Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Big Lake Kingdom Hall Public Drinking Water System, Big Lake, Alaska PWSID # 220150.001

DRINKING WATER PROTECTION REPORT 1645

Alaska Department of Environmental Conservation

January, 2009

Source Water Assessment for Big Lake Kingdom Hall Public Drinking Water System Big Lake, Alaska PWSID# 220150.001

DRINKING WATER PROTECTION REPORT 1645

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

CONTENTS

TABLES

APPENDICES

Source Water Assessment for
Big Lake Kingdom Hall Source of Public Drinking Water, Big Lake, Alaska

Drinking Water Protection
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for Big Lake Kingdom Hall is a Class B (transient/non-community) water system consisting of one well located at mile 51 of the Parks Highway in Big Lake, Alaska. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Very High**. Combining these two ratings produces a **Medium** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Big Lake Kingdom Hall public drinking water source include: a heavy equipment rental/storage, assumed septic systems, assumed heating oil tanks, roads, and a medical/veterinary facility. 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 Big Lake Kingdom Hall received a vulnerability rating of **Medium** for all three contaminant categories. 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 Big Lake Kingdom Hall to protect public health.

BIG LAKE KINGDOM HALL PUBLIC DRINKING WATER SYSTEM

The Big Lake Kingdom Hall public water system is a Class B (transient/non-community) water system. The system consists of one well located at mile 51 of the Parks Highway in Big Lake, Alaska (see Map A in Appendix A). The town of Big Lake lies between the lake of the same name and the Parks Highway, about 12 miles southwest of Wasilla. Big Lake is located within the Matanuska-Susitna Borough. The area receives 14 inches of rain and 48 inches of snow per year. January temperatures can range from -33 to 33 degrees Fahrenheit, while July temperatures can range from 42 to 83 degrees. The population of Big Lake is 3,166 (ADCCED, 2009).

About 85% of homes in Big Lake use water wells and septic systems. The rest of the homes in the area use outhouses and haul water. Enstar provides piped natural gas to the community and electricity is provided by Matanuska Electric Association (ADCCED, 2009).

According to the sanitary survey for this system (12/15/2005), the well extends approximately 48 feet below the ground surface, and is completed in an unconfined aquifer. This system operates continuously and serves less than 80 non-residents through one service connection.

BIG LAKE KINGDOM HALL 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 input parameters describing the attributes of the aquifer in this calculation were adopted from the State of Alaska Department of Water Resources (Jokela *et. al.*, 1991).

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 Big Lake Kingdom Hall 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 Big Lake Kingdom Hall 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 BIG LAKE KINGDOM HALL 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 Big Lake Kingdom Hall received a **Low** susceptibility rating. The sanitary survey indicates that the well is capped with a sanitary seal, the land surface is appropriately sloped away from the well, and the well is properly grouted according to DEC regulations. Sanitary seals prevent potential contaminants from entering the well while sloping of the land surface and grouting help 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 Big Lake Kingdom Hall system draws water from an unconfined aquifer overlain by unconsolidated alluvial deposits. It received a **Very High** susceptibility rating because of its unconfined nature and the presence of other wells penetrating the vadose zone of the protection area. Because an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, it is susceptible to contamination from outside sources. Furthermore, the presence of other wells penetrating the vadose zone of the protection zone can allow contaminants to travel into the shared aquifer with precipitation and runoff. .

Table 2 summarizes the Susceptibility scores and ratings for the Big Lake Kingdom Hall system.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	25	Very High
Natural Susceptibility	25	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:

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 Big Lake Kingdom Hall system.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	25	Medium
Nitrates and/or Nitrites	15	Low
Volatile Organic Chemicals	30	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 Big Lake Kingdom Hall system. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	50	Medium
Nitrates and/or Nitrites	40	Medium
Volatile Organic Chemicals	55	Medium

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Medium** with septic systems, roads, and a medical/veterinary facility 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. Bacteria and viruses have not recently been detected during water sampling of the system at Big Lake Kingdom Hall (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 **Medium**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Low** with septic systems, roads, and a medical/veterinary facility contributing to the risk to the drinking water well.

The sampling history for Big Lake Kingdom Hall well indicates that nitrates have been detected in the water during the last 5 years of sampling, with the highest concentration of 0.642 mg/l on 11/06/2007 (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 **Medium**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **High** with a heavy equipment storage lot, septic systems, heating oil tanks, roads, and a medical/veterinary facility contributing to the risk to the drinking water well.

The water system at Big Lake Kingdom Hall 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 Big Lake Kingdom Hall 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 Big Lake Kingdom Hall drinking water source.

REFERENCES

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

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

Jokela, J.B., Munter, J.A., and Evans, J.G., 1991, Ground-water resources of the Palmer-Big Lake area, Alaska: a conceptual model. Division of Geological &Geophysical Surveys Reports of Investigations 90-4, State of Alaska Department of Natural Resources, Fairbanks, AK.

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

APPENDIX A

Big Lake Kingdom Hall
Drinking Water Protection Area Location Map
(Map A)

Public Water Well System for PWS #220150.001 Big Lake Kingdom Hall

Legend

Class B Public Water System Well

Groundwater Protection Zones

Zone A Protection Area - Several Months Travel Time

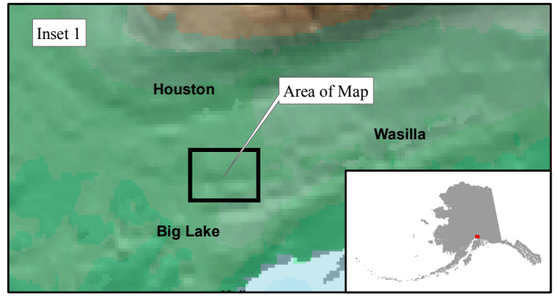
Zone B Protection Area - 2 Years Travel Time

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.



Alaska DEC

N W E S

0 0.5 1 2 Miles

Big Lake Kingdom Hall
PWS 220150.001

Appendix A Map A

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Big Lake Kingdom Hall (Tables 1-4)

Table 1

Contaminant Source Inventory for ***BIG LAKE KINGDOM HALL***

PWSID 220150.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Heavy equipment rental/storage	C18	C18-01	A	C	
Septic systems (serves one single-family home)	R02	R02	A	C	4 assumed septic systems
Tanks, heating oil, residential (above ground)	R08	R08	A	C	4 assumed heating oil tanks
Highways and roads, paved (cement or asphalt)	X20	X20	A	C	3 roads
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	C	
Septic systems (serves one single-family home)	R02	R02	B	C	7 assumed septic systems
Tanks, heating oil, residential (above ground)	R08	R08	B	C	7 assumed heating oil tanks
Highways and roads, paved (cement or asphalt)	X20	X20	B	C	3 roads

Table 2

Contaminant Source Inventory and Risk Ranking for BIG LAKE KINGDOM HALL Sources of Bacteria and Viruses

PWSID 220150.001

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	4 assumed septic systems
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	3 roads
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Medium	C	
Septic systems (serves one single-family home)	R02	R02	B	Low	C	7 assumed septic systems
Highways and roads, paved (cement or asphalt)	X20	X20	B	Low	C	3 roads

Table 3

Contaminant Source Inventory and Risk Ranking for BIG LAKE KINGDOM HALL Sources of Nitrates/Nitrites

PWSID 220150.001

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	4 assumed septic systems
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	3 roads
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	
Septic systems (serves one single-family home)	R02	R02	B	Low	C	7 assumed septic systems
Highways and roads, paved (cement or asphalt)	X20	X20	B	Low	C	3 roads

Table 4

Contaminant Source Inventory and Risk Ranking for BIG LAKE KINGDOM HALL Sources of Volatile Organic Chemicals

PWSID 220150.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Heavy equipment rental/storage	C18	C18-01	A	Medium	C	
Septic systems (serves one single-family home)	R02	R02	A	Low	C	4 assumed septic systems
Tanks, heating oil, residential (above ground)	R08	R08	A	Medium	C	4 assumed heating oil tanks
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	3 roads
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	
Septic systems (serves one single-family home)	R02	R02	B	Low	C	7 assumed septic systems
Tanks, heating oil, residential (above ground)	R08	R08	B	Medium	C	7 assumed heating oil tanks
Highways and roads, paved (cement or asphalt)	X20	X20	B	Low	C	3 roads

APPENDIX C

Big Lake Kingdom Hall
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map C)

Public Water Well System for PWS #220150.001 Big Lake Kingdom Hall
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

Existing or Potential Contaminant Sources

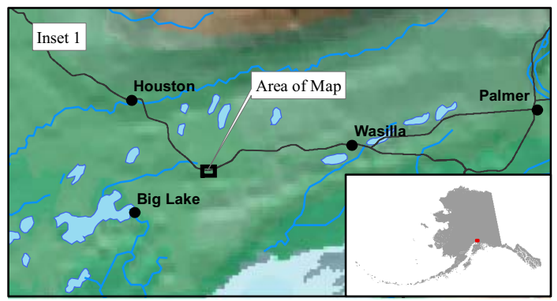
- *Heavy equipment rental/storage (C18)*
- *Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes) (X40)*

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.



N
W E
S

0 375 750 1,500 Feet

Big Lake Kingdom Hall
PWS 220150.001

Appendix C Map C