
# Source Water Assessment

## A Hydrogeologic Susceptibility and Vulnerability Assessment for Silver Budda Lodge Public Drinking Water System, Sterling, Alaska PWSID # 249098.001

DRINKING WATER PROTECTION REPORT 1727

Alaska Department of Environmental Conservation

December, 2008

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The Drinking Water Protection (DWP) section of the Drinking Water Program is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (DEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. It is anticipated this assessment will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of public drinking water source. If you have any additional information that may affect the results of this assessment, please contact the DWP staff at the following number: 1-866-956-7656.

December, 2008

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# Source Water Assessment for Silver Budda Lodge Source of Public Drinking Water, Sterling, Alaska

**Drinking Water Protection**
**Alaska Department of Environmental Conservation**

## EXECUTIVE SUMMARY

The public water system for Silver Budda Lodge is a Class B (transient/non-community) water system consisting of one well located on the Kenai River, in Sterling, Alaska. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Low**. Combining these two ratings produces a **Low** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Silver Budda Lodge public drinking water source include: a coal mining area, septic systems, heating oil tanks, and roads. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the public water source for Silver Budda Lodge received a vulnerability rating of **Low** for bacteria and viruses, **Low** for nitrates and nitrites, and **Very High** for volatile organic chemicals. This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of Silver Budda Lodge to protect public health.

## SILVER BUDDA LODGE PUBLIC DRINKING WATER SYSTEM

The Silver Budda Lodge public water system is a Class B (transient/non-community) water system. The system consists of one well located on the Kenai River, in Sterling, Alaska (see Map in Appendix A). The community of Sterling (population 5,123) sits at the junction of the Moose and Kenai Rivers, approximately 18 miles east of the City of Kenai. It lies within the Kenai Peninsula Borough, which has a population of approximately 50,000 and encompasses an area of more than 25,600 square miles (KPB, 2008).

The Sterling area receives 20 inches of precipitation annually, and average temperatures range from 4 to 22 degrees Fahrenheit in the winter and from 45 to 65 degrees Fahrenheit in the summer (ADCCED, 2008).

There is no public water supply or sewage system in the area, as all households use individual water wells and septic systems. Natural gas is supplied to the area by Enstar while electricity is provided by Homer Electric Association (ADCCED, 2008).

The Kenai Peninsula is divided into two distinct geographic areas: the Kenai Mountains to the east and the Kenai Lowlands to the west. The Kenai Lowlands are a glaciated coastal shelf approximately 100 miles long, bordered on the west and north by Cook Inlet and on the east by the northeast-trending Kenai Mountains. The Lowlands are predominately drained by the Kenai River and contain the communities of Sterling, Soldotna, Kenai, Nikiski, Clam Gulch, and Homer. The Kenai Mountains extend from the southern tip of the Peninsula north to Turnagain Arm, and include the communities of Hope, Moose Pass, Cooper Landing, and Seward (Karlstrom, 1964).

The following summary of regional geology and hydrogeology is based on studies by: Bailey and Hogan (1995); Freethey and Scully (1980); Glass (1996); Hartman, *et al*. (1972); and Karlstrom (1964). The most significant groundwater resources in the Kenai Lowlands are contained in coarse-grained sands and gravels. They are characterized by high rates of recharge, and are usually found in flood plain, river terrace, and alluvial deposits. Unsorted glacial moraine and drift deposits generally have poor groundwater yields, as do discontinuous layers of confining clays and silt that are common throughout unconsolidated cover. Unconsolidated sediment is more common in the northern portions of the Lowlands, where it locally hosts thicker, more extensive clay aquitards and multiple aquifers.

Most of the wells in the Sterling area are deep, with depths ranging from 50 to 200 feet. Static water levels in many of these wells are between 10 and 30 feet below the surface. Although groundwater quality can vary significantly over short distances, groundwater supplies are generally abundant in the area.

According to the well log, the well extends approximately 155 feet below the ground surface, and is completed in a confined aquifer and screened in sand. This system operates from May to September and serves twenty-five non-residents through nine service connections.

## SILVER BUDDA LODGE DRINKING WATER PROTECTION AREA

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the drinking water protection area. The drinking water protection area is the area circling the well (the area influenced by pumping) and also the area upgradient of the well, usually forming a parabola shape. Because releases of contaminants within the protection area are most likely to impact the well, this area will serve as the focus for voluntary protection efforts.

There are many different methods for calculating the size of protection areas. Drinking Water Protection (DWP) uses a combination of two simple groundwater flow equations, the Thiem and uniform flow equations for all groundwater wells screened in unconsolidated material. The orientation of the protection zone is then drawn using a water table elevation map (if available) or a land surface elevation map of the area. The protection zone calculated by the DWP is an estimate using the available information and resources, and may differ slightly from the actual capture zone. Because of uncertainties and changing site conditions, a factor of safety is added to the protection zone to form the drinking water protection area for the well.

The parameters used to calculate the shape of this protection zone are general for the whole alluvial plain and were obtained from various United States Geological Survey (USGS) reports, area well logs, and the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

The protection areas established for wells by the DEC are usually separated into two zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the protection area.

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the two protection area zones for wells and the calculated time-of-travel for each:

**Table 1. Definition of Zones**

| Zone | Definition |
|---|---|
| A | Several months time-of-travel |
| B | Less than the 2 year time-of-travel |

The drinking water protection area for Silver Budda Lodge was determined using an analytical calculation and includes Zones A and B (see Map A of Appendix A).

## INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

DWP has completed an inventory of potential and existing sources of contamination within the Silver Budda Lodge drinking water protection area. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class B public water system assessments, the following three categories of drinking water contaminants were inventoried:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals

The sources are displayed on Map C of Appendix C and summarized in Table 1 of Appendix B.

## RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a "potential" or "existing" source of contamination is a function of toxicity and volumes of specific contaminants associated with that source. Rankings include:

- Low;
- Medium;
- High; and
- Very High.

Tables 2 through 4 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

**VULNERABILITY OF SILVER BUDDA LODGE DRINKING WATER SYSTEM**

Vulnerability of a drinking water source to contamination is a combination of two factors:

- Natural Susceptibility; and
- Contaminant Risks.

A score for the Natural Susceptibility of the well is reached by considering the properties of the well and the aquifer.

Susceptibility of the Wellhead (0-25 Points)
+
Susceptibility of the Aquifer (0-25 Points)
=
Natural Susceptibility of the Well (0-50 Points)

A ranking is assigned for the Natural Susceptibility according to the point score:

| Natural Susceptibility Ratings | |
|---|---|
| 40-50 pts | Very High |
| 30 to < 40 pts | High |
| 20 to < 30 pts | Medium |
| < 20 pts | Low |

Factors contributing to the susceptibility of the wellhead are: whether the sanitary seal is in place, protection from flooding, and if the well casing is properly grouted.

The wellhead for the Silver Budda Lodge received a **Low** susceptibility rating. No sanitary survey is available for this system, however, a site visit (9/17/2008) confirmed that a sanitary seal is installed and the land surface is appropriately sloped away from the well. It is unknown if the well is grouted according to DEC regulations. Sanitary seals prevent potential contaminants from entering the well, while sloping of the land surface away from the wellhead provides adequate surface water drainage, and concrete or grouting around the wellhead helps to prevent potential contaminants from traveling down the outside of the well casing.

Factors contributing to the susceptibility of the aquifer are: whether the aquifer is confined or unconfined, whether the well is completed in unconsolidated or fractured bedrock, whether wells and bore holes are penetrating the aquifer and, if applicable, the confining layer.

The Silver Budda Lodge draws water from a confined aquifer overlain by 74 feet of clay. The aquifer received a **Low** susceptibility rating because of its thick and moderately deep confining layer. Deeper aquifers are more protected from surface contaminants while thicker confining layers provide greater protection from any contamination that does manage to penetrate to that depth.

Table 2 summarizes the Susceptibility scores and ratings for the Silver Budda Lodge system.

**Table 2. Susceptibility**

| | Score | Rating |
|---|---|---|
| Susceptibility of the Wellhead | 5 | Low |
| Susceptibility of the Aquifer | 8 | Low |
| Natural Susceptibility | 13 | Low |

Contaminant risks are derived from an evaluation of the routine sampling results of the water system and the presence of potential sources of contamination. Contaminant risks to a drinking water source depend on the type and distribution of contaminant sources. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

| Contaminant Risk Ratings | |
|---|---|
| 40-50 pts | Very High |
| 30 to < 40 pts | High |
| 20 to < 30 pts | Medium |
| < 20 pts | Low |

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants for the Silver Budda Lodge system.

**Table 3. Contaminant Risks**

| Category | Score | Rating |
|---|---|---|
| Bacteria and Viruses | 12 | Low |
| Nitrates and/or Nitrites | 12 | Low |
| Volatile Organic Chemicals | 50 | Very High |

Finally, an overall vulnerability score is assigned for each water system by combining each of the contaminant risk scores with the natural susceptibility score:

Natural Susceptibility (0-50 Points)
+
Contaminant Risks (0-50 Points)
=
Vulnerability of the Drinking Water Source to Contamination (0-100 Points)

Again, rankings are assigned according to a point score:

| Overall Vulnerability Ratings | |
|---|---|
| 80-100 pts | Very High |
| 60 to < 80 pts | High |
| 40 to < 60 pts | Medium |
| < 40 pts | Low |

Table 4 contains the overall vulnerability scores (0-100) and ratings for each of the three categories of drinking water contaminants for the Silver Budda Lodge system. Note: scores are rounded off to the nearest five.

**Table 4. Overall Vulnerability**

| Category | Score | Rating |
|---|---|---|
| Bacteria and Viruses | 25 | Low |
| Nitrates and/or Nitrites | 25 | Low |
| Volatile Organic Chemicals | 65 | High |

**Bacteria and Viruses**

The contaminant risk for bacteria and viruses is **Low** with septic systems and roads contributing to the risk to the drinking water well.

Coliforms (a bacteria) are found naturally in the environment and although they aren't necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli, which only come from human and animal fecal waste. Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2008).

Only a small amount of bacteria and viruses are required to endanger public health. Positive samples increase the overall vulnerability of the drinking water source, indicating that the source is susceptible to bacteria and virus contamination. The drinking water at Silver Budda Lodge has not been recently sampled for bacteria and viruses (data reviewed in April, 2008).

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

**Nitrates and Nitrites**

The contaminant risk for nitrates and nitrites is **Low** with septic systems and roads contributing to the risk to the drinking water well.

The drinking water at Silver Budda Lodge has not been recently sampled for nitrates and nitrites (data reviewed in April, 2008).

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

**Volatile Organic Chemicals**

The contaminant risk for volatile organic chemicals is **Very High** with septic systems, a coal mining area, heating oil tanks, and roads contributing to the risk to the drinking water well.

The drinking water at Silver Budda Lodge has not been recently sampled for volatile organic chemicals (data reviewed in April, 2008).

After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **High**.

**Using the Source Water Assessment**

This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of Silver Budda Lodge to protect public health. It is anticipated that Source Water Assessments will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of Silver Budda Lodge drinking water source.

# REFERENCES


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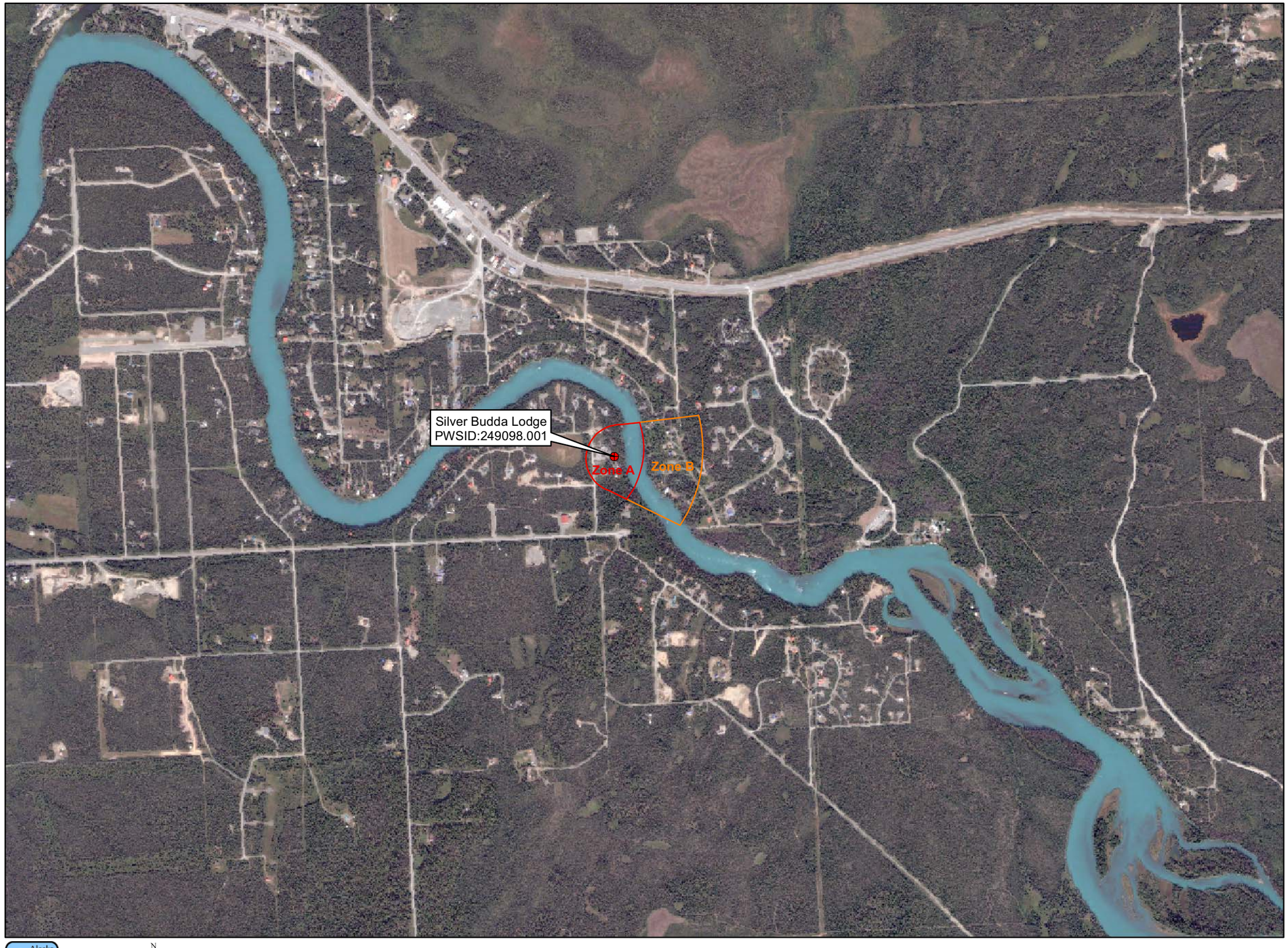
# APPENDIX A

## Silver Budda Lodge
## Drinking Water Protection Area Location Map
## (Map A)

# Public Water Well System for PWS #249098.001 Silver Budda Lodge




## Legend

Class B Public Water System

**Groundwater Protection Zones**

Zone A Protection Area - Several Months Travel Time

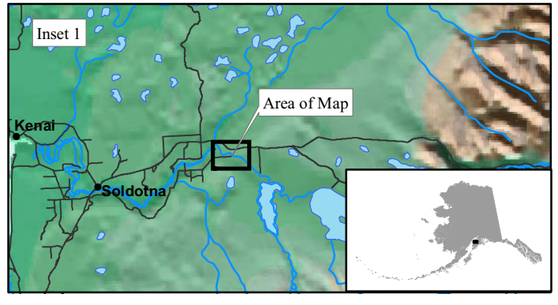
Zone B Protection Area - 2 Years Travel Time

**Data Sources:**
**Contaminant Sources, Public Water System Wells, Alaska Department of Environmental Conservation (ADEC)**

**All other data:**
**Alaska Statewide Digital Mapping Initiative (SDMI)**

**Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class B Public Water Systems" published by ADEC**

**URS Corporation does not guarantee the accuracy or validity of the data provided.**




Alaska DEC

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Silver Budda Lodge
PWS 249098.001

**Appendix A Map A**

# APPENDIX B

## Contaminant Source Inventory and Risk Ranking for Silver Budda Lodge (Tables 1-4)

***Table 1***

# *Contaminant Source Inventory for* ***SILVER BUDDA LODGE***

***PWSID 249098.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Map Number* | *Comments* |
|---|---|---|---|---|---|
| Coal mining (active or inactive?) | E01 | E01 | A | C | |
| Septic systems (serves one single-family home) | R02 | R02 | A | C | 2 assumed |
| Tanks, heating oil, residential (above ground) | R08 | R08 | A | C | 2 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | A | C | 1 road |
| Coal mining (active or inactive?) | E01 | E01 | B | C | |
| Septic systems (serves one single-family home) | R02 | R02 | B | C | 5 assumed |
| Tanks, heating oil, residential (above ground) | R08 | R08 | B | C | 5 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | B | C | 1 road |

***Table 2***

# *Contaminant Source Inventory and Risk Ranking for SILVER BUDDA LODGE*

## *Sources of Bacteria and Viruses*

***PWSID 249098.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Septic systems (serves one single-family home) | R02 | R02 | A | Low | C | 2 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | A | Low | C | 1 road |
| Septic systems (serves one single-family home) | R02 | R02 | B | Low | C | 5 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | B | Low | C | 1 road |

***Table 3***

# *Contaminant Source Inventory and Risk Ranking for SILVER BUDDA LODGE*

## *Sources of Nitrates/Nitrites*

***PWSID 249098.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Septic systems (serves one single-family home) | R02 | R02 | A | Low | C | 2 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | A | Low | C | 1 road |
| Septic systems (serves one single-family home) | R02 | R02 | B | Low | C | 5 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | B | Low | C | 1 road |

***Table 4***

# *Contaminant Source Inventory and Risk Ranking for SILVER BUDDA LODGE*

## *Sources of Volatile Organic Chemicals*

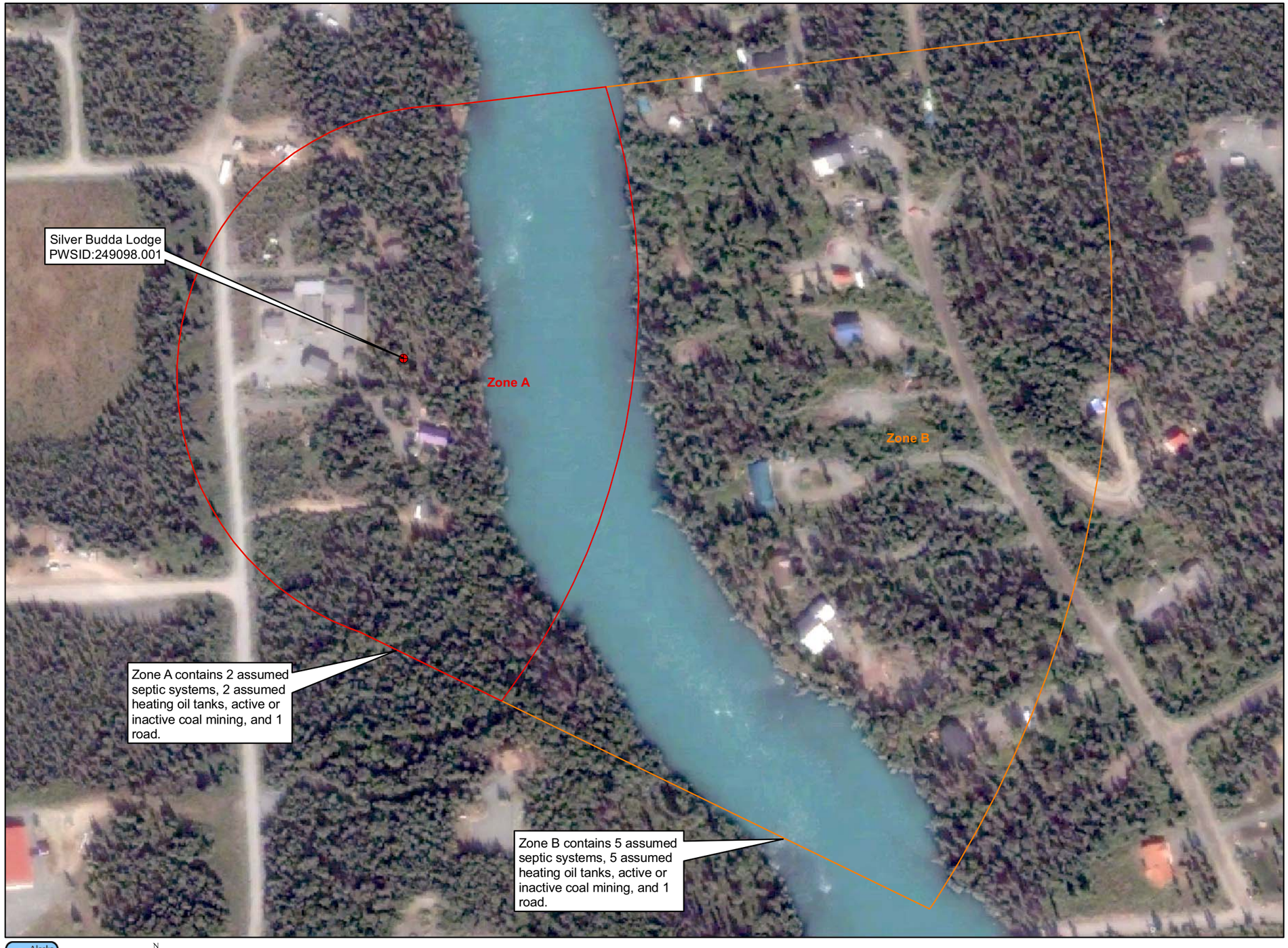
***PWSID 249098.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Coal mining (active or inactive?) | E01 | E01 | A | High | C | |
| Septic systems (serves one single-family home) | R02 | R02 | A | Low | C | 2 assumed |
| Tanks, heating oil, residential (above ground) | R08 | R08 | A | Medium | C | 2 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | A | Low | C | 1 road |
| Coal mining (active or inactive?) | E01 | E01 | B | High | C | |
| Septic systems (serves one single-family home) | R02 | R02 | B | Low | C | 5 assumed |
| Tanks, heating oil, residential (above ground) | R08 | R08 | B | Medium | C | 5 assumed |
| Highways and roads, paved (cement or asphalt) | X20 | X20 | B | Low | C | 1 road |

# APPENDIX C

## Silver Budda Lodge
## Drinking Water Protection Area
## and Potential and Existing Contaminant Sources
## (Map C)

# Public Water Well System for PWS #249098.001 Silver Budda Lodge
# Showing Potential and Existing Sources of Contamination




## Legend

- Class B Public Water System

**Groundwater Protection Zones**

- Zone A Protection Area - Several Months Travel Time
- Zone B Protection Area - 2 Years Travel Time

**Data Sources:**
**Contaminant Sources, Public Water System Wells, Alaska Department of Environmental Conservation (ADEC)**

**All other data:**
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**Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class B Public Water Systems" published by ADEC**

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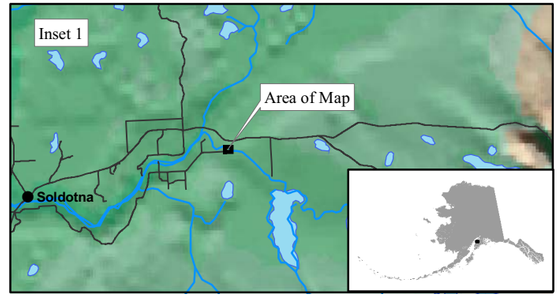


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Silver Budda Lodge
PWS 249098.001

**Appendix C Map C**