provides information about specific sites through the EPA Envirofacts website.

**Confined Animal Feeding Operation (CAFO).** Any agricultural operation that feeds animals within specific areas, not on rangeland. Certain CAFOs require permits for operation.

**Confined Aquifer.** A fully saturated aquifer overlain by a confining unit such as a clay layer. The static water level in a well in a confined aquifer is at an elevation that is equal to or higher than the base of the overlying confining unit.

**Confining Unit.** A geologic formation present above a confined aquifer that inhibits the flow of water and maintains the pressure of the groundwater in the aquifer. The physical properties of a confining unit may range from a five-foot thick clay layer to shale that is hundreds of feet thick.

**Delineation.** The process of determining and mapping source water protection areas.

**Glacial.** Of or relating to the presence and activities of ice or glaciers. Also, pertaining to distinctive features and materials produced by or derived from glaciers.

**Geographic Information Systems (GIS).** A computerized database management and mapping system that allows for analysis and presentation of geographic data.

**Hardness.** Characteristic of water caused by presence of various calcium and magnesium salts. Hard water may interfere with some industrial processes and prevent soap from lathering.

**Hazard.** A relative measure of the potential of a contaminant from a facility or associated with a land use to reach the water source for a public water supply. The location, quantity and toxicity of significant potential contaminant sources determine hazard.

**Hydraulic Conductivity.** A constant number or coefficient of proportionality that describes the rate water can move through an aquifer material.

**Hydrology.** The study of water and how it flows in the ground and on the surface.

**Hydrogeology.** The study of geologic formations and how they effect groundwater flow systems.

**Inventory Region.** A source water management area for groundwater systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified three year groundwater travel time.

**Lacustrine.** Pertaining to, produced by, or formed in a lake or lakes.

**Large Capacity Septic System.** Defined by Underground Injection Control regulations as an on-site septic system serving 20 or more persons.

**Leaking Underground Storage Tank (LUST).** A release from a UST and/or associated piping into the subsurface.

**Maximum Contaminant Level (MCL).** Maximum concentration of a substance in water that is permitted to be delivered to the users of a public water supply. Set by EPA under authority of the Safe Drinking Water Act to establish concentrations of contaminants in drinking water that are protective of human health.

**Montana Bureau of Mines and Geology – Groundwater Information Center (MBMG/GWIC).** The database of information on all well drilled in Montana, including stratigraphic data and well construction data, when available.

**Montana Pollutant Discharge Elimination System (MPDES).** A permitting system that utilizes a database to track entities that discharge wastewater of any type into waters of the State of Montana.

**National Pollutant Discharge Elimination System (NPDES).** A national permitting system that utilizes a database to track entities that discharge wastewater into waters of the United States.

**Nitrate.** An important plant nutrient and type of inorganic fertilizer that can be a potential contaminant in water at high concentrations. In water the major sources of nitrates are wastewater treatment effluent, septic tanks, feed lots and fertilizers.

**Nonpoint-Source Pollution.** Pollution sources that are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. Examples of nonpoint- source pollution include agriculture, forestry, and run-off from city streets. Nonpoint sources of pollution, such as the use of herbicides, can concentrate low levels of these chemicals into surface and/or groundwaters at increased levels that may exceed MCLs.

**Pathogens.** A microorganism typically found in the intestinal tracts of mammals, capable of producing disease.

**Phase II (and IIB) Rules.** EPA updated or created legal limits on 38 contaminants. The rules became effective July 30, 1992 and January 1, 1993. Some of these contaminants are frequently-applied agricultural chemicals such as nitrate and others are industrial solvents.

**Phase V Rule.** EPA set standards for 23 contaminants in addition to those addressed by the Phase II Rules. The Phase V Rule became effective January 17, 1994. Some of these contaminants include inorganic chemicals such as cyanide and other Phase V contaminants are pesticides that enter water supplies through run-off from fields where farmers have applied them or by leaching through the soil into groundwater. Six are probable cancer-causing agents. Others can cause liver and kidney damage, or problems of the nervous system and brain.

**Point Source.** A stationary location or a fixed facility from which pollutants are discharged. This includes any single identifiable source of pollution, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fracture, container, rolling stock (tanker truck), or vessel or other floating craft, from which pollutants are or may be discharged.

**Pollutant.** Generally, any substance introduced into the environment that adversely affects the usefulness of a resource (e.g. groundwater used for drinking water).

**Permit Compliance System (PCS).** An EPA database that provides information on the status of required permits for specific activities for specific facilities. The data can be accessed through the EPA Envirofacts website.

**Public Water System (PWS).** A system that provides water for human consumption through at least 15 service connections or regularly serves 25 individuals.

**Pumping Water Level.** Water level elevation in a well when the pump is operating.

**Recharge Region.** An area in which water is absorbed that eventually reaches the zone of saturation in one or more aquifers. As a source water management region, the term generally describes the entire area that could contribute water to an aquifer used by a public water supply. Includes areas that could contribute water over long time periods or under different water usage patterns.

**Resource Conservation and Recovery Act (RCRA).** Enacted by Congress in 1976. RCRA's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner.

**Resource Conservation and Recovery Information System (RCRIS).** Is a database that provides information about specific sites through the EPA Envirofacts website.

**Secondary Maximum Contaminant Levels (SMCL).** The maximum concentration of a substance in water that is recommended to be delivered to users of a public water supply based on aesthetic qualities. SMCLs are non-enforceable guidelines for public water supplies, set by EPA under authority of the Safe Drinking Water Act. Compounds with SMCLs may occur naturally in certain areas, limiting the ability of the public water supply to treat for them.

**Section Seven Tracking System (SSTS).** SSTS is an automated system EPA uses to track pesticide producing establishments and the amount of pesticides they produce.

**Source Water.** Any surface water, spring, or groundwater source that provides water to a public water supply.

**Source Water Delineation and Assessment Report (SWDAR).** A report for a public water supply that delineates source water protection areas, provides an inventory of potential contaminant sources within the delineated areas, and evaluates the relative susceptibility of the source water to contamination from the potential contaminant sources under "worst-case" conditions.

**Source Water Protection Areas.** For surface water sources, the land and surface drainage network that contributes water to a stream or reservoir used by a public water supply. For groundwater sources, the area within a fixed radius or three-year travel time from a well, and the land area where the aquifer is recharged.

**Spill Response Region.** A source water management area for surface water systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified four-hour water travel time in a stream or river.

**Standard Industrial Classification (SIC) Code.** A method of grouping industries with similar products or services and assigning codes to these groups.

**Static Water Level (SWL).** Water level elevation in a well when the pump is not operating.

**Susceptibility (of a PWS).** The relative potential for a PWS to draw water contaminated at concentrations that would pose concern. Susceptibility is evaluated at the point immediately preceding treatment or, if no treatment is provided, at the entry point to the distribution system.

**Synthetic Organic Compounds (SOC).** Man made organic chemical compounds (e.g. herbicides and pesticides).

**Total Dissolved Solids (TDS).** The dissolved solids collected after a sample of a known volume of water is passed through a very fine mesh filter.

**Total Maximum Daily Load (TMDL).** The total pollutant load to a surface water body from point, nonpoint, and natural sources. The TMDL program was established by section 303(d) of the Clean Water Act to help states implement water quality standards.

**Toxicity.** The quality or degree of being poisonous or harmful to plants, animals, or humans.

**Toxicity Characteristic Leachate Procedure.** A test designed to determine whether a waste is hazardous or requires treatment to become less hazardous.

**Toxic Release Inventory (TRI).** An EPA database that compiles information about permitted industrial releases of chemicals to air and water. Information about specific sites can be obtained through the EPA Envirofacts website.

**Transmissivity.** A number that describes the ability of an aquifer to transmit water. The transmissivity is determined by multiplying the hydraulic conductivity time the aquifer thickness.

**Turbidity.** The cloudy appearance of water caused by the presence of suspended matter.

**Unconfined Aquifer.** An aquifer containing water that is not under pressure. The water table is the top surface of an unconfined aquifer.

**Underground Storage Tanks (UST).** A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals, and the associated plumbing system.

**Volatile Organic Compounds (VOC).** Chemicals such as petroleum hydrocarbons and solvents or other organic chemicals that evaporate readily to the atmosphere.

**Watershed.** The region drained by, or contributing water to, a stream, lake, or other water body of water.

\* With the exception of the definitions for Lacustrine, Phase II and Phase V Rules, and Standard Industrial Classification Code, definitions were adapted from EPA's Term References System (formerly known as Glossary of Selected Terms and Abbreviations) which can be found at:

<http://www.epa.gov/trs/index.htm> . The definitions of glacial and lacustrine were taken from the Glossary of Geology by Robert L. Bates and Julia A. Jackson.

The definitions for Phase II and Phase V Rules were adapted from:

<http://www.epa.gov/OGWDW/source/therule.html#PhaseII>  
<http://www.epa.gov/OGWDW/source/therule.html#PhaseV>

The definition for Standard Industrial Classification Code was adapted from:

[EPA/Office of Enforcement and Compliance Assurance: Guide to Environmental Issues:  
Glossary of Terms & Acronyms \*Term Detail\*](#)

**Appendix A**  
**Well Log**

**Montana Bureau of Mines and Geology  
Ground-Water Information Center Site Report  
BIG HOLE NATIONAL BATTLEFIELD**

[Plot this site on a topographic map](#)

**Location Information**

GWIC Id: 107554  
Location (TRS): 02S 17W 24 DCAA  
County (MT): BEAVERHEAD  
DNRC Water Right: W162331-00  
PWS Id: 01271002  
Block:  
Lot:  
Addition:

Source of Data: LOG  
Latitude (dd): 45.6415  
Longitude (dd): -113.6426  
Geomethod: MAP  
Datum: NAD27  
Altitude (feet): 6290.00  
Certificate of Survey:  
Type of Site: WELL

**Well Construction and Performance Data**

Total Depth (ft): 250.00  
Static Water Level (ft): 76.67  
Pumping Water Level (ft):  
Yield (gpm): 10.00  
Test Type:  
Test Duration:  
Drill Stem Setting (ft):  
Recovery Water Level (ft):  
Recovery Time (hrs):  
Well Notes:

How Drilled:  
Driller's Name: VOLLMER & SON  
Driller License:  
Completion Date (m/d/y): 6/25/1965  
Special Conditions:  
Is Well Flowing?:  
Shut-In Pressure:  
Geology/Aquifer: 120SDMS  
Well/Water Use: PUBLIC WATER SUPPLY

**Hole Diameter Information**

No Hole Diameter Records currently in GWIC.

**Casing Information<sup>1</sup>**

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
0.0	250.0	6.0				STEEL

**Annular Seal Information**

No Seal Records currently in GWIC.

**Completion Information<sup>1</sup>**

From	To	Dia	# of Openings	Size of Openings	Description
200.0	245.0	6.0			MILLS KNIFE

**Lithology Information**

From	To	Description
0.0	40.0	UNCONSOLIDATED POORLY SORTED- SUB TO WELL ROUNDED- LIGHT COLORED- IRON STAINED SAND- GRAVEL AND COBBLES. MOSTLY QUARTZITE- SOME GRANITE AND MUCH MUSCOVITE MICA IN MINUTE BOOKS AND FLAKES
40.0	55.0	GRAVEL AND SAND- SEMICONSOLIDATED- SUBANGULAR TO SUBROUND QUARTZITE. SOME MICA. LENSES OF GRAY BENTONITIC CLAY
55.0	60.0	CONGLOMERATE- LIME-CEMENTED- SUBROUNDED GRAY QUARTZITE- SOME FINE MICA
60.0	65.0	GRAVEL- SEMICONSOLIDATED; SUBROUND; CLEAR QUARTZ AND WHITE QUARTZITE WITH A FEW GRANITE PEBBLES AND SOME MICA. INTERBEDDED LENSES OF GRAY BENTONITIC CLAY
65.0	75.0	GRAVEL- SEMICONSOLIDATED; SUBANGULAR LIGHT GRAY QUARTZITE
75.0	100.0	CONGLOMERATE- TRACE OF LIMY CEMENT; SUBANGULAR WHITE TO GRAY QUARTZITE AND CLEAR QUARTZ SAND AND GRAVEL; SOME IRON STAIN. THIN BEDS OF GRAY BENTONITIC CLAY.
100.0	130.0	CONGLOMERATE- POORLY CONSOLIDATED; 90 PERCENT LIGHT TO DULL GRAY QUARTZITE. 10 PERCENT DARK- GRAY TO BROWN QUARTZITE PEBBLES. SOME WATER.
130.0	170.0	CONGLOMERATE- WELL CEMENTED- LIGHT GRAY QUARTZITE PEBBLES AND SOME MICA FLAKES. INTERBEDDED LENSES OF DARK-GRAY BENTONITIC CLAY
170.0	195.0	CONGLOMERATE- SUBANGULAR LIGHT- TO DARK-GRAY QUARTZITE PEBBLES. SOME MICA AND GRANITIC PEBBLES
195.0	198.0	CLAY- BROWN- IRONSTAINED- BENTONITIC
198.0	215.0	SANDSTONE- POORLY CONSOLIDATED; 85 PERCENT SUB- ANGULAR MILKY QUARTZITE- 10 PERCENT CLEAR QUARTZ SOME FINELY DIVIDED MICA AND A FEW THIN LENSES OF BENTONITIC

		CLAY. WATER BEARING.
215.0	245.0	SANDSTONE- POORLY CONSOLIDATED; SUGARY QUARTZITE GRAINS AND SOME MICA FLAKES. WATER BEARING.
245.0	250.0	SAND- POORLY CONSOLIDATED- VERY FINE GRAINED.

<sup>1</sup> - All diameters reported are **inside** diameter of the casing.

These data represent the contents of the GWIC databases at the Montana Bureau of Mines and Geology at the time and date of the retrieval. The information is considered unpublished and is subject to correction and review on a daily basis. The Bureau warrants the accurate transmission of the data to the original end user. Retransmission of the data to other users is discouraged and the Bureau claims no responsibility if the material is retransmitted. Note: non-reported casing, completion, and lithologic records may exist in paper files at GWIC.

**Appendix B**  
**Concurrence Letter**