

# **Sula Ranger Station**

## **Source Water Delineation and Assessment Report (SWDAR)**

### **Sula Ranger Station United States Forest Service Public Water Supply**

**State of Montana Public Water Supply ID# MT0062214**

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## INTRODUCTION

The Safe Drinking Water Act (SDWA) Amendments of 1996 requires states to develop and implement Source Water Assessment Programs (SWAP) to analyze existing and potential threats to the quality of the public drinking water supplies throughout the state. The Montana SWAP was formally approved by the US Environmental Protection Agency (EPA) in November 1999. The Montana SWAP was developed from the former Wellhead Protection Program, but includes surface water sources and requires a more rigorous inventory of potential contaminant sources. SWAP addresses only public water systems (PWS) regulated according to the Federal Safe Drinking Water Act. A public water supply system is defined, according to Federal and Montana regulations, as a system that supplies water for human consumption. A public water supply system has at least 15 service connections or regularly provides water to at least 25 persons daily for a minimum of 60 days in a calendar year. There are three types of public water supply systems:

- Community water systems provide water on a year-round basis, and have a minimum of 15 service connections or regularly serve at least 25 residents. In addition to incorporated towns, community systems may serve smaller areas such as housing subdivisions or trailer courts.
- Non-transient non-community systems do not serve communities, but provide water regularly to a minimum of 25 of the same people for at least 6 months of a year. These systems serve public buildings such as schools and hospitals, where people are employed but do not reside. The Sula Ranger Station is classified as a non-transient, non-community system.
- Transient non-community systems do not serve communities, and do not regularly serve a minimum of 25 of the same people for at least 6 months of the year. These systems are usually seasonal, and are located in areas such as campgrounds and parks.

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to help public drinking water supplies protect their water source from contamination. The United States Forest Service (USFS) works with the Montana DEQ to complete delineation and assessment reports for USFS managed public water supplies in Montana. The Source Water Delineation and Assessment Report (SWDAR) compiles the appropriate data and other technical information about an area to allow the USFS to develop source water protection plans for potable water supplies. Delineation is a process whereby areas that contribute water to aquifers or surface waters used for drinking water, called source water protection areas, are identified on a map. Geologic and hydrologic conditions are evaluated in order to delineate source water protection areas. Assessment involves identifying potential contaminant sources in delineated source water protection areas, and evaluating the potential for contamination of drinking water from these sources under "worst-case" conditions such as a flood, fire or human error.

### **Scope and Purpose**

This report presents the source water delineation and assessments for the public water supply for the Sula Ranger Station public water supply. This report was prepared by James Swierc and Joe

Gurrieri, Hydrogeologists with the USFS. Assistance was provided by Chuck Oppgard, previous operator of the Sula Ranger Station water system.

The Sula Ranger Station is located approximately two miles south of the Town of Sula in southern Bitterroot County, Montana. This report is intended to meet the technical requirements for the completion of the delineation and assessment report for this 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).

### **Limitations**

This report was prepared to assess threats to the Sula Ranger Station public water supply, and is based on published information and information obtained from USFS staff familiar with the system and area. The inventory of potential contaminant sources focuses on the management areas delineated for the public water supply in this report. As a result, other potential sources of contamination to surface and ground water in the area may not be identified.

The term “contaminant” is used in this report to refer to any chemical or biologic constituent in water that are listed as regulated under state and federal regulations. Water constituents are generally regulated based on health effects that may occur when ingested at certain levels. Water quality standards are based on maximum contaminant level goals (MCLGs) for a compound, which represents a concentration where adverse health effects are not considered likely to occur when ingested. However, as natural waters contain many dissolved constituents and MCLGs are frequently not attainable with economically viable water treatment alternative, maximum concentration levels (MCLs) are used. MCLs represent concentrations that may result in chronic or acute health problems when ingested. MCLs are based on the relative risk, or likelihood that health problems may occur, and economics associated with a treatment technology for a specific constituent of water. In some cases, sources for constituents with Secondary MCLs are also evaluated in this report. Secondary MCLs are non-regulatory guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water.

## **BACKGROUND**

### **Study Area**

The Sula Ranger Station located in the southeastern part of the Bitterroot Valley in southern Ravalli County ([Figure 1](#)). The area is relatively isolated by the mountains in the area, and is predominantly undeveloped at this time. Darby is the largest town in the area and is located approximately 25 miles north of the Idaho Border. The Sula Ranger Station is located approximately 18 miles southeast of Darby. The Sula Ranger Station is located at an approximate elevation of 4600 feet above mean sea level on the boundary between Sections 21 and 22 of Township 1 North, Range 19 West at approximately 45.82°N latitude and 113.96°W longitude. Darby is the closest community with commercial services in the predominantly rural area. The economy of the area includes agriculture, the timber industry, tourism, and small businesses.

### **Geographic Setting**

The Sula Ranger Station is located in the southern part of the Sapphire Mountains in the Bitterroot National Forest. The facility is located in the valley of the Camp Creek, a tributary to the East Fork of the Bitterroot River prior to the confluence with the West Fork to form the Bitterroot River in the southern part of the Bitterroot Valley. The Bitterroot Valley is bounded by the Bitterroot Mountains on the west, and the Sapphire Mountains on the east. The area is located within the upper reaches of the Bitterroot River watershed (USGS Hydrologic Unit Code 17010205), located within the Westslope, or Columbia River Watershed Management Region for Montana. Camp Creek flows northward adjacent to the western boundary of the Sula Ranger Station facility. The topography of the area is mountainous, with a large amount of vertical relief. The area is primarily forested except for bare regions at high elevations, and discontinuous areas in the valley bottoms. The majority of residents in the area live in the lower elevations in the valleys. The geographic setting, including the watershed, is shown in [Figure 2](#).

### **Climate**

The climate is typical of southwestern Montana. Precipitation averages 15.85 inches a year as measured at the weather station at Darby. The mountains and higher elevation areas obtain more precipitation, which is not reflected in this weather data. The wettest months are May and June averaging 1.90 and 1.98 inches monthly, respectively. The driest months are February and July, averaging 0.96 and 0.97 inches per month. The temperature ranges from an average high of 84.0 °F in July (minimum July average of 47.4 °F) to an average of 35.7 °F in January (minimum January average of 18.0 °F).

### **General Description of the PWS Source Waters**

The Sula Ranger Station public water supply source location is on the eastern edge of the floodplain for Camp Creek which flows into the East Fork of the Bitterroot River, as depicted in [Figure 3](#). The PWS obtains ground water from a well drilled through alluvium or glacial valley fill deposits granitic bedrock of the Idaho Batholith. The aquifer can be characterized as generally unconfined with relatively shallow ground water.

## **Public Water Supply**

The Sula Ranger Station public water supply serves a population of approximately 15 permanent residents and 25 non-resident employees per day in the summer. The system has a total of 9 service connections. Water demand is approximately 2800 gallons per day in the summer and 1500 gallons per day in the winter. Information on the system was obtained primarily from a recent sanitary inspection of the system in April 2002. A copy of this report is included in Appendix A. The system utilizes one well installed in 1965 to an estimated depth of 211 feet. Water from the well is pumped into a 19,000 gallon concrete underground storage tank. The well is located inside a pumphouse, with the location shown in [Figure 2](#). Water is pumped into the distribution system from the storage tank. A map of the layout of the distribution system is included in Appendix A. There is currently no treatment or disinfection system applied to the water before distribution to consumers.

## **Wastewater Treatment**

Wastewater from the facility buildings is treated with onsite septic systems and drainfields located near facility buildings.

## **Water Quality**

Every PWS is required to perform monitoring for contamination to their water supply. The monitoring constituents include coliforms and other signs of pathogenic organisms, nitrates, metals and for multiple chemicals. The monitoring schedule depends on many factors such as the size and source water for a PWS, the number of sources (e.g. wells), and the population served. Each PWS has a specific monitoring program tailored to their system that follows the general protocols for operation of a PWS defined by DEQ. A review of the DEQ PWS database indicates that monitoring results for the Sula Ranger Station PWS show no violations or exceedences of any drinking water quality standards, other than for total coliform. Over the past decade the system has averaged one positive coliform bacteria reading per year. More recently, positive coliform bacteria results were detected in 1998, 1999, 2001 and 2002. Some of the positives were caused by breaks in the water lines. The entire water distribution system was replaced in 2003, with improved bacterial quality of the water system. The highest level of nitrate detected during the past five years was 0.18 mg/l, considerably below the maximum Contaminant level of 10 mg/l set by the U.S. Environmental Protection Agency (EPA).

Ground water quality in the area is generally good and meets the needs of local consumers who utilize the resource. Ground water quality data from the area from MBMG-GWIC is included in Appendix C. This data is considered representative of background water quality in the area.

All of the surface water streams in the study area, including the Bitterroot River and tributaries, are classified as B-1 waters using the State of Montana stream classification system for beneficial uses. These types of waters are suitable for drinking, culinary and food processing purposes after conventional treatment. Additional uses include bathing, swimming and recreation, growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers, and agricultural and industrial water supply. The Total Maximum Daily Loading (TMDL) assessment for the surface waters in the area will identify threats to the listed potential

uses for the surface waters in the area. The TMDL assessment will evaluate the ability of the surface waters to buffer various types of discharges to the waters, including both natural and human caused sources, and the impact to the overall health of the water bodies. These include wastewater treatment plant discharges, surface water runoff and non-point source pollution. After the TMDL assessment is complete, the results will be presented to area and community leaders to help identify and plan methods to meet the goals of the TMDL assessment in preserving and improving surface water quality in the area. Since the USFS manages much of the land in the upper reaches of the watershed, they will be involved in this process. The Bitterroot River watershed TMDL is scheduled for completion in 2004.

## DELINEATION

The source water protection areas, the land area that contributes water to the Sula Ranger Station PWS source is identified in this chapter. Delineation of management areas for source water protection are based on the hydrogeologic setting of the water source, in accordance with the requirements outlined in the Montana Source Water Protection Program (DEQ, 1999). For ground water systems in general, there are three regions referred to as the control zone, inventory region, and recharge region. The control zone, also known as the exclusion zone, is an area at least 100-foot radius around the well. The area within a three-year time of travel distance upgradient of the well defines the inventory region for unconfined aquifers. The recharge region represents the area where the source aquifer for a water system is replenished.

### Regional Geology

The bedrock geology of the Sula Ranger Station watershed area comprises predominantly Cretaceous-Tertiary granite of the Idaho Batholith, and related rocks (Ross et. al, 1955). Quaternary alluvium is present filling the base of stream valleys, with glacial tills and outwash present at discontinuous locations beneath the alluvium. Several geologic studies have been performed on the hydrogeology of the Bitterroot Valley (McMurtrey et. al, 1959; Lonn and Sears, 2001); however, none of these studies have included the hydrogeology of the headwaters for the Bitterroot River watershed where the Sula Ranger Station is located. A generalized geologic map of the area is shown in [Figure 3](#). The interpretation of the geology and hydrogeology of the area is based on standard hydrogeological principles, information presented in the regional references, and an evaluation of well logs for the area obtained from the Montana Bureau of Mines and Geology Ground Water Information Center (MBMG-GWIC). Summary tables of wells and well lithology and construction logs from MBMG-GWIC are included in Appendix B.

### Hydrogeology

Ground water in the area near the Sula Ranger Station is present in a shallow unconfined alluvial aquifer overlying fractured granitic bedrock present in the base of the valley for Camp Creek. The alluvium is approximately 50 feet thick, with a shallow water table averaging 10 feet or less. The static water level reported for the PWS well is also at 10 feet, indicating the connection between the two hydrogeologic bodies. Water within the alluvium and fractured bedrock are considered to be in a single unconfined aquifer. Ground water flow in the aquifer generally parallels the stream and valley gradient, with flow towards the stream in sections where stream flow increases or gains. Flow is away from the stream in areas where stream flow decreases due to discharge to ground water. Ground water flow at the Sula Ranger Station is interpreted to flow generally north parallel to Camp Creek, with a component towards Camp Creek. This flow direction reflects a stream system that gains flow, consistent with flow to rivers in mountainous areas with high relief.

### Conceptual Model and Assumptions

A conceptual hydrogeologic model is a simplified representation of the hydrogeologic system. For the Sula Ranger Station public water supply, ground water occurs in an unconfined fractured bedrock aquifer. Ground water flow is generally parallel to Camp Creek. Recharge to the

aquifer occurs from direct infiltration of precipitation to the aquifer system, and potentially from stream loss in certain areas of the valley and during the dry periods. Based on the hydrogeologic setting, the Sula Ranger Station water source is an unconfined aquifer in fractured bedrock and unconsolidated alluvium, which is considered to have a *high* source water sensitivity to contamination.

### **Well Information**

The location of the well for the Sula Ranger Station is depicted in [Figure 2](#). Information on the source is summarized in Table 1. Copies of the driller construction logs for the well are included with Appendix A. The MBMG-GWIC database was queried for well logs in the area (Appendix B), including well information for the PWS well. The well is the second well for the system, the first having gone dry, and is located in the central part of the facility. This well was installed in 1965 with 8-inch steel casing to an approximate depth of 213 feet.

### **Delineation Methods and Criteria**

The source water protection management areas were defined for an unconfined aquifer in accordance with the requirements of the DEQ Source Water Protection program (DEQ, 1999). The control zone around the well comprises a distance of 100 feet radius around the wellhead. The Inventory Region for the well comprises the area within the Camp Creek floodplain upgradient for the estimated three year time of travel distance for ground water. The recharge area is delineated as the watershed area upstream from the drinking water source. Since the aquifer is in connection with surface water, a surface water buffer zone is delineated, comprising a buffer of ½ mile on each side of Camp Creek and major tributaries for a distance of 10 miles upstream from the well.

**Table 1. Source Well Information for Sula Ranger Station.**

Information	Well 1
PWS Source Code	002
Well Location (T, R, Sec)	T1N, R19W Sec 22 CBCD
Well Location (lat, long)	45.8189°N Lat 113.9550°W Long
MBMG #	173848
Water Right #	C050070-00
Date Well was Completed	1965
Total Depth	213 feet
Perforated Interval	Open hole 53 – 213 feet
Static Water Level	10 feet
Pumping Water Level	40 feet
Drawdown	30 feet
Yield/Test Pumping Rate	8.5 gpm
Specific Capacity	0.283 gpm/foot

### Ground Water Flow Rates and Time of Travel

Time of travel calculations were completed using the uniform flow equation (EPA, 1993). Conservative estimates for aquifer properties are made using available data from published reports. The values for these estimates are generally based on the information reported for the system in Land and Water (1999). The criteria for selection of each value used for the ground water flow estimates is summarized in the following discussions:

- **Transmissivity:** The transmissivity value is estimated as 169 ft<sup>2</sup>/day, based on the specific capacity of the well
- **Thickness:** The value for the thickness of the aquifer is estimated at 160 feet, based on the static water level and the depth of the well.
- **Hydraulic Conductivity:** A value for hydraulic conductivity is estimated using the basic relationship Transmissivity (T) = Hydraulic Conductivity (K) x Aquifer Thickness (b). From this relationship, the estimated value for the hydraulic conductivity (K) is 1 ft/day.
- **Hydraulic Gradient:** The hydraulic gradient is estimated from the flow gradient of Camp Creek upstream from the well. A value of 0.017 is used here.
- **Flow Direction:** The flow direction is considered north, generally parallel to Camp Creek.
- **Porosity:** The value for effective porosity is estimated at 1% (Todd, 1980). The estimated value is considered representative of fractured bedrock.
- **Pumping Rate:** The pumping rate for the well is estimated at 2 gpm, reflecting the yield of the well. The sanitary survey indicates usage at 2,800 gpd.

### **Calculation Results and Source Water Protection Management Zones**

The results of the ground water flow rate calculations are summarized in Appendix D. The calculations indicate that ground water within the alluvial aquifer flows an estimated 697 feet (0.13 miles) over a one-year period, and 1,961 feet (0.37 miles) during three years. The management areas delineated for the Sula Ranger Station PWS are depicted in [Figure 4](#). The inventory zone is present in the alluvium of the floodplain of Camp Creek, for a distance of 0.37 miles upstream from the well. The watershed of Camp Creek above the Sula Ranger Station is delineated as an informal recharge area for the aquifer. The surface water buffer zone is delineated as a ½ mile wide buffer around Camp Creek to the headwaters of the watershed.

### **Limiting Factors**

The hydrogeologic assessment presented in this section is based on the available information on the area. The approach reflects uncertainties in the available data used to estimate the time of travel distances. The interaction of surface and ground water represents the greatest area of uncertainty in this assessment. Additional limitations in the time of travel calculations result from the use of the Uniform Flow Equation for analysis of flow rates, which does not account for the continuous discharge of ground water to the Camp Creek as a surface water body. The limits of the Inventory Zone were determined based on the general shape of the floodplain, which is assumed to represent the general limits of the aquifer material, which has not been mapped at the scale required for this assessment.

## INVENTORY

An inventory of potential sources of contamination was conducted for Sula Ranger Station well control and inventory zones. Potential sources of all primary drinking water contaminants, including pathogens, were identified. However, only significant potential contaminant sources based on criteria outlined in the Montana Source Water Protection Program (DEQ, 1999) were selected for detailed inventory. These are listed in Table 2. The inventory for the Sula Ranger Station PWS focuses on all activities in the control zone, certain sites or land use activities in the inventory zones, and general land uses and large facilities in the recharge region. The inventory results from the various steps are summarized in Table 3. The significant potential contaminant sources in the inventory region for the well includes petroleum from aboveground storage tanks or in vehicles on site; nitrates and pathogens from the septic systems and from agriculture; and herbicides and pesticides from cropped agricultural land.

### Inventory Method

The initial inventory steps comprise querying existing state and federal electronic databases for regulated facilities that use, store or release regulated chemicals. The steps to the database searches, and the results from each step are listed in Appendix E. The assessment of agriculture land use and urban areas, and major transportation routes through the area are shown in [Figure 5](#). This method helps ensure the inventory is a complete data collection exercise to identify all potential contaminant sources.

The results of the inventory process are summarized in Table 3, which summarizes the properties or sites within the inventory zone study area. The potential contaminants are listed, with a description of the potential release mechanism for the site. In all cases, releases may occur due to unavoidable conditions such as flooding, lightning or fire. The sites where this is the primary potential release mechanism are identified as concerns resulting from such a disaster. For other sites where other release mechanisms may be more common, the potential for a release from such a disaster is assumed.

Class V injection wells are classified as waste disposal conduits that discharge directly to shallow ground water. The evaluation of the use of Class V injection wells in Montana is currently the responsibility of the EPA.

The Montana Source Water Protection Program identifies specific types of potential contaminant sources as significant, for further evaluation of the susceptibility of the water source to these sources. The categories of significant potential contaminant sources are listed in Table 2.

**Table 2 – Significant Potential Contaminant Sources (DEQ, 1999)**

1. Large quantity hazardous waste generators.	8. Animal feeding operations.
2. Landfills.	9. Abandoned or active mines, and gravel pits.
3. Underground storage tanks.	10. Septic systems.
4. Underground injection wells.	11. Sewer mains.
5. Major roads or rail transportation routes.	12. Storm sewer outflows.
6. Cultivated cropland greater than 20 % of the inventory region.	13. Wastewater treatment facilities, sludge handling sites, or land application areas.
7. Known groundwater contamination (including open or closed hazardous waste sites, state or federal superfund sites, and UST leak sites).	

**Inventory Results/Control Zone**

The control zone represents the most critical point to protecting the integrity of a wellhead for ground water sources. The land around the control zone for the well includes the area in the pumphouse, which provides security to the wellhead. No significant potential contaminant sources were identified in the Control Zone.

**Inventory Results/Inventory Region**

The inventory region represents the area near the source well where any contamination spilled onto the ground or subsurface has the potential to migrate directly into the PWS source aquifer. A summary of the inventory results of significant potential contaminant sources are listed in Table 3. The potential sources identified include petroleum storage tanks, septic systems, agricultural land use and the main area highway.

**Table 3 - Summary of Inventory Results for Sula Ranger Station PWS.**

<i>Source Type</i>	<i>Potential Contaminants</i>	<i>Description/Concern</i>
<b>Step 1 Results</b>		
<i>Agricultural Land Use</i>	<i>Pathogens and Nitrates; Pesticides and Herbicides</i>	<i>Non-point source pollution, concentration of fertilizers/chemicals in surface/ground water</i>
<i>Urban Land Use</i>	<i>Spills of various chemicals</i>	<i>Non-point source pollution, small spills of household chemicals</i>
<i>Septic Systems</i>	<i>Pathogens and Nitrates</i>	<i>Non-point source pollution, loading of ground water system with effluent</i>
<i>Storm Water Discharge Points</i>	<i>Various chemicals</i>	<i>Non-point source releases from urban land use concentrated into point source to ground water; storm sewer system discharges to Camp Creek</i>
<i>EPA-Envirofacts (Step 2)</i> <i>No sites identified</i>		
<i>EPA-PCSs Sites (Step 3)</i> <i>No sites identified</i>		
<i>DEQ Database (Step 4)</i> <i>No sites identified</i>		
<i>Business SIC Code Search (Step 5)</i> <i>No sites identified</i>		
<b>Miscellaneous Others, including Step 6</b>		
<i>Major Roads</i>	<i>Spills of various chemicals</i>	<i>Disaster – spill/release of chemicals and fuels transported on Highway</i>
<i>Petroleum Storage</i>	<i>Petroleum Hydrocarbons</i>	<i>Disaster – spill/release of chemicals and fuels from storage or during transportation</i>
<i>Class V Injection Wells</i>	<i>Various chemicals</i>	<i>Direct discharge of chemical to shallow ground water system</i>

**Table 4. Significant potential contaminant sources for Sula Ranger Station PWS.**

<i>Source</i>	<i>Contaminants</i>	<i>Description</i>
<i>Agricultural Land Use</i>	<i>Pathogens and Nitrate; Pesticide/Herbicides (SOCs)</i>	<i>Primary concern from limited areas of cultivated and grazing lands in watershed upstream from well.</i>
<i>Septic Systems</i>	<i>Pathogens and Nitrate</i>	<i>Area south of well with low density, within well inventory zone and surface water buffer zone</i>
<i>Storm Water Discharge Points</i>	<i>Various organic chemicals</i>	<i>Not inventoried at this time</i>
<i>Major Roads</i>	<i>Various Chemicals</i>	<i>US Highway 93 runs adjacent to western part of the facility, concern over an accident and spill of any transported chemicals</i>
<i>Petroleum Storage</i>	<i>Petroleum Hydrocarbons</i>	<i>1,000 – Gallon Diesel and Gasoline Tanks, one 250 gallon fuel oil tank.</i>

### **Inventory Results/Surface Water Buffer Zone**

The surface water buffer zone is the area of one half mile on each side of the surface water bodies upstream from the PWS source to the headwaters of the watershed, as shown in [Figure 4](#).

The inventory of the surface water buffer zones focuses on potential contaminants with acute health risks, such as pathogens or nitrates. The delineated area includes areas with septic systems, and limited agricultural development with related potential contaminants.

### **Inventory Results/Recharge Region**

The recharge region for the well is Camp Creek Watershed. The area within the watershed is predominantly national forest land, with a limited amount of agriculture. A limited amount of mining has occurred within the watershed.

### **Inventory Update**

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

### **Inventory Limitations**

The inventory is limited by the accuracy of information in databases used for the assessment. The windshield survey provides a level of quality assurance that the information presented reflects current conditions at the time of preparation of this report. The location of Class V injection wells is not complete at this time, and is currently being compiled by EPA for the area. The data from the MBMG-GWIC database on wells in the area may not be complete, as not all wells are included in the database.

## SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would pose concern. Susceptibility is assessed in order to prioritize potential pollutant sources for management actions by local entities, in this case the Sula Ranger Station PWS.

The goal of Source Water Management is to protect the source water by 1) controlling activities in the control zone, 2) managing significant potential contaminant sources in the Inventory Region, and 3) ensuring that land use activities in the Recharge Region pose minimal threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources identified in the previous chapter according to susceptibility. Alternative management approaches that could be pursued by the Sula Ranger Station PWS to reduce susceptibility are recommended.

Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to the PWS source (Table 5). Susceptibility ratings are presented for each significant potential contaminant source and each associated contaminant.

**Table 5 - Relative susceptibility to specific contaminant sources as determined by hazard and the presence of barriers.**

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

For point sources, the relative hazard for the potential contaminant sources is assigned based on the type of aquifer. For the unconfined aquifer system for the Sula Ranger Station PWS, the relative hazards for point source are based on the location of the potential contaminant source relative to the well. Potential sources within a one-year time of travel distance to the well are assigned a relative hazard of high. Potential contaminant sources located between a one-year and three-year time of travel distance are assigned a relative hazard of moderate. Any other potential contaminant sources within the recharge area are assigned a relative hazard of low.

After the relative hazard of a potential contaminant source is assigned, the relative susceptibility is determined based on the presence of barriers that may mitigate the potential for a contaminant source to impact a water source. Barriers may represent natural conditions, engineered barriers or management actions. Natural barriers include anything that can be demonstrated as effective in mitigating the migration of any chemicals released at the surface, such as thick clay-rich soils

or surface flowing artesian conditions. Engineered barriers represent man-made structure to contain chemicals if they are released, such as spill containment for underground storage tanks. Management barriers are plans that prohibit or control potentially polluting activities, but only if there is a plan or approach that has been formally implemented.

For the Sula Ranger Station PWS source, no natural barriers were identified present due to the coarse grained and highly transmissive nature of the source aquifer. A barrier for the petroleum storage tanks is a spill response plan prepared by the USFS specifically for the facility.

For non-point sources, the relative hazard is assigned based on the relative concentrations present within the delineated inventory zone for the aquifers, following the criteria listed in Table 6.

**Table 6 – Relative Hazards for Non-Point Potential Contaminant Sources**

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

### **Susceptibility Assessment Results**

The results of the susceptibility assessment for the Sula Ranger Station PWS are listed in Table 7, which reviews the relative hazard, barriers and susceptibility ranking of each potential source. Management actions are recommended that may be implemented as management barriers to help reduce the relative susceptibility of the wells to each potential contaminant source.

The primary threats identified within the one-year time of travel distance are septic systems at the facility and the main highway through the area. The proximity of these sources results in the classification of the potential susceptibility of the wells as very high to contamination from each of these sources.

**Table 7. Susceptibility assessment of significant potential contaminant sources.**

Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management
<b><i>Control Zone</i></b>						
Lawn Management	Pesticides/ Herbicides/ Nitrates and Pathogens	Leaching and Runoff	Low	None	Moderate	Limit use of fertilizers or other chemicals in area around control zone
<b><i>Inventory Zone</i></b>						
Septic Systems (Individual on-site)	Nitrates and Pathogens	Infiltration	High	None	Very High	Monitor system performance
Septic Systems (General density in inventory zone)	Nitrates and Pathogens	Infiltration	Low	None	Moderate	Monitor system performance
Petroleum Storage Tanks	Petroleum Hydrocarbons	Leakage, Runoff and Infiltration	High	Spill Response Plan	High	Locate Tanks downgradient from PWS Well
US Highway 93	Various Chemicals	Accidental Spill, Runoff and Infiltration	High	None	Very High	Develop Emergency Response Plan
<b><i>Recharge Area and Surface Water Buffer Zone</i></b>						
Agricultural Land	Pesticides/ Herbicides/ Nitrates and Pathogens	Infiltration and Runoff	Low	None	Moderate	Promote the use and development of agricultural BMPs for the area
Septic Systems	Nitrates and Pathogens	Infiltration	Low	None	Moderate	Monitor system performance

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