

Bitterroot International Systems
**SOURCE WATER DELINEATION AND
ASSESSMENT REPORT**

Bitterroot International Systems
Public Water System

PWSID # MT0003749

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GLOSSARY AND LIST OF ACRONYMS*

Acute Health Effect An adverse 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.

AST Aboveground storage tank.

Best Management Practices (BMPs) Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Coliform Bacteria Bacteria found in the intestinal tracts of animals. Their presence in water is an indicator of pollution and possible contamination by pathogens.

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 that inhibits the flow of water.

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.

Delineation A process of mapping source water management areas.

DEQ Montana Department of Environmental Quality.

EPA United States Environmental Protection Agency.

GWIC Ground-Water Information Center online well database administered by the Montana Bureau of Mines and Geology.

Hardness Characteristic of water caused by presence of various chemical compounds. Hard water may interfere with some industrial processes and prevent soap from lathering.

Hazard A measure of the potential of a contaminant leaked from a facility to reach a public water supply source. Proximity or density of significant potential contaminant sources determines hazard.

HazMat Hazardous Materials Response Team.

Hydraulic Conductivity A coefficient of proportionality describing the rate at which water can move through an aquifer.

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

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.

MGWPCS Montana Ground Water Pollution Control System.

MPDES Montana Pollution Discharge Elimination System.

NOAA National Oceanic and Atmospheric Administration.

Nitrate An important plant nutrient and type of inorganic fertilizer. In water, the major sources of nitrate pollution are septic tanks, sanitary sewers, feed lots and fertilizers.

Nonpoint-Source Pollution Pollution sources such as stormwater runoff that are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet.

NPL National Priority List (Superfund).

Pathogens Bacterial organisms typically found in the intestinal tracts of mammals, capable of producing disease.

Point-Source A stationary location or fixed facility from which pollutants are discharged.

Public Water System A system that provides piped water for human consumption to 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 Source water management region that is generally the entire area that could contribute water to an aquifer used by a public water system. 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.

SDWA Safe Drinking Water Act.

Source Water Protection Area For surface water sources, the land and surface drainage network that contributes water to a stream or reservoir used by a public water supply.

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

Susceptibility (of a PWS) The potential for a public water system to draw water with contamination 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) Manmade organic chemical compounds such as 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.

Transmissivity The ability of an aquifer to transmit water.

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

UST Underground storage tank.

Volatile Organic Compounds (VOC) Any organic compound that evaporates readily to the atmosphere.

MWQA Montana Water Quality Act.

WQD Missoula Valley Water Quality District.

* Definitions taken from EPA's Glossary of Selected Terms and Abbreviations
(<http://www.epa.gov/ceisweb1/ceishome/ceisdocs/glossary/glossary.html>)

INTRODUCTION

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for the Bitterroot International Systems PWS as required by the Montana Source Water Protection Program and the federal Safe Drinking Water Act (SDWA).

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protecting public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is termed delineation and assessment. The emphasis of this delineation and assessment report is identifying significant potential contaminant threats to public drinking water sources and providing the information needed to develop a source water protection plan for the Bitterroot International Systems PWS.

Delineation is a process whereby areas that contribute water to aquifers or surface waters used for drinking water, called source water protection areas, are identified on a map. Geologic and hydrologic conditions are evaluated in order to delineate 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 potential for contamination of drinking water by these sources.

Delineation and assessment is the foundation of source water protection plans, the mechanism the Bitterroot International Systems PWS can use to protect their drinking water source. Although voluntary, source water protection plans are the ultimate focus of source water delineation and assessment. This delineation and assessment report is written to encourage and facilitate the Bitterroot International Systems PWS operator and the community to complete a source water protection plan that meets their specific needs.

CHAPTER 1

BACKGROUND

The Community

Missoula County is located in the Missoula Basin in the southern end of the Missoula-Ninemile Valley ([Figure 1](#)). The population of Missoula County in 2000 was 95,802 with 57,053 people living in the city of Missoula (Census 2000). The Bitterroot River enters Missoula from the south and the Clark Fork River enters from the northeast. US Highway 93 serves Missoula from the south and the north and Interstate 90 passes along the northern edge of Missoula ([Figure 2](#)). Major Missoula area employers include the University of Montana, and the two local hospitals, each employing more than 1000 people. Stimson Lumber operates a lumber and plywood mill in the Bonner area, and employs 450 people. Other economic contributors include Smurfit-Stone Container, several transportation companies, as well as tourism, small businesses and outlying agriculture and timber operations. Wastewater from much of the City of Missoula is collected in one sanitary sewer system, undergoes treatment, including biological nutrient removal, and discharges into the Clark Fork River near the western edge of Missoula. Surrounding areas, including the Wye, rely on onsite sewage disposal systems. Mountain Water Company supplies most City of Missoula residents and businesses with drinking water; much of the outlying area is served by individual or small public water supply wells.

Geographic setting

Missoula is located in the southern end of the Missoula-Ninemile Valley as shown in [Figure 1](#). The valley elevation ranges from approximately 3000 to 3200 feet above sea level, with surrounding mountain ranges, including the Sapphire Range to the east, the Bitterroot Range to the south, the Rattlesnake Range to the north, and the Ninemile Divide to the west, rising to elevations of 5000 to 8000 feet. The Clark Fork and Bitterroot Rivers drain the valley; the Clark Fork flows westward through the valley, and the Bitterroot flows across the southwest corner of the valley, and joins the Clark Fork at Kelly Island, approximately 4 miles west of the City of Missoula. Milltown Dam and Milltown Reservoir are located approximately 5 miles upstream from Missoula at the confluence of the Clark Fork and Blackfoot Rivers. Rattlesnake Creek was a main source of drinking water until an outbreak of illness associated with *Giardia lamblia* in 1983 prompted the local water company to discontinue use of Rattlesnake Creek water and rely exclusively on groundwater from the Missoula Aquifer. The Missoula Aquifer has been designated a “sole-source” aquifer by the United States Environmental Protection Agency.

The climate in Missoula is typical of western Montana. Missoula receives approximately 13.5 inches of rain per annum, and 45 inches of snow. The annual average temperature is 44°F with average maximum temperatures occurring in July (83°F) and average minimum temperatures occurring in January (15°F).

General description of the Source Water

The Bitterroot International Systems well is completed in the Missoula/Ninemile Valley alluvial aquifer. The aquifer in the Wye area consists of unconsolidated alluvial fan deposits of sand, gravel and cobbles, interfingering with Glacial Lake Missoula clay and silt, and is recharged mainly from leakage and underflow from O’Keefe Creek and tributary drainages, and hills flanking the valley.

The Public Water Supply

The Bitterroot International Systems PWS is a non-transient, non-community water system that obtains water from one well, located at 8275 Highway 10 West, in Missoula County. The well draws from approximately 290 to 305 feet below the ground surface. The Bitterroot International Systems PWS currently serves an estimated population of 55 with 1 active service connection. The location of the well is shown in [Figure 2](#). The well is linked to 4 captive air tanks and a particulate cartridge filter, located in the shop, prior to distribution. A general plan showing the layout of the distribution system is presented in Appendix A, with a copy of the sanitary survey.

Water Quality

Every PWS is required to perform monitoring for contamination to their water supply. Water is typically monitored for total coliform and fecal coliform, nitrates, metals and chemicals. The monitoring schedule depends on the population served, the number of wells and the source water for the PWS. DEQ defines monitoring programs and protocols that are specific to each PWS. Bitterroot International Systems had a violation of the MCL for coliform bacteria in March of 1997. Table 1 lists typical constituents of the Missoula Aquifer, in the Wye area.

Table 1. Sample groundwater quality data for the Wye area, Missoula County (WQD, 1996-2003).

Sample date	Well #/ Location	pH	Ca Mg/L	Mg Mg/L	Na Mg/L	S0 ₄ Mg/L	NO ₃ Mg/L	Cl Mg/L	HCO ₃ Mg/L	Fe Mg/L	Ba Mg/L	As Mg/L
1996 - 2003 (Ave.)	WQD # 15, 16, 38/ 14N20W, Sect. 16, 21 & 34	7.2	33.9	13.9	12.7	7.66	1.79	9.07	145	0.009	0.17	0.0004

Table 2. Water quality data for Bitterroot International Systems (MDEQ, PWS analytical results, 1995-2001).

Sample Date	Well #/ Location	pH	Ca Mg/L	Mg Mg/L	Na Mg/L	S0 ₄ Mg/L	NO ₃ Mg/L	Ba Mg/L	As Mg/L	FI Mg/L	Organic Chemicals Mg/L
1995- 2001 (Ave.)	PWS #3749/ 14N20W, sect. 28	7.8	31.1	0.006	13.7	<6	0.39	0.1	None Detected	0.4	None Detected

CHAPTER 2 DELINEATION

The source water protection area, the land area that contributes water to the Bitterroot International Systems PWS, is identified in this chapter. Four management areas are identified within the source water protection area: the control zone, inventory region, surface water buffer zone and recharge region. The control zone, also known as the exclusion zone, is an area at least 100-foot radius around the well. The inventory region represents the zone of contribution of the well, which approximates a three-year groundwater time-of-travel. Analytical equations describing ground water flow using estimates of pumping and aquifer characteristics and simple hydrogeologic mapping are used to calculate groundwater time-of-travel distance. The surface water buffer zone is delineated based on standard distance criteria of 10 miles upstream from the ground water inventory zone and encompasses ½ mile width of land area on each side of the drainages. The recharge region represents the entire portion of the aquifer that contributes water to the Bitterroot International Systems water system.

Hydrogeologic Conditions

Geologic and hydrogeologic studies of the Missoula area are listed in Table 3, with a summary of maps listed in Table 4. The following description is derived from these reports.

The Missoula Valley is part of a structural basin that began to open about 65 million years ago, during the early Tertiary crustal movement that created the Rocky Mountains. Precambrian metasedimentary rocks of the Belt Supergroup, and a few interspersed Paleozoic sedimentary rocks surround the valley, with peaks of 5000 to 7000 feet elevation. This relatively impermeable and deeply eroded landscape was partially filled with Tertiary and Quaternary alluvium, and Glacial Lake Missoula clays and silts. Portions of the Tertiary sediments were scoured from the valley during the repeated draining of Glacial Lake Missoula approximately 12,000 to 15,000 years ago, during the Wisconsin glacial stage, and were replaced with layers of sand, gravel and cobbles, deposited during these catastrophic events and more recent alluvium deposited along the river channel and flood plain. The sediments generally become finer to the southwest of the valley as a result of dissipating energy after sediment-carrying water flowed out of Hellgate Canyon and across the broader Missoula Valley, depositing coarser sediments first and then gradually allowing deposition of finer sediments.

The Missoula Aquifer is semi-confined in this area, and composed mainly of unconsolidated Quaternary alluvial fan deposits and Glacial Lake Missoula clay and silt. Layers of clay and silt deposited in the lake are interfingered with sand and gravel layers that were deposited between the multiple episodes of draining and refilling the Lake. Tertiary deposits (mostly Renova and Sixmile-Creek Equivalents) flank and underlie the area of Quaternary alluvium, but are generally fine-grained and much less productive than the more recent deposits. Some wells in the outlying areas of the valley are finished in Precambrian bedrock, but these are also much less productive than the main water-bearing alluvium, and derive water mainly from fractures. Depth to the water table ranges from approximately 6 to 70 feet below land surface, depending on distance from rivers and tributary streams. The seasonal fluctuation of the groundwater table ranges from approximately 2 to 13 feet (Woessner, 1988) and depends upon proximity to the recharge source and hydraulic conductivity of the surrounding aquifer sediments. The lateral extent of the Missoula Aquifer varies from about 0.25 miles wide at the mouth of Hellgate Canyon, to 6.25 miles wide between Maclay Flats and the mouth of Grant Creek; the overall length is approximately 20 miles. Groundwater flows generally westward through the Bitterroot International Systems area. The aquifer has high source water sensitivity because it is semi-confined and comprised of relatively coarse-grained material. The Missoula Valley Aquifer has been designated a “Sole Source

Aquifer” by the U.S. EPA. A geologic map of the Missoula area is presented in [Figure 3](#). [Figure 4](#) represents a generalized ground water flow map. Geologic cross sections are shown in [Figure 5](#).

Table 3. List of geologic or hydrogeologic investigations for the Missoula area.

Title of Project	Reference	Area Covered	Project Purpose.
Roadside Geology of Montana	D. Alt and D.W. Hyndman, 1986	Montana	Summaries of general geology of different regions in Montana.
Interactions Between the Clark Fork River and Missoula Aquifer, Missoula County, Montana	K.W. Clark, 1986	Missoula Valley	Define hydrogeology of Clark Fork River and Missoula Aquifer.
Hydrogeology and water resources of the Missoula Basin, Montana	A.L. Geldon, 1980	Missoula Basin	To determine the storage potential of the basin.
Geographic, Geologic, and Hydrologic Summaries of Intermontane Basins of the Northern Rocky Mountains, Montana	Kendy and Tresch, 1996.	Intermontane basins of the northern Rocky Mountains	Summarize the geographic, geologic and hydrologic characteristics of the Rocky Mountain region in western Montana.
Geology and Ground-water Resources of the Missoula Basin, Montana	McMurtrey, et. al, 1965	Missoula Basin	Summary of geology and hydrogeology
A Single Layer Transient Flow Model of the Missoula Aquifer	R.D. Miller	Missoula Valley	Computer model to define groundwater flow and hydraulic properties of the Missoula Aquifer.
Hydrology and Water Chemistry of Shallow Aquifers Along the Upper Clark Fork, Western Montana	D.A. Nimick, 1993	Upper Clark Fork region	Analyze hydrology of bedrock and unconsolidated Tertiary and Quaternary deposits
The Source, Fate and Movement of Herbicides in an Unconfined, Sand and Gravel Aquifer in Missoula, Montana	M.H. Pottinger, 1988	North central Missoula Valley	Hydrologic properties and groundwater flow of aquifer to determine source and fate of herbicide contamination.
The Hydrogeology of the Central and Northwestern Missoula Valley	C.A. Smith, 1992	Portion of Missoula Valley	Geology, hydrologic properties, groundwater flow, interaction with river and water quality of the Missoula Aquifer.
Missoula Valley Aquifer Study: Hydrogeology of the eastern portion of the Missoula Aquifer, Missoula County, Montana	W.W. Woessner, 1988	Eastern portion of the Missoula Aquifer	To assess existing and future anthropogenic effects on the aquifer

Table 4. List of geologic or hydrogeologic maps available for the Missoula area.

Title or Description	Date	Area Covered	Reference
Geologic Map of the Missoula West 30' x 60' Quadrangle	1998	Missoula Valley west of Missoula, and Bitterroot Valley south to Stevensville, MT	Lewis, R.S., 1998. MBMG Open File 373.
Potentiometric Map, March 1993 and June 1993	1994	Hellgate Canyon, Missoula County	Gestring, S.L., 1994. The Interaction of the Clark Fork River and the Hellgate Valley on the Aquifer Near Milltown, MT
Geologic Map and Sections of the Bonner Quadrangle, Montana	1961	Bonner Quadrangle	Nelson and Dobell, 1961
Generalized geologic map of the Butte 1 X 2 degree quadrangle, Montana	1987	Approximately 100 X 70 mi. area of Missoula, Powell, Lewis & Clark and Deer Lodge Counties	Wallace, C.A., USGS Miscellaneous Field Studies Map MF-1925

Conceptual Model and Assumptions

A conceptual hydrogeologic model is a simplified representation of the hydrogeologic system. This section describes the conceptual model used for this report.

The ground water in this part of the Missoula Valley is generally semi-confined under discontinuous Glacial Lake Missoula silts and clays, and occurs primarily in unconsolidated Quaternary sand and gravel units, which are laterally and basally bounded by much less permeable tertiary sediments and bedrock. Tertiary sediments and fractured bedrock yield small quantities of water in some areas. Recharge in this area is derived mainly from leakage and underflow from tributary drainages, and hills flanking the valley. Ground water flows generally southwestward through the Wye area ([Figure 5](#)).

Methods and Criteria

The Montana Department of Environmental Quality specifies the methods and criteria used for source water protection zone delineation for the Bitterroot International Systems PWS (DEQ, 1999). Because the upper Clark Fork alluvial aquifer communicates with the Clark Fork River and communicates with tributary streams in the area, Surface Water Buffer Zones were applied to the Clark Fork River and tributary drainages. Time-of-travel calculations were completed for the ground water system using the uniform flow equation (U.S.E.P.A. 1991). Using published reports, estimates of the aquifer properties were made and are discussed in the following section. The recharge area is defined as the area where the aquifer is present upgradient from the well(s). The surface water buffer zones were delineated based on standard distance criteria of 10 miles upstream from the ground water inventory zone and encompassed ½ mile width of land area on each side of the drainages.

Well(s) Information

The wells are located at 8275 Highway 10 West, in Township 14 North, Range 20 West, section 28, Missoula County. Table 3 is a summary of the wells information and Appendix B contains a copy of the well log. The well is drilled to a depth of 280 feet.

Table 5. Source well information for Bitterroot International Systems PWS.

Information	Well #1
PWS Source Code	003749-002
Well Location (T, R, Sec or lat, long)	Lat: 46.9500° Long: - 114 .1375°
MBMG#	139877
Water Right #	C096101-00
Date Well was Completed	10/13/93
Total Depth	280 ft.
Perforated Interval	230 to 240 ft.
Static Water Level	177 ft.
Pumping Water Level	--
Drawdown	--
Test Pumping Rate	25 gpm
Specific Capacity	--

Model Input

Time-of-travel input values are conservative assumptions made to identify areas that potentially impact source water for the Bitterroot International Systems PWS. The criteria for selection of each value used for this delineation is summarized as follows:

Thickness: The thickness of the aquifer is estimated to be 15 ft, inferred from area well logs.

Hydraulic Conductivity: A value for hydraulic conductivity is estimated to be 300 ft/day, based upon Smith (1992) and typical hydraulic conductivities of moderately sorted unconsolidated deposits (Freeze and Cherry, 1979). We have chosen a value that should provide a conservative estimate of time-of-travel distances.

Transmissivity: The estimated value for transmissivity in this area is 4500 ft²/day ($T = Kb$, where K = hydraulic conductivity = 300 ft/day; b = aquifer thickness = 15 ft).

Hydraulic Gradient: The estimated hydraulic gradient is 0.003 (WQD, 1998).

Flow Direction: The estimated average flow direction for the purposes of this study is southwest (225 degrees; WQD, 1998).

Porosity: The value for effective porosity is estimated at 25%. The estimated value is considered representative of unconsolidated sand and gravel, and is between two published estimates of 20% (Clark, 1986) and 40% (McMurtrey et al., 1965).

Pumping Rate: The estimated combined pumping rate of the wells is 0.95 gallons per minute based on 25 gallons per day, estimated use per non-resident user (Solley, et al., 1998; Salvato, 1992).

Time-of-Travel Calculation

Travel distances for 100 days, one year and three years are calculated using the Uniform Flow Equation (U.S.E.P.A., 1991; see Appendix D). The one- and three-year time-of-travel distances are used in Chapter 4 to rate the hazards of potential contaminant sources.

Table 6. Estimates of input parameters used to delineate the Bitterroot International Systems source water protection area.

Input Parameter	Range of Values	Values Used
PWS Source Code		003749 -002, 003749 -003
Transmissivity	1500 – 18,000 ft²/day	4500 ft²/day
Thickness	5 – 40 ft.	15 ft.
Hydraulic Conductivity	25 - 450 ft/day	300 ft/day
Hydraulic Gradient	0.0002-0.005	0.003
Flow Direction	180 – 270 deg.	225 deg.
Effective Porosity	20 – 40%	25%
Pumping Rate	0.72 – 1.2 gpm	0.95 gpm
100-day TOT	35 – 1150 ft.	380 ft. 0.07 miles
1-Year TOT*	72 – 4200 ft.	1350 ft 0.26 miles
3-Year TOT*	140 – 12,500 ft.	4000 ft 0.76 miles

*Time of Travel

Delineation Results

The results of the calculations indicate an estimated average distance of 380 feet (0.07 miles) for a 100-day time of travel (TOT), an average distance of 1350 feet (0.26 miles) for a one-year TOT and an average distance of 4000 feet (0.76 miles) for a three-year TOT. The delineated inventory zones are depicted in [Figure 6](#) for the Bitterroot International Systems PWS. The surface water buffer zones for the Clark Fork River are shown in [Figure 7](#). The recharge region for the aquifer comprises the aquifer upgradient from the supply wells. A 45-degree range of groundwater flow directions was used to define the lateral boundaries of the inventory region ([Figure 5](#)).

Limiting Factors

This delineation is based on estimated aquifer properties, pumping conditions and groundwater flow conditions, and assumes uniform flow in a homogeneous aquifer. Conclusions based on this

interpretation are uncertain because the extent and properties of the aquifer, and the direction and rate of groundwater flow are not known precisely, and the actual transient flow and heterogeneous stratigraphy can only be roughly approximated by the above assumptions. Time-of-travel distances are estimates based on available data. We have chosen input parameter values that will give us conservative but reasonable estimates of capture zones. This should provide a protective margin for inaccuracy inherent in calculations of this nature.

CHAPTER 3 INVENTORY

An inventory of potential sources of contamination was conducted for the Bitterroot International Systems PWS within the control and inventory regions. Potential sources of all primary drinking water contaminants and pathogens were identified, however, only significant potential contaminant sources were selected for detailed inventory. The significant potential contaminants in the Bitterroot International Systems PWS inventory region are nitrate, pathogens, fuels, solvents, herbicides, pesticides, and metals. The inventory for the Bitterroot International Systems PWS focuses on all activities in the control zone, municipal and private facilities in the inventory region, and general land uses and large facilities in the recharge region.

Inventory Method

Available databases were searched to identify businesses and land uses that are potential sources of regulated contaminants in the inventory region. A “windshield survey” was conducted to obtain additional information for this assessment. The following steps were followed:

Step 1: Urban and agricultural land uses were identified from the U.S. Geological Survey's Geographic Information Retrieval and Analysis System. Sewered and unsewered residential land use was identified from boundaries of sewer coverage obtained from municipal wastewater utilities. Septic system density outside of the sewered area was evaluated using the Montana Department of Revenue Computer Assisted Mass Appraisal (CAMA) database.

Step 2: EPA's Envirofacts System was queried to identify EPA regulated facilities located in the Inventory Region. 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). 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: The Permit Compliance System (PCS) was queried using Envirofacts to identify Concentrated Animal Feeding Operations with MPDES permits. The water system operator or other local official familiar with the area included in the inventory region identified animal feeding operations that are not required to obtain a permit.

Step 4: Databases were queried to identify the following in the inventory region: Underground Storage Tanks (USTs), hazardous waste contaminated sites (DEQ CECRA and WQA sites), landfills, abandoned mines and active mines including gravel pits. Any information on past releases and present compliance status was noted.

Step 5: County records were queried to identify businesses that generate, use, or store chemicals in the inventory region. The facilities include equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers.

Step 6: A “windshield survey” was undertaken to identify additional potential contaminant sources not listed in the databases. These are listed in Table 8.

Step 7: Major road and rail transportation routes were identified throughout the inventory region.

Step 8. All land uses and facilities that generate, store, or use large quantities of hazardous materials were identified within the recharge region and identified on the base map.

Potential contaminant sources are designated as significant if they fall into one 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 UST leak sites).
- 5) Underground injection wells.
- 6) Major roads or rail transportation routes.
- 7) Cultivated cropland greater than 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.

Inventory Results/Control Zone

The area immediately surrounding the well is commercial/industrial.

Inventory Results/Inventory Region

Significant potential contaminant sources for the Bitterroot International Systems PWS include nearby septic systems; an animal feeding operation; fuel and chemical spills along transportation routes and pipelines; and underground storage tanks. Bitterroot International Systems is approximately 400 feet from Highway 10. The Missoula Livestock Exchange, a permitted confined animal feeding operation, is located just downgradient, and is not in the inventory region. Septic system density is $<1/\text{mi}^2$ in the 1-year time-of-travel, and approximately $47/\text{mi}^2$ in the 3-year time-of-travel region. The significant potential contaminant sources within the inventory zone are listed in Table 8. The general locations of these sources are shown in [Figure 10](#).

Inventory Results/Surface Water Buffer Zones

No Surface Water Buffer Zone has been delineated, because only small, ephemeral drainages exist near the inventory regions. Bitterroot International Systems is approximately 1500 feet and 4000 feet from small ephemeral drainages.

Inventory Results/Recharge Region

The land use in the recharge area is primarily forest (64%) grass/rangeland (21%), agricultural (12%), and commercial/industrial (3%). Septic system density in the recharge region is approximately $21/\text{mi}^2$. Bitterroot International is approximately 0.8 miles from the railroad, and 1600 feet from I-90. Potential hazards and general land use for the area are depicted in [Figure 8](#).

Table 7. Significant Potential Contaminant Sources for PWS #3749 Inventory Region

Facility Name	Address/Location	Type of Facility	Potential Contaminants
I-90		Interstate Highway	Fuel, other chemical spills
Hwy 93 & Hwy 10		U.S. Highway	Fuel, other chemical spills
Montana Rail Link		Rail line	Fuel/chemical spills
Crossroads	8018 Hwy 93 North	UST; Pollution Prevention Permit	Fuel
Septic System Density: <1/ mi ² 1-yr. TOT 47/ mi ² 3-yr. TOT	Non-point		Pathogens, nitrate
Agricultural Land Use 12%	Non-point		Pathogens, nitrate, pesticides
Missoula Cartage Company, Inc	9300 Cartage Rd	Active UST Release; Pollution Prevention permit	Diesel, New Oil, Waste Oil, New Gear Oil
Missoula Freightliner	8745 Hwy 93 N	Pollution Prevention Permit	Waste Oil, New Oil
Muralt's Travel Plaza	8800 Truck Stop Rd	Active UST Release; Pollution Prevention permit	Gasoline, Diesel, Motor Oil, Waste Oil
Northwest Peterbilt	9550 Cartage Rd	Pollution Prevention permit	Oil, Waste Oil, Waste Gear Lube

Inventory Update

The certified operator will update the inventory every year. Changes in land uses or potential contaminant sources will be noted and additions made as needed. The complete inventory will be submitted to DEQ every five years to ensure re-certification of the source water delineation and assessment report.

Inventory Limitations

The accuracy of the inventory is limited by the accuracy of information provided by state and federal databases. The windshield survey provides a level of quality assurance that the information presented reflects actual conditions. The inventory is also limited by the accuracy of the delineation, which is discussed above.

CHAPTER 4 SUSCEPTIBILITY ASSESSMENT

The susceptibility of Bitterroot International Systems wells to significant potential contaminant sources is assessed in this chapter. Susceptibility is the potential for a well to be contaminated by one of the sources inventoried in the previous chapter. Hazard ratings and the presence of barriers determine susceptibility (Table 9). Hazard ratings are determined by the proximity of a potential point-source contaminant or the density of non-point source potential contaminants to the well. For the Bitterroot International Systems PWS, contaminant sources within the one-year TOT were given a high hazard rating and all other sources within the inventory region were given moderate hazard rating. The susceptibility is then determined based upon the hazard and any barriers that mitigate the hazard. Barriers can be engineered structures, management actions and/or natural conditions. Spill catchments for fueling facilities and leak detection for underground storage tanks are examples of engineered barriers. Emergency planning and availability of trained hazardous materials response team, and best management practices are examples of management barriers. Clay soils, deep wells and a thick layer of substrate above an aquifer can be considered natural barriers.

Table 9. Relative susceptibility to specific contaminant sources as determined by hazard and the presence of barriers.

Presence Of Barriers	Hazard		
	High	Moderate	Low
No Barriers	Very High Susceptibility	High Susceptibility	Moderate Susceptibility
One Barrier	High Susceptibility	Moderate Susceptibility	Low Susceptibility
Multiple Barriers	Moderate Susceptibility	Low Susceptibility	Very Low Susceptibility

For point sources, the relative hazard of the significant potential contaminant sources listed in Table 7 reflects the location of the sites relative to the PWS wells and how long ground water would take to travel from that site to the wells. For sites located within a time of travel distance of less than one year, the relative hazard is assigned as high. For the remaining sites located in the inventory region, the relative hazard assigned is moderate.

For non-point sources, the relative hazard is assigned based on the following table.

Table 10. Non-point source relative hazard ratings.

Source Type	High Hazard	Moderate Hazard	Low Hazard
Septic Systems	>300 per sq. mi.	50-300 per sq. mi	<50 per sq. mi.
Municipal Sanitary Sewer (% Land Use)	>50% of region	20%-50% of region	<20% of region
Cropped Agricultural Land (% Land Use)	>50% of region	20%-50% of region	<20% of region

Table 11. Susceptibility assessment for significant potential contaminant sources in the Control Zone and Inventory Region.

Map ID#	Facility Name	Contaminant	Hazard	Barriers	Susceptibility	Management
Labeled	Hwy 10 W.	Fuel/chemicals	High	Haz Mat Team	Moderate	
Labeled	I-90/Hwy 93/Montana Rail Link	Fuel/chemicals	Moderate	Haz Mat Team	Low	
Non-point	Septic density of 47/mi ²	Pathogens & nitrate	Low		Moderate	
Labeled	USTs	Fuel	Moderate	Leak prevention & detection	Moderate	
Labeled	Pollution Prevention Facilities	Fuel/chemicals	Moderate	P2 requirements /inspections	Moderate	

REFERENCES

- Clark, K.W., 1986. Interactions between the Clark Fork River and Missoula Aquifer, Missoula, Montana. University of Montana, M.S. thesis, 150 p.
- Driscoll, F.G., 1986. Groundwater and wells, 2nd Edition. Johnson Division, St. Paul, Minnesota.
- Evans, C.A., 1998. A Constrained Gravity Model of the Central Missoula Valley and Shape of the Ninemile Fault. University of Montana M.S. Thesis, 45 p.
- Fetter, C.W., Jr., 1980. Applied Hydrogeology. Charles E. Merrill, Columbus, Ohio, 488 p..
- Freeze, R.A., and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, NJ, 604 p.
- Geldon, A. L., 1980. Hydrogeology and Water Resources of the Missoula Basin, Montana. University of Montana, M.S. thesis, 114 p.
- Kendy, E., and Tresch, R.E., 1996. Geographic, Geologic, and Hydrologic Summaries of Intermontane Basins of the Northern Rocky Mountains, Montana. U. S. Geological Survey Water-Resources Investigations Report 96-4025, 233 p.
- Miller, R.D., 1990. A Single Layer Transient Flow Model of the Missoula Aquifer. Missoula City-County Health Department Report, 253 p.
- Missoula Valley Water Quality District, 1996. Evaluation of Unsewered Areas in Missoula, Montana.
- Montana Bureau of Mines and Geology, Ground-Water Information Center online well log database.
- Montana Department of Environmental Quality (DEQ), 1999. Montana Source Water Protection Program.
- National Oceanic and Atmospheric Administration, National Climatic Data Center online database.
- Nimick, D.A., 1993. Hydrology and Water Chemistry of Shallow Aquifers Along the Upper Clark Fork, Western Montana. U.S. Geological Survey Water-Resources Investigations Report 93-4052, 63 p.
- Pottinger, M.H., 1988. The Source, Fate and Movement of Herbicides in an Unconfined, Sand and Gravel Aquifer in Missoula, Montana. University of Montana M.S. Thesis, 172 p.
- Salvato, J.A., 1992. Environmental Engineering and Sanitation. John Wiley & Sons, Inc. pp. 285-294.
- Smith, C.A., 1992. The Hydrogeology of the Central and Northwestern Missoula Valley. University of Montana M.S. Thesis, 169 p.

Solley, W.B., Pierce, R.R. and Perlman, H.A., 1998. Estimated Use of Water in the United States in 1995. U.S.G.S. Circular 1200, pp. 24 – 27.

U.S. Environmental Protection Agency, 1997. Water on Tap: A Consumer's Guide to the Nation's Drinking Water.

Woessner, W.W., 1988. Missoula Valley Aquifer Study: Hydrogeology of the Eastern Portion of the Missoula Aquifer, Missoula County, Montana. University of Montana Department of Geology, 127 p.

APPENDIX A

PWS System Layout and Sanitary Survey

APPENDIX B

Well Log for PWS

**Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
BITTERROOT INTERNATIONAL SYSTEMS INC**

Location Information

GWIC Id: 139877	Source of Data: LOG
Location (TRS): 14N 20W 28 BABB	Latitude (dd): 46.9500
County (MT): MISSOULA	Longitude (dd): -114.1375
DNRC Water Right: C096101-00	Geomethod: MAP
PWS Id: 03749002	Datum: NAD27
Block:	Certificate of Survey:
Lot:	Type of Site: WELL
Addition:	
Site Notes: TRACT LOCATION BASED ON DESCRIPTION FROM DEQ.	

Well Construction and Performance Data

Total Depth (ft): 280.00	How Drilled: ROTARY
Static Water Level (ft): 177.00	Driller's Name: JEROME
Pumping Water Level (ft):	Driller License: WWC249
Yield (gpm): 25.00	Completion Date (m/d/y): 10/13/1993
Test Type: AIR	Special Conditions:
Test Duration: 1.00	Is Well Flowing?:
Drill Stem Setting (ft):	Shut-In Pressure:
Recovery Water Level (ft):	Geology/Aquifer: 120SNGR
Recovery Time (hrs):	Well/Water Use: DOMESTIC
	PUBLIC WATER SUPPLY

Well Notes: JEROMES FILE NO: 5991

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Annular Seal Information

From	To	Description
0.0	0.0	BENTONITE

Casing Information¹

From	To	Dia	Description
-2.0	280.0	6.0	A53B STEEL

Completion Information¹

From	To	Dia	Description
230.0	240.0	6.0	3/16 X 1 INCH HOLTE PERFS

Lithology Information

From	To	Description
0.0	197.0	CLAY GRAVEL COBBLESEAMS
197.0	280.0	SAND GRAVEL

¹ - 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 C

MBMG-GWIC Well Logs for Area

**Ground Water Information Center
Wells Report**

The following data were returned from the GWIC databases for the area you requested. For a more detailed description of the data view the [GWIC Metadata report](#). If you notice data entry errors or have questions please let us know by clicking [here](#) to send us an E-mail. If you wish to view a one page report for a particular site, click the hyperlinked **Gwic Id** for that well. Scroll to the right of your screen to view all the data.

Retrieval Statistics *				
Field	Max	Min	Count	Avg
Total Depth	632.00	76.50	63	209.82
Pumping Water Level	304.50	75.00	36	138.43
Static Water Level	190.00	59.00	57	117.28
Yield (gpm)	150.00	6.00	61	23.28

* These statistics do not take any geographic, topographic, or geologic factors into consideration. Negative swl values are reported for water levels that are above land surface.

Gwic Id	DNRC WR	Site Name	Location	Ver?	Type	Td	Pwl	Swl	Yield	Date	Use
123643		CARAS GEORGE	14N20W28	NO	WELL200.00	190.00	147.00	25.00	6/27/1991	DOMESTIC	
71077		CUSTOM ENTERPRISES	14N20W28	NO	WELL110.00	93.00	78.00	10.00	1/14/1976	INDUSTRIAL	
71075	20429	HIGHTOWER & WALLACE CONSTRUCTION	14N20W28	NO	WELL178.00	175.00	130.00	15.00	6/12/1978	INDUSTRIAL	
71078		HWC CONSTRUCTION	14N20W28	NO	WELL160.00	107.00	95.00	20.00	8/26/1980	INDUSTRIAL	
71084	2993	JACOBS JACK	14N20W28	NO	WELL143.00	140.00	113.00	15.00	7/1/1974	INDUSTRIAL	
71080		JONES EQUIPMENT	14N20W28	NO	WELL240.00	176.00	165.00	25.00	11/9/1984	DOMESTIC	
71079		MCCUE BOB	14N20W28	NO	WELL500.00			30.00	11/16/1979		
71082		P & C FABRICATION	14N20W28	NO	WELL180.00	118.00	107.00	25.00	11/1/1983	INDUSTRIAL	
71083		RATHBUN LARRY D.	14N20W28	NO	WELL190.00	148.00	127.00	30.00	4/3/1985	DOMESTIC	
71074	20307	SCHMAUTZ BERNICE	14N20W28	NO	WELL140.00	90.00	80.00	12.00	6/29/1978	DOMESTIC	
71081		SCHWANS SALES ENTERPRISES INC	14N20W28	NO	WELL170.00	93.00	80.00	10.00	4/15/1983		
71089		AUNE PETER O-- ESTATE OF	14N20W28A	NO	WELL286.00	276.00	155.00	25.00	5/13/1971	DOMESTIC	
71087		AUNE PETER O.	14N20W28A	NO	WELL227.00	75.00		14.00	7/12/1969	DOMESTIC	

71088	AUNE PETER O.	14N20W28A	NO	WELL275.00	170.00	25.00	1/1/1941	DOMESTIC
191961	K AND E EQUIPMENT	14N20W28AA	NO	WELL165.00	92.00	20.00	8/28/2001	DOMESTIC
199511	MARVINS BAR	14N20W28AA	NO	WELL235.00	174.00	15.00	10/15/2002	DOMESTIC
169643	KEYSTONE CONSTRUCTION	14N20W28AAC	NO	WELL203.00157.00		20.00	11/18/1998	DOMESTIC
163017	RUSSELL EXCAVATING	14N20W28AB	NO	WELL400.00304.50178.00	60.00		7/30/1997	DOMESTIC
71086	C075229-00REDWOOD LODGE	14N20W28ABAA	NO	WELL247.00185.00176.00	55.00		11/13/1979	COMMERCIAL PUBLIC WATER SUPPLY
176869	FRAZER TRANSPORT	14N20W28ABC	NO	WELL140.00	92.00	6.00	7/6/1999	DOMESTIC
706451	C097072-00MARVINS TAVERN	14N20W28ABDC	NO	WELL259.00			1/1/1941	PUBLIC WATER SUPPLY
181238	KASHIRETS NIKOLAY	14N20W28AC	NO	WELL180.00	105.00	10.00	4/1/2000	DOMESTIC
171795	MISSOULA VILLAGE WEST TRAILER COURT	14N20W28ACAB	NO	WELL				PUBLIC WATER SUPPLY
71090	PALMER TRUCKING COMPANY	14N20W28ACCBA	NO	WELL180.00145.00135.00	15.00		6/27/1979	DOMESTIC
161985	CROSSROADS TRUCK CENTER	14N20W28ADA	NO	WELL320.00	170.00	60.00	5/15/1997	DOMESTIC
204742	MISSOULA CHRISTIAN FELLOWSHIP	14N20W28ADB	NO	WELL126.00115.00101.00	25.00		5/20/1994	DOMESTIC PUBLIC WATER SUPPLY
151151	BITTERROOT INTERNATIONAL	14N20W28BA	NO	WELL315.00	185.00	50.00	6/30/1995	DOMESTIC
139877	C096101-00BITTERROOT INTERNATIONAL SYSTEMS INC	14N20W28BABB	NO	WELL280.00	177.00	25.00	10/13/1993	DOMESTIC PUBLIC WATER SUPPLY
153843	C096084-00WILLIAMS EQUIPMENT	14N20W28BADB	NO	WELL320.00	170.00	60.00	11/13/1995	PUBLIC WATER SUPPLY
139878	EDWARDS HOWARD	14N20W28BB	NO	WELL220.00	160.00	15.00	12/15/1993	DOMESTIC
191986	FRASER JOE	14N20W28BB	NO	WELL180.00	97.00	7.00	11/6/2001	DOMESTIC
189610	C116159-00MORGENSTERN DICK C/O KEYSTONE CONSTRUCTION	14N20W28BCB	NO	WELL218.00	115.00	20.00	4/9/2001	DOMESTIC
204436	EVANS BILL	14N20W28BDD	NO	WELL200.00	108.00	12.00	7/8/2003	DOMESTIC
71091	JENSEN DAN	14N20W28C	NO	WELL200.00101.00	89.00	15.00	8/28/1987	DOMESTIC
163016	COLLINS TOM F JR	14N20W28CA	NO	WELL160.00112.00112.00	7.00		7/8/1997	DOMESTIC
182197	SVABODA REX	14N20W28CA	NO	WELL180.00	128.00	15.00	3/23/2000	DOMESTIC

176870	NEILSON RAY OR LARRY	14N20W28CAB	NO	WELL121.00106.00105.00	20.00	10/22/1999	DOMESTIC		
181237	CHINIKAYLO FEDOR	14N20W28CB	NO	WELL175.00	95.00	15.00	4/3/2000	DOMESTIC	
71092	9353RASMUSSEN STAN	14N20W28CD	NO	WELL 76.50	75.00	59.00	18.00	5/13/1976	DOMESTIC
71093	6105REAL LOG HOMES INC	14N20W28D	NO	WELL372.00300.00102.00	40.00	7/10/1975	DOMESTIC		
71094	BROWN DICK	14N20W28DA	NO	WELL132.00124.00	84.00	12.00	4/23/1974	DOMESTIC	
189612	COUFAL LARRY	14N20W28DA	NO	WELL227.00	160.00	20.00	5/10/2001	DOMESTIC	
142299	CULLINAN TERRY	14N20W28DA	NO	WELL240.00	96.00	15.00	5/6/1994	DOMESTIC	
157522	HETTICK HARLEY	14N20W28DA	NO	WELL200.00	114.00	25.00	8/2/1996	DOMESTIC	
197548	KRIEG JO (FREDS LOUNGE)	14N20W28DA	NO	WELL250.00	190.00	20.00	8/14/2002	DOMESTIC	
156556	MELS AUTO ELECTRIC	14N20W28DA	NO	WELL200.00	151.00	25.00	6/24/1996	DOMESTIC	
165666	MISSOULA RV REPAIR	14N20W28DA	NO	WELL150.00115.00	99.00	20.00	1/5/1998	DOMESTIC	
706452	THOR LUMBER CO	14N20W28DA	NO	WELL180.00			1/1/1919	DOMESTIC	
71095	BARKLEY BEN	14N20W28DAB	NO	WELL150.00140.00	85.00	25.00	5/2/1974	INDUSTRIAL	
71096	1835THORTON LUMBER CO	14N20W28DAB	NO	WELL140.00128.00	80.00	15.00	1/3/1974	COMMERCIAL DOMESTIC	
71085	TRANSPORT EQUIPMENT INC	14N20W28DABD	NO	WELL154.00	96.00	85.00	15.00	9/2/1987	DOMESTIC PUBLIC WATER SUPPLY
167589	HALL ROGER A	14N20W28DAD	NO	WELL120.00101.00	89.00	22.00	3/2/1998	DOMESTIC	
71097	SCHAFFERS MOBIL SER	14N20W28DADCANO	WELL	96.00	84.00	80.00	8.00	10/8/1967	DOMESTIC
169644C107404-00	FRONTIER WEST INC	14N20W28DB	NO	WELL153.00145.00	93.00	12.00	12/11/1998	DOMESTIC	
154288	MONTANA SALVAGE POOL	14N20W28DB	NO	WELL180.00	135.00	20.00	12/6/1995	DOMESTIC	
167421	WILTZEN JOHN	14N20W28DB	NO	WELL390.00140.00		20.00	6/23/1998	DOMESTIC	
71098	WILLISON GENE	14N20W28DBADBNO	WELL	170.00125.00110.00		20.00	7/7/1976		
71076	GALLAGHER CEDAR PRODUCTS	14N20W28DBDA	NO	WELL120.00	95.00	85.00	15.00	3/16/1977	DOMESTIC INDUSTRIAL
158545	ACE AUTO SALVAGE	14N20W28DC	NO	WELL220.00	122.00	6.00	10/8/1996	DOMESTIC	
158146	JACKSON GRAHAM	14N20W28DC	NO	WELL180.00	118.00	7.00	9/30/1996	DOMESTIC	
71099	RASMUSSEN STAN	14N20W28DC	NO	WELL157.00	78.00	72.00	150.00	1/7/1981	

191990	KINNEY LEWIS F14N20W28DD	NO	WELL190.00	126.00	14.00	9/14/2001	DOMESTIC
71100	R-LITE	14N20W28DDBB	NO	WELL632.00216.00	71.00	18.00	6/28/1966
	CONCRETE						INDUSTRIAL
	PRODUCTS INC						IRRIGATION
71101	RASMUSSEN	14N20W28DDCD	NO	WELL116.00115.00	68.00	30.00	6/17/1977
	ROGER						DOMESTIC

End of Report. **64** record(s) listed.

This report is restricted to site types of **WELL, BOREHOLE, SPRING, and COAL BED METHANE WELL.**

Explanation of Columns: **Td** = Total depth of well in feet below ground

Pwl = Pumping water level in feet below ground

Swl = Static water level in feet above/below ground - Negative values are reported for water levels that are above land surface.

Yield = Yield in gallons per minute

Date = Completion date of well/borehole

Use = Reported use of water

Ver? = Was location verified?

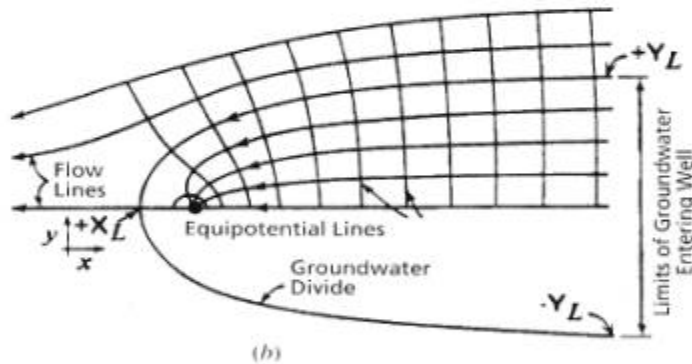
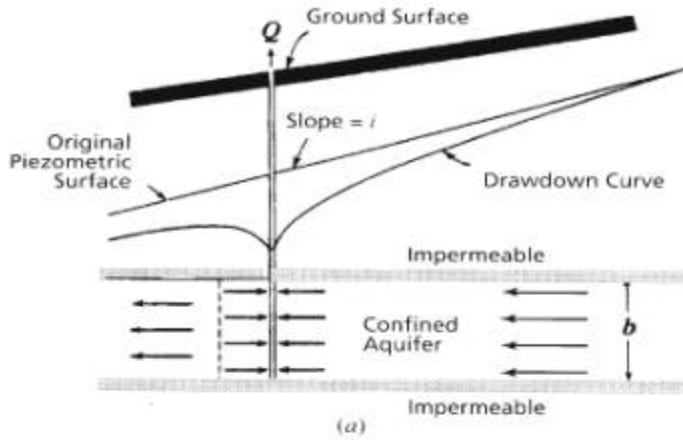
The preceding materials represent the contents of the GWIC databases at the Montana Bureau of Mines and Geology at the time and date of the retrieval. The information is considered unpublished and is subject to correction and review on a daily basis. The Bureau warrants the accurate transmission of the data to the original end user at the time and date of the retrieval. Retransmission of the data to other users is discouraged and the Bureau claims no responsibility if the material is retransmitted.

APPENDIX D

Time of Travel Calculations

UNIFORM GROUNDWATER FLOW EQUATION

Flow to a well penetrating a confined aquifer having a sloping plane piezometric surface - vertical section and plan view (Todd, 1980).



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

Uniform-Flow Equation

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

Distance to
Down-Gradient
Null Point

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

Boundary Limit

Legend:

● Pumping Well

Where:

Q = Well Pumping Rate
K = Hydraulic Conductivity
b = Saturated Thickness
i = Hydraulic Gradient
 $\pi = 3.1416$

TIME-OF-TRAVEL CALCULATION METHOD

The time of travel for water to move along a line parallel to the hydraulic gradient, from a point to a pumping well (EPA 1991).

$$T_x = \frac{n}{Ki} \left[X_L - \frac{Q}{2\pi Kbi} \ln \left(1 + \frac{2\pi Kbi}{Q} X_L \right) \right]$$

- T_x = travel time from point x to a pumping well
- n = porosity
- X_L = distance from pumping well over which groundwater travels in T_x
- Q = discharge
- K = hydraulic conductivity
- b = aquifer thickness
- i = hydraulic gradient

APPENDIX E

Inventory Sheets

APPENDIX F

Checklist

*Department of Environmental Quality
Source Water Protection Program*

CERTIFICATION CHECKLIST

*Source Water Delineation and Assessment Reports (SWDAR)
For Community and non-community non-transient PWSs*

The following items represent the minimum requirements for certification of a completed SWDAR for Community and non-community non-transient PWSs. The SWDAR represents the technical component of the SWPP, and must be completed per the 1996 amendments to the Federal Safe Drinking Water Act. This checklist should be used in conjunction with the information and general format provided in the template for preparing SWDAR documents. While the format of the template may be modified as needed, all requested information should be included for certification.

For any items that are not applicable or information is not available, note in checklist column and provide an explanation. Attach additional sheets for explanation, if necessary.

Name of System:	Bitterroot International Systems
PWS #:	3749
Date Submitted:	August 30, 2004
Operator Name:	Brian Hensel
SWPP Contact:	Name: Stan Spencer Address: P.O. Box 16475 Missoula, MT 59808 Phone: (406) 721-6320
Person Preparing	Name: Michelle Hutchins, Environmental Health Specialist
Plan Contact:	Address: Missoula City County Health Department 301 W. Alder Missoula, MT 59802 Phone: (406) 258-4890

The following summary checklist is derived from the Source Water Delineation and Assessment Report template document. The completed plan should include summary discussions, when appropriate, for each listed item. Indicate the page and/or section number where this information is, or indicate not applicable (n/a) when appropriate. For items indicated as not applicable, the text should indicate why.

Introduction

Page

Person who prepared document	iv
Name of system and county located in	iv
PWS Identification Number	iv
PWS contact person, with address and phone number	cover

Chapter 1 – Background

This section provides background information on the community served by the PWS.

Page

1. The Community:	1
• Population	1
• Economic base	1
• Major water users	1
• Major waste generators	1
• Domestic sewage treatment and disposal	1
2. Geographic Setting	1
• Geographic setting, including surrounding area	1
• Physiographic features	1
• Streams and lakes	1
• Climate information (including annual precipitation and temperatures)	1
• A vicinity map at appropriate scale	Fig. 1

For surface water sources, or ground water systems influenced by surface water

• 8 and 11 digit USGS Hydrologic Units	n/a
• Montana Watershed Management Region	n/a

3. General Description of Source Water 1

Description of PWS system, including:

- Source of water (number of wells, depths, etc.) 2
- Well lithology and construction logs (in appendix) Appx B
- Distribution system 1, Appx A
- Number of connections and users 2
- PWS Treatment System 2

- Copy of latest Sanitary Survey (in appendix) Appx A

- A map indicating the general layout of the PWS. Appx A

4. Water Quality:

- Summarize enforcement actions in the past 5 years 2
- Describe background/regional water quality 2
- Table summarizing background water quality 3

For surface water sources, or ground water systems influenced by surface water

- Use classification n/a
- Threatened or impaired streams in watershed n/a
- TMDL development prioritization and status n/a

Chapter 2 – Delineation

This section provides information on the hydrogeology of the water supply for the PWS. Background information on the hydrogeologic setting should be assembled into a *Hydrogeologic Conceptual Model* that summarizes the ground water system in a simplified manner. The background information should support the process to delineate management areas.

	<u>Page</u>
1. Hydrogeologic Conditions	4
• Identification of references for hydrogeologic information	4
• Summary tables of hydrogeologic studies and maps for area	5-6
• Summary of wells in area from GWIC database	Appx C
• Geologic map(s) included (if not, valid justification for omission)	Fig. 3
• Geologic cross section(s) included	Fig. 5
For ground water systems:	
• Identify aquifer	4
• Geologic setting of aquifer	4
• Aquifer properties (lithology, boundaries, etc.)	4
• Aquifer type (confined, unconfined, semi-confined)	4
• Connection with surface water	4
• Classify sensitivity of hydrogeologic setting of source water	4
For surface water sources, or ground water systems influenced by surface water	
• Hydrogeologic setting of PWS watershed	n/a
• Identification of references for hydrogeologic information	n/a
• Stream flow characteristics	n/a
2. Conceptual Model and Assumptions	6
• Seasonal trends in system	4
• Assumptions made to simplify model	9
For ground water systems:	
• Aquifer boundaries	4
• Aquifer recharge areas	6
• Ground water flow direction	6
• Communication with surface water	6
For surface water sources, or ground water systems influenced by surface water	
• Relationships of surface water with ground water system	n/a
3. Well (or source) Information	
For ground water systems:	

- Well depths, construction details 7
- Well locations described 7
- Summary table of source information 7
 [Source information to include: PWS Source Code, Well Location, MBMG (GWID) No., MT Water Right No., Date Well completed, total depth, perorated interval, static water level, pumping water level, drawdown, test pumping rate, and specific capacity]

For surface water sources, or ground water systems influenced by surface water

- Description of source water intake system n/a
- Streamflow data, if available n/a

4. Delineation Methods and Criteria

- Overview of approach used for delineation 6

5. Model Input

For ground water systems:

- Identify analytical method used, with source reference 6
- Values of hydraulic parameters identified, with ranges 9
- Identify hydrogeologic parameter values used, with rationale 7-8
- Summary table of input values for model 9
- Reference and justification for assumed values 7-8
- Time of travel equations or model specifications 7-8

For surface water sources, or ground water systems influenced by surface water

- Time of travel calculations for surface water body n/a
- Summary of ranges for streamflow parameter values n/a
- Identify streamflow parameter values used with rationale n/a
- Summary table of input values for model n/a

6. Delineation Results

- Travel time calculation results, or computer model calibration criteria 9
- Management zones identified on map(s) Figs. 6 & 7
- Delineated areas reflect seasonal variations in hydrologic systems 9

7. Limiting factors

- Identify uncertainties in delineation approach based on assumptions 9
- Identify how uncertainties may effect delineated areas 9

Chapter 3 – Inventory

This section identifies all known and potential contaminant sources which may affect the PWS.

- | | | |
|----|---|-------|
| 1. | Inventory methods identified | 10-11 |
| 2. | Appropriate databases searched, with potential sources identified | 10-11 |

For ground water systems:

- **Control zone** 11

Description of land uses
 Description of potential contaminant sources
 Worksheets completed for significant potential sources
 Potential contaminant sources summarized in a table
 Potential contaminant sources located on a base map

- **Inventory Region** 11

Description of land uses
 Description of potential contaminant sources
 Worksheets completed for significant potential sources
 Potential contaminant sources summarized in a table
 Potential contaminant sources located on a base map

- **Surface Water Buffer** 12

Description of land uses
 Description of potential contaminant sources for pathogens (acute health hazards)

- **Recharge Region** 15

Description of land uses
 Description of large potential contaminant sources
 Large potential sources and land use shown on a map

For surface water sources, or ground water systems influenced by surface water

- **Spill Response Region** n/a

Description of land uses
 Description of potential contaminant sources
 Worksheets completed for significant potential sources
 Potential contaminant sources summarized in a table
 Potential contaminant sources located on a base map

- **Watershed Region** n/a

Description of land uses
 Description of large potential contaminant sources

Map of watershed region showing significant potential contaminant sources
(e.g. MPDES permitted discharges, to the extent practical with existing databases)

For all systems

- Inventory update – procedures to update every five years 15
- Inventory limitations identified 15

Chapter 4 – Susceptibility Assessment

This section evaluates the potential for the PWS water supply to be contaminated by the significant potential sources of contamination identified in Chapter 3. This information can be used by local officials to prioritize management actions for the delineation control and inventory zones. Worksheets to be considered when completing each task are listed with each topic.

Attach completed worksheets as Appendices to final document

1. Hazard of potential contaminant sources identified 17-19
2. Barriers for each potential contaminant sources identified and evaluated 17-19
 - Supporting information for identification of features as barriers 17-19
3. Threats from significant potential contaminant sources ranked 17-19

References

All technical references are listed in the appropriate format 21-22

Appendices

All necessary supporting information is included in Appendices yes

List any Deficiencies:

none

APPENDIX G

Letter of Concurrence

Source Water Protection Section
Department of Environmental Quality
POB 200901
Helena, MT 59602-0901

RE: Source Water Delineation & Assessment Report

To Whom It May Concern:

The Bitterroot International Systems public water system has reviewed the source water delineation and assessment report (SWDAR) dated August 2004. We concur that the delineation component appears to describe current conditions at the water system based on reasonably available information and that the susceptibility assessment identifies the origins of regulated contaminants to the extent practical.

We understand that the Bitterroot International Systems PWS SWDAR will be made available to the public by DEQ as described in the Montana Source Water Protection Program. Also, we will make a copy of the report available for the public to view during our normal office hours and describe the results in subsequent releases of our consumer confidence report.

Signed,

Signature

Title and Date

Figures