Stockett
Water and Sewer District
Public Water System

PWSID # MT0000579

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

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INTRODUCTION

Russell Levens, Hydrogeologist with the Montana Department of Environmental Quality (DEQ) completed this Source Water Delineation and Assessment Report. Beverly Pepos, certified operator for the Stockett Water and Sewer Discrict public water system, reviewed the report for accuracy.

PURPOSE

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for the Stockett Water and Sewer District as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (P.L. 104-182).

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protect public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is "delineation and assessment". Delineation is a process of mapping source water protection areas that contribute water used for drinking. Assessment involves identifying locations or regions in source water protection areas where contaminants may be generated, stored, or transported, and then determining the relative potential for contamination of drinking water by these sources. The primary purpose of this source water delineation and assessment report is to provide information to help the Stockett Water and Sewer District complete a source water protection plan to protect its drinking water source.

Limitations

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

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

CHAPTER 1

BACKGROUND

The Community

Stockett is a small, unincorporated community with approximately 140 residents, located 13 miles southeast of Great Falls in Cascade County (Figure 1). The population of Cascade County was estimated at 78,282 in 1999, most of who live in Great Falls. Most residents of Stockett either work in Great Falls or are retired.

The basis of the economy around Stockett is small-grain farming and ranching. The only businesses in town are a restaurant/bar, a liquor store, a heavy construction contractor, and a bookeeping and tax service. There are no other public water systems. Sewage is collected in a sanitary sewer system and treated at a wastewater plant north of town.

Geographic Setting

Stockett is located along Cottonwood Creek (HUC# 10030102120) between flat-topped benches that slope gently to the north away from the Little Belt Mountains (Figure 1). This tableland topography is dissected by generally north-flowing tributaries of the Missouri River.

Stockett is at approximately 47.4° north-latitude and 111.1° west-longitude and 3,750 feet above sea level. The average high and low temperatures at the nearest weather station in Great Falls are 85° and 56° in July and 34° and 14° in January. The climate is semi-arid with precipitation averaging 15 inches per year concentrated in May and June. Snowfall averages 46 inches per year. Wind is a constant presence on the bench tops, quickly blowing snow into coulees or melting it during chinooks, warm winds that can raise the air temperature 50° in a few hours.

Irrigated and dryland farming, and cattle grazing are the primary land uses. Stockett is in a historical coal-mining district dating to the late 1800's with many abandoned underground mines underlying the benches near town.

General Description of the Source Water

Stockett Water and Sewer District gets water from an infiltration gallery and a well. The infiltration gallery consists of two 100-foot long laterals that intercept groundwater at the site of a perennial spring that discharges from alluvium along Cottonwood Creek. An 830-foot deep well completed in the Mission Canyon limestone of the Madison Group serves as a backup water source when demand exceeds the spring capacity. Besides the public water supply wells, five private wells are listed in the Montana Bureau of Mines and Geology Ground Water Information Center database for the Stockett area (approximate locations of all wells are shown on Figure 2 and well logs are included in

Appendix D). Three wells in Stockett and one near Stockett's infiltration gallery are completed at less than 50 feet in alluvium. Completion information is not available for the fifth private well located at a farmstead east of the infiltration gallery.

Table 1. List of geologic or hydrogeologic maps for the Centerville area.

Type Of Map & Features	Scale	Area Covered	Reference
Potentiometric surface map of water in the Madison Group, Montana	1:500,000	Western half of state	Feltis, 1980
Contours in feet on the top of the Madison Group	1:500,000	Western half of state	Feltis, 1980, (2)
Geologic Map of the Southeast Great Falls Quad.	1:24,000	7.5 Minute Quad.	Osborne et al., 1987

The Public Water System

The Stockett Water and Sewer District serves 225 residents through 83 active service connections. Water from the infiltration gallery flows to a clear well and then by gravity through a pipeline approximately 1 ½ miles to Stockett. Sodium hypochlorite is injected for disinfection approximately 300 feet downstream from the clear well. The backup well near the junction of Stockett Road and Cottonwood Coulee Road, a 100,000-gallon storage tank near the south end of town, and the distribution lines complete the system (see Appendix A for map of system).

Water Quality

The Stockett Water and Sewer Disctrict's water is routinely monitored for compliance with drinking water standards. Bacteriological monitoring occurs monthly. Compliance with other drinking water standards is based on additional sampling on a variety of schedules. Among regulated contaminants, nitrate and coliform bacteria were detected in the last five years. Nitrate can come from fertilizer, or human or animal wastes but also is naturally occurring. The highest level of nitrate was 3.16 mg/L detected at the entry point for the spring infiltration gallery. This nitrate concentration is below the maximum contaminant level of 10 mg/L set by the U.S. Environmental Protection Agency (EPA) but appears to be elevated. Coliform bacteria were detected on two occasions in the past five years with a health advisory resulting from one instance when coliform bacteira also was detected in a repeat sample.

Analyses of water samples from Stockett's spring and well, and a well in alluvium and mine drainage near Stockett's spring are available from the Montana Bureau of Mines and Geology, Ground-Water Information Center (GWIC) (Table 2). Low pH and high concentrations of dissolved iron, sulfate, and other ions that characterize the mine drainage samples result from oxidation of sulfide minerals associated with coal and adjacent rocks. Analyses of samples from Stockett's spring and well and the well near Stockett's spring are similar and do not exhibit obvious signs of contamination by mine drainage. However, evidence presented by the Montana Bureau of Mines and Geology indicates that mine drainage has contaminated alluvium in the Stockett area and has reached the Madison Aquifer north of Stockett (Osborne, 1987).

Table 2. Concentrations of major ions in wells in and near Stockett (MBMG).

GWIC #	Depth ft	pH	Sc S/cm	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Fe mg/L	Mn mg/L	SiO_2 mg/L	HCO_3 mg/L	Cl mg/L	SO_4 mg/L	NO_3 mg/L	TDS
162423 Stockett Spring	NA	7.36	760	104.0	38.3	13.9	5.2	<0.003	<0.002	11.2	433.1	4.9	67.1	2.9	461
2284 Stockett Well	830	7.63	519	64.3	33.4	5.9	2.5	0.002	0.001	9.4	277.7	2.1	69.3	1.29	328
2167 Alluvium	13	7.34	970	90.0	41.8	12.0	3.5	0.006	0.003	11.6	389	4.9	70.8	7.07	434
***144853 Mine Drainage**	NA	2.9	4328	346.1	139.9	15.1	3.7	732.8	2.34	93.9	0	2.45	5028	0.15	6643
***2165 Mine Drainage**	NA	2.75	5651	347.5	142	14.2	1.7	912	2.38	104.7	0	6.7	5703	0.23	6466

* averages of multiple samples

CHAPTER 2

DELINEATION

Areas that contribute water to the Stockett Water and Sewer District's spring and backup well are identified in this chapter. Four management regions are identified (control zone, inventory region, surface water buffer, and recharge region). The goal of management in the control zone is to protect against direct introduction of contaminants into the spring, well, or the immediate surrounding areas. The inventory region and surface water buffer should be managed to prevent release of contaminants that could flow to the spring or well before being removed by natural processes. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage.

Geologic Conditions and Aquifer Characteristics

Most of the following description of geologic conditions near Stockett is summarized from a report published by the Montana Bureau of Mines and Geology (MBMG) (Osborne et al., 1987). Bedrock in the vicinity of Stockett ranges from Mississippian age Madison Group to Cretaceous age Blackleaf Formation (Figure 3). A sandstone layer at the base of the Blackleaf Formation and mudstone and sandstone layers of the Kootenai Formation top the benches around Stockett. Mudstone with minor sandstone layers and coal beds of the Morrison Formation outcrop along coulee walls. Sandstone of the Swift Formation and limestone of the Madison Group outcrop along the base of coulees or underlie alluvium near Stockett, and outcrop in the foothills of the Little Belt Mountains.

Geologic structure near Stockett is characterized by a broad arch gently dipping toward the northwest from the Little Belt Mountains (Wilke, 1983). The regional bedrock dip near Stockett is 1.5° , N35° W (Daniel and others, 1986). Average orientations of near vertical fracture pairs that extend through the Kootenai, Morrison, and Swift formations as measured by Osborne, et al. (1987) were N35° E and N56° W at one location and N44° E and N50° W at another location. Orientations of Walker Coulee, Sand Coulee, and many lesser, unnamed coulees generally parallel the northeast trending fracture set.

Important aquifers near Stockett include sandstone layers in the Kootenai, Morrison, and Swift formations and limestone in the Mission Canyon limestone of the Madison Group. Alluvium filling coulee bottoms yields water to wells but often is contaminated by mine drainage or sewage disposal systems and has generally been abandoned as a water source. Kootenai and Morrison aquifers mostly receive recharge from bench tops and discharge to underground mines or outcrops along coulees. The Madison Group and Swift Formation behave as a single aquifer unit that is recharged at its outcrops and where it underlies alluvium along coulees. Water from the Swift/Madison aquifer upwells through overlying formations to feed Giant Springs along the Missouri River at Great Falls.

According to Osborne et al. (1987), groundwater flow in the Kootenai follows the regional fracture trend to the northeast. In contrast, a potentiometric map prepared by Feltis (1980) indicates groundwater flow in the Swift/Madison aquifer is parallel to the regional bedrock dip with a hydraulic gradient of approximately 0.005. Static water levels in wells measured by Osborne, et al. (1987) indicate that vertical groundwater flow is downward from bedrock and alluvium overlying the Swift/Madison aquifer.

Alluvium along Cottonwood Creek that feeds Stockett's infiltration gallery consists of an estimated 20 feet of light brown sand, silt, and clay with coarser lenses (Erickson and Wheaton, 1999). Bedrock beneath the infiltration gallery is Swift Formation consisting of fine- to coarse-grained calcareous sandstone containing interbeds of shale and conglomerate. Underlying the Swift is the Mission Canyon Formation consisting of gray limestone known to contain large voids or caverns in wells drilled in the Stockett area. Stockett's well is completed in the Swift/Madison aquifer.

A hydrogeologic analysis by the Montana Bureau of Mines and Geology (Erickson and Wheaton, 1999) concluded that Stockett's infiltration gallery probably is not under the direct influence of surface water for the purpose of compliance with the surface water treatment rule. The findings of this report do not imply that alluvium at the infiltration gallery is not hydraulically connected to Cottonwood Creek but that there probably is sufficient natural filtration to remove insects or other microorganisms and to reduce turbidity.

Table 3. List of Geologic or hydrogeologic research activities in the Stockett area.

Title Of Project	Period Of Project	Location Or Area Covered	Project Objectives
Interaction Between Ground Water and Surface Water Regimes and Mining-induced Acid Mine Drainage (AMD) in the Stockett-sand Coulee Coal Field	1980-1983	Sand Coulee Creek Watershed	To formulate acid mine drainage mitigation techniques
Appraisal of Water in Bedrock Aquifers, Northern Cascade County, Montana	1979-1983	Northern Cascade County (780 sq. mi.)	To describe the occurrence and chemical quality of water in bedrock aquifers
Acid Mine Drainage Control in the Sand Coulee Creek and Belt Creek Watersheds, Montana 1983-1987; V.1 and V.2	1983-1987	Sand Coulee Creek and Belt Creek Watersheds	To test hydrogeologic techniques of acid mine drainage control
Hydrogeologic Assessment of the Stockett, Montana Public Water Supply for Ground Water Under the	1999	Cottonwood Creek near Stockett	To determine if Stockett's Spring Radial Collection System is under the direct

Direct Influence of Surface Water			influence of surface water

Conceptual Model

The Stockett Water and Sewer District's Spring Radial Collection System gets water from alluvium along Cottonwood Creek (see cross-section in Figure 4). Losses from Cottonwood Creek in addition to precipitation and groundwater discharge from bedrock are probably sources of recharge to alluvium at the spring. The aquifer tapped by the spring is classified as unconsolidated alluvium (unconfined) having high sensitivity to contamination, pending final determination of its groundwater under the direct influence status.

Recharge to the Swift/Madison aquifer used by Stockett's well is from precipitation and losses from streams at its outcrops and downward leakage from overlying alluvium and fractured bedrock. Groundwater flow direction is uncertain, but is generally north. Because younger mudstone layers have been removed by erosion, the Swift/Madison aquifer probably is unconfined at Stockett. Consequently, the aquifer is classified as shallow fractured or carbonate bedrock having high sensitivity.

Water Sources

Stockett Water and Sewer Disctrict's Spring Radial Collection System is 1 ½ miles southeast of Stockett along Cottonwood Creek. The system was constructed in the early 1980's and redesigned and reconstructed in 1989 (Erickson and Wheaton, 1999). The gallery consists of two 100-foot long, eight-inch diameter PVC slotted well screens (laterals) laid horizontally and connected to a central clear well. The laterals are oriented perpendicular to groundwater flow direction and laid in a bed of washed gravel. Design capacity of the infiltration gallery was 150 gpm.

Stockett's backup well is approximately 450 feet southwest of the of the intersection of state Highway 227 (Stockett Road) and Cottonwood Coulee Road. Drilled in 1977, the well is 830 feet deep and yielded 50 gpm in a flow test conducted when it was completed (see Table 4 for completion details and Appendix D for well log).

Table 4. Source well information for the Stockett Water and Sewer District.

-	**Spring Radial Collection System Source #002**	**Post Office Town Well #1 Source #003**
MBMG #	162423	2284
Water Right #	Unknown	Unknown
Latitude / Longitude	47.3373 ° / -111.1543 °	47.3546 ° / -111.1657 °
Date Completed	1989	12/14/77
Depth	17 ft	830 ft
Perforated Interval	16 – 17 ft	Unknown
Static Water Level	Unknown	300 ft
Pumping Water Level	Unknown	Unknown
Drawdown	Unknown	Unknown
Test Rate	150 gpm	50 gpm
Pumping Specific Capacity	Unknown	Unknown
Source Type	Unconsolidated Alluvium (unconfined)	Shallow Fractured or Carbonate Bedrock

Aquifer Properties

Estimates including aquifer flow properties, well discharge rate, groundwater gradient, and ambient groundwater flow direction are used in this section to estimate one-year and three-year groundwater times-of-travel for Stockett's infiltration gallery and for their well (Table 5; Appendix B). Times-of-travel are needed to define boundaries of the inventory regions for Stockett's two sources and to determine susceptibility. Aquifer flow properties estimated are transmissivity, hydraulic conductivity, thickness, and effective porosity. Flow test data and representative published values were used to estimate transmissivity and hydraulic conductivity. Lithology descriptions from well logs and published data were used to estimate effective porosity and thickness. Maps of geologic structure, land slope, and groundwater elevations were used to estimate groundwater gradient and flow direction.

Hydraulic Conductivity and Transmissivity – Hydraulic conductivity is a measure of the ease at which water flows through porous materials such as rock or soil and transmissivity is a measure of the ease at which water flows through the full thickness of an aquifer. Estimates of hydraulic conductivity and transmissivity are based on well yield data reported on well logs and data for similar rocks published in texts and literature.

Thickness –Thickness of the alluvial aquifer along Cottonwood Creek is estimated by the saturated thickness of gravel reported in the plans for the Stockett Spring Radial Collection System (approximately 10 ft). Thickness of the Swift/Madison aquifer at Stockett is estimated at 50 ft although it could be as much as several hundred feet (the total thickness of the Swift/Madison aquifer). Smaller aquifer thicknesses yield larger time-of-travel distances so a 50 ft thickness should result in a conservative delineation (i.e a larger inventory region).

Effective Porosity - Total porosity, the percent of a rock occupied by voids, of alluvium similar to that along Cottonwood Creek typically ranges from 25 to 40 percent depending on the proportions of clay, sand, and gravel. Sandstone and limestone similar to the Swift/Madison aquifer typically have total porosities ranging from 2 to 30 percent depending on the porosity of the original sediment and subsequent cementing or dissolution (Freeze and Cherry, 1979). The porosity that water actually flows through, called effective porosity, usually is less than total porosity. Therefore, effective porosities of 20 and five percent were used for alluvium and the Swift/Madison aquifer respectively.

Groundwater Gradient and Flow Direction – The groundwater gradient and flow direction in the alluvium tapped by Stockett's spring is estimated from the gradient and flow direction of Cottonwood Creek. For Stockett's well, a range of groundwater flow directions is estimated from the regional dip of the Swift/Madison aquifer and the strike of steep dipping fractures in the vicinity of Stockett (Osborne et al., 1987). Groundwater gradient is estimated from the regional dip of the Swift/Madison aquifer (0.015) and a potentiometric map (0.005) (Feltis, 1965). To account for uncertainty in groundwater flow direction a 45-degree range of groundwater flow directions was used to define the inventory region.

Well Production – Well production is estimated from typical water use values published in the Manual of Small Public Water Supply Systems (EPA, 1991) and information in public water supply files at DEQ. The total well production used to calculate time-of-travel is approximately 175 gallons per person per day or approximately double the value obtained from the Manual of Small Public Water Supply Systems.

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

Input Parameter	Spring Radial Collection System		Post Office Town Well #1	
	Range	Value Used	Range	Value Used
Hydraulic Conductivity	50 – 5,000 ft/day	500 ft/day	5 - 500 ft/day	50 ft/day
Thickness	2 – 15 ft	10 ft	10 - 200 ft.	50 ft.
Transmissivity	100 – 10,000 ft/day	5,000 ft^2/day	100 – 10,000 ft^2/day	2,500 ft^2/day
Effective Porosity	10 – 25 %	20 %	1-20 %	5 %
Gradient	0.005 -0.030	0.01	0.005 - 0.015	0.01
Well Production	20,000 – 50,000 gal/day	30,000 gal/day	0 – 40,000 gal/day	10,000 gal/day
Flow Direction	N22.5ºW – N22.5ºE	N	N35ºW - N40ºE	N45ºW - N45ºE
One-Year Time-of-Travel	0.7 – 4.5 mi	1.8 mi	0.2 - 3.5 mi	0.8 mi
Three-Year Time-of-Travel	1.9 – 13.2 mi	5.3 mi	0.4 mi - 10.4 mi	2.1 mi

Times-of-travel listed in Table 5 are uncertain because properties of the alluvium along Cottonwood Creek and the Swift/Madison aquifer are naturally variable and there are limited data on them. Hydraulic conductivity can vary by a factor of 100 and estimates of thickness and effective porosity can vary by a factor of 10. Groundwater gradients could be in error by a factor of four and groundwater flow directions could be off by 45° . The accuracy of hydraulic conductivity estimates affects the accuracy of time-of-travel estimates the most because hydraulic conductivity values are highly uncertain and because time-of-travel calculations are highly sensitive to different hydraulic conductivity values. Time-of-travel calculations also are highly sensitivity to different values of effective porosity and groundwater gradient, although these properties are known more accurately than hydraulic conductivity. In the cases of the alluvium along Cottonwood Creek and the Swift/Madison aquifer at Stockett, aquifer thickness and well yield have the least affect on the accuracy of time-of-travel estimates.

Delineation Results

DEQ's Source Water Protection Program (DEQ, 1999) specifies methods and criteria used to delineate subregions of the source water protection area for the Stockett Water and Sewer District. Following this guidance, control zones consisting of 100-ft radius circles were delineated for each source. The boundary of the inventory region for Stockett's spring was delineated by the boundaries of the alluvium along Cottonwood Creek and the calculated three-year time-of-travel distance (Figures 5). The inventory region for the backup well extends 1,000 feet down gradient and in a 45° wedge for a three-year time-of-travel distance up gradient (Figure 6). In addition, outcrops of the Swift/Madison aquifer along Number 5 Coulee are included in the inventory region for Stockett's well because time-of-travel estimates are highly uncertain in aquifers, such as the Swift/Madison aquifer, where large voids may be encountered. Outcrops are areas where water can infiltrate directly to the aquifer and potentially follow interconnected flowpaths to Stockett's well.

Surface water buffers are delineated to include all land and water between benches for ten miles upstream from each of Stockett's water sources. A fixed 1,000-ft buffer delineates the surface water buffer when coulees are less than 1,000 feet wide (Figure 5 and Figure 6). The extent of alluvium along Cottonwood Creek delineates the recharge region for Stockett's infiltration gallery and outcrops in the foothills of the Little Belt Mountains delineate the recharge region for Stockett's well.

Limitations

The reader should keep in mind that this delineation is based on estimated properties and groundwater flow conditions. Conclusions based on this interpretation are uncertain because the extent and properties of the aquifer, and the direction and rate of groundwater flow are not known precisely. Nonetheless, conservative selection of parameters for time-of-travel calculations should assure that Stockett Water and Sewer District's source water protection areas include all significant potential contaminant sources.

CHAPTER 3

INVENTORY

Potential sources of contamination were inventoried to assess the susceptibility of Stockett's drinking water sources to contamination. Potential sources of contaminants subject to primary drinking water standards and cryptosporidium were identified. The contaminant source inventory for the Stockett focuses on all activities in the control zone, municipal and private facilities in the inventory region, potential sources of nitrate and microbial contaminants in the surface water buffer, and general land uses and large facilities in the recharge region. Nitrate, pathogens, and pesticides were the most common potential contaminants identified in Stockett's source water protection area.

Inventory Method

Databases were searched to identify businesses and land uses that are potential sources of regulated contaminants. The following steps were followed:

Step 1: Urban and agricultural land uses were identified from landcover data collected by the Montana Gap Analysis project (Redmond et al., 1998).

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 on the basis of Standard Industrial Classification 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, 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. Abandoned Mines
4. Hazardous waste contaminated sites
5. Underground storage tanks
6. Major roads or rail transportation routes
7. Cultivated cropland
8. Animal feeding operations
9. Wastewater lagoons or spray irrigation
10. Septic systems
11. Sewered residential areas
12. Storm sewer outflows
13. Floor drains, sumps, or dry wells

Inventory Results/Control Zones

The control zone for Stockett's spring radial collection system is undeveloped grassland and hay fields. Application of pesticides and fertilizers on the hay field is a potential contaminant source in this area. Cottonwood Avenue and one or more residences are within 100 feet of Stockett's well. Road oil and chemicals from small spills are potential contaminants along Cottonwood Avenue. Small quantities of pesticides, fuels, and solvents are stored and pesticides are used for weed and insect control at residences. No septic systems are located within 100 ft of either of Stockett's sources, however a sewer main is within the control zone for Stockett's well.

Inventory Results/Inventory Regions-Surface Water Buffer

Spring Radial Collection System

Landcover in the inventory region is 56 percent grass or shrubs, 37 percent riparian vegetation, four percent forest, and three percent irrigated cropland (Figure 7). An abandoned coal mine underlies the bench immediately east of the inventory region (Figure 9). The surface water buffer also is mostly grass and shrubs (61 percent) but includes a greater proportion cropland (25 percent combined dryland and irrigated). There are three homes or farmsteads within the surface water buffer.

Contamination from cropland may result from improper mixing, handling, and application of pesticides or fertilizer. Nitrate and microbial contaminants from septic systems and motor fuel may contaminate ground water at homes or farmsteads. Low pH water containing metals that drains from portals of the abandoned coal mine east of the inventory region can reach the spring by infiltrating alluvium along Cottonwood Creek.

Post Office Town Well #1

Landcover in the inventory region is 75 percent grass or shrubs, 4 percent riparian vegetation, 10 percent forest, and 11 percent cultivated cropland (Figure 8). Two abandoned coal mines are included in the inventory region (Figure 9). The surface water buffer also is 57 percent grass and shrubs, 11 percent riparian vegetation, 7 percent forest, and 25 percent cropland. There are several homes or farmsteads within the surface water buffer.

Again, contamination from cropland may result from improper mixing, handling, and application of pesticides or fertilizer. Nitrate and microbial contaminants from septic systems and motor fuel may contaminate ground water at homes or farmsteads. Low pH water containing metals that drains from portals of abandoned coal mines can reach the well through fractures in bedrock or through alluvium in contact with the Swift/Madison aquifer.

Table 6. Significant potential contaminant sources for Stockett's water sources.

Water Source	Potential Contaminant Source	Hazard
Spring Radial Collection System	Cultivated Cropland	Spills and excess application of pesticides and fertilizer
	Residential Septic Systems	Infiltration of untreated sewage
	Abandoned Coal Mines	Drainage containing high dissolved solids and metals infiltrating the aquifer
Post Office Town Well #1	Stockett Sanitary Sewer	Leaks
	Residential Septic Systems	Infiltration of untreated sewage
	Stockett Road	Fuel spills from vehicle accidents
	Abandoned Coal Mines	Drainage containing high dissolved solids and metals infiltrating the aquifer

Inventory Results/Recharge Region

Roughly 30 percent of the recharge region is cultivated dryland or irrigated crops and the remainder is grassland or shrubs. Hogs and other livestock are raised at a concentrated animal feeding operation (CAFO) approximately six miles southeast of Stockett and small farmsteads are scattered throughout the remainder of the recharge region. Application of pesticides and fertilizer on cropland, fuels stored at farmsteads, and animal waste applied on cropland at the CAFO are potential contaminant sources in the recharge region.

Inventory Update

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

Inventory Limitations

The potential sources of contaminants for the Stockett Water and Sewer District public water supply were determined from readily available information. Unregulated activities or unreported contaminant releases may have been missed; however, multiple sources of data were used to help ensure that any major threats to the Stockett’s water sources are identified.

CHAPTER 4

SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a well to be contaminated by one of the potential contaminant sources sources inventoried in the previous chapter. Hazard ratings and the presence of barriers determine susceptibility (Table 7). Hazard ratings are determined by the proximity of a potential contaminant source to Stockett's infiltration gallery or well. Point contaminant sources within a one-year time-of-travel of Stockett's water sources are given a high hazard rating and all other point sources in the inventory region are given a moderate hazard rating. Hazard for cropland is based on the percent of the inventory region or surface water buffer cultivated for dryland or irrigated crops. Hazard for septic systems is based on their density as estimated by population density. Barriers can be engineered structures, management actions, and/or natural conditions. Examples of engineered barriers are liners in wastewater treatment lagoons and double-walled underground fuel storage tanks. Chemical management plans and procedures for safe mixing and application of agricultural chemicals are considered management barriers. Finally, thick clay soils, a deep water table, and a deep well can be natural barriers.

Table 7. 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

The following are brief descriptions of the susceptibility assessments for each source included in Table 8.

Spring Radial Collection System

Septic Systems –Population density in the inventory region and surface water buffer is low and, accordingly, hazard for septic systems is rated low. Susceptibility is rated moderate because there are no barriers to contamination.

Abandoned Mines – Hazard is rated high because open portals of the abandoned mine to the east of the spring are within a one-year time-of-travel distance. Susceptibility is rated very high because there are no barriers.

Cultivated Cropland **–** Hazard is rated low because less than 20 percent of the inventory region or surface water buffer is cultivated cropland. Susceptibility is rated moderate because there are no barriers.

Post Office Town Well #1

Septic Systems –Population density outside the Stockett sewer district is low and, accordingly, hazard for septic systems is rated low. Susceptibility is rated low because the combination of a thick unsaturated zone and depth of the well intake is a barrier.

Abandoned Mines – Hazard is rated high because an abandoned mine is within a one-year time-of-travel distance from Stockett's well. Susceptibility is rated high because the combination of thick unsaturated zone and depth of well intake is a barrier.

Cultivated Cropland **–** Hazard is rated low because less than 20 percent of the inventory region or surface water buffer is cultivated cropland. Susceptibility is rated low because a combination of a thick unsaturated zone and depth of well intake is a barrier.

Sanitary Sewer **–** Hazard is rated high because sewer mains are within the control zone of the well. Susceptibility is rated very high because the only reliable barrier in the control zone is a properly sealed well and little is known about the construction of the Post Office Town Well #1.

Table 8. Susceptibility of Stockett's water sources to significant potential contaminant sources in the inventory regions and surface water buffers.

-	Source	Contaminant	Contaminant Origin	Hazard Rating	Barriers	Susceptibility	Management
Spring Radial Collection System	Abandoned Mines	Metals	Infiltration of mine drainage	High	None	Very High	Monitoring
	Septic Systems	Nitrate and Microbial Contaminants	Drain field leachate	Low	None	Moderate	Monitor residential growth
	Cultivated Cropland	Nitrate and Pesticides	Spills or excessive application	Low	None	Moderate	Provide information to land owners on proper chemical use
Post Office Town Well #1	Sanitary Sewer	Nitrate and Microbial Contaminants	Leaks from sewer mains	High	None	Very High	Monitoring and Maintenance
	Abandoned Mines	Metals	Infiltration of mine drainage	High	Thick unsaturated zone and deep intake	High	Monitoring
	Septic Systems	Nitrate and Microbial Contaminants	Drain field leachate	Low	Thick unsaturated zone and deep intake	Low	Monitor residential growth

	Cultivated Cropland	Nitrate and Pesticides	Spills or excessive application	Low	Thick unsaturated zone and deep intake	Low	Provide information to land owners on proper chemical use

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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.

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

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.

Hardness. Characteristic of water caused by presence of various chemical compounds. 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.

Hydrologic Unit Codes (HUC). Uniform, nationally consistent map codes for river basins.

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

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 nitrate pollution are septic tanks, sanitary sewers, feed lots and fertilizers.

Nonpoint-Source Pollution. Pollution sources such as stormwater runoff 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. Bacterial organisms 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.

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

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

Recharge Region. A source water management region that is generally the area that could contribute water to an aquifer used by a public water supply over long time periods or under different water usage patterns.

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.

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

Susceptibility (of a PWS). The potential for a public water supply to draw water with contamination that would pose concern

Synthetic Organic Compounds (SOC). Manmade 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.

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.

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

Volatile Organic Compounds (VOC). Organic compounds which evaporates readily to the atmosphere.

* Definitions taken from EPA's Glossary of Selected Terms and Abbreviations (http://www.epa.gov/ceisweb1/ceishome/ceisdocs/glossary/glossary.html)