

City of Hardin
Public Water Supply
PWSID # MT0000235

*SOURCE WATER DELINEATION AND
ASSESSMENT REPORT*

Date of Report: 23 July 2002

Operator/Manager:

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INTRODUCTION

This Delineation and Assessment Report was prepared by Jim Stimson, a hydrogeologist with the Source Water Protection Program of the Montana Department of Environmental Quality (DEQ), and by intern Shonna Jorgensen. The City of Hardin public water supply (PWS) is located in Big Horn County, Montana, about 46 miles east of Billings. The DEQ PWS identification number, operator name, and operator number for the Hardin PWS appear on the title page of this report.

Purpose

This report is intended to meet the technical requirements for the completion of the source water delineation and assessment report for the City of Hardin PWS 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 the protection of public drinking water supplies from contamination. The primary purpose of this source water delineation and assessment report is to provide information to assist the City of Hardin PWS operator in the identification of potential contaminant sources near the City of Hardin wells and the need for a source water protection plan to protect the City of Hardin drinking water sources.

Delineation and assessment constitute major components of the Montana Source Water Protection Program. Delineation entails mapping the boundaries of source water protection areas, which encompass ground water and/or surface waters contributing to public water supply sources. Assessment involves identifying locations or regions within source water protection areas where contaminants may be generated, stored, transported, or disposed, and determining the relative susceptibility of drinking water to contamination from these sources.

Limitations

This report was prepared to assess threats to the City of Hardin public water supply, and is based on published data and information obtained from local residents familiar with the community. The terms “drinking water supply” and “drinking water source” refer specifically to the sources of the public water supplies, and not any other public or private water supply. Also, not all of the potential or existing sources of groundwater or surface-water contamination in the area of the City of Hardin are identified. Only potential sources of contamination in areas that contribute water to the identified drinking water sources are considered.

The terms “contaminant” and “toxin” are used in this report to refer to constituents for which maximum concentration levels (MCLs) have been specified under the national primary drinking water standards, and to certain carcinogenic or toxic constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1 BACKGROUND

The Community

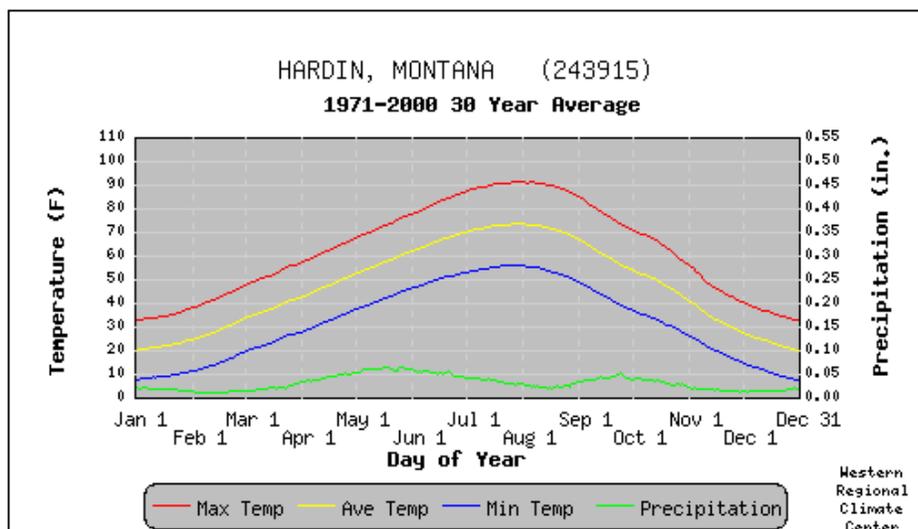
Hardin is the county seat of Big Horn County and is about 46 miles east of Billings, Montana along Interstate 90 on the banks of the Bighorn River near Little Bighorn Battlefield National Monument (Figure 1). Hardin is on the northern border of the Crow Indian Reservation. The Big Horn Canyon National Recreation Area and Yellowtail Dam are located about 25 miles south of Hardin on State Highway 313.

The U.S. Census Bureau estimates the 2000 population of Big Horn County at 12,671 people, 3,384 of whom reside in Hardin. Big Horn County's population increased by about 12% and Hardin's increased by about 15% since 1990. Interstate 90 runs near Hardin and connects to points south including Sheridan, Wyoming.

Tourism, recreation, and the service industry contribute significantly to the economy of Hardin, especially in relation to Native American culture and western historical sites. Mining has also played an important role in the local and regional economy. The largest revenue-generating industries in Big Horn in 1999 were services, 23.3 percent of earnings; federal, state and local government, 19.6 percent; and mining, 19.0 percent (www.bea.doc.gov/bea/regional/bearfacts). Dryland wheat farming and livestock ranching represent a significant part of the economy in and around Hardin and within Big Horn County as a whole.

Within the city limits, residents obtain their drinking water from the municipal PWS. There are seven other PWS located in the vicinity of Hardin but five of these systems purchase water from Hardin's water supply. The Purple Cow Restaurant and the Hardin KOA campground are PWSs that are not on Hardin's water supply system and use groundwater as their source water. The municipal sewer district services all residents within town limits. Municipal wastewater discharges to a multi-cell infiltration pond are located about one mile east of town. Residents in areas outlying town limits utilize on-site septic systems for waste disposal.

Figure 2. Hardin Average Temperatures and Precipitation



Climate

Based on Western Regional Climatic Center data for the period of record, annual precipitation averages 11.77 inches. Monthly average precipitation ranges from 0.38 inches in February to 1.98 inches in June. Summer thunderstorms and winter snows provide a majority of the precipitation in the area. The annual mean snowfall in Hardin is 22.4 inches. A summary of the available climatic data for the Hardin area is presented in Table 1 below.

Table 1. Climatic Summary
 City of Hardin, Montana (243915)
 Period of Record Monthly Climate Summary
 Period of Record : 7/1/1948 to 12/31/2001

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	32.6	40.9	49.0	60.8	71.7	80.9	89.9	88.9	76.6	64.8	47.6	36.9	61.7
Average Min. Temperature (F)	6.5	13.9	21.3	31.3	41.4	49.6	54.8	52.6	42.3	31.6	20.3	10.6	31.3
Average Total Precipitation (in.)	0.57	0.38	0.61	1.38	1.81	1.98	1.09	0.81	1.21	0.96	0.51	0.45	11.77
Average Total Snow Fall (in.)	5.7	2.7	3.9	2.5	0.1	0.0	0.0	0.0	0.3	0.4	1.8	4.9	22.4
Average Snow Depth (in.)	2	1	1	0	0	0	0	0	0	0	1	2	1

Percent of possible observations for period of record.

Max. Temp.: 92.6% Min. Temp.: 92.4% Precipitation 93% Snowfall: 78% Snow Depth: 76.6%

Source: Western Regional Climate Center, wrcc@dri.edu

Geographic Setting

Hardin is located in the non-glaciated Missouri Plateau portion of the Great Plains physiographic province of North America. This area is also designated as the non-glaciated central ground-water region of the United States (Heath, 1984). The elevation at Hardin is approximately 2,900 feet above mean sea level and the town is located a little over a mile west of the Bighorn River near the confluence of the Little Bighorn River (Figure 1 and 4). The Bighorn River valley is approximately one mile wide in the vicinity of Hardin.

About 19,000 square miles in Wyoming and 3,900 square miles in south-central Montana are drained by the Bighorn River and its tributaries (Hamilton and Paulson, 1968). The Bighorn Mountains to the south of Hardin represent the headwaters for the Bighorn River and its tributaries. Significant tributaries to the Bighorn River near Hardin include Peritsa Creek, Williams Coulee, and the Little Bighorn River (Figure 4). The U.S. Geological Survey operates a stream gauging station near Bighorn, Montana, (Station Number 06294500). The station has a period of record extending from October 1981 to present. Previous flow data for this station are published under stations 06294700 Bighorn River at Bighorn, MT (1956-81), and 06294700 near Custer (1945-55). The USGS states that flows are equivalent at all sites. Annual average flow for the Bighorn River is 3,800 cubic feet per second (cfs) over the 56-year period of record.

Maximum and minimum annual discharge for the same period are 5,719 and 1,453 cfs (NWISWeb Data for the Nation).

Geology

This section provides an overview of the geology and hydrology of the area in the vicinity of Hardin. The geology of the area can be used to determine the locations, boundaries, and hydraulic properties of local aquifers. An understanding of hydrogeologic conditions also provides an explanation for the sensitivity of local aquifers to potential contamination sources.

Reports used for this section include Richards (1955), Moulder et al. (1960), Hamilton and Paulson (1968), and Vuke et al (2000). Hamilton and Paulson report that 8,000 feet of rock exposed in the Lower Bighorn Valley range in age from Mississippian to Recent, and that 75% of that thickness is comprised of shale or sandy shale that yields very little water. Aquifers do occur in the Quaternary alluvium and terrace deposits, Tertiary alluvial terrace deposits, and in sandstone units within the Hell Creek, Parkman, and Cloverly formations (Moulder et al., 1960 and Hamilton and Paulson 1968).

Alluvium in the present day Bighorn River valley range in thickness from 10 to 30 feet over a width ranging between $\frac{1}{4}$ and 1 mile wide. The alluvium consists of lenses of unconsolidated clay, sand, and gravel. The Bighorn River alluvium yields economic quantities of water and in most places represents an unconfined aquifer.

Modern rivers, including the Bighorn and Little Bighorn, have cut down through the older bedrock formations. As many as six terrace deposits consisting of alluvial gravel lenses laid down by the Bighorn River and its tributaries are present above the present day river valley. Episodic uplift and mountain building in the Bighorn-Prior Mountain Ranges is thought to have caused the streams to incise, or down cut, through their channel bottoms and establish new streambeds at lower elevations. Terraces range from 20 to as much as 600 feet above the present Bighorn River Valley (Hamilton and Paulson, 1968). Terrace deposits consist of sandy gravel lenses that are 10 to 40 feet thick. Some of the terrace deposits are lithified with carbonate cements (Hamilton and Paulson, 1968). Hardin is located on one of the terrace deposits above the present day Bighorn River Valley (Figure 3). Some of the terraces may be equivalent to the Tertiary Flaxville Formation of Northeastern Montana. Ground water is present within some of the terraces, especially where irrigation occurs on the terrace. In the central part of the Bighorn River Valley south of Hardin, ground water is under confined conditions. Measurement of pressure within flowing wells indicates that the water level (piezometric surface) is as much as 10 to 15 feet above the top of the terrace gravel aquifer (Hamilton and Paulson, 1968).

Sand, shale, coal, and limestone beds exposed at the land surface in the vicinity of Hardin were deposited between 115 and 70 million years ago in a broad shallow sea that covered parts of Montana, Wyoming, and Idaho (Alt and Hyndman, 1995). The shallow sea extended west and retreated east several times during the Cretaceous Period. The geologic formations shown in Figure 3 are relatively flat but they are gently folded in some places. Isolated geologic fault zones are located in areas southwest, northwest, and southeast of Hardin but no faulting occurs in the immediate vicinity of the town. Aquifers within the Hell Creek, Parkman, and Cloverly formations appear to be confined as indicated by static water levels above the top of the aquifer and some flowing wells.

Older bedrock formations are exposed at the land surface toward the interior part and along the flanks of the Bighorn Mountains. Some of these formations, like the Madison Limestone are considered to be a potential source of ground water and can yield significant volumes of water to wells. However, the older bedrock formations are found at considerable depth below the land surface in the vicinity of Hardin and are not usually considered to be a target for water wells because of the other shallower aquifers present in the area.

In some areas within the Bighorn and Little Bighorn valleys, the water table rises near or above the land surface. This condition is often described as waterlogging, where substantial land areas have highly saturated soil or root zones. The condition limits the utility of land for a variety of purposes and can lead to the precipitation of natural salts that are harmful to crops. Causes of waterlogged land in this area can include one or more factors including: poorly drained impermeable soils, merging of gently sloping water table with steeply sloping land, such as at the scarp base of terrace deposits, and by thinning of the alluvial gravel deposits that overlie impermeable bedrock such as shale (Hamilton and Paulson, 1968; Moulder et al., 1960). Ground water drain canals have been used to collect the ground water in waterlogged land and discharge it to the river.

The Public Water Supply

The Hardin PWS is classified as a community system under the Federal Safe Drinking Water Act, because the system serves at least 25 year-round residents through at least 15 service connections. The PWS services 3,225 residents via 1,355 active service connections. Larry Vandersloot, Superintendent of Public Works, has reviewed the report and made note that there have been upgrades to the system since the last sanitary survey inspection was conducted on October 31, 2000.

Hardin receives its water from one source, the Bighorn River. The river is the permanent source for the City of Hardin and is adequate both in quality and quantity. Water from the river is collected through two intakes located on the river's banks. One intake, old but still functional, could be pressed into service in cases of emergency. The new intake is located just upstream from the old and has two lines descending at approximately a 45-degree angle into the river. The intakes are inspected and cleaned regularly and appear to be in very good condition (DEQ Permitting and Compliance Division, 2000). The pressure system that exists supplies water to users outside the city limits per agreement and does not have any use for the public water system. Treatment is a conventional treatment plant design utilizing filtration and disinfection. Two 150-pound gas chlorine bottles at the treatment plant provide disinfection. Two water tanks, one concrete and the other steel, totaling 1,000,000 gallons, provide storage for the town.

The treatment plant at Hardin uses coagulation and filtration in its treatment process. A sedimentation basin allows for a sufficient amount of particle removal by settling before the water reaches the filters. There are four slow sand filters that further remove particles from the water and produce a very low turbidity finished water. The treatment plant at Hardin also feeds fluoride at a rate of 1.4 ppm.

The distribution system for Hardin is constructed of transite, asbestos, and PVC pipe. The PVC is being used to replace the older lines. Water is typically pumped at a rate of 420,000 to 500,000 gallons per day.

Due to the fact that Hardin obtains its drinking water from a surface water supply, the source water is classified as highly sensitive to contamination, in accordance with Montana Source Water Protection Program aquifer/source water sensitivity criteria (1999).

Water Quality

Public water systems must conduct routine monitoring for contaminants in accordance with Federal Safe Drinking Water Act requirements. A community public water supply, like Hardin, must sample in accordance with schedules specified in the Administrative Rules of Montana (ARM). Monitoring includes coliform bacteria, lead, copper, nitrate, nitrite, volatile organic chemicals (including hydrocarbons and chlorinated solvents), inorganic chemicals (including metals), synthetic organic chemicals (including pesticides), and radiological contaminants. Transient, non-community PWSs, like the Purple Cow Restaurant, the KOA Campground, and the Texaco Gas Station, are required to conduct routine monitoring only for pathogens (including coliform bacteria), nitrate, and nitrite. All contaminant concentrations detected in required samples must comply with numeric maximum contaminant levels (MCLs) specified in the Federal Safe Drinking Water Act.

The U. S. Geological Survey collects water quality data for the Bighorn River south of Hardin near St. Xavier. Table 2 summarizes this data.

The State of Montana classifies Bighorn River and its tributaries as B-1 and B-2 surface water. According to the classification, the Bighorn River is to be maintained as suitable for drinking, culinary and food processing purposes after conventional treatment for the removal of naturally present impurities. These waters must also be maintained as suitable for bathing, swimming, and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. These surface water classifications are pursuant to the Administrative Rules of Montana 17.30.600-625.

City of Hardin PWS Water Quality

Within the past five years, no positive fecal coliform samples were collected during routine contaminant monitoring. No MCL exceedances were noted for any other constituents monitored over the past five years.

Table 2 - Water Quality Data for USGS 0628700 near St. Xavier

	TEMPERATURE, WATER (DEG. C)	TEMPERATURE, AIR, DEGREES CELSIUS	DISCHARGE, CUBIC FEET PER SECOND	DISCHARGE, INSTANTANEOUS, CUBIC FEET PER SECOND	GAGE HEIGHT, FEET	
Average	8.56	12.69	4176.23	3442.71	61.12	
Max	21.50	36.00	20200.00	12100.00	64.61	
Min	1.00	-25.00	358.00	332.00	59.38	
	TURBIDITY (JACKSON CANDLE UNITS)	COLOR (PLATINUM-COBALT)	SPECIFIC CONDUCTANCE (MICROSIEMENS/CM AT 25 DEG.	OXYGEN DISSOLVED (MG/L)	BIOCHEMICAL OXYGEN DEMAND, 5-DAY AT 20 DEGREES C	PH, WATER, WHOLE, FIELD, STANDARD UNITS
Average	2.42	5.78	835.73	11.52	1.18	7.90
Max	6.00	17.00	1180.00	13.20	2.70	8.50
Min	1.00	0.00	285.00	9.60	0.60	6.60
	PH, WATER, WHOLE, LABORATORY, STANDARD UNITS	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	ACID NEUTRALIZING CAPACITY (ANC), WATER, UNFILTE	ACID NEUTRALIZING CAPACITY (ANC), WATER, UNFILTE	ACID NEUTRALIZING CAPACITY (ANC), WATER, UNFILTE	NITROGEN ORGANIC TOTAL (MG/L AS N)
Average	8.24	4.19	162.44	197.71	0.09	0.00
Max	9.00	16.00	216.00	260.00	6.00	0.00
Min	8.00	1.30	107.00	130.00	0.00	0.00
	NITROGEN AMMONIA DISSOLVED (MG/L AS N)	NITROGEN, NITRITE, DISSOLVED, MG/L AS N	NITROGEN NITRATE DISSOLVED (MG/L AS N)	NITROGEN NITRITE PLUS NITRATE DISSOLVED (MG/L AS	PHOSPHATE ORTHO DISSOLVED (MG/L AS PO4)	PHOSPHORUS TOTAL (MG/L AS P)
Average	0.02	0.00	0.21	0.40	0.03	0.05
Max	0.13	0.01	0.57	2.20	0.15	0.12
Min	0.00	0.00	0.00	0.00	0.00	0.00
	PHOSPHORUS DISSOLVED (MG/L AS P)	PHOSPHORUS ORTHOPHOSPHATE DISSOLVED (MG/L AS P)	PHOSPHORUS ORTHOPHOSPHATE DISSOLVED (MG/L AS P)	PHOSPHORUS TOTAL (MG/L AS P)	PHOSPHORUS DISSOLVED (MG/L AS P)	PHOSPHORUS ORTHOPHOSPHATE DISSOLVED (MG/L AS P)
Average	0.03	0.02	0.02	0.05	0.03	0.02
Max	0.47	0.05	0.05	0.12	0.47	0.05
Min	0.00	0.00	0.00	0.00	0.00	0.00
	HARDNESS TOTAL (MG/L AS CAC03)	NONCARBONATE HARDNESS WATER WHOLE TOTAL, FIELD,	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM DISSOLVED (MG/L AS MG)	SODIUM DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO
Average	287.02	121.77	73.21	24.87	77.42	2.00
Max	410.00	220.00	110.00	38.00	118.00	3.00
Min	160.00	45.00	43.00	13.00	40.00	1.00
	SODIUM, PERCENT	SODIUM PLUS POTASSIUM DISSOLVED (MG/L AS NA)	POTASSIUM DISSOLVED (MG/L AS K)	CHLORIDE DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE DISSOLVED (MG/L AS F)
Average	36.66	84.67	3.83	10.77	271.35	0.43
Max	42.00	95.00	22.00	24.00	400.00	0.80
Min	30.00	69.00	1.30	3.30	140.00	0.10
	SILICA DISSOLVED (MG/L AS SIO2)	BORON DISSOLVED (UG/L AS B)	IRON, TOTAL, (UG/L AS FE)	IRON DISSOLVED (UG/L AS FE)	MANGANESE DISSOLVED (UG/L AS MN)	TOTAL COLIFORM, M ENDO MF METHOD, WATER, COLONIE
Average	10.24	119.42	90.00	35.57	18.56	210.92
Max	16.00	300.00	180.00	210.00	160.00	1000.00
Min	0.20	60.00	0.00	0.00	0.00	2.00

Table 2 Continued

	METHYLENE BLUE ACTIVE SUBSTANCE (MG/L)	ALDRIN, TOTAL (UG/L)	LINDANE, TOTAL (UG/L)	P,P'-DDD, WATER, UNFILTERED, RECOVERABLE, UG/L	P,P'-DDE, TOTAL (UG/L)	P,P'-DDT, WATER, UNFILTERED, RECOVERABLE, UG/L
Average	0.02	0.00	0.00	0.00	0.00	0.02
Max	0.10	0.00	0.00	0.00	0.00	0.08
Min	0.00	0.00	0.00	0.00	0.00	0.00

	DIELDRIN, TOTAL (UG/L)	ENDRIN, WATER, UNFILTERED, RECOVERABLE, UG/L	HEPTACHLOR, TOTAL (UG/L)	HEPTACHLOR EPOXIDE, TOTAL (UG/L)	2,4-D, TOTAL (UG/L)	2,4,5-T, TOTAL (UG/L)
Average	0.00	0.00	0.00	0.00	0.04	0.00
Max	0.00	0.00	0.00	0.00	0.07	0.00
Min	0.00	0.00	0.00	0.00	0.00	0.00

	SILVEX, TOTAL (UG/L)	SOLIDS, RESIDUE ON EVAPORATION AT 180 DEG C, DIS	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER DAY)	SOLIDS, DISSOLVED (TONS PER ACRE-FOOT)	PHOSPHORUS ORTHOPHOSPHATE, TOTAL (MG/L AS P)
Average	0.00	630.43	564.19	5925.59	0.79	0.01
Max	0.00	842.00	792.00	33100.00	1.15	0.02
Min	0.00	363.00	322.00	511.00	0.44	0.00

	NITROGEN, NITRATE, DISSOLVED (MG/L AS NO3)	NITROGEN, NITRITE, DISSOLVED (MG/L AS NO2)	IRON (UG/L AS FE)	POTASSIUM 40 DISSOLVED (PCI /L AS K40)	SPECIFIC CONDUCTANCE MICROSIEMENS/CM AT 25 DEG C	ACID NEUTRALIZING CAPACITY (ANC), WATER, UNFILTE	HARDNESS, NONCARBO NATE, AS CaCO3, MG/L
Average	0.94	0.02	5.00	2.80	881.11	162.50	161.43
Max	2.90	0.04	10.00	3.10	1040.00	190.00	220.00
Min	0.00	0.01	0.00	2.50	776.00	130.00	120.00

CHAPTER 2 DELINEATION

The source water protection area, the land area that contributes water to the City of Hardin public water supply surface water intakes, is delineated in this chapter. The purpose of delineation is to map the source of Hardin’s drinking water and to define areas within which to prioritize source water protection efforts.

Source water protection areas for surface water sources are subdivided into Spill Response and Watershed Regions, each with separate management goals. The Spill Response Region encompasses an area upstream of the Hardin PWS in which contaminants can be drawn into the intake with little lag time. The Watershed Region encompasses the entire area of the watershed upstream of the Hardin PWS.

Hydrogeologic Conditions

The headwaters for the Bighorn River and its tributaries are in the Bighorn Mountain Range approximately 25 miles to the south of Hardin. Table 3 summarizes the daily mean flow statistics for the USGS gauging station near St. Xavier. Figure 5 shows the peak flow levels for the period of record and Figure 6 shows the flood frequency analysis for the Bighorn River at St. Xavier.

Table 3 - Daily mean flow statistics for 7/19 based on 67 years of record in ft³/sec

Minimum	Mean	Maximum	80 percent exceedence	50 percent exceedence	20 percent exceedence
987	5,071	18,800	2,226	4,030	6,924

Figure 5. Peak Flow Levels for the Bighorn River at St. Xavier

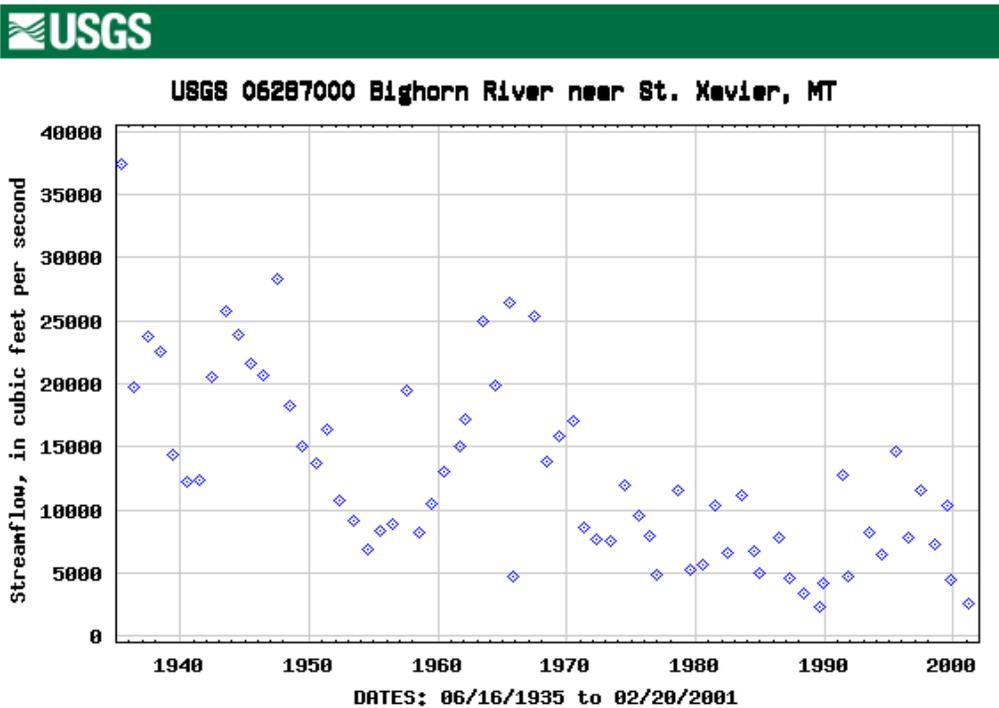
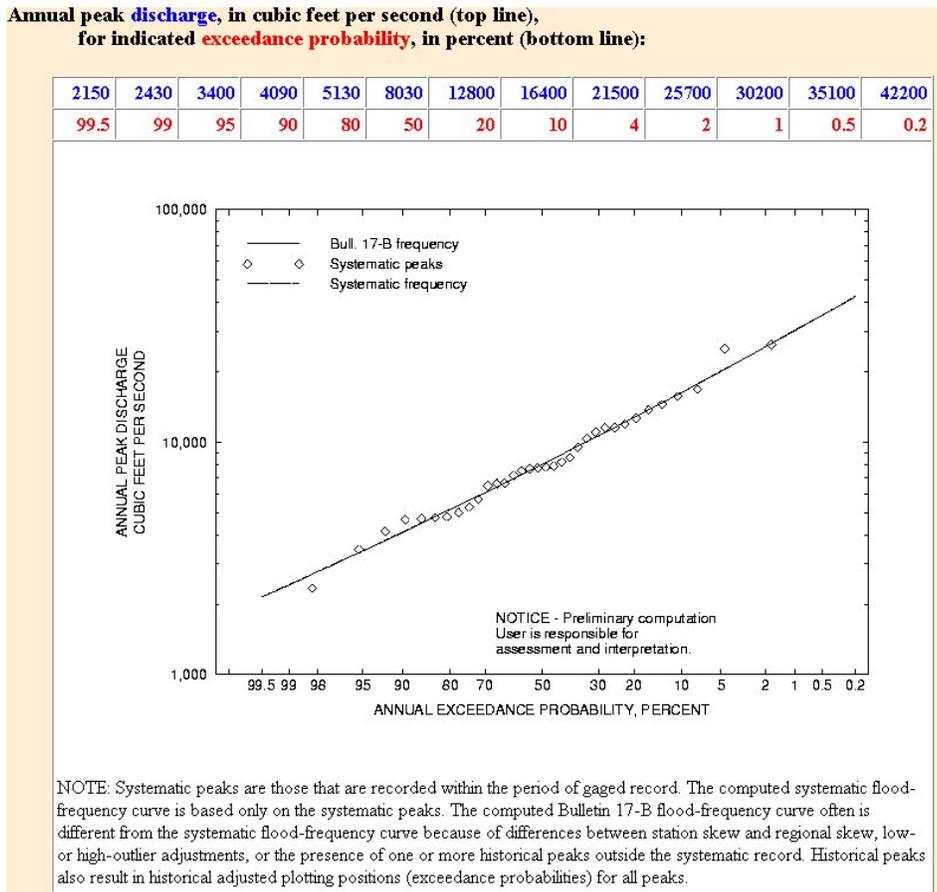


Figure 6. Flood Frequency Analysis for the Bighorn River at St. Xavier



Using DEQ Source Water Protection Program criteria for ranking aquifer/source water sensitivity (Table 4 below), the City of Hardin PWS source water is considered highly sensitive to contamination. The sensitivity ranking is a result of the surface water source for the Hardin PWS.

Table 4. Source water sensitivity criteria (DEQ, 1999).

Source Water Sensitivity
<p>High Source Water Sensitivity Surface water and GWUDISW Unconsolidated Alluvium (unconfined) Fluvial-Glacial Gravel Terrace and Pediment Gravel Shallow Fractured or Carbonate Bedrock</p>
<p>Moderate Source Water Sensitivity Semi-consolidated Valley Fill sediments Unconsolidated Alluvium (semi-confined)</p>
<p>Low Source Water Sensitivity Consolidated Sandstone Bedrock Deep Fractured or Carbonate Bedrock Semi-consolidated Valley Fill Sediments (confined)</p>

Conceptual Model and Assumptions

The headwaters of the Bighorn River and its tributaries are in the Bighorn Mountains to the south of Hardin. Annual precipitation for this mountain range is between 28 and 32 inches, with a significant portion of that precipitation occurring as snow during the winter months and as spring rain (Figure 2). Peak flows for the Bighorn River commonly occur in spring and early summer, and low flows are more common in late summer through the winter months.

Spills and leaks of contaminants represent a high hazard if they are located so that they result in direct discharge into Peritsa Creek, Williams Coulee, the Little Bighorn River, the Bighorn River or into one of the other immediate surrounding tributaries to these surface water bodies upstream of the Hardin PWS source intakes (Table 8). The concern is that these spills or leaks could reach the surface water intakes before plant operators can close the intake. The seasonal timing of direct discharges into the river can complicate the potential threat to the public water supply. Spills occurring during high water periods will tend to travel toward the surface water intake faster than during low water conditions. However, dilution during high flows in the spring and early summer may help reduce the hazard posed to the public water supply. Direct discharges to the river during low flow conditions will have less chance to be diluted before reaching the surface water intake. Other contaminant sources may discharge to the river and its tributaries in a less direct manner. These contaminant sources are within the watershed but are farther from the river and contaminants can be flushed into the streams during spring snowmelt or storm events. Indirect discharge to streams can also come from contaminant sources that infiltrate into aquifers which then discharge to the surface water bodies via hydraulic connections. Because these contaminants are not discharged directly into the river, they tend to pose a less immediate threat to the public water supply and are usually assigned a lower hazard rating.

Delineation Results

Spill Response Region

The Spill Response Region for the City of Hardin PWS extends 1/2 mile downstream and approximately 10 miles upstream of the City of Hardin surface water intake (Figure 4). It encloses the shoreline of the Bighorn River and also parts of Peritsa Creek and Williams Coulee, which are tributaries that join the Bighorn River just upstream from the intake. The width of the region extends 1/2 mile on either side of the Bighorn River, Peritsa Creek, and Williams Coulee. Peritsa Creek and Williams Coulee are included in the spill response region because they are both major tributaries to the Bighorn River upstream of the Hardin PWS intake.

Watershed Region

The Watershed Region for the City of Hardin PWS intakes encompasses the portion of the Lower Bighorn watershed upstream of the surface water intake. It extends approximately 40 miles upstream from the intake and is approximately 40 miles across at its widest point.

Limiting Factors

The delineations for the Hardin PWS Spill Response Region and Watershed Region are based on fixed-distance and watershed mapping. The Spill Response Region represents an approximation of the distance required for contaminants released upstream to reach the surface water intake with relatively short lag time. Numerous assumptions are associated with these Source Water Protection Program (SWPP) criteria for Spill Response Region delineations. Contaminant transport rates and concentrations will vary depending on stream/river flow conditions, groundwater flux into the river, contributions from overland flow, soil types, slope, characteristics of riparian vegetation, the extent of riparian vegetation buffer zones, the extent and duration of contamination, contaminant solution density, mechanical dispersion, biological transformation, dilution, molecular diffusion, adsorption, precipitation, oxidation, complexation, and volatilization. As a result, some areas within the Spill Response Region may be more conducive to contaminant transport than others, and should be designated as higher priority areas for source water protection efforts.

CHAPTER 3 INVENTORY

An inventory of potential sources of contamination was conducted to assess the susceptibility of the City of Hardin PWS to contamination, and to identify priorities for source water protection planning. Inventories were conducted within the delineated Spill Response and Watershed Regions. The inventory focuses on facilities that generate, use, store, transport, or dispose of potential contaminants, and on land types on which potential contaminants are generated, used, stored, transported, or disposed. Additionally, the inventory identifies potential sources of all primary drinking water contaminants and *Cryptosporidium*. Only significant potential contaminant sources were selected for detailed inventory. The significant contaminants posing potential threats to the City of Hardin PWS include nitrate, pathogens, herbicides, and pesticides. The inventory for the Hardin PWS also focuses on all activities in the Spill Response Region, as well as general land uses and large potential contaminant sources in the Watershed Region.

Inventory Method

Available databases were initially searched to identify businesses and land uses that are potential sources of regulated contaminants in the inventory region. The following steps were followed:

Step 1: Land cover is identified from the National Land Cover Dataset compiled by the U.S. Geological Survey and U.S. Environmental Protection Agency (U.S.G.S., 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), hazardous waste contaminated sites, landfills, and abandoned mines.

Step 4: A business phone directory 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 Standard Industrial Codes.

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

Step 6. All significant potential contaminant sources were identified in the inventory region and land uses and facilities that generate, store, transport, or dispose large quantities of hazardous materials were identified within the recharge region.

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) Hazardous waste contaminated sites
- 4) Underground storage tanks
- 5) Major roads or rail transportation routes
- 6) Cultivated cropland
- 7) Animal feeding operations
- 8) Wastewater lagoons or spray irrigation
- 9) Septic systems
- 10) Sewered residential areas
- 11) Storm sewer outflows
- 12) Floor drains, sumps, or dry wells
- 13) Abandoned or active mines

Inventory Results/Spill Response Region

Land areas within the spill response and watershed region are sparsely populated and fairly rural. The principal types of land cover in the Spill Response Region are ag-land (41%), grassland (32%), fallow (13%), open water (4%), wetland (4%), shrubland (3%), and forest (3%) (Figure 7 and Table 7). Activities on agricultural land pose a moderate potential threat to the City of Hardin PWS because they occupy approximately 41% percent of the Spill Response Region. The concern here is the potential for mismanagement or over- application of fertilizers and/or pesticides on the agricultural land that occupies a large portion of the spill response region. A full listing of businesses in and around the City of Hardin (based on SIC codes and their potential to be contaminant sources) and other types of facilities was compiled and is present in Appendix A. While some of these businesses are considered potential sources of contamination, they do not pose a threat to the PWS because they are located over a mile west of the Bighorn River and the PWS intake.

Low septic densities occur over the entire spill response region (99.7% overall). The Hardin municipal sewer system is located outside of the spill response region. Main breaks or leaking connections in the system pose a minimal threat to the PWS. No concentrated animal feeding operations are located in the spill response region (Figure 7).

**Table 5. Significant potential contaminant sources in the Spill Response Region
City of Hardin PWS**

Potential Source	Potential Contaminants	Hazard
Cultivated Cropland	Fertilizers, pesticides, pathogens, nitrate	Spills, over application, surface runoff
Chicago, Burlington, and Quincy Railway	Pesticides, fertilizers, VOCs, other	Spills, storm water runoff, infiltration into ground water
Wastewater Discharges	VOCs, SOCs, pathogens, nitrate, TDS	Leaks, spills, improper handling and disposal/discharge of chemicals used by various businesses and are released to systems that allow discharge of contaminants with wastewater to surface water
Class V Injection Wells (existence and locations are not known) where storm and/or wastewater is concentrated and recharges groundwater.	VOCs, SOCs, petroleum hydrocarbons, metals, pathogens, nitrate	Leaks, spills, improper handling and disposal/discharge of chemicals used by various businesses and are released to systems that allow infiltration of contaminants to the subsurface or to the storm water system

From the above list of potential contaminant sources, some are considered significant based upon the volume of potential releases, the volume of hazardous materials typically handled, the potential of the released materials to impact nearby surface water or groundwater, and the proximity of the sources to the

PWS surface water intakes. Significant potential contaminant sources from the above list are discussed individually in the following section on Susceptibility Assessment and they are listed in Table 9.

Inventory Results/Watershed Region

The Watershed Region for the City of Hardin PWSs encompasses the entire Lower Bighorn Watershed located upstream of the PWS intake (Figure 8). Most of the significant potential contaminant point sources are located north of Hardin's PWS intake. Spills of fertilizers, pesticides, volatile organic compounds (VOCs), and synthetic organic compounds (SOCs) could occur along the interstate and the Chicago, Burlington, and Quincy railroad tracks within the Watershed Region (Figure 8). However, the railroad tracks and the highway appear to be more than a mile west and north of the intake and do not threaten the public water supply. The Watershed Region encompasses a large portion of the City of Hardin and the businesses located there. As such, it also encompasses a number of significant potential contaminant sources, such as storm and wastewater discharges, UST/LUST locations in and around town, and a crude oil pipeline. A full listing of businesses in the City of Hardin (based on SIC codes) was compiled and is present in Appendix A. Potential contaminant sources in Hardin are located over a mile from the intake (Figure 4 and 6) and do not pose a threat to the PWS. Predominant land covers in the Watershed Region include grassland (57%), ag-land (16%), shrubland (11%), fallow (10%), and forest (6%) (see Figure 8). Almost all of the agricultural land cover is concentrated in the river and stream valleys (Figure 8). For this reason, activities on agricultural land are considered to pose a potential threat to the City of Hardin.

Low septic densities occur over the entire Watershed Region (99% overall). There are areas of medium septic density in close proximity to the Bighorn River and the PWS's water intake. The Hardin municipal sewage lagoons are located primarily inside of the Watershed Region and only comprise a small area. Both lagoons are north and down stream from the intake and very likely do not pose a threat to the public water supply. However, sewer main breaks or leaking connections in the system could pose a threat to the PWS, depending on where the main lines are located with respect to the intake (Figure 4). One concentrated animal feeding operation (CAFO) is located in the Little Bighorn River drainage about 3 miles upstream from the confluence with the Bighorn River. The Hardin PWS intake is almost a mile upstream from the confluence of the Little Bighorn River and therefore the CAFO is not considered a threat to Hardin's source water (Figure 8). Table 6 below lists the significant potential contaminant sources identified in the Watershed Region.

**Table 6. Significant potential contaminant sources in the Watershed Region
City of Hardin PWS**

Potential Source	Potential Contaminants	Hazard
Cultivated Cropland	Fertilizers, pesticides, pathogens, nitrate	Spills, over application, surface runoff
Chicago, Burlington, and Quincy Railway	Pesticides, fertilizers, VOCs, other	Spills, storm water runoff, infiltration into ground water
Highways, roads, and pipelines	Pesticides, fertilizers, VOCs, other	Spills, storm water runoff, infiltration into ground water
On-site residential septic systems	Nitrate, pathogens	Leaks in septic tanks, leaks in collection lines, system failure, infiltration of untreated effluent into shallow ground water, which may in turn reach surface water
Large capacity septic systems	Nitrate, pathogens	Leaks in septic tanks, leaks in collection lines, system failure, infiltration of untreated effluent into shallow ground water, which may in turn reach surface water
Municipal Sewer	Nitrate, pathogens	Leaks in mains/lines, system failure, infiltration of untreated effluent into shallow ground water, which may in turn reach surface water
USTs/LUSTs	VOCs, petroleum hydrocarbons	Spills, leaks impacting groundwater and or reaching surface water
Assorted businesses in town	VOCs, SOCs, petroleum hydrocarbons, metals, pathogens, nitrate	Releases or spills, mishandling of chemicals, improper disposal of chemicals anywhere near the lake
Class V Injection Wells (existence and locations are not known) where storm and/or wastewater is concentrated and recharges groundwater.	VOCs, SOCs, petroleum hydrocarbons, metals, pathogens, nitrate	Leaks, spills, improper handling and disposal/discharge of chemicals used by various businesses and are released to systems that allow infiltration of contaminants to the subsurface or to the storm water system
Storm Water / Wastewater Discharges	VOCs, SOCs, pathogens, nitrate, TDS	Leaks, spills, improper handling and disposal/discharge of chemicals used by various businesses and are released to systems that allow discharge of contaminants with wastewater to surface water

From the above list of potential contaminant sources, some are considered significant based upon the volume of potential releases, the volume of hazardous materials typically handled, the potential of the released materials to impact nearby surface water or groundwater, and the proximity of the sources to the PWS surface water intakes.

Inventory Update

To make this SWDAR a useful document in the years to come, the owners, manager, or the certified water system operator(s) for the public water supply for the City of Hardin 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 extent of the potential contaminant source inventory is limited in several respects. The inventory is based on data readily available through state documents, published reports, and GIS data. Documentation may not be readily available on some potential sources. As a result, all potential contaminant sources may not have been identified. In some instances, inadequate location information precluded the inclusion of potential sources in the inventory.

CHAPTER 4 SUSCEPTIBILITY ASSESSMENT

Susceptibility of the City of Hardin PWS's source water is determined by two factors: the potential of a contaminant reaching the intake and the resulting health hazard. Susceptibility is assessed in order to prioritize potential pollutant sources in the Spill Response Region in order to guide management actions undertaken by local entities, in this case the City of Hardin and Big Horn County.

The goal of source water management is to protect the source water, manage significant potential contaminant sources in the Spill Response Region, and ensure that land use activities in the Watershed Region pose minimal threats to the source water. Management priorities in the Spill Response 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 City of Hardin PWS owners and operators to reduce susceptibility are also included in this section of the report.

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 reach the PWS intake. The hazard presented by point sources of contaminants in Hardin's Spill Response Region depends on whether contaminants can discharge directly into the Bighorn River or into two of its joining tributaries, Williams Coulee and Peritsa Creek. Point source hazard is also dependent on the health affects associated with potential contaminants. Hazard ratings for point and nonpoint sources are assigned based on criteria listed in Table 8. Barriers can be anything that decreases the likelihood that contaminated water will reach Hardin's surface water intake. Examples of barriers include: a vegetated riparian area, protective forest management practices, and dilution.

Table 7. Hazard of Potential Contaminant Sources, Determination of For Surface Water Sources

Potential Contaminant Sources	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
Point Sources of Nitrates or Pathogens	Potential for direct discharge to surface water	Potential for discharge to groundwater hydraulically connected to surface water	potential contaminant sources in the watershed region
Point Sources of VOCs, SOCs, or Metals	Potential for direct discharge of large quantities from roads, rails, or pipelines	Potential for direct discharge of small quantities to surface water	Potential for discharge to groundwater hydraulically connected to surface water
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 percent of region	20 to 50 percent of region	Less than 20 percent of region

Barriers to contamination can be anything that decreases the likelihood that contaminants will reach a spring or well. Barriers can be engineered structures, management actions, or natural conditions. Examples of engineered barriers 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 can be natural barriers.

Table 8. 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

Susceptibility ratings are presented individually for each significant potential contaminant source and each associated contaminant (Table 9).

Susceptibility Assessment Results

Table 9. Susceptibility Assessment Significant Potential Contaminant Sources in the Spill Response and Watershed Regions City of Hardin PWS surface water intakes						
Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendations
Cultivated Cropland	Fertilizers, pesticides, pathogens, nitrate	Spills, over application, surface runoff	Moderate	-Dilution	Moderate	Educate land owners on proper application and storage of pesticide and fertilizers; implement agricultural BMPs
Chicago, Burlington, and Quincy Railway	Pesticides, fertilizers, VOCs	Spills, storm water runoff, infiltration into ground water	Moderate	-Both rail lines are over one mile from the river and partially down stream from the intake. -Dilution; County Emergency Response Plan, training and preparation of local response personnel.	Low to Moderate	Maintain preparedness of local emergency personnel through active training, runoff diversion, continued remediation of former release sites
Wastewater Discharges	VOCs, SOCs, pathogens, nitrate, TDS	System failure, exceeding effluent limits	Moderate	-Located downstream of the PWS intake	Low	Ensure proper maintenance and operation of system; monitor leaks in system; develop an alternative treatment plan in the event of system failure
Municipal Sewer System	Pathogens, nitrate	Leaks in sewer mains to groundwater, which may reach surface water	Low	-Dilution	Low to Moderate (if close to intake location)	Ongoing testing and maintenance of lines and system, replacement of old lines, compliance with current regulations for discharges
Class V Injection Wells	VOCs, SOCs, pathogens, nitrate	Infiltration of contaminants into aquifer	Low	-Spill prevention, dilution, ongoing monitoring of groundwater, monitoring for spills, ongoing remediation of spill sites	Very Low	Inventory; Educate business owners and the public on proper waste disposal and recycling

Table 9, above, displays the susceptibility assessment results for the City of Hardin PWS surface water intakes. The town's intake, located on the Bighorn River, is susceptible to a number of different contaminants, including pathogens, nitrates, fertilizers, pesticides, VOCs, and total dissolved solids. The above assessment addresses the Spill Response Region for the City of Hardin PWS.

The susceptibility assessment results for each significant potential contaminant source identified is described below:

Agricultural lands – The potential hazard imposed by pathogens and nitrate originating from agricultural lands is moderate. Cropped agricultural lands occupy 41% of the spill response region, and 16% of the watershed, falling between 20% and 50% of the total areas of the regions, respectively. The susceptibility of the intake to these agricultural sources of nitrate and pathogens is also moderate due to the presence of a single barrier. Adequate dilution is provided by the Bighorn River to reduce water quality impacts to non-significant levels.

Chicago, Burlington, and Quincy Railway – The potential hazard imposed by pesticides, fertilizers, VOCs and SOCs originating from the railway and former spills along the railway pose a moderate hazard. This is because tracks are located over a mile from the river but there is potential for a spill originating on or near the tracks in some location southwest of Hardin along Peritsa Creek. These spills could indirectly discharge into the Bighorn River upstream from the City of Hardin's surface water intake. The susceptibility of the Hardin PWS to contaminants originating from this source is considered to be low to moderate. Multiple barriers identified for this source include dilution in the river and use of a county emergency plan.

Wastewater Discharges- The potential hazard imposed by VOCs, SOCs, pathogens, and nitrate originating from wastewater discharges related to Hardin's wastewater treatment operations is moderate. The susceptibility of the Hardin PWS intake to contaminants originating from this source is low. One barrier was identified for this source, the location of the wastewater discharges, which are downstream from the PWS intake.

Municipal Sewer System – The potential hazard imposed by pathogens and nitrate originating from Hardin's municipal sewer system is low to moderate depending on how close the sewer mains are located to the surface water intake. The susceptibility of the intakes to nitrate and pathogens originating from this source is also low to moderate, as the only barrier identified between this source and the town's intake would be dilution in the river. Verifying that the mains are not located close to or upstream from the intake would set the susceptibility rating at low.

Class V Injection Wells – The potential hazard imposed by VOCs, SOCs, pathogens, nitrate, and other contaminants originating from the class V injection wells is considered low. The susceptibility of the intake to contaminants originating from this source is very low due to several barriers including spill prevention, dilution, monitoring of groundwater, and monitoring of spills.

It should be noted that even small releases of some chemicals in close proximity to a surface water intake can have significant negative impact on water quality, and is therefore a significant threat to the public water supply. Steps can be take to reduce the likelihood of releases in the source water for the PWS or in the vicinity of the sources. Some of these steps (considered management recommendations) are listed below.

Management Recommendations

Management recommendations are included in the susceptibility table for the Hardin PWS (Table 9). If these management recommendations are implemented, they may be considered additional barriers that will reduce the susceptibility of Hardin's intake to specific sources and contaminants.

Management recommendations fall into the following categories:

- Sewer maintenance and leak detection
- Municipal sewer extension
- Agricultural best management practices
- Stormwater management
- Proper disposal and monitoring of oil and gas production wastewater
- Education
- Emergency Response Planning

Sewer Maintenance and leak detection – Early warning of leaks and scheduled replacement of aging sewer lines will reduce the susceptibility of Hardin's intake to contamination from municipal septic wastes.

Sewer Extension – Installation of advanced septic treatment systems such as sand filters can limit contamination from new rural residential development, however, annexation and extension of sewers is the only way to reduce contamination from existing unsewered developments.

Agricultural and silvicultural best management practices (BMPs) – BMPs that address application and mixing of fertilizer and pesticides are a viable alternative to prohibition of their use. BMPs may also be utilized to minimize surface runoff and soil erosion on cultivated fields. Erosion control, selective logging, and other silvicultural practices (essentially BMPs) should be considered on a county-wide basis. BMPs are generally voluntary but their implementation can be encouraged through education and technical assistance. County planning can help promote the implementation of BMP on lands that are outside city limits but indirectly affect the city PWS.

Education - Educational workshops provided to the general public by the city, county, or state promote safe handling and proper storage, transport, use, and disposal of hazardous materials. Ongoing training provided to designated emergency personnel will promote the efficiency and effectiveness of emergency responses to hazardous material spills. Likewise, educational workshops provided to rural homeowners will promote the proper maintenance and replacement of residential septic systems. The EPA and the State of Montana can provide educational materials on these topics.

Hazardous Materials Collection Days – Several counties in the state that have vulnerable water supplies have implemented scheduled days for the collection of hazardous wastes from the public. These vary in the inclusiveness of what materials are collected, how the materials are handled, and how they are disposed of, but they all act to reduce the amount of unauthorized or improper disposal of these wastes. Used motor oil collection stations could be established and available to the public on a regular basis.

Emergency Response Plan – Several counties have compiled Emergency Response Plans that were then adopted by the local communities. The usefulness and effectiveness of a response plan are maximized if it

contains a clear listing of all emergency contacts, emergency numbers, and resources available within the county to respond to an emergency situation, such as a hazardous material spill. Emergency plans are not difficult to develop or distribute, but have a significant benefit to the citizens and municipalities within the county.

These management recommendations should be considered by the City of Hardin PWS operator, the city administration, and the Big Horn County administration. Should contamination reach the town's intake, the City and County will likely need to work cooperatively to address remediation or relocation of the Hardin PWS source.

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 mile as an area of investigation for the use of organic chemicals. Vulnerability assessment of spring water sources should use a minimum fixed radius of 1.0 mile 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. DEQ's PWS Section and DEQ's Source Water Protection Program will conduct review of an organic chemical monitoring waiver application. Other state agencies may be asked for assistance.

Susceptibility Waiver for Confined Aquifers

Confined groundwater is isolated from overlying material by relatively impermeable geologic formations. A confined aquifer is subject to pressures higher than atmospheric pressure that would exist at the top of the aquifer if the aquifer were not geologically confined. A well that is drilled through the impervious layer into a confined aquifer will enable the water to rise in the borehole to a level that is proportional to the water pressure (hydrostatic head) that exists at the top of a confined aquifer.

The susceptibility of a confined aquifer relates to the probability of an introduced contaminant to travel from the source of contamination to the aquifer. Susceptibility of an aquifer to contamination will be influenced by the hydrogeologic characteristics of the soil, vadose zone (the unsaturated geologic materials between the ground surface and the aquifer), and confining layers. Important hydrogeologic controls include the thickness of the soil, the depth of the aquifer, the permeability of the soil and vadose zones, the thickness and uniformity of low permeability and confining layers between the surface and the aquifer, and hydrostatic head of the aquifer. These factors will control how readily a contaminant will infiltrate and percolate toward the groundwater.

The Susceptibility waiver has the objective of assessing the potential of contaminants reaching the groundwater used by the PWS. A groundwater source that appears to be confined from surface infiltration in the immediate area of the wellhead may eventually be affected by contaminated groundwater flow from elsewhere in the recharge area. Contaminants could also enter the confined aquifer through improper well construction or abandonment where the well provides a hydraulic connection from the surface to the confined aquifer. The extent of confinement of an aquifer is critical to limiting susceptibility to organic chemical contamination. Regional conditions that define the confinement of a groundwater source must be demonstrated by the PWS in order to be considered for a confined aquifer susceptibility waiver. Confinement of an aquifer can be demonstrated by pump test data (storage coefficient), geologic mapping, and well logs. Site specific information is required to sufficiently represent the recharge area of the aquifer and the zone of contribution to the PWS well. The following information should be provided:

- Abandoned wells in the region (zone of contribution to the well),
- Other wells in the region (zone of contribution to the well),
- Nitrate/Coliform bacteria analytical history of the PWS well,
- Organic chemical analytical history of the PWS well,

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 contained within 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 usually locally recharged from surface water or precipitation. In general, groundwater flow gradients in unconfined aquifers reflect surface topography, and the residence time of

water in the aquifer is comparatively shorter than for water in confined aquifers. Similar water chemistry often exists between unconfined groundwater and area surface water, and physical parameters and dissolved constituents can be an indicator of the hydraulic connection between groundwater and surface water. Consequently, unconfined aquifers can be susceptible to contamination by organic chemicals migrating from the ground surface to groundwater.

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 development, monitoring history of the source, geologic characteristics of the unsaturated soil and vadose zones, and chemical characteristics of the organic chemicals pertaining to their mobility and persistence in the environment. The zone of contribution of the unconfined groundwater source must be defined and plotted. This should describe the groundwater flow directions, gradients, and a 3-year time-of-travel. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and those nearby should be provided as well.

Waiver Recommendation

The town of Hardin has a waiver for Phase 2 and 5 Inorganic constituents that includes Barium, Cadmium, Chromium, Fluoride, Mercury, Selenium, Antimony, Thallium, Beryllium, and Nickel. Based on past monitoring results and the susceptibility assessment of the Hardin PWS intakes, the City of Hardin PWS may not be eligible for additional monitoring waivers. However, to be sure that eligibility for all available waivers is considered, the City of Hardin PWS could submit a letter to DEQ requesting monitoring waivers. The PWS may also need to provide additional information to DEQ regarding chemical use within the Spill Response Region. Table 11 shows how the identified potential contaminant sources in the spill response and watershed regions could effect eligibility for monitoring waivers for the City of Hardin. It should also be noted that it is not possible to receive monitoring waivers for pathogens, nitrate, or arsenic.

Table 10. Susceptibility Assessment as it relates to waiver eligibility for significant potential contaminant sources in the Spill Response Region
City of Hardin PWS surface water intakes

Source	Contaminant	Susceptibility	Waiver Eligibility
Cultivated Cropland	Fertilizers, pesticides	Moderate	Chemical use likely precludes waivers for some chemicals
Chicago, Burlington, and Quincy Railway	Pesticides, fertilizers, VOCs	Moderate	Chemical use likely precludes waivers for some chemicals
Wastewater Discharges	Pathogens, nitrate, VOCs, SOCs	Moderate	Waivers are not available for pathogens and nitrate
Class V Injection Wells	VOCs, SOCs, pathogens, nitrate	Very Low	Waivers are not available for pathogens and nitrate

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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.

* Definitions taken from EPA's Glossary of Selected Terms and Abbreviations and other sources.

FIGURES

FIGURE 1

FIGURE 3

FIGURE 4

FIGURE 7

FIGURE 8

APPENDICES

APPENDIX A

Listing of Potential Contaminant Sources by SIC Code and Other Sources

NAME	ADDRESS	CITY	STAT	ZIP	PHONE	SIC1	SIC2	SIC3	SIC4	LATITUDE	LONGITUDE	COUNTYNAME
5 J's Auto & Diesel Repair	306 S Mitchell Ave	Hardin	MT	59034	406-665-2324	753801	753811	753812	769942	45.723660	-107.62224	Big Horn
American Inn	1324 N Crawford Ave	Hardin	MT	59034-1007	406-665-1870	738977				45.742860	-107.61210	Big Horn
Angler's Edge Outfitters	PO Box 551	Hardin	MT	59034-0551	406-666-2417	799928				45.732600	-107.61330	Big Horn
Big Horn Body Shop & Towing	Lot 7 Lincoln St	Hardin	MT	59034	406-665-3800	753201	754901	523110		45.732600	-107.61330	Big Horn
Big Horn Christian Academy	West Of Hardin	Hardin	MT	59034	406-665-3550	821103				45.732600	-107.61330	Big Horn
Big Horn County Ambulance Svc	809 N Custer Ave	Hardin	MT	59034-1300	406-665-3022	922403				45.736620	-107.60748	Big Horn
Big Horn County Clerk	121 3rd St W	Hardin	MT	59034-1905	406-665-9730	911103				45.731340	-107.60772	Big Horn
Big Horn County Electric	303 S Mitchell Ave	Hardin	MT	59034	406-665-2830	491101				45.723720	-107.62218	Big Horn
Big Horn County Memorial Hosp	17 N Miles Ave	Hardin	MT	59034-2323	406-665-2310	806202	805101	839998		45.728580	-107.61696	Big Horn
Big Horn County Supt Of Schls	121 3rd St W	Hardin	MT	59034-1905	406-665-1507	821103				45.731340	-107.60772	Big Horn
Big Horn Well Svc	19 N Crow Ave	Hardin	MT	59034-2335	406-665-2361	753801				45.729060	-107.60874	Big Horn
Bighorn Fly & Tackle Shoppe	1426 N Crawford Ave	Hardin	MT	59034-1008	406-665-1321	594113	594131			45.744960	-107.61204	Big Horn
Bighorn Taxidermy	115 1/2 13th St E	Hardin	MT	59034	406-665-1760	769904				45.742440	-107.60448	Big Horn
Bill's Auto Parts	214 N Crow Ave	Hardin	MT	59034-1920	406-665-1778	553111				45.730560	-107.60874	Big Horn
Broadway Flying J	315 13th St W	Hardin	MT	59034-1006	406-665-1237	554103				45.742320	-107.61084	Big Horn
Bullis Mortuary	507 N Center Ave	Hardin	MT	59034-1809	406-665-1207	726103	726105			45.733500	-107.60592	Big Horn
Burlington Northern Railroad	190 Subdivision	Hardin	MT	59034	406-665-1805	401101				45.732600	-107.61330	Big Horn
Camp Custer Svc	219 E Railroad St	Hardin	MT	59034-1914	406-665-2303	541105				45.730680	-107.60502	Big Horn
Cenex Convenience Store	1223 N Crawford Ave	Hardin	MT	59034	406-665-1155	541103				45.740940	-107.61222	Big Horn
Chevrolet Parts & Svc	16 3rd St W	Hardin	MT	59034-1904	406-665-1614	753801				45.731400	-107.60616	Big Horn
City Mayor	406 N Cheyenne Ave	Hardin	MT	59034-1811	406-665-1649	911104				45.732540	-107.60430	Big Horn
Commercial Testing & Engrng	Sarpy Creek	Hardin	MT	59034	406-342-5269	873402				45.732600	-107.61330	Big Horn
Community Elementary School	RR 1 Box # 1098	Hardin	MT	59034-9713	406-665-1696	821103				45.732600	-107.61330	Big Horn
Community Home Oxygen Inc	833 3rd St W	Hardin	MT	59034-1605	406-665-2886	504712	516920	599920		45.731280	-107.62038	Big Horn
Culligan Of Hardin	335 S Mitchell Ave	Hardin	MT	59034	406-665-2114	762928	738984			45.723300	-107.62224	Big Horn
Dale's Conoco	126 3rd St W	Hardin	MT	59034-1906	406-665-1578	554101	753801			45.731400	-107.60778	Big Horn
Digital Development Corp	212 N Center Ave	Hardin	MT	59034-1908	406-665-3348	357101	506338	399305		45.730560	-107.60580	Big Horn
Dollies	804 3rd St W	Hardin	MT	59034-1606	406-665-1424	541103				45.731340	-107.61972	Big Horn
Eagle Nest Lodge & Outfitters	S Of Hardin	Hardin	MT	59034	406-665-3711	799934				45.732600	-107.61330	Big Horn
Eastern Montana Crematory	Water Plant Rd	Hardin	MT	59034	406-665-1207	726102				45.732600	-107.61330	Big Horn
Farmers Union Assn	225 W Railroad St	Hardin	MT	59034-2360	406-665-1103	517208	519104	519114	553123	45.728520	-107.60952	Big Horn
Fort Smith Head Start Program	502 Avenue C	Hardin	MT	59034	406-666-2366	821103				45.732600	-107.61330	Big Horn
Graber Music Svc		Hardin	MT	59034	406-665-3373	769913				45.732600	-107.61330	Big Horn
Graham Staunton Chevrolet Inc	16 3rd St W	Hardin	MT	59034-1904	406-665-1611	551102	753801	551105		45.731400	-107.60616	Big Horn
Hank's Husky Svc	127 1/2 E Railroad St	Hardin	MT	59034-1913	406-665-1704	753801				45.730560	-107.60532	Big Horn
Hanser's Hardin	25 3rd St E	Hardin	MT	59034-1901	406-665-2706	754901				45.731400	-107.60544	Big Horn
Hardin Adult Education	522 N Center Ave	Hardin	MT	59034-1810	406-665-3413	821103				45.733620	-107.60586	Big Horn
Hardin Auto Co	416 N Center Ave	Hardin	MT	59034-1808	406-665-1211	551102	753801	551105		45.732600	-107.60586	Big Horn
Hardin City Clerk	406 N Cheyenne Ave	Hardin	MT	59034-1811	406-665-2113	911104				45.732540	-107.60430	Big Horn
Hardin City Mayor	406 N Cheyenne Ave	Hardin	MT	59034-1811	406-665-2113	911104				45.732540	-107.60430	Big Horn
Hardin Express Ctr	1424 N Crawford Ave	Hardin	MT	59034-1008	406-665-2227	541103				45.744900	-107.61204	Big Horn
Hardin High School	702 N Terry Ave	Hardin	MT	59034-1498	406-665-1908	821103				45.735480	-107.61480	Big Horn
Hardin Intermediate School	631 5th St W	Hardin	MT	59034-1613	406-665-1708	821103				45.733320	-107.61558	Big Horn
Hardin Middle School	611 5th St W	Hardin	MT	59034-1613	406-665-1408	821103				45.733320	-107.61516	Big Horn
Hardin Photo Svc	309 N Center Ave	Hardin	MT	59034-1909	406-665-2800	722101				45.731580	-107.60586	Big Horn
Hardin Primary School	314 3rd St W	Hardin	MT	59034-1704	406-665-2505	821103				45.731400	-107.61066	Big Horn
Hardin School Superintendent	N Of Hardin	Hardin	MT	59034	406-665-1304	821103				45.732600	-107.61330	Big Horn
Jailhouse Gallery Big Horn	218 N Center Ave	Hardin	MT	59034-1908	406-665-3239	599969				45.730620	-107.60580	Big Horn
Janelle's Country Kennels	907 3rd St W	Hardin	MT	59034-1632	406-665-2333	075204	599930	075211		45.731220	-107.62242	Big Horn
Jay's Body Shop & Svc Ctr	201 E Railroad St	Hardin	MT	59034-1914	406-665-3969	753801	753201	523110	754901	45.730620	-107.60508	Big Horn
John Thompson Trucking	203 N Choteau Ave	Hardin	MT	59034-1732	406-665-1728	421203				45.730440	-107.61330	Big Horn
Ken's Tire Svc	323 N Cheyenne Ave	Hardin	MT	59034-1911	406-665-2122	553123				45.731700	-107.60436	Big Horn
Kingfisher Lodge/Big Horn	Hc 36	Hardin	MT	59034-9802	406-666-2326	799928	701101			45.732600	-107.61330	Big Horn
Kinney's Saddle Shop	1407 N Custer Ave	Hardin	MT	59034-1108	406-665-3422	594120	319998	594109		45.742800	-107.60766	Big Horn
L & B's	531 E Railroad St	Hardin	MT	59034	406-665-3414	541105				45.732600	-107.61330	Big Horn
Lammers Trading Post	17 4th St E	Hardin	MT	59034-1826	406-665-2603	594709	594120	593226		45.732420	-107.60550	Big Horn
Land O'lakes Harvest States	E Frontage Rd	Hardin	MT	59034	406-665-1855	519102				45.732600	-107.61330	Big Horn
Last Stand Lodge	Star Route Box 2131	Hardin	MT	59034	406-665-3489	799928	799934	799992	472501	45.732600	-107.61330	Big Horn
Matovich Oil Bulk Plant	313 W Railroad St	Hardin	MT	59034-2333	406-665-1400	517214				45.727920	-107.61108	Big Horn
Mike's Repair Shop	1120 N Crawford Ave	Hardin	MT	59034-1214	406-665-1853	753801				45.740220	-107.61216	Big Horn
Newell's Electronics	218 N Center Ave	Hardin	MT	59034-1908	406-665-3218	573117	573103	599999		45.730620	-107.60580	Big Horn
Peavy Grain Co	206 W Railroad St	Hardin	MT	59034-2334	406-665-3403	422101				45.728640	-107.60934	Big Horn
Protech Mechanical Inc	515 4th St W	Hardin	MT	59034-1726	406-855-4381	171102	171118	171117	506328	45.732360	-107.61360	Big Horn
Roy's Body Shop	303 4th St E	Hardin	MT	59034-1836	406-665-1310	753201				45.732420	-107.60148	Big Horn
Royal Lube	1200 N Crawford Ave	Hardin	MT	59034-1009	406-665-2350	754903				45.740460	-107.61216	Big Horn
Schoen's Auto Supply Inc	305 N Cheyenne Ave	Hardin	MT	59034-1911	406-665-1702	553111				45.731520	-107.60436	Big Horn
Stevenson's Iga	901 N Center Ave	Hardin	MT	59034-1322	406-665-1687	541105	546102	591205		45.739080	-107.60592	Big Horn
Sun Ice Co	331 S Mitchell Ave	Hardin	MT	59034	406-665-1111	599977	171117	171102	507507	45.723300	-107.62224	Big Horn
Sweets-N-Such	829 3rd St W	Hardin	MT	59034-1605	406-665-1453	544101	594701	594712	599940	45.731280	-107.62032	Big Horn
Telephone Answering Svc	201 4th St W	Hardin	MT	59034-1705	406-665-3387	738903				45.732360	-107.60898	Big Horn
Thompson Trucking	RR 1	Hardin	MT	59034-9801	406-665-2421	421307	421203			45.732600	-107.61330	Big Horn
Town Pump	1012 N Crawford Ave	Hardin	MT	59034	406-665-2423	541103				45.739020	-107.61210	Big Horn
Two Leggin Water Users Assn	RR 1 Box # 1012	Hardin	MT	59034-9707	406-665-2580	497102	839998			45.732600	-107.61330	Big Horn
U-Haul Co	126 3rd St W	Hardin	MT	59034-1906	406-665-2937	751303	751903	735934		45.731400	-107.60778	Big Horn

APPENDIX B

DEQ PWS's Database Output

APPENDIX C

Sanitary Survey

APPENDIX D

**Concurrence Letter &
Other Correspondence**