Chico Hot Springs

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Source Water Delineation and Assessment Report

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This Source Water Delineation and Assessment Report, also known as a SWDAR, was completed by Jim Stimson, Hydrogeologist with Montana Department of Environmental Quality (DEQ) and by intern Chris Gourley.

Purpose

This report is intended to meet the technical requirements for completion of the delineation and assessment report 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 whereby areas that contribute water to aquifers or surface water bodies that are used to supply drinking water are identified on a map. These areas are called source water protection areas. Assessment involves identifying locations in the delineated 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 Chico Hot Springs protect its drinking water source.

Limitations

This report was prepared to assess threats to the Chico Hot Springs public water system 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 the Chico Hot Springs public water system and not any other public or private water system. Also, not all of the potential or existing sources of ground water or surface water contamination in the area are identified. Only potential sources of contamination in areas that contribute water to Chico Hot Springs public water system spring are considered.

The term “contaminant” is 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

At maximum capacity Chico serves about 350 people, 10 people live onsite year-round . Connections are present for 3 lodges, 5 houses, 3 cottages, 2 chalets, 4 cabins, the barn, pool, saloon, and private residence. Chico Hot Springs can be reached by traveling about 20 miles south of Livingston on US Highway 89 to Emigrant and then about 3 miles southeast on a paved road to the site on the eastern side of the Paradise Valley (Figure 1). The population of Park County was estimated at 15,982 in 1999 of which 7,626 live in Livingston.

Geographic Setting

Chico Hot Springs is located in the midwestern part of the Paradise Valley at approximately 45^{o}19'56"-north latitude and 110^{o}41'25"-west longitude. The site ranges in elevation from 5280 feet at the main lodge to 5510 feet at the spring site and is within the Upper Yellowstone Watershed (HUC # 10070002). The Paradise Valley separates the Absaroka-Beartooth and Gallatin mountain ranges and is approximately 35 miles long and 5 miles wide at its widest point about 15 miles south of Carter's Bridge. At its southern end near the mouth of Yankee Jim Canyon the valley is about 0.8 miles wide and near Carter's Bridge at the northern end, the valley is about 0.5 miles wide. The elevation of the valley floor in the north (Carter's Bridge) is about 4,540 feet above sea level and 5,009 feet above sea level to the south near the mouth of Yankee Jim Canyon. Mountain peaks within both the Absaroka-Beartooth and Gallatin ranges rise above 10,000 feet above sea level and relief between the peaks and valley floor is on the order of 5,000 feet.

The average daily high and low temperatures at Livingston are 84.6°F and 51.7°F in July and 34.8°F and 16.2°F in January. Precipitation averaging 17.9 inches annually is heaviest in May and June. Average annual snowfall is 44.2 inches.

General Aquifer Setting

The Chico Hot Springs Public Water Supply is fed by a spring located on Forest Service land about a quarter of a mile south of the resort near a small dry drainage. Collection pipes capture the water and feed it into two concrete spring boxes. The spring was evaluated for possibly being ground water under the influence of surface water. A microscopic particulate analysis (MPA) was conducted upon the recommendation of a draft hydrologic assessment report by Alan English (attached). The MPA showed that the spring water was at low risk from being under the influence of surface water. Copies of the MPA and the draft hydrologic assessment are available from the DEQ upon request.

Water Quality

Water quality data from the Paradise Valley for 5 sites sampling springs and 5 others for wells comes from Clark, 1991. Calcium (Ca), sodium (Na), and bicarbonate (HCO_3) are the major dissolved constituents (Table 1). The pH averages just above being neutral at 7.3 and the total dissolved solid concentration ranges between 116 and 246 mg/l.

Table 1. Chemical analyses of water from the Paradise Valley, south of Livingston.

Hydrologic Source: Springs **Publication: Clark, 1990**

Location	Ca	Na	Mg	K	HCO3 Field	HCO3 Lab	Cl	SO4
A1	1.36	0.45	0.68	0.09	2.19	2.02	0.13	0.38
A3	1.79	0.43	0.8	0.1	2.56	2.54	0.15	0.39
N1	1.63	1.25	0.65	0.11	3.94	3.45	0.15	0.5
A6	2.2	1.25	0.65	0.11	3.94	3.95	0.15	0.64
Average	1.74	0.80	0.73	0.10	3.11	2.90	0.14	0.50
Max	2.20	1.25	0.87	0.11	3.94	3.95	0.15	0.64
Min	1.36	0.43	0.65	0.09	2.19	2.02	0.13	0.38

Location	SiO2	Sr	SI c	pH Field	pH Lab	TDS (mg/l)	SC Field	SC Lab
A1	0.37	120	-0.84	6.9	7.21	156.17	256	267.9
A3	0.46	150	-0.82	6.62	6.97	188.2	300	317.1
A5	0.55	180	-0.46	7.71	7.4	205.3	312	336.1
N1	0.42	160	-0.07	7.85	7.85	180.8	295	308.2
A6	0.46	270	-0.13	7.36	7.48	246.5	398	424.4
Average	0.45	176	-0.46	7.29	7.38	195.39	312	331
Max	0.55	270	-0.07	7.85	7.85	246.50	398	424
Min	0.37	120	-0.84	6.62	6.97	156.17	256	268

Hydrologic Source: Wells Publication: Clark, 1990

Location	Ca	Na	Mg	K	HCO3 Field	HCO3 Lab	Cl	SO4
04S09E04daa	1.46	0.77	0.47	0.09	2.5	2.21	0.17	0.37
03S09E10adc	1.78	1.67	0.15	0.04	3.35	3.36	0.04	0.19
03S09E36bdd	1.78	0.6	0.32	0.08	2.76	2.49	0.03	0.21
03S09E35dbb	1.53	0.49	0.23	0.06	2.23	2.09	0.02	0.17
PS	1.38	0.49	0.18	0.06	1.85	1.93	0.02	0.14
Average	1.59	0.80	0.27	0.07	2.54	2.42	0.06	0.22
Max	1.78	1.67	0.47	0.09	3.35	3.36	0.17	0.37
Min	1.38	0.49	0.15	0.04	1.85	1.93	0.02	0.14

Location	SiO2	Sr	SI c	pH Field	pH Lab	TDS (mg/l)	SC Field	SC Lab	Geologic Source
04S09E04daa	0.51	150	-0.94	6.9	7.05	174.4	247	288.3	Qal*
03S09E10adc	0.21	75	0.014	8.29	7.87	185.9	335	352.3	Mmc
03S09E36bdd	0.2	43	-0.4	7.2	7.45	152.2	266	286.5	Qaf**
03S09E35dbb	0.16	36	-0.77	7.06	7.22	126.4	231	242.1	Qaf**
PS	0.18	32	-1.07	7.25	6.95	116.8	202	221.7	Qaf**
Average	0.25	67.2	-0.63	7.34	7.31	151.14	256	278	
Max	0.51	150	0.01	8.29	7.87	185.9	335	352	
Min	0.16	32	-1.07	6.9	6.95	116.8	202	222	

* Qal = Yellowstone Aquifer in Clark's Thesis

**Qaf + Alluvial Fan Aquifer in Clark's Thesis

Monitoring and Enforcement Actions

The Chico Hot Springs PWS 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 depending on system classification and population served. Nitrate can come from human or animal wastes but also occurs naturally. The highest level detected in the Chico's spring in the last five years was 0.69 mg/l, considerably below the maximum concentration level of 10 mg/l set by the U.S. Environmental Protection Agency (EPA). Chico Hot Springs has had one bacteria hit within the past five years, repeat testing showed that the water supply was clear of bacterial contamination.

CHAPTER 2 - DELINEATION

The source water protection areas for Chico Hot Springs public water system are delineated in this chapter. The purpose of delineation is to map the source of the water supply's drinking water and to define areas within which to prioritize source water protection efforts. Four types of management regions are identified; they are the control zone, one-mile fixed radius inventory zone, the recharge region, and the surface water buffer zone.

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

Hydrogeologic Conditions

Descriptions of hydrogeologic conditions in the Paradise Valley and Livingston areas from reports by Montagne and Chadwick (1982), Groff (1962), Roberts (1972), and Clark (1991) are summarized in this section. The Paradise Valley of the Yellowstone River separates the Absaroka Range to the east and Gallatin Range to the west. The high peaks of the Absaroka Range consist of Precambrian metamorphic rocks of the Beartooth Plateau (Figure 2). These rocks estimated to be nearly 3 billion years old were uplifted along deep-seated faults and sculpted by alpine glaciers. The Gallatin Range consists of Tertiary volcanic rock overlaying folded sedimentary layers and crystalline basement rock. At the northern-most end of the Paradise Valley, the Yellowstone River cuts through a canyon in steeply folded and faulted Paleozoic sedimentary rocks that make up the north end of both the Absaroka and Gallatin ranges.

Within the Paradise Valley, bedrock ranging in age from Precambrian through the Tertiary is exposed at the land surface. There are also younger deposits derived from glacial activity and the Yellowstone River. The Paradise Valley is interpreted to be a Basin and Range-style block faulted basin (Reynolds, 1979). The basin beneath the valley is tilted to the east, toward the Deep Creek normal fault that marks the western-most boundary of the Absaroka-Beartooth mountain front. The basin also dips to the south. Depth to bedrock near the north-end of the valley is estimated to be about 50 feet (Kirby, 1940 from Clark, 1991), while to the south, a deep well has penetrated nearly 6,000 feet of Tertiary and Quaternary rocks (Clark, 1991). In this regard, the basin beneath the Paradise Valley is comparable to the one beneath the Big Hole Valley in southwestern Montana (Clark, 1991, see also Levings, 1986). Because the alluvial aquifer thins to the north within the valley, some ground water flow is directed to the surface, as indicated by the Armstrong and Nelson springs. Movement along several geologic faults that cross the Paradise Valley may have contributed to thinning of the aquifer and the location of these springs. Ground-water flow gradients are thought to be directed upward from the aquifer toward the Yellowstone River alluvium in the north part of the valley. As a result, ground water likely exits the valley to the north as surface water rather than ground-water "underflow". In the middle and southern parts of the Paradise Valley, ground-water flow is generally from upland regions toward the Yellowstone River and then northward.

Published reports on ground-water resources in the Paradise Valley usually mention five potential aquifers including 1) Quaternary Yellowstone River alluvium, glacial outwash and alluvial fan deposits, 2) Miocene lake sediments in the vicinity of Hepburn Mesa, 3) Eocene volcanic lava flows, 4) the Mississippian age Madison Limestone, and 5) older bedrock formations of various ages. However, ground water is obtained primarily from shallow wells drilled into the Yellowstone River alluvium, glacial outwash and alluvial fan deposits which function essentially as a continuous aquifer (Clarke, 1991). The other potential aquifers listed do provide water to wells but they are often not as productive and reliable as the Yellowstone River alluvial aquifer. The Madison Limestone is considered to have potential as a reliable source of ground water but there are only a few wells completed in the Madison within the Valley. Again, as a general rule, bedrock formations that are older than the Madison are generally not considered to be reliable sources of ground water.

The Montana Ground Water Information Center (GWIC) records about 1,400 wells in the Paradise Valley. Of these, about 40% are less than 75 feet deep and 80% of the wells are less than 200 feet deep. The deepest well is 1,600 feet and is completed in a sand and gravel aquifer. Examining well depths within the Valley shows that wells north of Spring and Suce Creeks average about 74 feet deep with a average yield of 36 gallons per minute (gpm) while the average depth for wells to the south is about 142 feet and average yield is 29 gpm.

Chico Hot Springs can be reached by traveling about 20 miles south of Livingston on US Highway 89 to Emigrant and then about 3 miles southeast on a paved road to the site on the eastern side of the Paradise Valley. The Chico Hot Springs PWS provides water for 20 service connections. It is unclear from current information what the exact resident, transient, and non-transient populations served by the water supply are. Information from the most current sanitary survey puts the resident population at about 10 and the combined transient and non-transient at a maximum of 345. Water demand ranges from approximately 500 to 17,750 gallons per day assuming 50 gallons per day per resident, employee, or visitor (EPA, 1991). It is believed that the spring is fed from water out of the fractured dacite bedrock. Groundwater flow through these faults is fairly unpredictable but is believed to generally flow north-northwest.

Table 2. List of geologic or hydrogeologic maps available for the Livingston vicinity.

Description	Date	Area Covered	Reference
Local Geology	1964	Livingston 24K Quad	Roberts, A.E. 1964. Geology of the Livingston Quadrangle Montana, U.S. Geological Survey Geologic Quadrangle Maps of the United States, one-sheet.
Regional Geology	1972		Roberts, A.E. 1972. Cretaceous and Early Tertiary Depositional and Tectonic History of the Livingston Area, Southwestern Montana, Plates 1 and 3.

Conceptual Model

Aquifers within the Paradise Valley receive recharge from the melt-water moving off of the Gallatin Range to the west and the Absaroka-Beartooth Range to the east (Figure 3). Only a few of the larger stream tributaries flowing over the alluvial fans at the base of the Absaroka-Beartooth Range reach the Yellowstone River. The majority of the smaller tributaries have water flowing only in the upper reaches; the lower reaches are dry. This shows the streams lose water into the alluvial fan sediments and provide recharge to aquifers within these deposits. Clarke (1991) presented evidence that the water lost to the fans continues to flow into the Yellowstone River alluvium located down-gradient from the fans. In general, ground water flows from the upland areas toward the Yellowstone River and then northward toward the end of the valley in the vicinity of Carter's Bridge. The alluvial aquifer thins appreciably to the north resulting in several prominent springs emerging along the central part of the valley. The thinning likely causes ground-water flow in general to be directed upward and toward the Yellowstone River near the northern end of the Paradise Valley. The spring that Chico Hot Springs uses as its source water is located about 2,000 feet southeast of the resort near the base of the Absoroka-Beartooth Mountains (Figure 1). The exact location of the spring emerging from the bedrock is not exposed at the land surface and as a consequence, the origin of the cold-water spring is unclear. A hydrologic assessment of the cold-water spring was completed by Alan English of the Montana Bureau of Mines and Geology (MBMG) and concluded that the cold-water spring could be related to unmapped faults related to the range front fault. Water emerging from the cold-water spring is interpreted in this report to originate east of the spring site from precipitation and snow melt that infiltrates into the bedrock. An unnamed stream may also contribute water to the cold-water spring.

Source Spring

The source spring water emerges from an area mapped as fractured Tertiary dacite porphyry bedrock and is collected using perforated pipes buried in the spring discharge area. Water is delivered from the pipes to two deteriorating concrete collection boxes. These collection boxes are leaking, improperly sealed, and overall are in a bad state of repair. It is conceivable from their location on the hill and their general state of repair that surface water could enter and mix with the groundwater here. Water from the collection boxes flows by gravity down to the buildings onsite at approximately 87 pounds per square inch because of the 200 foot change in elevation.

Table 3. Field Parameters for Chico Hot Springs PWS, English (2000).

Parameter	Measurement
ph	7.27 Std. Units
Specidic Conductance	160 μmhos
Temperature	7.6°C
Eh	319 millivolts

Delineation

Methods and criteria for delineating source water protection areas are specified in the Montana Source Water Protection Program (DEQ, 1999). Source water protection areas delineated for Chico Hot Springs include controls zones for the spring and common inventory and recharge regions (Figure 4 & 6).

Control Zones - 100-foot radius control zones are delineated for the Chico Hot Spring's PWS; all sources of potential contaminants should be excluded in this region.

One-mile Fixed Radius Inventory Zone – The inventory zone is delineated as a one-mile fixed radius circle. Precipitation and snow melt east of the cold-water spring provide recharge for the source water. The unnamed stream may also contribute water to the cold-water spring. All sources of potential contaminants are inventoried in this region.

Recharge Region - On a broad scale, the entire Paradise Valley provides recharge to the alluvial aquifer used by the Chico Hot Springs public water supply. Efforts to maintain and improve water quality within the valley will benefit Chico and other public water supplies within the valley. Watersheds within the valley include the southern-most part of HUC# 10070002050, and hydrologic units 10070002010, 10070002020, 10070002030, and 10070002040. On a local scale, the Chico Hot Springs spring receives recharge in a shorter time frame from a smaller area or sub-watershed surrounding the wells (Figure 6). Changes in land use and management of potential contaminant sources within the smaller watershed will have a more immediate affect on the Chico's source water. The inventory for the recharge region includes both the smaller and larger watershed regions and focuses on potential sources of nitrate and pathogens. The goal of management in the recharge region is to maintain and improve the long-term quality of ground water in the alluvial aquifer.

Surface Water Buffer – A surface water buffer zone was delineated for the stream above the spring site, but it is not shown on any of the maps because no land uses within the buffer zone are considered significant potential contaminant sources.

Table 4. Note: Table 4 is omitted because time-of-travel calculations were not used to establish the

inventory regions.

CHAPTER 3 - INVENTORY

An inventory of potential contaminant sources was conducted to assess the susceptibility of the Chico Hot Springs PWS to contamination and to provide a foundation for source water protection planning. The inventory for Chico focuses on facilities that generate, use, or store potential contaminants and certain land uses in the inventory region delineated in the previous section. Sources of all primary drinking water contaminants and cryptosporidium are identified, although only potential sources of contaminants that are the greatest threat to human health were selected for detailed inventory. The contaminants of greatest concern to Chico Hot Springs are nitrate, microbial contaminants, and agricultural chemicals including fertilizers and pesticides.

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: Land cover is identified from the National Land Cover Dataset compiled by the U.S. Geological Survey and U.S. Environmental Protection Agency (USGS, 2000). Land cover types in this dataset were mapped from satellite imagery at 30-meter resolution using a variety of supporting information.

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

Step 3: DEQ databases were queried to identify underground storage tanks (UST), hazardous waste contaminated sites, landfills, and abandoned mines.

Step 4: A business phone directory was consulted to identify businesses that generate, use, or store chemicals in the inventory region. Equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers were targeted by 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, sources of nitrate and microbial contaminants were identified in the surface water buffer, 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 runoff
12) Floor drains, sumps, or dry wells

Inventory Results/Control Zones

The control zone for the Chico Hot Springs freshwater spring is located south-southeast and about 200 feet up the western slope of a hill from the main lodge. No structures other than the spring boxes are present in the control zone.

Inventory Results/One-mile Fixed Radius Inventory Zone

Land cover in the inventory region of Chico Hot Springs is 49 percent grassland, 10 percent shrubland, and 41 percent forest (Figure 5). Grassland, shrubland, and forest are not considered potential sources of contamination. Chico Hot Springs has at least one septic drainfield. Septic density in and around the Chico is of low density and is down-gradient from the Chico's PWS. Septic systems are considered potential sources of pathogens. Chico is believed to have at least 1 septic system and it considered a significant potential contaminant source because it is believed to be of large capacity, serving 20 or more people per day, and is located within the inventory region. Large capacity septic systems are considered point sources of potential contaminants when they are located within the inventory region.

No businesses that use or generate hazardous chemicals were identified in the inventory region. The most likely contaminants in the inventory region are microbial contaminants, nitrate and pesticides.

Structural problems and deterioration of the spring boxes are considered a potential source of contamination. Broken pipes or other openings in the structures create access for wildlife and insects, increasing the risk of pathogenic contamination.

Table 5. Significant potential contaminant sources in the inventory region of Chico Hot Springs public water system spring.

Source	Contaminants of Concern
Chico Hot Springs septic drainfields	Microbial contaminants and nitrate
Animal/wildlife wastes entering spring collection galleries	Microbial contaminants and nitrate

Inventory Result/Recharge Region and Surface Water Buffer Zone

Land use in the recharge region represented by HUC 10070002010 is 47 percent forest, 39 percent grassland,10 percent shrubland, and 2 percent ag-land (Figure 5). As mentioned above, forest, grasslands, and shrubland are not considered potential contaminant sources. The main concern for the recharge and surface water buffer regions would have to be pathogen or nitrate contamination from septic systems or ag-land. There is only a small portion of ag-land in the recharge and surface water buffer regions and it along with all of the septic systems are believed to be down-gradient from the spring.

Inventory Update

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

Inventory Limitations

The potential sources of contaminants described above are identified from readily available information. 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 source water for Chico Hot Springs have been identified.

CHAPTER 4 - SUSCEPTIBILITY ASSESSMENT

The susceptibility of the Chico Hot Springs PWS to contamination is assessed in this chapter. The proximity of a potential contaminant source to a spring or the density of non-point potential contaminant sources determines the threat of contamination, referred to here as hazard (Table 6). For Chico Hot Springs, a one–mile fixed radius inventory zone in conjunction with hydrogeologic mapping of the alluvial aquifer were used to identify areas from where possible contaminants could enter Chico's water supply. High hazard is assigned to significant potential contaminant sources within the one-mile fixed radius of Chico's spring, moderate and low hazard were assigned to potential sources outside the one-mile fixed radius inventory zone depending on distance and number of barriers. Hazard and the existence of barriers to contamination determine susceptibility (Table 7).

Barriers can be anything that decrease the likelihood that contaminants will reach a well or spring. Barriers can be engineered structures, management actions or natural conditions. Examples of engineered barriers are spill catchment structures for industrial facilities and leak detection for underground storage tanks. Emergency planning and best management practices can be considered management barriers. Thick clay-rich soils, a deep water table or a thick saturated zone above the well intake can be natural barriers.

Table 6**.** Hazard of potential contaminant sources for the Chico Hot Springs public water system.

	High Hazard	Moderate Hazard	Low Hazard
Point Sources of Contaminants	Within one-half mile of a well	From one-half to one mile (the limit of the inventory region)	Beyond the inventory region
Septic Systems	More than 300 per sq. mi.	50 – 300 per sq. mi.	Less than 50 per sq. mi.
Cropland (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region

Table 7. Susceptibility to potential contaminant sources based on 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

Susceptibility ratings are presented individually for each significant potential contaminant source in the inventory region and the surface water buffer (Table 8). In addition, Chico Hot Springs may be susceptible to contamination from Class V injection wells that have not been identified.

Chico Hot Springs Septic Systems – Hazard is rated high because the Chico's septic system(s) are large capacity and the drainfield and system are within the inventory zone. Susceptibility is rated low because the system(s) are located over 2,000 from the spring and are down-gradient from the spring

Chico Hot Springs Collection Galleries – Hazard is rated high due to the structural problems and deterioration noted in the sanitary survey. The concern is that pathogens will be introduced to the source water in the collection galleries.

Management Recommendations

Management recommendations are listed along with the susceptibility analysis in Table 8. Some of these recommendations are beyond Chico Hot Spring's control and are intended for governmental entities such as the City of Livingston or Park County that have the authority or ability to implement them. If implemented, these recommendations can be considered additional barriers that will reduce the susceptibility of Chico Hot Springs PWS to specific sources and contaminants.

Table 8. Susceptibility assessment for Chico Hot Springs PWS.

Source	Contaminant	Hazard Rating	Barriers	Susceptibility	Management
Large capacity septic system drainfields	Bacti / Nitrate	High	- Drainfields are down-gradient	Low	None Needed
Animal wastes and wildlife	Bacti / Nitrate	High	- None	Very High	Overhaul / Rebuild Spring Water Collection Galleries

Spring Water Collection Galleries – As noted in the sanitary survey, serious structural problems exist for the galleries. Overhauling or rebuilding the galleries could reduce the hazard and susceptibility ratings.

Inventory and permitting or closure of Class V injection wells – The U.S. EPA is implementing a program to identify and permit or close sumps, floor drains, dry wells, or commercial septic systems that are potential contaminant sources. This program is being implemented gradually with EPA planning to complete an assessment for Livingston within the next year. EPA's first step is to mail shallow well inventory request forms to businesses that often have Class V injection wells (they concentrate on automotive service businesses). EPA makes decisions on permitting and closure based on responses they receive and subsequent inspections. Permit recipients are required to sample their shallow injection wells quarterly and ensure that the fluid being injected meets drinking water standards.

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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.

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.

Delineation. A process of mapping source water management areas.

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

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

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

Inventory Region. A source water management area that encompasses the area expected to contribute water to a public water system within a fixed distance or a specified ground water 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 system. Set by EPA under authority of the Safe Drinking Water Act.

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

Nonpoint-Source. Pollution sources that are diffuse and do not have a single point of origin.

Pathogens. A bacterial organism 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. A system that provides piped water for human consumption to 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. A source water management region that is generally the entire area that could contribute water to an aquifer used by a public water system. 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.

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 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 system.

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

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

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

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). Any organic compound which evaporates readily to the atmosphere.

* Definitions taken from EPA’s Glossary of Selected Terms and Abbreviations