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# Source Water Assessment

A Hydrogeologic Susceptibility and  
Vulnerability Assessment for  
Bethel Longhouse Hotel  
Public Drinking Water System,  
Bethel, Alaska

PWSID # 270401.001

DRINKING WATER PROTECTION REPORT 1759

Alaska Department of Environmental Conservation

January, 2009

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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 toll-free number 1-866-956-7656.

January, 2009

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# Source Water Assessment for Bethel Longhouse Hotel

## Source of Public Drinking Water, Bethel, Alaska

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### Drinking Water Protection Alaska Department of Environmental Conservation

#### EXECUTIVE SUMMARY

The public water system for Bethel Longhouse Hotel is a Class B (transient/non-community) water system consisting of one well located on 3<sup>rd</sup> Avenue in Bethel, Alaska. The wellhead received a susceptibility rating of **High** and the aquifer received a susceptibility rating of **Low**. Combining these two ratings produces a **Medium** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Bethel Longhouse Hotel public drinking water source include: assumed septic systems, assumed and confirmed heating oil tanks, diesel tanks, a motor vehicle repair shop, a glycol (disposal/storage) facility, and a road. 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 sources for Bethel Longhouse Hotel received a vulnerability rating of **Low** for bacteria and viruses, **Low** for nitrates and nitrites, and **Medium** 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 Bethel Longhouse Hotel to protect public health.

#### BETHEL LONGHOUSE HOTEL PUBLIC DRINKING WATER SYSTEM

Bethel Longhouse Hotel public water system is a Class B (transient/non-community) water system. The system consists of one well located on 3<sup>rd</sup> Avenue in Bethel, Alaska (see Map A in Appendix A). Bethel lies at the mouth of the Kuskokwim River, about 400 air miles west of Anchorage. The city has a population of 5,653 according to the 2000 census (ADCCED 2008). Some residents of Bethel are hooked up to water and sewer system, but most have water delivered and use septic tanks. Electricity is provided by Bethel Utilities Corporation. Bethel is categorized as a large town/Regional Center and it serves as a transportation hub for the Yukon – Kuskokwim Delta and southwestern Alaska (ADCCED 2009).

Bethel lies on the alluvial plain of the Kuskokwim River. The area around Bethel is made up of large deposits of alluvium consisting of mud, silt, sand, gravel, and boulders, but also containing wood, peat, and other organic material. The soils of this area are similar in their composition to those of Alaska's

western coastal plain and river deltas (Dorava and Hogan, 1995).

Groundwater in the Bethel area is mostly present in the form of an aquifer confined under permafrost in layers of silt, sand, and pebbles. A few isolated areas exist east and west of the city that are free of permafrost to a depth of 60 meters (Dorava and Hogan, 1995).

According to the sanitary survey for this system (04/04/2005), the well extends approximately 400 feet below the ground surface and is completed in a confined aquifer.

This system operates continuously and serves 2 residents and 75 non-residents through one service connection.

#### BETHEL LONGHOUSE HOTEL 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 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 Bethel Longhouse Hotel was determined using an analytical calculation and includes Zones A and B (see Map A in Appendix A).

**INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES**

DWP has completed an inventory of potential and existing sources of contamination within the Bethel Longhouse Hotel 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 BETHEL LONGHOUSE HOTEL 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.

$$\begin{aligned}
 &\text{Susceptibility of the Wellhead (0-25 Points)} \\
 &\quad + \\
 &\text{Susceptibility of the Aquifer (0-25 Points)} \\
 &\quad = \\
 &\text{Natural Susceptibility of the Well (0-50 Points)}
 \end{aligned}$$

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 Bethel Longhouse Hotel received a **High** susceptibility rating, largely due to its location within a suspected floodplain. The most recent sanitary survey (04/04/2005) indicates that a sanitary seal is installed on the well and the land surface is sloped away from the well, but the well is not 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. Additionally, the wellhead lies within a floodplain, which is the main contributing factor to the susceptibility rating for this system.

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 Bethel Longhouse Hotel system draws water from a confined aquifer overlain by 350 feet of permafrost. It received a **Low** susceptibility rating because of its deep nature and thick confining layers. 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 Bethel Longhouse Hotel system.

**Table 2. Susceptibility**

|                                | <b>Score</b> | <b>Rating</b> |
|--------------------------------|--------------|---------------|
| Susceptibility of the Wellhead | 15           | High          |
| Susceptibility of the Aquifer  | 9            | Low           |
| Natural Susceptibility         | 24           | Medium        |

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:

| <b>Contaminant Risk Ratings</b> |           |
|---------------------------------|-----------|
| 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 Bethel Longhouse Hotel system.

**Table 3. Contaminant Risks**

| <b>Category</b>            | <b>Score</b> | <b>Rating</b> |
|----------------------------|--------------|---------------|
| Bacteria and Viruses       | 12           | Low           |
| Nitrates and/or Nitrites   | 12           | Low           |
| Volatile Organic Chemicals | 35           | 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:

$$\begin{aligned}
 &\text{Natural Susceptibility (0-50 Points)} \\
 &\quad + \\
 &\quad \text{Contaminant Risks (0-50 Points)} \\
 &\quad = \\
 &\text{Vulnerability of the Drinking Water Source to} \\
 &\quad \text{Contamination (0-100 Points)}
 \end{aligned}$$

Again, rankings are assigned according to a point score:

| <b>Overall Vulnerability Ratings</b> |           |
|--------------------------------------|-----------|
| 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 Bethel Longhouse Hotel system. Note: scores are rounded off to the nearest five.

**Table 4. Overall Vulnerability**

| Category                   | Score | Rating |
|----------------------------|-------|--------|
| Bacteria and Viruses       | 35    | Low    |
| Nitrates and/or Nitrites   | 35    | Low    |
| Volatile Organic Chemicals | 55    | Medium |

#### **Bacteria and Viruses**

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

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

Only a small number of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected in the water within the last 5 years of sampling of the Bethel Longhouse Hotel system (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 a road contributing to the risk to the drinking water well.

The sampling history for Bethel Longhouse Hotel well indicates that nitrates have not been detected in the water within the last 5 years of sampling (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 **High** with assumed septic systems, assumed and confirmed heating oil tanks, diesel tanks, a motor vehicle repair shop, a glycol (disposal/storage) facility, and a road contributing to the risk to the drinking water well.

The drinking water at Bethel Longhouse Hotel has not recently been 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 **Medium**.

#### **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 Bethel Longhouse Hotel 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 Bethel Longhouse Hotel drinking water source.

## REFERENCES

Alaska Department of Commerce, Community and Economic Development (ADCCED), Accessed 2009 [WWW document]. URL: [http://www.commerce.state.ak.us/dca/commdb/CF\\_COMDB.htm](http://www.commerce.state.ak.us/dca/commdb/CF_COMDB.htm)

Dorava, J.M. and Hogan, E.V., 1995, Overview of Environmental and Hydrological Conditions at Bethel, Alaska. U.S. Geological Survey Open-File Report 95-173.

Freeze, R.A. and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Englewood Cliffs, NJ.

United States Environmental Protection Agency (EPA), Accessed 2008 [WWW document]. URL: <http://www.epa.gov/safewater/contaminants/index.html>.



## **APPENDIX A**

### **Bethel Longhouse Hotel Drinking Water Protection Area Location Map (Map A)**

Public Water Well System for PWS #270401.001 Bethel Longhouse Hotel



Legend

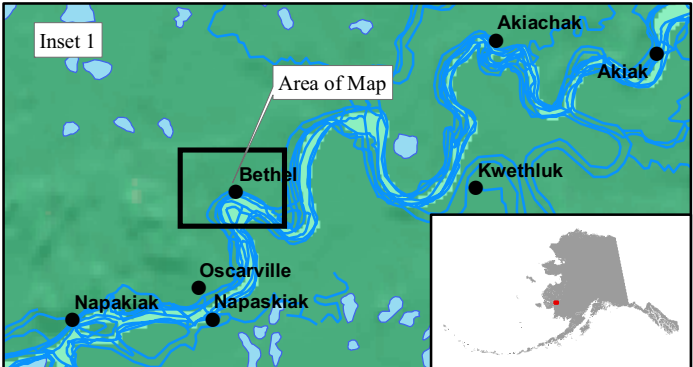
- Class B Public Water System Well
- Groundwater Protection Zones**
- Zone A Protection Area - Several Months Travel Time
- Zone B Protection Area - 2 Years Travel Time

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.



Bethel Longhouse Hotel  
 PWS 270401.001  
 Appendix A Map A

## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking for Bethel Longhouse Hotel (Tables 1-4)**

**Table 1**

**Contaminant Source Inventory for  
BETHEL LONGHOUSE HOTEL**

**PWSID 270401.001**

| <b>Contaminant Source Type</b>                   | <b>Contaminant Source ID</b> | <b>CS ID tag</b> | <b>Zone</b> | <b>Map Number</b> | <b>Comments</b>              |
|--|------------------------------|------------------|-------------|-------------------|------------------------------|
| Motor /motor vehicle repair shops                | C31                          | C31-01           | A           | C                 |                              |
| Motor /motor vehicle repair shops                | C31                          | C31-02           | A           | C                 |                              |
| Septic systems (serves one single-family home)   | R02                          | R02              | A           | C                 | 5 assumed septic systems     |
| Tanks, heating oil, residential (above ground)   | R08                          | R08              | A           | C                 | 5 assumed heating oil tanks  |
| Tanks, diesel (above ground)                     | T06                          | T06-01           | A           | C                 |                              |
| Tanks, diesel (above ground)                     | T06                          | T06-02           | A           | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-01           | A           | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-02           | A           | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-03           | A           | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-04           | A           | C                 |                              |
| Glycol (disposal or storage)                     | X07                          | X07-01           | A           | C                 |                              |
| Highways and roads, paved (cement or asphalt)    | X20                          | X20              | A           | C                 | 1 road                       |
| Septic systems (serves one single-family home)   | R02                          | R02              | B           | C                 | 20 assumed septic systems    |
| Tanks, heating oil, residential (above ground)   | R08                          | R08              | B           | C                 | 20 assumed heating oil tanks |
| Highways and roads, paved (cement or asphalt)    | X20                          | X20              | B           | C                 | 1 road                       |

**Table 2**

*Contaminant Source Inventory and Risk Ranking for  
BETHEL LONGHOUSE HOTEL  
Sources of Bacteria and Viruses*

**PWSID 270401.001**

| <i>Contaminant Source Type</i>                 | <i>Contaminant Source ID</i> | <i>CS ID tag</i> | <i>Zone</i> | <i>Risk Ranking for Analysis</i> | <i>Map Number</i> | <i>Comments</i>           |
|--|------------------------------|------------------|-------------|----------------------------------|-------------------|---------------------------|
| Septic systems (serves one single-family home) | R02                          | R02              | A           | Low                              | C                 | 5 assumed septic systems  |
| 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                 | 20 assumed septic systems |
| Highways and roads, paved (cement or asphalt)  | X20                          | X20              | B           | Low                              | C                 | 1 road                    |

Table 3

*Contaminant Source Inventory and Risk Ranking for  
BETHEL LONGHOUSE HOTEL  
Sources of Nitrates/Nitrites*

PWSID 270401.001

| <i>Contaminant Source Type</i>                 | <i>Contaminant Source ID</i> | <i>CS ID tag</i> | <i>Zone</i> | <i>Risk Ranking for Analysis</i> | <i>Map Number</i> | <i>Comments</i>           |
|--|------------------------------|------------------|-------------|----------------------------------|-------------------|---------------------------|
| Septic systems (serves one single-family home) | R02                          | R02              | A           | Low                              | C                 | 5 assumed septic systems  |
| 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                 | 20 assumed septic systems |
| Highways and roads, paved (cement or asphalt)  | X20                          | X20              | B           | Low                              | C                 | 1 road                    |

Table 4

*Contaminant Source Inventory and Risk Ranking for  
BETHEL LONGHOUSE HOTEL  
Sources of Volatile Organic Chemicals*

PWSID 270401.001

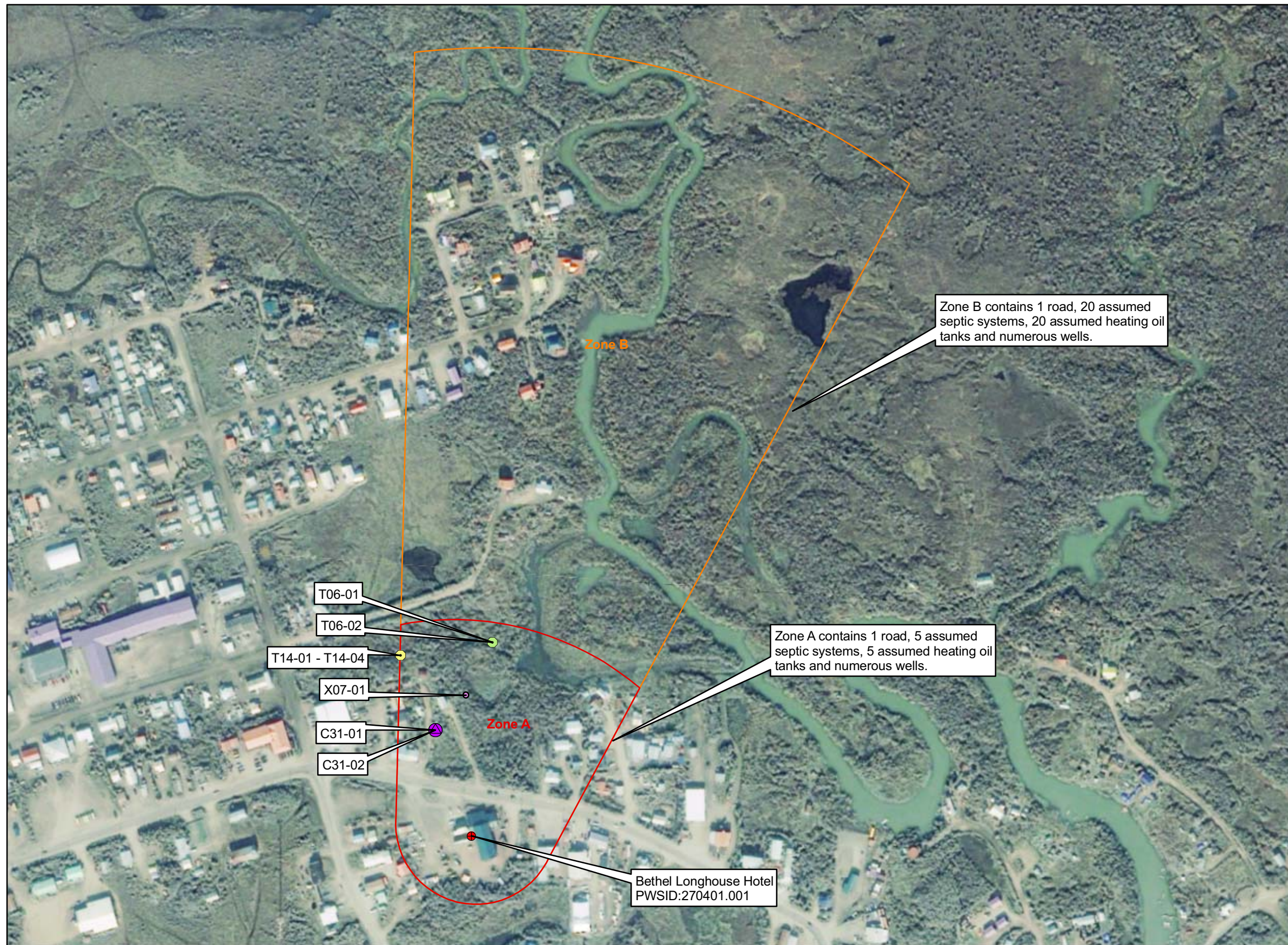
| <i>Contaminant Source Type</i>                   | <i>Contaminant Source ID</i> | <i>CS ID tag</i> | <i>Zone</i> | <i>Risk Ranking for Analysis</i> | <i>Map Number</i> | <i>Comments</i>              |
|--|------------------------------|------------------|-------------|----------------------------------|-------------------|------------------------------|
| Motor /motor vehicle repair shops                | C31                          | C31-01           | A           | Medium                           | C                 |                              |
| Motor /motor vehicle repair shops                | C31                          | C31-02           | A           | Medium                           | C                 |                              |
| Septic systems (serves one single-family home)   | R02                          | R02              | A           | Low                              | C                 | 5 assumed septic systems     |
| Tanks, heating oil, residential (above ground)   | R08                          | R08              | A           | Medium                           | C                 | 5 assumed heating oil tanks  |
| Tanks, diesel (above ground)                     | T06                          | T06-01           | A           | Medium                           | C                 |                              |
| Tanks, diesel (above ground)                     | T06                          | T06-02           | A           | Medium                           | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-01           | A           | Low                              | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-02           | A           | Low                              | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-03           | A           | Low                              | C                 |                              |
| Tanks, heating oil, nonresidential (aboveground) | T14                          | T14-04           | A           | Low                              | C                 |                              |
| 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                 | 20 assumed septic systems    |
| Tanks, heating oil, residential (above ground)   | R08                          | R08              | B           | Medium                           | C                 | 20 assumed heating oil tanks |
| Highways and roads, paved (cement or asphalt)    | X20                          | X20              | B           | Low                              | C                 | 1 road                       |

## **APPENDIX C**

### **Bethel Longhouse Hotel Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map C)**



**Public Water Well System for PWS # 270401.001 Bethel Longhouse Hotel  
Showing Potential and Existing Sources of Contamination**



**Legend**

- Class B Public Water System Well
- Groundwater Protection Zones**
- Zone A Protection Area - Several Months Travel Time
- Zone B Protection Area - 2 Years Travel Time
- Potential and Existing Contaminant Sources**
- Motor /motor vehicle repair shops (C31)
- Tanks, diesel (above ground) (T06)
- Tanks, heating oil, nonresidential (aboveground) (T14)
- Glycol (disposal/storage) (X07)

**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.**

