Duncan Ranch Colony

The attached Source Water Delineation and Assessment Report (SWDAR) for Duncan Ranch Colony was completed by Bill O'Connell of Montana Rural Water Systems, Inc. and Lisa O'Connell of Montana Tech as part of a June, 2003 report entitled "Hydrogeologic Assessment of the Principal Aquifers in the Upper Musselshell River Basin, Montana in Support of Source Water Assessment and Delineation Reports for Public Water Systems". Additional regional background information and assessment methodology for the Musselshell Project area from the Hydrogeologic Assessment is available at

Regional Background Information and Assessment Methodology

The primary intent of a Source Water Delineation and Assessment Report is to provide the background information for the community to use in developing local drinking water protection strategies. The attached report for Duncan Ranch Colony incorporates delineation and assessment components and includes a limited management and emergency response plan. ***DEQ has not reviewed the report or plan to confirm that it meets the requirements of Montana's Source Water Protection Program or that it is protective of your drinking water supply.***

It is highly recommended that the water system and community:

- Review the delineation of the inventory region to ensure it is protective of the long-term water quality;
- "Enhance" or refine the identification of the potential contamination sources and susceptibility analysis through further research and local input;
- Ensure that the management plan adequately identifies and reduces the risks of groundwater contamination from all potential contaminant sources (existing and future) that may affect the drinking water supply; and
- Ensure that the emergency plan identifies the potential threats to the drinking water supply and provides the detail necessary to implement a response to contamination or disruption of the public water system.

Technical assistance is available through DEQ for communities that choose to move beyond the assessments and voluntarily develop a Drinking Water Protection Plan. Clean safe drinking water is fundamental to the viability of any community. Protecting the drinking water source is a wise and relatively inexpensive investment in the community's future.

For technical assistance with review of this assessment or in developing plans to protect your public water system contact:

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WELLHEAD/ SOURCE WATER PROTECTION PLAN
DUNCAN RANCH COLONY,
HARLOWTON, MONTANA

WELLHEAD/ SOURCE WATER PROTECTION PLAN

DUNCAN RANCH COLONY
HARLOWTON, MONTANA

Public Water System

PWSID # MT0000418

Report Date: February 21, 2001

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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.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Enacted in 1980. CERCLA provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.
Delineation. A process of mapping source water management areas.
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 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 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 typically found in the intestinal tracts of mammals, capable of producing disease.
Point-Source. A stationary location or fixed facility from which pollutants are discharged.
Public Water System. A system that provides piped water for human consumption to at least 15 service connections or regularly serves 25 individuals.
Pumping Water Level. Water level elevation in a well when the pump is operating.
Recharge Region. A source water management region that is generally the entire area that could contribute water to an aquifer used by a public water supply. Includes areas that could contribute

water over long time periods or under different water usage patterns.
Resource Conservation and Recovery Act (RCRA). Enacted by Congress in 1976. RCRA's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner.
Section Seven Tracking System (SSTS). SSTS is an automated system EPA uses to track pesticide producing establishments and the amount of pesticides they produce.
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 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. 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). Any organic compound 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

This Report was completed by Bill O'Connell, Groundwater Technician with Montana Rural Water Systems inc. (MRWS), Lisa O'Connell with the Montana Bureau of Mines and Geology, and Ben Waldner, the licensed operator for Duncan Ranch Colony's Public Water System (PWS).

Purpose

This report uses the Source Water Assessment Program (SWAP) to meet the technical requirements for the completion of the Wellhead/Source Water Protection Plan (SWPP) for Duncan Ranch Colony combined with a watershed evaluation of the Upper Musselshell River drainage. A Source Water Assessment is required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996.

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 that 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 purpose of the source water protection plan is to provide information to a PWS helping them protect their drinking water source.

Limitations

This report was prepared to assess threats to Duncan Ranch's 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 community'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 Colony area are identified. Only potential sources of contamination in areas that contribute water to its drinking water source are considered.

The term "contaminant" is 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 certain constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1
BACKGROUND

The Community

Duncan Ranch Colony is located in central Montana, along east-west running US highway 12, 13 miles west of Harlowton. The colony is a Hutterite religious community with 100 residents. The Public Water System (PWS) has 15 hook-ups and provides some water to their agricultural operation. See the vicinity map in figure 1.

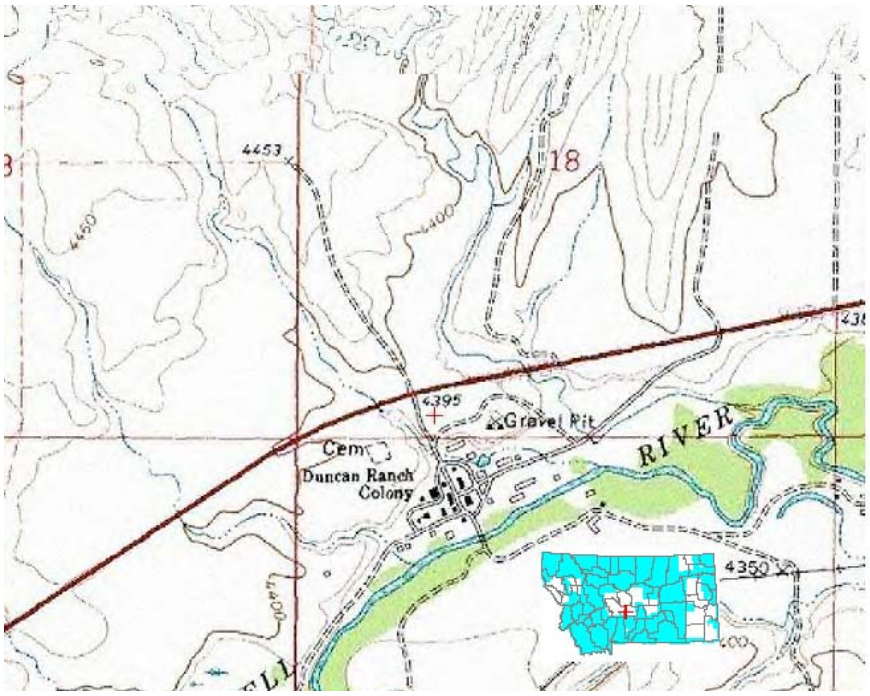

Figure 1. Duncan Ranch vicinity map

Geographic setting

Duncan Ranch Colony is located in the Un-Glaciated Missouri Plateau of the Great Plains Physiographic Province of central Montana. The Little Belt Mountains to the north and the Crazy and Castle Mountains to the south and west are the most visible geographic features in the area. The Musselshell River forms the southern boundary of the colony as it flows to the east in this region.

The average annual temperature in the region is 44.2^{o} F and the average annual precipitation is 14 to 18 inches (National Water and Climate Center).

General Description of the Source Water

The Duncan Ranch Colony uses groundwater supplied by one well (figure 3) as its' drinking water source. The Well, is a flowing artesian well and completed in a confined aquifer. The water in the aquifer is pressurized from a combination the weight of the overlying sediments and the elevation of the recharge area above the wellhead. The pressure is sufficient to push the water out of the wellhead. The wellhead is sealed shut to prevent the water from flowing like a spring. The aquifer is recharged in the highlands south or north of the colony, where the sandstone unit is recharged. See the well location on the map in Figure 2.

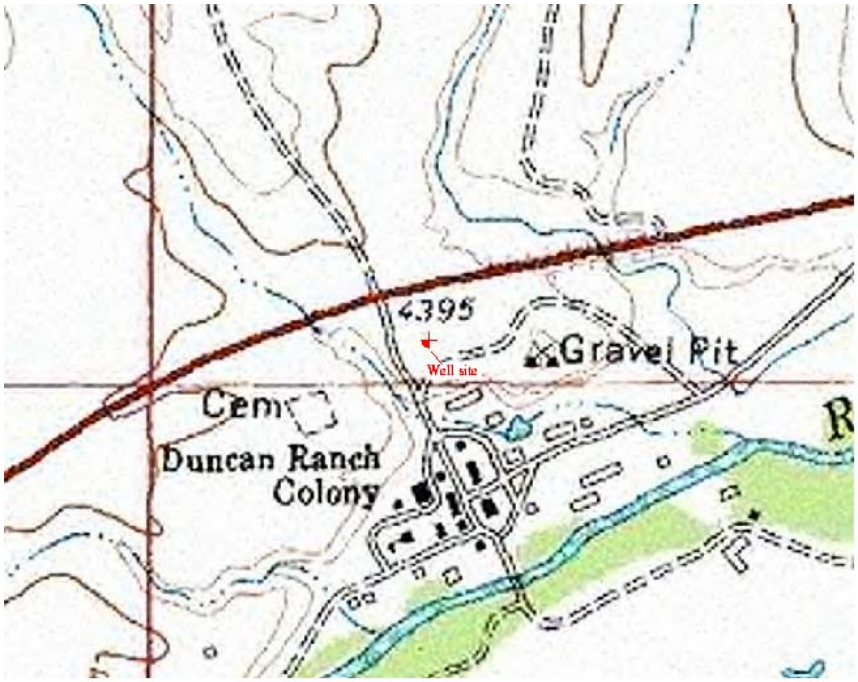

Figure 2. Well location for Duncan Ranch Colony

Table 1. List of geologic or hydrogeologic maps available for the Harlowton, Montana area.

Title or Description	Scale	Area Covered	Reference
Topographical	1:24,000	Harlowton	NRIS, map finder
Geological	Various	Montana	Taylor and Ashley
Geological	1:100,00	Harlowton 30'x60' Quadrangle	Wilde and Porter

The Public Water Supply

The Public Water Supply consists of 1 well drilled in 1998. The well is tied directly into the distribution system. The distribution system consists of 2 inch pvc pips and has 15 hookups and serves 100 people.

Water Quality

Duncan Ranch Colony 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. The water is a sodium/sulfate type with a total dissolved solid (TDS) content of 2339 parts per million. The TDS exceeds the water quality recommendation of 500 parts per million (National Secondary Drinking Water Standards). The water quality and drillers log how the well is completed in the Claggett Shale Formation.

Influencing Factors

The Source Water Protection Plan (SWAP) was started as part of a program to combine a watershed evaluation of the Upper Musselshell basin completed by the MBMG with the SWPP for the public water systems, including the Duncan Ranch Colony completed by MRWS.

Source Water Protection Management

Ben Waldner, the colony's licensed operator and plumber will oversee implementation of the SWPP.

CHAPTER 2
DELINEATION

The portion of the aquifer that contributes water to the Colony's well is identified in this chapter. Three management regions (the control zone, inventory region, and recharge region) are mapped for the well. The goal of management in the control zone is to protect against direct introduction of contaminants into the well or the immediate surrounding area.

Management in the inventory region should focus on pollution prevention activities where water is likely to flow to the wells within a relatively short time period. The goal of management in the recharge region is to maintain and improve the quality of groundwater that could reach the well over longer times or with increasing water usage.

Geologic Conditions and Aquifer Characteristics

Duncan Ranch uses groundwater supplied by one well to meet its' drinking water requirements. The well is 497 feet deep and flows at the surface under artesian pressure (4 psi). The water chemistry indicates the water is Sodium/sulfate and has a total dissolved solid concentration of 2339 parts per million. This water chemistry identifies the aquifer as Claggett.

The geology in this area is very complex on both large and small scale. The Little Belt and Big Snowy Mountains are part of two separate geologic (tectonic) blocks. The Crazy Mountains south of the colony is part of the Crazy Mountain structural Basin. These blocks are large sections of the Earth's crust that have formed independent of each other and are the large-scale geologic structures. The Wheatland Syncline running north and east of the colony and the Big Elk and the Little Elk Domes south of the colony are smaller scale geologic structures.

Duncan Ranch sits on the west flank of the Wheatland Syncline as it plunges to the south. The well is on the tip of a finger of sediments that sit 20 feet above the current flood plain of the Musselshell River. The sediments on either side of the finger have been eroded away by streams flowing south to the River. The Syncline has lifted the Claggett Formation to the north.

The Big Elk Dome rises due south of the colony and gives it's name to a sandstone member of the Colorado Group. The Colorado Group is primarily a shale formation and is located below the Eagle Sandstone formation. The Big Elk sandstone is located 1100 feet below the top of the Colorado Group. The Big Elk Formation has been lifted several hundred feet above Musselshell River as the Big Elk Dome was formed. The uplifted formations rise to the south and are exposed along the flanks of the Big Elk Dome.

Well

The Duncan Ranch Colony's public water system is supplied by one well. The well was drilled in 1998 to a depth of 457 feet. A 12 inch diameter hole was drilled to 80 feet and 82 feet of steel casing was placed into the hole. An 8 inch diameter hole was drilled to 457 feet and 5 inch plastic casing was installed from 10 feet to 457 feet. The well was cemented from a depth of 430 feet to the surface. The well is completed with ¼ inch drill holes from 435 feet to 455 feet in a sandstone unit of the Claggett Shale.

The well was test pumped at 130 gpm for 8 hours. The pumping water level stabilized at 6.5 feet below the surface for a total drawdown of 15.74 feet. The Specific Capacity of the well is a measure of the well efficiency and for this well it is 8.25 gallons of water per minute per foot of drawdown. This is a very good value and indicates the well will meet the Colony's requirements for many years. See the well logs and water chemistry results in appendix IV for additional information.

Table 2. Well information for Duncan Ranch.

	Duncan Ranch Well
MBMG #	169015
Water Right #	
Latitude / Longitude	46.4444/-110.0231
Date Completed	July 10, 1998
Depth	457
Perforated Interval	435 feet to 455 feet
SWL Depth	Flowing (4 psi)
PWL Depth	6.5 feet
Drawdown	15.74 feet
Test Pumping Rate	130 gpm
Specific Capacity	8.25 gpm/ft
Pumping Rate	35 gpm
Source Type	bedrock confined

Conceptual Model and Assumptions

The aquifers are recharged from infiltrating surface water where the formations are exposed north and south of the Colony. The geologic formation containing the aquifer is the Claggett Shale and is exposed several miles south and north of Duncan Ranch. The elevation at which recharge occurs make the aquifer pressurized and the well flows at the surface.

Methods and Criteria

DEQ's Source Water Protection Program specifies methods and criteria used to delineate subregions of the source water protection areas for Duncan Ranch. A one-hundred-foot radius **Control Zone** was delineated for each source. This is in accordance with DEQ 1, regulations for construction of water and wastewater systems.

The **Inventory Region** was delineated using the Uniform Flow Equations but due to the size of the area delineated and the flowing artesian conditions at the well, the 1000 foot radius circle centered on the well was used.

CHAPTER 3
INVENTORY

Potential sources of contamination were inventoried to assess the susceptibility of the Duncan Ranch Colony's drinking water sources to contamination. Potential sources of all contaminants with primary drinking water standards and cryptosporidium were identified but a detailed inventory was conducted only for potential sources of contaminants that are the greatest threat to health. The contaminants of greatest concern to the Colony are the secondary contaminants sodium, sulfate and TDS.

The inventory focuses on all activities in the control zone, major facilities in the inventory region, and general land uses in the recharge region.

Inventory Method

Databases were 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: Major road and rail transportation routes were identified throughout the inventory region.
Step 2. All land uses and facilities that generate, store, or use large quantities of hazardous materials were identified within the recharge region and identified on the base map.

Potential contaminant sources are designated as significant if they fall into one of the following categories:

1.Large quantity hazardous waste generators
2) Landfills
3. 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
9. Septic systems, Sewered residential areas
10) Storm sewer outflows

Inventory Results/Control Zone

The control zone is the 100 foot radius around each well. Within the control zone for the existing wells, the main potential contaminant is from vehicle traffic near the wellhead.

Inventory Results/Inventory Region

The Inventory Region includes sanitary sewers, highways, and agricultural operations. See figure 3.

Table 4, Results for Duncan Ranch Colony's inventory regions

map ID	contaminant source	description
	Agriculture	nitrates and chemicals
	Cemetery	Chemicals or nitrates
	municipal sewer	leaks, nitrates and pathogens
	highways	Chemical spills

Inventory Results/Recharge Region

The Recharge Region for the well outside the inventory region is located forest and pasture land. See figure 3.

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

The potential sources of contaminants for Duncan Ranch are determined from readily available data and reports. Unregulated activities or unreported contaminant releases may have been missed. The use of multiple sources of data, however, should ensure the major threats to the source water for the Colony.

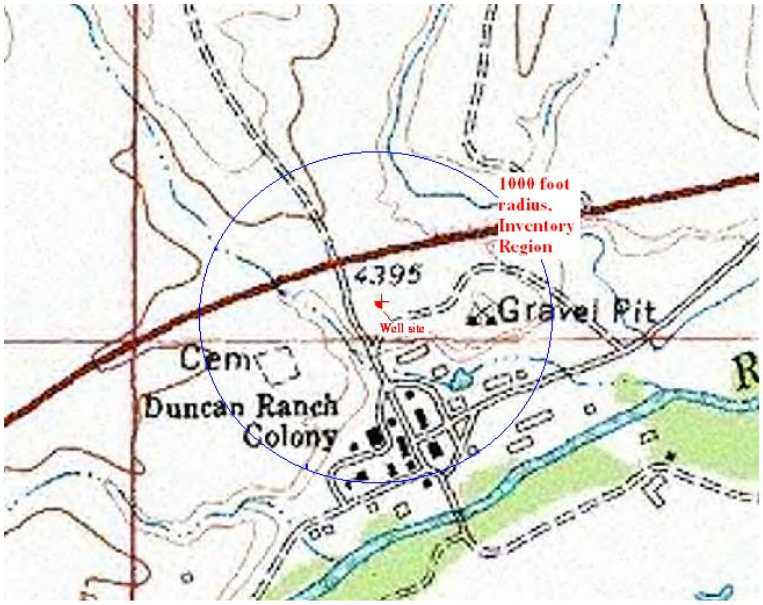

Figure 3. Inventory Region

CHAPTER 4
SUSCEPTIBILITY ASSESSMENT

The susceptibility of Duncan Ranch Colony's well to significant potential contaminant sources is assessed in this chapter to rank threats to the drinking water source. The degree of susceptibiltiy is determined by the hazard associated with a source and the existence of barriers to contamination (Table 5). The proximity of point contaminant sources to the colony's well or the density of non-point sources in the inventory region determines hazard (Table 6). Barriers can be anything that decreases the likelihood that contaminated water will flow to the town's wells. 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 can be considered management barriers. Thick clayey soils, a deep water table, or a thick saturated zone above the well intake can all be natural barriers.

Susceptibility ratings are presented individually for each significant potential contaminant source in the inventory region. Duncan Ranch Colony is not considered susceptible to individual point sources in the recharge region because dispersion and dilution of contaminants should reduce concentrations of contaminants below levels associated with adverse health affects.

Table 5. 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

Table 6. Hazard of potential contaminant sources for Duncan Ranch Colony.

	High Hazard	**Moderate Hazard**	**Low Hazard**
Point Sources of All Contaminants	Within one-year TOT	one to three years TOT	Over three years TOT
Septic Systems	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

The results of the susceptibility assessment for Duncan Ranch are summarized in Table 7. The following are brief descriptions of the susceptibility assessments for each significant potential contaminant source.

Table 7. Susceptibility assessment for the Duncan Ranch Inventory region.

Source	**Contaminant**	**Hazard**	**Rating**	**Barriers**	**Susceptibility**	**Management**
Municipal sewers	pathogens and nitrates	Leaks	high	:well intake below 435 feet :well grouted to 430 feet :flowing well	very low	routine monitoring
pasture land	pathogens, nitrates	Infiltration	Low	:well intake below 435 feet :well grouted to bedrock :flowing well	Very low	routine monitoring
Highway	VOCs SOCs other chemicals	spills	high	well intake below 435 feet :confined aquifer	very low	routine monitoring
Cemetery	chemicals	Infiltration	Low	confined aquifer distance to well depth to groundwater	very low	routine monitoring

CHAPTER 5
MANAGEMENT

The goal of the Source Water Protection Program is to prevent Duncan Ranch's drinking water source from being contaminated. All land uses have been inventoried and the potential for these activities to contaminate the drinking water have been ranked. Management activities can be considered as another barrier developed to reduce the susceptibility of a specific contaminant from entering the Colony's water.

Control Zone Management

No chemicals will be used, stored or transported within the 100 foot radius of the well.

Inventory Region Management

Management of this region for Duncan Ranch is based on the well's depth and location away from most land use activities. The Colony will control the land use near the wells.

Recharge Region Management

The recharge region for Duncan Ranch is in the highlands several miles away from the colony. The land between the colony and the highlands is agricultural. The recharge travel time makes land use management unrealistic.

Management Implementation

The management strategies have been in use as part of the Public Water Systems operation.

CHAPTER 6
EMERGENCY PLAN

Procedures for responding to emergencies are described and an emergency coordinator is designated in this chapter. The equipment and materials needed to respond to an emergency and the source of a temporary water supply are also described.

Possible Disruption Threats

The main threat to the PWS has been identified as casing failure or line breaks. A failure of the casing could allow contaminated surface water or poorer quality water from a different aquifer to enter the well.

Emergency Coordinator

The emergency coordinator for Duncan Ranch is Ben Waldner.

Equipment and Material Resources

A catastrophic loss of water will require the services of an engineer and a well driller. Minor disruptions to the public water system will be handled by the colony.

Procedures to Shut Down the Well

The well can be isolated from the water distribution system by using the valves at the well site. The well can be turned off at the pump house but requires a key for access. The keys are located with the operator.

CHAPTER 7
ALTERNATE WATER SOURCES

Duncan Ranch has sufficient water to meet the Colony's requirements and no new wells are planned at this time.

REFERENCES

1. Alt, David, A., and Hyndman, Donald, W., 1992, Roadside Geology of Montana

2. Levens, Russell, L.,1999, DEQ, Source Water Protection Plan, Sage Creek Hutterite Colony

3. Groff. S., L., 1962, Reconnaissance Ground-Water Studies, Wheatland, Eastern Meagher, and Northern Sweet Grass Counties, Montana

Appendix I
Glossary

Appendix II
Water Chemistry

Appendix III
Geologic Maps

Appendix IV
Well Logs