

Roberts – Carbon County Water/Sewer District

PWSID MT0000317

Report Date: February 12, 2005

Revised:

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Executive Summary

February 12, 2005

Introduction and Background

Roberts is located near Rock Creek, which is a tributary of the Clarks Fork of the Yellowstone River ([Figure 1](#) and [Figure 3A](#) and [Figure 3B](#)). Roberts is about 32 miles south of Laurel and about 15 miles north of Red Lodge. State Highway 12 / 212 passes directly through town. The rail line through Roberts was abandoned about fifteen years ago. The U.S. Census Bureau estimates the 2000 population of Carbon County at 9,552 people, and according to the most recent sanitary survey 300 reside in Roberts. Carbon County's population has increased about 18% since the 1990 census.

The Roberts public water supply is classified as a community system under the Federal Safe Drinking Water Act, because the system serves at least 25 year-round residents through at least 15 service connections. The PWS services about 300 residents with about 120 active service connections.

The public water supply is served by ground water from 2 wells. Four wells are listed for Roberts in the Montana Bureau of Mines and Geology (MBMG) well log database. The wells drilled in 1996 belong to the city and the other two wells listed belong to the city fire department. All of these wells are completed in sand and gravel deposits that are between 20 to 30 feet below the land surface. These sand and gravels are interpreted as part of an alluvial terrace deposit (Qat on the MBMG geologic map in [Figure 4A](#). Two of the wells are listed as being completed in 1996 and the other two are listed as completed in 1964 (Appendix A). The aquifer that all of these wells draw water from is interpreted to be a shallow unconfined aquifer and is considered to have high sensitivity to contamination.

Within the past five years, Roberts has two positive total coliform detection in June 27 and July 1 of 2002 (Appendix B). Follow-up samples tested negative. There have been not positive bacteria detections since 2002. No MCL exceedances were noted for any other constituents monitored over the past five years. The highest nitrate value recorded for water from the wells is 0.57 milligrams per liter (mg/l), and an average nitrate value for all of the wells is 0.12 mg/l, which is significantly below the MCL of 10 mg/l. Overall, the water quality for this system is very good.

Delineation of Source Water Protection Areas

The purpose of delineation is to map the source of drinking water for the public water supply and to define areas within which to prioritize source water protection efforts. Four source water protection areas are defined for Roberts ([Figure 3A](#) and [Figure 3B](#), [Figure 7](#), [Figure 8](#) and [Figure 9](#)). They are 1) a 100-foot control zone around each of the wells, 2) a single inventory region based on ground-water flow time-of-travel estimates, 3) a recharge region corresponding to the watershed that surrounds the public water supply, and 4) a surface water buffer region extending ½ mile down-stream from the wells and 10 miles upstream. The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's wells. The inventory and surface water buffer regions should be managed to prevent contaminants from reaching the wells before natural processes reduce their concentrations. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage.

Source water for the Roberts public water supply comes from unconsolidated sand and gravel beds within an alluvial terrace deposit ([Figure 4A](#) and [Figure 4B](#)). Aquifers within the terraces are interpreted to be generally unconfined. In general, recharge is considered to come from a combination of precipitation, snowmelt runoff, infiltration of flood irrigation water on near by fields, and leakage from streams and irrigation canals located on top of the terrace deposit. For the terrace aquifers, water loss from irrigation ditches and flood irrigated fields are important sources of recharge (Warren, 2000). Ground water flow direction is interpreted to be primarily from upland areas toward the river for both shallow alluvial and bedrock aquifers ([Figure 3A](#) and [Figure 3B](#)). Within the terraces and close to Rock Creek, the ground water flow direction is interpreted to be approximately parallel to the stream.

Inventory of Potential Contaminant Sources

The inventory of potential contaminant sources is used to assess the susceptibility of the Roberts public water supply to contamination and to identify priorities for source water protection planning. The inventory focuses on facilities that generate, use, store, transport, or dispose of potential contaminants and on land types where potential contaminants are present. Some potential contaminant sources are considered significant based upon 1) the volume of potential releases, 2) the volume of hazardous materials typically handled, 3) the potential of the released materials to impact nearby surface water or ground water, and 4) the proximity of the potential contaminant sources to the source of water used by the public water supply. Maps showing the inventory results are shown in [Figure 3A](#) and [Figure 3B](#), [Figure 6](#), [Figure 7](#), [Figure 8](#) and [Figure 9](#).

Susceptibility is the potential for a public water supply to draw in water contaminated by inventoried sources. Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of natural or man-made barriers that decrease the likelihood that contaminated water will flow to the public water supply wells (Tables 7 and 8). For wells tapping an unconfined aquifer hazard is based primarily on the type of potential contaminant source and on their location relative to the public water supply wells (Table 7). Table 9 lists all of the potential contaminant sources identified in this inventory and includes the hazard and final susceptibility ratings assigned to each potential contaminant source.

Roberts has multiple businesses that could be considered potential contaminant sources but most of them are small and do not handle commercial volumes of hazardous materials. In addition, the town is located in a down-gradient position from the public water supply wells. This means that ground water beneath the town is flowing away from the wells and not toward them. As a result, businesses in town are not considered to pose a threat to the public water supply.

Potential contaminant sources that could pose a threat to the public water supply include: the railroad corridor, State Highway 212/12, and agricultural lands.

The hazard associated with the railroad comes from accidents that could result in spills and releases that would infiltrate into the aquifer used by the town of Roberts. Rail cars can carry relatively large volumes of hazardous materials and the hazard rating is set at high. Susceptibility is set at high with one barrier recognized.

State Highway 212/12 passes through the inventory region up-gradient from the wells and in fairly close proximity to the wells ([Figure 3A](#) and [Figure 3B](#)). The highway is not a major truck route and truck traffic volume is not considered to be high. Susceptibility is set at moderate with multiple barriers recognized.

The concern with agricultural lands is over-application or misuse of fertilizers and/or pesticides that can result in those ag-chemicals infiltrating into ground water and running off in to surface water bodies that may have hydraulic connection with aquifers used for public water supply. The hazard associated with the ag-land is set at moderate and the susceptibility of the water supply to the ag-land is set to moderate to low with multiple barriers identified (Table 9).

Septic density around Roberts and the public water supply wells is low. There does not appear to be developed home lots with septic system close to the wells ([Figure 3A](#) and [Figure 3B](#)). Hazard and susceptibility are set at low.

Nationally, Class V Injection Wells or waste disposal wells historically have been used to dispose of a variety of wastes and are considered to represent a potential hazard to source water. Due to the fact that the town, where most Class V wells would be located, is down-gradient from the public water supply wells and there no shops or buildings close to the wells, hazard and susceptibility are set to low and very low, respectively.

All other potential contaminant sources identified are assigned a low to very low susceptibility rating. [Figure 3A](#) and [Figure 3B](#), [Figure 6](#), [Figure 7](#), [Figure 8](#) and [Figure 9](#) show the locations of potential contaminant sources in relation to the public water supply. All potential contaminant sources may not have been identified in this inventory. In some instances, inadequate location information in the available databases can result in some potential contaminant sources not being included in the inventory. Review of the inventory and this report by the local public water supply operator and the community can help address limitations of the inventory process.

Management Recommendations

It should be noted that even small releases of some chemicals in close proximity to a well, spring, infiltration gallery, or surface water intake can have significant negative impact on water quality, and is therefore a significant threat to a public water supply. Steps can be taken to reduce the likelihood of releases to the source water for the public water supply or in the vicinity of the sources. Some of these steps are listed in Table 9 and under the Management Recommendations section on page 23.

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INTRODUCTION

This Delineation and Assessment Report was prepared by Jim Stimson, a hydrogeologist with the Source Water Protection Program of the Montana Department of Environmental Quality (DEQ). Roberts Public Water Supply (PWS) is located in Carbon County, Montana, about 32 miles south of Laurel and about 15 miles north of Red Lodge, Montana ([Figure 1](#)). The DEQ PWS identification number, operator name, and operator phone number for the Roberts PWS appear on the title page of this report.

Purpose

This report is intended to meet the technical requirements for the completion of the source water delineation and assessment report for the Roberts PWS as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (P.L. 104-182). The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to the protection of public drinking water supplies from contamination. The primary purpose of this source water delineation and assessment report is to provide information to assist the Roberts PWS operator in the identification of potential contaminant sources near and upstream from the town's wells and to encourage the development of a source water protection plan to help protect the town's drinking water for the long term.

Delineation and assessment constitute major components of the Montana Source Water Protection Program. Delineation entails mapping the boundaries of source water protection areas, which encompass ground water and/or surface waters contributing to public water supply. Assessment involves identifying locations or regions within source water protection areas where contaminants may be generated, stored, transported, or disposed, and determining the relative susceptibility of drinking water to contamination from these sources.

Limitations

This report was prepared to assess threats to the Roberts PWS and is based on published data including the most recent sanitary survey, and information obtained from local residents familiar with the community. The terms "drinking water supply" and "drinking water source" refer specifically to the sources of Roberts public water supply, and not any other public or private water supply. Also, not all of the potential or existing sources of ground water or surface-water contamination in the area of Roberts are identified. Only potential sources of contamination in areas that contribute water to the identified drinking water sources are considered.

The term "contaminant" is used in this report to refer to constituents for which maximum concentration levels (MCLs) have been specified under the national primary drinking water standards, and to certain carcinogenic or toxic constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1 BACKGROUND

The Community

Roberts is located near Rock Creek, which is a tributary of the Clarks Fork of the Yellowstone River (Figure 1, Figure 3A and Figure 3B). Roberts is about 32 miles south of Laurel. State Highway 12 / 212 passes directly through town and an active line of the Northern Pacific/Burlington Northern Railroad is adjacent the highway. The U.S. Census Bureau estimates the 2000 population of Carbon County at 9,552 people, and according to the most recent sanitary survey 300 reside in Roberts. Carbon County’s population has increased about 18% since the 1990 census.

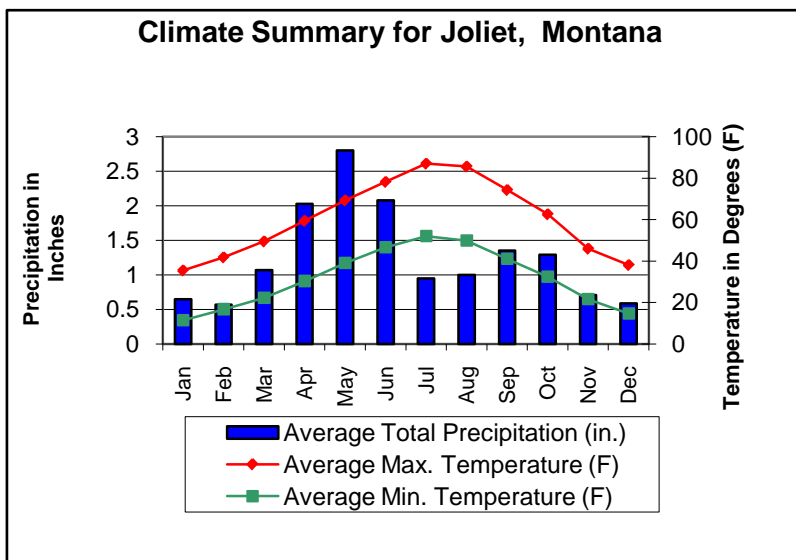
Within the town limits, residents obtain their drinking water from the municipal public water supply. Residents in town utilize on-site septic systems for waste disposal. There are no other public water supplies located in Roberts.

Table 1. Public Water Supplies in the area. Not Used In This Report

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Climate

Figure 2. Average Temperatures and Precipitation



Climate data for Joliet is used to summarized general climate characteristics in Roberts and is presented in Figure 2. The average daily high and low temperatures at Joliet are 87 °F and 52.1°F in July, and 35.5 °F and 11.5 °F in January (Figure 2). Based on Western Regional Climatic Center data for the period of record, annual precipitation averages 15.9 inches. Monthly average precipitation ranges from 0.65 inches in December to 2.8 inches in May. Summer thunderstorms and winter snows provide a majority of the precipitation in the area. The annual mean snowfall in Joliet is 1 inches. A summary of the available climatic data for the Joliet area is presented in Table 2 below.

Table 2. Climate Summary.

JOLIET, MONTANA (244506)													
Period of Record Monthly Climate Summary													
Period of Record : 9/ 2/1951 to 9/30/2004													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	35.5	41.8	49.5	59.4	69.3	78.2	87	85.6	74.3	62.6	46	38.1	60.6
Average Min. Temperature (F)	11.5	16.8	22.3	30.4	39.1	46.7	52.1	50	41.1	32.5	21.7	14.7	31.6
Average Total Precipitation (in.)	0.65	0.57	1.07	2.03	2.8	2.08	0.95	1	1.35	1.29	0.71	0.59	15.09
Average Total SnowFall (in.)	9.8	7.1	9.6	6.6	0.7	0	0	0	0.7	3.2	7.2	9.5	54.4
Average Snow Depth (in.)	3	2	1	0	0	0	0	0	0	0	1	2	1

Western Regional Climate Center, wrcc@dri.edu

Geographic Setting

Roberts is located in the Glaciated Rocky Mountain Region of the United States (Heath, 1984). The town is located on the northwestern edge of Rock Creek ([Figure 1](#)) and is about 32 miles south of Laurel. The Beartooth Mountain Front at Red Lodge is about 15 miles to the southwest of town. The Rock Creek Valley is about 1 to 1 ½ miles wide near Roberts. Topographic relief in the area is moderate with nearby up-land areas rising about 200 to 300 feet above the valley. Many of the creeks and tributaries in the area have moderately incised channels. There are prominent alluvial terraces that flank both sides of Rock Creek that extend essentially from the Beartooth Mountain Front and to several miles beyond the Roberts area ([Figure 1](#), [Figure 3A](#) and [Figure 3B](#), [Figure 4A](#) and [Figure 4B](#)).

Geology

This section provides an overview of the geology and hydrology of the vicinity of Roberts and Joliet, Montana. The geologic quadrangle maps used to describe the general geology in the area include Lopez, 2000, Geologic Map of the Bridger Quadrangle, Montana Bureau of Mines and Geology Geologic Map Series Number 58 and Lopez, D.A., 2001, Preliminary geologic map of the Red Lodge 30' x 60' Quadrangle, south-central Montana, Montana Bureau of Mines and Geology Open File Report 423. The geology of the area can be used to determine the locations, boundaries, and hydraulic properties of local aquifers. An understanding of hydrogeologic conditions also provides an explanation for the sensitivity of local aquifers to potential contamination sources.

Unconsolidated alluvium is present in the Rock Creek Valley and in the local tributary valleys ([Figure 4A](#)). The alluvium consists of lenses and beds of unconsolidated gravel, sand, silt, and clay. Alluvial deposits are thicker within the larger stream valleys. The alluvium yields economic quantities of water to wells and in represents an important shallow source of ground water from an unconfined aquifer.

Alluvial terrace deposits are also present at some locations within the larger stream valleys. Three terraces are mapped near Roberts and extend south to Red Lodge and the Beartooth Mountain Front

([Figure 4A](#)). Terraces in the area are known as the Red Lodge Bench or West Bench which is located just northwest of Rock Creek, and the East Bench located east of the creek. The terrace deposits represent older alluvium that was deposited by the ancestral streams over the last 10,000 years or so. Some of the terraces are between tens and hundreds of feet above the modern streams and are considered to be Quaternary age, ranging from Pleistocene to Recent. These terrace deposits consist of gravel, sand, silt, and clay. In some parts of Montana, the terrace deposits can be mapped as three or four distinct geologic deposits distinguished by their elevations above the present-day river flood plains. In some areas, the gravel deposits within the terraces provide ground water to wells where there is a source of recharge from tributary streams, irrigation canals, and flood irrigation. Studies in the Red Lodge area documented the importance of leakage from irrigation canals and infiltration from irrigated fields providing recharge to aquifers within the terrace deposits (Warren, 2000). The Finn Ditch, Dry Creek, and numerous irrigated fields south west of Roberts are very likely important sources of recharge for the aquifer tapped by the Robert public water supply wells.

Alluvial fan deposits are absent in the Roberts area and to the south toward Red Lodge. Near Joliet, an alluvial fan deposits of unconsolidated gravel, sand, silt and clay is present at the valley margin north of Rock Creek and rests on top of the alluvial terrace and the Creek's alluvium. The fan deposits gradually "join" the alluvium in up-stream areas ([Figure 4A](#)). The fans can in some places act as confining layers above the alluvial gravel deposits that supply water to wells.

The Tertiary age Fort Union Formation dominates the landscape near Roberts. This formation is made up of four members, three of which are exposed at the land surface in the Roberts area. They include the Tongue River Member, Lebo Shale, and the Tulluck Member. Overall, the Fort Union Formation consists of interbedded sandstone and shale with some coal beds present in the Tongue River Member. The Upper Cretaceous age Lance Formation is also exposed at the land surface southeast of Roberts and consists of interbedded sandstone and shale.

From a water availability standpoint, aquifers within the modern alluvium are often the most reliable and consistent source of ground water and they are tapped for public and private water supply by numerous shallow wells. Terrace deposits can also be important aquifers in parts of the valley where there are sources of recharge like flood irrigation and leakage from streams and canals. The two wells serving the Roberts public water supply tap a sand and gravel aquifer within a prominent alluvial terrace just west of Rock Creek ([Figure 4A](#)). Deeper wells are completed in the older bedrock formation in some areas around the Roberts and Joliet area. They target sandstone beds within the bedrock formations. While the older bedrock formations can be sources of ground water, they usually yield smaller volumes of water to wells than the younger alluvial deposits. [Figure 4B](#) represents a conceptual ground-water model for the Roberts area and shows the general relationships between the younger alluvial deposits and the older bedrock formations. The figure is not drawn to scale and only represents an illustration of the conceptual model for the occurrence of ground water in the vicinity. .

The Public Water Supply

The Roberts public water supply is classified as a community system under the Federal Safe Drinking Water Act, because the system serves at least 25 year-round residents through at least 15 service connections. The PWS services about 300 residents with about 120 active service connections.

The public water supply is served by ground water from 2 wells. Four wells are listed for Roberts in the Montana Bureau of Mines and Geology (MBMG) database and it is unclear which of these wells are currently active and serving the town of Roberts. Driller’s logs for each of the four wells are included in Appendix A. All of these wells are completed in sand and gravel deposits that are between 20 to 30 feet below the land surface. These sand and gravels are interpreted as belonging to terrace deposit 1 (Qat) on the MBMG geologic map in [Figure 4A](#). Two of the wells are listed as being completed in 1996 and the other two are listed as completed in 1964 (Appendix A). The aquifer within the terrace deposit is interpreted to be a shallow unconfined aquifer and is considered to have high sensitivity to contamination, in accordance with Montana Source Water Protection Program criteria (1999), also see Table 3 below.

Table 3. Source water sensitivity criteria (DEQ, 1999).

The water from the active wells is treated with chlorine. Water from the wells is pumped to a 100,000-gallon clear well that also provides contact time for the chlorine.

Public water systems must conduct routine monitoring for contaminants in accordance with Federal Safe Drinking Water Act requirements. A community public water supply, like Roberts, must sample in accordance with schedules specified in the Administrative Rules of Montana (ARM). Monitoring includes coliform bacteria, lead, copper, nitrate, nitrite, volatile organic chemicals (including hydrocarbons and chlorinated solvents), inorganic chemicals (including metals), synthetic organic chemicals (including pesticides), and radiological contaminants. Transient, non-community PWSs are required to conduct routine monitoring only for pathogens (including coliform bacteria), nitrate, and nitrite. All contaminant concentrations detected in required samples must comply with numeric maximum contaminant levels (MCLs) specified in the Federal Safe Drinking Water Act.

Source Water Sensitivity
High Source Water Sensitivity Surface water and GWUDISW Unconsolidated Alluvium (unconfined) Fluvial-Glacial Gravel Terrace and Pediment Gravel Shallow Fractured or Carbonate Bedrock
Moderate Source Water Sensitivity Semi-consolidated Valley Fill sediments Unconsolidated Alluvium (semi-confined)
Low Source Water Sensitivity Consolidated Sandstone Bedrock Deep Fractured or Carbonate Bedrock Semi-consolidated Valley Fill Sediments (confined)

Roberts PWS Water Quality

Within the past five years, Roberts has two positive total coliform detection in June 27 and July 1 of 2002 (Appendix B). Follow-up samples tested negative indicating the water was not contaminated by bacteria. No MCL exceedances were noted for any other constituents monitored over the past five years, this includes nitrate. The highest nitrate value recorded for water from the wells is 0.57 milligrams per liter (mg/l), and an average nitrate value for all of the wells is 0.12 mg/l, which is significantly below the MCL of 10 mg/l. Overall, the water quality for this system is very good.

CHAPTER 2 DELINEATION

The source water protection areas for the Roberts public water system are delineated in this chapter. The purpose of delineation is to map the source of drinking water for the public water supply and to define areas within which to prioritize source water protection efforts. Normally for a public water supply using ground water there are three source water protection regions delineated for each well. They include: 1) a 100-foot control zone, 2) a 3-year Time-Of-Travel (TOT) inventory region, or an inventory region based on hydrogeologic mapping, and 3) a recharge region corresponding to the watershed that surrounds the public water supply. For ground water sources that are located close to streams, a surface water buffer region is also routinely delineated.

For Roberts, the four source water protection regions mentioned above are delineated for each of the public water supply wells ([Figure 1](#), [Figure 3A](#) and [Figure 3B](#), [Figure 7](#), and [Figure 8](#)). A shared or common inventory region is delineated to include both of the town's active wells and is based on general hydrogeologic mapping and estimates of 3-Year Time-Of-Travel. A surface water buffer region is delineated and extends ½ mile down stream from the general location of the wells and 10 miles upstream. This surface water buffer region extends ½ mile from each bank of Rock Creek and extends up some major tributaries. The recharge region corresponds to the watershed surrounding the Rock Creek Valley.

The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's wells or the immediate surrounding areas. The inventory and surface water buffer regions should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage.

General Hydrogeologic Setting

Ground water within the Rock Creek Valley can be found in several distinct aquifers or hydrologic units (groups of aquifers). Some of the wells near Roberts are completed in the alluvial sand and gravel deposits adjacent Rock Creek. This aquifer is relatively shallow and it is interpreted to be unconfined. There are some areas where the alluvial aquifer can be locally confined by clay or silty clay beds related to over-bank flow deposits (flood events) or by alluvial fan deposits. However for the most part, the shallow alluvial aquifer within the Rock Creek Valley is unconfined and has a high sensitivity to potential contaminant sources.

Regionally within the Yellowstone River Valley and some of its tributaries like the southern Rock Creek Valley, there are up to five distinct alluvial terraces with varying thicknesses of unconsolidated gravel and sand. Three terraces are mapped in the Roberts area. Some of the terraces are more extensive than others and can be distinguished from each other by their elevation above the modern stream's flood plain. Some of the gravel deposits within the terraces function as aquifers where they receive recharge from irrigation canals, streams, and irrigated fields (Warren, 2000). Aquifers within the terraces can yield substantial volumes of water if reliable sources of recharge are present. However, the terraces are often eroded by streams (dissected) and this can lead to natural dewatering of the gravel and sand deposits. The terraces are not reliable sources of ground water where recharge is inconsistent or absent, or where they are

substantially dissected by erosion. A good number of wells in the area are located on the terrace. Aquifers within the terrace deposits are generally shallow and unconfined and they are also considered to have a high sensitivity to potential contaminant sources.

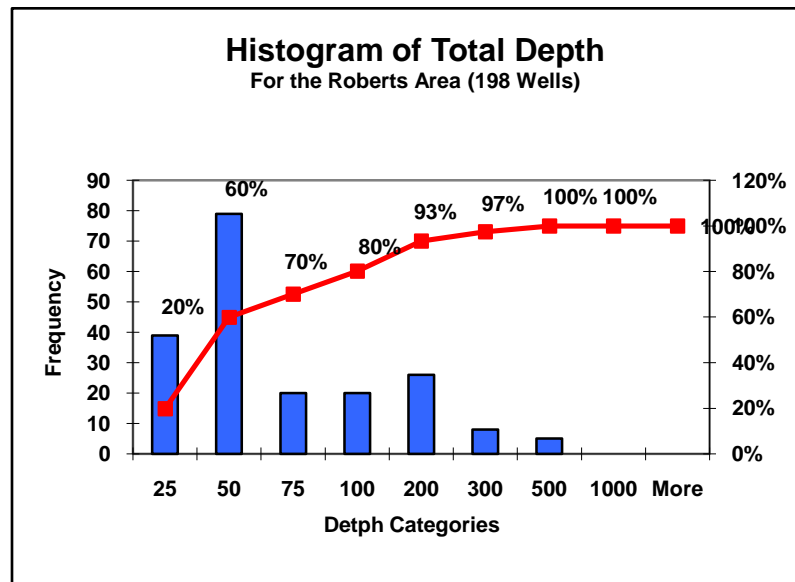
As mentioned previously, ground water is encountered within older bedrock formations. Most of the formations exposed in the Roberts area are Tertiary and Upper Cretaceous in age. They are covered in some places by the modern alluvium, the alluvial terrace, and alluvial fans (Figure 4A). The Fort Union Lance formations outcrop around the vicinity of Roberts.

Local Hydrogeologic Setting

Roberts' public water supply wells are located about ¾ of mile from town on a youngest terrace gravel deposit (Qat). Logs for wells belonging to Roberts are included in Appendix A and indicate the wells range from 31 to 37 feet deep. The upper 30 feet or so of the terrace consists of varying amounts of sand and gravel. Static water level for these wells is between 4 and 9 feet below the land surface. Pumping water level is shown as 13 and 15 feet below land surface for two of the wells. The wells yield between 40 and 70 gallons per minute (gpm).

Figure 5. Well Depth Histogram For Wells In The Area.

Information for wells in the vicinity of Roberts was retrieved from the Montana Ground Water Information Center (GWIC) September 9, 2004. Figure 5 shows a frequency distribution of total depth of these wells. Figure 5 indicates that about 60 percent of the wells in the area are relatively shallow and are less than or equal to 50 ft. Eighty percent are less than 100 feet deep. The average depth for all of the wells in the recharge region is 73 feet below land surface (ft. bls) and the maximum depth is 400 ft. bls. Average static water level for these wells is 16 ft. bls and the maximum is 120 feet. Pumping water level average is 31 ft. bls and average yield for wells in this area is 20 gallons per minute (gpm) with a maximum yield listed at 295 gpm.



Conceptual Model and Assumptions

Source water for the Roberts public water supply comes from unconsolidated sand and gravel beds within an alluvial terrace deposit (Figure 4A and Figure 4B). Aquifers within the terraces are interpreted to be generally unconfined. In general, recharge is considered to come from a combination of precipitation, snowmelt runoff, irrigation return flows, and leakage from streams and irrigation canals. For the terrace aquifers, water loss from irrigation ditches and flood irrigated fields are important sources of recharge (Warren, 2000).

Ground water flow direction is interpreted to be primarily from upland areas toward the river for both shallow alluvial and bedrock aquifers (Figure 3A and Figure 3B). Within the terraces and close to Rock Creek, the ground water flow direction is interpreted to be approximately parallel to the stream.

Summary of Well Information

Table 4. Information from drillers logs.

Well Name: MBMG # DNRC WR#	206322	206323	102937	102938
Location	05S 21E 31 DD	05S 21E 31 DC	05S 21E 31 AD	05S 21E 31 AD
Date Completed	4/29/1996	4/27/1996	1/1/1964	1/1/1964
Depth (ft bgs*)	31	35	36	37
Screened Interval (ft**)	25 - 30	28 - 35	23 - 33	22 - 32
SWL Depth (ft bgs*)	9	9	4	4
PWL Depth (ft bgs*)	-	-	15	13
Drawdown (ft**)	-	-	9	9
Test Pumping Rate (gpm***)	40	50	70	70
Specific Capacity (gpm/ft****)	-	-	7.78	7.78

*ft bgs = feet below ground surface, **ft = feet, ***gpm = gallons per minute, ****gpm/ft = gallons per minute per foot of drawdown.

Delineation Results

Control Zones

The control zone for each well consists of a 100 foot fixed radius circle, in accordance with the criteria specified in the Source Water Protection Program Document (1999). All potential sources of contamination are inventoried within the control zones. The general location of the control zones are shown in [Figure 3A](#) and [Figure 3B](#) but detailed maps of the control zones are not shown.

Inventory Region

A single inventory region is delineated for the wells based on hydrogeologic mapping and 3-Year Time-Of-Travel distance estimates. All potential sources of contamination are inventoried within the inventory region.

Surface Water Buffer Region

Due to the fact that water within irrigation canals and applied to fields southwest of Roberts represent an important source of recharge to the aquifer tapped by the public water supply wells, a surface water buffer is delineated primarily on Dry Creek and the Finn Ditch but also includes other canals and tributaries located on the West Bench ([Figure 7](#)). The surface water buffer region extends ½ mile down stream from the general location of the wells and 10 miles upstream ([Figure 7](#)). The buffer region is ½ mile from each bank of each creek ([Figure 7](#) and [Figure 8](#)). Sources of pathogens and nitrate are inventoried within this region.

Recharge Region

The Watershed Region for the Roberts wells encompasses the land area surrounding the river valley that includes the Fifth Code Hydrologic Unit: 10070006150 (Figure 8 and Figure 9). The watershed has an area of about 370 square miles. General land uses and large potential contaminant sources are inventoried in this region.

Table 5 - Input parameters and calculated times-of-travel

Only three general studies on the ground-water resources in the area that included Roberts were available for this report. No site-specific ground water studies were available. Aquifer test data and other estimates of aquifer characteristics were used from studies conducted in the Red Lodge area for wells that were completed in the alluvial terraces and Rock Creek alluvium (Warren, 2000 and Uthman, 2002). The conceptual model presented in this report is a simplification of the real ground-water flow system near Roberts but is considered to be sufficiently accurate to assess the susceptibility of the Roberts public water supply to potential sources of contamination in the area.

Limiting Factors

Input Parameter	
Transmissivity	11,424 ft ² /day
Thickness	28 ft.
Hydraulic Conductivity	408 ft/day
Hydraulic Gradient	0.01
Flow Direction	Southwest to Northeast
Effective Porosity	25% (0.25)
Pumping Rate	30,000 cubic feet per day
1-Year TOT	9,685 ft.
3-Year TOT	28,775 ft.

CHAPTER 3 INVENTORY

An inventory of potential sources of contamination was conducted to assess the susceptibility of the Roberts public water supply to contamination, and to identify priorities for source water protection planning. Inventories were conducted within the control zone, and the inventory, surface water buffer, and recharge regions. The inventory focuses on facilities that generate, use, store, transport, or dispose of potential contaminants, and on land types on which potential contaminants are generated, used, stored, transported, or disposed. Additionally, the inventory identifies potential sources of all primary drinking water contaminants and Cryptosporidium. Only significant potential contaminant sources were selected for detailed inventory.

Inventory Method

Available 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.

Step 2: 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: A business phone directory was consulted to identify businesses that generate, use, or store chemicals in the inventory region. Equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers were targeted by Standard Industrial Codes.

Step 5: Major road and rail transportation routes were identified.

Step 6. 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:

- 1) Large quantity hazardous waste generators
- 2) Landfills
- 3) Hazardous waste contaminated sites
- 4) Underground storage tanks
- 5) Major roads or rail transportation routes
- 6) Cultivated cropland
- 7) Animal feeding operations
- 8) Wastewater lagoons or spray irrigation
- 9) Septic systems
- 10) Sewered residential areas
- 11) Storm sewer outflows
- 12) Floor drains, sumps, or dry wells
- 13) Abandoned or active mines

Inventory Results/Control Zones

The control zones for both of the wells appear to include a portion of State Highway 212/12, the railroad tracks, and undeveloped land ([Figure 3A](#) and [Figure 3B](#)). The hazard comes from accidents resulting in spills and releases that would occur near or up-gradient from the public water supply wells. The highway is not a major truck route and truck traffic volume is not considered to be high. The railroad is considered to pose a greater potential threat to the source water than the highway because rail cars can carry relatively large volumes of hazardous materials. Another potential threat to the public water supply wells in the control zone comes from weed control activities along both the highway and railroad. It would be advisable not to use pesticides or herbicides near the well locations. In general, land areas in and around the control zones for both wells appear to be undeveloped.

Inventory Results/Inventory Region

State Highway 212/12 passes through the inventory region up-gradient from the wells and in fairly close proximity to the wells ([Figure 3A](#) and [Figure 3B](#)). The Burlington Northern Santa Fe Railroad line is shown as an active line and passes through the inventory region. If accidents, leaks or spills occurred within the inventory region, the source water and the wells could be put at risk of contamination.

Dry Creek, the Finn Ditch, and several smaller irrigation canals are located on the West Bench and within the inventory region ([Figure 3A](#) and [Figure 3B](#)). Irrigation canals often lose water through their sides and base and provide recharge to aquifers. Studies in the Red Lodge area by the Montana Department of Natural Resources and Conservation (DNRC) have documented the importance of irrigation canals providing recharge to aquifers within the bench or terrace deposits (Kirk, 2000). If the canal water or irrigation water is of lower quality than the ground water, it can be considered a potential contamination source that could have a negative impact on the town's source water. The canals carry water diverted from the Rock Creek at several locations upstream from town. It is assumed that the water quality of canals is very similar to their source stream. In this case Rock Creek has relatively high quality water that would not pose a threat to the town's ground water source.

It is worth noting that the DNRC studies near Red Lodge were initiated in part to examine the potential impacts of land use changes on ground water availability. The concern is that irrigated agricultural land is being taken out of production and subdivided which could, at some time in the future, reduce the need for irrigation water and the need of some canals. Reducing irrigation and abandoning irrigation canals would reduce the volume of water recharging aquifers within the terrace gravel deposits and could negatively impact ground-water availability in the area (Warren, 2000). Reducing

the volume of recharge could also have a negative impact on ground-water quality. It is true that population growth and development pressure near Roberts is not as great as it is near Red Lodge, at least at the present time. However, future growth within the county will very likely involve developments on the West and East Benches. Subdividing ag-land and terminating some irrigation canals could conceivably become an issue for the Roberts public water supply some time in the future. It would be advisable for the communities and the county to include source water protection issues like this in county-level growth and management plans. The plans could include management options like maintaining flow in some irrigation ditches and canals to provide “artificial” recharge to aquifers that provide source water to public water supplies and private wells in the area. The Montana Source Water Protection Program will assist public water supplies upon request in developing a Source Water Protection Plan that can be incorporated into a larger growth management plan.

Agricultural land use accounts for about 66% of the land area within the inventory region. Much of this land is shown as hay and pasture land. Agricultural land is considered be a significant potential contaminant source. Over application of fertilizers and/or pesticides can result in those ag-chemicals infiltrating into ground water and running off in to surface water bodies that may have hydraulic connection with aquifers that supply water. The percentage of ag-land in the inventory region is just large enough to be assigned a high hazard rating in accordance with the Source Water Protection Program guidelines. Other land use / land cover types in the inventory region are grassland at 19%, forest at 12%, and urban at 3%. Grassland and forest are not considered to be a potential contaminant source. Septic density throughout the inventory region is low and septic systems and drainfields are not considered to pose a threat to the source water.

Other potential contaminant sources, including Class V injection wells, are located in the Robert are located down-gradient from the public water supply wells. This means that ground water beneath town is flowing away from the wells and not toward them. These potential contaminants sources do not pose a threat to the town’s source water.

From the above list of potential contaminant sources, some are considered significant based upon the following factors: the volume of potential releases, the volume of hazardous materials typically handled, the potential of the released materials to impact nearby surface water or groundwater, and the proximity of the sources to the PWS well and infiltration lines. Significant potential contaminant sources from the above section are summarized for each source of water in Table 6 below.

Table 6 - Significant potential contaminant sources identified.

Inventory Region for Well 1 and the Infiltration Lines			
Source	ID Number on Maps	Contaminant	Hazard
Railroad Corridor	Not Numbered	Variety of hazardous materials including VOCs and SOCs, others?	Spills and releases related to accidents
State Highway 12	Not Numbered on the map	Variety of hazardous materials including VOCs and SOCs, others?	Spills and releases related to accidents
Irrigation Canals	Not Numbered	Fertilizers, pesticides, pathogens, nitrate others?	Spills, leaks impacting groundwater and or reaching surface water
Cultivated Cropland (less than 20% in the inventory region)	Not Numbered	Fertilizers, pesticides, pathogens, nitrate	Spills, over application, surface runoff

Inventory Results/Surface Water Buffer Region

Site-specific studies would be needed to verify that canals and irrigated fields located on the West Bench are significant sources of recharge for the aquifer tapped by the two Robert wells. Nevertheless, based on the work near Red Lodge, it is reasonable to assume that the aquifer received recharge from these sources. For this reason, the surface water buffer region is delineated for the irrigation canals and not for Rock Creek that is interpreted as being located down-gradient from the wells. Potential sources of pathogens and nitrate are the focus of the inventory for this region. Land use represents 64% agricultural land, 28% grassland, and the remaining land use consisting of forest, urban areas, and small areas of open water and wetlands (Figure 7). Information available for this report does not indicate the presence of wastewater treatment discharge sites, confined animal feeding operations (CAFOs), or high septic density areas within the surface water buffer region. Potential contaminant sources in the Red Lodge area are located near the distal end of the surface water buffer regions and they are not located on the West Bench but within the Rock Creek valley. These potential sources of contamination are not considered to pose a threat to the Roberts public water supply.

Inventory Results/Recharge Region

The inventory within the recharge region also focuses on potential sources of nitrate and pathogen. It is assumed that distance from the public water supply wells and dilution will reduce the hazard posed by potential contaminant sources identified in the source water protection region.

Land cover in the recharge or watershed region is 54 percent grassland, 29 percent agricultural land and the remainder is made up of forest land (16%) (Figure 9). As stated previously, grasslands are not considered potential contaminant sources. Agricultural land is considered a potential contaminant sources due to the use of fertilizers, pesticides and herbicides. The concern here is the potential for mismanagement or over-application of fertilizers and/or pesticides on the agricultural lands that could result in SOCs entering the river up-stream from the public water supply wells. The percent of agricultural land represents a moderate hazard to the source water.

A number of oil and gas exploration wells and mine sites are located within the recharge region ([Figure 9](#)). Several oil and gas fields are located mainly south and east of Joliet and include the Belfry, Clarks Fork, and Elk Basin fields. Oil and gas fields and mine sites are located in the southern distal part of the recharge region and they are not considered to pose a threat to the source water.

[Figure 9](#) also shows several hazardous spill response sites in the recharge region. None of the sites involve nitrate or pathogen releases. One site is the Joliet Weed Control Shop. The other site is the Grizzly Peak Inc maintenance shop near Red Lodge. Both sites are not considered to pose a threat to source water.

Inventory Update

To make this SWDAR a useful document in the years to come, the owners, manager, or the certified water system operator(s) for the public water supply should update the inventory for their records 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 at least every 5 years to ensure that this report/plan stays current in the public record.

Inventory Limitations

The extent of the potential contaminant source inventory is limited in several respects. The inventory is based on data readily available through state documents, published reports, and other public sources. Documentation may not be readily available on some potential sources. As a result, all potential contaminant sources may not have been identified. In some instances, inadequate location information precluded the inclusion of potential sources in the inventory.

CHAPTER 4 SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources. Susceptibility is assessed in order to help prioritize management actions for each potential contaminant source.

The goal of source water management is to protect the source water by 1) controlling activities in the control zone, 2) managing significant potential contaminant sources in the inventory region, and 3) ensuring that land use activities in the recharge region pose minimal threats 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. The PWS operators, town, and county officials could pursue alternative management approaches to help reduce susceptibility that are listed in Table 9 and discussed briefly in Chapter 5.

Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to the PWS wells (Tables 7 and 8). For point sources, hazard is rated by the proximity of a potential contaminant source to the wells. A high hazard rating is assigned to point sources located in land areas where the Eagle Formation is exposed at the land surface and where the outcrop is buried beneath Rock Creek alluvium.

When time-of-travel calculations performed, high hazard is assigned to point sources within the 1-year time-of-travel distance to a well. A moderate hazard rating is assigned to point sources located between the 1-year time-of-travel distance and the 3-year time-of-travel distance to a well. A low hazard rating is assigned to point sources located farther than the 3-year time-of-travel distance to a well. Hazard ratings for nonpoint sources are assigned based on the following criteria in Table 7.

Table 7. Hazard of potential contaminant sources for the public water system wells.

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

Barriers to contamination can be anything that decreases the likelihood that contaminants will reach public water supply wells. Barriers can be engineered structures, management actions, or natural conditions. Examples of engineered barriers are spill catchment structures for industrial facilities and leak detection for underground storage tanks. Emergency planning and best management practices are considered management barriers. Thick clay-rich soils, a deep water table or a thick saturated zone above the well intake can be natural barriers. Table 8 shows how barriers are used to adjust the final

susceptibility ratings.

Table 8. Susceptibility of Source Water based on Hazard rating and the presence of Barriers

	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
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 ratings are presented individually for each significant potential contaminant source and each associated contaminant on the following page (Table 9).

Table 9. Susceptibility Assessment Significant Potential Contaminant Sources in the Inventory Region – Roberts Public Water Supply.

Inventory Region							
Source	ID Number on Maps	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendations
Railroad Corridor	Not Numbered	Variety of hazardous materials including VOCs and SOCs, others?	Spills and releases related to accidents	High	-Emergency response	High	- Maintain preparedness of local emergency personnel through active training, storm water diversion and other measures
State Highway 12 / 212	Not Numbered on the map	Variety of hazardous materials including VOCs and SOCs, others?	Spills and releases related to accidents	Moderate	-Low traffic volume -Emergency response	Low	- Maintain preparedness of local emergency personnel through active training, storm water diversion and other measures
Cultivated Cropland (<20% in the inventory region)	Not Numbered	Fertilizers, pesticides, pathogens, nitrate	Spills, over-application, surface runoff	Moderate	-None	Moderate to Low	-Support the agricultural community's educational efforts to distribute materials and resources to land owners on the proper application and storage of pesticide and fertilizers; implement agricultural BMPs
Individual Septic Systems	Not Numbered	Pathogens and nitrate,	Infiltration into shallow ground water	Low	-No septic systems close to the wells	Low	Support efforts to provide educational workshops to the general public by the city, county, or state promote safe handling and proper storage, transport, use, and disposal of hazardous materials. Scheduled days for the collection of hazardous wastes from the public.
Assorted businesses in town	Not Numbered	VOCs, SOCs, petroleum hydrocarbons, metals, pathogens, nitrate	Releases or spills, mishandling of chemicals, improper disposal of chemicals anywhere near the river	Low	-Roberts is located in a down-gradient location from the wells.	Very Low	Support efforts to provide educational workshops to the general public by the city, county, or state promote safe handling and proper storage, transport, use, and disposal of hazardous materials. Scheduled days for the collection of hazardous wastes from the public.

<p>Class V Injection Wells (existence and locations are not known) where storm and/or wastewater is concentrated and recharges groundwater.</p>	<p>Not Numbered</p>	<p>VOCs, SOCs, petroleum hydrocarbons, metals, pathogens, nitrate</p>	<p>Leaks, spills, improper handling and disposal/discharge of chemicals used by various businesses and are released to systems that allow infiltration of contaminants to the subsurface or to the storm water system</p>	<p>Low</p>	<p>-Roberts is located in a down-gradient location from the wells.</p>	<p>Very Low</p>	<p>Inventory; Provide educational information, materials and resources to business owners and the public on proper waste disposal and recycling</p>
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Management Recommendations

It should be noted that even small releases of some chemicals in close proximity to a well, spring, infiltration gallery, or surface water intake can have significant negative impact on water quality, and is therefore a significant threat to a public water supply. Steps can be taken to reduce the likelihood of releases to the source water for the PWS or in the vicinity of the water sources (wells, springs, etc.). Some of these steps (considered management recommendations) are listed below. Some management recommendations are also included in the susceptibility table (Table 9). If these, and other, management actions are implemented; they may be considered additional barriers that will reduce the susceptibility of the public water supply wells to specific sources of contamination.

Specific management recommendations for the Roberts Public Water Supply:

The public water supply serving Roberts has a high susceptibility to the railroad tracks that run the length of the inventory region and just west of the two wells ([Figure 3A](#) and [Figure 3B](#)). The public water supply is moderate to low susceptibility to agricultural land in the inventory region. Working with the agricultural community to increase awareness of the public water supply's location and encouraging the use of Best Management Practices (BMPs) for fertilizer, pesticide, and herbicide application would help lower the hazard posed by agricultural chemicals. Working with county and regional emergency response personnel to make sure they are aware of the public water supply's location in relation to the railroad tracks will also help shorten response time and could lessen the hazard posed by the railroad. Documentation that Roberts and/or Carbon County has an emergency response plan to address accidents and spills occurring close to town and the public water supply wells could be used as a barrier to lower the susceptibility rating in this report.

Other general management recommendations fall into the following categories:

- Agricultural best management practices
- Education
- Emergency Response Planning

Agricultural and silvicultural best management practices (BMPs) – BMPs that address application and mixing of fertilizer and pesticides are a viable alternative to prohibition of their use. BMPs may also be utilized to minimize surface runoff and soil erosion on cultivated fields. Erosion control, selective logging, and other silvicultural practices (essentially BMPs) should be considered on a county-wide basis. BMPs are generally voluntary but their implementation can be encouraged through education and technical assistance. County planning can help promote the implementation of BMP on lands that are outside the town limits but indirectly affect the city PWS.

Education - Educational workshops provided to the general public by the county or state promote safe handling and proper storage, transport, use, and disposal of hazardous materials. Ongoing training provided to designated emergency personnel will promote the efficiency and effectiveness of emergency responses to hazardous material spills. Likewise, educational workshops provided to rural homeowners will promote the proper maintenance and replacement of residential septic systems. The EPA and the State of Montana can provide educational materials on these topics.

Emergency Response Plan – Several counties have compiled Emergency Response Plans that were then adopted by the local communities. The usefulness and effectiveness of a response plan are maximized if it contains a clear listing of all emergency contacts, emergency numbers, and resources available within the

county to respond to an emergency situation, such as a hazardous material spill. Emergency plans are not difficult to develop or distribute, but have a significant benefit to the citizens and municipalities within the county.

CHAPTER 5 MONITORING WAIVERS

Waiver Recommendation

It does not appear that Roberts has any monitoring waivers. Based on the susceptibility assessment of the town's source water, the Source Water Protection Program would not recommend waivers. The larger percentage of agricultural land in the inventory region and surface water buffer region indicates that agricultural chemicals (SOCs) are used on lands located up-gradient and up-stream from the water supply wells. From a source water protection standpoint, water quality monitoring will act as a first defense to detect problems with water quality in the area.

However, to be sure that eligibility for all available waivers is considered, the public water supply operators are encouraged to carefully review the following section on Monitoring Waiver Requirements. If after reviewing this section it is determined that additional waivers are feasible, the PWS should submit a letter with the proper documentation to DEQ requesting monitoring waivers. Table 9 in the Susceptibility Chapter can be used as a guide to request monitoring waivers.

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 excluded from monitoring requirements by statewide 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.

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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 supply source. Proximity or density of significant potential contaminant sources determines hazard.

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

Inventory Region. A source water management area that encompasses an area expected to contribute water to a public water supply 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 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.

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.

* Definitions taken from EPA's Glossary of Selected Terms and Abbreviations and other sources.

FIGURES

Figure1. General Location Map.

Figure 2. Climate Summary– Imbedded in text on page 4.

Figure 3A and Figure 3B. Inventory of Potential Contaminant Sources.

Figure 4A . General Geology Map.

Figure 4B General Geology Cross-section

Figure 5. Well Depth Histogram – Imbedded in text on page 9

Figure 6. Inventory Region Map with Landcover / Landuse.

Figure 7: Surface Water Buffer Region with Landcover / Landuse

Figure 8: Recharge Region with Landcover / Landuse

Figure 9: Recharge Region Inventory Map

APPENDICES

APPENDIX A – Well Logs for the Town of Roberts

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
TOWN OF ROBERTS

Plot this site on a topographic map

Location Information

GWIC Id: 206322
Location (TRS): 05S 21E 31 DD
County (MT): CARBON
DNRC Water Right:
PWS Id:
Block: 1
Lot:
Addition:

Source of Data: LOG
Latitude (dd): 45.3519
Longitude (dd): -109.1735
Geomethod: TRS-TWN
Datum: NAD27
Altitude (feet):
Certificate of Survey: 1076
Type of Site: WELL

Well Construction and Performance Data

Total Depth (ft): 31.00
Static Water Level (ft): 9.00
Pumping Water Level (ft):
Yield (gpm): 40.00
Test Type: AIR
Test Duration: 24.00
Drill Stem Setting (ft): 30.00
Recovery Water Level (ft): 9.00
Recovery Time (hrs): 0.17

How Drilled: ROTARY
Driller's Name: DEBUFF
Driller License: WWC581
Completion Date (m/d/y): 4/29/1996
Special Conditions:
Is Well Flowing?:
Shut-In Pressure:
Geology/Aquifer: Not Reported
Well/Water Use: DOMESTIC
PUBLIC WATER SUPPLY
TEST WELL

Well Notes:

Hole Diameter Information

From	To	Diameter
0.0	25.0	9.0
25.0	31.0	6.0

Annular Seal Information

From	To	Description
0.0	25.0	BENTONTIE

Lithology Information

From	To	Description
0.0	4.0	TOP SOIL
4.0	30.0	COARSE GRAVEL BOULDERS AND SAND
30.0	31.0	BROWN CLAY

Casing Information¹

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-2.0	31.0	6.0	0.280		WELDED	STEEL

Completion Information¹

From	To	Dia	# of Openings	Size of Openings	Description
25.0	30.0	6.0		.020	STAINLESS STEEL

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
TOWN OF ROBERTS

Plot this site on a topographic map

Location Information

GWIC Id: 206323
Location (TRS): 05S 21E 31 DC
County (MT): CARBON
DNRC Water Right:
PWS Id:
Block: 1
Lot:
Addition:

Source of Data: LOG
Latitude (dd): 45.3519
Longitude (dd): -109.1790
Geomethod: TRS-TWN
Datum: NAD27
Altitude (feet):
Certificate of Survey: 1076
Type of Site: WELL

Well Construction and Performance Data

Total Depth (ft): 35.00
Static Water Level (ft): 9.00
Pumping Water Level (ft):
Yield (gpm): 50.00
Test Type: AIR
Test Duration: 24.00
Drill Stem Setting (ft): 30.00
Recovery Water Level (ft): 9.00
Recovery Time (hrs): 0.08

How Drilled: ROTARY
Driller's Name: DEBUFF
Driller License: WWC581
Completion Date (m/d/y): 4/27/1996
Special Conditions:
Is Well Flowing?:
Shut-In Pressure:
Geology/Aquifer: Not Reported
Well/Water Use: DOMESTIC
PUBLIC WATER SUPPLY
TEST WELL

Well Notes:

Hole Diameter Information

From	To	Diameter
0.0	25.0	9.0
25.0	37.0	6.0

Annular Seal Information

From	To	Description
0.0	0.0	BENTONITE

Lithology Information

From	To	Description
0.0	6.0	TOP SOIL
6.0	35.0	COARSE GRAVEL BOULDERS AND SAND
35.0	37.0	BROWN CLAY

Casing Information¹

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-2.0	28.0	6.0	0.280		WELDED	STEEL

Completion Information¹

From	To	Dia	# of Openings	Size of Openings	Description
28.0	35.0	6.0		.020	STAINLESS STEEL

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
TOWN OF ROBERTS

Plot this site on a topographic map

Location Information

GWIC Id: 102937
Location (TRS): 05S 21E 31 AD
County (MT): CARBON
DNRC Water Right:
PWS Id:
Block:
Lot:
Addition:

Source of Data: LOG
Latitude (dd): 45.3592
Longitude (dd): -109.1735
Geomethod: TRS-TWN
Datum: NAD27
Altitude (feet): 4590.00
Certificate of Survey:
Type of Site: WELL

Well Construction and Performance Data

Total Depth (ft): 36.00
Static Water Level (ft): 4.00
Pumping Water Level (ft): 15.00
Yield (gpm): 70.00
Test Type: BAILER
Test Duration: 1.00
Drill Stem Setting (ft):
Recovery Water Level (ft):
Recovery Time (hrs):
Well Notes:

How Drilled: SPUDDER
Driller's Name: WHAM
Driller License: WWC005
Completion Date (m/d/y): 1/1/1964
Special Conditions:
Is Well Flowing?:
Shut-In Pressure:
Geology/Aquifer: 110TRRC
Well/Water Use: PUBLIC WATER SUPPLY

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information¹

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
0.0	19.9	12.0				
19.9	35.9	8.0				28# STEEL

Annular Seal Information

No Seal Records currently in GWIC.

Completion Information¹

From	To	Dia	# of Openings	Size of Openings	Description
23.0	33.0	8.0			TORCH CUTS

Lithology Information

From	To	Description
0.0	10.0	BOULDERS
10.0	20.0	GRAVEL (WATER)
20.0	22.0	SAND & ROCK
22.0	31.0	GRAVEL & SAND (WATER)
31.0	34.0	YELLOW CLAY
34.0	36.0	BLUE

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
TOWN OF ROBERTS

Plot this site on a topographic map

Location Information

GWIC Id: 102938
Location (TRS): 05S 21E 31 AD
County (MT): CARBON
DNRC Water Right:
PWS Id:
Block:
Lot:
Addition:

Source of Data: LOG
Latitude (dd): 45.3592
Longitude (dd): -109.1735
Geomethod: TRS-TWN
Datum: NAD27
Altitude (feet): 4590.00
Certificate of Survey:
Type of Site: WELL

Well Construction and Performance Data

Total Depth (ft): 37.00
Static Water Level (ft): 4.00
Pumping Water Level (ft): 13.00
Yield (gpm): 70.00
Test Type: BAILER
Test Duration: 1.00
Drill Stem Setting (ft):
Recovery Water Level (ft):
Recovery Time (hrs):
Well Notes:

How Drilled: SPUDDER
Driller's Name: WHAM
Driller License: WWC005
Completion Date (m/d/y): 1/1/1964
Special Conditions:
Is Well Flowing?:
Shut-In Pressure:
Geology/Aquifer: 110TRRC
Well/Water Use: PUBLIC WATER SUPPLY

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information¹

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
0.0	19.9	12.0				
19.9	35.3	8.0				28 # STEEL

Annular Seal Information

No Seal Records currently in GWIC.

Completion Information¹

From	To	Dia	# of Openings	Size of Openings	Description
22.0	32.0	8.0			TORCH CUTS

Lithology Information

From	To	Description
0.0	10.0	BOULDERS
10.0	20.0	GRAVEL (WATER)
20.0	23.0	SAND & ROCK
23.0	31.0	GRAVEL (WATER)
31.0	34.0	YELLOW CLAY
34.0	37.0	BLUE SHALE

Ground-Water Information Center
Site Name: ROBERTS SCHOOL

Water Quality Report
Report Date: 2/3/2005
Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2004Q0071 / 196860	Sample Date: 8/14/2003 1:15:00 PM
Location (TRS): 05S 21E 32 BBAC	Agency/Sampler: MBMG / CAC
Latitude/Longitude: 45° 21' 46" N 109° 9' 54" W	Field Number: 196860
Datum: NAD83	Lab Date: 10/7/2003
Altitude: 4555.00	Lab/Analyst: MBMG / KTH
County/State: CARBON / MT	Sample Method/Handling: PUMPED / 4230
Site Type: WELL	Procedure Type: DISSOLVED
Geology: 112SNGR	Total Depth (ft): 40.000
USGS 7.5' Quad: ROBERTS	SWL-MP (ft): NR
PWS Id:	Depth Water Enters (ft): 22.000
Project: GWCP06	

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	34.700	1.732	Bicarbonate (HCO3)	191.500	3.139
Magnesium (Mg)	12.700	1.045	Carbonate (CO3)	0.000	0.000
Sodium (Na)	8.400	0.365	Chloride (Cl)	8.030	0.227
Potassium (K)	2.340	0.060	Sulfate (SO4)	7.460	0.155
Iron (Fe)	0.015	0.001	Nitrate (as N)	<0.5 P	0.000
Manganese (Mn)	0.070	0.003	Fluoride (F)	<0.05	0.000
Silica (SiO2)	16.200		Orthophosphate (OPO4)	<0.05	0.000
Total Cations		3.211	Total Anions		3.521

Trace Element Results (µg/L)

Aluminum (Al):	<30	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	<1	Cobalt (Co):	<2	Nickel (Ni):	2.310	Thallium (Tl):	<5
Barium (Ba):	101.000	Copper (Cu):	2.240	Silver (Ag):	<1	Uranium (U):	0.898
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	<1	Vanadium (V):	<5
Boron (B):	<30	Lithium (Li):	1.660	Strontium (Sr):	234.000	Zinc (Zn):	9.600
Bromide (Br):	<50					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	184.260	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	281.430	Hardness as CaCO3:	138.920	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	310.000	Field Alkalinity as CaCO3:	104.000	PCP (µg/L):	NR
Lab Conductivity (µmhos):	304.000	Akalinity as CaCO3:	157.060	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.000	Ryznar Stability Index:	8.347	Field Nitrate (mg/L):	NR
Lab pH:	7.180	Sodium Adsorption Ratio:	0.310	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	13.500	Langlier Saturation Index:	-0.584	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	NR	Field Redox (mV):	188.500

Notes

Sample Condition:
Field Remarks:
Lab Remarks:

Ground-Water Information Center
Site Name: BELL HUNTER

Water Quality Report
Report Date: 2/3/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2003Q0451 / 154728	Sample Date: 9/8/2002 6:40:00 PM
Location (TRS): 05S 21E 32 CDCD	Agency/Sampler: MBMG / CAC
Latitude/Longitude: 45° 20' 58" N 109° 9' 42" W	Field Number: 154728
Datum: NAD83	Lab Date: 12/23/2002
Altitude: 4710.00	Lab/Analyst: MBMG / KTH
County/State: CARBON / MT	Sample Method/Handling: PUMPED / 4230
Site Type: WELL	Procedure Type: DISSOLVED
Geology: 125FRUN	Total Depth (ft): 220.000
USGS 7.5' Quad: ROBERTS	SWL-MP (ft): 95.820
PWS Id:	Depth Water Enters (ft): 120.000
Project: GWCP06	

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	57.200	2.854	Bicarbonate (HCO3)	326.000	5.343
Magnesium (Mg)	19.400	1.596	Carbonate (CO3)	0.000	0.000
Sodium (Na)	31.000	1.349	Chloride (Cl)	0.500	0.014
Potassium (K)	1.940	0.050	Sulfate (SO4)	42.200	0.879
Iron (Fe)	0.008	0.000	Nitrate (as N)	<0.5 P	0.000
Manganese (Mn)	<0.001	0.000	Fluoride (F)	0.260	0.014
Silica (SiO2)	10.900		Orthophosphate (OPO4)	<0.05	0.000
Total Cations		5.863	Total Anions		6.250

Trace Element Results (µg/L)

Aluminum (Al):	<30	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<10	Chromium (Cr):	<10	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	<10	Cobalt (Co):	<2	Nickel (Ni):	<2	Thallium (Tl):	<20
Barium (Ba):	132.000	Copper (Cu):	40.700	Silver (Ag):	NR	Uranium (U):	NR
Beryllium (Be):	<2	Lead (Pb):	<10	Selenium (Se):	<15	Vanadium (V):	<10
Boron (B):	<30	Lithium (Li):	15.100	Strontium (Sr):	541.000	Zinc (Zn):	11.700
Bromide (Br):	<50					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	324.050	Field Hardness as CaCO3:		Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	489.460	Hardness as CaCO3:	222.680	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	524.000	Field Alkalinity as CaCO3:	258.000	PCP (µg/L):	NR
Lab Conductivity (µmhos):	566.000	Akalinity as CaCO3:	267.380	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.200	Ryznar Stability Index:	7.271	Field Nitrate (mg/L):	0.000
Lab pH:	7.360	Sodium Adsorption Ratio:	0.900	Field Dissolved O2 (mg/L):	
Water Temp (°C):	11.000	Langlier Saturation Index:	0.045	Field Chloride (mg/L):	
Air Temp (°C):	NR	Nitrite (mg/L as N):	NR	Field Redox (mV):	94.800

Notes

Sample Condition:
Field Remarks:
Lab Remarks:

APPENDIX B - DEQ PWS's Database Output

APPENDIX C – Sanitary Survey

APPENDIX D - Concurrence Letter & Other Correspondence