

# HEBGEN LAKE ESTATES

## PUBLIC WATER SUPPLY

PWS ID No. MT0001983

### DRAFT SOURCE WATER DELINEATION & ASSESSMENT REPORT

PREPARED BY:

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## EXECUTIVE SUMMARY

This Source Water Delineation and Assessment Report (SWDAR) was prepared as required by the federal Safe Drinking Water Act, according to a detailed Source Water Assessment Plan developed by a statewide Montana citizens' advisory committee, and approved by the US Environmental Protection Agency (EPA). The Department of Environmental Quality (DEQ) is completing assessment and delineation reports for all public water systems in Montana. These reports are intended to provide information so that the public water system, local officials, consumers, and community citizens can develop strategies to protect drinking water sources. The information provided includes the delineation of the area most critical to maintaining safe drinking water (the inventory region), an inventory of significant potential sources of contamination within this area, and an assessment of the relative threat that these sources pose to the water system.

The Hebgen Lake Estates PWS provides drinking water to a residential subdivision. The system is supplied by one well, located at the western edge of the subdivision, on Grizzly Bear Loop. The aquifer is semiconfined. In accordance with the Montana Source Water Protection Program criteria (1999), the aquifer (source water) is considered to have a moderate sensitivity to potential contaminant sources since it is semiconfined by glacial till. Sensitivity is defined as the relative ease with which contaminants may migrate to the source water.

As part of this assessment, three types of source water protection management areas were mapped for the Hebgen Lake Estates public water system. They are the *control zone*, the *inventory region*, and the *recharge region*. The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's well or immediate surrounding areas. The control zone is delineated as a 100-foot radius around the wellhead. The inventory region should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. The inventory region includes the area that is expected to supply groundwater to the well over the next three years. The recharge region is considered to be the upper Madison River watershed. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage. All sources of potential contaminants should be excluded from the control zones. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- No potential sources of contamination were identified within the control zone. However, an abandoned or inactive well may be present within this region, and could provide a conduit for contaminants to rapidly reach the source water.
- Significant potential contaminant sources within the inventory region are limited. The subdivision's wastewater treatment system and sewer lines are potential sources of nitrate and pathogens, as are the few scattered septic systems located outside the subdivision. The PWS' susceptibility to these features is low, however. Mapped agricultural land in the area is limited, and that present is grass rangeland.
- No significant land use threats were identified within the recharge region.

As expected, given the remote setting, relatively few potential contaminant sources were identified within the Hebgen Lake Estates PWS inventory region. The PWS' susceptibility to identified potential contaminant sources is rated "low". Coliform bacteria have not been detected in the Hebgen Lake Estates PWS water within the past five years. Nitrate has been detected in the source water, but at concentrations considerably below the regulatory limit. Arsenic has been detected regularly, but at concentrations below the amended MCL that takes effect in 2006 (0.010 mg/L).

Low risk potential sources and potential sources located outside the inventory region, but within the recharge region, may still pose a threat over time, but are not discussed in detail in this assessment. This provides a quick look at the existing potential sources of contamination that could, if improperly managed or released, impact the source water for the Hebgen Lake Estates. 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.

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## 1.0 INTRODUCTION

Eric Sivers, a hydrogeologist with the Montana Department of Environmental Quality (DEQ) Source Water Protection Section, completed the Hebgen Lake Estates (PWS ID No. 0001326, AKA Gallatin County RID 322) Source Water Delineation and Assessment Report (SWDAR).

The primary purpose of this source water delineation and assessment report is to provide information that helps Hebgen Lake Estates protect its drinking water source. The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protect public drinking water supplies from contamination. The major components of the Montana Source Water Protection Program are *delineation* and *assessment*. Delineation is the process of identifying the areas that contribute drinking water, and mapping source water protection areas. Assessment involves identifying locations or regions in source water protection areas where contaminants may be generated, stored, or transported, and then determining the hazard these sources pose to the drinking water.

This Source Water Delineation and Assessment Report is intended to meet the technical requirements for completion of the delineation and assessment for the Hebgen Lake Estates Public Water System (PWS) 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].

## 2.0 BACKGROUND

The Hebgen Lake Estates PWS is located in Gallatin County in southwestern Montana, approximately 10 miles north-northwest of West Yellowstone, and 60 miles south-southwest of Bozeman. At the time of the 2000 Census, the population of Gallatin County was 67,831. According to the most recent sanitary survey (August 2004), the Hebgen Lake Estates PWS serves an estimated population of 55.

### 2.1 PHYSICAL SETTING

#### 2.1.1 Geography and Geology

Hebgen Lake Estates is located on Horse Butte Peninsula, on the eastern end of Hebgen Lake (Figure 1). The lake is located in the Upper Madison River valley, at an elevation of approximately 6,550 feet above mean sea level.

The Upper Madison River valley extends over roughly 110 square miles of southwestern Montana. The drainage basin extends to the headwaters of the Madison River in Yellowstone National Park. The Upper Madison River valley extends downriver through the Madison River Canyon to the debris dam created by the 1959 Hebgen Lake earthquake. The Upper Madison River basin is bordered by the Madison Range to the north, the continental divide to the south, the Madison River valley to the west, and for this report, the Montana-Wyoming border to the east (Kendy and Tresch, 1996). The major geographic features of the valley are the Madison River and Hebgen Lake. The valley is underlain by unconsolidated glacial and alluvial deposits (Richmond, 1964). The mountains surrounding the basin are composed of bedrock varying in age from Archean (pre-Belt series) to Tertiary. These bedrock units are generally less permeable than the unconsolidated basin sediments, although fractures or carbonate dissolution features create significant local flow conduits. The relief in the area is controlled by two downdropped fault blocks (Hebgen Lake and Red Canyon fault blocks) and

the adjacent mountains (Witkind *et al.*, 1964). These fault blocks are bounded on their northeastern edges by normal faults that ruptured in the 1959 earthquake.

Hebgen Lake Estates is located in the Western Mountain Ranges groundwater region of North America. These regions were delineated by Heath (1984), who characterized the West region as: ‘*mountains with thin soils over fractured rocks of Precambrian to Cenozoic age alternating with valleys underlain by alluvial and glacial deposits of Pleistocene age.*’ The community is in the Madison River Watershed (10020007), in the Upper Missouri River drainage of Montana (Figure 1).

### 2.1.2 Climate

Climate in the region is wetter than is typical of southwestern Montana. Annual total precipitation is 28.32 inches, whereas the Alder 17S climate station, located in the Madison valley to the northwest, receives only 13 inches. Rainfall occurs May through September with May and June being the wettest months. The area receives an annual average of 208 inches of snow, falling mainly October to May. Climate data for the area was recorded at the Hebgen Dam climate station, covering the period between July 1948 and September 2004. This data was provided by the Western Regional Climate Center, operated by the Desert Research Institute of Reno, Nevada. See Table 1 for additional climate information.

**Table 1. Monthly Climate Summary: Hebgen Dam Climate Station (244038)**

Period of Record: 07/01/1948 to 09/30/2004

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Ave. Max. Temp (F)	21.9	27.8	36.4	46.6	59.0	68.7	78.2	77.1	66.8	52.0	33.4	22.8	49.2
Ave. Min. Temp. (F)	2.9	5.1	11.6	22.4	31.4	38.2	43.5	42.5	35.5	27.7	17.1	5.3	23.6
Ave Tot. Precip. (in.)	3.09	2.43	2.40	1.92	2.89	3.03	1.76	1.75	1.72	1.72	2.49	3.11	28.32
Ave. Tot. Snowfall (in.)	47.3	36.5	29.8	10.5	2.8	0.3	0.0	0.0	0.4	5.3	27.2	48.1	208.2
Ave Snow Depth (in.)	28	35	36	19	1	0	0	0	0	0	5	17	12

## 2.2 THE PUBLIC WATER SUPPLY

### 2.2.1 Water Supply System

The Hebgen Lake Estates PWS serves approximately 55 residents through 37 service connections. The Hebgen Lake Estates PWS is classified as a community public water system since it serves at least 25 residents. Information on the water system was obtained from correspondence in the DEQ Public Water Supply Section files. Groundwater is provided by one well. A backup well is reported to be inactive, and was rehabilitated in 2004. No storage is present.

### 2.2.2 Supply Well Information

The Hebgen Lake Estates’ drinking water is supplied by one well located in lots 9 and 10, on Grizzly Bear Loop (Figure 2). The well is cased with eight-inch steel, and perforated from 93 to 105 feet below grade. The perforated interval corresponds to a gravel stratum. The well casing is sealed to 10 feet below grade with cement. The well was completed in 1979.

### 2.2.3 Source Water

The Hebgen Lake Estates well is completed in gravel deposits that are believed to represent glacial outwash. A gravel layer occurring between 90 and 130 feet is reported in drillers' logs in the southern West Yellowstone Basin (Richmond, 1964). This aquifer is recharged by Hebgen Lake. The recharge area is delineated as the upper portion of the Madison River watershed (Figure 1). Additionally, some recharge to the aquifer is probably contributed by infiltration of precipitation on the Horse Butte peninsula.

According to the Source Water Protection Program (DEQ, 1999) the source water aquifer is considered to have moderate sensitivity to potential contamination, since it is semi-confined by glacial till.

## 2.3 WATER QUALITY

Every PWS samples their water supply on a regular basis. Monitoring programs are tailored to each system, following the general protocols defined by DEQ. Analytical parameters include coliform bacteria, nitrates, metals, radionuclides, petroleum hydrocarbons and synthetic 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. Monitoring schedules are available at: <<http://nris.state.mt.us/wis/swap/swapquery.asp>>.

Analytical results are compared to quality standards established by the USEPA. Maximum Contaminant Levels (MCLs) are enforceable standards for contaminants in drinking water. National Secondary Drinking Water Standards (referred to as SMCLs) are non-enforceable guidelines for undesirable constituents (sulfate, iron, manganese, sodium, fluoride, etc.) that may cause aesthetic (color, odor, taste) or cosmetic (fixture/laundry staining, skin/tooth discoloration) problems. Some secondary contaminants such as sulfate and sodium may have (non-acute) health effects. USEPA water quality standards are available at: <<http://www.epa.gov/safewater/mcl.html>>.

Most analytical results are reported in milligrams per liter (mg/L), a unit equivalent to one part per million (ppm). Some parameters (such as organic chemicals) are reported in micrograms per liter ( $\mu\text{g/L}$ ), which is equivalent to parts per billion (ppb).

### 2.3.1 Public Water Supply Monitoring Results

For this report, the Source Water Protection Section hydrogeologist reviewed the Hebgen Lake Estates monitoring data from the past five years. The water quality is high. Coliform bacteria have not been detected during this period. Nitrate has been occasionally detected at concentrations ranging from 0.77 mg/L to 1.1 mg/L, well below the MCL of 10 mg/L. Arsenic is regularly detected at concentrations between 0.003 to 0.006 mg/L. The MCL for arsenic is currently 0.050 mg/L, but is changing to 0.010 mg/L in 2006. The arsenic detections are not surprising, as the Madison River is noted for its arsenic content, derived from the Yellowstone thermal areas. The water quality results are attached as Appendix B.

### 2.3.2 Background Water Quality Monitoring Results

No background water quality data was identified for the Hebgen Lake Estates supply well. Background water quality sampling typically includes general water quality parameters including major dissolved ions (calcium, magnesium, sodium, potassium, iron, manganese, silica, bicarbonate, carbonate, chloride, sulfate, nitrate, fluoride and orthophosphate), trace elements, and metals. Since the PWS does not disinfect, the inorganic monitoring results are generally suggestive of the background water quality.

### 3.0 MANAGEMENT AREA DELINEATION

This report identifies three source water management areas. The goal of source water management is protection of 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.

#### 3.1 CONCEPTUAL MODEL

Hebgen Lake Estates' source water is located in the Madison watershed (USGS Hydrologic Unit Code 10020007), and specifically within the Upper Madison River watershed. As described above, Hebgen Lake Estates' drinking water is interpreted to originate as rain/snowfall and runoff in the upper Madison watershed. The source water recharge is probably comprised of local infiltration of precipitation on Horse Butte, and from Hebgen Lake. The aquifer is a gravel layer approximately 90 feet below the surface, and is semi-confined by glacial till.

#### 3.2 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 the well.

*Inventory Region* – The inventory region is the area that is expected to contribute to the water supply within no less than three years. All significant sources of potential contaminants are inventoried in this region. According to the DEQ's Source Water Protection Program criteria for an unconfined aquifer (DEQ, 1999), the inventory zone for the well was delineated based on a three-year time of travel. For the purposes of this report, this is mapped as a one-mile radius. This distance roughly corresponds to the extent of the local drainage of the Horse Butte Peninsula. Additionally, as the exact direction of groundwater flow in the aquifer is uncertain, a fixed radius inventory zone is more conservative.

*Recharge Region* – Recharge to the Hebgen Lake Estates source water is probably from two areas. Rain and snowfall on Horse Butte probably contribute a local component. Infiltration of surface water and precipitation in the upper Madison River valley recharges the source aquifer as well, and considering that the gravel aquifer is reported to extend over the southern portion of the basin, regional recharge is probably more significant than local recharge. The inventory for the recharge region focuses on general land uses (and large industrial facilities, if present). The goal of management in the recharge region is to maintain and improve the long-term quality of groundwater in the aquifer.

### 4.0 INVENTORY

Significant potential contaminant sources in the source water management areas were inventoried to assess the susceptibility of Hebgen Lake Estates' source water to contamination, and to provide a foundation for source water protection planning. The inventory for Hebgen Lake Estates 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 potential sources of contamination to the drinking water. Contamination of drinking water sources is less likely when potential contaminants are properly used and managed.

#### 4.1 INVENTORY METHOD

The inventory focus is slightly different in each of the delineated management areas. The inventory for Hebgen Lake Estates focuses on all activities in the control zone; 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: 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>>.
- 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 System (TRIS), 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/gisdatalib/gisDataList.aspx>>.

Potential contaminant sources are considered 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

## 4.2 INVENTORY RESULTS

### 4.2.1 Control Zone Inventory Results

No potential sources of contamination were identified within the 100-foot radius control zone. As a blanket statement, the wellhead should be fenced off from livestock, wildlife, and passers-by, and drainage away from the wellhead should be maintained.

### 4.2.2 Inventory Region Results

The inventory results for the Hebgen Lake Estates source water are summarized in Table 2. No UST facilities or petroleum releases were identified within the inventory region. The PWS includes a wastewater treatment facility, approximately 250 feet northwest of the supply well. This is considered a point source of potential contaminants (rather than a land use).

The primary land cover within the inventory region is grassland, with minor evergreen forest. Septic system density within the inventory region is low and is not considered a hazard to the PWS source water. Additional point sources of potential pollutants (such as businesses or facilities listed on regulatory databases) were not identified in the inventory region.

### 4.2.3 Recharge Region Inventory Results

According to the 1992 National Land Cover Dataset, the primary land cover in the recharge region is grassland and evergreen forest. Septic system density within the watershed/recharge region is low and is not considered a hazard to the PWS drinking water. Minor urban land uses are present in West Yellowstone, but these are not considered significant to the Hebgen Lake Estates source water.

Additional sources of potential pollutions (such as businesses or facilities listed on regulatory databases) were not identified in the recharge region.

## 4.3 INVENTORY UPDATE

To make this SWDAR a useful document in the future, the 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.

## 5.0 SUSCEPTIBILITY ASSESSMENT

### 5.1 INTRODUCTION TO SUSCEPTIBILITY

*Susceptibility* is a measure of the likelihood for a public water supply to be impacted by inventoried contaminant sources. Susceptibility assessments help local management prioritize potential pollutant sources. Alternative management approaches that could be used by the PWS managers and operators to reduce susceptibility are recommended in this chapter.

### 5.2 DETERMINATION OF SUSCEPTIBILITY

According to the DEQ Source Water Protection Program (DEQ, 1999), susceptibility is determined by considering the *hazard* rating for each potential contaminant source relative to any *barriers* between that contaminant and the water source. Proximity or density of significant potential contaminant sources and nature of contaminants determines hazard. Susceptibility and hazard are determined in accordance with a matrix provided in the Source Water Protection Program.

Barriers to contamination are anything that decrease the likelihood of contaminants reaching a spring or well. Barriers may 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 are identified for the Hebgen Lake Estates public water system.

### **5.3 RESULTS OF SUSCEPTIBILITY ASSESSMENT**

A summary of the susceptibility assessment for the Hebgen Lake Estates well is provided in Table 2. This table only includes the potential contaminant sources (identified in the inventory) 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.

**Table 2. Susceptibility Assessment of Significant Potential Contaminant Sources**

Potential Contaminant Source	Potential Contaminants	Hazard	Hazard	Barriers	Susceptibility	Management Recommendations
<i>Inventory Region</i>						
Sewer lines, lift station, lagoons	NO <sub>3</sub> and pathogens.	System failure resulting in discharge of untreated effluent; discharge of viable pathogens into groundwater.	Low	Downgradient location	Low	The system should be inspected regularly to ensure that any leaks are promptly detected and addressed.
Land use: Agricultural Land: grazing lands	NO <sub>3</sub> and pathogens from pastures.	Contaminants leaching into groundwater	Low	None	Very Low	None.
Land use: Low Septic System Density	Pathogens, nitrate (NO <sub>3</sub> )	System failure could result in discharge of untreated effluent	Low	Low percentage of inventory region	Very Low	Encourage septic system owners to periodically inspect their septic systems. Septic tanks should be pumped on a regular basis. Effluent filters greatly reduce the chances of solids blocking the drain system.
<i>Recharge Region</i>						
Agricultural Land: grazing lands	NO <sub>3</sub> and pathogens from pastures.	Contaminants leaching into groundwater	N/A	N/A	N/A	Encourage BMPs.

From a source water protection perspective, the most significant potential contaminant source is the wastewater treatment system serving the subdivision. However, this is located in a presumed downgradient groundwater flow direction. To date, the PWS’ nitrate and coliform monitoring history has not shown any evidence of impact to the well.

## 6.0 LIMITATIONS

This Source Water Delineation and Assessment Report is intended to meet the technical requirements for delineation and assessment of the Hebgen Lake Estates Public Water System (PWS) 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:

- This report was prepared to assess the susceptibility of the Hebgen Lake Estates PWS to significant potential contaminant sources, and is based on available information, as described above. The terms “drinking water supply” or “drinking water source” refer specifically to the source of the Hebgen Lake Estates public water supply and not any other public or private water supply.
- Not every potential or existing source of groundwater or surface water contamination in the Hebgen Lake Estates area has been identified. Consideration was limited to potential sources of contamination that are within the inventory region. Additionally, consideration was limited to contaminant types that the DEQ Source Water Protection Section has determined to be significant.
- A site visit was not performed. Consequently, unregulated activities or unreported contaminant releases may have been overlooked. Potential contaminant sources with incorrect geographic references may not have been considered.
- The potential contaminant sources described in the inventory are identified from readily available information, as described in Chapter 4. Multiple data sources are used to increase the likelihood that major threats to the source water are identified. The inventory is not exhaustive. Absence of a potential contaminant in the inventory or susceptibility assessment of this report should not be interpreted to eliminate the potential for contamination.
- Without extensive field investigations beyond the scope of this report, determining the speed and direction of groundwater flow in the PWS vicinity requires numerous assumptions. Therefore, delineation of the inventory region was done on a conservative basis.
- The DEQ hydrogeologist preparing this report is obviously less familiar with the community than the PWS operator. It is highly recommended that PWS personnel and the community enhance or refine the inventory through further research and local input.

## 7.0 CONCLUSIONS

The Hebgen Lake Estates PWS provides drinking water to a residential subdivision. The system is supplied by one well, located at the western edge of the subdivision, on Grizzly Bear Loop. The aquifer is semiconfined. In accordance with the Montana Source Water Protection Program criteria (1999), the aquifer (source water) is considered to have a moderate sensitivity to potential contaminant sources since it is semiconfined by glacial till. Sensitivity is defined as the relative ease with which contaminants may migrate to the source water.

As part of this assessment, three types of source water protection management areas were mapped for the Hebgen Lake Estates public water system. They are the *control zone*, the *inventory region*, and the *recharge region*. The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's well or immediate surrounding areas. The control zone is delineated as a 100-foot radius around the wellhead. The inventory region should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. The inventory region includes the area that is expected to supply groundwater to the well over the next three years. The recharge region is considered to be the upper Madison River watershed. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage. All sources of potential contaminants should be excluded from the control zones. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- No potential sources of contamination were identified within the control zone. However, an abandoned or inactive well may be present within this region, and could provide a conduit for contaminants to rapidly reach the source water.
- Significant potential contaminant sources within the inventory region are limited. The subdivision's wastewater treatment system and sewer lines are potential sources of nitrate and pathogens, as are the few scattered septic systems located outside the subdivision. The PWS' susceptibility to these features is low, however. Mapped agricultural land in the area is limited, and that present is grass rangeland.
- No significant land use threats were identified within the recharge region.

As expected, given the remote setting, relatively few potential contaminant sources were identified within the Hebgen Lake Estates PWS inventory region. The PWS' susceptibility to identified potential contaminant sources is rated "low". Coliform bacteria have not been detected in the Hebgen Lake Estates PWS water within the past five years. Nitrate has been detected in the source water, but at concentrations considerably below the regulatory limit. Arsenic has been detected regularly, but at concentrations below the amended MCL that takes effect in 2006 (0.010 mg/L).

Low risk potential sources and potential sources located outside the inventory region, but within the recharge region, may still pose a threat over time, but are not discussed in detail in this assessment. This provides a quick look at the existing potential sources of contamination that could, if improperly managed or released, impact the source water for the Hebgen Lake Estates. 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.

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## 8.0 REFERENCES

- Heath, Ralph C., 1984. Ground-water Regions of the United States, U.S. Geological Survey, Water Supply Paper 2242, Washington D.C., 78p.
- Kendy, Eloise and Tresch, R. E., 1996. Geographic, geologic, and hydrologic summaries of intermontane basins of the Northern Rocky Mountains, Montana. Water-Resources Investigation 96-4025, 233 p.
- Montana Bureau of Mines and Geology, 2004. Groundwater Information Center, lithologic well logs. <http://mbmgwic.mtech.edu/>
- Montana Department of Environmental Quality Public Water Supply Section, 2005. Safe Drinking Water Information System (SDWIS).
- Montana Department of Environmental Quality (DEQ), 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. 2005. <http://nris.state.mt.us/interactive.html>
- Raines, G.L., and Johnson, B.R., 1995, Digital representation of the Montana state geologic map in ARC/INFO export format.: U.S. Geological Survey Open-File Report 95-0691.
- Richmond, G.M., 1964. Glacial Geology of the West Yellowstone Basin and Adjacent Parts of Yellowstone National Park, *in* The Hebgen Lake, Montana Earthquake of August 17, 1959. U.S. Geological Survey Professional Paper 435, 241 p.
- 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].
- 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 Geological Survey. 1992. National Land Cover Dataset, Montana. 30-meter electronic digital land cover dataset interpreted from satellite imagery. <http://nris.state.mt.us/nsdi/nris/nlcd/nlcdvector.html>
- Various Authors, 2000-2005. Correspondence in DEQ’s PWS files regarding the Hebgen Lake Estates Water Supply.
- Western Regional Climate Center Montana Climate Summaries. [wrc@dri.edu](mailto:wrc@dri.edu)
- Witkind, I.J. *et al.*, 1964. Pre-Tertiary Stratigraphy and Structure of the Hebgen Lake Area , *in* The Hebgen Lake, Montana Earthquake of August 17, 1959. U.S. Geological Survey Professional Paper 435, 241 p.

## 9.0 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. 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 wells 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.

**Sensitivity.** The relative ease with which contaminants can migrate to source water through the natural materials

**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 (TCLP). A test designed to determine whether a waste is hazardous or requires treatment to become less hazardous.

Toxic Release Inventory System (TRIS). 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.

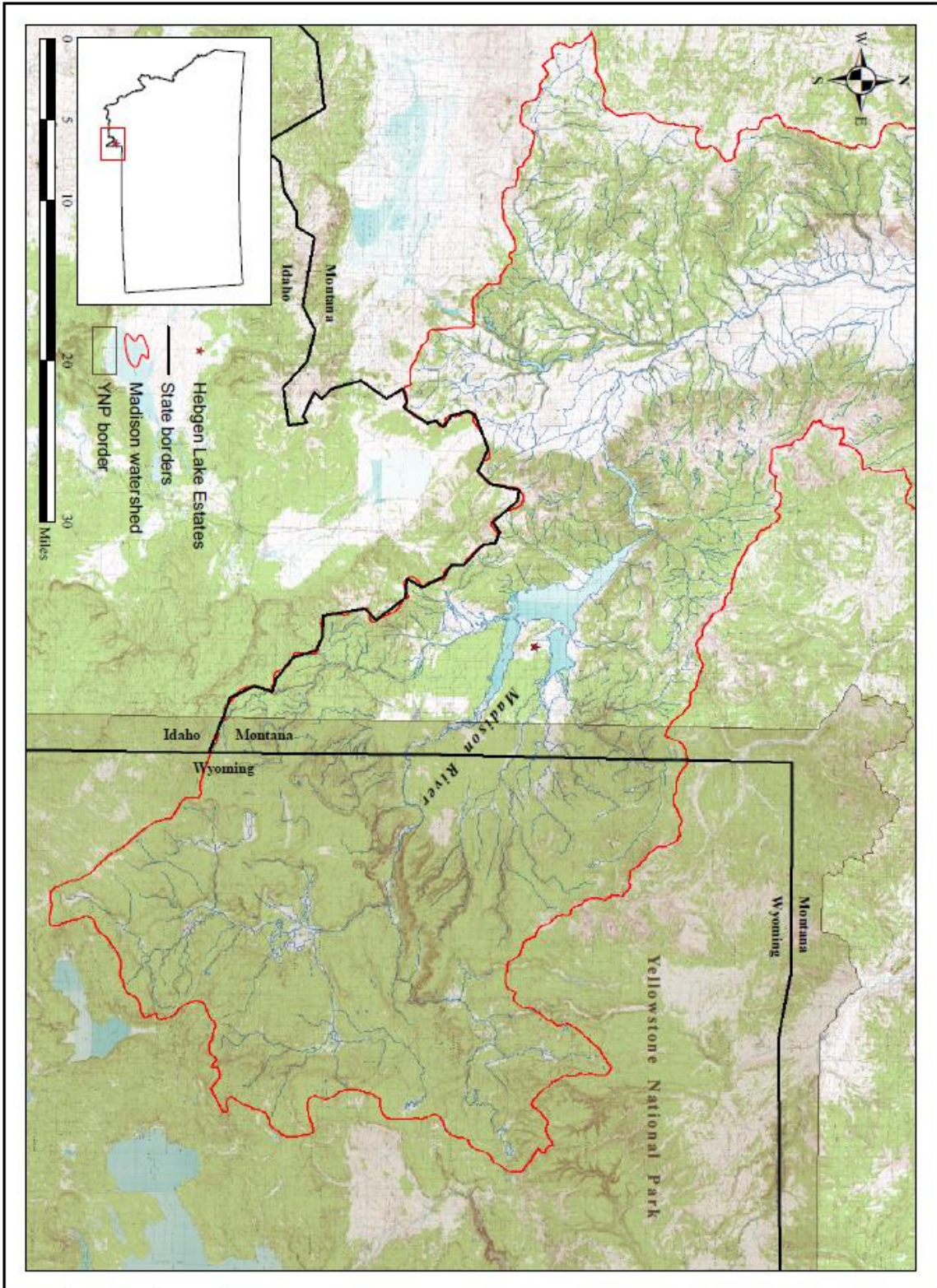
Underground Storage Tanks (UST). A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals, and the associated plumbing system.

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.



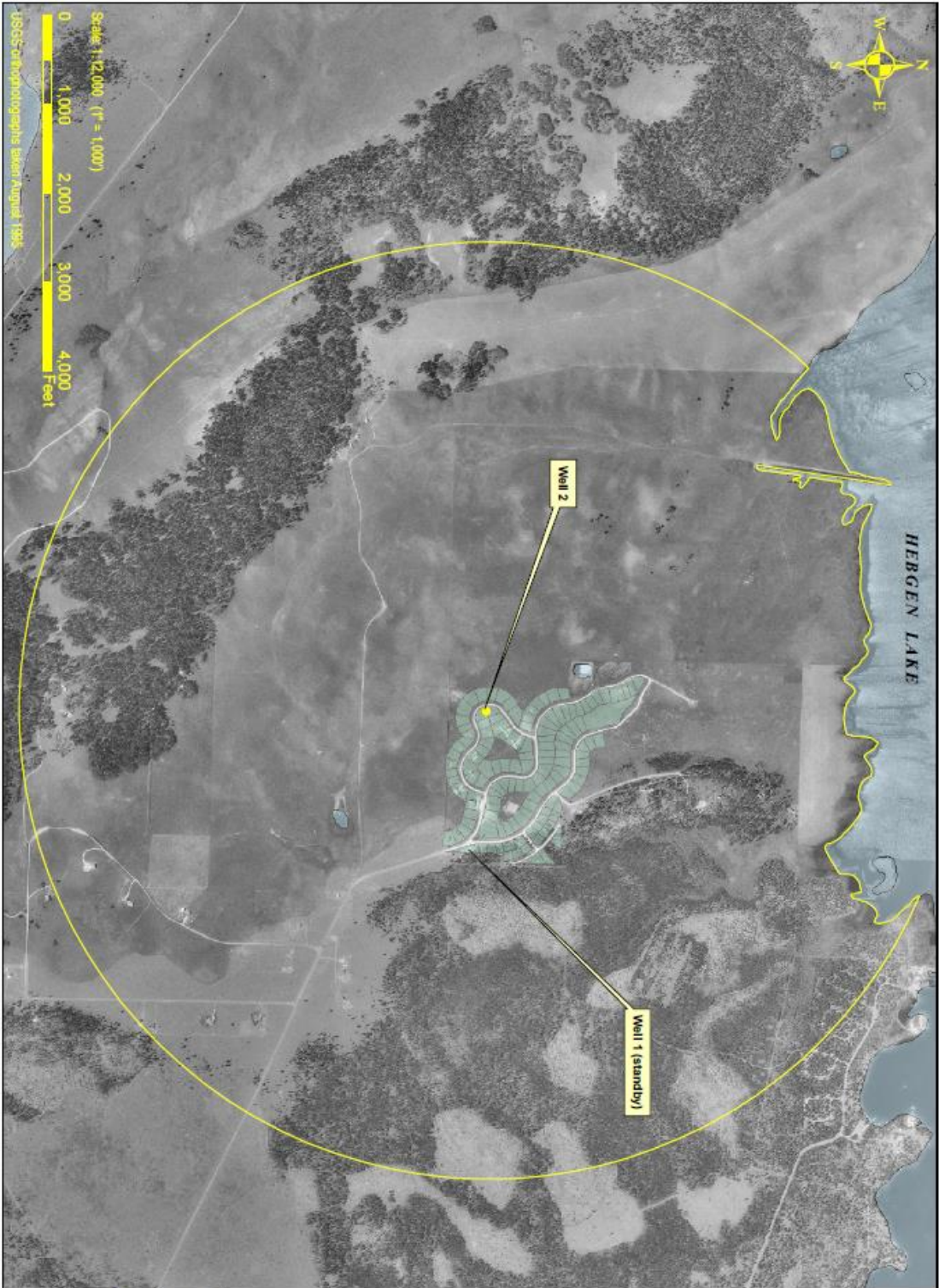
## FIGURES



**GALLATIN CO. RID 322 AKA HEBGEN LAKE ESTATES  
 (PWS ID MT0001983)  
 &  
 MADISON RIVER WATERSHED**

Mapping by: E. Svare, DEQ SWP  
 September 2005  
 Base map provided by MT NRIS  
 (http://nris.state.mt.us)

**FIGURE 1**



INVENTORY REGION DELINEATION  
 GALLATIN CO. RID 322 AKA HEBGEN LAKE ESTATES  
 PWS ID MT0001983

Mapping by E. Sivas, DEQ SWP  
 August 2005  
 Basemap provided by MTNRIS  
 http://www.state.mt.us



FIGURE 2

**APPENDIX A**

**PWS SANITARY SURVEY AND WELL LOG**

**Montana Bureau of Mines and Geology  
Ground-Water Information Center Site Report  
HEBGEN LAKE ESTATES**

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

**Location Information**

GWIC Id: 106653	Source of Data: LOG
Location (TRS): 12S 04E 24 CCDD	Latitude (dd): 44.7672
County (MT): GALLATIN	Longitude (dd): -111.1900
DNRC Water Right: P097872-00	Geomethod: MAP
PWS Id: 01983003	Datum: NAD27
Block: 2	Altitude (feet):
Lot: 9&10	Certificate of Survey:
Addition: HEBGEN LAKE ESTATES	Type of Site: WELL

**Well Construction and Performance Data**

Total Depth (ft): 123.00	How Drilled: ROTARY
Static Water Level (ft): 37.00	Driller's Name: LINDSAY
Pumping Water Level (ft): 77.00	Driller License: WWC253
Yield (gpm): 300.00	Completion Date (m/d/y): 6/6/1979
Test Type: PUMP	Special Conditions:
Test Duration: 24.00	Is Well Flowing?:
Drill Stem Setting (ft):	Shut-In Pressure:
Recovery Water Level (ft):	Geology/Aquifer: Not Reported
Recovery Time (hrs):	Well/Water Use: PUBLIC WATER SUPPLY
Well Notes:	

**Hole Diameter Information**

From	To	Diameter
0.0	123.0	8.0

**Annular Seal Information**

From	To	Description
0.0	10.0	CEMENT

**Lithology Information**

From	To	Description
0.0	10.0	TOPSOIL

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

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
0.0	123.0	8.0	0.322			STEEL

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

From	To	Dia	# of Openings	Size of Openings	Description
93.0	105.0	8.0		3/16 X 2 IN	PERFS

10.0	40.0	GRAVEL AND CLAY
40.0	93.0	SILTY SAND
93.0	105.0	GRAVEL
105.0	123.0	SILTY SAND

<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**

**WATER QUALITY ANALYTICAL REPORT  
(AVAILABLE UPON REQUEST)**



**APPENDIX C**

**SOURCE WATER MONITORING WAIVERS  
(UPDATES AVAILABLE UPON REQUEST)**



## MONITORING WAIVERS

### Waiver Recommendation

The PWS currently has no monitoring waivers beyond the statewide waivers. Diquat, endothall, glyphosate, dioxins, ethylene dibromide (EDB), dibromochloropropane (DBCP), polychlorinated biphenyls (PCBs), cyanide and asbestos (at the source) are excluded from monitoring requirements by statewide waivers.

Once sufficient monitoring history is established, the Hebgen Lake Estates PWS may be eligible for several monitoring waivers. Possible waivers include: Phase II inorganics (barium, cadmium, chromium, fluoride, mercury and selenium), Phase V inorganics (antimony, thallium, beryllium and nickel), synthetic organic compounds (SOCs) and volatile organic compounds (VOCs). Under these waivers, monitoring schedules for these parameters could be reduced to every nine years, rather than every one or three years.

The Source Water Protection Section recommends that the operator request monitoring waivers once the required history (three rounds) is established. The PWS must be in compliance with monitoring requirements to be considered. Written waiver requests must be sent to DEQ at the address below:

Greg Butts  
Montana DEQ, PWS Section  
109 Cooperative Way  
Suite 105  
Kalispell, MT 59901

Upon receipt of a waiver request, DEQ will review the system's compliance history, historical monitoring results and source water setting. If waivers are considered appropriate, DEQ will provide the operator with application forms, guidance and technical assistance. If requested by DEQ, the PWS may also need to provide additional information regarding chemical use in the area within the Inventory Region. A site visit may be required to further investigate VOC and SOC use within the inventory region.

### Monitoring Waiver Requirements

#### Use Waivers

A Use Waiver may be granted if it is determined that target organic chemicals were/are not used, manufactured, or stored in the area of a water source. If certain organic chemicals have been used, or if the use is unknown, the system would be determined to be vulnerable to organic chemical contamination and ineligible for a Use Waiver for those particular contaminants.

#### Susceptibility Waivers

If a Use Waiver is not granted, a system may still be eligible for a Susceptibility Waiver, if through a vulnerability assessment it is demonstrated that the water source would not be susceptible to contamination. The purpose of the vulnerability assessment procedures outlined in this section is to determine which of the organic chemical contaminants are in the area of investigation. The vulnerability assessment of a surface water source must consider the watershed area above the source, or a minimum fixed radius of 1.5 miles upgradient of the surface water intake. PWSs developed in unconfined aquifers should use a minimum fixed radius of one mile as an area of investigation for the use of organic chemicals. Vulnerability assessment of spring water sources should use a minimum fixed radius of one mile as an area of investigation for the use of organic chemicals. Surface water and shallow groundwater sources under the direct influence of surface water (GWUDISW) should assess the watershed area above the source, or a minimum fixed radius of one and one-half miles upgradient.

Given the wide range of landforms, land uses, and the diversity of groundwater and surface water sources across the state, additional information is often required during the review of a waiver application. Additional information may include well logs, pump test data, water quality monitoring data from surrounding public water systems, delineation of zones of influence and contribution to a well; time-of-travel or attenuation studies; vulnerability mapping; and the use of computerized groundwater flow and transport models. DEQ's PWS Section and Source Water Protection Program

will conduct review of an organic chemical monitoring waiver application. Other state agencies may be asked for assistance.

#### *Susceptibility Waiver for Unconfined Aquifers*

Unconfined aquifers are the most common source of usable groundwater. Unconfined aquifers are not contained within impervious geologic strata. As a result, the upper groundwater surface, or water table, in an unconfined aquifer is not under the pressure that produces hydrostatic head common to confined aquifers.

Unconfined aquifers are usually locally recharged from surface water or precipitation. In general, groundwater flow gradients in unconfined aquifers reflect surface topography, and the residence time of water in the aquifer is generally shorter than for water in confined aquifers. Similar water chemistry often exists between unconfined groundwater and area surface water, and physical parameters and dissolved constituents can be an indicator of the hydraulic connection between groundwater and surface water. Consequently, unconfined aquifers can be susceptible to contamination by organic chemicals migrating from the ground surface to groundwater.

Properly assessing a susceptibility waiver application for an unconfined source aquifer requires: site-specific information pertaining to the location and construction of the source development, monitoring history of the source, geologic characteristics of the unsaturated soil and vadose zones, and chemical characteristics of the organic chemicals pertaining to their mobility and persistence in the environment. The zone of contribution of the unconfined groundwater source must be defined and plotted. This should describe the groundwater flow directions, gradients, and a 3-year time-of-travel. All surface water bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and those nearby should be provided as well.