Source Water Delineation and Assessment Report

KING RANCH COLONY

Public Water Supply

PWSID # MT0000432

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List of Acronyms

AFO – Animal Feeding Operation

BMP - Best Management Practices

CAFO - Confined Animal Feeding Operation (generally larger numbers of animals)

CECRA - Comprehensive Environmental Cleanup and Responsibility Act

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act

DEQ – Montana Department of Environmental Quality

LUST - Leaking Underground Storage Tank

MCL - Maximum Contaminant Level

MBMG-GWIC - Montana Bureau of Mines and Geology – Ground Water Information Center

MPDES - Montana Pollutant Discharge Elimination System

NPDES - National Pollutant Discharge Elimination System

PWS - Public Water Supply

RCRA - Resource Conservation and Recovery Act

SMCL - Secondary Maximum Contaminant Levels

SWDAR - Source Water Delineation and Assessment Report.

SWPP - Source Water Protection Plan

SWL - Static Water Level

SOC - Synthetic Organic Compounds

TMDL - Total Maximum Daily Load

UST - Underground Storage Tank

VOC - Volatile Organic Compounds

See glossary at end of text for definitions of acronyms and other terms used in this report

1.0 INTRODUCTION

The Safe Drinking Water Act (SDWA) Amendments of 1996 requires states to develop and implement Source Water Assessment Programs (SWAP) to analyze existing and potential threats to the quality of the public drinking water supplies throughout the state. The Montana SWAP was formally approved by the US Environmental Protection Agency (EPA) in November 1999. The Montana SWAP was developed from the former Wellhead Protection Program, but includes surface water sources and requires a more rigorous inventory of potential contaminant sources. For communities that have already developed wellhead protection plans, SWAP revises these plans to meet the expanded requirements.

SWAP addresses only public water systems (PWS) regulated according to the Federal Safe Drinking Water Act. A public water supply system is defined, according to Federal and Montana regulations, as a system that supplies water for human consumption. A public water supply system has at least 15 service connections or regularly provides water to at least 25 persons daily for a minimum of 60 days in a calendar year.

Source water protection is a common sense approach to guarding public health by protecting drinking water supplies. Source water protection means preventing contamination and reducing the need for treatment of drinking water supplies. Source water protection also means taking positive steps to manage potential sources of contaminants and contingency planning for the future by determining alternate sources of drinking water. Protecting source water is an active step towards safe drinking water; a source water protection program (along with treatment, if necessary) is important for a community's drinking water supply. A community may decide to develop a source water protection program based on the results of a source water assessment, which includes the delineation of the area to be protected and an inventory of the potential contaminants within that area.

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to help public drinking water supplies protect their water source from contamination. The Montana Source Water Protection Program is responsible for completing delineation and assessment reports for all public water supplies in Montana. The Source Water Delineation and Assessment Report (SWDAR) compiles the appropriate data and other technical information about an area to allow PWSs to develop source water protection planning. Delineation is a process whereby areas that contribute water to aquifers or surface waters used for drinking water, called source water protection areas, are identified on a map. Geologic and hydrologic conditions are evaluated in order to delineate source water protection areas. Assessment involves identifying potential contaminant sources in delineated source water protection areas, and evaluating the potential for contamination of drinking water from these sources under “worst-case” conditions such as a flood, fire or human error. Although voluntary, source water protection plans are the ultimate focus of source water delineation and assessment. This delineation and assessment report is written to encourage and facilitate the King Ranch Colony in developing protection planning that meets their specific needs.

Scope and Purpose

This report presents the assessment for the King Ranch Colony public water supply. James Swierc, Hydrogeologist with the Montana Department of Environmental Quality (DEQ), prepared the original report (2002). Assistance was provided at that time by George Hofer, operator of the public water supply for the colony. The SWDAR was updated in 2014 by Jeffrey Frank Herrick, Hydrogeologist with DEQ’s Source Water Protection Program.

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for this 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).

Limitations

This report was prepared to assess threats to the King Ranch Colony (also known as the King Colony) public water supply (PWS), 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 sources for regulated public water supplies, and not any other type of water supply. The inventory of potential contaminant sources focuses on the management areas delineated for the public water supply in this report. As a result, other potential sources of contamination to surface and groundwater in the area may not be identified.

The term “contaminant” is used in this report to refer to any chemical or biologic constituent in water that are listed as regulated under state and federal regulations. Water constituents are generally regulated based on health effects that may occur when ingested at certain levels. Water quality standards are based on maximum concentration levels (MCLs). MCLs represent concentrations that may result in chronic or acute health problems when ingested. MCLs are based on the relative risk, or likelihood that health problems may occur and economics associated with a treatment technology for a specific constituent of water.

2.0 BACKGROUND

The Community / Colony

The King Ranch Colony is a Hutterite colony located in Fergus County, in central Montana (Figure 1). There are approximately 55 residents at the colony. The nearest town is Lewistown (population 5,813), located approximately 15 miles east of the colony. The economy of the colony relies on the production of a variety of agricultural products. Refer to Figure 1 for a map of the location of the King Ranch Colony and Figure 2 for a general layout of the Colony facilities.

The Colony complex comprises several residential buildings, a kitchen building, and several other buildings and facilities that support the agricultural activities at the colony. A map showing the layout of the colony is included with Appendix A. The colony PWS obtains water from a small spring located on the western side of the main colony complex. Wastewater is treated in a lagoon located east of the main colony buildings and east of Little Rock Creek. This location is downgradient from the spring source and all other colony buildings. Animal waste from the barns is stored in concrete pits, and is disposed by land application to cropland. Refer to Figure 2 for the general layout of the Colony.

Geographic Setting

King Ranch Colony is located in the south-central part of the Judith Basin as shown in Figure 1. The basin is bounded by the Little Belt and Big Snowy Mountains to the south, and the Moccasin Mountains to the north. The mountains in this area represent a significant feature with peaks that rise over 4,000 feet above the plains. Surface drainage in the area is to the north, with Little Rock Creek flowing through the eastern part of the main colony complex. Little Rock Creek is part of the Rock Creek Watershed (HUC #10040103040) of the Judith River Watershed (HUC #10040103) of the Lower Missouri River system in Montana.

The climate is typical of central Montana, with a limited amount of precipitation averaging 18.50 inches a year as measured in Lewistown. The wettest months are May and June averaging 2.94 and 3.60 inches a month, respectively. The driest months are November through February, with monthly averages ranging from 0.71 to 0.83 inches per month. The temperature ranges from an average high of 81.2°F in July (minimum July average of 49.4°F) to an average of 32.4°F in January (minimum January average of 9.9°F).

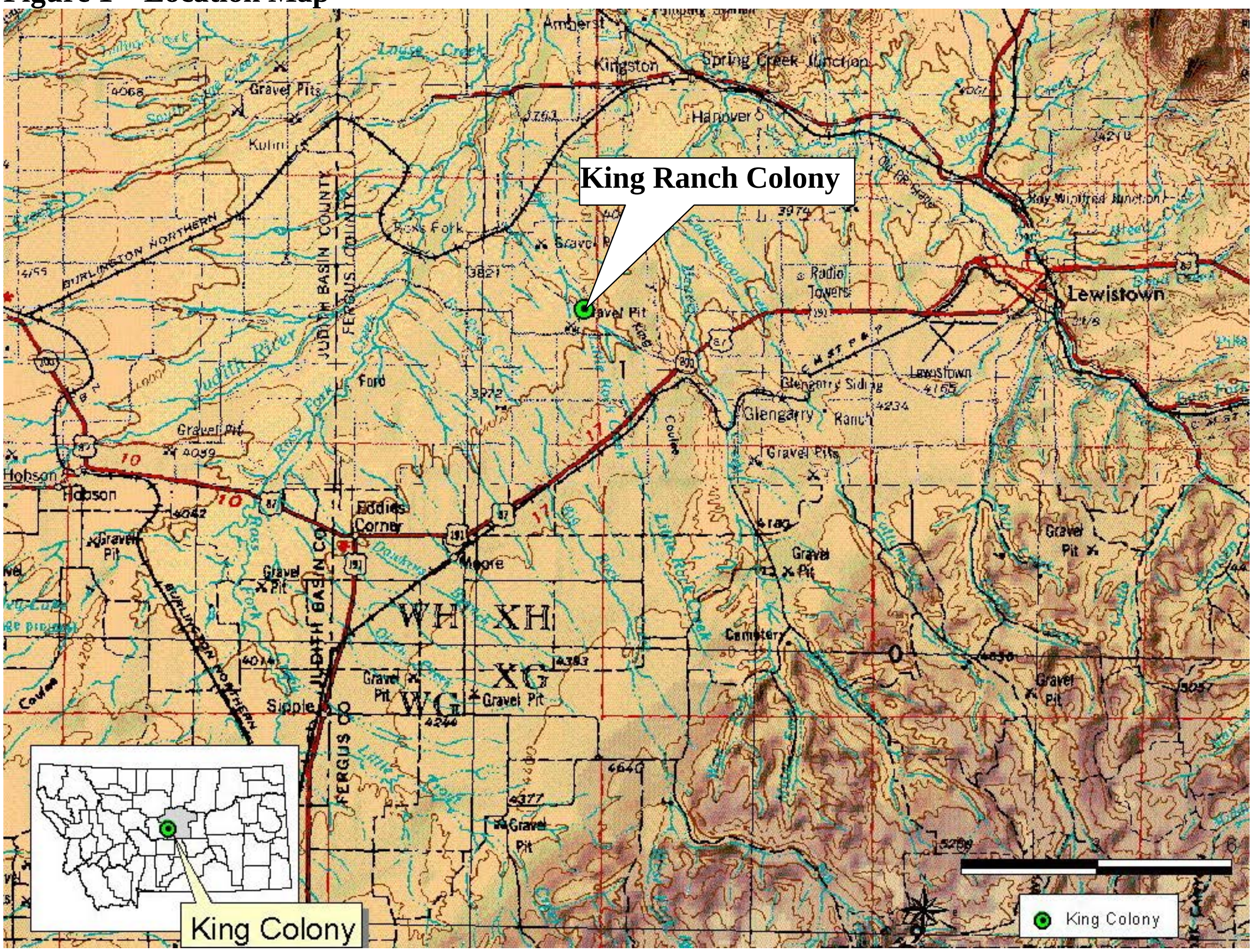
General Description of the Source Water

The King Ranch Colony PWS obtains drinking water from a spring source located within the western portion of the main colony complex. The hydrogeology of the system was summarized in Norbeck (2000). The source aquifer is interpreted to be the alluvial terrace gravels overlying the relatively impermeable shale of the Colorado Formation. Groundwater flows generally to the north, following the regional topographic gradient, on top of the shale. Beneath the Colony, the groundwater flow direction is modified by local topography. It probably flows to the north or more likely to the north northeast. The aquifer is recharged throughout the area south of the spring along all stream channels and anywhere the terrace gravels are exposed to surface water infiltration. The major source of recharge is interpreted to occur from stream loss as water flows over the Kootenai Formation onto the terrace gravels. It should be noted that wherever surface water is present in the area of the Colony, it is actually where groundwater is interacting with surface water. In addition, the water level in a stream or pond represents the water table elevation in the surrounding sediments. Figure 2 has a 2011 color aerial photo base and depicts the location of Little Rock Creek as it flows northwest along the east side of the Colony. Also depicted on the aerial photo are several old and now abandoned stream channels. These function as long ponds or drainage ditches present inside and around the Colony. Although surface water may not appear to flow along these old steam channels, groundwater will continue to preferentially flow along these features.

The Public Water Supply

The spring source for the PWS (Source 002) is located in the western part of the main colony complex (Figure 2). Information on the PWS for The King Ranch Colony was reviewed in the more recent sanitary surveys completed for the colony (most recently in September 2013). The information in this report comes from DEQ records and from information gathered during site visits. A copy of the sanitary survey is included in Appendix A. The water system for King Colony serves the resident population of 55 people through 19 active service connections located in the colony residential and other buildings.

Figure 1 – Location Map



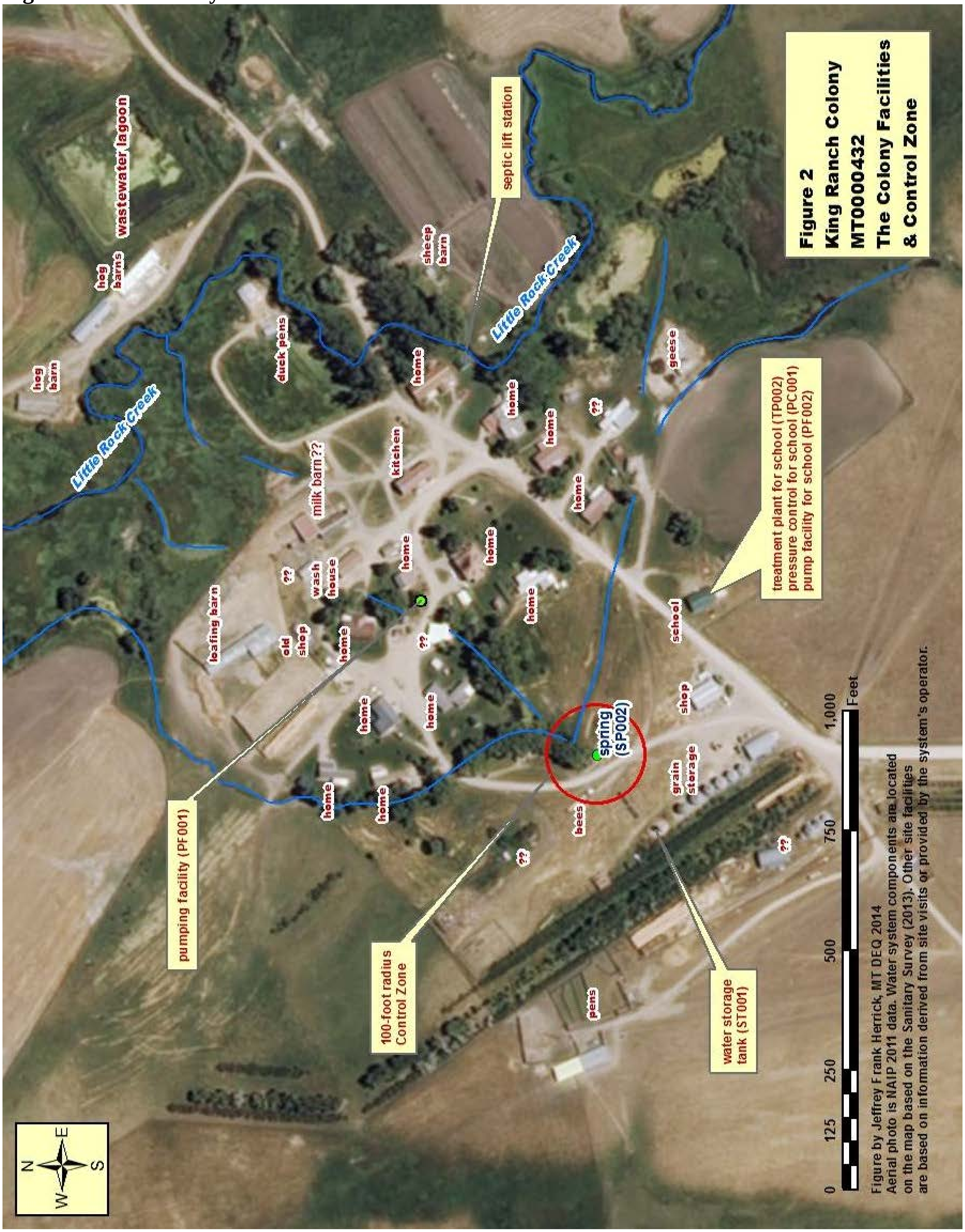
The following description is adapted from report by Norbeck (2000) and more recent DEQ Sanitary Surveys. The source spring is present on the western side of the Little Rock Creek drainage. Water flows to the surface in a small cinder-block house, where it flows by gravity to a pump house. The water is then sent to the school where there is a pressure control assembly and the water is disinfected using an ultraviolet system. After disinfection, the water is then pumped to a 9,000 gallon tank located west of the spring. Water is fed by gravity from the storage tank to the rest of the distribution system.

The spring discharge has been estimated to be approximately 28 gallons per minute (gpm) in 1999 when the system was visited by a representative of the Montana Bureau of Mines and Geology. Approximately 8 gpm are fed into the water system, with the remainder discharged out of the spring building to surface water.

Water Quality

Every PWS is required to perform monitoring for contamination to their water supply. The monitoring constituents include coliform bacteria and other signs of pathogenic organism, nitrates, metals and for multiple other chemicals. The monitoring schedule depends on many factors such as the size and source water for a PWS, the number of sources (e.g. wells), and the population served. Each PWS has a specific monitoring program tailored to their system that follows the general protocols for operation of a PWS defined by DEQ. A review of the DEQ PWS database indicates that monitoring results for the King Colony PWS show consistent problems with MCL violations (for exceedences of the drinking water quality standards) for Nitrate during the past 5 years. The MCL is the EPA's maximum contaminant level allowable in drinking water. The health standard for nitrates (the MCL) is 10 mg/L. The monitoring results for the potable water supply indicate nitrate levels generally ranging from 14 to 22 mg/L over the last five years. However, there are also several samples with significantly lower concentrations scattered over the last 5 years. The elevated concentrations of nitrate in the spring are very likely from agricultural activities, human waste, and animal waste. These sources are discussed in Chapter 4 of this report.

Figure 2 – The Colony Facilities and Control Zone



3.0 DELINEATION

The source water protection area is the land area that contributes water to the King Ranch Colony's PWS source. Three source water protection regions are identified surrounding the Colony's spring water source. These three regions, the Control Zone, Inventory Region, and Recharge Region. The Control Zone, also known as the exclusion zone, is an area at least 100-foot radius around the spring source building. The Inventory Region is defined as the area within a 1-mile radius circle of the spring. That 1-mile radius circle is modified to eliminate locations that are either too far downgradient or across the other side of Little Rock Creek from the Colony. The Recharge Region represents the area where the source aquifer for the King Ranch Colony water system source is replenished.

Hydrogeologic Studies

Communities within the Judith Basin typically obtain their water from surface flowing artesian wells that tap into deep regional bedrock aquifers. There have been several studies of the regional hydrogeology of the area. These are summarized as follows:

- Perry, E.S., 1932. Ground-Water Resources of the Judith Basin, Montana. Montana Bureau of Mines and Geology Memoir 7
- Zimmerman, E.A., 1966. Geology and Ground Water Resources of Western and Southern Parts of Judith Basin, Montana. Montana Bureau of Mines and Geology Bulletin 50-A.

- The spring source for the PWS was evaluated by the Montana Bureau of Mines and Geology for a determination of the effects of surface water on the spring. A copy of this study is included in Appendix D. This study is summarized in:

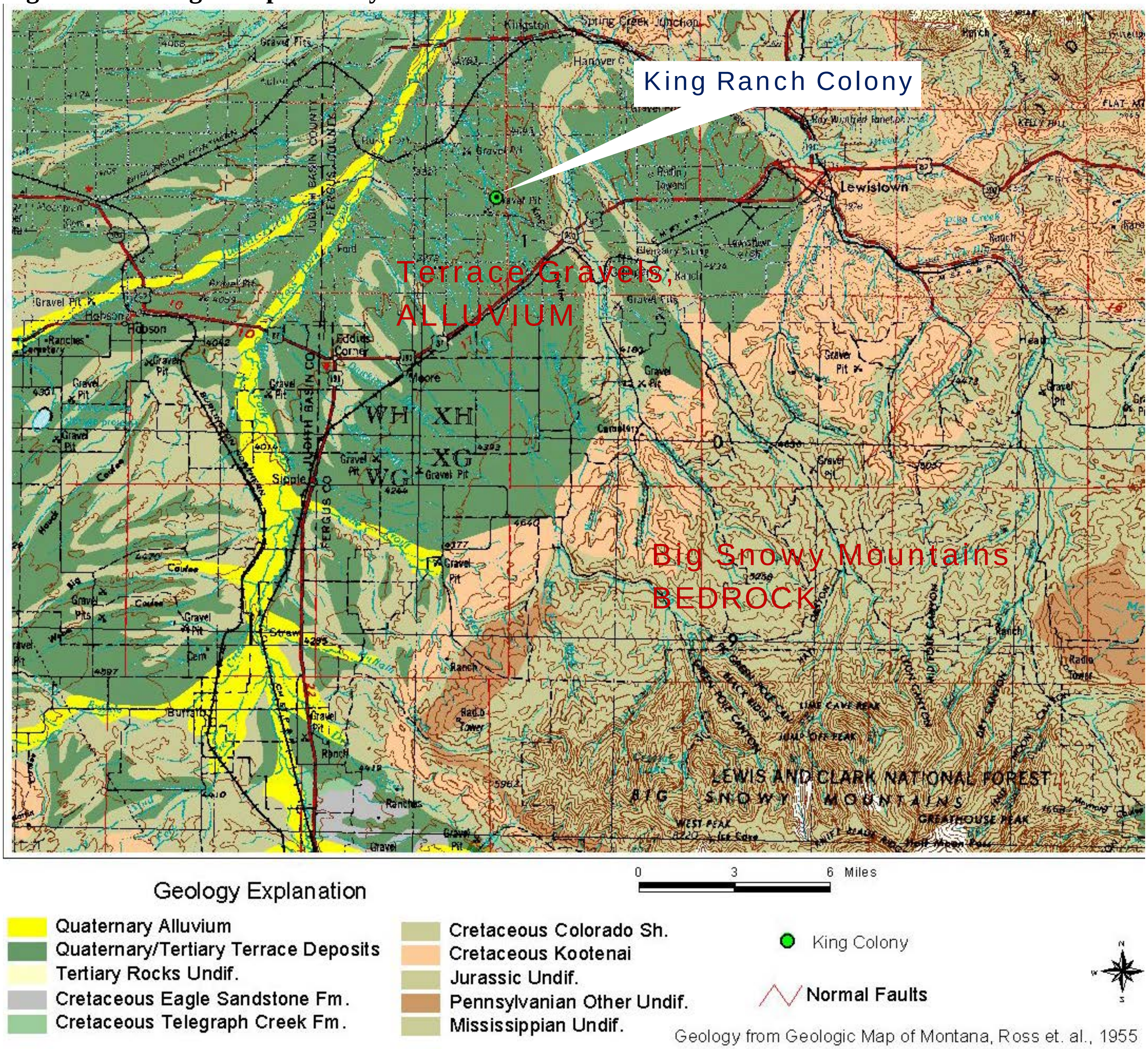
- Norbeck, P., 2000. Hydrogeologic Assessment of the King Colony Water Supply for Groundwater Under the Direct Influence of Surface Water. Montana Bureau of Mines and Geology Open File Report MBMG 401-S.

The following discussion of the hydrogeology of the area is based on information presented by Norbeck (2000) and other geologic investigations. A generalized geologic map of the area is included in Figure 3.

Hydrogeologic Conditions

The King Ranch Colony is located in the central eastern portion of the Judith River Basin, in the low foothills northwest of the Big Snowy Mountains. The Little Belt Mountains are present along the southwestern part of the Judith River Basin. Sedimentary Formations around the mountains, including those southeast of the colony, were tilted upwards by the mountains. As a result, older rock formations are present in the central part of the mountains with progressively younger rocks present moving away from the core. The rocks on the northwest flank of the Big Snowy Mountains in the area near the King Ranch Colony all dip northwest under the Judith Basin. The Madison limestone, an important regional aquifer in central Montana, receives recharge where the upended/tilted rock units are exposed in the core (the central area) of the Big Snowy Mountains and the Little Belt Mountains. Groundwater in all of the deep bedrock aquifers beneath the colony are interpreted to flow generally to the northwest into the Judith Basin. With groundwater recharge at higher elevations in the mountains, the major aquifers yield surface flowing artesian wells to communities in the Judith Basin. These wells need to be deep enough to take advantage of the water bearing formations containing water under pressure. The shallow bedrock beneath and around the King Ranch Colony is the Colorado Shale, which is a fine-grained rock with little permeability for groundwater flow. The shale is covered by terrace gravels, with an approximate thickness of 35 feet in the area near the colony (Norbeck, 2000). Abundant shallow groundwater is present in the terrace gravel deposits, extending from the base of these gravels to the top of the water table (which is often near the ground surface). Note that surface water in the stream or local ponds signifies where groundwater is interacting with surface water. Some of the linear ditches or canals that bisect the Colony (see Figure 2) are old abandoned stream channels. These channels may or may not contain a pond or flowing water, but they will all behave as preferential paths for groundwater to travel to the north and northeast.

Figure 3 – Geologic Map of Study Area



The regional (deep) groundwater beneath the King Ranch Colony is interpreted to flow to the northwest, following the regional topography. The water bearing terrace gravels form a separate, shallow, unconfined aquifer. This shallow alluvial aquifer beneath the colony is influenced by local topography and will flow from high ground to low ground and to points where the water can discharge into a stream. The higher ground is to the southwest of the Colony and the point(s) of discharge is to the northeast along Little Rock

Creek. So it is the author's (Jeffrey F. Herrick's) interpretation that the unconfined shallow groundwater probably flows to the north, or more likely to the north northeast. Springs occur at locations where topography intercepts the water table. These springs are often located along the flanks of stream valleys (such as Little Rock Creek) or in low spots and swales that are often within the stream valley. Recharge to the aquifer occurs from direct infiltration of precipitation, from local stream loss, and from stream loss where the streams flow from the more impermeable bedrock units in the mountains onto the gravel terraces. For purposes of this assessment, the location of the contact between the Kootenai Formation and the terrace gravels is considered to be a major area where recharge to the shallow aquifer can occur. For a more thorough discussion of the local and regional hydrogeology, the reader is referred to Norbeck (2000), located in Appendix D.

Conceptual Model and Assumptions

A conceptual hydrogeologic model is a simplified representation of the hydrogeologic system. For the King Ranch Colony, water is derived from a spring that discharges from a locally shallow unconfined aquifer. The aquifer is present in terrace alluvial gravels that appear to be around 35 feet thick in the vicinity of the Colony. This alluvial aquifer is recharged to the south of the Colony where the terrace gravels are exposed at the surface, along Little Rock Creek, and at the contact of the gravels with the bedrock of the Kootenai Formation (on the northwest flanks of the Big Snowy Mountains). This contact is where surface streams will lose abundant water into the terrace gravels. Shallow groundwater in the vicinity of the King Ranch Colony flows in a general north, or more likely north northeast direction following the local topography.

Based on the hydrogeologic setting, the King Colony water source is a spring source from a shallow unconfined aquifer in unconsolidated terrace gravels. Since the source is a spring which has been classified as Groundwater Under the Direct Influence of Surface Water (see Appendix B), the water source is considered to have a ***high*** source water sensitivity to contamination.

Spring Information

The location of the spring source for the King Ranch Colony is depicted in Figure 3. Information on this source is summarized in Table 1.

Table 1 - Source Information for King Ranch Colony.

Information	Spring Source
PWS Source Code	SP002
Spring Location (T, R, Sec)	T15N, R16E Sec 13 DCCC
Spring Location (lat, long)	47.0556°N Lat -109.6400°W Long
MBMG #	180148
Water Right #	*Not Reported*
Yield	28 gpm *

* Yield estimated by MBMG in February 1999

Delineation Methods and Criteria

The source water protection management zones for the spring source are delineated based on the criteria for springs from unconfined aquifers outlined in the DEQ Source Water Protection program document (DEQ, 1999). This includes identification of a Control Zone, Inventory Region, and the Recharge Region, all of which are successively larger areas surrounding the colony's spring source.

Groundwater Time of Travel Estimates

Groundwater time of travel calculations were originally performed in 2002 to aid in source water protection planning for the King Ranch Colony PWS and the development of the assessment report at that time. Time of travel estimates are used in the susceptibility assessment for unconfined aquifers, and aid in the delineation of source water protection areas. Unfortunately, there is no data available characterizing the hydraulic properties of the terrace gravel aquifer in the area around the King Ranch Colony. As a result, default distances are used to establish practical and straightforward area within which the colony should manage potential contaminants. The groundwater time of travel calculations and other hydraulic parameter estimates originally used for this system are included with Appendix C. Experience suggests that most of the significant contaminant sources (for a sensitive water source) are located in the immediate surrounding area. As a result, more recent maps of the Control Zone and area around the spring source; and within a 1-mile radius circle Inventory Region were carefully prepared and included in this report for use by the water system operator. Note that these maps utilize color aerial photographs collected in 2011, which should be useful for the system operator in their efforts to manage and protect the public water supply.

Source Water Protection Regions

The delineated management area for the spring is depicted on Figures 2 and 4. This Control Zone is the area within a 100-foot radius circle around the spring source. The Inventory Region is delineated as the area within a 1-mile radius circle and upgradient from the spring source. The circle was modified to eliminate downgradient areas or those on the far side of Little Rock Creek from the colony and the colony spring source. The Recharge Region is identified as most of the watershed for Little Rock Creek and Beaver Creek south of the King Ranch Colony towards the Big Snowy Mountains. The watershed extends just into the mountains recognizing that the streams lose most of their water to the terrace gravel aquifer when they flow from over relatively impermeable beds of the Kootenai Formation onto the permeable gravel deposits.

Limiting Factors

The complex and unpredictable nature of groundwater flow within fractured bedrock aquifers limits the accuracy of any hydrogeologic assessment. Regional topography and local near surface topography provide additional complications. As a result, the groundwater system is evaluated based on known and standardized principles of hydrogeology, as well as the experience gained from working in source water protection. The assessment presented in this document is based on published works; however, the actual groundwater flow system may be significantly more complicated than presented here. Communication between the deeper regional Madison Limestone aquifer to shallower alluvial (near surface sediments) may occur along unmapped fault planes or other geologic structures. The delineations presented in this report are considered accurate and protective of the drinking water source by using conservative assumptions for interpretations regarding the nature of the hydrologic system.

Figure 4 –Control Zone

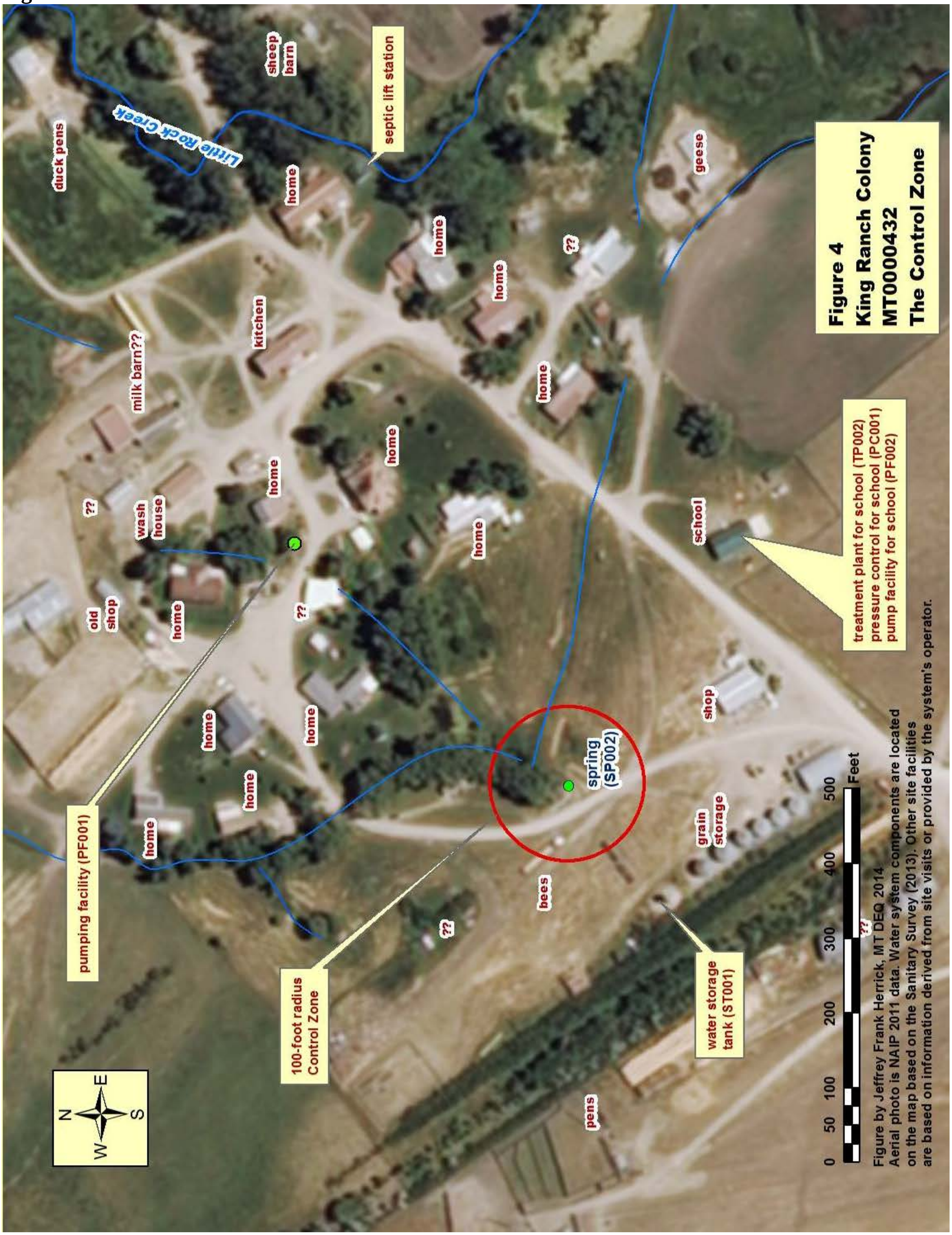


Figure 5 –Inventory Region

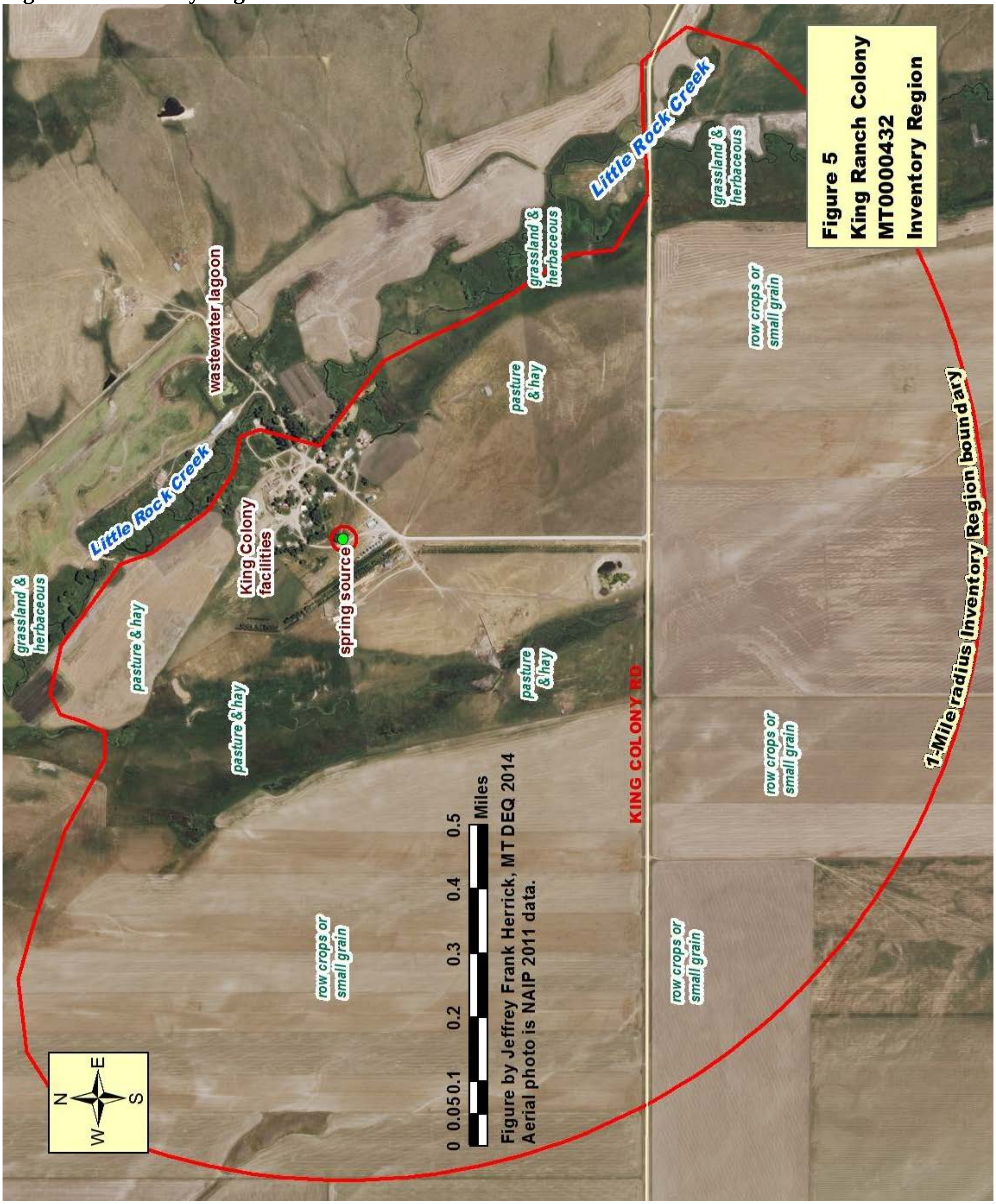
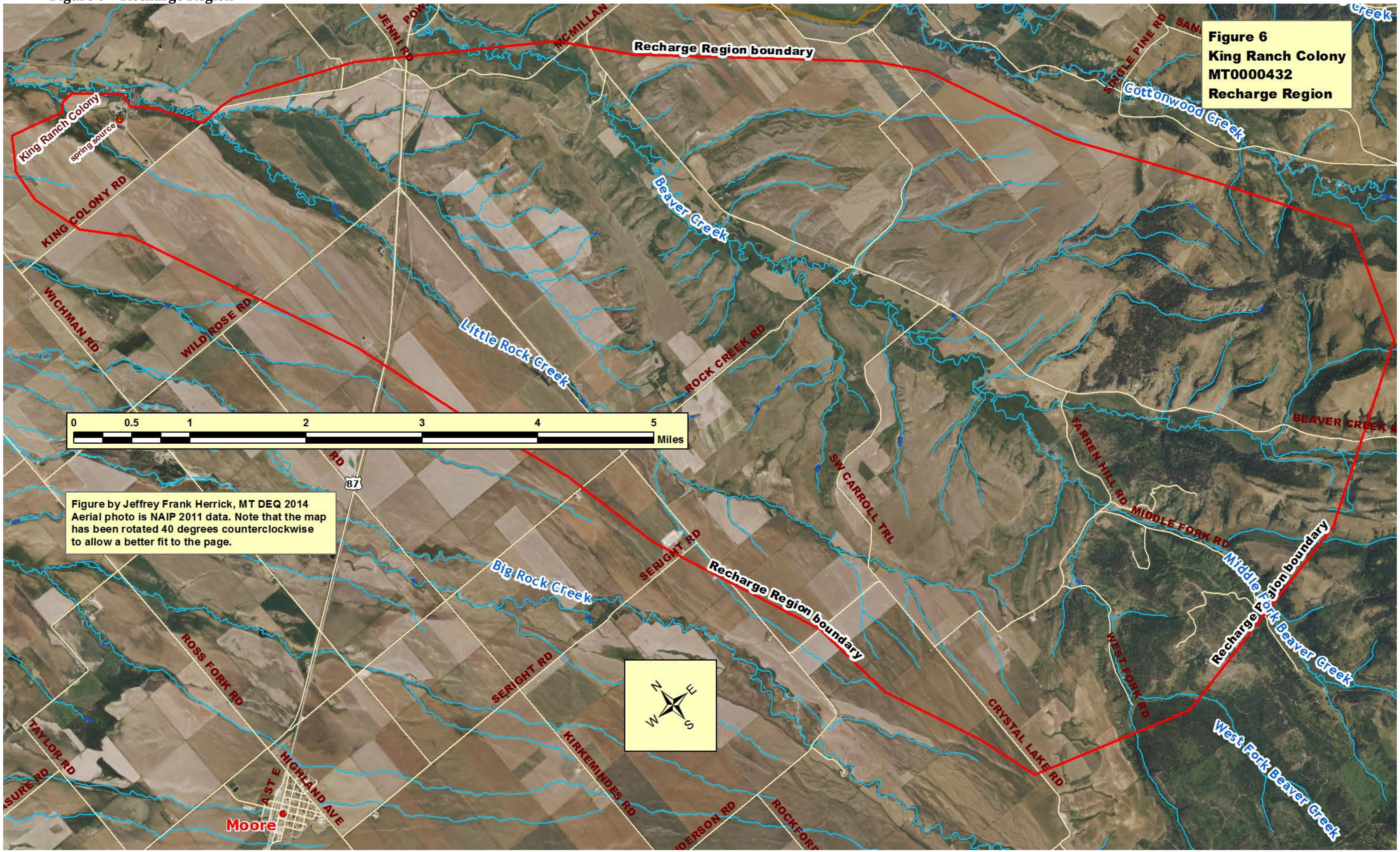


Figure 6 – Recharge Region



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4.0 INVENTORY RESULTS

An inventory of potential sources of contamination was conducted for the King Ranch Colony PWS within the delineated source water protection regions. Potential sources of all primary drinking water contaminants and Cryptosporidium were identified; however, only significant potential contaminant sources were selected for detailed inventory. The significant potential contaminants in the King Ranch Colony PWS management regions are nitrates, pathogens, and herbicides/pesticides and fertilizer from agricultural land.

Inventory Method

The inventory for King Ranch Colony was obtained by visiting the colony and discussing colony activities with representatives from the colony. Information on the PWS, land use, agricultural chemical storage and application, and waste disposal practices were identified at that time. Urban and agricultural land uses were identified from the United State Geological Survey land use classification project (USGS, 2000) and review of the more recent aerial photographs. Major transportation routes through the area, including railroad lines, were also identified. This information is depicted in Figures 5 and 6.

Inventory Results / Control Zone & Inventory Region

The potential contaminant sources identified for the <u>Control Zone</u> for the PWS spring are:

- Animal feeding operations (AFOs, where animals and their waste is concentrated). All of these AFOs are located outside of the 100-foot radius Control Zone as seen on Figure 4, but some are in a location that is located directly adjacent to a surface water body (a long pond. Records suggest that there is a geese production area located southeast of the spring. This AFO is next to surface water (pond) which is one of the linear features seen on Figure 4. These features are actually old abandoned stream channels, and the one southeast of the spring leads directly to the spring. Note that these features are a preferential flow path for groundwater. And
- The sewer system (servicing homes and other buildings). The specific location of the sewer lines is not known. If these are older style clay pipes, they have a high probability to leak effluent. If any of these lines pass near or up gradient from the spring, and they leak, the spring can become contaminated.

The potential contaminant sources for the <u>Inventory Region</u> (as depicted on Figure 5) are:

- Agricultural land used for small grains, hay, and/or pasture. These have an increased significance as potential contaminant sources if animal manure is spread on their surfaces.
- Animal feeding operations (AFOs, where animals and their waste is concentrated). These are located outside of the Control Zone as seen on Figure 4, but are where animals are concentrated in the vicinity of the spring building. Linear surface water features seen on Figure 4 are actually old abandoned stream channels that intersect near the spring. Note that these features are a preferential flow path for groundwater and surface water.
- The sewer system (servicing homes and other buildings). The specific locations of the sewer lines are not known. If these are older style clay pipes, they have a high probability to leak effluent. If any of these lines pass near or up gradient from the spring, and they leak, the spring can become contaminated.

The above listed potential contaminant sources inside the Inventory Region are summarized in Table 2. The primary hazards to the PWS source are: leakage from septic lines; animal wastes that may infiltrate into the ground or flow to a nearby abandoned stream channel (then to be transported by groundwater to the spring); general agricultural related hazards from accidental spills or releases of farm chemicals; over application of chemicals and manure spreading; and from crop rotations that can increase nitrates in the soil which can then leach into groundwater. The spring is housed in a protected building inside the Control Zone. There is no other protection noted for the spring source around the perimeter of the Control Zone.

Inventory Results / Recharge Region

The Recharge Region is comprised of agricultural cropland (small grains and hay), some pasture and open range cattle grazing, a lot of streamside riparian areas that may or may not support grazing, and US Highway 87/191 and railroad tracks cross the Recharge Region a few miles south of the colony. The railroad is operational, but seldom used. The highway can be a location of rare spills of hazardous chemicals. With the crop production the primary contaminants of concern would be: fertilizers, herbicides, and fuels for farm machinery. An accidental spill of fuels or other chemicals on the highway or railroad tracks represent the primary concern from the transportation routes through the Recharge Region.

Inventoried Significant Potential Contaminant Sources.

Source	Hazard
Control Zone & Inventory Region	
Animal Feeding Operations (AFOs)	Concentration of animals and animal wastes that can allow surface runoff of contaminants and infiltration into the ground. More significant if AFO is near an old stream channel and upgradient from the spring.
Pasture & hayfields	Land application of animal waste, chemical spills, and excess application of fertilizers.
Cropped Agricultural Land	Land application of animal waste, chemical spills, excess application of fertilizers or herbicides, crop fallow and crop rotations.
Colony sewage system	Release or leakage of sewage from lines, especially if the lines are older style clay pipes with leaky couplings.
Recharge Region	
Cropped Agricultural Land	Land application of animal waste spills, excess application of fertilizers or herbicides, crop fallow and production rotations.
US Highway 87/191	Accidental release of chemicals.
Railroad Tracks	Seldom used. Accidental release of chemicals could occur.

Inventory Update

The certified water system operator should update the inventory yearly for his records. Changes in land uses or potential contaminant sources should be noted and additions made as needed. The complete inventory can be submitted to DEQ every five years. It would be very beneficial to the colony to develop a good map of the sewer lines as they travers through the colony complex.

Inventory Limitations

The potential sources of contaminants for the King Ranch Colony are taken from data and reports that are readily available. Consequently, unregulated activities or unreported contaminant releases may have been missed. The use of multiple sources of data, however, should help assure that contaminant sources that are identified represent the major threats to the source water for the King Ranch Colony.

5.0 SUSCEPTIBILITY ASSESSMENT

General Discussion

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 the King Ranch Colony PWS.

The goal of Source Water Management is to protect the source water by:

1) Restricting certain activities inside 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.

Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to the King Ranch Colony spring (Table 3). Hazard is rated by the proximity of the potential contaminant sources to the wells. Susceptibility ratings are presented individually for each significant potential contaminant source and each associated contaminant. The susceptibility of the spring to each potential contaminant source is assessed separately. For spring sources from unconfined aquifers, hazards for point sources are typically assigned based on the area covered by the source and/or the location of the potential contaminant source within the Inventory Region.

Hazard of Potential Point Sources

Potential contaminant sources located in close proximity and within a 1-mile distance up gradient of the spring are assigned a high hazard. Potential contaminant sources located within the Recharge Region are assigned a moderate to low hazard.

Hazard of Potential Non-Point Sources

Source Type	***High Hazard***	***Moderate Hazard***	***Low Hazard***
Septic Systems	> 300 per sq. mi.	50 – 300 per sq. mi.	< 50 per sq. mi.
Municipal/Community Sanitary Sewer coverage (% Land Use)	> 50% of region	20% – 50% of region	< 20% of region
Cropped Agricultural Land (% Land Use)	> 50% of region	20% – 50% of region	< 20% of region

Relative Susceptibility Based on Hazards and Barriers

Presence Of Barriers	Hazard High	Moderate	Low
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

Implementation of best management practices, including fencing, increasing the size of the Control Zone, and adequately protecting that larger Control Zone, can collectively reduce the susceptibility of the system to contamination. Fencing and signs to keep vehicles, animals, etc. away from the Control Zone is large step in protecting the system's drinking water.

Susceptibility Assessment Summary Table.

Source	**Contaminant(s)**	**Hazard**	**Hazard Rating**	**Barriers**	**Susceptibility**	**Management Suggestions**
Inventory Region (includes the Control Zone)						
Animal Feeding Operations (AFOs) in the Inventory Region Upgradient from the spring	Nitrates & pathogens	Leaching into ground and surface runoff to old stream channels	High	• None (groundwater flows toward the spring)	Very High Susceptibility	• Protect upgradient area from livestock, especially the old stream channel and nearby surface water. • Develop best management practices for animal feeding. This is especially important in handling animal waste. • Develop an alternate water source (spring or well) in an upgradient location.
Animal Feeding Operations (AFOs) in the Inventory Region Downgradient from the spring	Nitrates & pathogens	Leaching into ground and surface runoff to old stream channels	High	• Groundwater flow direction is away from the spring	High Susceptibility	• Protect upgradient area from livestock, especially near surface water ditches, streams, or low areas. • Develop best management practices for animal feeding. This is especially important in handling animal waste. • Develop an alternate water source (spring or well) in an upgradient location.
Pasture & Hayfields in the Inventory Region	Nitrates & pathogens	Leaching into ground and surface runoff	High	• Richest pasture land to the west is lateral to the groundwater flow direction (it's not upgradient from the spring). The pasture that is upgradient from the well does not appear to be heavily grazed.	High Susceptibility	• Keep the density of grazing animals as low as possible to reduce the accumulation of manure upgradient from the spring. • Monitor and carefully handle fuels, fertilizers, manure, and other agricultural chemicals to ensure that they do not damage groundwater up gradient from the spring. • Develop an alternate water source (spring or well) in an upgradient location.

Source	Contaminant(s)	Hazard	Hazard Rating	Barriers	Susceptibility	Management Suggestions
Cropped Agricultural Land (appears to be small grains) in the Inventory Region	Nitrates & pathogens	Spills with leaching into the ground	High	• These fields appear to be isolated from the spring by distance (King Colony Road) or they are to the west and somewhat lateral to the groundwater flow direction.	High Susceptibility	• Monitor and carefully handle fuels, fertilizers, manure, and other agricultural chemicals to ensure that they do not damage groundwater up gradient from the spring.
Cropped Agricultural Land in the Recharge Region	SOCs, nitrates, pathogens	Leaching and Runoff	Moderate	• These fields isolated from the spring by distance (King Colony Road) or they are to the west and somewhat lateral to the groundwater flow direction. • Most of these fields are on the far east side of Beaver Creek or drain to Little Rock Creek or Big Rock Creek. This strongly reduces any likelihood that groundwater from these fields will carry contamination the length of the Recharge Region to reach the spring.	High Susceptibility	• Carefully handle fuels, fertilizers, manure, and other agricultural chemicals to ensure that they do not damage groundwater up gradient from the spring. This is suggesting that you handle, transport, and store these chemicals properly. • Apply the fertilizers at appropriate rates per acre and follow the chemical's labels if other chemicals are applied to the ground or crops. • If vegetable crops are raised, be careful to follow the chemicals with regard to application, irrigation, and harvest dates (to prevent human exposure to the chemicals).

Source	Contaminant(s)	Hazard	Hazard Rating	Barriers	Susceptibility	Management Suggestions
US Highway 87/191 in the Recharge Region	Various chemicals	Spills due to vehicular accidents	Moderate	• The highway in the vicinity of the Recharge Region was recently upgraded, widened, and repaved.	High Susceptibility	• Develop a list of stakeholders, emergency responders, and other resources. Contacts could be DEQ, Montana DES (Dept. of Emergency Services), County Sheriff, and the Montana Highway Patrol. Resources could be things such as the owner of a water truck with a pump, backhoes, dump truck, or other people that may be useful during an emergency or spills along the highway. These spills can often soak into the ground and reach groundwater, or they might run along the surface and reach surface water. They can then drain from the streams and recharge groundwater, potentially up gradient from the spring.
Colony Sewage System Lines in the Inventory Region (within the colony)	Nitrates & pathogens	Leakage of effluent from sewer lines that can reach the shallow groundwater	Moderate (overall area covered by sewer lines is low, but the sewers are in close proximity to the spring (within 200-300 feet)	• Although installation diagrams are not available, most of these lines are not likely to be in the vicinity of the spring. • Density of these sewer lines and the facilities they serve is low. • Flow in these sewer lines is to the east and away from the spring.	Low Susceptibility	• Attempt to map out the locations of all sewer lines. • Try to evaluate if these lines leak. This can be difficult to do, as leaks are subsurface and hard to find. A pressure test may be useful. • Develop an alternate water source (spring or well) in an upgradient location.

Source	Contaminant(s)	Hazard	Hazard Rating	Barriers	Susceptibility	Management Suggestions
Railroad Tracks in the Recharge Region	Various chemicals	Spills due to derailing or other accidents	No Hazard assigned. This train line has only limited use at this time.		No Susceptibility assigned	• If at a future time the railroad expands its operations to haul freight, such as oil or other chemicals, this potential contaminant source will become tremendously more of a threat to the colony's drinking water. This is primarily due to the volumes of any spills that could occur along the railroad line. The railroad, if a train ever derails, could dump tremendous volumes or tonnage of hazardous materials.

Susceptibility Summary

The results of the susceptibility assessment indicate that the colony's animal feeding areas, the surrounding cropped fields, and the sewer system lines represent the significant potential threat identified for the source water for the King Ranch Colony PWS. The water source seems to have a very high susceptibility to AFOs that are located upgradient (southeast) of the spring and adjacent to the old stream channel. This AFO is likely to be the source of the elevated nitrate. The least significant potential contaminant source seems to be the septic sewer lines for the colony for which the water source has a low susceptibility. But if these lines are old and if they are made of clay pipe with old-style clay bell connections, they have the potential to have considerable leaks to the groundwater that could go unnoticed. If any of these leaking lines are located near or directly upgradient (south or southeast) of the source, the source would be extremely vulnerable to the septic effluent. The water source would have a very high susceptibility to contamination from this potential contaminant source.

CCR Susceptibility Information

The King Colony obtains its drinking water from a spring source located within the western portion of the main colony complex. A source water assessment is available through the internet link at http://deq.mt.gov/wqinfo/swp. The assessment indicates our spring water source has a very high susceptibility to activities associated with the colony operations, especially nitrate. The most likely sources of nitrate are located within the Colony and are related to pens and/or fenced areas that concentrate animals and animal wastes. Additionally, surface water runoff may collect and transport animal waste to nearby surface water (or other areas) where it can infiltrate into the ground and reach groundwater.

Management Suggestions

The Susceptibility Assessment Summary Table on the previous pages describes the potential contaminant sources for the colony spring. The potential threats to the drinking water are highest for those potential sources that are located in close proximity or directly upgradient from the spring. The table lists Barriers that may stand between the water source and the potential contaminant sources and may reduce the chances of contaminant releases that will impact the drinking water. The more barriers that are in place, the better protected a water source will be. The column on the far right of the table is a listing additional steps that can be taken by the water system operator to add additional barriers (or other actions) that will protect the drinking water for the colony. In addition to the management suggestions listed above is the concept of establishing an alternate water source. This can be another spring or a well. The new source should be located in an upgradient location to ensure that the colony (and most of the potential contaminant sources associated with it) will be downgradient from the water source. The aerial photo suggests that another spring may be located east of the sheep barns. A water well could be drilled and installed in the pasture directly south of the well or possibly in the stream floodplain upstream/upgradient of the colony. The well will likely not need to be deep to access the shallow water table aquifer contained in the terrace gravels or in the stream alluvium. If sufficient funds are available, the colony may consider the drilling and installation of a deeper well that could potentially draw water from one of the deep confined aquifers in the Madison or other formations. These deeper wells are extremely well protected from contamination at the surface. Consultation with knowledgeable local drillers can help you to determine the feasibility of drilling the deeper water well successfully in this location.

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