Oak Ridge Subdivision

PWSID MT0004250

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Revised:

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Executive Summary

August 23, 2005

Introduction and Background

Oak Ridge Subdivision is located west of Billings in the Yellowstone River Valley. The latest sanitary survey states that Oak Ridge is designed for 80 homes and its public water supply serves between 200 and 300 residents. Two water supply wells provide water to the subdivision and they are located near the intersection of Dovetail Lane and 48th Street West (Figure 1). Individual septic systems and drainfields are used for waste disposal on each lot. There are several other public water supplies near Oak Ridge including: Wells Garden Estates to the south and Aldinger Acres to the northwest (Figure 1).

Oak Ridge pubic 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 has 83 active service connections. The wells used by Oak Ridge are about 80 feet deep and completed in gravel deposits that are about 30 feet thick. The gravels are overlain by multiple layers that contain significant volumes of clay that help protect the aquifer from potential sources of contamination located at or near the land surface. The aquifer is interpreted to be semi-confined and to have a moderate sensitivity to potential sources of contamination (Table 3).

Within the past five years, Oak Ridge had one positive total coliform detection in May 2004. Follow-up samples tested negative indicating the water was not contaminated by bacteria. Water quality data for other constituents monitored over the past five years were not available at the time of writing this report, with the exception of nitrate. The highest nitrate value recorded for water from all of the wells is 1.39 milligrams per liter (mg/l), and an average nitrate value for the three reported samples is 1.07 mg/l, which is significantly below the MCL of 10 mg/l.

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. Three source water protection areas are defined for Oak Ridge (Figures 3A, Figure 3B, Figure 7, and Figure 8). They are 1) a 100-foot control zone around each of the wells, 2) a single inventory region, and 3) a recharge region corresponding to the watershed that surrounds the public water supply. The inventory region is used based on a Time-Of-Travel (TOT) calculation that estimates the distance ground water travels in a one- and three-year period. The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's wells. The inventory region 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.

Oak Ridge is located on an alluvial fan that sits on top of an alluvial terrace (Figure 4A). Driller’s logs for the Oak Ridge wells indicate that they are completed in gravel beds that are about 30 feet thick. The logs also indicate multiple layers above the gravel beds that have significant volumes of clay. The clay dominated beds help protect the gravel aquifer from potential contaminant sources. The aquifer is interpreted to be semi-confined with moderate source water sensitivity to contamination (DEQ, 2000). Ground-water flow is interpreted to be from the northwest to the southeast (Figure 4A). The gravel aquifer used by Oak Ridge receives recharge from precipitation and snowmelt, irrigation water applied to fields located generally northwest of the subdivision, water loss from stream and canals, and possibly from other aquifers within older bedrock.

Inventory of Potential Contaminant Sources

The inventory of potential contaminant sources is used to assess the susceptibility of the Oak Ridge 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 Figures 3A, Figure 3B, Figure 6, Figure 7 and Figure 8.

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). 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.

Agricultural land is the dominant land use within the inventory regions (Figure 6). 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.

Most of the area around Oak Ridge has a moderate septic density although there are several areas outside the inventory region east of the subdivision that have high septic density. The septic density is a general indicator of the number of septic systems and drainfields in operation in the area. Municipal sewer main lines are being extended into the west Billings area, and one of those lines run parallel to Grand Avenue. It is not know if the line is active at this time. Both septic systems and municipal sewer mains can be sources of nitrate and pathogen.

The Big Ditch is located up-gradient from the public water supply wells just inside the one-year Time-Of-Travel distance (Figures 3A, and Figure 3B). Irrigation canals often lose water through their sides and base and provide recharge to aquifers. If the canal water is of lower quality than the ground water, it can be a potential contamination source and have a negative impact on the source water. In this case the canal carries water diverted from the Yellowstone River. The Yellowstone has relatively high quality water that would not pose a threat to the ground water.

Grand Avenue and several smaller access roads are located between the one- and three-year Time-Of-Travel distances (Figures 3A,and Figure 3B). While the traffic load on Grand Avenue is substantial at times, it is not a major transportation route for large vehicles carrying hazardous material. The same is true of 48th Street. The potential hazard on the roads comes from accidents resulting in spills and releases in proximity to the public water supply wells.

There are about a dozen underground storage tank sites listed for the area around Oak Ridge (Figures 3A,and Figure 3B). Some of the sites had multiple tanks and several sites had leaks reported (Figures 3A, and Figure 3B). One former tank site is located just east of the subdivision and the wells. This site was owned by Hardt Bros. Partnership and had five (5) active tanks. All of the tanks were closed and removed from the ground between 1989 and 1993.

Other potential contaminant sources in the area may include Class V injection wells (floor drains, French drains, etc). These are drains that open to the shallow aquifer system and they not connected to a septic system or sewer service. The threat from Class V injection wells cannot be determined at this time because an accurate inventory of these wells has not been completed for Montana.

Figures 3A, Figure 3B, Figure 6, Figure 7, and Figure 8 show the locations of potential contaminant sources in relation to the public water supply. 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.

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 24.

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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). Oak Ridge Water Supply (PWS) is located in Yellowstone County, Montana, just west of the city of Billings (Figure 1). The DEQ PWS identification number, operator name, and operator phone number for the Oak Ridge 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 Oak Ridge 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 Oak Ridge 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 Oak Ridge PWS and is based on published data including the most recent sanitary survey (Carlson, 2005), 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 Oak Ridge 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 Oak Ridge 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

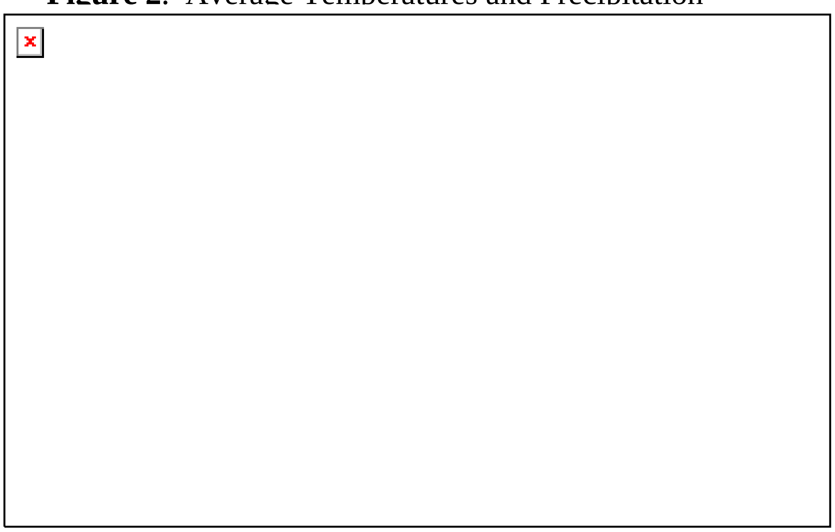
The Community

Oak Ridge Subdivision is located west of Billings in the Yellowstone River Valley. According to the sanitary survey the Oak Ridge is designed for 80 homes and its public water supply serves between 200 and 300 residents. The subdivision has two water supply wells located near the intersection of Dovetail Lane and 48th Street West (Figure 1). Individual septic systems and drainfields on each lot are used for waste disposal. City services are in the process of being extended into the area but it is not known if Oak Ridge will be connected to the city water and sewer service. There are several other subdivision public water supplies near Oak Ridge including: Wells Garden Estates to the south and Aldinger Acres to the northwest (Figure 1).

Table 1. Public Water Supplies in the area.

PWS ID	Name	Class	Source Water Type
MT0003552	Aldinger Acres Subdivision	Community	Groundwater
MT0003726	Hope Evangelical Church	Non-Community	Groundwater
MT0002927	Wells Garden Estates	Community	Groundwater
MT0004093	Blue Grass Water Users Association	Community	Groundwater
MT0003654	Cornerstone Community Church	Non-Community	Groundwater
MT0004250	OAK RIDGE ESTATES	Community	GW

Figure 2. Average Temperatures and Precipitation



Geographic Setting and Climate

The Yellowstone River Valley is located in southeastern Montana in the Yellowstone Plateau section of the Great Plains physiographic province. The climate in this area is considered semi-arid. Average daily maximum and minimum temperatures in the valley are 86.3° F and 13.9° F (Figure 2). Annual average precipitation is 14.41 inches with the wettest months typically in May and June (Western Regional Climate Center, Monthly Climate Summary 7/1/1948 to 03/31/2003).

Table 2. Climate Summary.

Western Regional Climate Center, wrcc@dri.edu

The Public Water Supply

Oak Ridge pubic 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 between 200 and 300 residents with about 83 active service connections.

Oak Ridge's public water supply is served by ground water from 2 wells that were drilled in 2000 according to the sanitary survey. The active wells are about 80 feet deep and completed in gravel deposits that are about 30 feet thick. The gravels are overlain by multiple layers that contain significant volumes of clay and help protect the aquifer from potential sources of contamination located at or near the land surface. The aquifer is interpreted to be semi-confined and to have a moderate sensitivity to potential sources of contamination (Table 3). Both wells terminate in shale bedrock.

Public water systems must conduct routine monitoring for contaminants in accordance with Federal Safe Drinking Water Act requirements. A community public water supply, like Oak Ridge, 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.

Table 3. Source water sensitivity criteria (DEQ,

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)

Oak Ridge PWS Water Quality

Within the past five years, Oak Ridge has one positive total coliform detection in May 2004. Follow-up samples tested negative indicating the water was not contaminated by bacteria. Water quality data for other constituents monitored over the past five years were not available at the time of writing this report, with the exception of nitrate. The highest nitrate value recorded for water from all of the wells is 1.39 milligrams per liter (mg/l), and an average nitrate value for the three reported samples is 1.07 mg/l, which is significantly below the MCL of 10 mg/l.

CHAPTER 2
DELINEATION

The source water protection areas for the Oak Ridge 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 Oak Ridge, the three source water protection regions mentioned above are delineated for each of the public water supply wells (Figure 1, Figures 3A, Figure 3B, Figure 7, and Figure 8). One-hundred foot control zones are delineated for each well. In addition, a shared inventory region is delineated and is based on a TOT calculation. The recharge region corresponds to a portion of the watershed surrounding the subdivision.

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 region 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

This section provides an overview of the geology and hydrology of the vicinity of Oak Ridge. 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, Geologic map of the Billings 30' x 60' quadrangle, Montana, Montana Bureau of Mines and Geology Geologic Map 59, scale 1:100,000. 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. Figure 4A shows the general geology of the area.

The Yellowstone River Valley lies between sandstone cliffs to the north and rolling hills underlain by a thick sequence of shale to the south. The cliffs are locally known as the “Rims” and they are composed of the Eagle Sandstone and the Telegraph Creek Formation. Both formations are Cretaceous in age. The formations dip gently to the north and they are not present in the Yellowstone River Valley. Within the valley, the Yellowstone River has cut down into a thick sequence of Cretaceous aged shale. The shale sequence is on the order of 2,000 feet thick and is widely exposed in the hills south of Billings (Lopez, 2000).

As the Yellowstone River cut down through the shale bedrock it formed five distinct alluvial terraces with varying thicknesses of sand and gravel on top of them. Some of the terraces are more extensive than others and several are important aquifers between Laurel and Billings (Olson and Reiten, 2002). The terraces are distinguished by their elevation above the modern Yellowstone River flood plain and, Olson and Reiten (2002), and Lopez (2001) describe them in detail. In several places in the valley, the terraces are overlain by alluvial fan deposits that are dominated by fine-grained clay sediments (Lopez, 2001).

Oak Ridge is located on an alluvial fan that is on top of a terrace (Figure 4A). Driller's logs for the Oak Ridge wells indicate that they are completed in gravel beds that are about 30 feet thick. The logs indicate that there are multiple layers above the gravel beds that have significant volumes of clay. The clay dominated beds help protect the gravel aquifer from potential contaminant sources located at or near the land surface. The aquifer is interpreted to be semi-confined with moderate source water sensitivity to contamination (DEQ, 2000). Ground-water flow is interpreted to be from the northwest to the southeast (Figure 4A). The gravel aquifer used by Oak Ridge receives recharge from precipitation and snowmelt, irrigation water applied to fields located generally northwest of the subdivision, water loss from stream and canals, and possibly from other aquifers within older bedrock.

Three bedrock formations are exposed at the land surface in the general vicinity of Oak Ridge (Figure 4A). They include the Niobrara Shale, Telegraph Creek Formation, and the Eagle Formation. These formations are not used to supply ground water in the west Billings area and will not be discussed further in this report.

Table 4: List of geologic or hydrogeologic research activities in the Yellowstone River Valley area.

Title of Project	Project Finished	Area Covered	Project Objectives
Phase 1: Assessment of Impacts of Non-point Source Pollution on Water Resources in the Middle Yellowstone Alluvial Valley.	Unpublished	Yellowstone River Valley	Impacts of non-point source pollution on water resources in the middle Yellowstone alluvial valley.
Geologic Map of the Billings Area, Yellowstone County, Montana. Geologic Map Series No.61-A	2002	Areas surrounding Billings Montana	Identify the geologic conditions surrounding Billings.
Geologic Map of the Billings 30' x 60' Quadrangle, Montana. Geologic Map Series No. 59.	2000	30' x 60' Quadrangle, of Billings Montana	Identify the different geologic conditions surrounding Billings.
Water Resources of the Yellowstone River Valley	1973	Billings to Park City Montana	Hydrologic Investigation of the Yellowstone River Valley
Hydrogeology of the West Billings Area, Montana Bureau of Mines & Geology Report of Investigation 10 Plate 1 of 2.	2002	Yellowstone River Valley	Yellowstone River Valley, South-Central Montana Changes in the shallow ground-water resources of West Billings, October 1998 to June 2001.
Characterization of Alluvial Aquifers in Treasure and Yellowstone Counties, Middle Yellowstone River Area, Montana Ground Water Assessment Atlas, Part B Map 3.	2003	Middle Yellowstone River area	Characterization of alluvial aquifers of the Yellowstone River Area

Conceptual Model and Assumptions

The Oak Ridge wells obtain water from a gravel deposit that is about 30 feet thick and is overlain by multiple clay beds. The aquifer is interpreted to be semi-confined. Recharge comes from a variety of sources located primarily northwest of the subdivision and includes precipitation, irrigation water, and water lost from surface water bodies, and possibly other aquifers. Ground water in the vicinity of Oak Ridge is flowing generally from the northwest to the southeast.

Summary of Well Information

Table 5. Information from drillers log for the Oak Ridge wells.

Well Name: MBMG # DNRC WR#	REGAL LAND DEV SOUTH WELL #1 186628	REGAL LAND DEV NORTH WELL #2 186625
Location	01S 25E 04 AA	01S 25E 04 AA
Date Completed	3/27/2000	4/4/2000
Depth (ft bgs*)	82.8	83
Screened Interval (ft**)	72.3 to 82.8	72 to 83
SWL Depth (ft bgs*)	23	22.1
PWL Depth (ft bgs*)	30.7	29.2
Drawdown (ft**)	-	-
Test Pumping Rate (gpm***)	347	355
Specific Capacity (gpm/ft****)	-	-

*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 Figures 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 a Time-Of-Travel (TOT) calculation. The Time-Of-Travel calculation estimates the distance that ground water would flow during a specific time period, in this case one and three years. The inventory region is delineated to help identify potential contaminant sources that are located within a three-year TOT distance from the public water supply wells. All potential sources of contamination are inventoried within the inventory region.

Recharge Region

The Watershed Region is delineated to include the portion of the watershed up-gradient or up-stream from the Oak Ridge wells. It includes part of the Fifth Code Hydrologic Unit: 10070004100 (Figure 7 and Figure 8). The watershed has an area of about 62 square miles. General land uses and large potential contaminant sources are inventoried in this region.

Limiting Factors

Parameters used in the TOT calculation come from average values reported in several studies of ground water resources in the Yellowstone Valley and Billings area. The conceptual model presented in this report is a simplification of the real ground-water flow system near Oak Ridge but is considered to be sufficiently accurate to assess the susceptibility of the public water supply to potential sources of contamination in the area.

Table 6. Time-Of-Travel Parameters

Input Parameter	
PWS Source Code	MT0004250
Transmissivity (Ft^2/ day)	900
Thickness (Ft)	10
Hydraulic Conductivity (Ft/day)	90
Hydraulic Gradient (Ft/Ft)	0.0054
Flow Direction	S 50 E
Effective Porosity (%)	25
Pumping Rate (Ft^3 / day)	56459
1-Year TOT (Ft)	2123
3-Year TOT (Ft)	4372

CHAPTER 3
INVENTORY

An inventory of potential sources of contamination was conducted to assess the susceptibility of the Oak Ridge 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 the two subdivision wells include a small segment of Dovetail Lane, which is the main access road into the subdivision, and 48th Street (Figures 3A, and Figure 3B). Several developed and undeveloped lots are partially included in each well's control zone. The pump house is close to both wells. Potential contaminants present in the control zones include yard and lawn chemicals, small volumes of fuel related to lawn care equipment, and possibly septic systems that service the developed lots. Accidents and spills on 48th street could also pose a threat to the subdivisions wells. The sanitary survey stated that "hazardous materials" were being stored near the pump house and photos were included that showed several 50 gallon drums close to the pump house. For the most part, potential contaminants are not routinely stored in commercial volumes in residential areas and the small volumes of materials stored on the developed lots are not considered to pose a threat to the wells or the source water. Nevertheless, it is advisable for residents and the PWS operators not to use or store fertilizers, pesticides, or herbicides near the well locations. While it was not specified what was stored in the drums next to the pump house, it would also be advisable to not store any potentially hazardous material near the wells or the pump house. It is not known if the drums have been removed or if the other deficiencies mentioned in the sanitary survey have been corrected.

Inventory Results/Inventory Region
Grand Avenue and several smaller access roads are located between the one- and three-year Time-Of-Travel distances (Figures 3A, and Figure 3B). While the traffic load on Grand Avenue is substantial at times, it is not a major transportation route for large vehicles carrying hazardous material. The same is true of 48th Street, which runs just east of the subdivision. The potential hazard comes from accidents resulting in spills and releases in proximity to the public water supply wells.

There are about a dozen underground storage tank sites listed for the area around Oak Ridge (Figures 3A, and Figure 3B). Some of the tank sites had multiple tanks and several tank sites have had leaks reported (Figures 3A, and Figure 3B). There are currently no active or leaking underground tank sites close to the subdivision's wells. One former tank site is located just east of the subdivision and the wells. This site was owned by Hardt Bros. Partnership and had five (5) active tanks at one time. All of the tanks were closed and removed from the ground between 1989 and 1993. All of the tank sites, including the Hardt site, are outside of the inventory region and they are located either in a cross-gradient or down-gradient location with respect to the subdivisions wells. This means that ground water beneath the underground storage tank sites is flowing either parallel to or away from the subdivision's wells and not toward them. As a consequence, the underground tank sites are not considered to pose a threat to the subdivision's source water.

Municipal sewer main lines are being extended into the west Billings area, and one of those lines run parallel to Grand Avenue. It is not know if the line is active at this time. The line is located within the inventory region. It is possible for sewer lines to leak, which could under some conditions pose a threat to shallow aquifer system. Leaking sewer lines would be a source of nitrate and pathogens. Most of the area around Oak Ridge has a moderate septic density although there are several areas outside the inventory region east of the subdivision that have high septic density. The septic density is a general indicator of the number of septic systems and drainfields in operation in the area. The high septic density areas are relatively small and appear to be in cross- and down-gradient locations with respect to Oak Ridge's wells (Figures 3A, and Figure 3B). The septic systems are also potential sources of nitrate and pathogens.

The Big Ditch is located up-gradient from the public water supply wells just inside the one-year Time-Of-Travel distance (Figures 3A, and Figure 3B). Irrigation canals often lose water through their sides and base and provide recharge to aquifers. If the canal water is of lower quality than the ground water, it can have a negative impact on the source water. The canal carry water diverted from the Yellowstone River. It is often assumed that the water quality of canals is very similar to their source stream. In this case the Yellowstone has relatively high quality water that would not pose a threat to the ground water.

Agricultural land is the dominant land use within the inventory region. From the aerial photo in Figure 3B, it appears that a significant portion of the ag-land is still in production although many fields are in the process of being subdivided. 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 potential contaminant sources in the area could include Class V injection wells (floor drains, French drains, etc). These are drains that are open to the shallow aquifer system and that are not connected to a septic system or sewer service. Class V wells were common in the past in a variety of private and commercial shops. The threat from Class V injection wells cannot be determined because an accurate inventory of these wells has not been completed for Montana. A local inventory of Class V injection wells is the best way to assess the threat they may pose to the 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 well in Table 9 in the next chapter.

Inventory Results/Recharge Region

The inventory within the recharge region also focuses on potential sources of nitrate and pathogen. It is assumed that in most cases 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 61 percent grassland, 34% percent agricultural land and the remainder is made up of forest land (3%) and small portion of urban land use that is primarily transportation corridors (Figure 7). 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 that could then enter the ground water and surface water bodies up-gradient from the public water supply wells. The percent of agricultural land represents a moderate hazard to the source water (see Table 7 in the next chapter).

Two wastewater permit sites are located within the recharge region up-gradient from the subdivision's wells (Figure 8). One of these sites is a confined animal feeding operation (CAFO) operated by Ralph Amen Farms Inc. The CAFO discharges to Hogan's Slough, which is a tributary to the Yellowstone River. Due to its location and the fact that the discharge from the site is transported to the Yellowstone River and not toward the subdivision's wells, the CAFO is not considered to pose a threat to Oak Ridge's source water. The other wastewater discharge site is located about 2 miles north of Oak Ridge. Information on this site indicates it is a small wastewater lagoon. Due to the distance and the small size of the lagoon, it is not considered a threat to the subdivision's source water.

The Yellowstone Country Club is the site of a former landfill. The landfill is not considered to pose a threat Oak Ridge's source water due the fact that the landfill has been closed for some time and is located over two miles from the subdivision.

A small number of oil and gas exploration wells are located within the recharge region (Figure 8). In this particular case, the oil and gas fields are not considered to pose a threat to the source water.

All of the other potential contaminant sources shown in Figure 8 are located closer to Billings and do not pose a threat to the shallow aquifer system west of town. Table 9 in the next chapter summarizes the inventory results and includes hazard and susceptibility ratings. Table 9 also includes possible management options that could be used to lower the subdivisions susceptibility to identified potential contaminant sources.

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.

When time-of-travel calculations are 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 Contaminate Sources	The PWS well is not sealed through the confining layer	Other wells in the inventory region are not sealed through the confining layer	All wells in the inventory region are sealed through the confining layer
Point Sources	High	Moderate	Low
Septic Systems (# per square mile)	High: > 300 Moderate: 50 to 300 Low: < 50	Moderate: > 300 Low: < 300	Low
Sanitary Sewer (% land use)	High: > 50 Moderate: 20 to 50 Low: < 20	Moderate: > 50 Low: < 50	Low
Cropland (% land use)	High: > 50 Moderate: 20 to 50 Low: < 20	Moderate: > 50 Low: < 50	Low

Barriers to contamination can be anything that decreases the likelihood that contaminants will reach a well. 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 of Significant Potential Contaminant Sources

Inventory Region

Potential Contaminant Source	Potential Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendation
Cropped Agricultural Land Use	SOCs, Nitrates, Pathogens	Contaminants leaching into groundwater	**High**	Multiple clay layers	**High**	Notify landowners of well and protection area locations. Encourage and support efforts to provide educational information, materials, and resources to land owners on the proper application and storage of pesticides and fertilizers and implementing agricultural best management practices (BMPs).
Septic Systems	Nitrates, Pathogens	Ongoing or catastrophic leakage of sewage into groundwater	**Moderate**	Multiple clay layers The majority of the lots appear to be in cross-gradient locations relative to the wells.	**Moderate to Low**	Properly operate and maintain the on-site septic system and distribution lines. A two to three year septic tank pumping maintenance schedule is recommended. Consider connecting to municipal sewer system, if available. Encourage and support city and county efforts to extend city sewer or to promote installation of community or advanced treatment septic systems and regular maintenance of septic tanks and distribution lines. Encourage and support city and county efforts to provide educational materials and workshops to the public on proper handling and disposal of industrial and household hazardous wastes and recycling. When possible connect to municipal water and sewer service.
Municipal Sewer Lines	Nitrates, Pathogens	Ongoing or catastrophic leakage of sewage into groundwater	**Moderate**	Multiple clay layers New Construction	**Moderate**	Encourage and support city efforts maintain new lines and replace old lines.
Irrigation Canals	SOCs, Nitrate, Pathogens	Leakage through canal channel and infiltration into groundwater	**Moderate to High**	Multiple clay layers	**Moderate to High**	Encourage canal owners to line the canal. When possible connect to municipal water and sewer service.

Potential Contaminant Source	Potential Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendation
Transportation Routes **Subdivision, county and city streets**	Pesticides, fertilizers, VOCs, SOCs, other	Spills, routine spraying, storm water runoff, infiltration into groundwater	**Moderate**	Multiple clay layers Relatively low traffic volume County Emergency Response Plan, training and preparation of local response personnel	**Low**	Encourage and support emergency planning, training of local emergency response personnel, use of levees and engineered storm drainage to carry any spills away and prevent infiltration into ground, cooperation with railroad managers or MDOT to reduce herbicide use.
Recharge Region						
Potential Contaminant Source	**Potential Contaminants**	**Hazard**	**Hazard Rating**	**Barriers**	**Susceptibility**	**Management Recommendation**
Cropped Agricultural Land Use (34% of Recharge Region)	SOCs, Nitrates, Pathogens	Contaminants leaching into groundwater	**Moderate**	Multiple clay layers	**Moderate**	Notify landowners of well and protection area locations. *E*ncourage and support efforts to provide educational information, materials, and resources to land owners on the proper application and storage of pesticides and fertilizers and implementing agricultural best management practices (BMPs).
Irrigation Canals	SOCs, Nitrate, Pathogens	Leakage through canal channel and infiltration into groundwater	**Moderate**	Multiple clay layers	**Moderate**	Encourage canal owners to line the canal. When possible connect to municipal water and sewer service.

Septic Systems	Nitrates, Pathogens	Ongoing or catastrophic leakage of sewage into groundwater	**4% high 30% moderate 65% low**	Multiple Clay Layers Distance from PWS Wells	**Moderate to Low**	Properly operate and maintain the on-site septic system and distribution lines. A two to three year septic tank pumping maintenance schedule is recommended. Consider connecting to municipal sewer system, if available. Encourage and support city and county efforts to extend city sewer or to promote installation of community or advanced treatment septic systems and regular maintenance of septic tanks and distribution lines. Encourage and support city and county efforts to provide educational materials and workshops to the public on proper handling and disposal of industrial and household hazardous wastes and recycling. When possible connect to municipal water and sewer service.
Transportation Routes **Highways and Railroad**	Pesticides, fertilizers, VOCs, SOCs, other	Spills, routine spraying, storm water runoff, infiltration into groundwater	**Moderate**	Multiple clay layers Distance from Public Water Supply Wells County Emergency Response Plan, training and preparation of local response personnel	**Low**	Encourage and support emergency planning, training of local emergency response personnel, use of levees and engineered storm drainage to carry any spills away and prevent infiltration into ground, cooperation with railroad managers or MDOT to reduce herbicide use.
Animal Feeding Operation	Nitrates, Pathogens	Improper storage and management of animal wastes may impact drinking water supply.	**High**	Multiple clay layers Distance from Public Water Supply Wells Cross-gradient location CAFO or AFO plant is operating within its regulatory permit.	**Low**	Notify landowners of well and protection area locations. Encourage use of agricultural best management practices (BMPs) to ensure wastes do not impact groundwater. Support efforts to monitor integrity of animal waste storage units/areas and encourage disposal of wastes outside of inventory region. Encourage use of agricultural best management practices (BMPs) in the watershed to keep cattle away from the wells and stream especially directly upstream of the well locations.

Landfills	Various	Contaminants leaching into groundwater	**Low**	Multiple clay layers Closed Facility Distance from Public Water Supply Wells	**Low**	Contact DEQ's Waste and Underground Tank Management Bureau (406-444-5300) to review closure permit requirements (if any) and to find out if site assessment or cleanup is pending or completed.
Crude Oil Pipelines	Petroleum hydrocarbons	Spills, leaks, and releases may impact groundwater	**Moderate**	Multiple clay layers Leak detection and monitoring Emergency Response	**Low**	Notify pipeline operators of well and protection area locations. Support the county's effort to maintain preparedness of local emergency personnel through active training. Encourage groundwater monitoring, spill prevention, BMPs, and ongoing remediation of soil or groundwater at leak sites.
Oil and Gas Wells and Test Holes	Total Dissolved Solids (TDS), Petroleum hydrocarbons	Improperly sealed or abandoned wells may facilitate contaminant transport to shallow or deeper aquifers.	**Low**	Multiple clay layers Areas of exploratory drilling are substantial distances from the wells. Number of oil and gas wells and test holes does not appear to be large.	**Low**	Encourage monitoring of drilling activities and oil field development near or adjacent the Inventory and Recharge Regions.

Active USTs	VOCs, petroleum hydrocarbons	Contaminants leaching into groundwater	**Low**	Multiple Clay Layers Located Down-gradient from Well Multiple Clay Layers	**Low**	Review permit status and ensure proper operation and maintenance, emergency planning, training of local emergency response personnel, groundwater monitoring, spill prevention, and BMPs.
Storm Sewer Outflows	Variety of potential contaminants including: Total Dissolved Solids, Nitrate, VOCs, SOCs from fertilizer, pesticides and herbicides.	Outflows and leaks impacting groundwater	**Low**	Distance from Public Water Supply Wells Most are down-gradient from the wells	**Low**	Support maintenance, rehabilitation, or replacement of existing sewer mains; use of sewer main liners; and rapid response planning for leaks or ruptures. Encourage and support city and county efforts to provide educational materials and workshops to the public on proper handling and disposal of industrial and household hazardous wastes and recycling

Notes:
VOCs - Volatile organic compounds (i.e. solvents, fuel components)
UST - Underground Storage Tank
BMPs - Best Management Practices
RR – Recharge Region
SOCs - Synthetic Organic Compounds (i.e. pesticides, herbicides, plasticizers)
LUST - Leaking Underground Storage Tank
DEQ- Montana Department of Environmental Quality
SIC - Standard Industrial Code

Management Recommendations

It should be noted that even small releases of some chemicals in close proximity to a public water supply well can have significant negative impact on water quality, and therefore are a significant threat to the public water supply. Steps can be taken to reduce the likelihood of releases in the source water for the PWS or in the vicinity of the sources. Some of these management recommendations are mentioned in the susceptibility table (Table 9). If these, and other, management recommendations are implemented; they may be considered additional barriers that will reduce the susceptibility of the intake to specific sources and contaminants.

***Restrict Chemical Handling, Use and Storage in the Control Zone for the Well* –** The PWS should restrict chemical handling, use and storage within the 100-fott radius Control Zone of the production well. Ongoing training should be provided to promote safe handling and proper storage, transport, use, and disposal of hazardous materials if these materials are used. Regular maintenance and inspections of the USTs, diesel generators, and concrete floors, should be conducted to protect the area from diesel or other chemical spills. Any USTs that are out of service should be removed and soils should be tested to evaluate potential impact from historic spills or leaks. Conduct tank and line integrity testing for active tanks and ensure proper operation and maintenance.

***Agricultural Best Management Practices (BMPs)* –** The water system should encourage land users to utilize BMPs to limit the application of pesticides, herbicides, and fertilizers in the inventory and recharge region. If significant grazing occurs in the recharge region, land users should be encouraged to keep the concentration of livestock low and to keep livestock away from the stream immediately up gradient of the well. BMPs are generally voluntary but their implementation can be encouraged through education and technical assistance.

***Sewer/Wastewater Treatment System Maintenance and Leak Detection* –** Early warning of leaks and scheduled replacement of aging sewer lines and wastewater treatment systems may reduce the susceptibility of the PWS to contamination from septic wastes.

***High Septic System Density Areas* –** An education program to educate residents on proper operation and maintenance of septic systems can reduce the susceptibility of the PWS's drinking water to septic wastes. Installation of advanced septic treatment systems such as sand filters can limit contamination from new rural residential development. However, annexation and extension of sewers is the only way to reduce contamination from existing unsewered developments.

***Inactive USTs/LUSTs* -** It is recommended that the PWS operator or community members contact DEQ's Waste and Underground Tank Management Bureau (406-444-5300) to obtain further information on the cleanup status and any permits or monitoring networks to verify existing contamination is being properly assessed and remediated. The PWS can work with DEQ to encourage proper abandonment for out-of-service tanks and soil testing to evaluate potential impact from historic spills or leaks.

***Stormwater Management* -** Stormwater planning should address source and drainage control. Source control can be accomplished through educational programs focusing on residential and commercial chemical use, disposal, and recycling. Drainage control and pollutant removal can be accomplished through the use of vegetated retention basins at outfall locations.

***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.

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

***Hazardous Materials Collection Days* –** Several counties in the state that have vulnerable water supplies have implemented scheduled days for the collection of hazardous wastes from the public. These vary in the inclusiveness of what materials are collected, how the materials are handled, and how they are disposed of, but they all act to reduce the amount of unauthorized or improper disposal of these wastes. Used motor oil collection station could be established and available to the public on a regular basis.

***Growth and development planning* - Several** areas within the project area are experiencing rapid growth and development. It would be advisable to encourage growth and development in areas that would not pose a threat to source water, that is, in areas that are outside of the Spill Response Region and away from tributaries, canals and ditches. Ground-water flow direction in these areas should also be taken into account.

***Drinking Water Protection Plan* –** The next phase of source water protection for the PWS would be for the water system owner/operator and the community to take the information presented in this source water delineation and assessment report and use it to continue development of a Drinking Water Protection Plan. The Drinking Water Protection Plan would clearly identify: 1) strategies to reduce the likelihood of contaminant releases within the inventory region, 2) the procedures to follow (emergency response plan) in the event that the PWS well becomes threatened by contaminants, and 3) identify alternate sources of drinking water.

CHAPTER 5
MONITORING WAIVERS

Waiver Recommendation

It does not appear that Oak Ridge has been granted any water quality monitoring waivers. Based on the susceptibility assessment of the subdivision's source water, the Source Water Protection Program does not recommend waivers. This is due in part to the fact that the aquifer serving the subdivision is relatively shallow and may not be confined in some areas up-gradient from the wells. Another factor that influences this recommendation is the fact that the west Billings area is growing rapidly and landuse changes will almost certainly have an effect on the quality of water within the shallow ground water system. The large percentage of agricultural land in the inventory region also supports maintaining a full regiment of water quality monitoring. 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 an 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.

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 an 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.

<u>Use Waivers</u>

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.

<u>Susceptibility Waivers</u>

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 mile 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 will 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 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 where the well provides 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,

<u>Susceptibility Waiver for Unconfined Aquifers</u>
Unconfined aquifers are the most common source of usable groundwater. Unconfined aquifers differ from confined aquifers in that the groundwater is not regionally contained within 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 usually locally recharged from surface water or precipitation. In general, groundwater flow gradients in unconfined aquifers reflect surface topography, and the residence time of water in the aquifer is comparatively shorter than for water in confined aquifers. Similar water chemistry often exists between unconfined groundwater and area surface water, and physical parameters and dissolved constituents can be an indicator 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 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 development, monitoring history of the source, geologic characteristics of the unsaturated soil and vadose zones, and chemical characteristics of the organic chemicals pertaining to their mobility and persistence in the environment. The zone of contribution of the unconfined groundwater source must be defined and plotted. This should describe the groundwater flow directions, gradients, and a 3-year time-of-travel. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and those nearby should be provided as well.

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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

APPENDICES

APPENDIX A – Well Logs

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
REGAL LAND DEV SOUTH WELL #1

Plot this site on a topographic map

Location Information

GWIC Id:	186628	Source of Data:	LOG
Location (TRS):	01S 25E 04 AA	Latitude (dd):	45.7822
County (MT):	YELLOWSTONE	Longitude (dd):	-108.6403
DNRC Water Right:		Geomethod:	TRS-SEC
PWS Id:		Datum:	NAD27
Block:	2	Altitude (feet):	
Lot:	1	Certificate of Survey:	
Addition:	OAK RIDGE EST	Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	82.80	How Drilled:	ROTARY
Static Water Level (ft):	23.00	Driller's Name:	PRO PUMP
Pumping Water Level (ft):	30.70	Driller License:	WWC508
Yield (gpm):	347.00	Completion Date (m/d/y):	3/27/2000
Test Type:	AIR	Special Conditions:	
Test Duration:	7.00	Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):	22.00	Geology/Aquifer:	Not Reported
Recovery Time (hrs):	2.00	Well/Water Use:	DOMESTIC IRRIGATION

Well Notes:

Hole Diameter Information

From	To	Diameter
0.0	82.8	10.0

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-2.0	72.3	10.0	0.250			STEEL

Annular Seal Information

From	To	Description
0.0	40.0	BENTONITE

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
72.3	82.8	10.0			.035 HOUSTON/ JOHNSON

Lithology Information

From	To	Description
0.0	19.0	SILTY TOPSOIL
19.0	30.0	SANDY SILT/CLAY
30.0	49.0	DENSE CLAY W/ SAND LAYERS
49.0	53.0	VERY SANDY
53.0	54.0	SAND/CLAY /GRAVEL
54.0	80.0	GRAVEL/SAND
80.0	81.0	SHALE W/ GRAVEL
81.0	82.8	SHALE

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
REGAL LAND DEV NORTH WELL #2

Plot this site on a topographic map

Location Information

GWIC Id:	186625	Source of Data:	LOG
Location (TRS):	01S 25E 04 AA	Latitude (dd):	45.7822
County (MT):	YELLOWSTONE	Longitude (dd):	-108.6403
DNRC Water Right:		Geomethod:	TRS-SEC
PWS Id:		Datum:	NAD27
Block:	2	Altitude (feet):	
Lot:	1	Certificate of Survey:	
Addition:	OAK RIDGE	Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	83.00	How Drilled:	ROTARY
Static Water Level (ft):	22.10	Driller's Name:	PRO PUMP
Pumping Water Level (ft):	29.20	Driller License:	WWC508
Yield (gpm):	355.00	Completion Date (m/d/y):	4/4/2000
Test Type:	AIR	Special Conditions:	
Test Duration:	5.00	Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):	221.25	Geology/Aquifer:	Not Reported
Recovery Time (hrs):	5.00	Well/Water Use:	DOMESTIC IRRIGATION

Well Notes:

Hole Diameter Information

From	To	Diameter
0.0	84.0	9.0

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-2.0	72.0	10.0	0.250			STEEL

Annular Seal Information

From	To	Description
0.0	54.0	BENTONITE

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
72.0	83.0	10.0			.035 HOUSTON/JOHNSON

Lithology Information

From	To	Description
0.0	30.0	SILTY TOPSOIL
30.0	54.0	CLAY/ SAND LAYERS
54.0	83.0	GRAVEL/SAND
83.0	84.0	SHALE

APPENDIX B - DEQ PWS's Database Output

APPENDIX C – Sanitary Survey

APPENDIX D - Concurrence Letter & Other Correspondence