Sand Coulee
Water Users Association
Public Water System

PWSID # MT0000325

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

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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.

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

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.

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

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

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

Hydrologic Unit Codes (HUC). Uniform, nationally consistent map codes for river basins.

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

Maximum Contaminant Level (MCL). Maximum concentration of a substance in water that is permitted to be delivered to the users of a public water supply. Set by EPA under authority of the Safe Drinking Water Act.

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

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

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

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

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

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

Recharge Region. A source water management region that is generally the area that could contribute water to an aquifer used by a public water supply over long time periods or under different water usage patterns.

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

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

Susceptibility (of a PWS) The potential for a public water supply to draw water with contamination that would pose concern

Synthetic Organic Compounds (SOC). Manmade organic chemical compounds (e.g. herbicides and pesticides).

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

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.

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

Volatile Organic Compounds (VOC). Organic compounds which evaporates readily to the atmosphere.

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

INTRODUCTION

Nancy Hein, Treasurer for Sand Coulee Water Users Association and Russell Levens, Hydrogeologist with the Montana Department of Environmental Quality (DEQ) completed this Source Water Protection Plan.

PURPOSE

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for the Sand Coulee Water Users Association 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 from contamination. A major component of the Montana Source Water Protection Program is "delineation and assessment". Delineation is a process of mapping source water protection areas, which contribute water used for drinking. Assessment involves identifying locations or regions in source water protection areas where contaminants may be generated, stored, or transported, and then determining the relative potential for contamination of drinking water by these sources. The primary purpose of this source water delineation and assessment report is to provide information that helps the Sand Coulee Water Users Association complete a source water protection plan to protect its drinking water source.

Limitations

This report was prepared to assess threats to the Sand Coulee Water Users Association public water supply, and is based on published information and information obtained from local residents familiar with the community. The terms "drinking water supply" or "drinking water source" refer specifically to the source of the Sand Coulee's public water supply and not any other public or private water supply. Also, not all potential or existing sources of groundwater or surface water contamination in the area of the Sand Coulee Water Users Association are identified. Only potential sources of contamination in areas that contribute water to its drinking water source 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 constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1

BACKGROUND

The Community

Sand Coulee is a small community in Cascade County with a population of 158. Residents either work in Great Falls, about 13 miles northwest of Sand Coulee, or are retired. Two Hutterite colonies are within a short distance of Sand Coulee. The basis of the economy around Sand Coulee is dry land farming and livestock raising. The only businesses in town are a taxidermy shop and two bars. Sewage is treated in individual septic systems.

A few concerned citizens formed Sand Coulee Water Users Association in 1959 because there was insufficient water for gardens and lawns. They sold water bonds to pay for their first well and main distribution line that were constructed in 1960. The community at annual meetings held in May elects a five- to six-member board to oversee operation of the public water system.

Geographic Setting

Sand Coulee is in central Montana approximately 13 miles southeast of Great Falls (Figure 1). As the name suggests, Sand Coulee is in a coulee between flat topped benches that slope gently to the north away from the Little Belt Mountains to the south of town. This tableland topography is dissected by generally north flowing tributaries of the Missouri River. Sand Coulee is along an unnamed tributary to Sand Coulee Creek, which flows into the Missouri (HUC# 10030102120).

The town is at approximately 47.5° latitude and 3,500 feet above sea level. The average high and low temperatures at the nearest weather station in Great Falls are 84.5° and 54.5° in July and 33.7° and 13.8° in January. The climate is semi-arid with precipitation averaging 14.73 inches per year concentrated in the months of May and June. Snowfall averages 45.8 inches per year. Wind is a constant presence on the bench tops, quickly blowing snow into coulees or melting it during warm winds called chinooks that can raise the air temperature 50° in a few hours.

Cultivated dryland small grains and hay or cattle grazing are the primary land uses. Sand Coulee is in a historical coal-mining district with many abandoned mines dating to the late 1800s. Extensive mine workings underlie the benches immediately south and east of Sand Coulee and to a lesser extent to the north.

General Description of the Source Water

The Sand Coulee Water Users Association obtains its water from two wells completed in a sandstone bedrock aquifer. Water that infiltrates the bench tops southwest of Sand

Coulee recharges the sandstone aquifer. Water discharges from the aquifer to underlying formations, to outcrops along coulees, and to mine workings. The aquifer is confined southwest of Sand Coulee but is unconfined west of Sand Coulee because of partial dewatering by nearby mine workings (Osborne et al., 1987).

The Public Water Supply

The Sand Coulee Water Users Association supplies water to a resident population of 158 people through 80 active service connections. Water is pumped to a 100,000-gallon storage tank approximately 500 feet east of the wells. Water is treated only when repair work or maintenance has been done. Bleach is used as a disinfectant if bacteriological tests come back positive.

Table 1. List of geologic or hydrogeologic maps available for Sand Coulee area

Type Of Map & Features	Scale	Area Covered	Reference
Contours of top of Morrison Coal Bed	1:48,000	14.35 sq. mi.	Osborne et al., 1987
Potentiometric Head in basal Kootenai sandstone	1:48,000	14.35 sq. mi.	Osborne et al., 1987
Aquifer status of basal Kootenai sandstone	1:48,000	14.35 sq. mi.	Osborne et al., 1987
Geologic Map of the Southeast Great Falls Quad.	1:24,000	7.5 Minute Quad.	Osborne et al., 1987

Peak water demand results from summer irrigation. An alternating day schedule is used to limit irrigation with half the town watering on Tuesday, Thursday, and Saturday and the other half watering on Monday, Wednesday and Friday. Irrigation is not allowed on Sunday to give the water storage tank time to refill. In dry years like 1998, the irrigation scheduling system has worked well without requiring additional restrictions. There are no other wells in the same aquifer within at least one mile of Sand Coulee’s wells.

Water Quality

Sand Coulee’s water is routinely monitored for compliance with drinking water standards. Bacteriological monitoring occurs monthly. Compliance with other drinking water standards is based on additional sampling on a variety of schedules. Nitrate was the only regulated contaminant detected in the last five years. Nitrate can come from human or animal wastes but also is naturally occurring. The highest level detected in Sand Coulee’s wells was 1.93 mg/l, considerably below the maximum concentration level of 10 mg/l set by the U.S. Environmental Protection Agency (EPA). There have been four health advisories in the past 5 years resulting from non-acute coliform bacteria violations. The problems apparently occurred because water was not chlorinated when a new line was installed and because of repairs to service connections (see sanitary survey in Appendix E for details).

The Montana Bureau of Mines and Geology (1983) sampled wells in the aquifer used by Sand Coulee as part of a study of mine impacts on water quality. The dominant dissolved ions detected in these samples were calcium, magnesium, and bicarbonate (Table 2). Total dissolved solids ranged from 369 to 433 mg/L, alkalinity ranged from 324 to 433 mg/L, and hardness ranged from 319 to 440 mg/L.

Table 2 Concentrations of major ions in wells completed in the sandstone aquifer used by Sand Coulee (MBMG, 1983)

-	PH	Sc S/cm	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Fe mg/L	Mn mg/L	SiO_2 mg/L	HCO_3 mg/L	Cl mg/L	SO_4 mg/L	NO_3 mg/L
1	7.17	796	46.5	78.8	11.0	3.2	<0.002	<0.001	6.5	516	3.8	23.7	4.29
2	6.63	677	67.8	36.4	21.2	6.5	<0.002	0.050	7.5	371.9	2.8	36.8	5.47

CHAPTER 2

DELINEATION

The area that contributes water to Sand Coulee's wells is identified in this chapter. Three management regions (the control zone, inventory region, and recharge region) are mapped. The goal of management in the control zone is to protect against direct introduction of contaminants into Sand Coulee's wells or the immediate surrounding area. The inventory region should be managed to prevent release of contaminants that could flow to Sand Coulee's wells within a relatively short time period. The recharge region is the entire area contributing recharge to Sand Coulee's wells. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased pumping.

Geologic Conditions and Aquifer Characteristics

Most of the following description of geologic conditions near Sand Coulee is summarized from a report published by the Montana Bureau of Mines and Geology (MBMG) (Osborne et al., 1987). Sand Coulee's wells penetrate interbedded sandstone, mudstone, and minor limestone of the Kootenai Formation (Figure 2). A sandstone layer at the base of the Kootenai Formation forms a regional aquifer that is the source of water for Sand Coulee. Lithology logs for the Sand Coulee wells and nearby wells drilled by the MBMG suggest the aquifer is 50 to 60 feet thick. However, most of the production from Sand Coulee's wells probably comes from coarse-grained sandstone and conglomerate near the base of the aquifer. A mudstone layer that overlies the basal sandstone is a confining unit south of Sand Coulee but discharge to mine workings has depressurized the aquifer resulting in unconfined conditions at Sand Coulee (Osborne et al., 1987). The Kootenai Formation is stratigraphically above and hydraulically upgradient of the area coal mines and, as a result, is not impacted by water contaminated by mine drainage.

A regional fracture trend oriented N40ºE is evident from the orientation of Walker Coulee and Sand Coulee and many lesser unnamed coulees. Groundwater flow in the Kootenai basal sandstone generally follows this fracture trend (Osborne et al., 1987).

Table 3 List of Geologic or hydrogeologic research activities in the Sand Coulee area

Title Of Project	Period Of Project	Location Or Area Covered	Project Objectives
Interaction Between Ground Water and Surface Water Regimes and Mining-induced Acid Mine Drainage (AMD) in the Stockett-sand Coulee Coal Field	1980-1983	Sand Coulee Creek Watershed	To formulate acid mine drainage mitigation techniques
Appraisal of Water in Bedrock Aquifers, Northern Cascade County, Montana	1979-1983	Northern Cascade County (780 sq. mi.)	To describe the occurrence and chemical quality of water in bedrock aquifers
Acid Mine Drainage Control in the Sand Coulee Creek and Belt Creek Watersheds, Montana 1983-1987; V.1 and V.2	1983-1987	Sand Coulee Creek and Belt Creek Watersheds	To test hydrogeologic techniques of acid mine drainage control

Conceptual Model

The source of Sand Coulee's drinking water is coarse grained sand or conglomerate at the base of the Kootenai Formation (see cross-section in Figure 3). Precipitation and excess irrigation on the bench tops southwest of Sand Coulee recharge the aquifer by flowing downward along steeply dipping fractures in overlying rock. Groundwater flow is to the northeast except where mine dewatering has depressed the water table. The basal Kootenai sandstone is unconfined at Sand Coulee, also because of partial dewatering of the aquifer by mines south of town.

Source-Wells

Sand Coulee Water User Association has two wells on the bench immediately west of Sand Coulee (see map in Appendix A and well logs in Appendix D). The primary well was drilled in October 1973 to a depth of 210 ft. Originally, an 8-inch diameter iron casing was set at 31 ft below the surface which was replaced with a 6-inch diameter casing set at the bottom of the well after the original casing collapsed in July 1996. A well screen was not installed; the casing was not perforated; and the depth of grouting is unknown. A new well was drilled in September 1999 to replace the original well that was drilled in 1960 after its casing collapsed. The new well is 181 ft. deep and is completed with five inch casing to its bottom. The casing was slotted from 165 ft. to 173 ft. (see Table 3 for well completion details).

Table 3 Source well information for the Sand Coulee Water Users Association

-	Source #003 (Well #2)	Source #004 (Well #3)	Source of Information
MBMG #	2254	Unknown	GWIC
Water Right #	6174	Unknown	Well Log
Latitude / Longitude	-	-	Well Log
Date Completed	10-11-73	7-21-99	Well Log
Depth	210 ft.	181 ft.	Well Log
Perforated Interval	Open Ended Casing to 210 ft.	Screen: 165 ft. – 173 ft.	Well Log
SWL Depth	Unknown	151 ft.	Well Log
PWL Depth	150 ft.	160 ft.	Well Log
Drawdown	Unknown	9 ft.	Well Log
Test Pumping Rate	60 gpm	30 gpm	Well Log
Specific Capacity	Unknown	3.33 gpm/ft.	Calculated
Source Type	Unconfined Bedrock	Unconfined Bedrock	Osborne et al., 1987

Methods and Criteria

DEQ's Source Water Protection Program (DEQ, 1999) specifies methods and criteria used to delineate subregions of the source water protection area for Sand Coulee. The control region for the Sand Coulee Water User Association corresponds to the fenced area surrounding the two wells. This area provides a 100-foot buffer. Hydrogeologic mapping and a time-of-travel equation describing uniform groundwater flow were used to delineate an inventory region bounded by a three-year time-of-travel distance (see Appendix B for TOT equations). In other words, this boundary delineates the distance in the aquifer that would be traveled by water or contaminants in three years. The stagnation point and boundary limits delineate the down gradient and lateral extent of the capture zone for the Sand Coulee's wells (see Appendix B for an explanation of the stagnation point and boundary limit). Hydrogeologic mapping based on the location of outcrops of the basal Kootenai sandstone and major topographic divides was used to delineate the recharge region.

Time-of-Travel Calculations

Travel distances for one and three years are calculated to approximate the combined effect of the two wells by assuming one well is pumped at the average combined pumping rate. The three-year time-of-travel distance determines the southern limit of the inventory region for Sand Coulee's wells. The one-year time-of-travel distance is used in Chapter 4 to rate the hazards of potential contaminant sources.

Estimates including aquifer flow properties, well discharge rate, ambient groundwater flow direction, and groundwater gradient are used to calculate the distance corresponding to one- and three-year times-of-travel (Table 4). Aquifer flow properties estimated are hydraulic conductivity, thickness, transmissivity, and effective porosity. A hydraulic conductivity (K) value of 20 ft./day for the basal Kootenai sandstone is used to delineate the inventory region. This estimate is greater than the values estimated from specific capacity tests but less than the highest value determined from aquifer tests in the Sand Coulee area (Osborne et al., 1987). Transmissivity was estimated at 200 $ft.^2$/day by assuming an aquifer thickness of 10 ft. (transmissivity equals hydraulic conductivity multiplied by aquifer thickness). Total porosity is the percent of a rock occupied by voids. For sandstone, total porosity typically varies from 5 - 30 percent depending on the porosity of the original sediment and its degree of cementing (Freeze and Cherry, 1979). Effective porosity or the porosity that water actually flows through will be less than total porosity. For Sand Coulee effective porosity is estimated at 10 percent to calculate the limits of the inventory region.

Groundwater flow direction and gradient were estimated from the potentiometric map of the basal Kootenai sandstone (Osborne et al., 1987) (Figure 4). The gradient is steep, ranging from 0.02 to 0.04 with the steeper values near mine workings south of Sand Coulee. The ground water flow direction near Sand Coulee's wells also is probably influenced by their proximity to the nearby mine workings and coulee. Therefore, a wide range of possible ground water flow directions was used to delineate the inventory region. Finally, the combined pumping rate of the two wells is based on 50 to 75 gallons per day estimated use per resident obtained from the Manual of Small Public Water Supply Systems (EPA, 1991).

Table 4 Estimates of input parameters used to delineate the source water protection area

Input Parameter	Range	Value Used
Hydraulic Conductivity	2 - 50 ft./day	20 ft./day
Thickness	2 - 80 ft.	10 ft.
Transmissivity	100 - 4000 $ft.^2$/day	200 $ft.^2$/day
Effective Porosity	5-30 %	10 %
Gradient	0.02 - 0.04	0.02
Well Production	8,000 – 12,000 gal/day	10,000 gal/day
Flow Direction	N40ºE	N5ºW to N85ºE
One-Year Time-of-Travel	500 – 3,000 ft.	1,700 ft.
Three-Year Time-of-Travel	1,200 – 9,000	4,600 ft.
Stagnation Point	25 – 40 ft.	50 ft.
Boundary Limit	80 – 130 ft.	170 ft.

Delineation Results

A 45-degree range of groundwater flow directions was used to define the lateral boundaries of the inventory region (Figure 5). A three-year time-of-travel distance of 4,600 ft. completes the boundary of the inventory region. This value is not sensitive to the pumping rate used. The area of the bench southwest of Sand Coulee bounded by outcrops of the basal Kootenai sandstone delineates the recharge region.

Limitations

The reader needs to understand that this delineation is based on estimated aquifer properties and groundwater flow conditions. Conclusions based on this interpretation are uncertain because the extent and properties of the aquifer, and the direction and rate of groundwater flow are not known precisely. Mine workings that partially drain the basal Kootenai aquifer make the pattern of ground water flow difficult to predict near Sand Coulee's wells. Also, the ability of the aquifer to transmit water probably varies considerably with variations in rock type and fracturing.

CHAPTER 3

INVENTORY

Potential sources of contamination were inventoried to assess the susceptibility of Sand Coulee's drinking water sources to contamination. Potential sources of all contaminants with primary drinking water standards and cryptosporidium were identified. A detailed inventory was conducted only for potential sources of contaminants that are the greatest threat to health. Nitrate, pathogens, and pesticides were the most common potential contaminants identified in Sand Coulee's source water protection area.

The inventory for the Sand Coulee Water Users Association focuses on all activities in the control zone, municipal and private facilities in the inventory region, and general land uses and large facilities in the recharge region.

Inventory Method

Information on potential contaminant sources in the control and inventory regions was taken from an intensive inventory conducted as part of an application for a waiver of organic chemical monitoring requirements submitted to DEQ by Nancy Hein. Not all of the information provided in the waiver application applies to the source water protection areas. Only those chemicals used in agricultural application are included here. Nancy Hein and Richard Weil collected information on pesticides and herbicides directly from landowners. General land uses in the recharge region were determined from data obtained from the U.S. Geological Survey (USGS) Geographic Information Retrieval and Analysis System.

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 treatment or spray irrigation lagoons
9. Septic systems
10. Sewered residential areas
11. Storm sewer outflows

Inventory Results/Control Zone

There are no chemicals stored or used in the control zone. The Sand Coulee Water Users Association has a deed for land and easement to the wells. Cutting instead of pesticides controls weeds within the control zone.

Inventory Results/Inventory Region

Cultivated cropland and spray irrigation of animal waste are the only significant potential contaminant sources in the inventory region (Table 5). Landcover in the inventory region is 67 percent grass and 21 percent dryland crops (Figure 6). Big Stone Hutterite Colony owns virtually all land in the inventory region. Mixing, handling, and application of herbicides and land application of animal wastes are potential contaminant sources that have been identified. Agricultural chemicals used are 2-4-D, Banvel, Roundup, Curtail, and Tordon.

Inventory Results/Recharge Region

Agriculture is the only significant land use in the recharge region (Figure 6). Of the recharge region, 38 percent is grassland, 21 percent is irrigated crops, 21 percent is covered by schrubs, and 8 percent is dryland crops. Application of herbicides on the cropland, land application of animal waste, and a sewage treatment lagoon at Big Stone Colony are potential contaminant sources.

Table 5 Significant potential contaminant sources in the inventory region of Sand Coulee

Source	**Hazard**
Cultivated Cropland	Spills and excess application of herbicides and fertilizer
Spray Irrigation of Animal Waste	Percolation of irrigation water containing nitrate and pathogens

Inventory Update

The certified operator should update the inventory for his records every year. Changes in land uses or potential contaminant sources should be noted and additions made as needed. A complete inventory should be submitted to DEQ every five years.

Inventory Limitations

All landowners were willing to give information on chemical use. This inventory is based on the information they provided.

CHAPTER 4

SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a well to be contaminated by one of the sources inventoried in the previous chapter. Hazard ratings and the presence of barriers determine susceptibility (Table 6). Hazard ratings are determined by the proximity of a potential contaminant source to the well. For Sand Coulee contaminant sources within a one-year time-of-travel are given a high hazard rating and all other sources in the inventory region are given a moderate hazard rating. Barriers can be engineered structures, management actions, and/or natural conditions. Examples of engineered barriers are bentonite liners in animal waste lagoons and secondary containment in chemical storage areas. Chemical or manure management plans and procedures for safe mixing and application of agricultural chemicals are considered management barriers. Finally, thick clay soils, a thick zone above the water table, and a deep well can be natural barriers.

Table 6 Susceptibility to specific contaminant sources as determined by hazard and the presence of barriers

-	**High Hazard**	**Moderate Hazard**	**Low Hazard**
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

The following are brief descriptions of the susceptibility assessments for each source included in Table 7.

Cultivated Cropland **–** Hazard is ranked high because more than 50 percent of the inventory region is dryland crops. Susceptibility is ranked moderate because there are multiple barriers. The unsaturated zone above the water table is over 100 feet thick and contains mudstone layers that should slow downward percolation of pesticides and fertilizer. Also, an agreement between the adjacent landowner and Sand Coulee Water Users Association includes restrictions on mixing chemicals in the inventory region (see Appendix C for copy of agreement).

Spray Irrigation of Animal Waste **–** Hazard is ranked high because a landowner within one-year time-of-travel of Sand Coulee's wells irrigates with animal waste effluent.

Susceptibility is ranked moderate because there are multiple barriers. The thick unsaturated zone with its mudstone is a barrier to percolation of nitrate and pathogens from animal waste. Also, an agreement between the adjacent landowner and Sand Coulee Water Users Association includes restrictions on application of animal wastes to cropland in the inventory region.

Table 7 Susceptibility of Sand Coulee's wells to significant potential contaminant sources in the inventory region

Source	Contaminant	Contaminant Origin	Hazard Rating	Barriers	Susceptibility	Management
Cultivated Cropland	Herbicides	Spills or excessive application	High	Thick Unsaturated Zone, Land Use Agreement	Moderate	Ensure that Land Use Agreement is Implemented
Spray Irrigation of Animal Waste	Nitrate and pathogens	Percolation of irrigation water	High	Thick Unsaturated Zone, Land Use Agreement	Moderate	Ensure that Land Use Agreement is Implemented

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