Christian Children's Ranch
Public Water System

PWS ID # MT0003720

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

PWS ID # MT0003720
Lake County, Montana

DOCUMENT DATE: 08 NOVEMBER 2004

PREPARED FOR:

CHRISTIAN CHILDREN'S RANCH
(a.k.a. Pine Haven Christian's Ranch)
Attn: Robert Andy Larsson, Financial and Administrative Contact
2010 Pistol Creek Road
St. Ignatius, Montana 59865

PREPARED BY:

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
Source Water Protection Program
P.O. Box 200901
Helena, Montana 59620-0901

EXECUTIVE SUMMARY

This Source Water Delineation and Assessment Report was prepared under the Federal Safe Drinking Water Act and the Montana Source Water Assessment Plan. The Department of Environmental Quality (DEQ) is ensuring that assessments are completed for all public water systems in Montana. The purpose of these reports is to provide information so that the public water system operator, consumers, and community citizens can begin developing strategies to protect your source of drinking water. The information that is provided includes the identification of the area most critical to maintaining safe drinking water (i.e., the Inventory Region), an inventory of potential sources of contamination within this area, and an assessment of the relative threat that these potential sources pose to the water system. Jeffrey Frank Herrick with DEQ's Source Water Protection Program completed this report.

The drinking water for the Christian Children's Ranch public water supply is produced from a single well (Well #3) located on the south central portion of the ranch (Figures 2, 3, & 5). At least a couple of other wells and a spring have been used in the past but are currently inactive. Based on several sanitary surveys, well logs, and the depth of the wells, it appears that an unconfined deep bedrock aquifer underlies the ranch. In accordance with the Montana Source Water Protection Program criteria (1999), the aquifer (source water) is considered to have a low sensitivity to potential contaminant sources since it a deep bedrock aquifer. Sensitivity is defined as the relative ease that contaminants can migrate to source water through the natural materials.

Three types of source water protection management regions for the Christian Children's Ranch public water system were mapped as part of this assessment. They are the Control Zone, Inventory Region, and the Recharge Region. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- The Control Zone is delineated as a 100-foot radius around each well and all sources of potential contaminants should be excluded in this region. The goal of management in the Control Zone is to avoid introducing contaminants directly into the water supply's well or immediate surrounding areas. No potential contaminant sources were noted as being within the Control Zone.
- Since the source water is unconfined, the Inventory Region for the PWS well consists of the aquifer and the watershed upgradient from the wellhead (see Figure 5). The Inventory Region should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. Significant potential contaminant sources that were identified within the Inventory Region include: the septic systems associated with ranch homes and facilities, and activities in and around the ranch buildings where chemicals or waste may be concentrated (stored, handled, or disposed).
- The Recharge Region was combined with the Inventory Region and is depicted on Figure 5.

Within this unconfined deep bedrock aquifer, groundwater generally flows from the south to the north beneath the ranch. Recharge to the deep aquifer is occurring south and east within the Mission Mountains.

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried contaminant sources at concentrations that would pose concern. 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 public water supply well intakes. The susceptibility analysis provides the community and the public water system with information on where the greatest risk occurs and where to focus resources for protection of this valuable drinking water resource. The Christian Children's Ranch's supply well appears to have a moderate susceptibility to onsite septic systems and to operations at the ranch.

The costs associated with contaminated drinking water are high. Developing an approach to protect that drinking water resource will reduce the risks of a contamination event occurring. In this report, we have summarized the local geology and well construction issues as they pertain to the quality of your drinking water source. We have identified the area we believe to be most critical to preserving

your water quality (the Inventory Region) and have identified potential sources of contamination within that area. In addition, we provide you with recommendations (i.e., Best Management Practices) regarding the proper use and practices associated with some common potential contamination sources. We believe public awareness is a powerful tool for protecting drinking water. The information in this report will help you increase public awareness about the relationship between land use activities and drinking water quality. Refer to the figures within the document to better understand the spatial relationship of the area. The susceptibility of the PWS to the significant potential contaminant sources is discussed on Table 8. Overall, there appear to be very few nearby threats to the production well beyond the onsite large capacity septic system.

TABLE OF CONTENTS

INTRODUCTION

General Discussion

This Delineation and Assessment Report was completed by Jeffrey Frank Herrick, a hydrogeologist with the DEQ Source Water Protection Program**.** The Christian Children's Ranch is located just southwest of the town of Saint Ignatius, which is in the southern portion of the Mission Valley. It is also on the Flathead Indian Reservation, home of the Confederated Salish and Kootenai Tribes.

The Christian Children's Ranch (a.k.a. Pine Haven Ranch) is served by a single public water supply (PWS). This water system provides drinking water to the residents/students and staff at the ranch. This report is intended to meet the technical requirements for the completion of the source water delineation and assessment report (a SWDAR) for the ranch facilities that are located off Pistol Creek Road, west of Saint Ignatius, Montana. This PWS is regulated by DEQ, and the report is completed according to the requirements of the Montana Source Water Protection Program and the federal Safe Drinking Water Act (SDWA).

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protecting public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is termed delineation and assessment. The emphasis of this delineation and assessment report is identifying significant potential contaminant threats to public drinking water sources and providing the information needed to institute source water protection planning and source water protection activities.

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 locations or regions in source water protection areas where contaminants may be generated, stored, or transported and then determining the potential for contamination of drinking water by these sources.

Delineation and assessment is the foundation of source water protection planning, the mechanism and steps that can be taken for the Christian Children's Ranch to protect their drinking water source. Although voluntary, source water protection plans are the ultimate focus of source water delineation and assessment. This delineation and assessment report is written to encourage and facilitate the PWS operator and the ranch management to complete a source water protection planning that meets their specific needs.

Limitations

This report was prepared to assess threats to the public water supply, and is based on published information and information obtained from persons familiar with the community. The terms "drinking water supply" or "drinking water source" refer specifically to the source of the Christian Children's Ranch public water supply and not any other public or private water supply. In addition, not all potential or existing sources of groundwater or surface water contamination in the area of the water supply are identified. Only potential sources of contamination in areas that contribute water to its drinking water source are considered.

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

CHAPTER 1
BACKGROUND

The Community

The Town of Saint Ignatius is located in the southern part of the Mission Valley, within the boundaries of the Flathead Indian Reservation (Figures 1 and 2). According to the 2000 US Census data, Saint Ignatius has a population of 788 people, with a couple of hundred others in the immediate area. The town appears to have grown only 1.3% since the 1990 US Census. According to the 2000 Census, Lake County has a population of 26,507 people and has grown 26% since 1990. The town can be informally separated into northern and southern halves by Mission Creek, which runs through the central part of the town (Figure 2). The local economy relies heavily on the agriculture, small businesses in the area, and tourism. The major highway in the area is US 93 which connects the Mission Valley and Flathead Lake regions with the Clark Fork River and Missoula area to the south. Wastewater from the community is collected in two sanitary sewer systems, serving the northern and southern parts of the town respectively. The sewer systems discharge to treatment ponds located west of the town. The Christian Children's Ranch is located 1.8 miles south of Highway 93 on Pistol Creek Road, which turns off of the highway about 1.8 miles southwest of Saint Ignatius (Figure 2).

Geographic setting

Saint Ignatius is located on the southern end of the Mission Valley as depicted on Figures 1 and 2. The elevation of the town is approximately 2930 feet above sea level (MSL) and the school is at around 3,700 feet above MSL. The Mission Mountains, with peaks as high as 8,600 feet above sea level, represent the eastern boundary to the valley. The mountains that form the western valley boundary are as high as 7,400 feet above sea level. The Mission Valley is drained by the Flathead River, which flows generally southward from Flathead Lake to a position approximately 10 miles west of Saint Ignatius near Dixon, where the flow direction changes toward the west. Mission Creek flows through Saint Ignatius in a general northwestern direction through town, with headwaters in the southern Mission Mountains. After flowing through town, Mission Creek joins with Post Creek, and flows generally east to its confluence with the Flathead River. Mission Reservoir is located approximately three miles east of Saint Ignatius on a southwest flowing tributary to Mission Creek. The reservoir was formerly utilized as a local drinking water source. The climate in the area is typical for this part of Western Montana. Saint Ignatius gets an average of 15.95 inches of precipitation annually, with the wettest months in May and June averaging 2.28 and 2.47 inches monthly, respectively. The driest months are January and February, with respective averages of 0.97 and 0.76 inches per month. The temperature ranges from an average high of 84.3°F in July (minimum July average of 49.4°F) to an average of 33.0°F in January (minimum January average of 16.8°F).

General description of the Source Water

The Christian Children's Ranch PWS obtains water from a single well that is installed into bedrock southwest of the ranch facilities. Records indicate that there are at least 2 other wells and a spring connected to the water system, but these are currently inactive and do not provide drinking water for the ranch facilities. The well draws water from an approximate depth of 275 feet below the ground surface. Groundwater in the area of the ranch probably flows toward and sub-parallel to the flow direction of surface water in Pistol Creek, which is north to northwest.

Figure 1 Mission Valley & Saint Ignatius Area

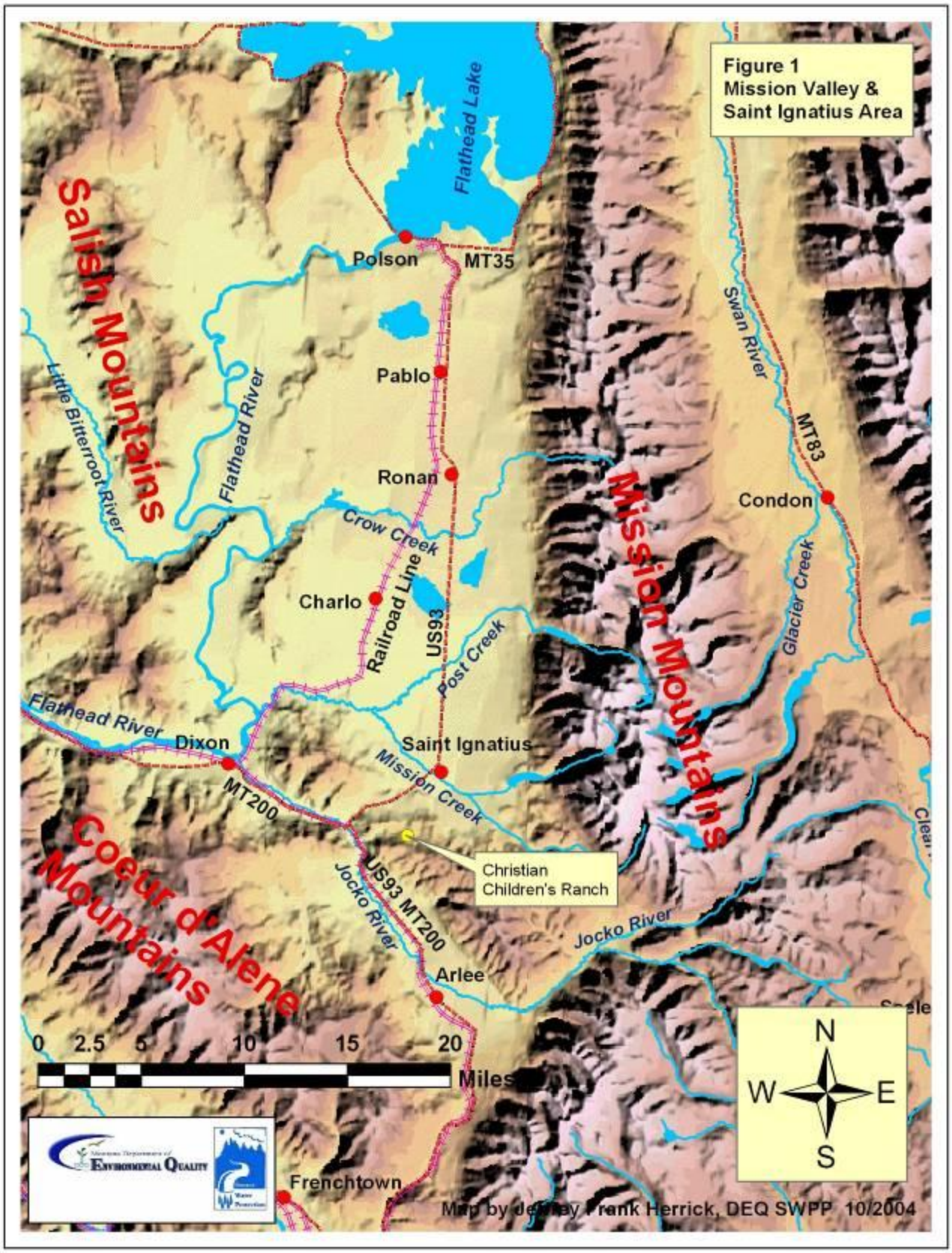
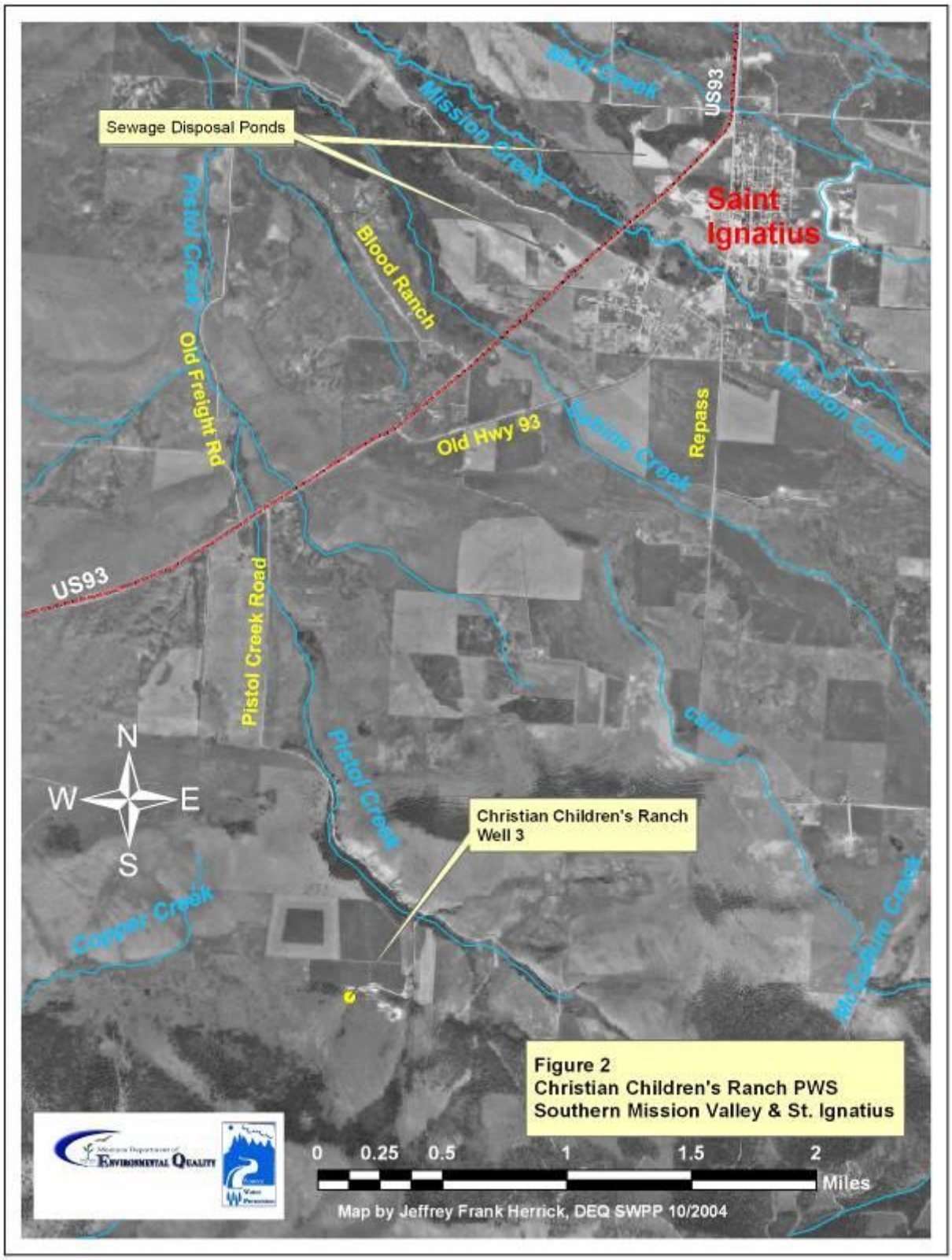


Figure 2 Sewage Disposal Ponds



The Public Water Supply

PWS Facilities

According to the DEQ PWS files, the Christian Children's Ranch PWS currently serves an estimated population of 68 through 9 service connections.

The population of 68 consists of around 65 residents (students and staff) and around 3 non-transients (persons who live off-site) (Robert Larsson, personal communication 11/2004). The PWS is classified by DEQ as a Non-Transient Non-Community PWS, but probably should be reclassified as a Community Non-Transient PWS because most of the residents and students actually live at the ranch year-round. According to several sources of information (including Sanitary Surveys by DEQ), Well 1, Well 2, and Well 3, along with the spring are essentially co-located near the Well 3 location that is plotted on Figures 2 and 3 (at least at the scale of this map). Well 3 is the only well that is currently being actively used to provide drinking water for the PWS. The water from the well is pumped into 2, 9,000 gallon above groundwater tanks that then feed by gravity to several group homes. Each of the homes has their own captive-air pressure tanks and booster pumps. There is currently no treatment system for the water. A general plan showing the layout of the distribution system is in the process of being developed by the operators. What well logs were available for the wells are provided in Appendix B. Table 1 below is a summary of the facilities that make up this PWS and is based on what is recorded in the DEQ PWS files.

Table 1. List of Facilities
Christian Children's Ranch PWS – MT0003720

Facility	PWS Facility ID per the DEQ PWS Section Database	Notes
Intake Spring in Hillside	No number is currently assigned in the DEQ Database.	This is a historic water source only. It was a subsurface intake that was probably constructed with buried perforated pipe (~10 feet deep). **Inactive**. Disconnected.
Well 1	WL002	East of well house, drilled in 1988. **Inactive** This well is not connected to the PWS. However, this well is being used by a residence.
Well 2	WL003	West of well house, drilled in 1994. **Inactive**
Well 3	WL004	Called the southwest well, drilled in 1995. **Active** This is currently the water source for the PWS.
Common Header	CH001 w/ EP502	This common header is located below and is for the 2 water storage tanks. **Active**
Distribution System	DS001 w/ SP001	Throughout the facility. **Active**
Pressure Control Assembly	PC001	Located in the uppermost group home. Each group home has a captive air tank, check valve, and booster pump. **Active**
Treatment	None	No treatment is applied to the water in this PWS

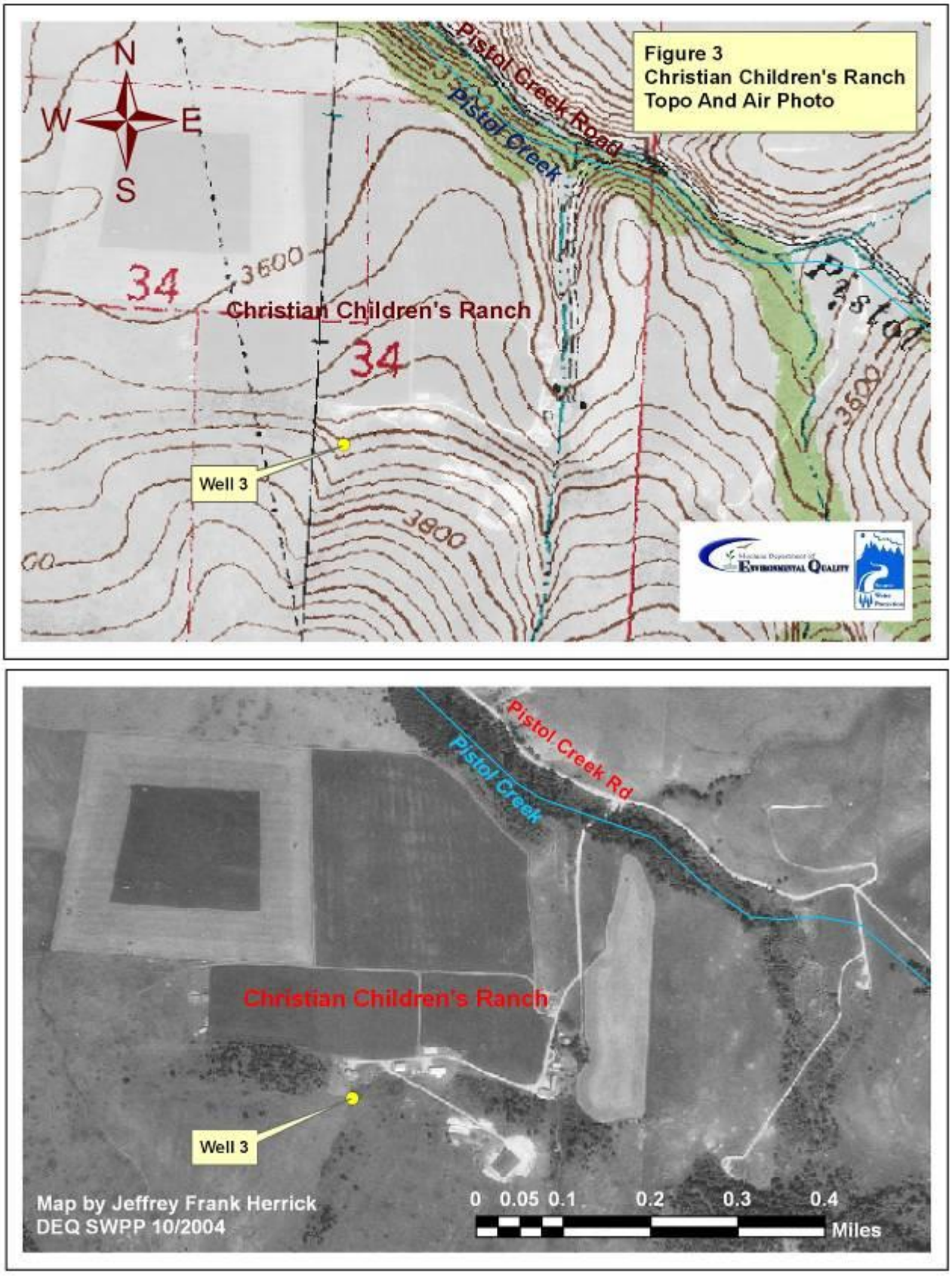
Table 1. List of Facilities

Christian Children's Ranch PWS – MT0003720

Facility	PWS Facility ID per the DEQ PWS Section Database	Notes
Storage Tank 1	ST001	Storage Facility (tank) 1, a 9,000 gallon above ground fiberglass tank. Both tanks are located near the wellhead. **Active**
Storage Tank 2	ST002	Storage Facility (tank) 2, a 9,000 gallon above ground fiberglass tank. Both tanks are located near the wellhead. **Active**

Note: Please refer to the 2001, 1999, and 1995 DEQ PWS Sanitary Surveys for further details on the layout of this system. The Sanitary Surveys are found in Appendix B. The DEQ PWS Database also summarizes this information along with water quality data and an output of this database is found in Appendix A.

Figure 3 Christian Children's Ranch



Well Information

The source wells and a spring source for the Christian Children's Ranch PWS are located in the southwestern part of the ranch as depicted in Figures 2 and 3. Only Well 3 is active. Copies of the drillers well logs are included in Appendix B, with a summary of well information listed in Table 2.

Table 2. Source/Well Information
Christian Children's Ranch PWS

Information	Well #1	Well #2	Well #3	Spring Source
PWS Source Code	WL002 Inactive	WL003 Inactive	WL004 **Active**	None Not listed
MBMG #	Unknown	Unknown	Unknown	Unknown
Water Right #	Unknown	Unknown	Unknown	Unknown
Date Well was Completed	01 July 1988	May 1994	08 November 1995	1978
Total Depth (feet bgs)	440	400	275	10
Casing Depth (feet bgs)	308	400	235	10
Perforated Interval (feet bgs)	270-300	Open bottom casing	235-275	10 horizontal perforated pipe
Static Water Level (feet bgs)	95	Unknown	178	Unknown
Pumping Water Level (feet bgs)	265	Unknown	240	Unknown
Drawdown (feet bgs)	170	Unknown	62	Unknown
Test Pumping Rate (gpm)	15	15	33	Unknown
Specific Capacity (gallons/minute /foot)	0.09	Unknown	0.53	Unknown
Source of Information	1988 Drilling Bill and Log	Referenced in a 1995 Sanitary Survey by DEQ	1995 Drilling Bill and Log	Referenced in a 1995 Sanitary Survey by DEQ

Note: No well logs were found in the Montana Bureau of Mines and Geology Groundwater Information Center database. No well logs were found for any of the wells other than the drilling bills noted above.

Water Quality

Every PWS is required to perform monitoring for contamination to their water supply. The monitoring constituents include coliform bacteria and other signs of pathogenic organism, nitrates, metals, and for other contaminants. 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 Christian Children's Ranch shows are recurring problem with their BACT samples. Water samples were routinely positive for coliform bacteria prior to 2000, but only occasional samples showed positive in the last few

years. The most recent samples that were in the database were also positive for coliform bacteria (09/2004). No samples proved to be positive for fecal coliform bacteria or *E. Coli*. An actual cause for the positive sample results for the coliform bacteria has not been identified to this point. The PWS showed no exceedences of any drinking water quality standards. Nitrate or nitrate was present in periodic sample results, but these numbers were low, ranging from Not Detected to 1.09 mg/L. These results are well below the federal MCL, which is 10 mg/L.

CHAPTER 2
DELINEATION

General Discussion

The source water protection area, the land area that contributes water to the Christian Children's Ranch PWS, is identified in this chapter. Three management areas are typically identified within the source water protection area. These three regions are 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 wellhead or other intake structure. The Inventory Region represents the zone of contribution to the well, which usually approximates a three-year groundwater time-of-travel distance. Analytical equations describing groundwater flow are used to calculate groundwater time-of-travel distance. These equations use estimates of pumping, aquifer characteristics, and simple hydrogeologic mapping. For water systems that are generally remote from significant potential contaminant sources, a modified 1-mile fixed radius circle around the wellhead is often sufficient to define the Inventory Region. The Inventory Region is intended to represent the entire portion of the aquifer that contributes water to the Christian Children's Ranch water system. The Recharge Region is typically a watershed above a water supply. The Recharge Region is the area that contributes water to local streams and recharges the aquifer. The boundaries of the Recharge Region are usually defined using topographic/watershed mapping.

Hydrogeologic Conditions

Geologic and hydrogeologic studies of the Mission Valley and Saint Ignatius area are listed in Table 3, with a summary of maps listed in Table 4. The hydrogeologic system in the Mission Valley, including the Saint Ignatius area, is described in detail by Slagle (1988) and Boettcher (1983). The following description of the local hydrogeology is adapted from these sources. Within the Mission Valley, the major geologic units include a thick sequence of glacial deposits of clay-rich tills with some sand and gravel outwash seams that can serve as productive local valley aquifers. These sediments were deposited by the advancing glacier over Tertiary basin-fill sediments as the large glaciers moved southward into and through the Mission Valley. In the Saint Ignatius area, glacial deposits are derived from local Alpine Glaciers that advanced westward out of the Mission Mountains into the Mission Valley. Clays and silts from glacial Lake Missoula cover the bedrock and glacial deposits in some areas surrounding the valley. Alluvium comprising sand, gravel, boulders, and some clay are present over the glacial material and the lacustrine strata in some areas, with the thickest deposits of alluvium located adjacent to the Mission Mountains.

The aquifer material near the town of Saint Ignatius is interpreted as being comprised of glacial outwash sediments covered with clay-rich glacial tills deposited when glaciers coming out of the Mission Mountain covered this part of the Mission Valley. The surficial material consists of unconsolidated deposits of sediments of various sizes in a clay-rich matrix. These clay-rich strata are present overlying coarser deposits of sand and gravel that produces water. The geology at the surface in the vicinity of the Christian Children's Ranch is a product of the deposition of the same glacial valley-fill sediments described above. It appears that there is 10 to 20 feet of glacial till (described in area well logs as clay and gravel) that rests directly on the bedrock. Some portion of this sediment at the surface may actually be lake deposits, but they haven't been mapped in the area. The topography suggests that there are numerous terraces and benches in the area like the one that the ranch is located on. It is unclear if these are mostly bedrock-cored terraces with glacial materials draped over their surfaces or if they are mostly lateral moraines comprised of glacial till. The ranch is located at the extreme south of the Mission Valley, so the glacial till materials are probably of local origin derived from the Mission Creek or other glaciated drainages in the southernmost part of the Mission Valley. These till materials are usually chaotic admixtures of clasts with a range of particle sizes (clay to boulders). These glacial deposits can be relatively impermeable to water

when the clay content and thickness are great. The underlying bedrock in the area is part of the PreCambrian Belt Supergroup, which are old sedimentary rocks that are seen in outcrops along the margins of the valley. These rock units are often fine-grained argillite/shale, limestone, or quartzite. The lithologic logs for wells in and around the ranch do not clearly identify what rock types comprise the local bedrock, but it is probably brown and green shale to argillite. Where local wells draw water from bedrock aquifers in the area, water availability is strictly dependant upon the well borehole intersecting water-bearing fractures within the otherwise impermeable rock units. All of the wells that have been drilled at the ranch were drilled and installed into the bedrock. The depth to water in these bedrock wells at the ranch is also dependant upon which fractures are producing the water and at what depth these fractures are encountered. Wells at the ranch are roughly summarized as follows:

Well 1. A bedrock well.
- 440 feet total depth bgs (below ground surface)
- casing to 308 feet bgs
- Static water level at 95 feet bgs
- Pumping water level at 265 feet bgs
- produced about 15 gpm (gallons/minute)

Well 2. A bedrock well.
- 400 feet total depth bgs
- casing to 400 feet bgs
- produced about 15 gpm

Well 3. A bedrock well.
- 275 feet total depth bgs
- casing to 235 feet bgs with perforations from 235-275 feet bgs
- static water level at 178 feet bgs
- pumping water level at 240 feet bgs
- produces about 33 gpm

Spring Source. This spring is one of a couple in the area near the wells. It derives water from the glacial materials that are sitting on the bedrock. Water was collected from a buried perforated pipe that may have been set at about 10 feet below ground surface (possibly near the overburden and bedrock interface). This spring water discharged was probably not derived from the water present in the deep bedrock aquifer, but was a product of local recharge of water that collects at the ground surface and infiltrates into the glacial till. The recharge area for the spring is probably the area directly uphill from the spring.

Although the recorded water levels in the area wells (based on well logs) are chaotic and unpredictable, it is believed that the groundwater within the bedrock beneath the Christian Children's Ranch is behaving in an unconfined manner (the bedrock is an unconfined aquifer). This means that there is no distinct confining unit that was identified above the water-bearing fractured rock and the groundwater isn't under hydrostatic pressure sufficient to cause the water level to rise significantly within the well casings. Groundwater flow direction is thought to be generally downhill and toward the larger surface streams. As such, groundwater flow beneath the Christian Children's Ranch is thought to be from south to north. The fractured bedrock aquifer receives recharge from the surface at any point uphill within the Mission Range and from stream loss as the streams begin their descent out of the mountains. As such, the author speculates that some of the water that reaches the ranch's well may indirectly come from Pistol Creek. Groundwater can cross topographic divides when it is present in deep bedrock aquifers, but realistically this isn't common. As such, the watershed above the ranch is the most probable recharge area for both the spring (shallow water on top of the bedrock) and the deep fractured bedrock aquifer. A geologic map of the southern Mission Valley, including the area around Saint Ignatius, is presented in Figure 4 and groundwater flow directions and a probable recharge area for the ranch production well are depicted on Figure 5.

Figure 4 Geologic Map Southern Mission Valley

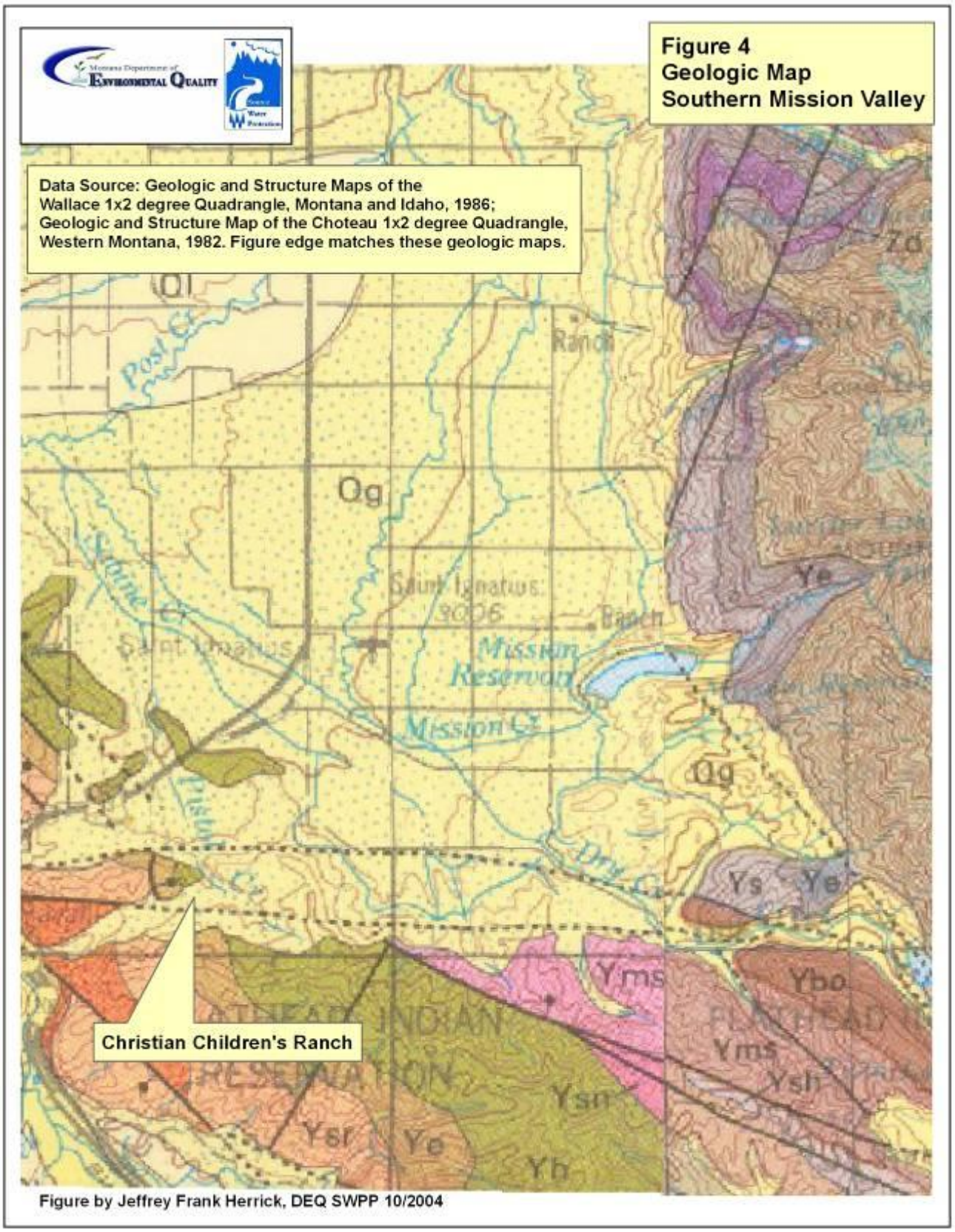


Figure 5 Christian Children's Ranch PWS Inventory Region

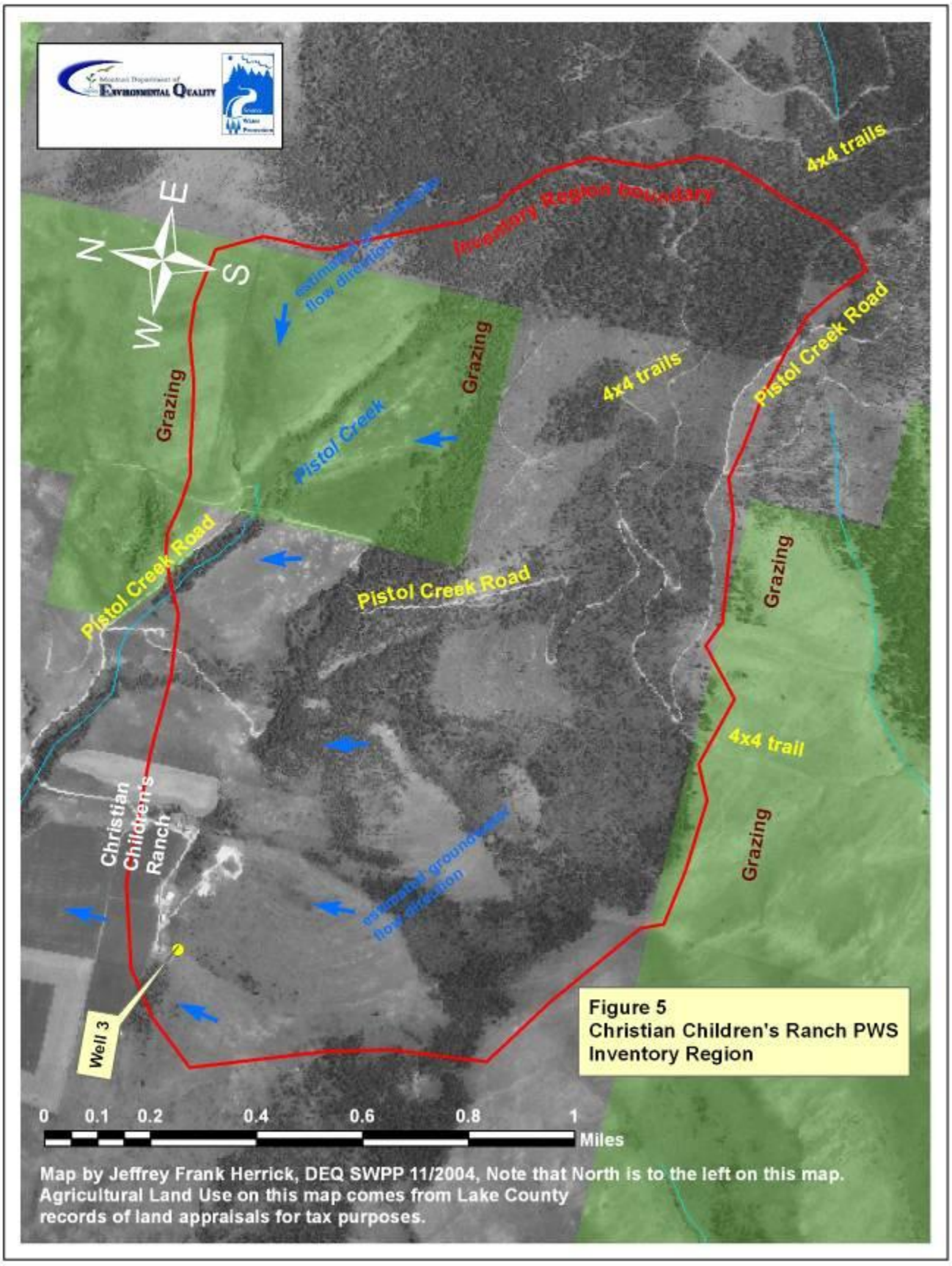


Table 3. List of area geologic or hydrogeologic investigations

Title of Project	Reference Information	Area Covered	Project Purpose
Physiography and Glacial Geology of Western Montana and adjacent areas	Alden, W.C., 1953 U.S. Geological Survey Professional Paper 231	Western Montana including the Mission Valley, and the Idaho Panhandle	Document the regional glacial history and related deposits.
Ground-Water Resources in the Central Part of the Flathead Indian Reservation, Northwestern Montana	Boettcher, A.J., 1982 Montana Bureau of Mines and Geology Memoir 48	Mission Valley and Little Bitterroot Valley	Document hydrogeology, groundwater quality, and potential for development of groundwater in the study area
Geohydrology of the Flathead Indian Reservation, Northwestern Montana	Slagle, S.E., 1988 U.S. Geological Survey Water-Resources Investigations Report 88-4142	Flathead Indian Reservation, including Mission Valley	Update Boettcher with a more comprehensive study covering the entire Flathead Reservation

Table 4. List of geologic or hydrogeologic maps

Title or Description	Date	Area Covered	Reference
Map showing generalized geology and depth to the top of Belt Supergroup; and Map showing altitude and configuration of the water surface of the valley-fill aquifers	1988	Flathead Reservation	Ground-Water Resources in the Central Part of the Flathead Indian Reservation, Northwestern Montana; Boettcher, A.J., 1982; Montana Bureau of Mines and Geology Memoir 48
Generalized geohydrologic map of the central part of he Flathead Indian Reservation; And Map showing potentiometric surface, well locations and low-flow measurement sites in the central part of the Flathead Indian Reservation	1982	Mission Valley and Little Bitterroot Valley	Geohydrology of the Flathead Indian Reservation, Northwestern Montana; Slagle, S.E., 1988; U.S. Geological Survey Water-Resources Investigations Report 88-4142

Based on the hydrogeologic setting, the aquifer is classified as having high source water sensitivity to contamination. Sensitivity is defined as the potential for contaminants to reach an aquifer before natural processes can reduce their concentrations below levels of concern.

Conceptual Model and Assumptions

A conceptual hydrogeologic model is a simplified representation of the hydrogeologic system. For the area around the Christian Children's Ranch, groundwater occurs within the shallow overburden of glacial till (with a discharge at the onsite springs) and within the fractured bedrock. Both sources of water are considered to be under unconfined conditions. The groundwater in the area is probably recharged by direct infiltration of surface water in the watershed above the well and spring and stream loss from the nearby Pistol Creek. It isn't clear if water discharging from Pistol Creek actually could reach the well during times of high production. Groundwater beneath the ranch flows generally parallel to the main streams in a north to north-northwestern direction (Figure 5).

Delineation Results

The methods and criteria used to delineate the source water protection zones for the Christian Children's Ranch water system are specified in the document titled Montana Department of Environmental Quality

Source Water Protection Program (DEQ, 1999). For this PWS, the criteria for unconfined aquifers was followed. A simplistic model of the capture zone for Well 3 was used to delineate the Inventory Region, where a 1-mile fixed radius circle was drawn around the wellhead. This circle was then modified to reflect what is known about groundwater flow direction(s) beneath the site, eliminating areas thought to be downgradient from the well. Figure 5 depicts the Inventory Region for the Christian Children's Ranch. This region is essentially the watershed above the ranch that includes a small portion of the watershed across and northeast of Pistol Creek. As such, the Inventory Region occupies the same area as the Recharge Region, so these 2 source water protection areas have been combined. The Recharge Region or the watershed is the area that is thought to provide recharge to the aquifer. The Inventory Region / Recharge Region is delineated on Figure 5.

Limiting Factors

The groundwater flow direction and the relationship between the local stream and the bedrock aquifer beneath the Christian Children's Ranch are inferred as no studies of groundwater flow in the area have been conducted. However, on a more regional scale, surface water and groundwater have been demonstrated to be in communication and groundwater flow in the alluvial and bedrock aquifers have been studied. For the purposes of this SWDAR (to clarify the significant potential contaminant sources for the ranch well) the model of groundwater flow discussed in this chapter is probably adequate. If more information concerning the local aquifers and groundwater behavior becomes available in the future, this SWDAR should be updated to reflect the new information.

CHAPTER 3
INVENTORY

An inventory of potential sources of contamination was conducted for the Christian Children's Ranch PWS within the Control Zone and Inventory Region. Potential sources of all primary drinking water contaminants and Cryptosporidium were identified, however, only significant potential contaminant sources were selected for detailed inventory. The significant potential contaminants in the ranch PWS Inventory Region are nitrates and pathogens from the onsite septic systems and agriculture. The inventory for the Christian Children's Ranch PWS focuses on all activities in the Control Zone, certain sites or land use activities in the Inventory Region.

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

Step 1: Land cover is identified from the National Land Cover Dataset compiled by the U.S. Geological Survey and U.S. Environmental Protection Agency (U.S.G.S., 2000). Land cover types in this dataset were mapped from satellite imagery at 30-meter resolution using a variety of supporting information. Alternately, an examination was made of agricultural land use as described by the county tax records, which is based on land appraisal for tax purposes. This is useful as it highlights irrigated and/or continuously cropped agricultural land. Additionally, agricultural land uses were identified based on data provided by Lake County. This data was derived from the appraisal of land values for tax purposes and is useful in that it identifies irrigated, continuously cropped, fallow, and grazing land.

Step 2: When applicable, EPA's Envirofacts System was queried to identify EPA regulated facilities. This system accesses the following databases: Resource Conservation and Recovery Information System (RCRIS), Biennial Reporting System (BRS), Toxic Release Inventory (TRI), Permit Compliance System (PCS), and Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS). The available reports were browsed for facility information including the Handler/Facility Classification to be used in assessing whether a facility is a significant potential contaminant source.

Step 3: DEQ databases were queried to identify Underground Storage Tanks (UST), hazardous waste contaminated sites, landfills, and abandoned mines.

Step 4: Major road and rail transportation routes were identified.

Step 5. All significant potential contaminant sources were identified in the inventory region and land uses and facilities that generate, store, transport, or dispose large quantities of hazardous materials were identified within the recharge region.

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

- Large quantity hazardous waste generators
- Landfills
- Hazardous waste contaminated sites
- Underground storage tanks
- Major roads or rail transportation routes
- Cultivated cropland

- Animal feeding operations
- Wastewater lagoons or spray irrigation
- Septic systems
- Sewered residential areas
- Storm sewer outflows
- Floor drains, sumps, or dry wells, and
- Abandoned or active mines

Inventory Results/Inventory Region

Well #3 is located south and west and away from all buildings and operations at the ranch. The sanitary surveys reviewed for this SWDAR did not indicate the presence of any activities or potential contaminant sources within or adjacent to the Control Zone (that is within 100 feet of the wellhead). Figure 5 shows an air photo of the area and identifies select agricultural land uses and the locations of potential contaminant sources within the Inventory Region boundary. A listing of potential contaminant sources is presented on Table 5 below. There is a section of land identified in the tax records as grazing land located southeast of the ranch along both sides of Pistol Creek. The percentage of this land use relative to the entire Inventory Region and its location relative to the well do not make it a significant potential contaminant source. It should be noted that because of the nature of the delineated region, the significant potential contaminant sources identified in this evaluation are only those located in close proximity to the well and on the ranch itself.

Table 5. Significant Potential Contaminant Sources
Christian Children's Ranch PWS

Potential Source	Potential Contaminants	Hazard
Septic Density (local higher concentration of onsite residential septic systems) servicing ranch buildings	Nitrate, pathogens, other	Leaks in septic tanks, leaks in sewer lines, system failure, infiltration of untreated effluent into groundwater
Agricultural operations that may occur around or within the ranch buildings	SOCs, VOCs, Pathogens, and Nitrates	These are activities that can release chemicals, such as: mechanical work, storage & mixing of farm chemicals, stockpiling of manure, other activities that could concentrate or release these chemicals

Note:

- No community or municipal sewer systems are present in the Inventory Region and all residences are serviced by onsite septic systems.
- Large capacity septic systems are those that serve more than 20 persons per day. The specific locations of these systems are not documented and it hasn't been determined if any of the residences, classes, or other facilities are actually better classified as large capacity septic systems.
- Septic Density is the density of private onsite septic systems and is typically based upon the 2000 Census data. That data didn't identify the Christian Children's Ranch as being an area of increased septic density based on the population contained in specific census blocks.

Area groundwater is generally found in a deep bedrock aquifer and flows south to north beneath the ranch as indicated on Figure 5. The most important potential contaminant sources within the Inventory Region are associated with the ranch itself, but didn't show up in any of the database searches. The significant potential contaminant sources identified for this PWS are septic systems and ranch-related agricultural activities. The septic systems are associated with the residences or ranch facilities that support the school. All of the buildings/facilities have to be serviced by septic systems that may or may not be considered large capacity septic systems. A large capacity septic system is one that services at least 20 persons per day. Large capacity septic systems can be major sources of contamination as they can act as underground

injection wells that allow water and water borne contaminants to recharge local groundwater.

The principal land covers in the Inventory Region are grassland, pasture, and evergreen forest. None of these land uses are considered to be potential contaminant sources for this PWS.

From the listing of potential contaminant sources, those considered significant are selected. This selection is based upon the volume of potential releases, the volume of hazardous materials typically handled, the potential of the released materials to impact groundwater, and the proximity of the sources to the PWS intake.

Inventory Update

To make this SWDAR a useful document in the years to come, the owners, manager, or the water system operator(s) for the Christian Children's Ranch public water supply should update the inventory for their records every year. Changes in land uses or the presence of new potential contaminant sources should be noted and additions made as needed. The complete inventory should be submitted to DEQ at least every 5 years to ensure that this report/plan stays current in the public record.

Inventory Limitations

The accuracy of the potential contaminant source inventory is limited in several respects. The inventory is based on data that is readily available through state documents, published maps and reports, GIS data, and discussions with people that are familiar with the area. Documentation may not be readily available on some potential sources. As a result, all potential contaminant sources may not have been identified or recognized as being significant potential contaminant sources. Little or no information is available concerning the facilities at the ranch; septic system status and location; or any agricultural activities at the ranch. The author of this SWDAR is depending on local knowledge of the PWS owner and/or operator for site-specific knowledge.

CHAPTER 4
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 Christian Children's Ranch PWS.

The goal of source water management is to protect the source water by 1) controlling activities in the Control Zone, and 2) ensuring that land use activities in the Inventory 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 PWS to reduce susceptibility are recommended. For wells that have an unconfined aquifer as the source water, the following table is used to determine the hazard rating of certain types of contaminants. For this SWDAR, the septic systems and agricultural activities in or around the ranch are considered point sources of potential contamination.

Table 6. Hazard, Determination of
For Unconfined Aquifers (for the Inventory Region as delineated in this report)

Potential Contaminant Sources	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
Point Sources of All Contaminants	Within 1-year TOT	1 to 3-years TOT	Over 3-years TOT
Septic Systems (density)	More than 300 per sq. mi.	50 – 300 per sq. mi.	Less than 50 per sq. mi.
Municipal Sanitary Sewer (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region
Cropped Agricultural Land (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region

Note: TOT describes the groundwater time-of-travel or the distance groundwater will travel in 1 or 3 years. For this report, the potential contaminant sources identified are both located within the 1-year groundwater TOT distance.

Hazard is rated by the proximity of a potential contaminant source to the well(s). Susceptibility is then 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 well (Table 7). Barriers are identified, and susceptibility ratings are assigned to each significant potential contaminant or contaminant source as seen in Table 8 below.

Table 7. Susceptibility, Determination of

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 the Christian Children's Ranch, the 2 significant potential contaminant sources are both assigned a high hazard. Barriers are in-place as described below.

Table 8. Susceptibility Assessment

Christian Children's Ranch PWS

Contaminant Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Septic Systems, servicing residences or other facilities	Nitrate and Pathogens	Leaks in septic tanks, leaks in sewer lines, system failure, infiltration of untreated effluent into groundwater	**High Hazard**	- Clay rich soils - Depth of static water level - Depth of well intake - These systems are lateral or downgradient from the well	**Moderate Susceptibility**	- As new systems are installed or repaired, consider construction of advanced treatment for sewage - maintain and monitor existing septic systems - Place educational posters/placards around shop sinks and drains to reduce chemical dumping
Operations that may occur around or within the farm buildings	SOCs, VOCs, Pathogens, and Nitrates	These are activities that can release chemicals, such as: mechanical work, storage & mixing of farm chemicals, stockpiling of manure, other activities that could concentrate or release these chemicals	**High Hazard**	- Clay rich soils - Depth of static water level - Depth of well intake - Active agricultural fields are mostly located lateral or downgradient from the well	**Moderate Susceptibility**	- Same as above. - Place educational posters/placards around shop sinks and drains to reduce chemical dumping - Remove any floor drains from shops - Promote chemical recycling programs - Store farm chemicals on concrete slabs with secondary containment - Eliminate rinsing of any chemical rigs or tanks anywhere near the well or the creek - manage the number of animals that graze in the field(s) upgradient from the well and reduce the amount of chemicals applied if hay is grown there

The results of the susceptibility assessment indicate that the septic systems associated with the facilities and the activities associated with agricultural production (that happen in and around the buildings)

represent the most significant potential threats to the source water for the Christian Children's Ranch PWS. There are multiple barriers in-place between these potential contaminant sources and the well resulting in the well having a moderated susceptibility to contamination from these sources. Both of the significant potential contaminant sources are easily managed to further reduce the potential that contaminants could reach the well and these are encouraged. These management suggestions, if implemented, would be considered further barriers to contaminant migration to the well.

CHAPTER 5
MONITORING WAIVERS

General Discussion of Waivers

This chapter addresses the Christian Children's Ranch PWS (MT0003720) that DEQ has classified as Non-Community Non-Transient public water supply. The authors' recommendation is based upon the determination of susceptibility as described in the last chapter.

Monitoring Waiver Requirements

The 1986 Amendments to the Safe Drinking Water Act require that community and non-community PWSs sample drinking water sources for the presence of volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). The US EPA has authorized states to issue monitoring waivers for the organic chemicals to systems that have completed an approved waiver application and review process. All PWSs in the State of Montana are eligible for consideration of monitoring waivers for several organic chemicals. The chemicals diquat, endothall, glyphosate, dioxins, ethylene dibromide (EDB), dibromochloropropane (DBCP), and polychlorinated biphenyls are currently excluded from monitoring requirements by statewide waivers.

Types of Waivers

Use Waivers

A Use Waiver can be allowed if through a vulnerability assessment, it is determined that specific organic chemicals were not used, manufactured, or stored in the area of a water source (or source area). If certain organic chemicals have been used, or if the use is unknown, the system would be determined to be vulnerable to organic chemical contamination and ineligible for a Use Waiver for those particular contaminants.

Susceptibility Waivers

If a Use Waiver is not granted, a system may still be eligible for a Susceptibility Waiver, if through a vulnerability assessment it is demonstrated that the water source would not be susceptible to contamination. Susceptibility is based on prior analytical or vulnerability assessment results, environmental persistence, and transport of the contaminants, natural protection of the source, wellhead protection program efforts, and the level of susceptibility indicators (such as nitrate and coliform bacteria). The vulnerability assessment of a surface water source must consider the watershed area above the source, or a minimum fixed radius of 1.5 miles upgradient of the surface water intake. PWSs developed in unconfined aquifers should use a minimum fixed radius of 1.0 miles as an area of investigation for the use of organic chemicals. Vulnerability assessment of spring water sources should use a minimum fixed radius of 1.0 mile as an area of investigation for the use of organic chemicals. Shallow groundwater sources under the direct influence of surface water (GWUDISW) should use the same area of investigation as surface water systems; that is, the watershed area above the source, or a minimum fixed radius of 1.5 miles upgradient of the point of diversion. The purpose of the vulnerability assessment procedures outlined in this section is to determine which of the organic chemical contaminants are in the area of investigation.

Given the wide range of landforms, land uses, and the diversity of groundwater and surface water sources across the state, additional information is often required during the review of a waiver application. Additional information may include well logs, pump test data, or water quality monitoring data from surrounding public water systems; delineation of zones of influence and contribution to a well; Time-of-Travel or attenuation studies; vulnerability mapping; and the use of computerized groundwater flow and transport models. DEQ's PWS Section and DEQ's Source Water Protection Program will conduct review of an organic chemical monitoring waiver application. Other state agencies may be asked for assistance.

Susceptibility Waiver for Unconfined Aquifers
Unconfined aquifers are the most common source of usable groundwater. Unconfined aquifers differ from confined aquifers in that the groundwater is not regionally overlain by relatively impervious geologic strata. As a result, the upper groundwater surface or water table in an unconfined aquifer is not under pressure that produces hydrostatic head common to confined aquifers.

Unconfined aquifers are often locally recharged from surface water or precipitation. In general, groundwater flow gradients in unconfined aquifers may reflect surface topography, and the residence time of water in the aquifer is typically comparatively shorter than for water in confined aquifers. Similar water chemistry may often exist between unconfined groundwater and area surface water, and physical parameters and dissolved constituents can be indicators of the hydraulic connection between groundwater and surface water. Consequently, unconfined aquifers can be susceptible to contamination by organic chemicals migrating from the ground surface or surface water to groundwater.

The objective of the Susceptibility Waiver application is to assess the potential of organic chemical migration from the surface to the unconfined aquifer. The general procedures make use of a combination of site-specific information pertaining to the location and construction of the source, monitoring history of the source, geologic characteristics of the vadose zones, and mobility and persistence characteristics of the organic chemicals. The zone of contribution of the unconfined groundwater source must be defined and plotted. Groundwater flow directions, gradients, and a 3-year time-of-travel should be described. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and nearby wells should also be provided.

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

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

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

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

The objective of the susceptibility waiver application is to assess the potential of organic chemical migration of contaminants into water that is used as a source. The general procedures make use of a combination of site-specific information pertaining to the location and construction of the water source development, monitoring history of the source, geologic/hydrologic characteristics of the source water, and chemical characteristics of the organic chemicals pertaining to their mobility and persistence in the environment. The area of contribution to the aquifer into which the PWS intake is installed must be defined and plotted. This should describe the subsurface stratigraphy, groundwater and aquifer characteristics, well construction, groundwater flow direction(s), and a listing (and a map) of other wells in the area that draw from the same formations. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well(s) should also be provided as part of the susceptibility waiver application.

Waiver Recommendation of this SWDAR

This recommendation is based on past monitoring results and the susceptibility assessment of the Christian Children's Ranch PWS as it is now configured, using 1 production well withdrawing groundwater from a deep bedrock aquifer under unconfined conditions. DEQ records suggest that the PWS currently has no waivers. Based on the monitoring history for the wells, the inferred geology of the area, the nature of the aquifer from which the well draws water, the results of the inventory, and the susceptibility assessment of this SWDAR, the Christian Children's Ranch PWS production well is probably eligible for waivers, to include those for VOCs (volatile organic chemicals), SOCs (synthetic organic chemicals), and some IOCs (inorganic chemicals). For monitoring waiver consideration, the Christian Children's Ranch PWS should submit a letter to the DEQ Public Water Supply Section requesting the specific monitoring waivers. If requested by DEQ, the PWS may also need to provide some additional information regarding chemical use in the area within or around the Inventory Region.

REFERENCES

Alden, W.C., **1953. Physiography and Glacial Geology of Western Montana and Adjacent Areas**; U.S. Geological Survey Professional Paper 231.

Alt, David, and Hyndman, Donald W., **1990**, **Roadside Geology of Montana**, Mountain Press Publishing Company, Flathead.

Alt, David, and Hyndman, Donald W., **1998, Northwest Exposures, A Geologic Story of the Northwest,** Mountain Press Publishing Company, Flathead.

Board of Water Well Contractors, **Administrative Rules of Montana**, 01/30/**2001**. **36.21.656-.660**

Boettcher, A.J., **1982. Ground-Water Resources in the Central Part of the Flathead Indian Reservation**, Northwestern Montana; Montana Bureau of Mines and Geology Memoir 48.

Fetter, C.W., **Applied Hydrogeology**, **1994**, 3rd Edition, Prentice Hall, Upper Saddle River, New Jersey.

Freeze, R. Allan and Cherry, John A., **1979. Groundwater,** Prentice-Hall, Inc.

Kendy, E., and R.E. Tresch, **1996**, **Geographic, Geologic, and Hydrologic Summaries of Intermontane Basins of the Northern Rocky Mountains**, Montana: U.S. Geological Survey Water Resources Investigations Report 96-4025, 233 p.

Heath, Ralph C., **1974. Ground-water Regions of the United States**, U.S. Geological Survey, Water Supply Paper 2242, Washington D.C., 78p.

Montana Bureau of Mines and Geology, **tabular well information, 2000**:
http://mbmgsun.mtech.edu/ & http://mbmggwic.mtech.edu/

Montana Bureau of Mines and Geology, May **2001**. Groundwater Assessment, Flathead Lake Area, Atlas 2, Part B, Maps 1-11, Open File Version on CD.

Montana Department of Environmental Quality, Permitting and Compliance Division: **1999 & 2002. Sanitary Survey,** for the Riverside Mobile Home Park PWS - PWS # MT0000108, and other correspondence.

Montana Department of Environmental Quality, Permitting & Compliance Division and the Drinking Water Assistance Program - Montana Water Center: **Ground Water Manual for Small Water Systems, January 1999**.

Montana Department of Environmental Quality, **Source Water Protection Program**, **1999**. Approved by EPA in November 1999, inclusive of **personal communications in 2003** with Joe Meek & others.

Montana State Library - Natural Resource Information Service, **2000. Graphical and tabular information**:
http://nris.state.mt.us/mapper/

Montana State Library - Natural Resources Information System (NRIS) **2000 map base of the USGS Topographical coverage** at 1:24,000 scale in MrSID format.

Raines, G.L. and B.R. Johnson, **1996**. **Digital Representation of the Montana State Geologic Map**: U.S. Geological Survey Open File Report 95-691, 19 p.

Slagle, S.E., **1988. Geohydrology of the Flathead Indian Reservation, Northwestern Montana**; U.S. Geological Survey Water Resources Investigations Report 88-4142.

U.S. Department of Commerce, **2003, Climatic Summary of the United States Supplement for 1914 Through 2002**, Montana: Washington. D.C. Department of Commerce, Weather Bureau, Climatology of the United States no. 86-20, p11 and 60. Specific data came from the website: wrcc@dri.edu

U. S. Environmental Protection Agency (US EPA), **1991**. **Manual of Small Public Water Supply Systems**, US EPA Office of Water (WH-550), EPA 570/9-91-003.

U.S. Geological Survey, **2000**. **National Landcover Dataset, Montana**. 30-meter electronic digital landcover / land use data set interpreted from satellite imagery.

GLOSSARY

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

Alkalinity. The capacity of water to neutralize acids.

Bgs. Below Ground Surface. This is the measure of a borehole or depth to features in the borehole or well (i.e., The static water level is 25 feet bgs.)

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.

CAFO. Confined animal feeding operation, which is typically registered by the State of Montana.

CECRA. This is the 1987 Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA) and provides Montana DEQ with similar authorities as provided under the federal Superfund Act (CERCLA). Montana CECRA sites are typically facilities that do not fall under the jurisdiction of the federal program.

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

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

Delineation. A process of mapping source water management areas.

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

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

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

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

IOCs. Inorganic Chemicals

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

Large Capacity Septic Systems. As defined by the US EPA Underground Injection Control (UIC) Program, these are septic systems that serve more than 20 persons per day for a period greater than 6 months of the year.

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

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

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

Pathogens. A bacterial organism or virus typically found in the intestinal tracts of mammals, capable of producing disease.

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

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

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

POTW. Publicly Owned Treated Wastewater facility, typically a municipal sewer treatment plant with a wastewater discharge.

SIC Code. The U.S. Standard Industrial Classification (SIC) Codes classify categories of businesses. SIC Codes cover the entire range of business categories that exist within the economy.

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

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

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

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

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

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

Transmissivity. The ability of an aquifer to transmit water.

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

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

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

Note: Definitions are taken from EPA's Glossary of Selected Terms and Abbreviations and other sources.

APPENDICES

Appendix A

PWS Database System Summary

PWS Database Water Quality History

Appendix B
Sanitary Surveys and Well Logs

Appendix C
Concurrence Letter