
**FLATHEAD LAKE BIOLOGICAL STATION
PUBLIC WATER SYSTEM
SOURCE WATER DELINEATION AND ASSESSMENT
REPORT**

*PWSID # MT0003724
Yellow Bay / Polson
Lake County
Montana*

18 MAY 2006

PREPARED FOR:

**UNIVERSITY OF MONTANA
FLATHEAD LAKE BIOLOGICAL
STATION**

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EXECUTIVE SUMMARY

This Source Water Delineation and Assessment Report was prepared under the Federal Safe Drinking Water Act and the Montana Source Water Assessment Plan. The Department of Environmental Quality (DEQ) is ensuring that assessments are completed for all public water systems in Montana. The purpose of these reports is to provide information so that the public water system operators, consumers, and community citizens can begin developing strategies to protect their source of drinking water. The information that is provided includes the identification of the areas most critical to maintaining safe drinking water (i.e., the Inventory Region), an inventory of potential sources of contamination within this area, and an assessment of the relative threat these potential sources pose to the water system. Jeffrey Frank Herrick a hydrogeologist with DEQ's Source Water Protection Program completed this report.

The drinking water for Flathead Lake Biological Station is supplied by a spring that is located southeast of the facilities and on the west side of the highway. The water that is discharging into the spring appears to come from semi-confined water-bearing sediments. In accordance with the Montana Source Water Protection Program criteria (1999), the aquifer (source water) is considered to have a moderate sensitivity to potential contaminant sources. Sensitivity is defined as the relative ease that contaminants can migrate to source water through the natural materials.

Three types of source water protection regions for Flathead Lake Biological Station public water supply were mapped as part of this assessment. They are the Control Zone, Inventory Region, and the Recharge Region. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- The Control Zone is delineated as a 100-foot radius around the well and all sources of potential contaminants should be excluded in this region. The goal of management in the Control Zone is to avoid introducing contaminants directly into the water supply's spring or the immediate surrounding area. No significant potential contaminant source was identified within the Control Zone.
- Since the source water comes from what appears to be a semi-confined aquifer, the Inventory Region for the well consists of a modified one-mile radius circle around the spring. The Inventory Region should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. Significant potential contaminant sources that were identified within the Inventory Region include: fruit processing operations; cherry orchard production; vehicular accidents with spills along the highway or along the road above the spring; areas of increased density of private onsite septic systems; and the sewer lines and wastewater treatment plant for the Biological Station.
- The goal of management in the Recharge Region is to maintain and improve water quality over long periods. This semi-confined aquifer supplying water to the spring is probably recharged up along the range front where the bedrock is shallow and the overburden is thin. The groundwater flow direction is thought to be in a west to southwesterly direction toward Yellow Bay. The only potential contaminant sources identified within the Recharge Region were already listed as part of the inventory for the smaller Inventory Region.

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried contaminant sources at concentrations that would pose concern. 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 public water supply intake. The susceptibility analysis provides the community and the public water system with information on where the greatest risk occurs and where to focus resources for protection of this valuable drinking water resource. Flathead Lake Biological Station public water supply source has a moderate susceptibility to the fruit processing operations located on the east side of the highway and north of the spring. The water system also has a moderate susceptibility to cherry orchards to the east of the highway and north of the spring on either side of the highway along with traffic accidents that may result in the release of hazardous chemicals. The water system has a low susceptibility to contamination associated with the medium density of private septic systems scattered along the east side of the highway. It has a very low susceptibility to any contamination associated with the septic sewer lines and the wastewater treatment plant for the Biological Station.

The costs associated with contaminated drinking water are high. Developing an approach to protect that drinking water resource will reduce the risks of a contamination event occurring. In this report, we have summarized the local geology and other issues as they pertain to the quality of your drinking water source. We have identified the areas we believe to be most critical to preserving your water quality (the Control Zone and the Inventory Region). We have identified several potential sources of contamination within the areas of interest. In addition, we provide you with recommendations (i.e., Best Management Practices or other activities) regarding the proper use and practices associated with some common potential contamination sources. We believe public awareness and active involvement by the PWS staff are powerful tools for protecting your drinking water. The information in this report will help you increase public awareness about the relationship between land use activities and drinking water quality. Refer to the figures found in Appendix A of this document to better understand the spatial relationship of the area. The susceptibility of the PWS to the significant potential contaminant sources is discussed in Table 9.

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INTRODUCTION

Author

Jeffrey Frank Herrick a hydrogeologist with DEQ's Source Water Protection Program, completed this Source Water Delineation and Assessment Report (SWDAR). Flathead Lake Biological Station Public Water Supply (PWS) was assigned the number MT0003724. This facility (with its water system) is on Yellow Bay on the east Shore of Flathead Lake between mile markers 17 and 18 along Highway 35. Contacts for the PWS are provided in Table 1 below.

Table 1. Flathead Lake Biological Station PWS Contacts

Name and Title	Telephone	Address
Mark Potter Administrative Contact, Operator	406-982-3301	331 Bio Station Lane Polson, MT 59860
Jack Stanford Financial Contact		

Purpose

This report is intended to meet the technical requirements for the completion of the source water delineation and assessment report (SWDAR) for Flathead Lake Biological Station PWS as required by the Montana Source Water Protection Program (SWPP) and the federal Safe Drinking Water Act (SDWA). The Montana Source Water Protection Program (SWPP) is intended to be a practical and cost-effective approach to protecting public drinking water supplies from contamination. A major component of the Montana SWPP is termed delineation and assessment. The emphasis of this delineation and assessment report is identifying significant potential contaminant threats to public drinking water sources and providing the information needed to develop a source water protection plan for Flathead Lake Biological Station PWS. Much of the generalized content for this SWDAR was borrowed from reports written for other Lake County PWSs.

Delineation is a process whereby areas that contribute water to aquifers or surface water 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 locations or regions in source water protection areas where contaminants may be generated, stored, or transported and then determining the potential for contamination of drinking water by these sources. Delineation and assessment is the foundation of source water protection plans, the mechanism that the Flathead Lake Biological Station PWS can use to protect their drinking water source. Although voluntary, source water protection planning is the ultimate focus of source water delineation and assessment. This delineation and assessment report is written to facilitate Flathead Lake Biological Station PWS and the community to be involved in source water protection planning activities that meet their specific needs.

CHAPTER 1 BACKGROUND

The Community

Flathead Lake Biological Station PWS supplies water to the Flathead Lake Biological Station. Flathead Lake Biological Station (often referred to in this report as the FLBS) is a fresh water research and educational facility associated with the University of Montana, and is located on Yellow Bay, in Lake County on the east Shore of Flathead Lake, approximately 17 miles northeast of Polson (refer to [Figure 1](#) and [Figure 2](#) in Appendix A). The Biological Station includes a year round fresh water research laboratory, three seasonal laboratories, an office/lecture hall, a dormitory/apartment building, a cookhouse/dining facility, 40 student cabins with three associated bathhouse buildings, 4 year round residences, a shop, a sewage treatment plant, and miscellaneous out buildings. A summary of the water system's facilities according the DEQ's PWS Database is found in Appendix C.

The population of Lake County is estimated at 26,500 people, which is comprised of both full-time and part-time residents. U.S. Census Bureau (2000 Census) data indicates most of the people are employed in the management, sales, or service occupations. The economy of the broader area is based on employment in the Flathead or Mission Valleys, retired individuals, as well as recreational and tourist services during the summer and winter provided by the proximity of Flathead Lake. No major industrial facilities or hazardous waste generators are currently located in the vicinity of the Bio Station. Montana Highway 35 is the major transportation corridor in the area ([Figure 1](#), [Figure 2](#), [Figure 3](#), [Figure 4](#), [Figure 5](#), and [Figure 6](#) in Appendix A).

Based on DEQ PWS records, it appears that the Flathead Lake Biological Station PWS serves approximately 142 persons through 15 active service connections. This population is roughly made up of 12 year round residents, 10 non-transients in the winter, and 120 non-transients in the summer (these are visiting students and researchers). The more recent sanitary surveys indicate that sewage from the facility (and from adjacent State Park facilities) is collected into an onsite sewage treatment plant, which then discharges to Flathead Lake north of the Biological Station (best seen on [Figure 5](#)).

Geographic Setting

Flathead Lake is located in a broad basin between the Salish Mountains and the Mission Mountains of northwestern Montana. The elevation of Flathead Lake itself is approximately 2,888 feet above mean sea level as measured at the lake's outlet on the Flathead River near Polson. The glaciated topography around Flathead Lake exhibits relatively varied relief typical a heavily glaciated intermountain region. The Flathead Valley and Flathead Lake region are located between the Salish Mountains on the west and the Mission Mountains and Whitefish Range on the east. It is noteworthy that the Mission Mountains border the lake on the east and rise abruptly to a height of 6,000 to 6,500 feet above mean seal level east of the Biological Station. Local mountain glaciers that coalesced with the Flathead Lobe of the Cordilleran Ice Sheet heavily glaciated this area. Flathead Lake appears to collect behind a large recessional moraine, which is present along the southern shore of the lake at Polson. Flathead Lake occupies an area of approximately 122,316 acres and is one of the largest natural lakes in this region of the USA. The main rivers that drain toward Flathead Lake are the Stillwater River, the Whitefish River, the Flathead River, and the Swan River, as well as a number of smaller tributary streams. The watershed that surrounds Flathead Lake is very large and consists of approximately 4,535,000 acres (~7,086 square miles). Flathead Lake empties to the south through the Flathead River at Polson. Water flow patterns

within Flathead Lake have never been characterized, but with the tributary streams and rivers located to the north and the outfall of the lake located at the south end, it is assumed that the net movement of water is toward the south. The Flathead River south of Polson flows south-southwest toward its confluence with the Clark Fork River just south of Paradise.

Climate

The climate around Flathead Lake is typical of mid-elevation intermountain basins of the Northern Rocky Mountains west of the Continental Divide. A nearby useful weather station is in Bigfork. Based on Western Regional Climatic Center data for the period of record, annual precipitation averages 21.97 inches. Monthly average precipitation ranges from 1.22 inches in February to 2.69 inches in May. The annual mean snowfall in Flathead Lake is 55.3 inches. Early summer thunderstorms and winter snows provide a majority of the precipitation in the area. A summary of the available climatic data for the Flathead Lake area is presented on Table 2 below.

Table 2. Climatic Summary

Bigfork 13 S, Montana (240755)

Period of Record Monthly Climate Summary - Period of Record: 11/01/1938 to 03/31/2004

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	33.1	37.5	44.6	55.1	64.5	71.2	81.0	79.6	68.9	55.7	41.6	35.4	55.7
Average Min. Temperature (F)	21.7	23.9	27.6	34.3	41.2	47.7	52.8	52.1	44.7	37.2	29.4	24.7	36.4
Average Total Precipitation (in.)	1.81	1.22	1.34	1.62	2.69	3.12	1.50	1.50	1.81	1.60	1.83	1.92	21.97
Average Total Snowfall (in.)	17.5	9.1	5.8	0.8	0.2	0.0	0.0	0.0	0.0	0.4	6.7	14.7	55.3
Average Snow Depth (in.)	5	5	3	0	0	0	0	0	0	0	1	3	1

Source: Western Regional Climate Center, wrcc@dri.edu

Description of the Source Water

Flathead Lake Biological Station PWS obtains water from a spring that appears to be artesian. The location of the spring is shown on [Figure 3](#), [Figure 4](#), [Figure 5](#), and [Figure 6](#) that are found in Appendix A. The principal aquifers in the area are within the Mid-Proterozoic age fractured bedrock and the unconsolidated glacial sediments. These unconsolidated sediments represent glacial outwash, ice-marginal stream deposits, and/or glacial till. A geologic map is found on [Figure 7](#) in Appendix A. There do appear to be 2 different aquifers beneath the area. The shallow aquifer appears to be unconfined and is within the glacial materials. The deeper aquifer is present mostly within the fractured bedrock and appears to be semi-confined. Confined aquifers are characterized by water levels in wells penetrating a confining unit that are elevated above the top of the aquifer, meaning that the aquifers are under pressure greater than atmospheric pressure at the top of the aquifer. The deeper bedrock aquifer doesn't generally behave as if the water is under pressure, based on water levels seen in area wells. An exception to this might be where it is discharging at the Biological Station's spring. It is felt that the groundwater discharging at the spring comes predominantly from this lower bedrock aquifer. Unfortunately, little evidence is available to demonstrate this with any confidence. Groundwater in both of these systems (shallow and deep) almost certainly moves away from the mountains and toward the lake and both the shallow and deep aquifers discharge into the lake. The shallow aquifer commonly will discharge to the ground surface at various locations around the bay where the water table intersects the surface. The deep aquifer may or may not discharge to the surface at locations where the local stratigraphy allows water to

move upward to the surface (e.g., a series of transmissive lenses that connect it to the surface). Groundwater probably flows roughly sub-parallel to the surface streams that drain toward Yellow Bay. Recharge to both aquifers comes from precipitation and direct infiltration, and from local streams that discharge water to the subsurface. Recharge to the aquifers is greatest from April to July because stream runoff from accumulated winter snow in the surrounding mountains is augmented by an average of 3.7 inches of rain per month in May and June. Groundwater moves slowly through the aquifers and eventually discharges into local streams to become base flow; it is discharged by wells and springs; it is removed by evapotranspiration; or the groundwater discharges directly into the lake. The actual groundwater movement around Yellow Bay has not been adequately characterized and the precise source of water in the Biological Station’s spring is not known with great confidence.

The Public Water Supply

The source for this water system is a well developed spring located in the headwall of a small drainage on the lakeside of the highway near the entrance road to the Yellow Bay State Park. This location is best seen on [Figure 5](#) and [Figure 6](#) in Appendix A. Water flows from the spring by gravity through a 4-inch ductile iron line down to a concrete reservoir (~1,000-gallons) located in the shop building. Excess water from the spring overflows the storage reservoir to a small adjacent stream. Water is pumped from the reservoir by a 15 horsepower centrifugal pump through a 3,000-gallon vertical air charged hydropneumatic pressure tank, and then to service at an operating pressure at the tank of 42 to 64 psi (pounds/inch²). It appears that this water reaches distribution without treatment. The following summary table is compiled from the DEQ PWS Database. A printout of this database relevant to this PWS is found in Appendix C.

Table 3. PWS Facilities

Flathead Lake Biological Station (# MT0003724)

Contact Information	Mark Potter Administrative Contact, Operator Jack Stanford Financial Contact 311 Bio Station Lane Polson, MT 59860 (406) 982-3301
PWS Class	Non-Transient, Non-Community PWS
Well/Intake Source Code	SP002
Well/Intake Name	Spring
Status	Active
Treatment System	None
Pressure Control Assembly	PC001 3,000 Pressure Tank Active
Distribution System	DS001 Distribution System Active w/ SP001
Storage Tank	ST001 1,000 gallon Storage Reservoir Active w/ EP502

PWS Water Quality

Water quality data for Flathead Lake Biological Station PWS dating back five years was printed out from DEQ's PWS Database. This data indicates that samples contained nitrate concentrations between 0.75 and 1.47 mg/L, which is well below the federal MCL of 10 mg/L. This concentration of nitrate in the water may represent a natural source (sometimes organic matter buried in glacial till) or it may represent an anthropogenic (human) source, but the concentration isn't unusual for groundwater in glaciated areas. Total coliform results have been negative over the past five years. Of the other inorganic and organic analyses performed on samples from this system, none of the parameters was present at elevated concentrations. The PWS is required to monitor for several contaminants on varying schedules. One bacteriological sample should be completed on a monthly basis; a nitrate sample should be done annually; monitoring for arsenic, inorganics, SOCs, and VOCs is required once every three years; and monitoring of lead, copper is required five times every years. As part of a GWUDISW (ground water under the direct influence of surface water) determination, a microscopic particulate analysis was performed on the spring water to determine if it could be classified as groundwater or surface water. The tests clearly indicated that the water was groundwater. It should be noted that the GWUDISW evaluation does not rule out a potential shallow aquifer as the source for water discharged at the spring.

CHAPTER 2 DELINEATION

General Discussion

The source water protection area, the land area that contributes water to Flathead Lake Biological Station public water supply (PWS) is discussed in this chapter. Three management areas are typically identified within the source water protection area. These three regions are the Control Zone, Inventory Region, and Recharge Region. The Control Zone, also known as the exclusion zone, is an area of at least 100-foot radius around the wellhead or surface water intake. The Inventory Region represents the zone of contribution of the well, which approximates a three-year groundwater time-of-travel or 1-mile radius (whichever is more appropriate). Analytical equations describing ground water flow using estimates of pumping and aquifer characteristics and simple hydrogeologic mapping can often be used to calculate groundwater time-of-travel distance in unconsolidated sedimentary materials. In certain hydrogeologic settings where the aquifer behaves as if it were under confined conditions, the Inventory Region is restricted to the 1,000-foot radius circle around the wellhead. The Recharge Region represents the entire portion of the aquifer that contributes water to a water system. This is often, but not always, the watershed above a well or spring.

Hydrogeologic Conditions

Flathead Lake is located in a broad basin between the Salish Mountains and the Mission Mountains of northwestern Montana. The elevation of Flathead Lake itself is approximately 2,888 feet above mean sea level as measured at the lake's outlet on the Flathead River near Polson. The glaciated topography around Flathead Lake exhibits relatively varied relief typical a heavily glaciated intermountain region. Present are kettles and kame terraces, extensive glaciofluvial outwash materials, lateral moraines, proglacial till, and recessional and terminal moraines. It is noteworthy that the Mission Mountains border the lake on the east and rise abruptly to a height of 6,000 to 6,500 feet above mean seal level.

Geology & Hydrology

The following is drawn primarily from the general discussions of Kendy and Tresch (1996), Alt and Hyndman (1986), Johns (1970) and the more recent MBMG Ground Water Resources of the Flathead Lake Area (2004). The Flathead Valley and Flathead Lake region are located between the Salish Mountains on the west and the Mission Mountains and Whitefish Range on the east. Local mountain glaciers that coalesced with the Flathead Lobe of the Cordilleran Ice Sheet heavily glaciated this area. The Cordilleran Ice Sheet was the continental glacier present west of the continental divide and flowed south directly through this area. Flathead Lake appears to collect behind a large recessional moraine, which is present along the southern shore of the lake at Polson. The terminal moraine that represents the furthest southern extent of this lobe of glacial ice is believed to be near Ronan. Flathead Lake is filled from the north by the Stillwater, Whitefish, and Flathead Rivers. Flathead Lake empties to the south through the Flathead River at Polson. Water flow patterns within Flathead Lake have never been characterized, but with the tributary streams and rivers located to the north and the outfall of the lake located at the south end, it is assumed that the net movement of water is toward the south. The Flathead River south of Polson flows south-southwest toward its confluence with the Clark Fork River just south of Paradise.

A geologic map for the region is presented on [Figure 7](#) in Appendix A. Metasedimentary rocks of the Belt Supergroup surround and underlie the Flathead Lake area, comprising a majority of the Salish

Mountains and Mission Range. These rocks include argillite, siltite, quartzite, and dolomite that are Precambrian age (a.k.a. mid-Proterozoic age). A few Cretaceous and Tertiary aged sedimentary or volcanic units are present in the region, but these are only remnants in scattered and isolated locations. None of these younger bedrock formations are seen around the margins of Flathead Lake. A bedrock elevation map is provided on [Figure 7](#) (along with geologic maps), which gives an idea of the shape of the bedrock beneath the younger geologic sediment and beneath the lake.

Continental and local mountain glacial activity have heavily sculpted and influenced this region. Four major glacial advances occurred in Montana during the Pleistocene Epoch (10,000 – 1.8 million years ago) (Alden, 1953). Ice covered the northern third of the state during the maximum extent of each glacial advance. The Rocky Mountain Trench (inclusive of the Flathead and Mission Valleys) was a primary avenue for the repeated southward advances of the Flathead Lobe of the Cordilleran Ice Sheet. The Rocky Mountain Trench runs north-northwest from Saint Ignatius through Eureka and into Canada. It appears that several glacial episodes are recorded in the Flathead Lake area and these episodes deposited Pleistocene age glacial till throughout the basin. This till is composed of heterogeneous, poorly sorted sand, gravel, pebbles, cobbles, and boulders in a sandy to clayey matrix. As glacial ice melted or the glaciers retreated, streams and rivers carried large volumes of reworked glacial debris, which settled out of suspension as unconsolidated, poor to moderately sorted, glacial-outwash deposits of sand, gravel, pebbles, and cobbles. Sediment clogged braided streams are typical of this reworking and transport process near the terminus of active glaciers. The distance of sediment transport for glacial outwash is very short. Common features of both large and small glaciers are streams that are flowing across, within, and below the ice, and generally parallel to the ice flow direction. These meltwater streams carry considerable water and sediment and discharge at the glacier's terminus. One of these types of streams often runs along the edge of a glacier and sub-parallel to the lateral moraine(s). This ice marginal stream deposits sand and gravel concurrent with the more chaotic glacial till deposited in the lateral moraines. It appears that there are extensive glacial till deposits spread along the east shore of Flathead Lake which appear to be analogous to lateral moraine material. This material resembles other glacial till deposits in that it is comprised of poorly sorted clasts in silt to clay matrix. Intermixed with this till material are better sorted stream deposits and glacial outwash. The geologists mapping the sediments along the east shore of the lake have depicted the deposits as glacial till and glaciofluvial deposits (Qg on the leftmost map on [Figure 7](#)) or as Quaternary alluvium (Qal, which is modern or glacial stream deposits on the center map on [Figure 7](#)). These 2 maps agree that glacial till and ice marginal stream deposits are both recognized in the area. It should be noted that the surface soils/sediment surrounding Yellow Bay tend to be coarse sand and gravel south of Elrod Hall and silt or clay to the north (personal communication, Mark Potter 2005). It appears that the sand and gravel represents the ice marginal stream deposits or glacial outwash as discussed above. It should be noted that glacial outwash consists of reworked till, but the material is often not as well sorted as seen in more active fluvial deposits that are made up of sand and gravel (with little or no silt or clay). Glacial outwash deposits can contain notable silt and clay and can occasionally act as confining units in some areas of the Flathead region. Another feature of the Flathead region are extensive lake deposits that were associated with the terminus of large glaciers or of Glacial Lake Missoula. Glacial lake deposits are typically silt and fine sand that are present in very finely stratified layers (varves) that may be laterally continuous within a basin. In many locations, these glacial lake deposits act as a localized confining unit for aquifers. The ancient Glacial Lake Missoula flooded the Clark Fork, Blackfoot, and Flathead River Valleys and its fine-grained lake deposits were left in the area surrounding Flathead Lake. These lakebed

sediments are not mapped at the surface in or around Yellow Bay, but are likely to be present beneath the surface in some locations.

The author has not personally studied groundwater flow in the area of Yellow Bay, but personal observations indicate that in this area there are a considerable number of groundwater discharges to surface water (hence the presence of numerous springs and gaining streams as they approach the lake). The author observed the discharge of groundwater directly into the lake along the shore of Yellow Bay and it was clear that groundwater was indeed in the process of discharging to the lake throughout this area. The depth to the water table (presumably the shallow unconfined aquifer) is not known. However, given the groundwater and surface water interactions in the area; the water table should be at or very near the ground surface throughout the area immediately around the bay and only a few feet deep higher on the flanks of the bay. This shallow water table and the obvious groundwater to surface water discharge into Yellow Bay suggests that any private onsite septic systems or process water discharges from agricultural activities located around the bay probably have some direct impacts on water quality in shallow groundwater, in local streams, and in the bay. It is assumed that these impacts will increase with increased development or with increased agricultural activities.

There is little or no information available on the aquifer materials or conditions from which the Biological Station spring is discharging. As such, several basic assumptions are being made in this report. The water being discharged at the spring is reported to be under considerable pressure head (hydrostatic head) and flows freely without much seasonal variation in discharge volume or water quality. The nitrate concentrations are low, which does not really indicate one way or the other if the water is receiving recharge from the surface. The constant flow that seems artesian suggests that if the spring was carefully sealed off and if a water level was to be measured, that level would be measured as a distance above the ground surface. When a confined aquifer well is unsealed and flows at the surface without pumping, this is called an artesian well. This is due to the pressure exerted on an aquifer that pushes the water up a well casing and if the pressure is great enough, the water level in the well will be above the ground surface (thus the flowing water and artesian conditions). As such, it can probably be safely assumed that the aquifer/water-bearing formations from which the spring is discharging are at least locally confined. It should be noted that shallow unconfined aquifers also generate springs at locations where the water table intersects the ground surface. No surface head is generally noted at the locations of the discharges and these springs also appear to demonstrate seasonal variations in discharge volume and water quality. The lateral extent of any confinement around the Biological Station PWS spring cannot be estimated with any confidence. It is assumed that the confining unit is made up of the low permeability glacial till that has been mapped across this area. The water-bearing unit(s) that supplies water to the spring may be an alluvial material of sand and gravel that is contained within or buried beneath the till, or the water may come from the deeper fractured bedrock. The water-bearing formations supplying water to the spring appear to be somewhat different from those supplying other spring water discharges in the area in that this spring is located further away from the lakefront, at a higher elevation, and is set deeper into the slope. Many of the other springs in the area appear to represent areas where the shallow unconfined water table aquifer is intersecting the ground surface. An examination of well logs for domestic wells in the area suggests that there is around 20 to 40 feet of mixed glacial material draped across the area's bedrock and most of these wells are withdrawing water from deeper in the bedrock. The deeper bedrock aquifer appears to be best described as semi-confined. Coarse sand and gravel units are noted in many of the logs and have been observed extensively at the ground surface. These are probably either ice marginal stream deposits or glacial outwash deposits that

are intermixed with glacial till. There is probably a sufficient thickness of fine-grained material (till or lakebed sediments) to act as a confining unit resting above water-bearing units contained within the till or within the fractured bedrock. It should be noted that the water level measured in the area wells is not elevated above the water-bearing units and none of the wells are artesian (free flowing at the surface). It is believed that the spring receives its water primarily from the deeper aquifer that in the area of the spring is behaving like a semi-confined aquifer. The author interprets the free flowing nature of the spring as anomalous when compared to the water levels seen in domestic wells and to the behavior of other springs in the area. The amount of shallow water table intermixing with the spring water is unknown. [Figure 10](#) in Appendix A is a map of the locations of local wells based on information provided by the MBMG GWIC. The Biological Station has recently installed a number of piezometers in the area that did not show up in this investigation. Well logs for area wells are found in Appendix E. Given the available information, it can't be predicted with any certainty if there is any local recharge (within a few hundred yards) for the water-bearing units supplying water to the PWS's spring. Local infiltration of surface water does occur in the area, but the connection between that local surface recharge and the spring has not been determined. On a larger scale, the water-bearing units that feed the spring are probably recharged higher in the stream watersheds along the range front above the areas of extensive glacial till. This recharge would be provided by Lolo Creek and Yellow Bay Creek discharging directly into the surrounding fractured bedrock. This fractured rock would then allow movement of groundwater down slope and would recharge other water-bearing units (within the overburden) or would provide water to the vicinity of the spring directly. The author believes that the water discharging to the surface at the spring is probably derived from the deeper semi-confined aquifer. An alternate hypothesis is that the spring discharge comes from a now abandoned and buried paleo-channel of either Lolo Creek or Yellow Bay Creek. If this were the case, the buried channel might receive water from one of those surface streams directly and the spring water chemistry would closely match that of the stream. Further investigation is needed to clarify the matter.

Source Water Sensitivity

Based on hydrogeologic conditions, the Flathead Lake Biological Station PWS is classified as probably having Moderate Source Water Sensitivity, according to the following table. The spring has a groundwater source that appears semi-confined, but the extent of surface water influence on the spring has not been characterized. The spring is described as having a discharge that does not resemble surface water (based on a microscopic particulate analysis (MPA)) and groundwater under the direct influence of surface water (GWUDISW) evaluation. The spring is also described as having a relatively constant discharge rate throughout the year. These suggests isolation from direct and nearby surface water recharge of groundwater. Although the water source for the spring appears confined, the degree of (the thickness and lateral extent of) this confinement can't be guaranteed. As such, the source water (the aquifer that provides the water to the spring) will be considered semi-confined.

Table 4. Source Water Sensitivity

High Source Water Sensitivity Surface water and GWUDISW Unconsolidated Alluvium Unconfined Aquifer Fluvial-Glacial Gravel Terrace and Pediment Gravel Shallow Fractured or Carbonate Bedrock
Moderate Source Water Sensitivity Semi-consolidated Valley Fill sediments Unconsolidated Alluvium Semi-confined Aquifer
Low Source Water Sensitivity Consolidated Sandstone Bedrock Deep Fractured or Carbonate Bedrock Semi-consolidated Valley Fill Sediments Confined Aquifer

Methods and Criteria

Source water protection areas are divided into zones or regions according to the amount of time water takes to reach the water supply intake or the hydrogeologic sensitivity of the source water. The intake for Flathead Lake Biological Station PWS water supply is a spring that appears to come from groundwater discharging to the surface. The source water protection areas for groundwater-based systems, in order of increasing size are the Control Zone, Inventory Region, and Recharge Region. The methods and criteria used to delineate the source water protection zones for Flathead Lake Biological Station PWS are specified in the DEQ’s SWPP (DEQ, 1999).

Table 5. Criteria for delineating source water protection regions.

If Your Source of Water Is:	Delineate These Water Protection Regions	Method For Each Region:	Minimum Distance Values
Unconfined / Semi-confined/Leaky-confined	- Control - Inventory - Recharge	-Fixed radius -Time-Of-Travel Calculation -Hydrogeologic Mapping	-Distance - 100 feet - Distance - Larger of 1,000 feet up-gradient or 3-year TOT or 1-mile radius (plus half-mile buffer around hydraulically connected surface water for 10 miles upstream*) -Physical and Hydrologic flow boundaries
*Ground Water that is hydraulically connected to Surface Water	-Surface Water Buffer Zone	- Fixed radius	-One-half mile buffer extending upstream a distance corresponding to a 4-hour TOT but not to exceed ten miles or the nearest intake. Buffer will not exceed the extent of the watershed.

Table 5. Criteria for delineating source water protection regions.

If Your Source of Water Is:	Delineate These Water Protection Regions	Method For Each Region:	Minimum Distance Values
Confined	<ul style="list-style-type: none"> - Control - Inventory - Recharge 	<ul style="list-style-type: none"> -Fixed Distance - Fixed radius -Hydrogeologic Mapping 	<ul style="list-style-type: none"> -Distance - 100 feet -Distance - Minimum of 1000 feet - Physical and Hydrologic flow boundaries
Surface water	-Spill Response	-Fixed Distance	One-half mile buffer extending upstream a distance corresponding to a 4-hour TOT but not to exceed ten miles or the nearest intake. Buffer will not exceed the extent of the watershed.

For a confined aquifer, the Control Zone is based on a fixed distance of a 100-foot radius around each well; the Inventory Region is based on a 1,000-foot fixed radius circle around the wellheads; and the Recharge Region is based on geologic mapping and locations of hydrologic boundaries. If the aquifer is semi-confined or unconfined, the control and Recharge Regions are the same as for a confined aquifer, but the Inventory Region can be determined using a calculation of groundwater velocity and an estimated 3-year groundwater time-of-travel (TOT) distance. When information is lacking, a fixed 1-mile radius circle around the wellheads can be used as a conservative and protective Inventory Region. This is useful in areas where the groundwater time-of-travel distance calculations are not appropriate (e.g., in fractured bedrock aquifers) or groundwater characteristics have not been well characterized. It turns out that fractured bedrock aquifer characteristics are extremely difficult to model due to the variability in fracturing (in quantity, openness, interconnectivity, and orientation). As such, the formulas used to determine groundwater velocity and groundwater time of travel distances often break down and are non-predictive in areas with fractured bedrock aquifers. This is often the case in areas of glacial till, owing to the chaotic nature of the glacial depositional environment and the resultant sedimentary deposits.

Delineation Results

The Control Zone is based on a fixed distance of 100-foot radius circle around the spring. The Inventory Region is based on a 1-mile fixed radius circle around the wellhead (modified to fit the area) as depicted on [Figure 8](#). Although the spring may receive water from a confined aquifer / water-bearing unit, local surface water recharge near the spring can't be ruled out. As such, the spring is being treated as a well that withdraws water from an unconfined or semi-confined aquifer. A modified 1-mile fixed radius circle Inventory Region is believed to be an appropriate and conservative estimate of the area that could contribute water to the spring being used by the Flathead Lake Biological Station and should be protective of public health. When groundwater time-of-travel calculations are made, 1-year and 3-year groundwater time-of-travel distances are determined around a wellhead. When a 1-mile radius circle is used as the Inventory Region, the entire region (within 1-mile of the wellhead) will be treated as a 1-year groundwater TOT distance in order to determine the hazard of any given potential contaminant source. The determination of hazard and the susceptibility of the source water will be explained in detail in the next chapter. The Recharge Region for Flathead Lake Biological Station is inclusive of the Gunderson Creek, Lolo Creek, and Yellow Bay Creek watersheds. The Recharge Region is depicted on [Figure 9](#) in Appendix A.

Limiting Factors

The available geologic evidence and area well logs suggest that the aquifer that provides water to the spring source for the Flathead Lake Biological Station can be treated as a confined or semi-confined aquifer. To be conservative, it is assumed in this report to be semi-confined. The assumed groundwater flow direction and gradients in the area are based on local topography, surface water flow directions, and discharge points around the bay. But actual local gradients and flow directions may vary considerably. There is very little information to make inferences about recharge to the local aquifers. Therefore, if more data that are current or if better information becomes available that sheds light on the spring source of the Flathead Lake Biological Station, the assumptions of the author may be revised about the aquifer characteristics and behavior of groundwater in the area.

CHAPTER 3 INVENTORY

General Discussion

An inventory of potential sources of contamination was conducted for Flathead Lake Biological Station PWS within the Control Zone, Inventory Region, and Recharge Region. Potential sources of all primary drinking water contaminants and *Cryptosporidium* were identified. However, only significant potential contaminant sources were selected for use in the susceptibility assessment that is described in the next chapter. The most significant potential contaminants in Flathead Lake Biological Station PWS Inventory Region include: spills that may occur along Highway 35; and areas of increased septic density to the east and north along Highway 35; and the orchards and farms directly east of Highway 35.

The inventory for Flathead Lake Biological Station PWS focuses on all activities in the Control Zone, certain sites or land use activities in the Inventory Region and Recharge Region.

Inventory Method

The initial inventory of the three zones included a search of available databases to identify potential sources of impacts. Available databases were initially searched to identify businesses and land uses that are potential sources of regulated contaminants in the Inventory Region. The following steps were followed:

Step 1: Urban and agricultural land uses were identified from the U.S. Geological Survey's Geographic Information Retrieval and Analysis System (<http://nris.mt.gov/gis/datalist.html>) and Lake County tax records. Sewered and unsewered residential land uses were identified from boundaries of municipalities and county land obtained from Lake County and the 2000 US Census data. Predominant agricultural land use is based upon county tax records, verified by an examination of air photos where useful.

Step 2: Where appropriate, EPA's Envirofacts System (<http://www.epa.gov/enviro/>) was queried to identify EPA regulated facilities located in the Inventory Region. This system accesses facilities listed in the following databases: Resource Conservation and Recovery Information System (RCRIS), Biennial Reporting System (BRS), Toxic Release Inventory (TRI), 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 should be classified as a significant potential contaminant source.

Step 3: As appropriate, the Permit Compliance System (PCS) was queried using Envirofacts (<http://www.epa.gov/enviro/>) to identify Concentrated Animal Feeding Operations with MPDES permits. The water system operator or other local official familiar with the area included in the Inventory Region identified animal feeding operations that are not required to obtain a permit.

Step 4: Databases were queried to identify the following in the Inventory Region: Underground Storage Tanks (UST) (<http://webdev.deq.mt.gov/UST/>), hazardous waste contaminated sites (DEQ hazardous waste site cleanup bureau), landfills, abandoned mines and active mines including gravel pits (<http://nris.mt.gov/gis/datalist.html>). Any information on past releases and present compliance status was noted.

Step 5: Major road and rail transportation routes were identified throughout the Inventory Region (<http://nris.state.mt.us/gis/datalist.html>).

Step 6. All land uses and facilities that generate, store, or use large quantities of hazardous materials were identified within the Recharge Region and identified on the base map.

Step 7: All wells located within the Inventory Region were identified and well logs were obtained when available.

Potential contaminant sources are designated as significant (DEQ, 2000) if they fall into one of the following categories:

- 1) Large quantity hazardous waste generators.
- 2) Landfills.
- 3) Underground storage tanks.
- 4) Known groundwater contamination (including open or closed hazardous waste sites, state or federal superfund sites, and UST leak sites).
- 5) Underground injection wells.
- 6) Major roads or rail transportation routes.
- 7) Cultivated cropland greater than 20 percent of the Inventory Region.
- 8) Animal feeding operations.
- 9) Wastewater treatment facilities, sludge handling sites, or land application areas.
- 10) Septic systems.
- 11) Sewer mains.
- 12) Storm sewer outflows.
- 13) Abandoned or active mines.

Inventory Results

Control Zone

The Control Zone is the area immediately surrounding the spring. The spring is located approximately as shown on [Figure 4](#), [Figure 5](#), and [Figure 6](#). The only potential contaminant source identified near the Control Zone is Highway 35 and the access road to the State Park, which are located at the far east-side and outside of the zone's boundary. A vehicular accident that resulted in a spill of a hazardous chemical could be catastrophic if it happened anywhere near the spring. The orchards and agricultural facilities to the east of Highway 35 are outside of the Control Zone (beyond 100 feet from the spring).

Inventory Region

The Inventory Region contains several significant potential contaminant sources. These are:

- vehicular accidents along the highway that may result in the release of a hazardous material;
- areas of increased septic density that provide an increase hazard of contamination from septic effluent;
- orchards and farm operations that are located just east of the highway from the spring and may generate chemical wastes that could impact groundwater; and
- the sewer line(s) that service the State Park and several of the southernmost buildings on the Biological Station may leak or rupture and release untreated sewage into the subsurface. It is recognized that these lines are all downgradient from the spring source for the PWS, but are included here only because they fall within the boundary of the Inventory Region.

Potential contaminant sources for the Inventory Region and Recharge Region are summarized in Table 6. It should be noted here that a chemical dry well was identified on one of the figures supplied in a sanitary survey. This dry well is located directly between the 3 laboratories on the Biological Station campus and is obviously intended to receive waste chemicals. Personal communication with Mark Potter on 29 August 2006 clarified that this facility is actually an above ground pad that is a fireproof structure made of cinder blocks and concrete. It is used for the temporary storage of containers of hazardous wastes pending transport to the U of M campus (in Missoula) for disposal or recycling. As such, this facility doesn't really function as an underground liquid waste disposal well (defined by the US EPA). The so-called dry well is located to the west and outside of the Inventory Region boundary and therefore is not part of the inventory (listed below).

Table 6. Significant Potential Contaminant Sources

for Flathead Lake Biological Station PWS

	Potential Contaminant Source	Contaminants
Control Zone	Vehicular accidents with large volume spills along the Highway. These would be very infrequent, but catastrophic events if they occurred anywhere near the spring. The highway and the State Park access road are both outside of the Control Zone, but the State Park access road runs directly uphill from the spring. A truck parked on that roadway that was leaking chemicals is the greatest threat to the spring.	VOCs, SOCs, Nitrate, Pathogens, Metals, other
Inventory Region	Vehicular accidents with large volume spills along the Highway. These would be very infrequent, but catastrophic events if they occurred anywhere near the spring. Because Lolo Creek runs along the roadside ditch on the west side of the highway, it has the potential to bring spilled chemicals toward the area of the spring.	VOCs, SOCs, Metals, other
	Areas of increased Septic Density to the east of Highway 35. If poorly maintained or if they fail altogether, these systems can discharge large volumes of untreated septic effluent to groundwater.	Pathogens and Nitrates
	Cherry orchards at the farms to the east of Highway 35 and north of the spring along either side of the highway. Fertilizers or other agricultural chemicals applied to the crop (or accidentally released) may infiltrate into soils and impact groundwater. These releases would probably be associated with accidental releases during application or storage of farm chemicals or the storage and/or transfer of fuels.	Herbicides or pesticides (SOCs), fertilizers, fungicides, petroleum hydrocarbons (VOCs), other (?)
	Fruit processing / agricultural operations at the farm(s) to the east of Highway 35 and north of the spring along either side of the highway. Some specialized activities at these ranches may increase the threat of contamination. This would be due to farm processes such as fruit preparation, washing or drenching, which are preparation of fruits for packaging and shipment. These pre-packaging treatments can generate discharges (wastewater streams) that can impact groundwater.	Fungicides, chlorine, or other organic or inorganic chemicals
	The community WWTP and sewer line(s) running to the WWTP from the buildings and other facilities south of the main entrance road (BioStation Lane). These lines or the WWTP may chronically or catastrophically leak untreated septic effluent into the shallow groundwater. It is assumed that the main sewer lines run from the station's facilities down the main street to the WWTP and from the plant down the main road to the discharge point in Flathead Lake. These lines and the WWTP are found within the boundary of the Inventory Region. They are included in this listing in spite of the recognized extremely remote possibility that they could somehow impact the spring.	Pathogens and Nitrates

Table 6. Significant Potential Contaminant Sources
 for Flathead Lake Biological Station PWS

Potential Contaminant Source		Contaminants
Recharge Region	Vehicular accidents with large volume spills along the Highway. These would be very infrequent, but catastrophic events if they occurred anywhere near or upgradient of the spring.	VOCs, SOCs, Metals, other
	Cherry orchards and agricultural operations at the farms to the east of Highway 35 and north of the spring along either side of the highway. Some specialized activities at these ranches may increase the threat of contamination.	Herbicides or pesticides (SOCs), fertilizers, fungicides, other (?)

Recharge Region

The most significant potential contaminant sources located within the Recharge Region are: spills that may occur along the highway; and the orchards and agricultural operations that may occur in an area of possible recharge to the spring. As is the case for these 2 potential contaminant sources, the rest of the inventoried potential contaminant sources are also included within the Inventory Region.

Inventory Update

Flathead Lake Biological Station PWS should update the inventory for their records every year. Changes in land uses or new potential contaminant sources should be noted and additions made as needed. The complete inventory should be submitted to DEQ every five years to ensure that this source water delineation and assessment report remains current in the public record.

Inventory Limitations

The extent of the potential contaminant source inventory is limited in several respects. The inventory is based on data that is readily available through state documents, published maps and reports, GIS data, and discussions with people that are familiar with the area. Also, documentation may not be readily available on some potential sources. Some potential contaminant source may not have been identified or recognized as being a significant potential contaminant source. The author of this SWDAR is depending on the PWS owners and/or operator for site-specific knowledge.

CHAPTER 4 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 Flathead Lake Biological Station PWS owners, managers, and the operator. The goal of source water management is to protect the source water by: 1) controlling activities in the Control Zone, 2) managing significant potential contaminant sources in the Inventory Region, and 3) ensuring that major land use activities or other significant activities in the Recharge Region pose minimal threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources according to susceptibility. Alternative management approaches that could be pursued by the PWS owners and the operator to reduce susceptibility are also recommended in this chapter.

Hazard Determination

For wells that have an unconfined or semi-confined aquifer as the source water, the following table is used to determine the hazard rating of certain types of potential contaminant sources. The determination of hazard for spring sources is somewhat different than for wells. This evaluation is treating the spring source as a well, due to its somewhat artesian nature. In situations where a fixed 1-mile radius circle Inventory Region was delineated, the 1-mile distance is treated as the 1-year groundwater time-of-travel distance. Therefore, each of the significant potential point sources of contamination identified within the region would be assigned a high hazard. The sewer coverage is being treated in terms of the percent of the Inventory Region occupied or serviced by lines (which is <20%).

Table 7. Hazard, Determination of
For Unconfined Aquifers (for the Inventory Region as delineated in this report)

Potential Contaminant Sources	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
Point Sources of Contamination	Within 1-year TOT	1 to 3-years TOT	Over 3-years TOT
Septic Systems (density of)	More than 300 per sq. mi.	50 – 300 per sq. mi.	Less than 50 per sq. mi.
Municipal Sanitary Sewer (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region
Cropped Agricultural Land (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region

Note: TOT describes the groundwater time-of-travel or the distance groundwater will travel in 1 or 3 years. For this report, the potential point sources of contamination identified are all located within the 1-year groundwater TOT distance.

Hazard is rated by the proximity of a potential contaminant source to the well or spring intake structure or by the concentration of a non-point source within the Inventory Region. These hazard determination criteria are presented in Table 7. Susceptibility is then determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that

contaminated water will flow to the PWS well or spring intake (Table 8). Barriers are identified, and susceptibility ratings are assigned to each significant potential contaminant or contaminant source as seen in Table 9 below.

Table 8. Susceptibility, based on Hazard 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

Discussion of Susceptibility

A summary of the susceptibility assessment for Flathead Lake Biological Station PWS spring is located in Table 9. Below is a brief discussion of the susceptibility assessment.

Agricultural Operations at Farms East of the Spring

The processing and packaging of cherries at farms and fruit packing facilities located north of the spring can generate considerable wastewater that results from the fruit washing process. This wastewater will contain elevated concentrations of chlorine (~50 mg/L), suspended plant juices, and potentially low levels of fungicides and/or pesticides. Discussions with the operator at the cherry packing facility indicates that all solids generated as part of the fruit handling, cleaning, and sorting will be sent offsite to be landfilled. Lake County currently landfills all solid waste outside of the county. The final rinse process wastewater will be retained then ultimately discharged as sprinkler irrigation water uphill and east of the facility. If this wastewater contains contaminants that are not reduced or dissipated during the irrigation process and it infiltrates into groundwater, then water quality at the spring has the potential to be impacted. This is very dependant upon where the water for the spring actually originates. The degree of local recharge to the spring is an unknown at this time and requires considerable future study. Several barriers are thought to stand between these fruit processing operations (especially the wastewater discharge in the orchard) and the spring source. Therefore, the spring source is considered to be moderately susceptible to contaminants (an assortment of chemicals) that originate with these operations. Suggestions on managing this contaminant source are provided in Table 9.

Cherry Orchards Surrounding the Farms East and North of the Spring

The production of cherry crops at farms located east and north of the spring involves the application of fertilizers, pesticides, herbicides, and fungicides on an as-needed basis. If a spill of these materials or of petroleum fuel occurs (during storage, transport, or application), then these chemicals may impact local groundwater. If groundwater is impacted, then water quality at the spring may also be impacted. This is contingent upon the degree of local recharge of the water that is able to reach the spring. Several barriers are thought to stand between these field operations and the spring source. Therefore, the spring source is considered to be moderately susceptible to contaminants (an assortment of chemicals) that originate with these fruit production operations. Suggestions on managing this contaminant source are provided in Table 9.

Table 9. Susceptibility Assessment

Flathead Lake Biological Station – Inventory Region

Source	Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management
<p>Fruit Processing. Agricultural operations at the farm(s) to the east of Highway 35 and north of the spring along either side of the highway.</p>	<p>Fungicides, chlorine, or other organic or inorganic chemicals</p>	<p>Some specialized activities at these ranches may increase the threat of contamination. This may be due to farm processes such as fruit preparation, washing or drenching, which are preparation of fruits for packaging and shipment. These pre-packaging treatments can concentrate some compounds and generate discharges (wastewater streams). These discharges have the potential to impact groundwater.</p> <p>[These activities are not currently regulated or monitored by county, state, tribal, or federal governments.]</p> <p>Because Lolo Creek runs along the roadside ditch west of the highway, it has the potential to bring some of these chemicals toward the area of the spring.</p>	<p>High Hazard</p>	<ul style="list-style-type: none"> <input type="checkbox"/> The aquifer providing water to the spring is considered semi-confined, and the clay and silt-rich glacial till that confines the water-bearing formations is a natural barrier. <input type="checkbox"/> All waste solids from the fruit processing at this facility will be shipped offsite to a landfill outside of Lake County. <input type="checkbox"/> The fruit processor is using a holding tank for the spent wash water. When the tank is full, then the wastewater will be pumped uphill to the east and applied through sprinkler irrigation to the cherry orchard. The facility operator is making an effort to increase the distance between the wastewater application and the PWS spring source. 	<p>Moderate Susceptibility</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Promote best management practices (BMPs) for orchard crop processing. The BioStation can provide these to the growers/fruit packer as a public service and technical assistance, as opposed to being in the context of a complaint about past or current practices. <input type="checkbox"/> Promote good communication and cooperative relationship with the local growers and fruit packer. This contact brings to light the fact that the Biological Station's spring source is located where it is and is vulnerable to chemicals that they may use and/or discharge. Part of the good cooperative relationship would be to provide courtesy technical assistance in any way that the Station or personnel can. <input type="checkbox"/> Consider diverting Lolo Creek out of the roadside ditch and allowing it to flow west near its original channel and into the swampy area east of the BioStation. <input type="checkbox"/> Investigate the relationship between recharge to the subsurface on the east side of the highway and discharge at the spring.

Table 9. Susceptibility Assessment

Flathead Lake Biological Station – Inventory Region

Source	Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Cherry orchards on the farms to the east of Highway 35 and north of the spring along either side of the highway.	Herbicides or pesticides (SOCs), fertilizers, fungicides, petroleum hydrocarbons (VOCs), other (?)	Fertilizers or other agricultural chemicals applied to the crop (or accidentally released) may infiltrate into soils and impact groundwater. These releases would probably be associated with accidental releases during storage or application of farm chemicals or the storage and/or transfer of fuels. Because Lolo Creek runs along the roadside ditch west of the highway, it has the potential to bring some of these chemicals toward the area of the spring.	High Hazard	<input type="checkbox"/> The aquifer providing water to the spring is considered semi-confined, and the clay or silt-rich glacial till that confines the water-bearing formations is a natural barrier. <input type="checkbox"/> Most, but not all, of the orchards are located on the far side (either south or north) of a stream. These surface water features can act as a barrier between the potential contaminant source and the spring. <input type="checkbox"/> Local farms utilize integrated pest management to reduce chemical use and reduce residuals on fruit. <input type="checkbox"/> Pesticide applications on orchards are done by trained and certified applicators and according to label restrictions.	Moderate Susceptibility	<input type="checkbox"/> Promote best management practices (BMPs) for orchard crop production. These can be accumulated and provided to the growers by the BioStation as a public service and technical assistance, as opposed to being in the context of a complaint about past or current practices. <input type="checkbox"/> Promote good communication and cooperative relationship with the local growers. This contact brings to light the fact that the Biological Station's spring source is located where it is and is vulnerable to chemicals that they may use. Part of the good cooperative relationship would be to provide courtesy technical assistance in any way that the Station or personnel can. <input type="checkbox"/> Consider diverting Lolo Creek out of the roadside ditch and allowing it to flow west near its original channel and into the swampy area east of the BioStation. <input type="checkbox"/> Investigate the relationship between recharge to the subsurface on the east side of the highway and discharge at the spring.

Table 9. Susceptibility Assessment

Flathead Lake Biological Station – Inventory Region

Source	Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Vehicular accidents along the Highway.	VOCs, SOCs, Metals, other	These accidents may be associated with large volume spills. These would be very infrequent, but catastrophic events if they occurred anywhere near the spring. Spilled materials could infiltrate into sediments and impact groundwater quality. Because Lolo Creek runs along the roadside ditch west of the highway, it has the potential to bring spilled chemicals toward the area of the spring.	High Hazard	<ul style="list-style-type: none"> <input type="checkbox"/> The aquifer providing water to the spring is considered semi-confined. The clay or silt-rich glacial till that confines the water-bearing formations is a natural barrier. <input type="checkbox"/> Some limited resources are available at the Biological Station and local landowners to respond to some chemical releases. <input type="checkbox"/> Emergency responders from Polson and/or Bigfork can provide some limited assistance in the event of a spill. 	Moderate Susceptibility	<ul style="list-style-type: none"> <input type="checkbox"/> Identify local resources (at or near the Biological Station) that can be called upon in the event of a spill. This would include manpower, heavy equipment (a backhoe or other), or other resources. <input type="checkbox"/> Promote working agreements with locals (local landowners, farmers, etc.) to aid in a spill cleanup. Promote contacts with the emergency responders in Bigfork or Polson that would be involved in a spill. Understand their abilities and limitations in the event of a spill near the spring. <input type="checkbox"/> Accumulate onsite equipment and resources that can be used in the event of a spill. These can involve the stockpiling of fuel absorbent padding or booms, clean soils, etc. as well as maintaining equipment (a bobcat or backhoe or other). <input type="checkbox"/> Mechanical barriers should be in-place to prevent vehicles (especially any trucks with tanks) from parking anywhere above the spring. This can be done with concrete and/or steel barricades. If sturdy enough, these may actually deflect a vehicle from dumping its load near the spring during an accident. <input type="checkbox"/> Thought should be given to an engineered drainage diversion between the active roadway(s) and the spring. This is intended to deflect any liquid or water entrained contaminant to one side and prevent it from running off the road surface and toward the spring. The road above the spring is the access road to the State Park. A curb or low berm along the road above the spring would easily fill the need. This simple drainage control would prevent most of the threats (localized) from runoff into the spring area from above. <input type="checkbox"/> Consider diverting Lolo Creek out of the roadside ditch and allowing it to flow west near its original channel and into the swampy area east of the BioStation. <input type="checkbox"/> Investigate the relationship between recharge to the subsurface on the east side of the highway and discharge at the spring.

Table 9. Susceptibility Assessment

Flathead Lake Biological Station – Inventory Region

Source	Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Areas of increased Septic Density to the east of Highway 35 (medium density).	Pathogens and Nitrates	Areas of increased Septic Density to the east of Highway 35 (medium density). If poorly maintained or if they fail altogether, these systems can discharge large volumes of untreated septic effluent to groundwater.	Moderate Hazard (due to a medium density)	<input type="checkbox"/> The aquifer providing water to the spring is considered semi-confined, and the clay or silt-rich glacial till that confines the water-bearing formations is a natural barrier. <input type="checkbox"/> Lake County requires pressure dosed septic treatment systems for all new septic systems.	Low Susceptibility	<input type="checkbox"/> Local promotion of advanced (Level 2) septic treatment systems. These are appropriate for replacement systems or for any new systems that are installed in the area surrounding Yellow Bay. <input type="checkbox"/> Creation of a local Water & Sewer District could help in the regulation and promotion of the implementation of rules requiring Level 2 septic treatment systems in the local drainage/watershed. <input type="checkbox"/> Public education on proper waste disposal of liquids. This can include a periodic liquid waste-recycling program. <input type="checkbox"/> Possible development of community septic effluent collection and wastewater treatment system for residences located on the east side of the highway, or for the entire Yellow Bay community. <input type="checkbox"/> Restrict or manage development of homes or industry within the Inventory Region and around Yellow Bay. <input type="checkbox"/> Investigate the relationship between recharge to the subsurface on the east side of the highway and discharge at the spring.

Table 9. Susceptibility Assessment

Flathead Lake Biological Station – Inventory Region

Source	Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Sewer Line(s) that drain from the State Park and buildings south of Bio Station Road and the Wastewater Treatment Plant (WWTP)	Nitrates and Pathogens	Chronic or catastrophic line leaks that would allow untreated sewage to impact groundwater	Low Hazard (area occupied by the lines is actually quite small)	<input type="checkbox"/> The aquifer providing water to the spring is considered semi-confined, and the clay or silt-rich glacial till that confines the water-bearing formations is a natural barrier. <input type="checkbox"/> Groundwater is thought to flow toward the lake (west by southwest). These sewer lines and the WWTP are all located downgradient from the spring. <input type="checkbox"/> The WWTP operator is trained, tested, and certified to operate and maintain this treatment system. <input type="checkbox"/> Groundwater has a vertical-upward groundwater gradient in the vicinity of the lakeshore. This is evidenced by the springs discharging into the lake and by the measurements taken in temporary piezometers installed into the gravels along the shoreline. <input type="checkbox"/> The FLBS facilities are involved in a major liquid chemical recycling program and run a dry repair shop.	Very Low Susceptibility	<input type="checkbox"/> Monitor sewer lines for chronic or catastrophic leakage. <input type="checkbox"/> If repairs or replacement of these lines is needed, install sleeves as a double seal around the lines where they are exposed. Secondary containment of any larger reservoirs / septic tanks is recommended. <input type="checkbox"/> Continue the liquid chemical waste recycling program with transport off-facility for disposal or recycling (at U of M campus).

Vehicle Accidents Along the Highway

Accidents that result in a release of fuel or other hazardous chemicals are a threat to the spring. The probability of a spill happening in the area above the spring is very high, but the frequency of such an event is very low. The State Park access road runs uphill of the spring, but appears to be outside of the Control Zone (beyond 100 feet). At least 3 barriers were identified that probably stand between a potential chemical spill and the spring intake. Therefore, the spring source is considered to be moderately susceptible to contaminants that originate with spills along the highway and access road to the State Park. Suggestions on managing spills along these roadways are provided in Table 9. Isolating spills from the area of the spring should be implemented as far as possible. The spring is located directly below the access road to the State Park and not directly below the highway. Mechanical barriers can be installed to block vehicles from parking above the spring. Additionally, some sort of drainage diversion should be considered between spills on the road surface and the spring. A roadside berm would take care of this need for runoff diversion. In addition, No Parking signs should be mounted along the stretch of road above the spring. This would reduce the time vehicles spend in the vicinity and reduce the chance of a spill. The BioStation should evaluate how to divert Lolo Creek out of its roadside ditch. This channelized ditch has the potential to conduct contaminants into the area of the spring. It is suggested that it be diverted to the south and into the swampy area east of the BioStation.

Areas of Increased Septic Density

The density of private onsite septic systems is considered medium in the census blocks located east and across the highway from the spring. These private systems may chronically leak if they have failed due to poor maintenance (a very common problem). At least a couple of barriers appear to be in place between these septic systems and the spring source. Therefore, the spring source is thought to have a low susceptibility to contaminants (nitrogen and pathogens) that originate with this concentration of private septic systems. Suggestions on managing these contaminant sources are provided in Table 9.

Septic Sewer Mains and Wastewater Treatment Plant

Septic sewer lines run from the State Park facilities north along the shore and connect to the Biological Station's wastewater treatment plant (WWTP). All of the FLBS facilities that have toilets and sink drains also connect to a sewer main that runs to the WWTP. None of the information found during the inventory process suggested that any historic leaks have occurred from these lines or the plant. These leaks can be small chronic leaks or large volume catastrophic subsurface spills. Sometimes these sorts of releases of septic effluent are quite difficult to recognize or find. If leaks occurred from these lines or from the treatment plant, untreated septic effluent may reach the groundwater. Because the Inventory Region encompasses some of these lines and the WWTP, then large volume releases have at least some limited potential to affect water quality at the spring (although admittedly, this is unlikely). Multiple barriers appear to be in place between the septic lines / WWTP and the spring source. Therefore, the spring source has a very low susceptibility to contaminants (nitrate and pathogens) that originate with a release of sewage to groundwater. Suggestions on managing this contaminant source are provided in Table 9.

Summary of Susceptibility

Flathead Lake Biological Station public water supply uses a spring located northeast of the facility and along the west side of the highway. DEQ classifies this water system as a Non-Transient Non-Community PWS. For the purposes of this delineation and assessment, the spring is believed to be discharging from a semi-confined aquifer. As such, the Biological Station's spring is being treated much

like a well and the Inventory Region is a modified one-mile fixed radius circle around the spring. The significant potential contaminant sources that were identified within the Inventory Region may affect water quality at the PWS. Because of the way the evaluation process is done, most of the inventoried contaminant sources were assigned a high hazard. The potential contaminant sources found within the Inventory Region are:

- Agricultural operations such as fruit growing and processing/packing.
- Non-routine spills or releases that may occur in the cherry orchards located east and north of the spring.
- Vehicular accidents that may occur along the highway or on the State Park access road, especially near the spring.
- Areas of increased septic density, especially directly east of the spring.
- Sewer lines and the WWTP for the facility.

Several natural, engineered, or management barriers are believed to be in-place to reduce the spring's susceptibility to these potential contaminant sources. The spring source appears to have a moderate susceptibility to contamination from the first 3 potential contaminant sources (listed above). The spring source appears to have a low susceptibility to contamination from the areas of increased septic density and a very low susceptibility to sewer main leaks or ruptures. The Recharge Region and Inventory Region are depicted on [Figure 8](#) and [Figure 9](#), and the susceptibility of the PWS is discussed on Table 9.

It should be noted that several assumptions were made to develop this delineation and assessment. It was estimated that the aquifer that provides water to the PWS well is behaving under semi-confined conditions. This appears to be true, but further study may prove otherwise. Because a contaminant source has not been identified in the inventory or susceptibility assessment of this report, it doesn't mean that the potential source is not there or that the potential for contamination does not exist. Therefore, if potential contaminant sources were present near or upgradient from the PWS intake, it would be prudent to understand the threat from these sources.

Assessment Limitations and Recommendation

Hydrogeologic Assumptions

A key limitation in this evaluation is the assumption that the spring for the Flathead Lake Biological Station is producing water from a semi-confined aquifer. The author believes that there are probably 2 aquifers in the area. The shallow aquifer is essentially an unconfined water table aquifer in the shallow glacial materials of the area. This shallow aquifer is recharged locally by infiltration from the surface and discharges to local streams or to the surface as springs. There is a deeper aquifer that resides mostly in the fractured bedrock. Most area wells tap this deeper aquifer. Water levels in the deeper aquifer are not elevated, so it typically does not behave as a confined aquifer in the area of Yellow Bay. The author estimates that the Flathead Lake Biological Station PWS spring source is a discharge point for this lower semi-confined aquifer. There is anecdotal evidence indicating that the spring's source water may be confined, but the evidence does not make an iron clad case and local recharge from the near surface can't be ruled out. If the spring water comes from water-bearing formations that are essentially a confined aquifer, the size of the Inventory Region might be greatly reduced (to ~1,000 feet around the spring) and the evaluation of hazard would be quite different.

Recommendations

It is very important to understand the exact nature of the water from the spring. A microscopic particulate analysis (MPA) was conducted on the spring and determined that the source was groundwater. That test does not rule out a nearby area of recharge to the shallow aquifer, which in turn

could supply water to the spring. It is suggested by the author that further tests be run on the water discharging from the spring to better characterize the source of this water.

- During fruit processing operation east of the highway, especially during the discharge of fruit rinsate wastewater, the spring should be analyzed for chlorine and chlorination by-products (trihalomethanes). This would be a simple and relatively inexpensive analysis. It appears that a wide assortment of chemicals can be used in the fruit packaging preparation, but chlorine is very common and would be present at the highest concentration. If the wastewater is discharged to the surface, then it will probably recharge the shallow groundwater. If that groundwater is in contact with the groundwater unit(s) providing water to the spring, then chlorine or chlorinated organic compounds will show up in the spring water sampled soon after a nearby cherry rinsing wastewater discharge occurs. Analysis for chlorine, chlorination residuals, and chlorination by-products is a routine drinking water analysis.
- A similar check on nearby recharge to the spring can be done by conducting a dye tracer study. The dye can be added to the shallow subsurface in an appropriate location east of the highway and upgradient from the spring. A suitable well would be the one that is present directly across the highway from Biostation Lane on the newly acquired property. A well was noted on that property during a visit in July 2005. It is believed that that well is tapping into the shallow water table aquifer. If the dye makes the journey from the shallow water table aquifer and is discharged at the spring, then one can be relatively sure that the spring is locally recharged. Colorimetric testing would need to be conducted at the spring or in the water storage tank on a routine basis in order to catch the dye as it moved through the system (if it moves through the system). An automated tester is probably best used in order to catch the dye as it moves through the system.
- The Montana Bureau of Mines and Geology (MBMG) is able to sample and analyze for tritium or other age-dependant parameters in groundwater. These analyses can sometimes provide insight into the age of groundwater (actually how long the water has been below the ground surface). If the spring water is very young, it may suggest a local recharge for the aquifer. If the water is older, it may suggest that little local recharge is occurring and that the spring is less vulnerable to local potential contaminant sources.
- The MBMG is also able to conduct analysis of a number of inorganic water quality parameters that will help to characterize the water in the spring and compare that water to that found in the shallow water table aquifer or the deeper semi-confined aquifer.

Monitoring Waiver Recommendation

This section addresses the Flathead Lake Biological Station PWS that DEQ has classified as Non-Community Non-Transient. The authors' recommendation is based upon the determination of susceptibility as described above.

Waiver Recommendation of this SWDAR

Based on past monitoring results and the susceptibility assessment of the Flathead Lake Biological Station PWSs as it is now configured (with one spring source), the PWS appears to be eligible for several monitoring waivers. DEQ records suggest that the PWS currently does not have monitoring waivers in place. Based on the monitoring history for the spring, the results of the inventory, the susceptibility assessment of this SWDAR, the geology of the area, the nature of the aquifer from which the spring appears to discharge water, this spring (and the PWS) may be eligible for volatile organics (VOCs) waivers and some inorganic (IOC) waivers. For monitoring waiver consideration, the PWS should submit a letter to DEQ requesting the specific monitoring waivers. If requested by DEQ, the PWS may also need to provide additional information.

Monitoring Waiver Requirements

The 1986 Amendments to the Safe Drinking Water Act require that community and non-community PWSs sample drinking water sources for the presence of volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). The US EPA has authorized states to issue monitoring waivers for the organic chemicals to systems that have completed an approved waiver application and review process. All PWSs in the State of Montana are eligible for consideration of monitoring waivers for several organic chemicals. The chemicals diquat, endothall, glyphosate, dioxins, ethylene dibromide (EDB), dibromochloropropane (DBCP), and polychlorinated biphenyls are excluded from monitoring requirements by statewide waivers.

Use Waivers

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

Susceptibility Waivers

If a Use Waiver is not granted, a system may still be eligible for a Susceptibility Waiver, if through a vulnerability assessment it is demonstrated that the water source would not be susceptible to contamination. Susceptibility is based on prior analytical or vulnerability assessment results, environmental persistence, and transport of the contaminants, natural protection of the source, wellhead protection program efforts, and the level of susceptibility indicators (such as nitrate and coliform bacteria). The vulnerability assessment of a surface water source must consider the watershed area above the source (a surface water intake). PWSs developed in unconfined aquifers should use a minimum fixed radius of 1.0 mile as an area of investigation for the use of organic chemicals. Vulnerability assessment of spring water sources should use a minimum fixed radius of 1.0 mile as an area of investigation for the use of organic chemicals. Shallow groundwater sources under the direct influence of surface water (GWUDISW) should use the same area of investigation as surface water systems; that is, the watershed area above the source. The purpose of the vulnerability assessment procedures is to determine which of the organic chemical contaminants are in the area of investigation.

Given the wide range of landforms, land uses, and the diversity of groundwater and surface water sources across the state, additional information is often required during the review of a waiver application. Additional information may include well logs, pump test data, or water quality monitoring data from surrounding public water systems; delineation of zones of influence and contribution to a well; Time-of-Travel or attenuation studies; vulnerability mapping; and the use of computerized groundwater flow and transport models. Review of an organic chemical monitoring waiver application will be conducted by DEQ's PWS Section and DEQ's Source Water Protection Program. Other state agencies may be asked for assistance.

Susceptibility Waiver for Unconfined Aquifers

Unconfined aquifers are the most common source of usable groundwater. Unconfined aquifers differ from confined aquifers in that the groundwater is not regionally overlain by relatively impervious geologic strata. As a result, the upper groundwater surface or water table in an unconfined aquifer is not under pressure that produces hydrostatic head common to confined aquifers.

Unconfined aquifers are often locally recharged from surface water or precipitation. In general, groundwater flow gradients in unconfined aquifers may reflect surface topography, and the residence time of water in the aquifer is typically comparatively shorter than for water in confined aquifers. Similar water chemistry may often exist between unconfined groundwater and area surface water, and physical parameters and dissolved constituents can be indicators of the hydraulic connection between groundwater and surface water. Consequently, unconfined aquifers can be susceptible to contamination by organic chemicals migrating from the ground surface or surface water to groundwater.

The objective of the Susceptibility Waiver application is to assess the potential of organic chemical migration from the surface to the unconfined aquifer. The general procedures make use of a combination of site-specific information pertaining to the location and construction of the source, monitoring history of the source, geologic characteristics of the vadose zones, and mobility and persistence characteristics of the organic chemicals. The zone of contribution of the unconfined groundwater source must be defined and plotted. Groundwater flow directions, gradients, and a 3-year time-of-travel should be described. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and nearby wells should also be provided.

Susceptibility Waiver for Confined Aquifers

Confined groundwater is isolated from overlying material by relatively impermeable geologic formations. A confined aquifer is subject to pressures higher than atmospheric pressure that would exist at the top of the aquifer if the aquifer were not geologically confined. A well that is drilled through the impervious layer into a confined aquifer will enable the water to rise in the borehole to a level that is proportional to the water pressure (hydrostatic head) that exists at the top of a confined aquifer.

The susceptibility of a confined aquifer relates to the probability of an introduced contaminant to travel from the source of contamination to the aquifer. Susceptibility of an aquifer to contamination will be influenced by the hydrogeologic characteristics of the soil, vadose zone (the unsaturated geologic materials between the ground surface and the aquifer), and confining layers. Important hydrogeologic controls include the thickness of the soil, the depth of the aquifer, the permeability of the soil and vadose zones, the thickness and uniformity of low permeability and confining layers between the surface and the aquifer, and hydrostatic head of the aquifer. These factors will control how readily a contaminant will infiltrate and percolate toward the groundwater.

The Susceptibility Waiver has the objective of assessing the potential of contaminants reaching the groundwater used by the PWS. A groundwater source that appears to be confined from surface infiltration in the immediate area of the wellhead may eventually be affected by contaminated groundwater flow from elsewhere in the recharge area. Contaminants could also enter the confined aquifer through improper well construction or abandonment creating a hydraulic connection from the surface to the confined aquifer. The extent of confinement of an aquifer is critical to limiting susceptibility to organic chemical contamination.

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GLOSSARY*

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

Alkalinity. The capacity of water to neutralize acids.

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

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

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

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

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

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

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

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

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

Confined Aquifer. A fully saturated aquifer overlain by a confining unit such as a clay layer. The static water level in a well in a confined aquifer is at an elevation that is equal to or higher than the base of the overlying confining unit.

Confining Unit. A geologic formation present above a confined aquifer that does not allow the flow of water, maintaining the pressure of the ground water in the aquifer. The physical properties of a confining unit may range from a five-foot thick clay layer to a shale that is hundreds of feet thick.

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

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

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

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

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

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

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

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

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

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

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

Maximum Contaminant Level (MCL). Maximum concentration of a substance in water that is permitted to be delivered to the users of a public water supply. Set by EPA under authority of the Safe Drinking Water Act to establish concentrations of contaminants in drinking water that are protective of human health.

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

Montana Pollutant Discharge Elimination System (MPDES). Database system to track entities that discharge wastewater of any type into waters of the State of Montana.

National Pollutant Discharge Elimination System (NPDES). A national database system to track entities that discharge wastewater.

Nitrate. An important plant nutrient and type of inorganic fertilizer that can be a potential contaminant in water at high concentrations. In water the major sources of nitrates are wastewater treatment effluent, septic tanks, feed lots and fertilizers.

Nonpoint-Source Pollution. Pollution sources that are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. Nonpoint sources of pollution, such as the use of herbicides, can concentrate low levels of chemicals into surface and/or ground waters at increased levels that may exceed MCLs.

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

Point-Source. A stationary location or fixed facility from which pollutants are discharged.

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

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

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

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

Resource Conservation and Recovery Act (RCRA). Enacted by Congress in 1976. RCRA's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner. The Resource Conservation and Recovery Information System (RCRIS) provides information about specific sites through the EPA Envirofacts website.

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

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

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

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

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

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

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

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

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

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

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

Transmissivity. A number that describes the ability of an aquifer to transmit water. The transmissivity is determined by multiplying the hydraulic conductivity time the aquifer thickness.

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

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

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

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

APPENDICES

Appendix A

Figures

<u>Figure 1</u>	Flathead Lake Region
<u>Figure 2</u>	Yellow Bay & Vicinity
<u>Figure 3</u>	Yellow Bay Area, 2005 Aerial Photo
<u>Figure 4</u>	Topographic Overlay of 2005 Aerial Photo
<u>Figure 5</u>	Flathead Lake Biological Station, Facilities Map
<u>Figure 6</u>	Spring Source Map
<u>Figure 7</u>	Geologic & Bedrock Elevation Maps
<u>Figure 8</u>	Inventory Region
<u>Figure 9</u>	Recharge Region
<u>Figure 10</u>	Area Well Locations

Appendix B

Photo Log For 2005 DEQ Visit

Sanitary Surveys

GWUDISW Determination

Relevant Correspondence

Appendix C

DEQ PWS Database

Facilities Summary

Monitoring Schedule

Water Quality Data

Appendix D

EPA Fact Sheet (Class V UICs)

Washing State Fact Sheet and BMP (Fresh Fruit Packing)

Wisconsin PDES Fact Sheet (Land Application of Food Processing By-Product Solids)

Appendix E
Well Logs for Area Wells

Appendix F
Concurrence Document