Hartland Hutterite Colony

PWSID # MT0004072

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

Report Date: February 22, 2001

Joseph Waldner

Certified Operator

HC 30, Box 69

Havre, MT 59501

phone: (406) 398-5350

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INTRODUCTION

The Source Water Delineation and Assessment Report for Hartland Hutterite Colony was completed by Russell L. Levens, Montana Department of Environmental Quality. Joeseph Waldner assisted extensively with the contaminant source inventory and reviewed a draft of this report for accuracy and completeness.

Purpose

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for the Hartland Hutterite Colony 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 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 primary purpose of this source water delineation and assessment report is to provide information to help the Hartland Colony complete a source water protection plan to protect its drinking water source.

Limitations

This report was prepared to assess threats to the Hartland Colony public water system 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 Hartland Colony’s public water system 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 Hartland Colony 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 contaminant levels (MCLs) have been specified under the national primary drinking water standards, and to certain constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1

BACKGROUND

The Community

Approximately 68 people live at Hartland Hutterite Colony and produce a variety of livestock and agricultural products including hogs, chickens, dairy products, and grain. The colony complex consists of barns, shops, and homes covering approximately 20 acres.

Human and animal wastes are piped to separate bentonite-lined lagoons. Effluent from two-cell animal waste lagoons is spray irrigated on nearby pasture.

Geographic setting

The colony is 3.5 miles from the U.S.-Canadian border in the northwest corner of Blaine County (Figure 1), an area of gentle plains shaped by continental glaciers. These plains are broken by coulees occupied by intermittent streams that flow only in response to snowmelt or intense summer storms. Shale bedrock that dips gently to the east is covered by deep, well-drained clay loam soils developed on glacial till. The nearest town with commercial services is Havre (pop. 10, 245), 43 miles to the southwest.

Hartland Colony lies along Woodpile Coulee, which is occupied by an intermittent tributary of Battle Creek. Precipitation at the nearest weather station in Havre averages 12.7 inches per year mostly falling as rain during May through August. Average low and high temperatures in Havre are 5.3° F and 25.5° F in January and 55.5° F and 84.4° F in July.

General Description of the Source Water

Hartland Colony draws water from a confined sandstone bedrock aquifer underlying approximately 650 ft of shale. Recharge to the aquifer is primarily from precipitation and stream losses at outcrops in distant mountains (Levings, 1982). Groundwater flow near the colony is generally eastward. The capacity of the colony's well is relatively low.

Table 1. List of geologic or hydrogeologic maps available for the vicinity of Hartland Colony.

Title or Description	Date	Area Covered	Reference
Map showing physiography and glacial geology	1932	Eastern Montana	Alden, W.C., 1932. Physiography and Glacial Geology of Eastern Montana and Adjacent Areas: U.S. Geological Survey Professional Paper 174, 133 p.
Potentiometric surface map of the Judith River Formation	1982	Eastern Montana and adjacent areas	Levings, G.W., 1982. Potentiometric-Surface Map of Water In the Judith River Formation in the Northern Great Plains Area of Montana: U.S. Geological Survey Open-File Report 82-562, 1 sheet.

The Public Water System

The following is taken from a sanitary survey completed in April 2000 (see Appendix E). Sixty-eight residents of Hartland Colony receive water through 12 service connections. The colony's well is 15 feet east of the plumbers shop which is the water distribution center and location of three 10,500-gallon water storage tanks. Water is distributed to the garage, shop, kitchen, school, housing, slaughterhouse, and barns. Water from the well is chlorinated with sodium hypochlorite solution as it is pumped to the storage tanks and a reverse osmosis system at the kitchen treats drinking water. A separate system distributes untreated water to barns for watering animals or other non-potable uses.

Water Quality

Water from the sandstone aquifer used at Hartland Colony is slightly alkaline with sodium (Na), bicarbonate (HCO_3), and chloride (Cl) the major dissolved constituents (Table 2). Bicarbonate is released with calcium and magnesium as slightly acidic water dissolves calcite and other carbonate minerals in recharge areas. The high sodium is probably a result of the calcium and magnesium exchanging for, and releasing, sodium attached to clay minerals in glacial till and shales encountered along the groundwater flow path. Sodium and chloride ions also can diffuse into the aquifer from underlying marine shales.

Table 2. Dissolved constituents in a wells in Hartland Colony's source aquifer.

-	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	CO_3 mg/L	Cl mg/L	SO_4 mg/L	NO_3 mg/L
Recharge Area (Tuck, 1993)	8.8	1320	0.9	0.2	360	0.6	0.05	0.005	7.7	810	52	2.5	3.6	0.05
Hartland Colony Well	8.1	2910	4.0	2.0	686	-	0.14	<0.01	-	1010	0	525	<1	<0.05
Downgradient From Colony (Zimmerman, 1960)	8.0	2420	2.4	1.9	609	2.4	0.5	-	10	953	-	166	279	3.9

Monitoring and Enforcement Actions

Water at Harland 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 VOC toluene was detected in a water sample from the colony's well in April 1997. Repeat samples in April and May 2000 did not contain detectable concentrations of toluene. Toluene is a component of gasoline and other fuels that are found in groundwater contaminated by leaks from underground storage tanks. There are no underground storage tanks at Hartland Colony nor have any been removed in the past. Because the colony's well is in a deep confined aquifer and there are no obvious contaminant sources, the toluene was probably introduced during well construction or during sample collection.

CHAPTER 2

DELINEATION

Areas that contribute water to Hartland Colony's well are identified in this chapter. Three management regions are mapped (control zone, inventory region, and recharge region). The goal of management in the control zone is to protect against direct introduction of contaminants into the colony's well or the immediate surrounding area. The inventory region should be managed to prevent release of contaminants that could flow to the colony's well within three years. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage.

Geologic Conditions and Aquifer Characteristics

Most of the following description is summarized from two reports published by the U.S. Geological Survey (Levings, 1982 and Alden, 1932). The geology of northcentral Montana is characterized by a thick section of sedimentary rocks that are covered by glacial sediments and locally interrupted by igneous intrusives (Figure 2). Igneous rock is formed from liquid masses called magma that rise thousands of feet toward the surface along faults. These masses cool and turn to rock below the surface and are exposed if overlying rock is removed by erosion. Igneous intrusions form the cores of several isolated mountain ranges in northcentral Montana, including the Sweet Grass Hills, the Bears Paw Mountains, and the Little Rocky Mountains. The flanks of these mountains are formed by layers of limestone, shale, and sandstone that were faulted and tilted as the igneous rocks were injected through them. These sedimentary layers dip away from the mountains locally and generally in an easterly direction regionally. Bedrock in much of north central Montana is covered by glacial deposits up to 100-ft thick that were left when continental glaciers receded. This material consists of a mixture of everything from clay to boulders and can contain sand and gravel layers deposited by glacial melt water.

Table 3. List of geologic or hydrogeologic research activities in the area of Hartland Colony.

Title of Project	Period of Project	Area Covered	Project Objectives
Physiography and glacial geology	1911 - 1932	Eastern Montana and adjacent states	Characterize the glacial geology and history of the northern great plains
Potentiometric surface of the Judith River Formation	1978 - 1982	Northern Great Plains of Montana	Show the generalized potentiometric surface of water in the Judith River Formation
Ground-Water Evaluation of the East Butte of the Sweet Grass Hills, North-Central Montana	1993 - 1995	Area surrounding East Butte, Sweet Grass Hills	Describe ground-water resources in a 12-township area surrounding East Butte of the Sweet Grass Hills

The uppermost bedrock formation at Hartland Colony is the Bearpaw shale, followed by the Judith River formation, the Claggett shale and the Eagle sandstone. The Bearpaw and Claggett shale formations are similar appearing dark gray marine shales that act as regional confining layers whereas the Judith River formation and Eagle sandstone are regional aquifers.

The colony's well taps the Judith River formation (Figure 3). The Judith River aquifer is recharged by precipitation and infiltration where it outcrops along the flanks of isolated mountain ranges. Much smaller amounts of recharge come from leakage through the Bearpaw and Claggett shales. The Milk River valley is a regional discharge area for the Judith River formation.

Conceptual Model and Assumptions

The Judith River formation is tapped by Hartland Colony's well. Groundwater in the Judith River formation flows generally from west to east but converges toward the Milk River south of the colony (Levings, 1982). Recharge is primarily from infiltration of precipitation and stream losses at outcrops of the Judith River formation. The Judith

River outcrops along stream cuts in a broad area west of the colony and along the flanks of distant isolated mountain ranges. Leakage from adjacent bedrock formations and glacial sediments are less significant sources of recharge. The Bearpaw shale is a confining layer that limits recharge. Therefore, areas where the Judith River formation outcrops, and the vicinity immediately around the colony’s well, are the areas of greatest concern for source water protection.

Source-Well

The colony’s well is 834 ft deep and penetrates 37 ft of glacial till, 656 ft of Bearpaw shale, and 178 ft of Judith River formation. (well logs are included in Appendix D and completion details are summarized in Table 4). The well is cased to 785 ft and is open hole from there to 834 ft.

Table 4. Source well information for Hartland Colony.

-	Source #002 (Well #1)
MBMG #	163487
Water Right #	C104409-00
Latitude / Longitude	48.9519° / -109.4661°
Date Completed	April 30, 1997
Depth	834 ft
Perforated Interval (open hole)	785 – 834 ft
SWL Depth	59 ft – 10 in
PWL Depth	214 ft
Drawdown	154 ft – 2 in
Test Pumping Rate	11 gpm
Specific Capacity	0.07 gpm / ft
Source Type	Consolidated Sandstone Bedrock

Methods and Criteria

Methods and criteria used to delineate source water protection areas for Hartland Colony are specified in the Montana Department of Environmental Quality's Source Water Protection Program (DEQ, 1999). Specifically, the methods and criteria are those for confined aquifers. Fixed distance criteria are used to delineate the control zone and inventory region. The recharge region is delineated by hydrogeologic mapping.

Time-of-Travel Calculation

Estimates of aquifer flow properties, well discharge rate, and groundwater gradient are used to calculate the time-of-travel between outcrops of the Judith River formation and Hartland Colony's well (Table 5). Estimates of aquifer properties including hydraulic conductivity and transmissivity are based on published values for the Judith River formation (Tuck, 1993; Miller and Norbeck, 1997) and calculations from specific capacity obtained from the log of the colony's well. Effective porosity is estimated from published values for similar rocks (Freeze and Cherry, 1979) and thickness is estimated from the log of the colony's well.

The flow rate of groundwater in the Judith River formation was determined using the equations in Appendix B.

Table 5. Estimates of input parameters used to delineate the source water protection area.

Input Parameter	Range	Value Used
Transmissivity	1 – 0.8 - 5,700 ft^2/day (based on specific capacities reported by Levings, 1982) 2 – 0.73 ft^2/day (aquifer test data) 239 ft^2/day (specific capacity) (Miller and Norbeck, 1997) 3 – 19 ft^2/day (specific capacity of Hartland Colony well)	200 ft^2/day
Thickness	20 - 400 ft	40 ft
Hydraulic Conductivity	0.5 - 10 ft/day	5 ft/day
Hydraulic Gradient	0.01 – 0.02	0.01
Effective Porosity	1 – 20%	2%
Pumping Rate	5,000 - 10,000 gal/day	10,000 gal/day
Groundwater Flow Rate	900 – 9,000 ft/year	1,500 ft/year

Delineation Results

The control zone for the colony's well is a 100-foot circle; all sources of potential contaminants should be excluded in this region. The inventory region is a 1,000-foot radius circle around the colony's well (Figure 4). This area will be the focus of the contaminant source inventory and susceptibility assessment presented in the next two sections. The time-of-travel from outcrops of the Judith River formation to the colony's well is probably in excess of 100 years. The recharge region is delineated by outcrops of the Judith River formation in distant mountain ranges and along stream cuts where glacial sediments are absent.

CHAPTER 3

INVENTORY

Potential sources of contamination were inventoried to assess the susceptibility of Hartland Colony's drinking water source to contamination. Sources of all primary drinking water contaminants and cryptosporidium were identified; however, only potential sources of contaminants that are the greatest threat to health were selected for detailed inventory. The contaminants of greatest concern to Hartland Colony are nitrate, microbial contaminants, fuels, solvents, and pesticides.

The inventory for Hartland Colony focuses on all activities in the control zone and point sources of all contaminants and certain land uses in the inventory region. General land uses and large point sources of contaminants are identified in the recharge region.

Inventory Method

Locations of underground storage tanks, hazardous waste generators, hazardous waste contaminated sites, landfills, and abandoned mines near Hartland Colony were identified from DEQ databases. Agricultural chemical application practices and waste disposal practices at the colony were described by Hartland Colony in its application to DEQ for organic chemical monitoring waivers. Land uses were identified from a land cover GIS coverage (U.S. Geological Survey, 2000). Russell Levens of Montana DEQ toured the colony in August 2000 with Joe Waldner to confirm the location of potential contaminant sources.

Inventory Results/Control Zone

The control zone includes the plumbers shop and surrounding open space. Vehicles are parked in and driven through the control zone. There is no known chemical use within the control zone.

Inventory Results/Inventory Region

The inventory region includes the entire farm complex (Figure 5). The farm complex consists of colony housing and school, hog, chicken, and cow barns, a slaughterhouse, equipment repair and maintenance shops, and garage (See Appendix A for PWS Site Plans). Aboveground storage tanks for unleaded gas, regular diesel, and farm diesel are located within the complex. Additional tanks store diesel for electrical power plants. Human waste is piped through sewer mains from each house and privies in other buildings to a treatment lagoon. Animal waste from the barns is piped to a separate two-cell lagoon. Pesticides for application on cropland are mixed in a building with a concrete floor or outside on a concrete pad. Potential contaminants at the colony include human and animal wastes, solvents and fuels, waste chemicals, and pesticides. The primary hazards are chemical or fuel spills, spills at the chemical mixing station, runoff from the stockyard and slaughterhouse, leakage from sewer mains, and seepage from lagoons (Table 6).

Table 6. Significant potential contaminant sources in the Hartland Colony inventory region.

Well	Source	Hazard
Well #1	Sanitary Sewer	Leaking sewer lines or collection system for housing and barns
Well #1	Domestic Sewage Lagoon	Seepage through bottom of lagoon
Well #1	Animal Waste Lagoon	Seepage through bottom of lagoon
Well #1	Concentrated Animal Feeding Operations	Leaching from animal wastes
Well #1	Stormwater Runoff	Spills and runoff from garage and chemical mixing areas
Well #1	Fuel Storage	Spills

Inventory Results/Recharge Region

Landcover near outcrops of the Judith River formation is primarily grassland, herbaceous plants, and shrubs (Figure 6). Pesticides, fertilizer, and fuels for farm machinery are potential contaminants in the recharge region, although chemicals are used infrequently in the most sensitive areas where the Judith River formation outcrops.

Inventory Update

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

Inventory Limitations

The potential sources of contaminants for Hartland Colony are taken from readily available data and reports. Consequently, unregulated activities or unreported contaminant releases may have been missed. The use of multiple sources of data, however, should ensure that the major contaminant threats to the source water for Hartland Colony are known.

CHAPTER 4

SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a well to be contaminated by one of the potential contaminant sources inventoried in the previous chapter. Hazard ratings and the presence of barriers determine susceptibility (Table 7). Hazard for wells in confined aquifers is rated high, moderate, or low depending on whether the public water system well or other wells in the inventory region are sealed into the confining layer. Hazard is low if all wells are sealed properly, moderate if wells other than the public water system well are sealed improperly, and high if the public water system well is sealed improperly. 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. Dilution through mixing also may be a natural barrier.

Table 7. Susceptibility to 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

Susceptibility Assessment Results

Hazard is rated low for all significant potential contaminant sources listed in Table 6 because Hartland Colony’s well is grouted into the confining shale layers. Contaminants released within the inventory region are unlikely to reach the aquifer along the well bore, bypassing the confining layer. Susceptibility is rated very low for all sources because multiple barriers to contamination are afforded by thick clay rich glacial deposits and the depth of the colony’s wells (Table 8).

Table 8. Susceptibility assessment for significant potential sources of contamination in the inventory region**.**

Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Sanitary Sewer	Pathogens and nitrate	Leaks	Low	Thick clay rich soils, Depth of intake	Very Low	Monitor for leaks and repair promptly
Domestic Sewage Lagoon	Pathogens and nitrate	Seepage through bottom of lagoon	Low	Thick clay rich soils, Depth of intake	Very Low	Monitor seepage losses
Animal Waste Lagoon	Pathogens and nitrate	Seepage through bottom of lagoon	Low	Thick clay rich soils, Depth of intake	Very Low	Monitor seepage losses
Concentrated Animal Feeding Operations	Pathogens and nitrate	Leaching	Low	Thick clay rich soils, Depth of intake	Very Low	Follow animal waste management plan
Fuel Storage	Gasoline and diesel	Spills	Low	Thick clay rich soils, Depth to intake	Very Low	Build containment around storage tanks
Stormwater Runoff	Fuels, solvents, waste oil, and pesticides	Spills	Low	Thick clay rich soils, Depth to intake	Very Low	Chemical management, waste chemical recycling, and spill prevention

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GLOSSARY*

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

Alkalinity. The capacity of water to neutralize acids.

Best Management Practices (BMPs). Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Coliform Bacteria. Bacteria found in the intestinal tracts of animals. Their presence in water is an indicator of pollution and possible contamination by pathogens.

Confined Aquifer. A fully saturated aquifer overlain by a confining unit such as a clay layer. The static water level in a well in a confined aquifer is at an elevation that is equal to or higher than the base of the overlying confining unit.

Confining Unit. A geologic formation that inhibits the flow of water.

Delineation. A process of mapping source water management areas.

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

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

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

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

Inventory Region. A source water management area that encompasses an area expected to contribute water to a public water system well within a fixed distance or a specified groundwater time-of-travel distance.

Maximum Contaminant Level (MCL). Maximum concentration of a substance in water that is permitted to be delivered to the users of a public water system. 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.

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

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

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 system.

Susceptibility (of a PWS). The potential for a PWS to draw water contaminated at concentrations that would pose concern. Susceptibility is evaluated at the point immediately preceding treatment or, if no treatment is provided, at the entry point to the distribution system.

Synthetic Organic Compounds (SOC). Man made organic chemical compounds (e.g. pesticides).

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

Total Maximum Daily Load (TMDL). The total pollutant load to a surface water body from point, non-point, and natural sources. The TMDL program was established by section 303(d) of the Clean Water Act to help states implement water quality standards.

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

Transmissivity. The ability of an aquifer to transmit water.

Unconfined Aquifer. An aquifer containing water that is not under pressure. The water table is the top surface of an unconfined aquifer.

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

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

* Definitions taken from EPA’s Glossary of Selected Terms and Abbreviations