City of Townsend
Public Water System

PWSID # MT0000344

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

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Table of Contents

Figures

INTRODUCTION

Carolyn DeMartino, a Water Quality Specialist with the Montana Department of Environmental Quality, completed the Townsend (PWSID# MT0000344) Source Water Delineation and Assessment Report (SWDAR). Information to complete this report was obtained from various sources including published documents, various databases, and from individuals familiar with the Townsend area. In addition to Mr. Herrington, Timothy Rauser is also a certified water operator for Townsend.

Purpose

This Source Water Delineation and Assessment Report is intended to meet the technical requirements for the completion of the delineation and assessment for the Townsend Public Water System (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 protect public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is "delineation and assessment". Delineation is a process of mapping source water protection areas, which contribute water used for drinking. Assessment involves identifying locations or regions in source water protection areas where contaminants may be generated, stored, or transported, and then determining the relative potential for contamination of drinking water by these sources. The primary purpose of this source water delineation and assessment report is to provide information that helps Townsend complete a source water protection plan to protect its drinking water source.

Limitations

This report was prepared to assess the source water susceptibility to contamination for the Townsend PWS. The report is based on published information and information obtained from local residents familiar with the community. The terms "drinking water supply" or "drinking water source" refer specifically to the source of the Townsend public water supply and not any other public or private water supply. Also, not every potential or existing source of groundwater or surface water contamination in the Townsend area has been identified. Only potential sources of contamination in areas that contribute water to its drinking water source are considered.

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

CHAPTER 1: BACKGROUND

The Community

Townsend is located in Broadwater County in south-central western Montana (Figure 1). Townsend, located approximately 35 miles southeast of Helena, is the county seat of Broadwater County . According to the Census Bureau the population of Broadwater County in 2000 was 4,385 with Townsend's population at 1,867. Historically, Townsend's economy was based on the railroad and mining, but eventually agriculture became the main economic driver for the community. Today, timber, mining, healthcare, and tourism also boost the Townsend economy. Area businesses include the Broadwater Health Care Center, gas stations, automotive dealerships and repair shops, grain elevators, seed companies, restaurants, and motels. The Townsend school system consists of an elementary, junior high, and high school.

The major transportation routes in the Townsend area are U.S. Highway 12 and U.S. Highway 287. Montana Rail Link provides railway transportation.

A municipal sanitary sewer serves Townsend. The wastewater treatment facility that serves Townsend is a partial mix, mechanically aerated, facultative pond system that is located northwest of town (Figure 2). The treatment system is designed to continuously discharge to a side channel of the Missouri River (Damshen and Associates, 1998).

Geographic Setting

The Townsend Valley in west-central Montana is a 600 square mile intermontane basin bordered by the Big Belt Mountains on the east and by the Elkhorn Mountains on the west. The Townsend Valley trends slightly northwest across the central part part of Broadwater County and the southeastern part of Lewis and Clark County. The City of Townsend is located in Sec. 31, Township 7 North, Range 2 East (Figure 2). The portion of the Townsend Valley underlain by Tertiary and younger sediments has a maximum width of 15 miles and is approximately 45 miles long. Near the southern end of the valley, the valley broadens into a low, gently sloping plain which is crossed by Crow Creek. The Crow Creek Plain is approximately 10 miles wide from east to west and 15 miles long (Lorenz and McMurtrey, 1956).

The Missouri River flows northward, entering the Townsend Valley near Toston, on the southern end of the valley. Canyon Ferry Dam on the northern end of the valley regulates flow out of Canyon Ferry Lake and the Missouri River. Canyon Ferry Lake was created upon the completion of the Canyon Ferry Dam in1954.

Climate in the Townsend area is considered semi-arid. Average daily high and low temperatures in Townsend are 82.9° F and 50.0° F in July and 32.5° F and 10.0° F. in January. Annual precipitation averages 10.71 inches with May and June being the wettest months. An annual average of 23.2 inches of snow is received in the Townsend area mainly November to April (Western Regional Climate Center, Monthly Climate Summary (7/1/1948 to 12/31/2001).

General description of the Source Water

The Townsend PWS obtains its water from two groundwater wells (Figure 2). Both Well 1 (Source ID WL002) and Well 2 (Source ID WL003) are completed in semi-consolidated Tertiary valley fill sediments overlain by Quaternary alluvium (Figure 3). While Well #3, located in northeast Townsend (Source ID WL004) is also completed in Tertiary sediments, it is inactive and not indicated on the map figures. Copies of the well logs are located in Appendix A.

The Public Water Supply

Townsend is considered a community PWS because there are greater than 15 service connections and greater than 25 residents are served by the system. Currently, the Townsend PWS provides water to approximately 2,004 residents through 729 active connections (DEQ SDWIS Database). The water system consists of Well #1 and Well #2, the distribution system, and a 200,000-gallon storage facility (DEQ, 2002 Sanitary Survey). Water from both Well #1 and Well #2 is pumped into the pumphouse for each well and from there the water is pumped to the storage tank. Water then flows by gravity to the distribution system. Groundwater from both of the wells is untreated. Well #3 is inactive. For additional information concerning the site layout, the Townsend PWS or the DEQ can be contacted.

Water Quality

Townsend's water quality is routinely monitored for compliance with drinking water standards. Bacteriological monitoring is conducted monthly. Compliance with other drinking water standards is based on additional monitoring on a variety of schedules. Coliform bacteria have been detected in water from Well 1 and Well 2 in the last five years. Nitrate plus nitrite as nitrogen detections in Well 1 over the past five years have ranged from 0.89 parts per million (ppm) to 1.38 ppm, and in Well 2 have ranged from 0.55 ppm to 2.33 ppm. These detections remain below the maximum contaminant level (MCL) of 10 mil1igrams per liter (DEQ SDWIS database).

Groundwater within the Townsend Valley is generally hard. The predominant elements found in groundwater contained in Tertiary deposits include calcium, sulfate and bicarbonate. A summary of water quality data for the Townsend wells is located in Appendix B.

CHAPTER 2: DELINEATION

The source water protection area, the land area that contributes water to Townsend's PWS wells, is identified in this chapter. The management areas identified within the source water protection area included the control zone, inventory region, and recharge region. The control zone is an area at least 100-foot radius around the well. The management goal of the control zone, also known as the exclusion zone, is to protect against the direct introduction of contaminants into the wells or in the immediate area surrounding each well. The inventory region represents the zone of contribution of the well, which approximates a three-year groundwater time-of-travel. Analytical equations describing ground water flow using estimates of pumping and aquifer characteristics, and simple hydrogeologic mapping are used to calculate groundwater time-of-travel distance (Appendix C). The management goal of the inventory region is to focus on pollution prevention activities at potential contaminant sources where it is likely that contaminated water would flow into the wells within a relatively short time-frame. The recharge region represents the entire portion of the aquifer that contributes water to the Townsend water system. Management in the recharge region should focus on maintaining and improving the quality of groundwater that could reach each well over longer timeframes or with increased water usage.

Hydrogeologic Conditions

Tertiary deposits consisting mainly of conglomerate, shale, sandstone, and tuff, and minor amounts of breccia, limestone, and diatomaceous earth underlie the Townsend Valley (USGS, 1964). Many of these deposits are poorly consolidated or unconsolidated. Much of the valley is also bordered by broad fans and aprons of Pleistocene and Recent alluvium that are in turn bordered in many places by low benchlands of Tertiary deposits. Igneous rocks that have intruded the sedimentary rocks in many places in the valley are also exposed. Near the northern end of the valley, Tertiary deposits dip 10° to 15° toward the Big Belt Mountains and terminate in a major steep fault zone at the mountain front. At the southern end of the valley, Tertiary beds are folded forming the broad, gentle sloped Dry Creek anticline east of Townsend. The east limb of the anticline may also terminate in mountain front faults (Lorenz and McMurtrey, 1956).

Groundwater underlying the Townsend Valley is located in both Quaternary and Tertiary deposits. Part of the groundwater in these deposits is under unconfined conditions and part is under confined conditions. The Townsend PWS wells are completed in semi-consolidated, Tertiary-aged valley fill. Based on Table 1, groundwater supplying the Townsend PWS wells would have a moderate sensitivity to potential contaminant sources. At the southern end of the valley water is confined under artesian pressure in the Tertiary beds that formed the Dry Creek Anticline. The primary sources of groundwater recharge to shallower unconfined deposits include direct precipitation, perennial streams, and seepage from irrigation canals. In portions of the valley Tertiary deposits are recharged through the upward migration of groundwater from underlying older rocks.

Table 1. Source Water Sensitivity Criteria

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)

Groundwater, in the Townsend Valley, moves from the bordering mountains towards the Missouri River in a direction that is nearly parallel to the tributaries and at right angles to the river. As the groundwater nears the river, it veers in a downstream direction. Water from Deep Creek provides a considerable amount of water to the aquifer. Groundwater moves northwesterly from the Deep Creek alluvial fan towards Townsend (Figure 4). The groundwater gradient from just north of Toston to Townsend slopes to the west at an average rate of 20 feet per mile (Lorenz and McMurtrey, 1956).

Conceptual Model and Assumptions

The Townsend Valley is an intermontane basin bordered by the Big Belt Mountains on the east and by the Elkhorn Mountains on the west. The valley trends slightly northwest across the central part of Broadwater County and the southeastern part of Lewis and Clark County. The Missouri River enters the Townsend Valley on the southern end of the valley near Toston, and flows northward. Canyon Ferry Dam on the northern end of the valley regulates flow out of Canyon Ferry Lake and flow along this segment of the Missouri River. Near the northern end of the valley, Tertiary deposits dip 10° to 15° toward the Big Belt Mountains and terminate in a major steep fault zone at the mountain front. At the southern end of the valley, Tertiary beds are folded forming the Dry Creek anticline. Also near the southern end of the valley, the valley broadens into a low, gently sloping plain that is crossed by Crow Creek. Much of the valley is bordered by broad fans and aprons of Pleistocene and Recent alluvium that are in turn bordered in many places by low benchlands of Tertiary deposits. Igneous rocks that have intruded the sedimentary rocks in many places in the valley are also exposed

Townsend's PWS wells are completed in semi-consolidated, semi-confined, Tertiary-aged valley fill. The primary sources of groundwater recharge to these wells include perennial streams, seepage from irrigation canals, and the upward migration of groundwater from underlying formations.

Well Information

Data for the Townsend wells is summarized in Table 2.

Table 2. Townsend PWS Well Information

Well Information	Well #1 Broadway Street	Well #2 Railroad Ave.	Well #3 N. Oaks Street (Inactive)
PWS Source Code	002	003	004
Well Location (T, R, Sec)	NWSENENW Sec 31, T. 7 N., R. 2E.	NWSENENW Sec 31, T. 7 N., R. 2E.	NE Sec 31, T. 7 N., R. 2E.
Latitude/ Longitude	46.3239/ 111.5274	46.3136/111.5310	46.3222/111.5187
MBMG #	19319	19301	19312
Water Right #	W010757	W010756	NA
Date Well was Completed	08/17/60	10/20/58	01/01/70
Total Depth	60	50	93
Perforated Interval	37’ to 60’	30’ to 50’	55’ to 60’
Static Water Level	9	8	9
Pumping Water Level	14	24	55
Drawdown	5	16	46
Yield	650	600	440
Test Pumping Rate	NA*	NA	NA
Specific Capacity	130	37.5	9.6

*NA – Not available

Time-of-Travel Model Input

DEQ’s Source Water Protection Program specifies the methods and criteria used to delineate subregions of the source water protection area for PWS wells. Time-of-travel (TOT) calculations were used to determine the inventory region for the Townsend PWS wells. Input parameters for the TOT calculations were estimated from the well logs and already published hydrogeologic reports. Estimates of these parameters are summarized in Table 3. The selection criteria for the parameters are described in the text following Table 3.

Table 3. Estimates of input parameters used to delineate the source water protection area.

Input Parameter	Range of Values/ Units	Values Used For Each Well		
		Well #1	Well #2	Well #3 (Inactive)
PWS Source Code	----	WL002	WL003	WL004
Transmissivity	$1x10^4$ to $1x10^5$ ft^2/day	28,050 ft^2/day	20,350 ft^2/day	----
Thickness	8 ft to 60 ft	51ft	37ft	----
Hydraulic Conductivity	1 to 10^4 ft/day	550 ft/day	550 ft/day	----
Hydraulic Gradient	.003 to .004	.004	.004	----
Flow Direction	N-NW	NW	NW	----
Effective Porosity	10-25%	15%	15%	----
Pumping Rate	500-650 gpm	630 gpm	500 gpm	----
1-Year TOT*	1 – 2 miles	1.3 miles	1.4 miles	----
3-Year TOT*	3 – 4 miles	3.2 miles	3.2 miles	----

*Time of Travel

PWS Source Code - is the specific identification code for each Townsend PWS well. The code is obtained from the DEQ Public Water Supply Section SDWIS database.

Transmissivity (T) - is the rate of groundwater flow through an aquifer cross-section of unit width over the entire saturated thickness of the aquifer under a unit hydraulic conductivity.

Thickness - denotes the aquifer thickness that was estimated from the well log(s).

Hydraulic Conductivity (K) - is the rate at which a porous material (e.g. sand and gravel) transmits water. This value was estimated from Driscoll, 1986.

Hydraulic Gradient (i) is the change in water level over distance. The value for the hydraulic gradient was obtained from Lorenz and McMurtrey, 1956.

Flow Direction - is the direction that ground water is flowing. This information was also obtained from Lorenz and McMurtrey, 1956.

Effective Porosity - as applied to aquifer materials it is the ratio of the volume of water that, after being saturated, the aquifer will yield by gravity to its own volume. The value was obtained from Driscoll, 1986.

Pumping Rate - is the pumping rate of Townsend's wells. This information was obtained from the April 2, 2002 sanitary survey.

1-Year TOT - is calculated. See TOT Calculation Table in Appendix C.

3-Year TOT - is also calculated. See TOT Calculation Table in Appendix C.

Delineation Results

The protections areas delineated for the Townsend PWS wells include 100-foot radius control zones for each well, one inventory region based on TOT equations that indicate the distance groundwater flows in one year and three years (Figure 5, Appendix C), a surface water buffer ½-mile around the Missouri River and Deep Creek for a distance of 10 miles upstream of the wells (Figure 9), and a recharge region (Figure 10). These protection areas will be discussed in greater detail in Chapter 3.

Limiting Factors

Delineation of the source water protection areas for the Townsend PWS wells is based on pumping conditions and groundwater data located in the most recent sanitary survey, published reports, and the lithology indicated on the well logs. The total amount of recharge to the system from streams, irrigation canals, and leakage from older underlying formations is unknown. Recharge to the groundwater system from streams and irrigation canals can vary seasonally.

Time of travel distances represent the time required for ground water to travel through a specified aquifer to the public water supply well. These distances do not represent the time required for contaminants to reach a public water supply well. Travel times for the migration of free phase contaminants that are not dissolved in the ground water vary tremendously from ground-water travel times. Free phase contamination migration rates are influenced by the characterisitics of the vadose zone, contaminant density, the slope of the water table, the slope of the base of the aquifer, aquifer porosity, lithologic heterogeneities, and the extent and duration of contamination.

Travel times for dissolved contaminant migration also differ from ground-water travel times. Dissolved contaminants are affected by advection, or the component of solute movement attributed to transport by flowing ground water (Freeze and Cherry, 1979). However, the migration of dissolved contaminant plumes is also affected by many additional factors, including the characterisitics of the vadose zone, the extent and duration of contamination, contaminant solution density, mechanical dispersion, biological transformation, dilution, molecular diffusion, adsorption, precipitation, oxidation, complexation, volatilization, radioactive decay, lithologic heterogeneities, and water extraction.

Inventory regions delineated using time-of-travel calculations should be used as a planning tool to identify areas within which the potential for contaminants to reach a public water supply source is highest. Ground-water time-of-travel calculations should not be used to estimate contaminant migration rates.

CHAPTER 3: INVENTORY

An inventory of potential contaminant sources was conducted within the Townsend PWS well control zones, and inventory regions, and recharge region. Potential sources of all primary drinking water contaminants and Cryptosporidium were identified, however, only significant potential contaminant sources were selected for the detailed inventory. Significant potential contaminants in the Dillon inventory region include nitrate, pathogens, fuels, solvents, agricultural chemicals, and metals.

The potential contaminant source inventory for Townsend focuses on all activities in the control zone, certain sites or land use activities in the inventory region, and general land uses and large facilities in the recharge region.

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: Urban and agricultural land uses were identified using the United States Geological Survey National Landcover Dataset 2000.

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 SIC code.

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, or use 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 Zone

Residential areas surround Townsend PWS Well #1 and Well #2 is surrounded by commercial businesses located near the Montana Rail Link railroad tracks. Streets and sewer mains are located within the 100-foot control zones of both these wells.

Inventory Results/Inventory Region

Land cover within the 1-year TOT inventory region for the Townsend wells includes 22% residential land and 14% commercial and industrial land and roads. Additional land cover types and their percentages are identified on Figure 6. Municipal sewer main areas and septic system density are identified on Figure 7. Significant potential contaminant sources in the inventory region are listed in Table 4 and indicated on Figures 6, Figure 7, and Figure 8. Appendix D contains a list of all identified potential contaminant sources within the Townsend PWS inventory region.

Table 4. Significant Potential Contaminant Sources In The Townsend PWS Well Inventory Regions.

SIGNIFICANT POTENTIAL CONTAMINANT SOURCES (PCSs)	MAP FIGURE ID #	POTENTIAL CONTAMINANTS	HAZARD
Municipal Sewer	Figure 7	Nitrates and pathogens	Main line breaks releasing contaminants water into area groundwater
USTs/LUSTs	Figure 8	For all USTs VOCs	Migration of VOCs in groundwater
Montana Rail Link Railway	Figure 8	VOCs, SOCs, nitrates	Accidental spills releasing contaminants water into area groundwater
Roads: US Highway 287 US Highway 12	Figure 8	VOCs, SOCs, nitrates, and pathogens	Accidental spills releasing contaminants into area groundwater
Irrigation Ditches: Montana Ditch Broadwater-Missouri Ditch	Figure 8	Nitrates and pathogens	Leakage from ditches into area groundwater
Cultivated Cropland	Figure 6	SOCs, nitrates, pathogens	Contaminants leaching into area groundwater
Septic Density	Figure 7	Nitrates and pathogens	Effluent leaching to groundwater
Other PCSs: 1-Year TOT 3-Year TOT	Figure 8	VOCS, SOCs,	Contaminants leaching into area groundwater
Class V Injection Wells	Unknown	VOCs, SOCs, metals	Infiltration of contaminated water intoarea groundwater

Municipal Sewer Mains - Municipal sewer mains cover approximately 50% of the 1-year TOT inventory region (Figure 7). Sewer main breaks or leaks could result in the release of nitrates and pathogens to area groundwater that supplies the Townsend PWS wells. It should also be noted that other utility corridors may act as preferential pathways for contaminants to travel and leach into area groundwater.

USTs/ LUSTs -Underground storage tanks and leaking underground storage tanks are located within the inventory region for the Townsend wells. In the past, underground storage fuel tank leaks were identified as the cause of petroleum leaking into the City swimming pool. In 1999, petroleum contaminated soil was discovered under area business. Again the cause was identified as leaking USTs. Monitoring wells drilled in the area also indicated that the released petroleum had contaminated area groundwater. While the Townsend

PWS wells were not impacted by these releases a future release may release VOCs to area groundwater that supplies the wells.

Montana Rail Link Railway – The railroad is located in the 1-year TOT inventory region for both of the Townsend PWS wells and is in close proximity to Well #2.

Roads – U.S. Highways 287 and 12 are located in the inventory region for both wells. Spills of fertilizers, pesticides, volatile organic compounds (VOCs), and synthetic organic compounds (SOCs) could occur due to traffic accidents and allow contaminants to leach to area groundwater.

Irrigation Ditches - Irrigation ditches/ canals are located throughout the inventory region. If unlined, these ditches may allow SOCs, nitrates, and pathogens, to leach into area groundwater.

Septic system density - Septic density is based upon population numbers of 2000 census with one septic system per 2.5 persons. Overall, septic density in the 1-year TOT inventory region for wells 1 and 2 is low (Figure 7). Within the 1 to 3-TOT inventory region there is an area of high septic density (320) located up gradient of the Townsend wells.

Cultivated Cropland – Within the total inventory region for the Townsend wells cultivated cropland, consisting of row crops and small grains, covers approximately 18 % of the land. SOCs, nitrates, and pathogens could migrate to area groundwater via surface water runoff.

Other PCSs – Other potential contaminant sources, for example, seed companies, farm suppliers, a recycling center, automotive dealerships/ part sales, and construction companies are located in the Townsend PWS wells inventory region. Business listings came from telephone directories / databases and other public sources. It does not indicate that these businesses are current polluters, but is simply listing them as potential contaminant sources based on experience with the chemicals handled by similar types of businesses. Other PCSs that are located within the 1-year TOT may introduce VOCs, SOCs, and nitrate into area groundwater due to accidental spills**.**

Class V Injection Wells – Locations have not been determined to date for this type of discharge. However, if any are located in the inventory region they could allow infiltration of contaminated water into area groundwater.

Inventory Results/ Surface Water Buffer

The surface water buffer delineated around the Missouri River and its major tributaries in the Townsend area is identified in Figure 9. Land cover in the surface water buffer includes 28% cultivated cropland. SOCs, nitrates, and pathogens have the potential to enter groundwater and surface water via surface water runoff and irrigation ditch return flows. Overall, septic density in the surface water buffer is low.

Inventory Results/ Recharge Region

The recharge region for the Townsend wells is identified in Figure 10. Land cover in the recharge region includes 16% cultivated cropland. SOCs, nitrates, and pathogens from this cropland may enter area groundwater and surface water via surface water runoff and irrigation ditch return flows. Overall, septic density in the recharge region is low.

Inventory Limitations

The potential contaminant inventory was conducted using various databases to acquire readily available information. Information was also obtained where possible, from individuals familiar with the City of Townsend. Consequently, unregulated activities or unreported contaminant releases may have been overlooked. The use of multiple sources of information, however, should ensure that the major threats to the Townsend wells have been identified.

Inventory Update

To make this SWDAR a useful document in the years to come, the certified water system operators for the Townsend PWS 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 every five years to ensure the source water delineation and assessment report remains current.

CHAPTER 4: SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would pose concern. Susceptibility is assessed in order to prioritize potential pollutant sources for management actions by local entities, in this case Dillon.

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 threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources identified in the previous chapter according to susceptibility. Alternative management approaches that could be pursued by the Dillon to reduce susceptibility are recommended.

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 Townsend's wells (Table 5).

Table 5. Relative susceptibility to specific contaminant sources as determined by hazard and the presence of barriers.

	High Hazard	**Moderate Hazard**	**Low Hazard**
No Barriers	Very High Susceptibility	High Susceptibility	Moderate Susceptibility
One Barrier	High Susceptibility	Moderate Susceptibility	Low Susceptibility
Multiple Barriers	Moderate Susceptibility	Low Susceptibility	Very Low Susceptibility

Hazard is rated by the proximity of a potential contaminant source to the wells. Table 6 identifies the hazard of potential contaminant sources associated with proximity to a PWS well or surface water intake or density within a PWS inventory or spill response region.

Table 6. Hazard of potential contaminant sources associated with proximity to a PWS well or surface waterintake or density within a PWS inventory or spill response region.

Type of Contaminant Source		**High Hazard**	**Moderate Hazard**	**Low Hazard**
SURFACE WATER	Point Sources of Nitrate or Microbes	Potential for direct discharge to source water	Potential for discharge to groundwater hydraulically connected to source water	Potential contaminant sources in the watershed region
	Point Sources of VOCs, SOCs, or Metals	Potential for direct discharge of large quantities from roads, rails, or pipelines	Potential for direct discharge of small quantities to source water	Potential for discharge to groundwater hydraulically connected to source water

Table 6. Hazard of potential contaminant sources associated with proximity to a PWS well or surface waterintake or density within a PWS inventory or spill response region.

Type of Contaminant Source		High Hazard	Moderate Hazard	Low Hazard
WELLS	**Point Sources of All Contaminants** (Unconfined)	Within 1-year TOT	1 to 3 years TOT	Over 3 years TOT
	Point Sources of All Contaminants ***(Confined)***	PWS well is not sealed through the confining layer	Well(s) in the inventory region other than the PWS well are not sealed through the confining layer	All wells in the inventory region are sealed through the confining layer
ALL	**Septic Systems**	More than 300 per sq. mi.	50 – 300 per sq. mi.	Less than 50 per sq. mi.
	Municipal Sanitary Sewer (% land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region
	Cropped Agricultural Land (% land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region

Susceptibility ratings are presented in Table 7 individually for each significant potential contaminant source and each associated contaminant and are discussed in the text following the table. Management recommendations that indicate how significant potential contaminant sources could be managed to prevent impacts to the Townsend wells are also provided in Table 7 and discussed in the text following the table.

Table 7. Susceptibility assessment for significant potential contaminant sources in Townsend's source water protection areas

Potential Contaminant Sources	Potential Contaminants	Hazard	Hazard Ranking	Barriers	Susceptibility	Management Recommendation
Municipal Sewer	Nitrates and pathogens	Contaminants leaking into groundwater	High	None	Very High	Conduct regular maintenance and inspections
USTs/LUSTs	VOCs	Migration of VOCs into groundwater	High	None	Very High	Conduct regular maintenance and inspections
Montana Rail Link Railroad	VOCs, SOCs, nitrates, pathogens	Contaminants migrating to groundwater	High	None	Very High	Implement spill response plan
Roads: US Highways 287 & 12	VOCs, SOCs, nitrates, and pathogens	Contaminants migrating to groundwater	High	None	Very High	Implement spill response plan
Irrigation Ditches	SOCs, nitrates, pathogens	Ditch water leaching to groundwater	High	None	Very High	Use BMPs
Septic Density	Nitrates and pathogens	Effluent leaching into groundwater	High	None	Very High	Conduct regular maintenance and inspections
Cultivated Cropland	SOCs, nitrates, pathogens	Contaminants leaching into groundwater	Low	None	Moderate	Use BMPs

Table 7. Susceptibility assessment for significant potential contaminant sources in Townsend's source water protection areas

Potential Contaminant Sources	Potential Contaminants	Hazard	Hazard Ranking	Barriers	Susceptibility	Management Recommendation
Other PCSs 1-Year TOT 3-Year TOT	VOCs, SOCs, nitrates	Contaminants leaching into groundwater	High Low	None for both	Very High Moderate	Conduct regular maintenance and inspections
Class V Injection Wells	VOCs, SOCs, metals	Contaminants leaching into groundwater	Unknown at this time	None	Unknown at this time	Work with EPA to determine the locations

Municipal Sewer Mains - Municipal sewer mains cover approximately 45% of the 1-year TOT inventory region and pose a high hazard to the Townsend PWS. Overall, the susceptibility is very high as there are no identifiable barriers to contamination. Regular maintenance and inspections should be conducted to replace older sewer lines as needed to prevent sewer line failures.

USTs/ LUSTs -Underground storage tanks and leaking underground storage tanks are located within the inventory region for the Townsend wells and pose a high hazard to the wells. The overall susceptibility is very high as there are no identifiable barriers to contamination. Regular inspections should be conducted to ensure that the tanks and their leak detection systems are functioning properly.

Montana Rail Link Railway – The railroad is located in the 1-year TOT inventory region for both of the Townsend PWS wells and poses a high hazard especially due to the close proximity to Well #2. The overall susceptibility is very high as there are no identifiable barriers to contamination. A spill response plan should be implemented to outline the procedures to take in the event the Townsend PWS wells are threatened by a spill.

Roads – U.S. Highways 287 and 12 are located in the inventory region for both of the Townsend wells and pose a high hazard to these wells. The overall susceptibility is very high as there are no identifiable barriers to contamination. A spill response plan should be implemented to outline the procedures to take in the event the Townsend wells are threatened by a spill.

Irrigation Ditches - Irrigation ditches/ canals are located within the 1-year TOT inventory region and pose a high hazard to the PWS wells. Overall, the susceptibility is very high as there are no identifiable barriers to contamination. Ditches should be inspected to determine if they are leaking. Area producers could use BMPs to prevent contaminants from entering into the irrigation ditches.

Septic system density - An area of high septic density is located up gradient of the Townsend wells. The hazard posed by this potential contaminant source is high high. The overall susceptibility is very high as no barriers to contamination were identified. Property owners should inspect septic systems to ensure their proper operation.

Cultivated Cropland – Cropland within the total inventory region for the Townsend wells covers approximately 18 % of the land and consists of row crops and small grains. The hazard posed by this significant potential contaminant source is low. Overall, the susceptibility is moderate as there are no identifiable barriers to contamination. Use of best management practices will help prevent contaminants from leaching into area groundwater or entering area surface water.

Other PCSs – Other potential contaminant sources, for example, seed companies, farm suppliers, a recycling center, automotive dealerships/ part sales, and construction companies are located in the Townsend PWS wells inventory region. Other PCSs located within the 1-year TOT pose a high hazard to the Townsend PWS wells. Overall, the susceptibility is Other PCSs located in the 1- to 3-year TOT inventory region pose a moderate hazard. The overall susceptibility is Regular equipment maintenance, following best management practices, and implementation of spill response plans may prevent contaminants from entering groundwater that supplies the PWS wells.

Class V Injection Wells – Locations have not been determined to date for this type of discharge. However, if any are located in the inventory region they could allow infiltration of contaminated water into area groundwater. The hazard and susceptibility for this potential contaminant source cannot be determined until additional information concerning their locations is identified. The Townsend PWS operator(s) could play a vital role in helping the U.S. EPA determine Class V injection well locations.

Chapter 5: 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. Following are descriptions of the different types of waivers. Monitoring waiver recommendations for White Sulphur Springs follows these descriptions.

Use Waivers

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

Susceptibility Waivers

If a Use Waiver is not granted, a system may still be eligible for a Susceptibility Waiver, if through a vulnerability assessment it is demonstrated that the water source would not be susceptible to contamination. Susceptibility is based on prior analytical or vulnerability assessment results, environmental persistence, and transport of the contaminants, natural protection of the source, wellhead protection program efforts, and the level of susceptibility indicators (such as nitrate and coliform bacteria). The vulnerability assessment of a surface water source must consider the watershed area above the source, or a minimum fixed radius of 1.5 miles upgradient of the surface water intake. PWSs developed in unconfined aquifers should use a minimum fixed radius of 1.0 miles as an area of investigation for the use of organic chemicals. Vulnerability assessment of spring water sources should use a minimum fixed radius of 1.0 miles 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. Review of an organic chemical monitoring waiver application will be conducted by DEQ's PWS Section and DEQ's Source Water Protection Program. 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,

Susceptibility Waiver for Unconfined Aquifers

Unconfined aquifers are the most common source of usable groundwater. Unconfined aquifers differ from confined aquifers in that the groundwater is not regionally 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 a 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.

Waiver Recommendation

Currently, Townsend has a Phase II inorganic monitoring waiver for wells 1& 2. Based on past monitoring results it appears that the Townsend wells would also be eligible for a Phase V inorganic monitoring waiver (J. Mullen, personal communication, 2003). The monitoring waiver has not been granted as of the date of this report.

Summary

The Townsend PWS Source Water Delineation and Assessment Report was prepared to assist Townsend to protect their two PWS wells from potential sources of contamination. The report provides information concerning the aquifer that supplies water to Townsend's wells, identifies the control zones, the inventory region, and recharge region. In addition to these protection areas, a surface water buffer was delineated around a portion of the Missouri River flowing upgradient of Townsend. Significant potential contaminant sources that may impact the wells are identified in each of these protection areas. Management recommendations that indicate how significant potential contaminant sources could be better managed to prevent impacts to the Townsend wells are also provided.

The next phase of source water protection for Townsend would be for the City to take the information presented in this report and use it to develop a Source Water Protection Plan. The Source Water Protection Plan would clearly identify: 1) strategies to reduce the likelihood of contaminant releases in the inventory region, 2) the persons to contact and procedures to follow in the event that either of the Townsend wells becomes threatened by regulated contaminants, and 3) identify alternate sources of drinking water.

REFERENCES

Freeze, R. Allan and Cherry, John A., 1979, Groundwater

Kinoshita, W.T., Davis, W.E., Smedes, Harry W., Nelson, Willis H., 1964, Bouger Gravity, Aeromagnetic, and Generalized Geologic Map of Townsend and Duck Creek Pass Quadrangles, Broadwater County, Montana, United States Geological Survey, Geophysical Investigations Map GP-439.

Lorenz, H.W. and McMurtrey, R.G., 1956, Geology and Occurrence of Ground Water in the Townsend Valley Montana, United States Geological Survey Water-Supply Paper 1360-C.

Montana Bureau of Mines and Geology, 2003, Groundwater Information Center, lithologic well logs.

Montana Department of Environmental Quality Public Water Supply Section, 2003, Safe Drinking Water Information System (SDWIS).

Montana Department of Environmental Quality Underground Storage Tank Program web-site.

Ross, Clyde P., Andrews, David A., and Witkind, Irving J., 1955, Geologic Map of Montana, Montana Bureau of Mines and Geology.

United States Census Bureau, 2000

United States Environmental Protection Agency "Envirofacts Data Warehouse and Applications".

United States Geological Survey. 2000. National Landcover Dataset, Montana. 30 meter electronic digital landcover dataset interpreted from satellite imagery.

Western Regional Climate Center wrcc@dri.edu, Montana Climate Summaries.

GLOSSARY*

Acute Health Effect. A negative health effect in which symptoms develop rapidly.

Alkalinity. The capacity of water to neutralize acids.

Aquifer. A water-bearing layer of rock or sediment that will yield water in usable quantity to a well or spring.

Barrier. A physical feature or management plan that reduces the likelihood of contamination of a water source from a potential contaminant source

Best Management Practices (BMPs). Methods for various activities that have been determined to be the most effective, practical means of preventing or reducing non-point source pollution.

Biennial Reporting System (BRS). An EPA database that contains information on hazardous waste sites. The data can be accessed through the EPA Envirofacts website.

Chronic Health Effect. A negative health effect in which symptoms develop over an extended period of time.

Class V Injection Well. Any pit or conduit into the subsurface for disposal of waste waters. The receiving unit for an injection well typically represents the aquifer, or water-bearing interval.

Coliform Bacteria. A general type of bacteria found in the intestinal tracts of animals and humans, and also in soils, vegetation and water. Their presence in water is used as an indicator of pollution and possible contamination by pathogens.

Community. A town, neighborhood or area where people live and prosper.

Comprehensive Environmental Cleanup and Responsibility Act (CECRA). Passed in 1989 by the Montana State Legislature, CECRA provides the mechanism and responsibility to clean up hazardous waste sites in Montana.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Enacted in 1980. CERCLA provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). A database that provides information about specific sites through the EPA Envirofacts website.

Confined Animal Feeding Operation (CAFO). Any agricultural operation that feeds animals within specific areas, not on rangeland. Certain CAFOs require permits for operation.

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 present above a confined aquifer that inhibits the flow of water and maintains the pressure of the ground water in the aquifer. The physical properties of a confining unit may range from a five-foot thick clay layer to shale that is hundreds of feet thick.

Delineation. The process of determining and mapping source water protection areas.

Glacial. Of or relating to the presence and activities of ice or glaciers. Also, pertaining to distinctive features and materials produced by or derived from glaciers.

Geographic Information Systems (GIS). A computerized database management and mapping system that allows for analysis and presentation of geographic data.

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

Hazard. A relative measure of the potential of a contaminant from a facility or associated with a land use to reach the water source for a public water supply. The location, quantity and toxicity of significant potential contaminant sources determine hazard.

Hydraulic Conductivity. A constant number or coefficient of proportionality that describes the rate water can move through an aquifer material.

Hydrology. The study of water and how it flows in the ground and on the surface.

Hydrogeology. The study of geologic formations and how they effect ground water flow systems.

Inventory Region. A source water management area for ground water systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified three year ground water travel time.

Lacustrine. Pertaining to, produced by, or formed in a lake or lakes.

Large Capacity Septic System. Defined by Underground Injection Control regulations as an on-site septic system serving 20 or more persons.

Leaking Underground Storage Tank (LUST). A release from a UST and/or associated piping into the subsurface.

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 to establish concentrations of contaminants in drinking water that are protective of human health.

Montana Bureau of Mines and Geology – Ground Water Information Center (MBMG/GWIC). The database of information on all wells drilled in Montana, including stratigraphic data and well construction data, when available.

Montana Pollutant Discharge Elimination System (MPDES). A permitting system that utilizes a database to track entities that discharge wastewater of any type into waters of the State of Montana.

National Pollutant Discharge Elimination System (NPDES). A national permitting system that utilizes a database to track entities that discharge wastewater into waters of the United States.

Nitrate. An important plant nutrient and type of inorganic fertilizer that can be a potential contaminant in water at high concentrations. In water the major sources of nitrates are wastewater treatment effluent, 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. Examples of nonpoint- source pollution include agriculture, forestry, and run-off from city streets. Nonpoint sources of pollution, such as the use of herbicides, can concentrate low levels of these chemicals into surface and/or ground waters at increased levels that may exceed MCLs.

Pathogens. A microorganism typically found in the intestinal tracts of mammals, capable of producing disease.

Phase II (and IIb) Rules. EPA updated or created legal limits on 38 contaminants. The rules became effective July 30, 1992 and January 1, 1993. Some of these contaminants are frequently-applied agricultural chemicals such as nitrate and others are industrial solvents.

Phase V Rule. EPA set standards for 23 contaminants in addition to those addressed by the Phase II Rules. The Phase V Rule became effective January 17, 1994. Some of these contaminants include inorganic chemicals such as cyanide and other Phase V contaminants are pesticides that enter water supplies through run-off from fields where farmers have applied them or by leaching through the soil into ground water. Six are probable cancer-causing agents. Others

can cause liver and kidney damage, or problems of the nervous system and brain.

Point Source. A stationary location or a fixed facility from which pollutants are discharged. This includes any single identifiable source of pollution, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fracture, container, rolling stock (tanker truck), or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutant. Generally, any substance introduced into the environment that adversely affects the usefulness of a resource (e.g. groundwater used for drinking water).

Permit Compliance System (PCS). An EPA database that provides information on the status of required permits for specific activities for specific facilities. The data can be accessed through the EPA Envirofacts website.

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

Pumping Water Level. Water level elevation in a well when the pump is operating.

Recharge Region. An area in which water is absorbed that eventually reaches the zone of saturation in one or more aquifers. As a source water management region, the term generally describes the entire area that could contribute water to an aquifer used by a public water supply. Includes areas that could contribute water over long time periods or under different water usage patterns.

Resource Conservation and Recovery Act (RCRA). Enacted by Congress in 1976. RCRA's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner.

Resource Conservation and Recovery Information System (RCRIS). Is a database that provides information about specific sites through the EPA Envirofacts website.

Secondary Maximum Contaminant Levels (SMCL). The maximum concentration of a substance in water that is recommended to be delivered to users of a public water supply based on aesthetic qualities. SMCLs are non-enforceable guidelines for public water supplies, set by EPA under authority of the Safe Drinking Water Act. Compounds with SMCLs may occur naturally in certain areas, limiting the ability of the public water supply to treat for them.

Section Seven Tracking System (SSTS). SSTS is an automated system EPA uses to track pesticide producing establishments and the amount of pesticides they produce.

Source Water. Any surface water, spring, or ground water source that provides water to a public water supply.

Source Water Delineation and Assessment Report (SWDAR). A report for a public water supply that delineates source water protection areas, provides an inventory of potential contaminant sources within the delineated areas, and evaluates the relative susceptibility of the source water to contamination from the potential contaminant sources under "worst-case" conditions.

Source Water Protection Areas. For surface water sources, the land and surface drainage network that contributes water to a stream or reservoir used by a public water supply. For ground water sources, the area within a fixed radius or three-year travel time from a well, and the land area where the aquifer is recharged.

Spill Response Region. A source water management area for surface water systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified four-hour water travel time in a stream or river.

Standard Industrial Classification (SIC) Code. A method of grouping industries with similar products or services and assigning codes to these groups.

Static Water Level (SWL). Water level elevation in a well when the pump is not operating.

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

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

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

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

Toxicity. The quality or degree of being poisonous or harmful to plants, animals, or humans.

Toxicity Characteristic Leachate Procedure. A test designed to determine whether a waste is hazardous or requires treatment to become less hazardous.

Toxic Release Inventory (TRI). An EPA database that compiles information about permitted industrial releases of chemicals to air and water. Information about specific sites can be obtained through the EPA Envirofacts website.

Transmissivity. A number that describes the ability of an aquifer to transmit water. The

transmissivity is determined by multiplying the hydraulic conductivity time the aquifer thickness.

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

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

Underground Storage Tanks (UST). A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals, and the associated plumbing system.

Volatile Organic Compounds (VOC). Chemicals such as petroleum hydrocarbons and solvents or other organic chemicals that evaporate readily to the atmosphere.

Watershed. The region drained by, or contributing water to, a stream, lake, or other water body of water.

* With the exception of the definitions for Lacustrine, Phase II and Phase V Rules, and Standard Industrial Classification Code, definitions were adapted from EPA's Term References System (formerly known as Glossary of Selected Terms and Abbreviations) which can be found at: http://www.epa.gov/trs/index.htm

The definitions of glacial and lacustrine were taken from the Glossary of Geology by Robert L. Bates and Julia A. Jackson.

The definitions for Phase II and Phase V Rules were adapted from:
http://www.epa.gov/OGWDW/source/therule.html#PhaseII
http://www.epa.gov/OGWDW/source/therule.html#PhaseV

The definition for Standard Industrial Classification Code was adapted from:
EPA/Office of Enforcement and Compliance Assurance: Guide to Environmental Issues: Glossary of Terms & Acronyms *Term Detail*

APPENDICES

APPENDIX A
Well Logs

APPENDIX B
Water Quality Data

APPENDIX C
Time-of-Travel Equations

APPENDIX D
Potential Contaminant Sources in the
Townsend Inventory Region

APPENDIX A

Well Logs

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
CITY OF TOWNSEND - WELL 1 (WL002)

Plot this site on a topographic map

Location Information

GWIC Id:	19319	Source of Data:	LOG
Location (TRS):	07N 02E 31 BADB	Latitude (dd):	46.3239
County (MT):	BROADWATER	Longitude (dd):	-111.5274
DNRC Water Right:	W010757-00	Geomethod:	MAP
PWS Id:	00344002	Datum:	1927
Block:		Certificate of Survey:	
Lot:		Type of Site:	WELL
Addition:			

Site Notes: TRACT LOCATION BASED ON LAT\LONG FROM DEQ.

Well Construction and Performance Data

Total Depth (ft):	60.00	How Drilled:	CHURN
Static Water Level (ft):	9.00	Driller's Name:	LINDSAY
Pumping Water Level (ft):	14.00	Driller License:	WWC038
Yield (gpm):	650.00	Completion Date (m/d/y):	8/17/1960
Test Type:	PUMP	Special Conditions:	
Test Duration:	9.00	Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	120SDMS
Recovery Time (hrs):		Well/Water Use:	PUBLIC WATER SUPPLY
Well Notes:			

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information[1]

From	To	Dia	Description
-3.0	37.0	13.0	50 LB STEEL

Annular Seal Information

From	To	Description
0.0	10.0	CEMENT

Completion Information[1]

From	To	Dia	Description
37.0	60.0	13.0	SIZE 50 JOHNSON WELL SCREEN

Lithology Information

From	To	Description
0.0	9.0	TOPSOIL, SOME SAND AND SILT
9.0	29.0	VERY LOOSE SAND AND GRAVEL
29.0	32.6	TIGHT GRAVEL
32.6	43.0	LOOSE COARSE SAND AND GRAVEL
43.0	44.0	TIGHT GRAVEL
44.0	47.0	VERY LOOSE, MEDIUM SIZE GRAVEL
47.0	49.0	VERY TIGHT GRAVEL
49.0	58.0	FIRM GRAVEL WITH SOME VERY FINE SAND
58.0	60.0	LARGE LOOSE CLEAN GRAVEL

[1] - All diameters reported are **inside** diameter of the casing.

These data represent the contents of the GWIC databases at the Montana Bureau of Mines and Geology at the time and date of the retrieval. The information is considered unpublished and is subject to correction and review on a daily basis. The Bureau warrants the accurate transmission of the data to the original end user. Retransmission of the data to other users is discouraged and the Bureau claims no responsibility if the material is retransmitted. Note: non-reported casing, completion, and lithologic records may exist in paper files at GWIC.

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
CITY OF TOWNSEND - WELL 2 (WL003)

Plot this site on a topographic map

Location Information

GWIC Id:	19301	Source of Data:	LOG
Location (TRS):	07N 02E 31 BBCD	Latitude (dd):	46.3136
County (MT):	BROADWATER	Longitude (dd):	-111.5310
DNRC Water Right:	W010756-00	Geomethod:	MAP
PWS Id:	00344003	Datum:	1927
Block:		Certificate of Survey:	
Lot:		Type of Site:	WELL
Addition:			

Site Notes: TRACT LOCATION BASED ON LAT\LONG FROM DEQ.

Well Construction and Performance Data

Total Depth (ft):	50.00	How Drilled:	CHURN
Static Water Level (ft):	8.00	Driller's Name:	LINDSAY
Pumping Water Level (ft):	24.00	Driller License:	WWC038
Yield (gpm):	600.00	Completion Date (m/d/y):	10/20/1958
Test Type:	PUMP	Special Conditions:	
Test Duration:	8.00	Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	120SDMS
Recovery Time (hrs):		Well/Water Use:	PUBLIC WATER SUPPLY
Well Notes:			

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information[1]

From	To	Dia	Description
-4.0	30.0	12.0	50 LB STEEL

Annular Seal Information

From	To	Description
0.0	12.0	CEMENT

Completion Information[1]

From	To	Dia	Description
30.0	50.0	12.0	JOHNSON EVERDUR WELL SCREEN

Lithology Information

From	To	Description
0.0	13.0	SOIL CLAY, SOME GRAVEL
13.0	14.0	FINE SAND
14.0	22.0	LOOSE MEDIUM SIZED WASHED SAND AND GRAVEL
22.0	23.0	VERY FINE SAND
23.0	26.0	LOOSE SAND AND GRAVEL MEDIUM SIZE AND SILTY
26.0	36.0	VERY CLEAN MEDIUM GRAVEL, SOME FINE SAND
36.0	38.0	MEDIUM TO COARSE GRAVEL, FINE RUNNING SAND, VERY HEAVY SAND CONTENT

38.0	40.0	TIGHT MEDIUM SAND AND GRAVEL
40.0	43.6	LOOSE COARSE SAND AND GRAVEL
43.6	44.6	VERY TIGHT SAND AND CLAY BOUND GRAVEL
44.6	47.0	LOOSE MEDIUM GRAVEL AND FINE SAND
47.0	50.0	FIRM COARSE GRAVEL AND FINE SAND

[1] - All diameters reported are **inside** diameter of the casing.

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
CITY OF TOWNSEND (Inactive Well)

Plot this site on a topographic map

Location Information

GWIC Id:	19312	Source of Data:	
Location (TRS):	07N 02E 31 A	Latitude (dd):	46.3222
County (MT):	BROADWATER	Longitude (dd):	-111.5187
DNRC Water Right:		Geomethod:	TRS-TWN
PWS Id:		Datum:	1927
Block:		Certificate of Survey:	
Lot:		Type of Site:	WELL
Addition:			
Site Notes:			

Well Construction and Performance Data

Total Depth (ft):	93.00	How Drilled:	
Static Water Level (ft):	9.00	Driller's Name:	
Pumping Water Level (ft):	55.00	Driller License:	1
Yield (gpm):	440.00	Completion Date (m/d/y):	1/1/1970
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	120SDMS
Recovery Time (hrs):		Well/Water Use:	PUBLIC WATER SUPPLY
Well Notes:			

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information[1]

From	To	Dia	Description
0.0	0.0	12.0	

Annular Seal Information

No Seal Records currently in GWIC.

Completion Information[1]

From	To	Dia	Description
55.0	60.0	0.0	

Lithology Information

No Lithology Records currently in GWIC.

[1] - All diameters reported are **inside** diameter of the casing.

APPENDIX B

Water Quality Data

Townsend Public Water System Well Water Quality Data

WELL NAME	PARAMETER SAMPLED	CONCENTRATION	UNIT	COLLLECTION DATE
WELL 1 BROADWAY ST	1,1,1-TRICHLOROETHANE	0		16-Apr-91
WELL 1 BROADWAY ST	1,1,1-TRICHLOROETHANE	0		12-Jul-93
WELL 1 BROADWAY ST	ANTIMONY	0		12-Jul-93
WELL 1 BROADWAY ST	ARSENIC	0.001	MG/L	12-Jul-93
WELL 1 BROADWAY ST	BARIUM	0.063	MG/L	12-Jul-93
WELL 1 BROADWAY ST	BERYLLIUM	0		12-Jul-93
WELL 1 BROADWAY ST	CADMIUM	0		12-Jul-93
WELL 1 BROADWAY ST	CHROMIUM	0		12-Jul-93
WELL 1 BROADWAY ST	DINOSEB	0		12-Jul-93
WELL 1 BROADWAY ST	FLUORIDE	0.4	MG/L	12-Jul-93
WELL 1 BROADWAY ST	MERCURY	0		12-Jul-93
WELL 1 BROADWAY ST	NICKEL	0		12-Jul-93
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	0.77	MG/L	12-Jul-93
WELL 1 BROADWAY ST	OXAMYL (VYDATE)	0		12-Jul-93
WELL 1 BROADWAY ST	POLYCHLORINATED BIPHENYLS (PCB)	0		12-Jul-93
WELL 1 BROADWAY ST	SELENIUM	0		12-Jul-93
WELL 1 BROADWAY ST	SIMAZINE	0		12-Jul-93
WELL 1 BROADWAY ST	THALLIUM	0		12-Jul-93
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	0.78	MG/L	22-Aug-95
WELL 1 BROADWAY ST	1,1,1-TRICHLOROETHANE	0		10-Dec-96
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	0.79	MG/L	10-Dec-96

Townsend Public Water System Well Water Quality Data

WELL NAME	PARAMETER SAMPLED	CONCENTRATION	UNIT	COLLLECTION DATE
WELL 1 BROADWAY ST	1,1,1-TRICHLOROETHANE	0		08-Jul-97
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	1.17	MG/L	08-Jul-97
WELL 1 BROADWAY ST	1,1,1-TRICHLOROETHANE	0		23-Nov-98
WELL 1 BROADWAY ST	ANTIMONY	0		23-Nov-98
WELL 1 BROADWAY ST	BERYLLIUM	0		23-Nov-98
WELL 1 BROADWAY ST	DINOSEB	0		23-Nov-98
WELL 1 BROADWAY ST	NICKEL	0		23-Nov-98
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	1.38	MG/L	23-Nov-98
WELL 1 BROADWAY ST	OXAMYL (VYDATE)	0		23-Nov-98
WELL 1 BROADWAY ST	POLYCHLORINATED BIPHENYLS (PCB)	0		23-Nov-98
WELL 1 BROADWAY ST	SIMAZINE	0		23-Nov-98
WELL 1 BROADWAY ST	THALLIUM	0		23-Nov-98
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	0.96	MG/L	24-Aug-99
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	0.89	MG/L	24-May-00
WELL 1 BROADWAY ST	1,1,1-TRICHLOROETHANE	0	MG/L	06-Dec-01
WELL 1 BROADWAY ST	ANTIMONY	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	ARSENIC	0		10-Sep-02
WELL 1 BROADWAY ST	BARIUM	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	BERYLLIUM	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	CADMIUM	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	CHROMIUM	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	DINOSEB	0	MG/L	10-Sep-02

Townsend Public Water System Well Water Quality Data

WELL NAME	PARAMETER SAMPLED	CONCENTRATION	UNIT	COLLLECTION DATE
WELL 1 BROADWAY ST	FLUORIDE	0.41	MG/L	10-Sep-02
WELL 1 BROADWAY ST	MERCURY	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	NICKEL	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	NITRATE+NITRITE (AS N)	1.09	MG/L	10-Sep-02
WELL 1 BROADWAY ST	OXAMYL (VYDATE)	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	POLYCHLORINATED BIPHENYLS (PCB)	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	SELENIUM	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	SIMAZINE	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	THALLIUM	0	MG/L	10-Sep-02
WELL 1 BROADWAY ST	1,1,1-TRICHLOROETHANE	0	MG/L	13-Sep-02
WELL 2 RAILROAD AVE	1,1,1-TRICHLOROETHANE	0		16-Apr-91
WELL 2 RAILROAD AVE	1,1,1-TRICHLOROETHANE	0		12-Jul-93
WELL 2 RAILROAD AVE	ANTIMONY	0		12-Jul-93
WELL 2 RAILROAD AVE	ARSENIC	0.009	MG/L	12-Jul-93
WELL 2 RAILROAD AVE	BARIUM	0.078	MG/L	12-Jul-93
WELL 2 RAILROAD AVE	BERYLLIUM	0		12-Jul-93
WELL 2 RAILROAD AVE	CADMIUM	0		12-Jul-93
WELL 2 RAILROAD AVE	CHROMIUM	0		12-Jul-93
WELL 2 RAILROAD AVE	DINOSEB	0		12-Jul-93
WELL 2 RAILROAD AVE	FLUORIDE	0.6	MG/L	12-Jul-93
WELL 2 RAILROAD AVE	MERCURY	0		12-Jul-93
WELL 2 RAILROAD AVE	NICKEL	0		12-Jul-93
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	0.59	MG/L	12-Jul-93
WELL 2 RAILROAD AVE	OXAMYL (VYDATE)	0		12-Jul-93

Townsend Public Water System Well Water Quality Data

WELL NAME	PARAMETER SAMPLED	CONCENTRATION	UNIT	COLLLECTION DATE
WELL 2 RAILROAD AVE	POLYCHLORINATED BIPHENYLS (PCB)	0		12-Jul-93
WELL 2 RAILROAD AVE	SELENIUM	0		12-Jul-93
WELL 2 RAILROAD AVE	SIMAZINE	0		12-Jul-93
WELL 2 RAILROAD AVE	THALLIUM	0		12-Jul-93
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	0.74	MG/L	22-Aug-95
WELL 2 RAILROAD AVE	1,1,1-TRICHLOROETHANE	0		10-Dec-96
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	0.85	MG/L	10-Dec-96
WELL 2 RAILROAD AVE	1,1,1-TRICHLOROETHANE	0		08-Jul-97
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	0.95	MG/L	08-Jul-97
WELL 2 RAILROAD AVE	1,1,1-TRICHLOROETHANE	0		23-Nov-98
WELL 2 RAILROAD AVE	ANTIMONY	0		23-Nov-98
WELL 2 RAILROAD AVE	BERYLLIUM	0		23-Nov-98
WELL 2 RAILROAD AVE	DINOSEB	0		23-Nov-98
WELL 2 RAILROAD AVE	NICKEL	0		23-Nov-98
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	1.43	MG/L	23-Nov-98
WELL 2 RAILROAD AVE	OXAMYL (VYDATE)	0		23-Nov-98
WELL 2 RAILROAD AVE	POLYCHLORINATED BIPHENYLS (PCB)	0		23-Nov-98
WELL 2 RAILROAD AVE	SIMAZINE	0		23-Nov-98
WELL 2 RAILROAD AVE	THALLIUM	0		23-Nov-98
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	1.23	MG/L	24-Aug-99
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	0.55	MG/L	24-May-00
WELL 2 RAILROAD AVE	ANTIMONY	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	ARSENIC	0.009	MG/L	10-Sep-02

Townsend Public Water System Well Water Quality Data

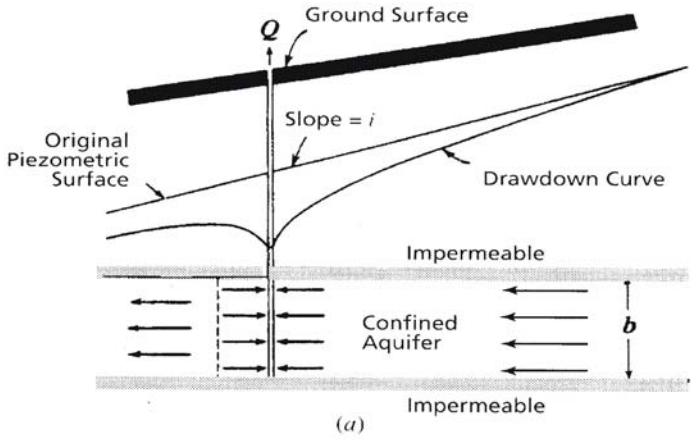
WELL NAME	PARAMETER SAMPLED	CONCENTRATION	UNIT	COLLLECTION DATE
WELL 2 RAILROAD AVE	BARIUM	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	BERYLLIUM	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	CADMIUM	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	CHROMIUM	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	DINOSEB	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	FLUORIDE	0.72	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	MERCURY	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	NICKEL	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	NITRATE+NITRITE (AS N)	2.33	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	OXAMYL (VYDATE)	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	POLYCHLORINATED BIPHENYLS (PCB)	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	SELENIUM	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	SIMAZINE	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	THALLIUM	0	MG/L	10-Sep-02
WELL 2 RAILROAD AVE	1,1,1-TRICHLOROETHANE	0	MG/L	13-Sep-02

APPENDIX C

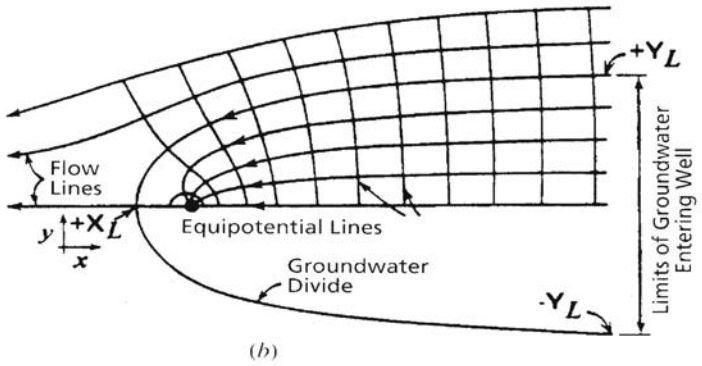
Time-of-Travel Calculations

UNIFORM GROUNDWATER FLOW EQUATION

Flow to a well penetrating a confined aquifer having a sloping plane piezometric surface - vertical section and plan view (Todd, 1980).



(a)



(b)

$$-\frac{Y}{X} = \tan\left(\frac{2\pi Kbi}{Q}Y\right)$$

Uniform-Flow Equation

$$X_L = -\frac{Q}{2\pi Kbi}$$

Distance to Down-Gradient Null Point

$$Y_L = \pm\frac{Q}{2Kbi}$$

Boundary Limit

Legend:

- Pumping Well

Where:

Q = Well Pumping Rate
K = Hydraulic Conductivity
b = Saturated Thickness
i = Hydraulic Gradient
π = 3.1416

TIME-OF-TRAVEL CALCULATION METHOD

The time of travel for water to move along a line parallel to the hydraulic gradient, from a point to a pumping well (EPA 1991).

$$T_X = \frac{n}{Ki}\left[X_L - \frac{Q}{2\pi Kbi} \ln\left(1 + \frac{2\pi kbi}{Q} X_L\right)\right]$$

T_X	=	travel time from point x to a pumping well
n	=	porosity
X_L	=	distance from pumping well over which groundwater travels in T_X
Q	=	discharge
K	=	hydraulic conductivity
b	=	aquifer thickness
i	=	hydraulic gradient

APPENDIX D

Listing of Identified
Potential Contaminant Sources

Appendix E

Concurrence Letter