Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for El Dorado Gold Mine Public Drinking Water System, Fox, Alaska PWSID # 311613.001

DRINKING WATER PROTECTION REPORT 1872

Alaska Department of Environmental Conservation

February, 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.

February, 2009

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Source Water Assessment for El Dorado Gold Mine Source of Public Drinking Water, Fox, Alaska

Drinking Water Protection
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for El Dorado Gold Mine is a Class B (transient/non-community) water system consisting of one well located at Mile 1.3 of the Elliot Highway, in Fox, Alaska. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produces a **Medium** rating for the natural susceptibility of the well. Identified potential and existing sources of contaminants for El Dorado Gold Mine public drinking water source include: placer metals mines (active or inactive), quarries, assumed residential heating oil tanks, 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 El Dorado Gold Mine 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 El Dorado Gold Mine to protect public health.

EL DORADO GOLD MINE PUBLIC DRINKING WATER SYSTEM

El Dorado Gold Mine public water system is a Class B (transient/non-community) water system. The system consists of one well located at Mile 1.3 of the Elliot Highway, in Fox, Alaska (see Map A in Appendix A). Fox (population 354) sits at the junction of the Elliot and Steese Highways, approximately 10 miles northeast of the City of Fairbanks. It is part of the Fairbanks North Star Borough, which encompasses an area of more than 7,400 square miles and has a population of 82,840 (FNSB, 2009)

The region receives 67.8 inches of snowfall a year, and a total of 11.5 inches of precipitation annually. Average January temperatures range from -17 to -2 degrees Fahrenheit, while average July temperatures range from 49 to 71 degrees Fahrenheit (ADCCED, 2009).

Three quarters of homes in Fox rely on individual water wells and septic systems, although some have water hauled in. A State-owned central water source is available at Mile 0.5 of the Elliot Highway. Refuse is transported to the Borough landfill, and electricity is provided by Golden Valley Electric Association (ADCCED, 2009)

According to the sanitary survey (02/05/2005), the El Dorado Gold Mine well extends approximately 60 feet below the ground surface. No well log is available for this system, so it is assumed it is bored into fractured bedrock, and so draws water from an unconfined aquifer. This assumption is based on information from nearby public water systems.

This system operates seasonally from mid-May to mid-September and serves five hundred non-residents through one service connection.

EL DORADO GOLD MINE 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 El Dorado Gold Mine 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 El Dorado Gold Mine 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 EL DORADO GOLD MINE 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 El Dorado Gold Mine received a **Low** susceptibility rating. The most recent sanitary survey (02/05/2005) 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.

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 depth and thickness of the confining layer.

As no well log is available for the El Dorado Gold Mine system, it is assumed it draws water from an unconfined aquifer consisting of fractured bedrock, based on information from nearby public water systems. It received a **High** susceptibility rating because of its relatively shallow, unconfined status. As an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, it is susceptible to contamination from outside sources. Therefore, deeper aquifers provide more protection than shallow ones.

Table 2 summarizes the Susceptibility scores and ratings for the El Dorado Gold Mine system.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	17	High
Natural Susceptibility	22	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 El Dorado Gold Mine system.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	15	Low
Volatile Organic Chemicals	25	Medium

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 El Dorado Gold Mine 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	45	Medium

Bacteria and Viruses

The contaminant risk to the drinking water well for bacteria and viruses is determined to be **Low**, with minimal risk resulting from a road.

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).

Samples testing positive for bacteria and viruses increase the overall vulnerability of the drinking water source by indicating that the source is susceptible to bacteria and virus contamination. Only a small number of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during the last five years of sampling at El Dorado Gold Mine (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 for El Dorado Gold Mine is determined to be **Low**. Quarries and a road contribute to the ranking.

The sampling history for El Dorado Gold Mine indicates that nitrates and nitrites have been detected several times within the last five years. The highest concentration detected was 0.636 mg/L on 05/09/2006 (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 determined to be **Medium**. Several assumed residential heating oil tanks are the primary contributor to this ranking, while quarries and a road add secondary risk.

Volatile organic chemicals have not been detected during the last five years of sampling at El Dorado Gold Mine (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 El Dorado Gold Mine 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 the El Dorado Gold Mine 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

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

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APPENDIX A

El Dorado Gold Mine
Drinking Water Protection Area Location Map
(Map A)

Public Water Well System for PWS #311613.001 El Dorado Gold Mine

Legend

Class B Public Water System

Groundwater Protection Zones

Zone A Protection Area - Several Months 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

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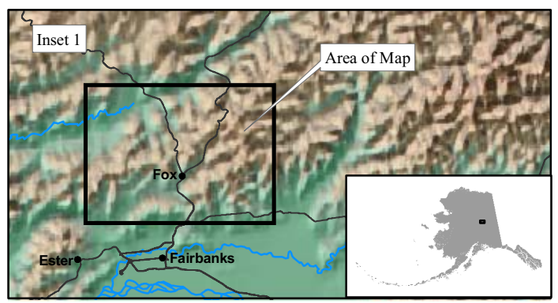

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El Dorado Gold Mine
PWS 311613.001

Appendix A Map A

APPENDIX B

Contaminant Source Inventory and Risk Ranking for El Dorado Gold Mine (Tables 1-4)

Table 1

Contaminant Source Inventory for ***El Dorado Gold Mine***

PWSID 311613.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Metals mining, placer (active or inactive?)	E04	E04-01	A	C	
Metals mining, placer (active or inactive?)	E04	E04-02	A	C	
Quarries (sand, gravel, rock, other?)	E10	E10-01	A	C	
Quarries (sand, gravel, rock, other?)	E10	E10-02	A	C	
Tanks, heating oil, residential (above ground)	R08	R08	A	C	3 inferred
Highways and roads, dirt/gravel	X24	X24	A	C	1 road

Table 2

Contaminant Source Inventory and Risk Ranking for El Dorado Gold Mine Sources of Bacteria and Viruses

PWSID 311613.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, dirt/gravel	X24	X24	A	Low	C	1 road

Table 3

Contaminant Source Inventory and Risk Ranking for El Dorado Gold Mine Sources of Nitrates/Nitrites

PWSID 311613.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Quarries (sand, gravel, rock, other?)	E10	E10-01	A	Low	C	
Quarries (sand, gravel, rock, other?)	E10	E10-02	A	Low	C	
Highways and roads, dirt/gravel	X24	X24	A	Low	C	1 road

Table 4

Contaminant Source Inventory and Risk Ranking for El Dorado Gold Mine

Sources of Volatile Organic Chemicals

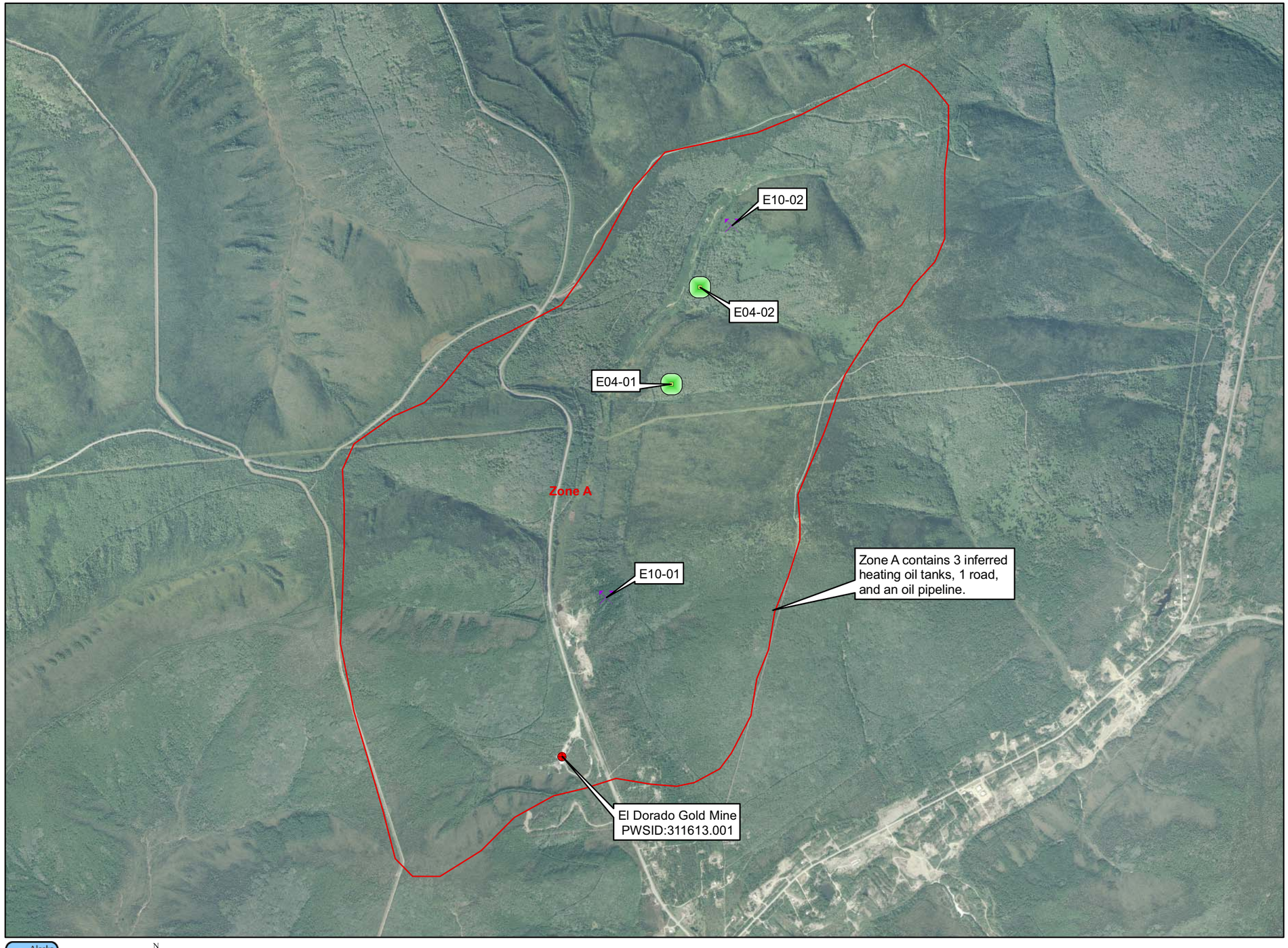
PWSID 311613.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Quarries (sand, gravel, rock, other?)	E10	E10-01	A	Low	C	
Quarries (sand, gravel, rock, other?)	E10	E10-02	A	Low	C	
Tanks, heating oil, residential (above ground)	R08	R08	A	Medium	C	3 inferred
Highways and roads, dirt/gravel	X24	X24	A	Low	C	1 road

APPENDIX C

El Dorado Gold Mine
Drinking Water Protection Area and
Potential and Existing Contaminant Sources
(Map C)

Public Water Well System for PWS #311613.001 El Dorado Gold Mine
Showing Potential and Existing Sources of Contamination



Legend

- Class B Public Water System

Groundwater Protection Zones

- Zone A Protection Area - Several Months Travel Time

Existing or Potential Contaminant Sources

- Metals mning, placer (active/inactive) (E04)
- Quarries (sand, gravel, rock, other) (E10)

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

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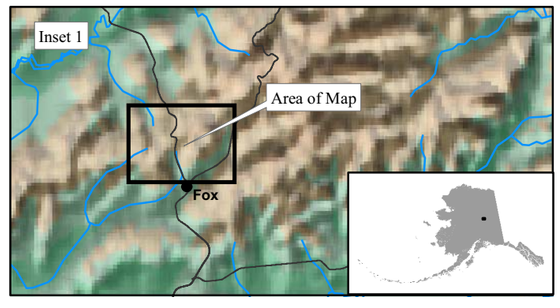

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El Dorado Gold Mine
PWS 311613.001

Appendix C Map C