Town of Pinesdale
Public Water Supply

PWS ID # MT0002926

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

Report Date: 12 September 2002

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by
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INTRODUCTION

Jeffrey Frank Herrick, a Hydrogeologist with the Montana Department of Environmental Quality (DEQ) and Joe Chiovaro, an intern with the DEQ completed this Source Water Delineation and Assessment Report.

Purpose
This Source Water Delineation and Assessment Report (SWDAR) is intended to meet the technical requirements for completion of delineation and assessment for the public water supply (PWS) of Town of Pinesdale, as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (P.L. 104-182).

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protect public drinking water supplies (PWSs) from contamination. A major component of the Montana Source Water Protection Program is termed “delineation and assessment.” Delineation is a process of mapping areas that contribute water used for drinking. Assessment involves identifying locations in the delineated areas where contaminants may be generated, stored, or transported, and then determining the relative potential for contamination of drinking water by these sources. This source water delineation and assessment is typically combined in the form of a source water delineation and assessment report (SWDAR). The primary purpose of a SWDAR is to provide information that helps the PWS owners and operators, and the citizens in the Town of Pinesdale protect their drinking water sources and provide the information needed to develop a Source Water Protection Plan (SWPP).

Limitations
This report was prepared to assess threats to the public water supply in Town of Pinesdale and is based on published and public information and input obtained from persons familiar with the community. The terms “drinking water supply” or “drinking water source” refer specifically to the source of the PWS in Town of Pinesdale and not any other public or private water supply. In addition, not all of the potential or existing sources of groundwater or surface water contamination in the area are identified. Only documented or known potential sources of contamination in areas that contribute water to public water supply sources are considered.

The terms “contaminant” is used in this report to refer to constituents for which Maximum Contaminant Levels (MCLs) have been specified under the national primary drinking water standards and to certain constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1
BACKGROUND

The Community
The Town of Pinesdale is a small, bedroom community located in the Bitterroot Valley of Western Montana. Situated in Ravalli County, Pinesdale is approximately seven miles northwest of Hamilton and five miles west of Corvallis in Section 33 of Township 07N, Range 21W. The roughly 540 residents of the community primarily work in nearby towns, where the main industries are retail, tourism, construction, timber, and administration. The town falls within the Corvallis High School district. The population of the area is increasing rapidly. In fact, Ravalli County is the fastest growing county in Montana, with an increase of over ten thousand residents in the last ten years. There is no municipal sewer system to treat sewage for the residents of Pinesdale, so the homes are serviced by private onsite septic systems. The water supply for the city comes from a nearby creek in conjunction with a series of wells.

Geographic setting
Pinesdale is about 3,800 to 4,500 feet about sea level at 46.32° north latitude and -114.21° west longitude (T 07N, R 21W, Section 33). The city is 600 to 700 feet above the Bitterroot River, at the base of the Bitterroot Mountains, which rise 8000 feet above the valley floor. The valley itself is a north-south trending valley, which lies between the Bitterroot Mountains on the west and the Sapphire Mountains on the east (see Figure 1). The Bitterroot River runs north through the center of the valley. The terrain around Pinesdale is primarily forested with evergreen trees, and has a general land cover typical of western Montana. The climate of the Bitterroot Valley is consistent with that of other lower elevation basins in the northern Rocky Mountains west of the Continental Divide. The average daily high and low temperatures at the nearest weather station, in Hamilton, are 84.6°F and 50.3°F in July and 34.7°F and 16.5°F in January, respectively. Average annual precipitation falls mostly as snow in late fall and winter, and averages about 12.21 inches per year.

Table 1. Climatic Data
Period of Record: 6/ 1/1895 to 12/31/2001 - Collected at Hamilton, Montana (243885)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	34.7	40.5	49.0	59.3	67.9	74.8	84.6	83.0	72.2	60.0	45.0	36.0	58.9
Average Min. Temperature (F)	16.5	20.2	26.4	32.9	39.6	45.9	50.3	48.8	41.5	33.4	24.9	18.6	33.3
Average Total Precipitation (in.)	0.96	0.79	0.73	0.88	1.55	1.74	0.81	0.84	1.07	0.89	1.01	0.93	12.21
Average Total Snow Fall (in.)	8.2	4.5	4.5	0.5	0.2	0.0	0.0	0.0	0.0	0.3	3.1	6.4	27.5
Average Snow Depth (in.)	2	2	1	0	0	0	0	0	0	0	1	1	1

Percent of possible observations for period of record: Max. Temp.: 89.6% Min. Temp.: 89.6% Precipitation: 90.5% Snowfall: 36% Snow Depth: 40.8%
Source: Western Regional Climate Center, wrcc@dri.edu

In general, the Bitterroot Valley is an approximately north-south trending intermontane basin averaging roughly 7 miles wide, and encompassing an area of about 430 mi^2 (Kendy and Tresch). It is bounded by the Bitterroot Mountains on the west, the Clark Fork River and Missoula Valley to the north, and the Sapphire Mountains on the east. The basin extends southward about 60 miles along the Bitterroot River from its confluence with the Clark Fork. The Bitterroot Valley contains two principle topographic features. In the center, the 1 to 2 miles wide basin is the flood plain of the Bitterroot River. Along the west and east sides of the basin are extensive high terraces or benches that range from 3 to 6 miles wide (see Figure 2). The Bitterroot Valley ranges in altitude from about 3,200 feet where the Bitterroot River flows out of the basin, to about 5,500 feet on the highest terrace.

General Description of the Source Water
The water system in Pinesdale consists of a creek gallery and a series of wells. The gallery is located on Sheafman Creek on the west side of Pinesdale. This creek drains a glacial valley to the west of town, and begins at Knaack Lake in the Bitterroot Mountains. As it drains eastward toward the Bitterroot Valley, water enters the stream from Sheafman Lake, as well as from the surrounding hillsides. Sheafman Creek flows through town before the water empties into Mill Creek, and eventually reaches the Bitterroot River.

There are four streams in the area of the Town of Pinesdale: Sheafman Creek, Cow Creek, Sage Creek, and Sheridan Creek. All four run east to west and flow into Mill Creek. The local geology consists of the granite of the Bitterroot Mountains (Idaho Batholith) overlain by sedimentary deposits of the valley terraces and floor. The front of the Bitterroot Mountains consists of a series of triangular spurs separated by east-west trending U-shaped glacial canyons. Streams that are tributaries of the Bitterroot River drain these canyons.

Public Water Supply
Pinesdale's 105 service connections are served by a surface water system backed up by three wells. The system is controlled by computer, which automates many routine operational functions and provides for constant monitoring and telemetry. There are two additional reservoirs attached to the distribution system located northwest of the Main East Well #1 (see Figure 3). The system also has three fire hydrants, which are flushed annually by the fire department.

Well #1 (the Main Well) is located above a gully at the base of the Bitterroot Mountains near Sage Creek. Well #1 was drilled in January of 1991 and has a yield of 35 gallons per minute. This well is 383 feet deep and is completed in the granitic bedrock. It has a pumping water level of 360 feet and a static water level that appears to be at or near the surface (this shallow water level may simply be an artifact of the poor lithologic log). No completion information was available on this well. The well log for this well may be found in Appendix A. Well #2 is located near Cow Creek, but is no longer in use and is thought to have been abandoned. Wells #3 and #4 are active and are known as the Backup Wells. They are located in a town park near the center of Pinesdale. They are believed to be completed in bedrock, but they do not appear to have significant recharge. There is a fair amount of uncertainty associated with these two wells. The well logs for these active wells (Backup Wells #3 & #4) have not been identified to the satisfaction of the operator or DEQ. A single well log, which was supposed to be for one of these wells, was attached to the Wellhead Protection Plan of 1999. That log indicates a depth of 460 feet and was completed on 04 May 1990. The handwritten log is provided in Appendix A. Alternately, a search of lithologic logs for wells in the area of Pinesdale suggest that a single well has a similar depth, and is in fact located very near the well set of Well #3 and Well #4. It is identified as a Town of Pinesdale well. This well was drilled to a depth of 523 feet and was completed on 27 November 1990. The lithologic log for this well is also included in Appendix A. Although correspondence from DEQ points out that the hand written log is not for either Well #3 or #4 and does not match the lithology of other wells in the vicinity of the Backup Wells, personal communication between the author and Tom Allsop (08/2002) indicates that the log is the best representation for these wells. Both of these wells are listed as entry points for groundwater, and chlorine treatment is applied as the water enters the storage and distribution system. The surface water (Sheafman Creek) is passed through both sand and paper filters, then treated with sodium hypochlorite upon entering the water treatment plant. Two clear wells are in place, which increase storage and enhance chlorine contact time. The Pinesdale PWS facilities are summarized in Tables 2 and 3 below.

Some additions to the system have occurred in the last few years. The first of these is the rerouting of the distribution system to accommodate the newer clear well of the two clear wells mentioned above. This well was put into use in 2000, and the construction specification for this structure may be found in Appendix B. In addition, Harmsco filters replaced the 3M filters in the treatment plant in 1999.

Table 2. PWS Relevant Information
Town of Pinesdale

PWS Name & Address	PWS ID	Class	Service Connections	Residents	Non-Residents	Contact Persons
Town of Pinesdale **Attn: Tom Allsop, Operator** **1002 Hwy. 93** **Victor, MT 59875** **Phone: 406/961-4883** **Fax: 406/961-8498**	02926	Community	105	540	0	Tom Allsop, Operator 1002 Hwy. 93 Victor, MT 59875 (406) 961-4883

Table 3. List of Facilities
Town of Pinesdale PWS

DEQ's PWS Section ID #	Status*	Facility Name
CH001	A	Common Header for Well 1 and Well 2 (inactive) EP505
CH002	A	Common Header for Backup Wells 3 & 4 EP504
CW001	A	Clear Well, Old
CW002	A	Clear Well, New
DS001	A	Distribution System SP001
IN002	A	Intake on Sheafman Creek
IN003	I	Intake on Cow Creek (deleted)
ST001	A	Storage Facility
ST002	A	Storage Facility
WL004	A	Well 3, Backup E
WL005	A	Well 4, Backup E
WL006	A	Main Well 1
WL007	I	North Well 2 (inactive)
TP002	A	Treatment Point for Sheafman Creek EP502
TP003	I	Treatment Point for Cow Creek EP503 (deleted)

* A = active; I = inactive; D = deleted

Water Quality

Below are tables (Tables 4 & 5) of data taken from both the monitoring information for the Town of Pinesdale, as well as from the water quality information from the Russ Prentice well located less than a tenth of a mile away from the Main South Well #1. Not all water quality data available for the Russ Prentice well was available for the Town of Pinesdale. With all values not reported for the town, refer to the water quality data in Table 4. Given the close proximity of this well to Well #1 of Pinesdale, this data is a reasonable approximation of the water quality for the area.

Table 4. Groundwater Water Quality
Background Data

Ground-Water Information Center **Internet Information Services Water Quality Report** **PRENTICE RUSS**			
Sample Id / Site Id:	1999Q0058 / 154007	Sample Date:	07/10/1998
Location (TRS):	07N 21W 33 ACBB	Agency/Sampler:	MBMG / CAC
Latitude/Longitude:	46° 19' 24" N 114° 13' 39" W	Field Number:	154007
Datum:	NAD27	Lab Date:	09/17/1998
Altitude:	4215.00	Lab/Analyst:	MBMG / BJK
County/State:	RAVALLI / MT	Sample Method/Handling:	NOT REPORTED / 4220
Site Type:	WELL	Procedure Type:	DISSOLVED
Geology:	211DBTL	PWS Id:	NR
USGS 7.5' Quad:	HAMILTON NORTH	Total Depth (ft):	300.00
Project Code(s):	GWAAMON / GWCP04	Depth Water Enters:	150.0 ft BGS
Drainage Basin:	PE	SWL (ft below MP):	62.20

Cations	**mg/L**	**meq/L**	**Anions**	**mg/L**	**meq/L**
Calcium (Ca)	29.24	1.46	Bicarbonate (HCO_3)	154.20	2.53
Magnesium (Mg)	4.71	0.39	Carbonate (CO_3)	0.00	0.00
Sodium (Na)	18.12	0.79	Chloride (Cl)	2.77	0.08
Potassium (K)	0.83	0.02	Sulfate (SO_4)	19.21	0.40
Iron (Fe)	0.04	0.00	Nitrate (as N)	<.25 P	0.00
Manganese (Mn)	0.00	0.00	Fluoride (F)	1.35	0.07
Silica (SiO_2)	15.70		Ortho-Phosphate (OPO_4)	0.08	0.00
Total Cations		2.69	Total Anions		3.08

Trace Element Results (µg/L)

Aluminum (Al):	<15.	Cadmium (Cd):	<2.	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2.	Chromium (Cr):	<2.	Molybdenum (Mo):	<10.	Titanium (Ti):	<10.
Arsenic (As):	8.09	Cobalt (Co):	<2.	Nickel (Ni):	3.30	Thallium (Tl):	<5.
Barium (Ba):	76.43	Copper (Cu):	<10.	Silver (Ag):	<1.	Uranium (U):	NR
Beryllium (Be):	<2.	Lead (Pb):	58.39	Selenium (Se):	1.34	Vanadium (V):	<5.
Boron (B):	<30.	Lithium (Li):	<50.	Strontium (Sr):	1229.00	Zinc (Zn):	34.35
Bromide (Br):	<25.					Zirconium (Zr):	<10.

**Total Dissolved Solids:	168.04	Field Alkalinity as CaCO3:	NR	Langlier Saturation Index:	-0.14
**Sum of Diss. Constituents:	246.28	Alkalinity as CaCO3:	126.47	Ammonia (mg/L):	NR
Field Conductivity (µmhos):	288.00	Field Nitrate (mg/L):	1.30	T.P. Hydrocarbons (µg/L):	NR
Lab Conductivity (µmhos):	290.00	Nitrite (mg/L as N):	NR	Field Dissolved O2 (mg/L):	NR
Field pH:	7.70	Water Temp (°C):	11.10	PCP (µg/L):	NR
Lab pH:	7.79	Air Temp (°C):	NR	Phosphate, TD (mg/L as P):	<.1
Field Hardness as CaCO3:	NR	Ryznar Stability Index:	8.07	Field Chloride (mg/L):	NR
Hardness as CaCO3:	92.38	Sodium Adsorption Ratio:	0.82	Field Redox (mV):	NR

Field Chemistry and Other Analytical Results
Additional Parameters

Parameter	Value
Nitrate Field (mg/L - N)	1.3
Phosphate T Dis (mg/L - P)	L.1
Thallium Diss. (ug/L-Tl)	L5

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **meq/L** = milliequivalents per Liter;**ft** = feet; **NR** = No Reading in GWIC
Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions;***** = Duplicate analysis not within control limits;****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO3, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.
Disclaimer: 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.

Table 5. Water Quality Data for the Town of Pinesdale PWS

	units	Sample Source ID	Highest Recorded Levels	MCL*
Cadmium	mg/l	All sources	0	0.005
Beryllium	mg/l	All sources	0	0.004
Barium	mg/l	001	0.02	2
Arsenic	mg/l	All sources	0	0.05
Antimony	mg/l	All sources	0	0.006
Nitrate plus Nitrite as N	mg/l	504	0.49	10
Chromium	mg/l	All sources	0	0.1
Fluoride	mg/l	505	0.4	4
Mercury	mg/l	001	0.0002	0.002
Selenium	mg/l	001	0.002	0.05
Thallium	mg/l	All sources	0	0.002

*MCL values come from the DEQ Source Water Protection Program Guide (1999).
Note that a more complete listing of data from the DEQ PWS Section's database is contained in Appendix B.

Mill Creek flows within one mile of the Main South Well #1. It has been classified as a TMDL (Total Maximum Daily Load) stream. A TMDL is the total amount of a pollutant, per day, (including a margin of safety) that a waterbody may receive from any source (point, nonpoint, or natural background) without exceeding the state water quality standards. A stream that is identified for TMDL development exceeds these standards in at least one category. Mill Creek is classified as a TMDL Stream because the cold water fishery and the recreational use are only partially supported. This is most likely due to flow or habitat alterations, as well as thermal modification. For more information, please see the following website: http://nris.state.mt.us/wis/environet/ .

Water Distribution and Treatment
The following table (Table 6) describes treatment of the Town of Pinesdale PWS. See the information in Appendix B for further details about system operation.

Table 6. Water Distribution and Treatment

Public Water Supply Location	Water Distribution	Treatment
Sheafman Creek Surface Water	Piping from the treatment facility	Four sets of sand and paper filters
Main South Well #1	Piping near the well	Chlorine at entry point
Inactive North Well #2	Not connected to the system	N/A
Backup East Wells #3 & #4	Piping near the wells	Chlorine at entry point

Monitoring and Enforcement Actions
The Town of Pinesdale PWS sources are routinely monitored for compliance with drinking water standards. Several schedules have been issued by the state for the monitoring of various chemicals. Bacteriological monitoring should occur monthly, while total nitrate testing is due annually. According to the most recent Operations & Maintenance Technical Assistance (O&M TA) report (16 December 1999), the monitoring records are well maintained.

Violations and reminders have occasionally been issued due to lack of reporting of nitrates analyses from 1996 to 2001. Some additional violations were issued for lack of reporting maintenance operations records. The lack of sampling and maintenance records sent to the state resulted in Pinesdale being placed on the EPA Significant Non-Compliance (SNC) List. It is important to note that these violations do not mean the Town of Pinesdale did not maintain records or test for these contaminants. Testing records appear to exist, but were never registered with the appropriate state agencies. On 05 August 2000, the Town of Pinesdale issued a boil water order. This order was not issued or requested by the state, and the town was not known to be in violation of any state ordinances . However, the local operators believed that fires and fire fighting efforts in the drainages above town might have put the safety of the water supply in jeopardy. Relevant correspondence is found in Appendix B.

On December 11, 1998 a partial wavier was issued for Organic Chemical Monitoring. This wavier was based upon a determination of the amount of chemical use within the area, and applied to EPA Analytical Methods 505 (PCBs), 535.2 (Semivolatiles) and 531.1 (Carbamate Pesticides). A wavier was not available for EPA Analytical Method 524.2 (VOCs) because of the use, storage and transport of bulk fuels within the area of investigation. The wavier did not include EPA Analytical Method 515.1 (Herbicides) because of the use of these chemicals within the area of investigation. A renewal of this partial wavier occurred on September 21, 1999, which extended the compliance period through 2001. This wavier only applies to the groundwater sources (Wells #1, #3, and #4) and does not apply to the surface water source (Sheafman Creek). A phase II Inorganic Wavier was approved for the system on February 2, 1997. This waiver applies to Barium, Cadmium, Chromium, Fluoride, Mercury, and Selenium. Waivers for Antimony (Sb), Beryllium (Be), Nickel (Ni), and Thallium (Tl) will be available after three rounds of sampling have been completed. The town is currently on reduced tap monitoring for lead and copper.

The Town of Pinesdale has only had one unsatisfactory bacteriological test on record (09 September 2001), which detected the presence of coliform bacteria. No *E.coli* was found present in the sample. All other tests since January of 1998 were satisfactory. In the most recently conducted evaluation, none of the chemicals tested for exceeded EPA standards. Previous chemical monitoring has yielded similar results. However, it is worthy of note that the North Well #2 (which is currently inactivated) was taken out of service because of a PCP (Pentachlorophenol) detect in 1995. Sample analytical data and information on past and current waivers are found in Appendix B.

Influencing Factors

The causes of potential contamination to a PWS vary due to such factors as the hydrogeology and land uses of the surrounding area. In general, the cause of coliform bacterial contamination is often the result of a combination of factors. Contributing factors include: the proximity of septic tanks/lines to the water source, aquifer sensitivity, the existence of hydraulic connections between surface water and production wells, potentially poor sanitary conditions of some public water supplies, and potentially poor construction of the distribution system. Anomalous one-time (non-repeated) bacteriological exceedences may also have more to do with sample collection, handling, or analysis, then actual source water contamination. Metal contamination is often the result of mining operations, either active or abandoned, in the area from which a PWS draw its water. Organic contaminants come from a variety of sources, including transportation routes (roads or railroads), underground storage tanks, or as the result of specific land uses (such as pesticides, herbicides, and commercial waste). Additionally, inconsistent sampling procedures or sample handling could result in the detection of these constituents. The area contributing water to the Pinesdale PWS is discussed in Chapter 2.

CHAPTER 2
DELINEATION

The source water protection areas for the Town of Pinesdale PWS sources are delineated in this chapter. The purpose of delineation is to map the source of drinking water and to define areas within which to prioritize source water protection efforts. Delineated areas are dependent upon the geology, hydrology, and hydrogeology of an area and upon the classification of the system, the type of intake (well or surface water intake), as well as the type of aquifer (confined or unconfined). The influencing factors and the delineated source water protection areas are discussed below.

For community non-transient groundwater systems, four types of management regions are typically used. These are the Control Zone, Inventory Region, Surface Water Buffer, and Recharge Region. The goal of management in the Control Zone (an area within a 100-foot radius circle around a well or spring) is to protect against direct introduction of contaminants into the PWS intake from immediate surrounding areas. The Inventory Region represents the effective zone of contribution to the well, which usually approximates a 3-year groundwater time-of-travel distance. The goal of management in the Inventory Region is to protect water quality for the present and near future. The Surface Water Buffer is an area from which nitrate or pathogenic contaminants can flow to the area of the well by means of the major surface water channels. The Recharge Region represents the entire portion of the aquifer that contributes water to the vicinity of the PWS groundwater well (this is essentially a portion of the watershed or the whole watershed). The goal of management in the Recharge Region is to maintain and improve water quality over long periods.

For community non-transient surface water systems, two areas are typically mapped. These are the Spill Response Region and the Watershed Region. Management in the Spill Response Region focuses on the threat of potential chemical spills and other contaminant sources located upstream of a surface water intake. The Spill Response Region is an area from which contaminants can flow to the area of the intake by means of the major surface water channels. The Watershed Region is a much larger area that will be managed to protect the long-term quality of drinking water sources from large point contaminant sources and non-point sources. However, in this report a combined delineation was derived, taking into account the location of potential sources of contamination, the local hydrogeologic conditions, and management feasibility concerns.

Hydrogeologic Conditions
The geology is a description of the sediments, bedrock, and structural features of the valley and surrounding area. This information is relevant because these rock units and sediments comprise the aquifer (the water bearing formation) into which the Town of Pinesdale PWS wells are installed. The hydrogeology is a description of the presence and movement of groundwater in bedrock and within the overlying sedimentary units. In addition, the geology influences the surface water systems, which provide the main source of drinking water for Pinesdale. The goal of this discussion is to help the reader to understand where the PWS is obtaining its water and the vulnerability its water sources to contamination. Most of the following information was drawn from Alt and Hyndman (1990, 1998) and Kendy and Tresch (1996).

Geology
The Bitterroot Valley is a structural basin formed initially during the emplacement of the Idaho Batholith and by eastward displacement of a major thrust plate along a shallow fault. Although the deep granite of the Idaho Batholith and its surrounding metamorphosed Belt formations lie to the west of the current location of the Sapphire Mountain range, they were once beneath it. The Sapphire Mountains, which comprises the eastern border of the Bitterroot Valley, represents a slab of shallow Precambrian sedimentary rocks that were sheared from the top of the Idaho Batholith on the other side of the valley around 50 million years ago. Most of the remaining eastern front of the Bitterroot Mountains has a smooth surface that tilts down to the east at an angle close to 25 degrees. A zone of distinctly platy and streaky looking rock more than a thousand feet thick called the Bitterroot mylonite overlies the smooth range front. This mylonitic zone is essentially the sheared material within the fault zone and was sheared, ground up, and altered by the movement of the Sapphire Mountains (formerly above it) toward the east. A large basin formed east of the Bitterroot Mountains and west of the Sapphire Mountains, which filled with younger sediment. Within the basin, lower Tertiary sediments have been deformed into a faulted syncline, whereas the Pliocene sediments are relatively undisturbed. This says that little or no movement along the fault has occurred during Pliocene times. According to gravity and magnetic data, Tertiary and Quaternary sediments attain a maximum thickness of more than 3,000 feet in the area near Corvallis, Hamilton, and Pinesdale (Alt and Hyndman, 1998). A geologic map for the area is presented on Figure 4.

The Bitterroot Mountains are composed of Cretaceous granitic rocks associated with the Idaho Batholith with some scattered exposures of younger volcanic, intrusive, or metasedimentary rock. The bedrock of the Idaho Batholith is mostly gray quartz monzonite. Along the western basin margin, the granitic rocks are bordered by gneiss, which formed during Batholith emplacement. Gneiss is granitic in nature, but usually contains clear flow banding seen in larger chunks and outcrops. The gneissic areas are often present as a contact halo around the batholith and is seen as an eastern border that may reach about 2,000 feet thick.

Tertiary sediments overlie bedrock throughout the basin with outcrops mostly visible on the eastern terraces of the Bitterroot Valley. These unconsolidated to semi-consolidated deposits are predominantly brown and gray clay, ash, and silt interbedded with occasional lenses of poorly sorted sand and gravel. Interbedded in the flood-plain deposits are unconsolidated sand and gravel lenses deposited by the ancestral Bitterroot River. A veneer of Quaternary deposits overlies Tertiary sediments except on the higher eastern terraces. Glacial till underlies many of the tributary valleys that emanate from the Bitterroot Mountains (because of glacial bulldozing and glacial-fluvial reworking of those older sediments). Glacial action has also left large moraines that in many places reach from the mountains to the center of the valley. Glacial outwash forms alluvial fans on the west side of the basin consisting of angular to well-rounded boulders, cobbles, gravel, sand, and silt. Outcrops of glacial-lakebed deposits are 40 to 50 feet thick and consist of fine-grained, well sorted sand interbedded with silt, clay, and some gravel. About 40 feet of Quaternary alluvial-fan deposits mantle the older Tertiary terraces in many places. In general, the sorting of fan materials increases and the average grain sized decreases with distance from the mouths of tributary canyons.

The Bitterroot River transports and deposits large amounts of silt and other sediments on a yearly basis, despite the fact that the area is heavily wooded and erosion is low. Evidently, a large section of the Bitterroot Valley in the area of Hamilton is dropping between two actively moving faults, both of which trend northeast. Pinesdale lies between these two faults, one of which lies to the south of Hamilton, and the other to the north or Stevensville. The river seems to be depositing large quantities of sediment on the floor of the dropping fault block, filling the depression as fast as it sinks. The rates or amount of displacement on these faults is not known.

<u>Hydrogeology</u>

The major surface water artery of the Bitterroot Valley is the Bitterroot River, which originates in the southern Bitterroot Mountains and flows northward through basin to its confluence with the Clark Fork River. The Clark Fork River eventually joins with other western flowing rivers of the Columbia Watershed. About four times as many tributaries join the Bitterroot River from the Bitterroot Mountains as from the relatively arid Sapphire Mountains (on the east side of the valley). Natural flows in the Bitterroot River and its tributaries typically peak in the spring, decline over the summer, and remain relatively stable through the winter. About 55 percent of the runoff in the river discharges in May and June in response to snowmelt and rainfall.

The quality of the surface water in the valley is influenced by the geology of the headwater areas. Streams draining the Bitterroot Mountains flow through a terrain of igneous and metamorphic rock, which are relatively resistant to dissolution. As a result, these streams have low concentrations of dissolved solids in comparison to the relatively high concentrations of dissolved solids found in streams draining the Sapphire Mountains to the east.

Groundwater is a widely used source of water for the residents in and around the Bitterroot Valley. Over 8,000 wells, including several municipal supply systems, pump groundwater from the basin. Quaternary alluvium is typically the most productive aquifer. Most wells using this aquifer have depths of 60 feet or less. Though little information is available the construction of the Town of Pinesdale's Backup Wells #3 & #4, they were installed into, or through, the Quaternary alluvium and/or glacial till. Driller's logs from other wells in the shallow formation indicate that the predominant lithology is coarse-grained sand and gravel with finer grained interbeds common to approximately 100 to 170 feet deep, with fractured granitic rock below that. Yields and specific-capacity values for wells installed in the shallow sedimentary materials are relatively large (mean values of 160 gallons per minute and 14 gallons per minute per foot respectively), but occasionally have limited recharge. Because of poor sorting and large proportion of fine-grained material, glacial till and glacial-lakebed deposits have low permeability. Yields from wells completed in these deposits average about 5 gallons per minute and a specific capacity of 20 gallons per minute per foot, however the glacial till in the area around Pinesdale is most likely only around 50 feet thick. Below this is the granite bedrock that surrounds and floors the entire basin. A number of wells have been completed in the bedrock, and these wells primarily yield small amounts of water from fractures and weathered zones, although the yield of the well is often dependent on the size and lateral extend of the fractures. The Main South Well #1 is completed in the bedrock and has yield of 35 gallons per minute. This is one of the higher yielding bedrock wells in the area. Transmissivities of bedrock appear to range from 5.6 to 230 square feet per day in this area. The sediments that mantle the area below the Town of Pinesdale appear to be between 100 to 170 feet thick. The materials appear to be complex and heterogeneous, ranging from boulders, to cobbles, to sand, to clay, with complex admixtures of each. The depositional environment of this overburden is thought to be glacial (which explains the heterogeneous materials) with fluvial reworking intermittently throughout the deposit. The further west one looks in town, the more alluvial materials become predominant in wells and on the surface.

Potentiometric maps (water table elevation maps) indicate that groundwater generally flows from the terraces toward the Bitterroot River flood plain, then northward paralleling the river. The hydraulic gradient is steepest along the western basin margin, and relatively flat beneath the Bitterroot River flood plain. Groundwater flow in the Pinesdale area flows preferentially through open bedrock fractures, but roughly parallels Sheafman Creek at the floor of the Sheafman Creek basin, and flows toward the basin floor from the higher elevations of the surrounding mountains. Sources of recharge to unconsolidated deposits in and around the basin margin include leakage from canals, recharge from irrigation water, subsurface flow from surrounding bedrock, direct infiltration from precipitation and snowmelt, and recharge from tributary streams. The bedrock that the Main Well #1 South taps into is technically unconfined. Although there are no laterally continuous confining layers present in the vicinity of the wells, the depth of the Main Well #1 (383 feet deep) and the shallow water levels in nearby wells of similar depths (~30 feet) suggest that the groundwater at that depth in the bedrock may behave as if it were confined. The elevated static water level in these deeper bedrock wells could be due to several factors:

- interaction between a shallow water table and the deeper groundwater because there are no real confining materials,
- movement of water up and down along a well as the result of a poor well seals, or
- because the deeper groundwater is under some pressure within the certain saturated fracture zones and rises up inside the well casings.

Unfortunately, Wells #3 and #4 do not have dependable lithologic logs and can’t shed much light on the subject.

Source Water Sensitivity
If Wells #3 and #4 are installed into the shallow glacial till or alluvium, their Source Water Sensitivity would be High (based on the criteria outlined in Table 7 below). If those wells are installed into the deeper bedrock that appears to be behaving as if it were under confined conditions (like Well #1), the Source Water Sensitivity would be Moderate to Low. Surface water sources are considered to have High Source Water Sensitivity. Based upon the overall hydrogeologic setting discussed in Table 7, this PWS system as a whole is classified as having High Source Water Sensitivity to contamination. This is because the town uses both a surface water system and a series of wells that may be installed into unconfined.

Table 7. Determination of Source Water Sensitivity

Source Water Sensitivity (based upon the water sources from which the PWS draws its water)
High Source Water Sensitivity Surface Water and Groundwater Under the Direct Influence of Surface Water (GWUDISW)* Unconsolidated Alluvium (unconfined aquifer conditions)** Fluvial-Glacial Gravel** Terrace and Pediment Gravel Shallow Fractured or Carbonate Bedrock
Moderate Source Water Sensitivity Semi-consolidated Valley Fill sediments Unconsolidated Alluvium (semi-confined aquifer conditions)
Low Source Water Sensitivity Consolidated Sandstone Bedrock Deep Fractured or Carbonate Bedrock*** Semi-consolidated Valley Fill Sediments (confined aquifer conditions) ***

* Surface water intake on Sheafman Creek
** Possibly applicable to Wells #3 & #4
*** Well #1 and possibly applicable to Wells #3 & #4

Conceptual Model and Assumptions

A conceptual hydrogeologic model is a simplified representation of the hydrogeologic system. In the Town of Pinesdale, the PWS consists of both a surface water system and a groundwater system. Sheafman Creek, the main supply of water for the town, receives its recharge from a relatively small drainage to the west of town. The groundwater is recharged from the surrounding bedrock. Both the groundwater and the surface water move in approximately the same direction, from west to east and toward the valley floor.

Table 8. PWS Well Information
Town of Pinesdale PWS

	Well #1 Main Well	Well #2 Inactive	Well #3 or #4 Backup	Well #3 or #4 Backup
PWS ID #	02926	02926	02926	02926
PWS Source ID #	WL006	WL007	WL004	WL005
Well Location (T, R, S)	T07N R21W S33	T07N R21W S28	T07N R21W S27	T07N R21W S27
Latitude Longitude	46.3264 -114.2272	46.3304 -114.2282	46.3317 -114.2109	46.3317 -114.2109
MBMG GWIC #	**123776**	**123775**	**56894**	**56899**
DNRC Water Right #	Not reported	Not reported	Not reported	Not reported
Date Well was Completed	12 January 1991	21 August 1972	02 September 1987	04 May 1990 or 27 November 1990
Total Depth (feet bgs)	383		360	460 or 523
Screen Interval (feet bgs)	Unknown	Open bottom	Open bottom	Open bottom
Static Water Level (feet bgs)	Unknown (perhaps ~30')			
Pumping Water Level (feet bgs)	360			
Drawdown (feet)	~330			
Yield = Q (gal/min)	35			
Yield = Q (ft^3/day)	6,738			
Specific Capacity = Q/drawdown	0.1			

- This PWS is considered a Community Non-Transient Public Water Supply.
- There is considerable doubt about the details associated with the PWS Wells #3 and #4. It is uncertain about the specific depths drilled, construction, and other details. Personal communication with Tom Allsop (09/2002) suggests that both wells are at least 300 feet deep which limits the probable candidates to the above listed GWIC wells #56894 and #56899 in the Pinesdale area.
- Well logs copied from the MBMG GWIC site and the handwritten log from the 1999 Wellhead Protection Plan are provided in Appendix A.

The information about each water source has been compiled from all available sources, which include: the DEQ's PWS database, Montana Bureau of Mines and Geology (MBMG) GWIC database, the Montana State Library Natural Resources Information System (NRIS), and information from state correspondence. The well logs for the Town of Pinesdale PWS, along with representative well logs for the other wells in the area, are located in Appendix A. Copies of other information from the state (mostly correspondence) may be found in Appendix B.

Delineation Results
In all instances, a 100-foot radius Control Zone is delineated around the wellhead and surface water intake. This is to ensure that the area immediately surrounding the well/intake remains free of contamination. Thus 100-foot radius Control Zones have been delineated and inventoried around the intake for Sheafman Creek, the Main South Well #1, and the Backup East Wells #3 & #4. These Control Zones are not depicted on a figure within this report.

A Spill Response Region and a Recharge Region are typically delineated and inventoried for surface water systems. A PWS using groundwater would normally have an Inventory Region (based on groundwater time of travel or a fixed 1-mile radius around the wellhead) and a Recharge Region. However, in this report all of these separate delineation areas were combined into a single Inventory Region, which encompasses all other regions. This was done because all the areas mentioned above had considerable overlap. A single delineation has more utility for the Town of Pinesdale PWS owners and operator because it results in a more understandable and manageable area. In addition, any significant potential contaminant sources present within any of the other delineations would still be inventoried under the single inclusive Inventory Region. It is noteworthy that the greatest threats of contamination to this water supply come from in the vicinity of town itself, and not from the drainage(s) that recharges the aquifer(s) below the PWS wells or that supply water to the PWS surface water intake.

The delineation for this PWS is based on several factors, taking into consideration the local hydrogeology, the potential contaminant sources, the amount of available information, and the probable interaction with surface water. All the recharge to both the surface water system and groundwater system comes from drainages west of town. It is unlikely that either groundwater or surface water present within the drainages is hydrologically connected to water outside this drainages (other than through input via precipitation into the watershed and the eventual discharge into of water to the Bitterroot Valley floor). The delineation boundary of the Inventory Region follows landmarks or physical boundaries whenever possible. The eastern boundary of the Inventory Region is approximately a 1-mile radius around the Backup Wells #3 & #4. This is a conservative delineation, as some of this area is thought to be down gradient of the PWS wells. The boundary then extends to the road that runs about 0.5 miles to the north of Sheafman Creek and along the boundary for the Town of Pinesdale. The line then follows the northern ridgeline of the Sheafman Creek drainage to the west, around Castle Crag, and down the southern side of the drainage eastward until it encompasses the 1-mile radius between Sheridan Creek and Mill Creek. The Inventory Region for Pinesdale is depicted on Figure 5.

Limiting Factors
The reader should keep in mind that any delineation makes some basic assumptions about the groundwater movement in the area. Two major assumptions are used in the application of many groundwater flow models; that the flow of water in the aquifer is uniform and that the flow of water in the aquifer is horizontal. The groundwater flow model should be considered within these limitations, as groundwater flow is generally not entirely uniform or strictly horizontal. It is also assumed that groundwater flows toward and parallels that of the streams draining through the area around the Town of Pinesdale. Conclusions based on the author’s interpretation of the hydrogeology are uncertain because the extent and properties of the aquifer, along with the direction and rate of groundwater flow are not precisely known. To address these uncertainties and address the fact that the Town of Pinesdale mixes surface water with groundwater to provide to customers, a single large Inventory Region was delineated, with boundaries that are large enough to conservatively include all potential current or future contaminant threats to the water supply.

CHAPTER 3
INVENTORY

An inventory of potential contaminant sources was conducted to assess the susceptibility of the Town of Pinesdale PWS to contamination and to provide a basis for source water protection planning. The inventory focuses on areas of known contamination; facilities that use, generate, transport, or store potential contaminants; as well as certain land uses within the Control Zone and Inventory Region delineated in the previous section. Sources of all primary drinking water contaminants and pathogens are identified, although only potential sources of contaminants that are the greatest threat to human health were selected for detailed inventory.

Inventory Method
Databases were searched to identify businesses, and land uses that are significant potential sources of regulated contaminants. The following steps were followed:

Step 1: Land use was identified from the National Land Cover Dataset compiled by the U.S. Geological Survey and the U.S. Environmental Protection Agency (USGS, 2000). Land cover types in this dataset were mapped from satellite imagery at 30-meter resolution using a variety of supporting information.

Step 2: EPA's Envirofacts System was queried to identify EPA regulated facilities. This system accesses the following databases: Resource Conservation and Recovery Information System (RCRIS), Biennial Reporting System (BRS), Toxic Release Inventory (TRI), Permit Compliance System (PCS), 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 is a significant potential contaminant source.

Step 3: DEQ databases were queried to identify underground storage tanks (UST/LUST sites), hazardous waste contaminated sites, landfills (State Superfund Sites), and abandoned mines. These include, but are not limited to, the DEQ Hazardous Waste Site Cleanup Bureau - Petroleum Release Section and State Superfund Sections databases. The DEQ SWPP/NRIS Mapper Query was also used to identify and locate these sites.

Step 4: A business telephone directory/database was consulted to identify businesses that generate, use, or store chemicals in the Inventory Region. Equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers were targeted by SIC code (Standard Industrial Classification Code).

Step 5: Major road and rail transportation routes were identified.

Step 6: All significant potential contaminant sources were identified within the Inventory Regions. This includes sources of nitrate and microbial contaminants, land uses and facilities that generate, store, or use large quantities of hazardous materials identified within the Recharge Region.

Potential contaminant sources are designated as significant under the Montana Source Water Protection Program if they fall into one of the following categories:

- Large quantity hazardous waste generators
- Landfills
- Hazardous waste contaminated sites
- Underground storage tanks
- Major roads or rail transportation routes
- Cultivated cropland
- Animal feeding operations
- Wastewater treatment or spray irrigation lagoons
- Septic systems
- Sewered residential areas
- Storm runoff (e.g. from logging operations)

- Floor drains, sumps, or dry wells (essentially Class V Injection Wells)
- Abandoned or active mines

In support of this inventory, an evaluation of land use was made for the area within the Inventory Region. Maps were developed that depict land use within these area using the USGS 30-meter Landcover data (2000). An analysis was performed on these data that allowed for a quantified determination of primary land uses. The land use maps and the supporting analyses for these areas are found on the following pages.

Inventory Results/Control Zone

The Control Zone is the area located within 100 feet of a PWS well or intake. This region is especially critical, as any contamination within the Control Zone has a high potential of entering the drinking water system for the community. For the surface water intake in Sheafman Creek, there are few identified potential sources of contamination. The intake is located up gradient from town and away from agricultural land.

The land uses within the Control Zones delineated for the active wells present some potential contamination sources. Within the Control Zone of the Main South Well #1, the land is primarily used for hay, pastureland, with some ground left fallow. Certain agricultural practices and chemicals may be potential contamination sources, especially in such close proximity to a wellhead. These include, but are not limited to nitrates from the application of fertilizers and other chemicals from pesticide and herbicide use. If the land is irrigated, the potential of contaminants reaching the well intake is significantly increased.

In the Control Zone delineated for the two wells in the park (Backup East Wells #3 & #4), the primary concern is the landscape of the park itself. Town park maintenance may be potential source of contamination to a well because of the chemicals applied to the lawns and/or other vegetation to promote and maintain them. One example is nitrate contamination from the application of lawn chemicals such as fertilizers to lawns and landscape followed by sprinkler irrigation. No information is known about the completion of these wells, and thus there is no record of any seal or the depth to the water table. Improperly sealed wells may provide conduits for contamination to get into the public drinking water supply.

Inventory Results/Inventory Region

Activities or facilities located within the boundaries of the Inventory Region where hazardous materials are generally handled, stored or generated are considered potential contaminant sources. Inventoried significant potential contaminant sources are addressed in the next chapter. The businesses, facilities, and land uses within the Inventory Region that are considered potential sources are listed on Table 9. It is important to remember that these businesses or facilities are included on the list solely because of the type of business or operation and the chemicals typically used by that type of business. This list does not imply that these businesses are actual polluters or that they mishandle the chemicals used. The locations of these possible contamination sources within the Inventory Region are shown on Figure 6.

The Sheafman Creek mine is only mine noted within the Inventory Region. This mine is located between Sheafman Creek and Cow Creek and slightly northeast of the Backup East Wells #3 & #4. Mining operations can be a major source of metals in both the surface water and the groundwater supply. The Sheafman Creek Mine is a placer mine of unknown status, which appears to be mining for titanium, iron, thorium, and zirconium.

Pinesdale School is also within the Inventory Region. Schools are primarily a source of nitrates due to the application of fertilizers on the school grounds. However, many schools also handle or store chemicals and supplies that, if disposed of improperly, may present a hazard to the drinking water.

Agricultural land constitutes about 7% of the area within the Inventory Region. This land consists of pastureland, land used for hay, and fallow ground. The agricultural practices of greatest threat to a PWS are those involving significant chemical application and irrigation. There is very little commercial and residential land use. Businesses and homes that generate, store, or dispose of small quantities of potential contaminants are generally not significant contamination threats if they handle those materials properly. However, disposal of even small quantities of contaminants in sumps, floor drains, dry wells, or septic tanks that are connected directly to the aquifer (via infiltration) or surface water can be significant threats. In addition, chemicals spilled at small businesses may be flushed to storm drains or local streams and indirectly reach the aquifer. Volatile organic compounds are the most prevalent chemicals used or stored and therefore the most likely to reach the groundwater where stormwater is concentrated and directly recharges the unconfined aquifer (these are called Class V injection wells). The locations of these injection wells are not known. The Town of Pinesdale is particularly vulnerable to any chemical misuse as the town gets its water from a surface water system and potentially from an unconfined aquifer. The land use in the Inventory Region is depicted in Figure 7.

The threat of contamination from the private residential septic systems is considered low because the area within the town and surrounding it is believed to have an overall low density of these systems. If these systems are well maintained and the population density remains static, the risk to the drinking water associated with the septic systems is considered low. It is noteworthy that density of private septic systems upgradient from the wells is low, whereas the area around and downgradient from the wells has a moderate septic density. Septic tanks can be significant sources of pathogens to a public water supply. Septic density in the area is depicted on Figure 8. A summary of the septic density, which is also called septic hazard, is presented in tabular format and discussed in the next chapter.

There are no major highways within the Inventory Region. The travel to and from, as well as within, Pinesdale is limited to county or private roads. Any transport of chemicals or application of pesticides makes these transportation routes potential sources of contamination.

The U.S. Forest Service owns the majority of the land in the Sheafman Creek drainage. There are few potential sources of contamination in the drainage, as it is a small area with limited access. Both mining and logging of the forest could pose a potential threat to the PWS surface water source by increasing turbidity in Sheafman Creek. Close monitoring of activity (proposed mining or logging operations) is an important step in ensuring the water quality for the town.

Table 9. Inventory of Potential Contamination Sources in the Inventory Region

Potential Contaminant Sources	Inventory Region	Map ID # w/in Inventory Region
% Septic Density by Ranking of Hazard	0% High Septic Density 21.76% Medium Septic Density 78.24% Low Septic Density	_______
Land Use	7% Bare Rock, 7% Agricultural, 16% Grassland, 16% Shrubland, 54% Forest	_______
Mines	Sheafman Creek Mine	#1
Roads	Main County Road	#2
Schools	Pinesdale School	#3

Note:

- Septic Density is based upon population numbers of 2000 Census with one septic system per 2.5 persons. The hazard associated with private septic systems is determined on the basis of density of these systems.
- The hazard is described as being: High with >300/mile^2, Moderate with 50-300/mile^2, and Low with <50/mile^2.
- Land Use is based upon the USGS Landcover data (2000).

Inventory Update

To make this SWDAR a useful document in the years to come, the owners or the certified water system operators for the public water supply in the Town of Pinesdale should update the inventory for their records every year. Changes in land uses or potential contaminant sources should be noted and additions made as needed. The complete inventory should be submitted to DEQ at least every 5 years to ensure that this report/plan stays current in the public record.

Inventory Limitations

The information compiled for this inventory was drawn from a number of public sources. It is as complete as possible, but is limited by the accuracy and/or completeness of the original data sources. For example, the information that addresses inactive and active mines did not describe the volumes or acreage of their associated tailing piles. It is also limited by the familiarity (or lack of familiarity) of the author with the specifics of the area. This inventory (as written) is not intended to be a substitute for the first-hand knowledge of the area that can be provided by the PWS operators and owners. As such, the initial edits of this document and the subsequent updates provided by these persons are critical to ensuring the accuracy and usefulness of this SWDAR.

CHAPTER 4
SUSCEPTIBILITY ASSESSMENT

Hazard Determination
Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would pose concern. Susceptibility is assessed in order to prioritize potential pollutant sources for management actions by local entities, in this case the citizens and Town of Pinesdale.

The goal of source water management is to protect 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 land use activities in the Inventory Region pose minimal threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources identified in the previous chapter according to susceptibility. Alternative management approaches that could be pursued by the Pinesdale PWS to reduce susceptibility are recommended.

Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to the wells or surface water intake. The susceptibility of the Pinesdale PWS to contamination is assessed in this chapter. The proximity of a potential contaminant source to a creek gallery or well, or the density of potential non-point contaminant sources determines the threat of contamination, referred to here as hazard. Table 10 below determines hazard within the Inventory Region as delineated in this SWDAR. For the sake of simplicity, all point sources within the Inventory Region are considered to pose a high hazard.

Table 10. Determination of Hazard of Potential Contaminant Sources

Potential Contaminant Sources	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
Point Sources of All Contaminants	Within the Inventory Region	___	Adjacent to, but outside the Inventory Region
Septic Systems (density)	More than 300 per sq. mi.	50 – 300 per sq. mi.	Less than 50 per sq. mi.
Municipal Sanitary Sewer (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region
Cropped Agricultural Land (percent land use)	More than 50 % of region	20 to 50 % of region	Less than 20 % of region

Susceptibility Determination
Barriers to contamination can be anything that decreases the likelihood that contaminants will reach a spring, well, or surface water intake. Barriers can be engineered structures, management actions, or natural conditions. Examples of engineered barriers are spill catchment structures for industrial facilities and leak detection for underground storage tanks. Emergency planning and best management practices are considered management barriers. Thick clay-rich soils, a deep water table or a thick saturated zone above the well intake, or a wide riparian zone along a creek can be natural barriers.

Table 11. Susceptibility of Source Water based on Hazard rating and the presence of Barriers.

	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
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

A Community Non-Transient PWS monitors for a wide range of contaminants on a varied schedule, dependant upon their history of contamination and regulatory requirements. Additional factors that are becoming useful in the determination of monitoring requirements for contaminants are:

- the presence of potential contaminant sources in proximity to the source water,
- the hazard posed by potential contaminant sources,
- the presence of barriers to those contaminants, and
- the susceptibility of the source water to the contaminants.

The significant potential contaminant sources are identified (by type of business or chemicals used) and by type and density of land use within the Inventory Region. These significant potential contaminant sources are listed on Table 12. This table addresses:

- types of significant contaminant sources,
- how the contaminants may be released to the environment and/or reach a collection point,
- Hazard rating for those contaminants,
- any barriers that may be present, and
- provide an evaluation of the susceptibility of the source to those contaminants.

The table also describes some management tools that can reduce the Hazard and Susceptibility to particular contaminant sources.

Inventory Region

Mining operations can be a major source of metals in a water supply. The erosion of tailings, transport by surface water, and the leaching of sediments all contribute to the potential contamination from mines. The Town of Pinesdale PWS has a moderate susceptibility to contamination from the Sheafman Creek mine, as it is within the Inventory Region. This mine is located only about a half-mile from the Backup East Wells #3 & #4, but it is probably down gradient from both the wellheads and the surface water intake. In addition, the depth of the wells probably provides a barrier to contamination.

The amount of agricultural land presents a low hazard to the PWS when considered as a percentage of the entire Inventory Region. However, most of the agricultural land is located near the wellheads and thus this land use is considered to be a moderate or even high hazard to the wells. The main types of contaminants that result from agricultural land uses are nitrate (from fertilizers) and some pathogens (from animal wastes, if present). If pesticides and/or herbicides are used on the land, they may also pose a hazard. The depth of the wells can be a barrier to contamination. It appears that the agricultural land is all located down gradient from the surface water intake. Thus, the susceptibility of this PWS to the contamination associated with agricultural land use is considered moderate to low.

The density of private septic systems in the area is considered a hazard because nitrates and pathogens can be released if any leaching from the tanks occurs. Based on the overall density of private septic systems, they present a low potential for seriously contaminating local groundwater and impacting the PWS wells. The medium septic density in the Inventory Region occurs in the area around and down gradient from both the surface water intake and the wellheads. Up gradient from the PWS is all low septic density. Since the overall septic density in the Inventory Region is low, and since there are a number of barriers (see Table 12 below), the Pinesdale PWS has a very low susceptibility to contaminants produced by private septic systems. There are no municipal sewers in the Inventory Region, thus there is no hazard associated with the potential release of sewage to groundwater.

The Pinesdale PWS has a very low susceptibility to contamination from the transportation routes in the Inventory Region. The roads are all county, private, or U.S.F.S. maintained roads that are primarily used only by the residents of Pinesdale. In addition, there is very little chemical or hazardous material transport along these roads and thus the roads present only a low hazard. As with the other potential contamination sources, the depth of the wells is considered a possible barrier, as is the location of the surface water intake upstream from any roads.

As mentioned above, increasing the number of barriers between the well and any of the potential contaminant sources can reduce the susceptibility of this PWS to the contaminants. Many of these barriers are listed as management practices, procedures, and prevention planning on Table 12. Cooperative and watershed planning agreements for the management of any significant potential contaminant sources and the reduction of the susceptibility to these sources should be undertaken. In addition, it should be noted that the well depth as a potential barrier is based primarily on the Main South Well #1, as there is little to no information about the Backup East Wells #3 & #4. The information that is available suggests that these wells are also drilled at a significant depth, though no well logs have been located for them.

Table 12. Significant Potential Contaminant Sources
Hazard Rating & Susceptibility Analysis by Source-Type within the Inventory Region

Source	Contaminant	Hazard / Origin of Contaminant	Hazard Rating	Barriers	Susceptibility of Wells and Surface Water Intake to this Source of Contamination	Management Needed to Reduce Potential Impacts
Mining Operations & Mine Tailings	Metals	Erosion of tailings, transport by surface water, leaching of sediments allowing metals to mobilize into groundwater	High Hazard	Immobility of the metals in sediment Dilution & mixing during transport Depth of well Location down gradient from surface water intake	Moderate Susceptibility	Regulatory compliance Erosion control Revegetation Repository maintenance Remedial activities and monitoring
Agricultural Land	Fertilizers, pesticides, and erosion	Over application or improper application of chemicals, poor cropping practices, and spills allow contaminants to reach groundwater	Moderate to High Hazard – because of location of agricultural land	Depth of well Location down gradient from surface water intake	Moderate Susceptibility	Best Management Practices Training & education Technical assistance Spill prevention
Private septic systems (septic density)	Sewage, nitrate, nitrite, pathogens	Nitrates & Pathogens that are insufficiently treated in private septic systems	Low Hazard – based upon small acreage of Moderate and High septic density	Depth of wells Most septic systems are located downgradient from wells and surface water intake	Very Low Susceptibility	Growth management Maintenance and replacement of old sewer systems Advanced sewage treatment systems
Transportation Routes	SOCs, VOCs, other organic contaminants, nitrates, nitrites, metals, petroleum contaminants	Vehicular accidents, roadside pesticide spraying, application of deicer compounds, concentration of storm water runoff	Low Hazard – because of low use	Depth of well Few roads above surface water intake	Very Low	Prevention planning Transportation restrictions Spill response planning & training DOT regulatory compliance Runoff diversion and catchment

Monitoring Waivers

Monitoring Waiver Requirements

The 1986 Amendments to the Safe Drinking Water Act require that community and non-community PWSs sample drinking water sources for the presence of volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). The US EPA has authorized states to issue monitoring waivers for the organic chemicals to systems that have completed an approved waiver application and review process. All PWSs in the State of Montana are eligible for consideration of monitoring waivers for several organic chemicals. The chemicals diquat, endothall, glyphosate, dioxins, ethylene dibromide (EDB), dibromochloropropane (DBCP), and polychlorinated biphenyls are excluded from monitoring requirements by statewide waivers.

Use Waivers

A Use Waiver can be allowed if through a vulnerability assessment, it is determined that specific organic chemicals were not used, manufactured, or stored in the area of a water source (or source area). 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. Susceptibility is based on prior analytical or vulnerability assessment results, environmental persistence, and transport of the contaminants, natural protection of the source, wellhead protection program efforts, and the level of susceptibility indicators (such as nitrate and coliform bacteria). 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 1.0 miles as an area of investigation for the use of organic chemicals. Vulnerability assessment of spring water sources should use a minimum fixed radius of 1.0 miles as an area of investigation for the use of organic chemicals. Shallow groundwater sources under the direct influence of surface water (GWUDISW) should use the same area of investigation as surface water systems; that is, the watershed area above the source, or a minimum fixed radius of 1.5 miles upgradient of the point of diversion. 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.

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, or 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. Review of an organic chemical monitoring waiver application will be conducted by DEQ’s PWS Section and DEQ’s Source Water Protection Program. 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 differ from confined aquifers in that the groundwater is not regionally overlain by relatively impervious geologic strata. As a result, the upper groundwater surface or water table in an unconfined aquifer is not under pressure that produces hydrostatic head common to confined aquifers.

Unconfined aquifers are often locally recharged from surface water or precipitation. In general, groundwater flow gradients in unconfined aquifers may reflect surface topography, and the residence time of water in the aquifer is typically comparatively shorter than for water in confined aquifers. Similar water chemistry may often exist between unconfined groundwater and area surface water, and physical parameters and dissolved constituents can be indicators 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 or surface water to groundwater.

The objective of the Susceptibility Waiver application is to assess the potential of organic chemical migration from the surface to the unconfined aquifer. The general procedures make use of a combination of site specific information pertaining to the location and construction of the source, monitoring history of the source, geologic characteristics of the vadose zones, and mobility and persistence characteristics of the organic chemicals. The zone of contribution of the unconfined groundwater source must be defined and plotted. Groundwater flow directions, gradients, and a 3-year time-of-travel should be described. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and nearby wells should also be provided.

<u>Susceptibility Waiver for Surface Water</u>
Many surface water bodies are locally recharged by precipitation. In general, residence time in local surface water bodies such as streams and narrow lakes is considered small, as the water moves through the system rather quickly. Water contained in large lakes and reservoirs may have variable residence times based on seasonal turnover, temperature inversions, stagnant depths or isolated reaches of the lake water, and throughput of water in the water body. Similar water chemistry often exists between shallow unconfined groundwater and 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. Alternately, surface water bodies directly or indirectly receive a considerable percentage of their water from groundwater. Therefore, surface water can be susceptible to contamination by organic chemicals migrating from groundwater into the surface water.

The objective of the susceptibility waiver application is to assess the potential of organic chemical migration of contaminants into surface water that is used as a source. The general procedures make use of a combination of site specific information pertaining to the location and construction of the water source development, monitoring history of the source, geologic/hydrologic characteristics of the source water, and chemical characteristics of the organic chemicals pertaining to their mobility and persistence in the environment. The area of contribution to the surface water body at the PWS intake must be defined and plotted. This should describe the water flow directions, stream discharge and velocity, and residence time of water in the stream, lake, or reservoir (if the information is available). All surface bodies within 1,000 feet of the PWS well(s) must be plotted. The Montana DEQ Source Water Protection Program typically will delineate and assess a larger (more conservative) area called a Spill Response Region that extends at least 0.5 miles downstream and approximately 10 miles upstream of the PWS surface water intake. It encloses the shoreline of any lakes along the length of the region. The width of the region extends 1/2 mile surrounding any lakes and on either side of the primary stream tributaries. Analytical monitoring history of the PWS intake should also be provided as part of the susceptibility waiver application.

<u>Waiver Recommendation</u>
Based on past monitoring results and the susceptibility assessment of the Sheafman Creek intake and the entry points for the wells, the Pinesdale PWS appears to be eligible for monitoring waivers and/or renewal of their current waivers. For monitoring waiver consideration, the Pinesdale PWS should submit a letter to DEQ requesting monitoring waivers. The PWS also needs to provide additional information to DEQ regarding chemical use within the Inventory Region.

Summary
This report was prepared to assist the owners and operator of the Town of Pinesdale PWS to better understand the public water supply for which they are responsible. The report provides information concerning the aquifer that supplies water to the well and identifies the Control Zone and Inventory Region. Within each of these protection areas, the significant potential contaminant sources that may impact the well water are inventoried and identified. Also included in the report are recommendations regarding how the potential sources of contaminants could be better managed to prevent impacts to the Pinesdale PWS.

The Town of Pinesdale’s water supply seems to be fairly secure from contamination. However, there are some steps that, if taken, would reduce the risk even further. The authors recommend that the town develop an Emergency Spill Response Plan that identifies the procedures that responders (typically these will be the operator and local residents) should follow in the event that the system is in danger of contamination from any type of pollutant. Additional steps should be taken to find more information pertaining to the Backup Wells #3 & #4. A good step in this direction is to determine the exact depth of the wells, and if possible, the depth and type of the casing (to determine the depth of the screen zone or the interval of the open hole). This information would allow the wells to be matched up with existing well logs. The lack of information, together with the location of these wells, makes this entry point the most likely source of contamination to the system as a whole. Finally, it is important for the owner/operator to continue to monitor the water quality for all potential contaminants, and report these results to the appropriate state agency. This will ensure that the public water supply at Pinesdale maintains its water quality and minimizes health risks.

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GLOSSARY

Acute Health Effect. An adverse health effect in which symptoms develop rapidly.

Alkalinity. The capacity of water to neutralize acids.

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.

Delineation. A process of mapping source water management areas.

Effective Porosity. The percent of soil, sediment, or rock through which fluids, such as air or water, can pass. Effective porosity is always less than total porosity because fluids can not pass through all openings.

Hardness. Characteristic of water caused by presence of various salts. 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.

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 an area expected to contribute water to a public water supply well within a fixed distance or a specified groundwater time-of-travel distance.

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.

Nitrate. An important plant nutrient and type of inorganic fertilizer. In water the major sources of nitrates are 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.

Pathogens. A bacterial organism or virus 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.

Porosity. The percent of soil, sediment, or rock filled by air, water, or other fluid.

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

SIC Code. The U.S. Standard Industrial Classification (SIC) Codes classify categories of businesses. SIC Codes cover the entire range of business categories that exist within the economy.

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.

Susceptibility (of a PWS). The 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. 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, non-point, and natural sources. The TMDL program was established by section 303(d) of the Clean Water Act to help states implement water quality standards.

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

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.

Volatile Organic Compounds (VOC). Any organic compound which evaporates readily to the atmosphere (e.g. fuels and solvents).

Recharge Region / Watershed. The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common delivery point.

Note: Definitions are taken from EPA’s Glossary of Selected Terms and Abbreviations and other sources.