KINROSS

FORT KNOX GOLD MINE
MONITORING PLAN

Prepared by:

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1 INTRODUCTION

Fairbanks Gold Mining, Inc. (FGMI), a wholly owned subsidiary of Kinross Gold U.S.A., Inc., is submitting this updated monitoring plan for the Fort Knox Mine to the Alaska Department of Environmental Conservation (ADEC) in accordance with AS 46.03.0100, 18 AAC 60.005, 18 AAC 15.090 and 18 AAC 72.600. Concurrently, the plan is being submitted to the U.S. Army Corps of Engineers (COE) as required by Section 404 Permit Number 4-920574 Fish Creek 23.

The Fort Knox Mine and all operating and ancillary facilities are located on private land and legally filed and held State mining claims. The State mining claims are on land administered by Alaska Department of Natural Resources (ADNR). State Water Rights are held by FGMI for the entire upper drainage of Fish, Solo, and Last Chance creeks with the point of use identified as the water supply reservoir.

It is the goal of FGMI to operate the mine and milling processes at the Fort Knox Mine in a manner that will ensure zero discharge for the protection and enhancement of surface and groundwater quality. This monitoring plan will assist FGMI in the establishment and refinement of operating procedures to ensure the long-term protection of State of Alaska land, wildlife, and water resources. Periodic updates of the monitoring plan will coincide with regulatory changes, five-year reviews, process modifications, or anomalies noted as a result of monitoring and sampling.

This monitoring plan is a part of the comprehensive environmental and operational management system for the Fort Knox Mine. The overall project and each process component have specific management plans, which dovetail with this monitoring plan. To minimize duplication of information and rationale for specific monitoring and sampling requirements the reviewer needs to reference the following management plans:

- Fort Knox Project Water Resources Management Plan, March 1994;
- Fort Knox Mine Tailing Storage Facility Operation and Maintenance Manual, R8, August 2019;
- Fort Knox Mine Water Supply Dam & Reservoir Operation and Maintenance Manual, R5, July 2019;
- Fort Knox Mine Reclamation & Closure Plan, R2, November 2013;
- Fort Knox Mine Reclamation & Closure Plan Amendment, March 2017
- Fort Knox Mine Reclamation & Closure Plan Amendment 2, January 2018
- Fort Knox Mine Reclamation & Closure Plan, August 2019
- Walter Creek Heap Leach Facility Project Description, January 2006;
- Walter Creek Heap Leach Facility Operations and Maintenance Manual Rev 15, March 2019
- Barnes Creek Heap Leach Facility Project Description, December 2016
- Waste Management Permit for Fort Knox Mine, 2014DB0002, Modification #2, June 13, 2018;
- Fort Knox Mine Drinking Water Monitoring Plan PWSID#314093, July 2015;
- Fort Knox Water Monitoring QA/QC and Field Procedures Manual, August 2019.

Access by Federal and State regulatory personnel to the Fort Knox Mine facilities for the purpose of inspecting for reclamation, wildlife mortalities, or other appropriate compliance areas are statutory/regulatory mandates and will be adhered to by FGMI, with the request that agents contact mine security to gain access. The health and safety of FGMI employees and that of regulatory personnel is the rationale for this request. Mining is regulated under the Mine Safety and Health Administration (MSHA) and their regulations require minimum training for employees and visitors for Hazard Recognition and Safety. Visitors, as well as employees, must wear safety equipment approved by MSHA. FGMI requests consideration by the regulatory agencies to conduct routine inspections during weekdays when administration and process managers are available to answer questions and, if necessary, accompany agents to different process components.

1.1 Applicant Information

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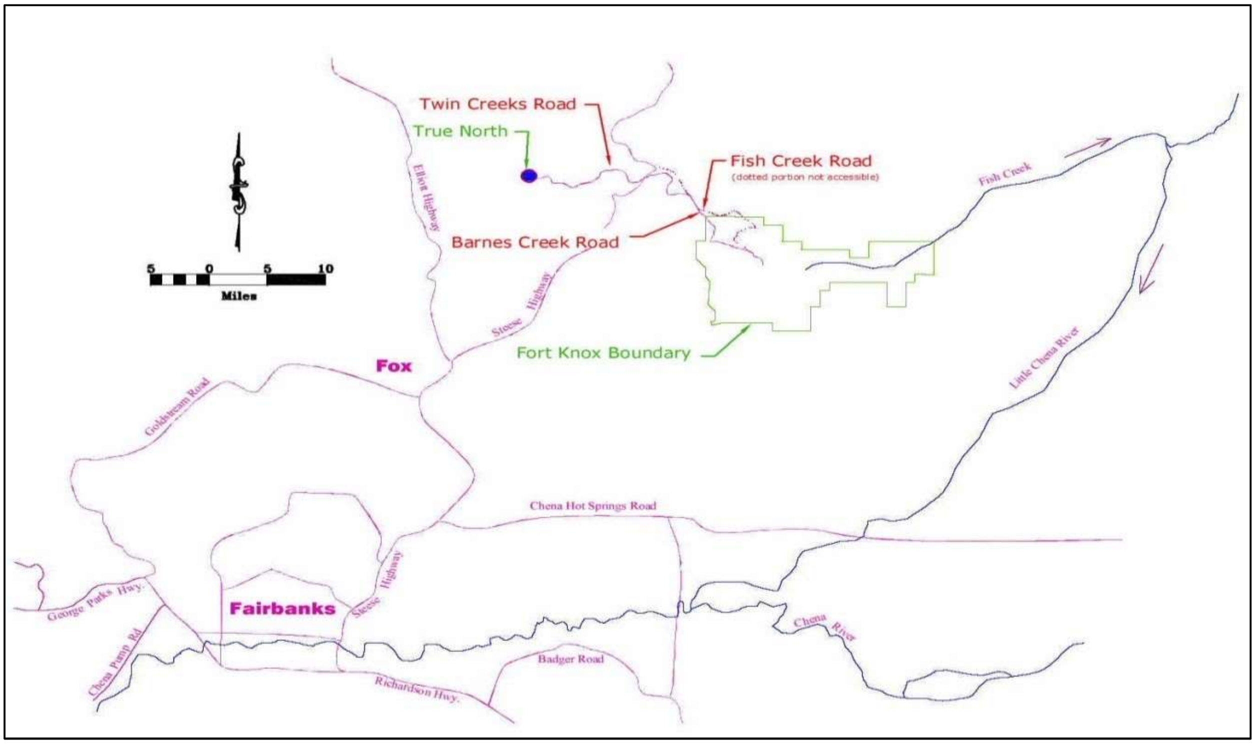
1.2 Site Description

The Fort Knox Mine is an open pit gold mine on the north flank of Gilmore Dome about 15 miles northeast of Fairbanks, Alaska (Figure 1.1). Using conventional open pit mining and milling technology and operating year round, 40,000 to 45,000 tons of ore per day are being processed, producing approximately 250,000 to 350,000 ounces of gold per year.

Figure 1-1 Site Location



Access to the site is via the Steese Highway, Fish Creek Road, and an access road. Fish Creek and its tributaries drain the project area. In the beneficiation procedures, the gold ore is crushed, then ground, and processed as slurry in a mill adjacent to the mine. The gold is extracted in tanks containing a cyanide solution that dissolves the gold. Next the gold is captured by activated carbon, then stripped from the carbon and recovered from solution by electrolysis. Once the gold is removed, the remaining slurry goes to the thickener that recovers a majority of the cyanide, other reagents, and heated water before the tailing slurry is released to the Tailing Storage Facility (TSF). The cyanide concentration in the tailing is maintained within permit limits using the INCO process when necessary. The INCO process combines sodium bisulfate and copper sulfate with air, in an agitated tank, to destroy the cyanide. Typically, maintaining the cyanide concentration in discharged tailing material does not require the use of the INCO process, but is controlled by the recovery of cyanide solution and the addition of freshwater to the thickened tailing. Tailing is piped to the TSF from the mill and deposited in the TSF sub-aerially using multiple discharge points. The Walter Creek valley fill heap leach is located in the upper end of the Walter Creek drainage upstream from the tailing impoundment. The Barnes Creek valley fill heap leach is located in the upper end of the Barnes Creek drainage, upstream from the tailings impoundment.

Ore for the heap leach will consist of run-of-mine rock from the Fort Knox Pit and various stockpiles. The ore is characterized by relatively high permeability that will promote solution flow and drainage for rapid rinsing at closure. In-heap storage of process solution and storm water will be accomplished by constructing an embankment in the downstream toe of the heap. The pregnant solution from the heap is piped to a Carbon-in-Columns plant that captures the gold. The carbon is then processed through existing facilities in the mill.

Tailings are deposited in the tailings impoundment. The tailing dam is an earth-filled structure designed to hold all process water from the mill, as well as surface runoff water. The dam is designed and maintained to contain the 100-year, 24-hour storm event in addition to the average 30-day spring breakup. The water in the impoundment is intended to contain levels of certain contaminants above drinking and/or aquatic water standards. Contaminant levels will be maintained below toxic levels for avian and terrestrial wildlife species. Impoundment water is not discharged but is recycled to the mill for reuse in the beneficiation process of the gold ore.

In November 2006, FGMI discovered a small seep just below the downstream toe of the dam on the south abutment. Since that time, FGMI has taken numerous steps to explore and address this issue, in conjunction with state and federal agencies. From the time the seep was discovered until the update of this report, extensive sampling has indicated that no process water has escaped FGMI's containment system. Down-gradient groundwater and wetland areas continue to be free from cyanide.

To ensure zero discharge, a seepage control system located at the toe of the dam collects subsurface flow and returns it to the tailing impoundment. A series of twelve groundwater interceptor wells (designated as IW-1, IW-2, IW-3, IW-5, IW-6, IW-7, IW-8, IW-11, IW-13, IW-14, IW-16, MW-1, MW-3, and 401) along with Sites 501 and 801 are located down gradient of the seepage control system. These wells collect a combination of groundwater and seepage. Well production is pumped either to the tailing seepage sump and subsequently to the tailing impoundment, or to the RO2 Water Treatment Plant and discharged into the North Channel, authorized by the APDES Permit dated April 30, 2018. Three additional groundwater monitoring wells are installed downstream of the interceptor wells to monitor water quality. They are designated as MW-5, MW-6, and MW-7. Six new groundwater monitoring wells were installed during the summer of 2017 between the interceptor wells and MW-5, MW-6 and MW-7. Water quality sampling began in 4th quarter 2017. These new wells are designated PMW-1 through PMW-6.

A fresh water supply reservoir is located on Fish Creek three miles below the tailing dam. Fresh water can be supplied from the reservoir to the mill for mixing reagents, gland water, and make-up water for the milling process when necessary. At this time no water from the reservoir is being withdrawn for use in the mill.

1.3 Objectives

Baseline monitoring for the Fort Knox Mine was started in 1989 and continued throughout the permitting process. The objective of baseline monitoring was to collect data that described the pre-mining surface water and groundwater quality in the project area. These data were used to determine the potential impacts caused by development and operation of the Fort Knox Mine. Construction of the mine commenced in the spring of 1995, and the first doré bar was poured in December 1996. Compliance monitoring was initiated on November 14, 1996 when mill operations commenced. The objective of compliance monitoring is to ensure that the Fort Knox Mine operates within permit limitations minimizing impact to the environment.

2 REGULATORY FRAMEWORK

This monitoring plan has been developed to meet the requirements of Title 18 Chapters 60 and 70 of the Alaska Administrative Code (AAC). Specifically, this document follows the guidelines set forth in Article 7 of 18.AAC.60; Monitoring and Corrective Action Requirements (Title 18 Chapter 60 Section 800-860) with the objective of meeting the requirements of 18 AAC 70.

Fort Knox operates the Tailing Storage Facility (TSF) under the Waste Management Permit # 2014DB0002, Modification #2. The permit is subject to the surface water and groundwater monitoring requirements of 18.AAC.60.810 and 18.AAC.60.825, respectively. A summary of the relevant portions of these regulations is provided below.

2.1 Surface Water Monitoring

Per 18.AAC.60.810 (a-g) the surface water monitoring program reflects the following requirements:

- 18.AAC.60.810(b) The points of compliance have been chosen so that highest concentrations of hazardous constituents migrating off the facility will be detected and so that interference from sources of pollution unrelated to the facility's waste management operations will be minimized.
- The criteria of 18.AAC.60.825(c) specifically applicable to surface water including;
    - 4(B) the volume and physical and chemical characteristics of the leachate;
    - 4(F) the existing quality of the groundwater, including other sources of pollution and their cumulative effects on the groundwater, and whether the groundwater is used or might reasonably be expected to be used for drinking water;
- 18. AAC.60.810 (d) Monitoring parameters have been selected that are indicative of the type of hazardous constituents associated with the type of waste handled at the facility.

The surface water monitoring program reflects these regulations in the following manner:

- The compliance points are located to ensure detection of changes in water quality and minimize the influence of historical mining activities
- A set of indicator parameters has been established that reflects the composition of the decant water in the TSF
- A compliance monitoring and reporting program based on indicator parameters has been defined to reflect the composition of the decant water and site-specific background water quality
- Tolerance intervals have been established for selected parameters to identify if statistically significant increases occur over background conditions

2.2 Groundwater Monitoring

The groundwater monitoring program reflects the following components of 18 AAC 60 and 18 AAC 70:

- 18 AAC.60.825 (a-e) The monitoring system has been designed to meet the requirements in terms of location, design, local hydrogeologic conditions, facility design, the ability to detect potential releases and local physiographic constraints.
- 18 AAC.60.825 (a1B) Sampling at other wells will provide an indication of background groundwater quality that is at least as representative as that provided by up gradient wells.

- 18 AAC.60.825 (c) Has established relevant points of compliance which reflect local hydrogeologic conditions, the volume and physical and chemical characteristics of the leachate (i.e. decant water), the existing quality of the groundwater, including other sources of pollution and their cumulative effects on the groundwater, and whether the groundwater is used or might reasonably be expected to be used for drinking water.
- 18 AAC 60.830 A compliance monitoring and reporting program based on indicator parameters has been defined to reflect the composition of the decant water and site-specific background water quality.

Similar to the surface water monitoring program the groundwater monitoring program reflects these regulations in the following manner:

- The compliance wells are located to ensure detection of changes in water quality and minimize the influence of historical mining activities.
- A set of indicator parameters has been established that reflects the composition of the decant water in the TSF.
- Appropriate tolerance levels have been established for parameters to appropriately reflect background conditions and allow detection of statistically significant increases.
- A compliance program and indicator parameters have been defined to reflect the composition of the decant water and site-specific background water quality.

For surface water and groundwater, the indicator parameters have been selected to provide definitive evidence if the TSF ceases to function as a zero discharge facility. They reflect parameters which are relatively conservative and at significantly higher concentrations in the decant pond relative to ambient downgradient water.

2.3 Background Conditions

Before depositing any waste in the TSF, Fort Knox collected baseline water quality data in the Fish Creek Drainage from 1989 through 1995. In the area downstream of the TSF, which was disturbed before 1989 by placer mining, the baseline period identified several parameters in both surface and ground water with concentrations exceeding Alaska Water Quality Standards. ADEC recognizes and acknowledges that concentrations of iron and manganese were elevated within the Fish Creek drainage after placer mining and before Fort Knox operations. Appendix A presents an analysis of the baseline data.

Due to their elevated concentrations below the TSF prior to mine operations, iron and manganese were specifically excluded from the suite of parameters chosen to indicate seepage and compliance with the mine’s zero discharge requirements. This is consistent with the need to minimize the interference of conditions unrelated to the mining operation relative to the effectiveness of the monitoring plan.

2.4 Mill and Tailing Facilities Process Fluids

Process fluids are any liquids including meteoric waters, which are intentionally or unintentionally introduced into any portion of the beneficiation process. All process fluids are controlled under the fluid management system, which consist of the following components:

- Mill/heap leach/process recovery plant including but not limited to all existing tanks, basins, sumps, pumps and piping necessary to interconnect the components that contain process fluid within this plant;
- Tailing impoundment, the main embankment (all phased lifts), tailing discharge lines, seepage collection within the main embankment, and the recycling system to return all seepage flows to the tailing basin;
- Interceptor wells to recover seepage that bypasses the reclaim system in the embankment toe and groundwater.
- Monitoring wells down gradient to assure interceptor system is performing as designed.

The process fluid monitoring network includes the following:

- Tailing at Mill (post cyanide detox)
- Tailing Liquor (filtrate)
- Tailing Solids
- Tailing Decant Solution
- Tailing Seepage Reclaim
- Site's 501 & 801
- Interceptor Wells (IW-1, IW-2, IW-3, IW-5, IW-6, IW-7, IW-8, IW-11, IW-14, IW-16, MW-1, MW-3, and Site 401)
- Pre-monitoring Wells (PMW-1, PMW-2, PMW-3, PMW-4, PMW-5, and PMW-6)
- Compliance Monitoring Wells (MW-5, MW-6, and MW-7)

The location for these points is illustrated on Figure 3.1 (Note tailing solids and liquor are sampled in the plant).

2.5 Heap Leach Process Fluids

The Walter Creek Heap Leach Facility Project Description (FGMI, 2006b) has a complete description of the various process components associated with the heap leach. Please refer to this document for more in-depth explanations of the heap and ancillary facilities.

The Walter Creek Valley Heap Leach Facility monitoring network includes:

- leak detection monitoring in the LCRS and Process Component Monitoring System (PCMS) sumps;
- the heap underdrain monitoring wells at the base platform, the bench of the in-heap storage pond embankment, and the crest of the in-heap storage pond embankment;
- monitoring well at the old batch plant (OL-296).

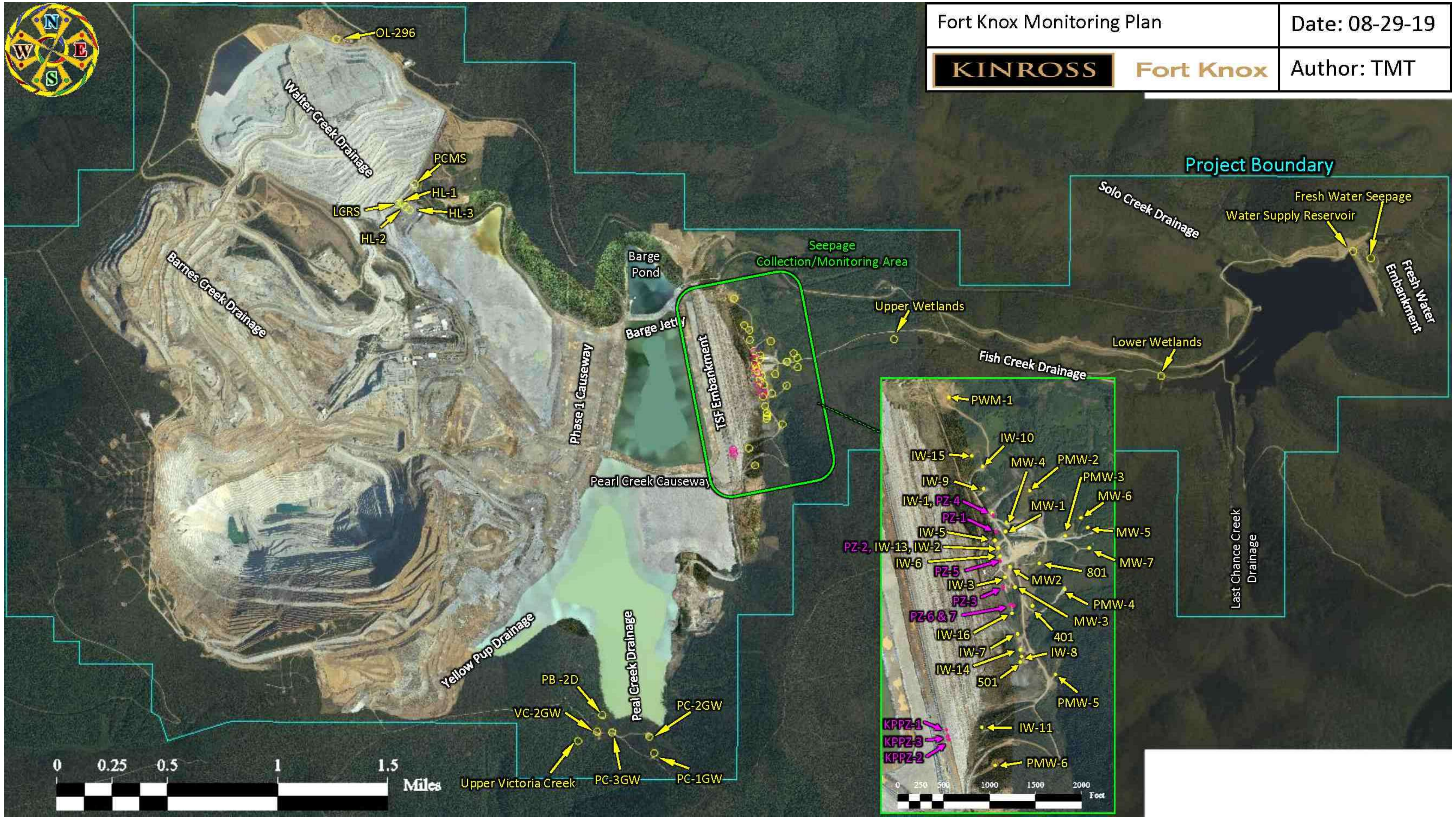
Developed wetlands and water supply reservoir

The monitoring network employed for the developed wetlands and water supply reservoir includes:

- Upper developed wetlands
- Lower developed wetlands

- Water supply reservoir
- Freshwater reservoir seepage

Figure 2-1: Locations of Monitoring Points



3 INDICATOR PARAMETERS AND TOLERANCE LEVELS

The Fort Knox TSF functions as a zero discharge facility. All contact water is captured within the facility as a result of surface water controls and the groundwater interception system. The purpose of the indicator parameter monitoring and reporting is to confirm that the TSF continues to function as a zero discharge facility. The indicator parameters represent constituents present in the decant pond that are at concentrations significantly higher than the downgradient surface water and groundwater. The parameters are relatively conservative in the environment and provide unambiguous data regarding the performance of the controls responsible for maintaining zero discharge.

3.1 Decant Water Composition

Decant water is characterized by high pH, high total dissolved solids, and elevated concentrations of nitrogen and many trace metals. Decant water is predominantly alkaline, with a pH range from 7 to 10, and an average of 8.4. When plotted on a tri-linear diagram, most decant water samples are of the calcium-sodium/sulfate type (Table 3.1).

A number of parameters are found in high concentrations, which contributes to high total dissolved solids concentrations (average of 796 mg/L). The most common constituents are sulfate (average concentration 359.2 mg/L), calcium (average concentration 120.3 mg/L), and sodium (average concentration 85.86 mg/L). Trace constituents include relatively high levels of iron, cyanide, Weak Acid-Dissociable (WAD) cyanide, antimony, arsenic, manganese, and barium. Full descriptive statistics can be found in Table 3.1.

3.2 Indicator Parameters

Indicator parameters were selected as those most likely to give an unambiguous chemical signature at monitoring locations in the event of a release from the tailing storage facility. Parameters were selected which showed a clear difference in concentration between decant waters and waters naturally found at monitoring locations. In selecting parameters, preference was also given to relatively conservative ions to reduce the possibility that these parameters would attenuate through chemical processes between the time of a possible release and when the constituents would arrive at the monitoring locations.

Based on these criteria, chloride, sulfate, nitrate, arsenic, cadmium, cyanide, nitrite, nitrogen as ammonia, and WAD cyanide were selected as indicator parameters. These parameters show significant differences in concentration between decant and ambient downgradient water (Table 3.2). These parameters are all conservative, and those most likely to undergo chemical reactions (ammonia, nitrate, nitrite, cyanide and WAD cyanide), are also likely to yield another of those parameters as a product, which will still indicate a potential discharge.

Table 3-1: Summary Statistics for Tailings Pond Decant Water

Variable	Number of		Fraction	Statistics Calculated Using Detected Observations Only (mg/L)				
	Detections	Non-Detects	Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation
Lab pH	41	0	0.00%	7	10	8.376	8.2	0.601
TDS	41	0	0.00%	180	1170	795.6	803	194.9
TSS	32	9	21.95%	1.2	175	25.98	21.5	29.7
Ca	59	0	0.00%	18	233	120.3	118	39.97
Mg	59	0	0.00%	0.94	12.7	5.809	5.6	2.131
Na	59	0	0.00%	8.6	119	85.86	88.5	21.76
K	59	0	0.00%	3.8	34.6	15.41	15.1	4.823
SI	59	0	0.00%	4	36.2	6.613	5.7	4.17
CL	41	0	0.00%	0.83	92	34.31	29.8	19.23
SO4	41	0	0.00%	5.33	637	359.2	353	133.8
NO3	41	0	0.00%	0.5	20.6	9.013	7.9	4.994
F	35	6	14.63%	0.1	1	0.395	0.36	0.162
Fe	46	13	22.03%	0.03	5.15	0.533	0.38	0.783
Mn	58	1	1.69%	0.008	0.307	0.062	0.0435	0.0521
As	58	1	1.69%	6.00E-03	1.09	0.326	4.00E-02	0.393
Cd	8	51	86.44%	5.00E-04	0.009	0.0027	7.35E-04	0.00378
Cn	38	3	7.32%	2.00E-02	3.8	0.828	2.50E-01	1.057
Cr	3	56	94.92%	3.00E-04	0.05	0.0169	4.00E-04	0.0287
Cu	59	0	0.00%	3.00E-02	3.04	0.88	0.447	0.933
Pb	11	48	81.36%	1.00E-04	0.012	0.0035	0.003	0.0032
Zn	19	40	67.80%	0.002	0.04	0.0159	0.01	0.0107
NO2	39	2	4.88%	1.00E-01	13.8	1.889	0.93	2.64
Ag	2	57	96.61%	2.00E-04	0.01	0.0051	0.0051	0.00693
Ba	59	0	0.00%	0.016	0.194	0.0357	0.032	0.0226
BI	0	59	100.00%	N/A	N/A	N/A	N/A	N/A
Hg	0	59	100.00%	N/A	N/A	N/A	N/A	N/A
Sb	47	12	20.34%	0.002	2.42	0.796	0.545	0.804
Se	33	26	44.07%	0.006	0.065	0.0261	0.023	0.0153
Nitrogen(as Ammonia)	39	2	4.88%	4.4	50.1	18.9	15.9	11.46
WAD Cyanide	38	3	7.32%	0.01	2.6	0.566	0.14	0.765
Total Alkalinity	41	0	0.00%	37	92	61.04	59	14.05
Bicarbonate Alkalinity	40	1	2.44%	5	86	51.37	53	20.43
PO4	25	17	40.48%	0.01	0.44	0.162	0.12	0.136

Table 3-2: Summary Statistics for Indicator Parameters in Decant and Monitoring Location Waters

		Number of		Proportion	Statistics Calculated Using Detected Observations Only (mg/L)				
	Variable	Detections	Non-Detects	Non-Detects	Minimum	Maximum	Mean	Median	SD
Decant Water	CL	41	0	0.00%	0.83	92	34.31	29.8	19.23
	SO4	41	0	0.00%	5.33	637	359.2	353	133.8
	NO3	41	0	0.00%	0.5	20.6	9.013	7.9	4.994
	AS	58	1	1.69%	6.00E-03	1.09	0.326	4.00E-02	0.393
	CD	8	51	86.44%	5.00E-04	0.009	0.00268	7.35E-04	0.00378
	CN	38	3	7.32%	2.00E-02	3.8	0.828	2.50E-01	1.057
	NO2	39	2	4.88%	1.00E-01	13.8	1.889	0.93	2.64
	Nitrogen (as Ammonia)	39	2	4.88%	4.4	50.1	18.9	15.9	11.46
	WAD Cyanide	38	3	7.32%	0.01	2.6	0.566	0.14	0.765
Groundwater Sites	CL	55	50	47.62%	0.7	26	2.941	2	4.961
	SO4	74	31	29.52%	0.39	910	31.65	18.5	105.1
	NO3	12	91	88.35%	0.01	13	2.28	0.09	4.243
	AS	45	92	67.15%	5.00E-04	0.0031	0.00128	0.0012	6.18E-04
	CD	2	136	98.55%	3.00E-04	6.00E-04	4.50E-04	4.50E-04	2.12E-04
	CN	4	102	96.23%	0.007	0.235	0.107	0.0935	0.115
	NO2	5	93	94.90%	0.01	0.12	0.046	0.02	0.0456
	Nitrogen (as Ammonia)	41	65	61.32%	0.05	0.43	0.13	0.1	0.0849
	WAD Cyanide	4	102	96.23%	0.011	0.091	0.0393	0.0275	0.0368
Surface Water Sites	CL	4	62	93.94%	0.7	1.7	0.975	0.75	0.486
	SO4	69	0	0.00%	1	58	16.77	15	10.78
	NO3	28	41	59.42%	0.02	1.6	0.331	0.205	0.402
	AS	8	61	88.41%	0.003	0.0437	0.0158	0.01	0.0145
	CD	0	69	100.00%	N/A	N/A	N/A	N/A	N/A
	CN	0	69	100.00%	N/A	N/A	N/A	N/A	N/A
	NO2	3	66	95.65%	0.04	0.95	0.357	0.08	0.514
	Nitrogen (as Ammonia)	45	24	34.78%	0.05	1.7	0.279	0.17	0.326
	WAD Cyanide	0	69	100.00%	N/A	N/A	N/A	N/A	N/A

Surface water sites include: Upper and Lower developed wetlands
Groundwater sites include monitoring wells MW-5, MW-6, and MW-7
Decant water is collected at the barge (Barge Pond)

3.3 Tolerance Limits

A number of methods are available to detect statistically significant deviations from baseline water quality. Among these methods, tolerance intervals have already been established as an acceptable method of detecting deviations from baseline conditions at the Fort Knox site in the Baseline Water Quality Analysis Memo (Appendix A). Appendix A contains explanations and references for tolerance interval techniques, along with citations for the ProUCL 4.0 software used to calculate tolerance limits and other statistics.

Before calculating tolerance limits, monitoring locations were divided into groups where necessary. This prevents inappropriately applying the same upper tolerance limits to monitoring locations with different water chemistries. Differences were identified using the Gehan test, a non-parametric method suitable for identifying differences between site chemistries. The Gehan test was selected over other methods because it is effective even when considering a high proportion of non-detected observations and multiple detection limits as are found in the monitoring location data for the indicator parameters (ProUCL Version 4.0 Technical Guide, 2007).

The results of the Gehan tests found that both surface water sites (the Upper Wetlands and Lower Wetlands monitoring locations) belonged to the same group. The groundwater monitoring locations were segregated into one group containing MW-5 & MW-6, and one grouping encompassing MW-7. This result confirms results of other analyses such as water typing using tri-linear diagrams, which also show that MW-7 has a distinct chemistry relative to the other monitoring wells (Table 3.3).

Upper tolerance limits with 95 percent coverage and 95 percent confidence were calculated for each group of monitoring locations using non-parametric methods, which were selected because of the high percentage of non-detected data (for a fuller explanation of the tolerance interval approach, consult Appendix A). Tolerance limits were computed using dissolved concentrations for groundwater sites and total concentrations for surface water sites. For parameters with no observations above the detection, the detection limit was used to define the upper tolerance limit. Results are summarized in Table 3.3 and Table 3.4.

Table 3-3: Upper Tolerance Limits for Groundwater Monitoring Locations

Indicator Parameter	**MW-5, MW-6**	**MW-7**
	Upper tolerance limit* (mg/L)	**Upper tolerance limit* (mg/L)**
As	0.005	0.002
Cu	0.02	0.02
Sb	0.002	0.0155
Cl	17	26
CN WAD	0.020	0.020
NO2	1	1
NO3	3.87	13
NH4	0.33	0.36
SO4	70	910

**Dissolved concentrations*

Note: If the minimum level (ML) for any indicator parameter is greater than the calculated tolerance limit, the ML will be adopted as the tolerance limit.

Table 3-4: Upper Tolerance Limits for Surface Water Monitoring Locations

Parameter:	**Upper and Lower Wetlands** **Upper tolerance limit*(mg/L)**
As	0.0437
Cu	0.01
Cl	2.5
CN WAD	0.020
NO2	1
NO3	1.4
NH4	1.1
Sb	0.005
SO4	53

** Total concentrations*

Note: If the minimum level (ML) for any indicator parameter is greater than the calculated tolerance limit, the ML will be adopted as the tolerance limit.

Other parameters will continue to be monitored as set forth in Sections 5 and 6. For wells and surface waters down gradient of the facility, monitoring of parameters other than indicator parameters is to provide continuing reference data for overall water quality within the system, rather than for compliance purposes.

4 ANALYTICAL PROFILES

The current analytical profiles used for surface water, groundwater, and organic parameters are summarized in Tables 4.1 through 4.2. Analytical methods are all USEPA and State approved. Baseline samples were analyzed for organic parameters only once. The results were below detection for all parameters and the analysis was not repeated.

Table 4-1: Analytical Profile I - Surface Water Inorganic Parameters

Major ion chemistry	Minor ion chemistry	Trace ion chemistry
Lab pH	* Arsenic	* Antimony
Lab Conductivity	Cyanide	* Aluminum
Temperature (field)	Total	* Barium
Turbidity	WAD	* Bismuth
Settleable Solids	Fluoride	* Cadmium
Total Suspended Solids	*Iron	* Chromium
Total Dissolved Solids	* Manganese	* Copper
* Calcium	Nitrogen, Ammonia	* Lead
* Magnesium	Nitrate as Nitrogen	* Mercury
* Potassium	Nitrite as Nitrogen	* Nickel
* Silicon	Total Phosphorus	* Selenium
* Sodium	TPH	* Silver
Chloride		* Zinc
Sulfate		
Alkalinity (as CaCO3)		
Bicarbonate		
Total Hardness		

** Total recoverable*

Table 4-2: Analytical Profile II - Groundwater Inorganic Parameters

Major ion chemistry	Minor ion chemistry	Trace ion chemistry
Lab pH	* Arsenic	* Antimony
Lab Conductivity	Cyanide	* Aluminum
Temperature (field)	Total	* Barium
Turbidity	WAD	* Bismuth
Total Suspended Solids	Fluoride	* Cadmium
Total Dissolved Solids	*Iron	* Chromium
* Calcium	* Manganese	* Copper
* Magnesium	Nitrogen, Ammonia	* Lead
* Potassium	Nitrate as Nitrogen	* Mercury
* Silicon	Nitrite as Nitrogen	* Nickel
* Sodium	Total Phosphorus	* Selenium
Chloride	Sulfide	* Silver
Sulfate		* Zinc
Alkalinity (as CaCO3)		
Bicarbonate		
Total Hardness		

**Dissolved*

On August 15, 2003 FGMI received approval from ADEC to reduce the water quality analysis for both Profile I and Profile II for Fort Knox. Approval was given to conduct analyses for dissolved constituents in groundwater samples and to conduct total recoverable analyses in surface water samples. Previously, analyses were performed for both total recoverable and dissolved constituents for both profiles.

5 COMPLIANCE MONITORING AND SAMPLING

5.1 Mill and Tailing Facilities Process Fluids

Monitoring requirements for the fluid management system associated with the Mill and Tailing Facilities are shown in Table 5.1. Analytical profiles are described in Section 4.0.

Table 5-1: Monitoring Requirements for Process Fluid Monitoring Network

Identification	Parameter	Frequency
Tailing at Mill (post cyanide detox)	pH and WAD CN	2 per day
Tailing Liquor (filtrate)	Profile I	Quarterly
Tailing Solids at Mill (post cyanide detox)	Profile II/MWM Acid/Base Accounting	Quarterly
Tailing Decant Solution	Profile I	Quarterly
MW-2	Profile I	Quarterly
Tailing Seepage Reclaim	Profile I	Quarterly
Interceptor Wells[1]	Profile II	Quarterly
Compliance Monitoring Wells[2]	Profile II	Quarterly
	Static Water Depth	Weekly

Results of analysis for the two samples per day collected from the mill tailings at the post cyanide detox point are recorded on the mill operations log and available for review. Mill tailing samples are drawn at two hour intervals on each of the two 12 hour shifts. The sample analyzed and reported represents a composite of the six, two hour interval, post cyanide detox, samples collected during each shift. The information is summarized on the quarterly report indicating maximum, minimum and average pH/WAD cyanide readings for the quarter.

Individual parameters may be reduced after additional sampling. The criteria for reducing parameters will be based on consistent results of analysis below the detection limit and the potential for changes that could result in water quality concerns.

5.2 Heap Leach Process Fluids

Table 5.2 summarizes the monitoring requirements for the Walter Creek Heap Leach Facility. Monitoring is required for the heap leach LCRS and PCMS and the underdrain system due to their potential to be affected by process fluids. The LCRS and the PCMS will be checked for flow weekly, and if fluid is present a monthly sample will be analyzed for WAD CN and pH. The underdrain system will be sampled quarterly. Underdrain system samples will be analyzed using the Profile II list of analytes (Table 4.2). The pregnant solution will also be sampled quarterly and analyzed for WAD CN and pH. The elevation of the in-heap storage pond will be monitored and controlled automatically.

Table 5-2: Summary of Heap Leach Monitoring Requirements

Identification	Parameter	Frequency
LCRS	WAD CN/pH	Monthly
PCMS	WAD CN/pH	Monthly
Under drain– HL1, HL2, HL3	Profile II	Quarterly
Pregnant Solution	WAD CN/pH	Quarterly
In-Heap Storage Pond	Elevation	Continuous Automatic Monitoring
Solution Recirculation/Rinsing	Profile II	Quarterly[1]

[1] *Begins after economic leaching is completed.*

Required monitoring locations will include the Walter Creek Valley Heap Leach Facility discharges, which include: 1) heap water to the TSF, 2) leak detection monitoring in the LCRS and Process Component Monitoring System (PCMS) sumps, 3) the heap underdrain system consisting of three monitoring wells in the following locations: the base platform, the bench of the in-heap storage pond embankment, and the crest of the in-heap storage pond embankment. The old batch plant well will be sampled as well. (OL296)

If WAD cyanide concentration above 10 mg/L is detected in the heap's PCMS sumps, then all sump water must remain contained within heap leach system. The Alaska Department of Environmental Conservation (ADEC) must be notified within one working day of discovery.

If WAD cyanide concentration above 0.2 mg/L is detected in the underdrain system, the permittee must notify ADEC within one working day of discovery. Then, the permittee must demonstrate to the department's satisfaction that all water reports to the TSF.

The specific Method Detection Level (MDL) and Minimum Level (ML) for WAD cyanide concentration values between the MDL and ML provide a margin of safety indicating increasing trends prior to any exceedances. Based on the rate and magnitude of a trend, ADEC may require corrective action. When a MDL is exceeded, the permittee shall verbally notify ADEC within 60 days of the end of the calendar quarter when it occurred and provide written notification within 7 days of verbal notice.

FGMI will conduct periodic audits for the purpose of reviewing performance under this permit and approvals, and the agencies' regulatory oversight of such performance, and to aid in updating the Reclamation and Closure Plan and associated closure and post closure monitoring cost estimate. The first audit occurred in 2011.

The Walter Creek Valley Heap Leach Facility must be closed before the TSF is closed. Until closure of the TSF, any surface, groundwater, heap process water, and any other water originating from Walter Creek Valley must meet the following requirements; the tailing waste slurry shall be neutralized to contain a monthly average of 10 mg/L or less of WAD cyanide. The maximum concentration of WAD cyanide in the slurry discharge shall be 25 mg/L. These discharge limits will be changed in accordance with the Waste Management Permit No. 2014DB0002, Modification #2.

5.3 Developed Wetlands and Water Supply Reservoir

The monitoring requirements for the developed wetlands and water supply reservoir are summarized in Table 5.3. Individual parameters may be reduced after additional sampling. The criteria for reducing parameters will be based on consistent result of analysis below the detection limit and the potential for changes that could result in water quality concerns.

Table 5-3: Developed Wetlands and Water Supply Reservoir

Identification	Parameter	Frequency
Upper developed wetlands	Profile I	Quarterly
Lower developed wetlands	Profile I	Quarterly
Water supply reservoir	Profile I	Quarterly
Surface water below the water supply reservoir (Freshwater Seepage)	Profile I	Quarterly

Victoria Creek Monitoring Wells and Surface Water Sites

Identification	**Parameter**	**Frequency**
Monitoring Wells		
PC-1GW, PC-2GW, PC-3GW, PB-2D	Profile II	Quarterly[1]
Surface Sites		
Upper Victoria Creek	Profile I	Quarterly

5.4 Characterization of Acid Generation Potential

Annual characterization of overburden/topsoil, B-stockpile, waste rock, and ore will continue over the life of the mine. Collection of representative samples will be based on annual operational and geological records identifying materials mined. Meteoric Water Mobility Procedure (MWMP) and acid/base accounting (ABA) will be performed on the samples. If ABA results show less than a 3 to 1 ratio of net neutralization potential to net acid generation, kinetic testing (12-week humidity cell testing) will be completed.

Tailing solids are submitted quarterly for ABA and Meteoric Water Mobility analysis. If these test results indicate less than 3 to 1 net neutralization potential, a 12-week humidity cell test will be completed. MWMP testing will also be performed on the tailings solids, using Profile II analysis.

5.5 Solid Waste Landfill Monitoring

Inert construction and demolition materials from the mine and mill operations will be disposed of in the solid waste land fill trenches in accordance with the Fort Knox Waste Management Permit 2014DB0002, Modification #2. For a more detailed discussion of permit requirements please refer to the Fort Knox Mine Solid Waste Management Plan. Since materials disposed of within the landfill trenches are inert, the potential for leachate is minimal. Furthermore landfill trenches will be located at least 100 feet from any surface water body, greater than 200 feet from any surface drinking water source and all surface water runoff will be diverted away or around landfill trenches to minimize infiltration. Additionally, trench bottoms will be located more than 10 feet above existing or expected future groundwater table. Therefore, no special groundwater or surface water monitoring is planned.

Weekly visual inspections will be made to ensure that landfill trenches are being operated properly and in compliance with the Fort Knox Waste Management Permit 2014DB0002, Modification #2. A summary of monitoring requirements for an active landfill is shown in Table 5.4.

Table 5-4: Summary of Monitoring Requirements for an Active Landfill

Frequency	Action
Weekly	Landfill inspection
Monthly	Litter cleanup, site wide, during snow free months (begin within 2 weeks of snowmelt)
Spring	Cover waste with 6" compacted soil
Fall	Cover waste with 6" compacted soil
Annually	Landfill Locations, report in Annual Report
As Needed	Cover light debris (foam, packing material) within 24 hrs of placement to prevent windblown debris
As Needed	Vector control (flies/rodents) to prevent health hazards

5.6 Embankment Monitoring

The TSF, Heap Leach and the Water Supply Reservoir embankments are routinely monitored. For a complete description of monitoring requirements, please refer to the most up to date Operations and Maintenance manuals for the Fort Knox Mine Tailing Storage Facility, Walter Creek Valley Fill Heap Leach Pad and, the Fort Knox Mine Water Dam. Tables 5.5, 5.6, and 5.7 summarize the respective inspection schedule.

Table 5-5: Tailing Storage Facility Inspection Schedule

DAILY

1. Mill operator’s Daily Report: inspection of tailing barge/reclaim pumps, seepage pumps and ballast readings. Barge and seepage water samples.
2. Tailing Embankment Inspection: Look for seepage, movement, subsidence or erosion of the upstream slope, downstream slope, downstream toe, and crest of dam.
3. Barge Inspection Form: record tailing discharge point, pool depth, instantaneous flow, totalizer flow, general housekeeping.
4. Inspection of tailing discharge lines, process water pipeline and discharge point.
5. Automatic collection of electronic depth-to-water data for Interceptor Wells (IW) 1–8 and 11, Monitor Wells (MW) 1 and 3, and seepage sump levels.

WEEKLY

1. Record totalizer flow for Interceptor Wells, MW-1 and MW-3.
2. Record Instantaneous flow for Interceptor Wells, MW-1 and MW-3.
3. Static water levels for MW-2 and MW-4 through MW-7.
4. Inspection of automatically collected depth-to-water data in mill control Data Collection System.

MONTHLY

1. Record Impoundment elevation level, record data graphically.
2. Read piezometers, record and convert raw data to pore pressures and equivalent head and graph.
3. Record total volume pumped and average flow rates to tails pond and mill.
4. Survey monuments as construction activities allow. Survey is expected to resume after final lift is completed in 2013.

SEMI-ANNUALLY

1. Inspect the sub-aqueous deposition.

ANNUALLY

1. Complete detailed facility inspection including all exposed earthwork, concrete, structural steelwork (bridge), pump house, sumps, valves, and exposed piping.
2. Review and update Water Dam Operation and Maintenance Manual, as necessary.
3. Review and update Emergency Action Plan, as necessary.

AS REQUIRED

1. Carry out checks and services, as specified by the manufacturer, on pumps, valves, and controls.

Table 5-6: Walter Creek Valley Fill Heap Leach Inspection Schedule

DAILY

1. Heap leach embankment inspection: inspect upstream slope, downstream slope, abutment and downstream toe. Inspect for settlement, misalignment and adequate freeboard.
2. Pregnant and barren pipeline corridor – inspect and record surface movements indicating problems with the pipe in the trench or the trench itself, excessive snow load, erosion, or maintenance needed for the corridor, including the discharge flow rate at the end of the pipe trench.

WEEKLY

1. Record LCRS, PCMS flows.
2. Surface water collection system – inspect for excessive erosion, debris, diversion ditch integrity of liner systems, channels, and ice jams during applicable weather conditions.

QUARTERLY

1. Survey monuments S-1 though S-7, read piezometers record and graph.
2. Record flow rates of the underdrain sump.

ANNUALLY

1. Annual Performance report per most current Certificate of Approval to Operate a Dam.
2. Review Emergency Action Plan, conduct orientation class and perform an internal drill exercise.

TRI-ANNUALLY

1. Periodic Dam Inspection.
2. Table top exercise of the Emergency Action Plan with all responsible parties. Revise Plan as required.

As Required

1. Carry out checks and services, as specified by the manufacturer, on pumps, valves, and controls.

Table 5-7: Water Supply Reservoir Inspection Schedule

DAILY

1. Check pump station including trash screens, heater, piping and valves when operating
2. Record instantaneous flow rates to tails pond and mill (when operating).
3. Check spillway for blockage damage.
4. Check condition of: Upstream slope, Downstream slope, Downstream toe, Crest of Dam.
5. Visually check seepage flow rate and clarity.

WEEKLY

1. Check pump station condition.
2. Record pond elevation weekly.
3. Check spillway and outlet works for blockage/damage.
4. Check embankment condition.
5. Observe flow into seepage sump, rate and clarity.
6. Check sump overflow line.
7. Check Solo Creek causeway.
8. Check Solo Creek culvert and riprap.
9. Check security and safety devices.

MONTHLY

1. Note pond elevation fluctuation.
2. Record total volume pumped and average flow rates to tails pond and mill.
3. Summarize pertinent weekly and daily comments.

QUARTERLY

1. Read piezometers, update graphs.

ANNUALLY

1. Complete detailed facility inspection including all exposed earthwork, concrete, structural steelwork (bridge), pump houses, sumps, valves, and exposed piping.
2. Review and update Water Dam Operation and Maintenance Manual, if necessary.
3. Review and update Water Dam Operation and Maintenance Manual, if necessary.
4. Review and update Emergency Action Plan, if necessary.

AS REQUIRED

1. Carry out checks and services, as specified by the manufacturer, on pumps, valves, and controls.

5.7 Potable Water Supply Monitoring

Routine sampling and analysis of water from the potable water system at appropriate points and times are completed in accordance with 18 AAC 80.200. Reporting requirements conform to 18 AAC 80.260. Presently, a detailed monitoring plan for the potable water system is described in the Fort Knox Mine Drinking Water Monitoring Plan PWSID#314093, July 2015. Table 5.8 summarizes the monitoring requirements for the potable water system.

Table 5-8: Summary of Potable Water Monitoring Requirements

Analyte	Analytical Method	Frequency	Report
Free Chlorine	Pocket Colorimeter	Monthly	Submit to ADEC
Bact-T	Laboratory	Monthly	Submit to ADEC
TTHM&HAA5	Laboratory	Every Three Years	Submit to ADEC
Sanitary Survey	ADEC Certified Inspector	Every Five Years	Submit to ADEC

5.8 Avian and Terrestrial Wildlife Monitoring

Frequent visual inspection of the tailing impoundment surface focuses on the decant pool and unconsolidated tailing depositional areas. No open pools of process solution were included in the heap leach design; therefore inspections would focus on any unusual occurrences of surface ponding of solution. Although all employees are directed to report unusual circumstances involving wildlife to security; all environmental, mill and mine maintenance, and mill and mine operations personnel have specific responsibility to thoroughly inspect and report wildlife mortalities and terrestrial animals mired in unconsolidated tailing.

Operational standards require the tailing discharge from the mill and the resultant decant pool to be non-toxic to avian and terrestrial wildlife species. However, realizing that all wildlife species have a finite life span, some natural mortalities will occur within the boundaries of the mine site. Occurrences within specific process component areas, such as the tailing impoundment, will require special collection and sampling.

All wildlife mortalities will be immediately reported to the security officer on duty. The species and a decant water or heap leach solution sample, will be collected should the mortality involve areas associated with decant water, heap leach solution, and mill process leach solution. The decant/solution sample will be collected as close to the site of the carcass as standing solution is present. The solution sample will be preserved immediately with sodium hydroxide to attain a pH >10 and submitted to an outside laboratory for WAD cyanide analysis. The collected wildlife species will be immediately preserved by freezing (size dependent) and temporarily stored in a facility under the control of mine security.

U.S. Fish & Wildlife Service (USFWS), the Alaska Department of Fish & Game (ADFG), and ADEC will be contacted to report appropriate mortalities within 24-hours or during their next scheduled workday. A written follow-up report (Appendix B) will be submitted to USFWS and ADFG with the date the mortality was discovered, identification of species, and WAD cyanide level of solution sample. The follow-up report will be submitted within seven (7) days of the initial verbal notification to allow verification of analytical results. In a verbal notification by Agent Ryan Kote (USF&W) to Dave Stewart (FGMI) on Monday, May 21, 2018, Agent Kote instructed Mr. Stewart the USF&W no longer required notification of accidental or incidental mortalities.

Mortality Contacts:

U.S. Fish & Wildlife Service
Ecological Service
101- 12th Avenue
Fairbanks, Alaska 99701
Telephone (907) 456-2335

Alaska Department of Fish & Game
1300 College Road
Fairbanks, Alaska 99701-1599
Telephone (907) 459-7282

Alaska Department of Environmental Conservation
610 University Avenue
Fairbanks, Alaska 99709
Telephone (907) 451-2136

All carcasses will be available for final collection by USFWS or ADFG, depending on species (i.e., migratory bird or game species). Laboratory results of analysis for WAD cyanide concentration from solution samples will determine final disposal procedure for all carcasses collected. WAD cyanide levels >25 mg/L will trigger a necropsy to determine cause of death. WAD cyanide levels <25 mg/L will not require further analytical analysis. Final deposition of all carcasses will be determined by the appropriate agency.

Terrestrial animals mired in unconsolidated tailing material will be extracted and moved or herded to a safe area. All attempts to extract mired animals will be based on evaluation as to the health and safety of employees and that of the animal.

5.9 Mine Closure Monitoring

For a complete description of monitoring after mine closure please refer to the Fort Knox Reclamation and Closure Plan. Table 5.9 is a summary of closure monitoring requirements for the pit lake, decant pond, seepage collection system, injection system, groundwater compliance wells and surface water compliance point. Table 5.10 shows a summary of monthly and quarterly analytes.

Table 5-9: Summary of Closure Monitoring

Monitoring location	0 to 2 years		3 to 5 years		+ 6 years	
	Frequency	Parameter list	Frequency	Parameter list	Frequency	Parameter list
Decant pond	Quarterly	Complete	Quarterly	Complete	Quarterly	Complete
Pit lake	Annual	Complete	Annual	Complete	Annual	Complete
Seepage collection system	Monthly	Indicator	Quarterly[1]	Complete	NA	NA
Injection system	Monthly	Indicator	Quarterly[1]	Complete	NA	NA
compliance wells	Monthly	Indicator	Quarterly	Complete	Annual	Complete
Surface water compliance point	NA	NA	NA	NA	Monthly[2]	Indicator

1 Only if operational

2 Discharges predicted to begin after about 12 years

Table 5-10: Summary of Monthly and Quarterly Analyte Lists

Monthly samples	Quarterly samples
pH	pH
TDS	TDS
Sulfate	TSS[1]
Alkalinity	Calcium
Arsenic	Magnesium
Antimony	Sodium
Cadmium	Potassium
Copper	Chloride
Iron	Sulfate
Manganese	Alkalinity
Selenium	Arsenic
Cyanide	Antimony
WAD cyanide	Cadmium
	Copper
	Iron
	Manganese
	Selenium
	Zinc
	Nitrate
	Nitrite
	Ammonia
	Cyanide
	WAD cyanide

[1] Surface water only

6 MONITORING/SAMPLE RECORDS AND REPORTING

6.1 Documentation of Measurements, Sampling, and Inspections

For each measurement or sample taken pursuant to this monitoring plan, the following information shall be recorded on the field data sheet:

- The exact place, date, and time of inspection, observation, measurement, or sampling;
- The person(s) who inspected, observed, measured, or sampled;

6.2 Retention of Records

During operation, closure and reclamation all records of monitoring activities and results, calibrations, and maintenance records will be retained for a period of three years.

6.3 Monitoring Reports and Submission Schedules

Indicator parameters have been selected to represent constituents present in the decant pond that are at concentrations significantly higher than the downgradient surface water and groundwater. The indicator parameters have been selected because they are relatively conservative in the environment and provide the best indication of performance of controls responsible for maintaining zero discharge. Monitoring results for indicator parameters will be compared with the upper tolerance limits established in Section 3.3. If an indicator parameter exceeds its established tolerance limit, this exceedance will be reported to the State.

Other parameters will continue to be monitored as set forth in Sections 4 and 5. For wells and surface waters downgradient of the facility, monitoring of parameters other than indicator parameters is to provide continuing reference data for overall water quality within the system, rather than for compliance purposes. This is consistent with operation of a zero-discharge facility where the primary purpose of monitoring is to confirm performance of discharge controls rather than measuring changes in downgradient water quality.

Monitoring results will be reported quarterly to ADEC. All quarterly reports will be submitted within 60 days of the end of the quarter. An Annual Activity Report will be presented to the ADEC, ADNR, U.S. Army Corps of Engineers (COE) and U.S. Environmental Protection Agency (EPA) during the first quarter of the following year summarizing monitoring results. Along with previous requirements from the Fort Knox Monitoring Plan, the annual report prepared for the ADEC, ADNR, COE and EPA will address the following:

- The groundwater collection system is operating adequately to collect all groundwater from the tailing impoundment.
- The LCRS and PCMS and underdrain groundwater collection systems are operating adequately.
- An updated annual water accounting including the heap leach.
- Contaminant levels within the tailing impoundment and documentation of any increases that would indicate toxic concentrations to wildlife.
- Reports will be on forms or in a data base format, which is agreeable to ADEC, ADNR, COE and EPA.

In addition, a trend analysis will be completed on selected parameters as a confirmation that the TSF continues to function as zero-discharge.

Appendix A

Baseline Water Quality Analysis

TECHNICAL MEMORANDUM

WATER
MANAGEMENT
CONSULTANTS
A Schlumberger Company

1875 LAWRENCE STREET, SUITE 500
DENVER, COLORADO 80202, USA

TELEPHONE: (303) 297 9005
TELEFAX: (303) 297 9007
www.watermc.com

To:	Delbert Parr (Delbert.Parr@Kinross.com)
Company:	FGMI
Project No.:	2766
From:	John Chahbandour (jchahbandour@watermc.com)
Date:	March 5, 2008
Subject:	Baseline Water Quality Analysis

1 INTRODUCTION AND METHODS

Water Management Consultants, Inc.–A Schlumberger Company (WMC) has completed a background water quality statistical analysis with the objective of establishing compliance levels for parameters with historically elevated concentrations in both groundwater and surface water in the Fish Creek drainage below the Ft. Knox tailing storage facility. The method utilized is based on guidelines set forth in the Alaska Administrative Code (AAC) Title 18 Chapter 60 Section 810-840. Under the Waste Management Permit # 2006-DB0043, the owner/operator must establish an appropriate method for evaluating statistically significant changes in water quality. The AAC identifies four different methods for evaluating water quality monitoring data: (1) parametric analysis of variance, (2) analysis of variance, (3) prediction or tolerance interval, or (4) control charts (18.AAC 60.830).

Analysis of the pre-mining baseline water quality data was completed using the tolerance interval approach to establish action limits for four parameters, antimony, arsenic, iron, and manganese. These constituents are known to occur at elevated levels in the Fish Creek drainage. The purpose of the tolerance interval approach is to define a concentration at which a there is 95 percent confidence that values reported below the action limits are consistent with background conditions. The analysis was completed using ProUCL 4.0, a statistical analysis program developed by the EPA (2007). The distributions of the data were analyzed for normality, transformed when possible and analyzed for upper tolerance limits (UTLs) using the appropriate parametric methodology outlined in the EPA guidance. In some cases (i.e., high percentage of non-detects), non-parametric techniques were used to establish the UTLs. Results from groundwater analysis are presented in Section 2, and results of the surface water analysis are presented in Section 3. Appendix A includes the water quality databases used in the statistical analysis. Appendix B presents the statistical analysis outputs.

2 GROUNDWATER

2.1 Background data: source and quality

Before Ft. Knox began mining operations, groundwater monitoring wells were installed in the Fish Creek drainage. A subset of these wells was selected to best represent the same groundwater system which provides water to the current compliance wells to characterize baseline water quality. Figure 2.1 illustrates the location of the baseline monitoring wells. Beginning in May 1992, water quality samples were collected from these wells on a quarterly basis until May of 1994. In September 1995, another set of samples was collected before operations began in 1996. A total of 199 groundwater samples were collected to establish baseline water quality conditions. The sampling frequency is summarized in Table 2.1.

These wells are all in the immediate vicinity of the existing compliance monitoring wells, and all lie in the same hydrogeologic system along the valley bottom. Groundwater compositions in the baseline wells are virtually identical to those in the compliance wells. As illustrated in Figures 2.2 through 2.4, the baseline samples plot within the same compositional field defined by the current compliance wells. The similarity between the two data sets indicates that the historical data are representative of current conditions and valid for establishing upper tolerance limits.

Figure 2.5 illustrates the frequency distributions for both total and dissolved concentrations of the four parameters analyzed. Figure 2.6 illustrates sample distribution by month and depth. The samples were collected from intervals between 20 and 142 feet. For comparison, the compliance monitoring wells have depths between 120 and 150 feet.

Table 2.1 Groundwater sample frequency

Site Name	1992	1993	1994	1995	Total
FA1	6	8	4		18
FA2	6	8	4		18
FA3	6	6	4		16
FA7	6	8	4		18
FA8	6	8	10	8	32
FB1S	6	8	4		18
FB4S	8	8	4		20
FB5S	6	3	6		15
FB7D	6	12	4		22
FB7S	8	8	4		20
FB8S	2				2
Total	66	77	48	8	199

2.2 Discussion

The results of the statistical analysis are presented in Table 2.2. Analysis of the data indicates that concentration distributions for groundwater are non-normal and non-transformable. The results of the normality testing are located in Appendix B.1. UTLs were therefore calculated using nonparametric techniques instead of being fit to a modeled distribution. Non parametric UTLs are established using the ordinal ranking of the observations and selecting a defined observation rank as the UTL. The selection was based on the observation resulting in 95 percent coverage of the average with a confidence of 95 percent.

Table 2.2 Groundwater summary statistics

Variable	# Detections	# Nondetects	% Nondetects	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	SD	Skewness	CV	Distribution
Fe (d)	99	1	1.00	0.011	58.2	14.96	8.91	15.19	1.066	1.015	Non-normal
Fe (t)	98	1	1.01	0.011	110	20.2	10.7	19.84	1.401	0.982	Non-normal
Mn (d)	100	0	0.00	0.016	2.19	1.019	1.09	0.496	-0.0688	0.487	Non-normal
Mn (t)	99	0	0.00	0.194	2.4	1.062	1.12	0.517	0.0279	0.487	Non-normal
As (d)	80	20	20.00	0.001	0.044	0.012	0.007	0.0116	1.037	0.962	Non-normal
As (t)	83	16	16.16	0.001	0.256	0.0182	0.01	0.0282	6.337	1.553	Non-normal
Sb (d)	8	92	92.00	0.003	0.1	0.00753	0.003	0.0157	4.697	2.087	Non-normal
Sb (t)	2	97	97.98	0.003	0.1	0.00749	0.003	0.0159	4.606	2.124	Non-normal

For summary statistics, all nondetects set to detection limits

CV – Coefficient of variation
SD – Standard deviation
(d) – Dissolved concentration
(t) – Total concentration

Table 3.3 Upper tolerance limits for surface water

Parameter	Derived from Log-Normal Distribution (mg/L)	Derived from Non-Parametric Techniques (mg/L)	Applicable Drinking Water Standard MCL (mg/L)	Recommended Action Limit (mg/L)
Dissolved Fe	1.94		0.3	1.941
Total Fe		39.5	0.3	39.5
Dissolved Mn	0.36		0.2	0.363
Total Mn		0.79	0.2	0.79
Dissolved As		0.008	0.05	0.05
Total As		0.045	0.05	0.05
Dissolved Sb		0.05	0.006	0.05
Total Sb		0.05	0.006	0.05

REFERENCES

Alaska Administrative Code (AAC) Title 18 Chapter 60 Section 810-840.

Environmental Protection Agency (EPA). 2007. EPA ProUCL Version 4.0 Users Guide. EPA/600/R-07/038.

EPA. 2006. Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S.

Table 2.3 presents the UTLs calculated for dissolved and total concentrations for each parameter. This method establishes a 95 percent confidence level for concentrations falling below the UTL. This means that concentrations not exceeding this limit can be reasonably expected to represent background conditions. Any detection above these tolerance levels would indicate a possible change from background conditions.

Table 2.3 Upper tolerance limits for groundwater

Parameter	Upper Tolerance Limit (mg/L)	Applicable Drinking Water Standard MCL (mg/L)	Recommended Action Limit (mg/L)
Dissolved Fe	52.5	1	52.5
Total Fe	60.1	NA	60.1
Dissolved Mn	1.9	0.2	1.9
Total Mn	1.96	NA	1.96
Dissolved As	0.034	0.05	0.05
Total As	0.065	NA	0.065
Dissolved Sb	NA	0.006	0.006
Total Sb	NA	NA	0.006

Note: Action limits presented for total concentrations for comparison purposes only. Compliance will be based on dissolved concentrations.

The upper tolerance limit for dissolved iron is 52.5 milligrams per liter (mg/L) which is significantly higher than the maximum contaminant level (MCL) of 1.0 mg/L. This reflects the naturally elevated levels of dissolved iron found in the Fish Creek drainage. The UTL for dissolved manganese is 1.9 mg/L, in comparison to the MCL of 0.05 mg/L. The manganese data are characterized by a low standard deviation indicating consistently elevated concentrations. The UTL for dissolved arsenic was less than that of the MCL due to a high proportion of nondetects. Therefore the recommended action limit for dissolved arsenic is the MCL of 0.05 mg/L. Detections of dissolved and total antimony were infrequent and the high number of analyses below the detection limit prevented the calculation of meaningful tolerance levels.

3 SURFACE WATER

3.1 Background data: source and quality

Before Ft. Knox mining operations began in the Fish Creek drainage, surface water monitoring sites were established in four of the sub-basins contributing to Fish Creek to define baseline surface water quality. The locations of these basins and the surface water sampling sites are presented in Figure 3.1. Beginning in May 1992, baseline water quality samples were collected from these locations until the mine opened in 1996. A total of 252 samples were collected during this period. The sampling frequency is summarized in Table 3.1. Figure 3.2 illustrates the frequency distributions of both total and dissolved levels of the four parameters analyzed. Figure 3.3 illustrates the distributions by month. Samples were taken on a biweekly frequency throughout the year to capture seasonal variations.

Table 3.1 Surface water sampling

Site Name	1992	1993	1994	1995	Total
Last Chance Creek	18	18	17	8	61
Lower Fish Creek	21	17	16	34	88
Solo Creek	18	19	16	8	61
Upper Fish Creek	14	16	12	NA	42
Total	71	70	61	50	252

3.2 Discussion

The results of the statistical analysis are presented in Table 3.2. Surface water data for dissolved iron and dissolved manganese are log-normally distributed. High percentages of non-detects in arsenic and antimony prevented definition of a distribution. The results of the normality testing are included in Appendix B.2.

Table 3.3 presents the UTLs calculated from the pre-Ft. Knox mine data for each parameter. The UTL for dissolved iron is 1.94 mg/L. This reflects the naturally high levels of dissolved iron found in the Fish Creek drainage and is consistent with groundwater quality data. The UTL for total iron is 39.5 mg/L. The UTL for dissolved manganese is 0.36 mg/L compared to an MCL of 0.2 mg/L. Total manganese has a UTL of 0.5 mg/L. The data for total and dissolved arsenic results in action limits equal to the MCL of 0.05 mg/L. The UTL for antimony was calculated to be 0.05 mg/L for dissolved and 0.05 mg/L for total, both above the MCL of 0.006 mg/L.

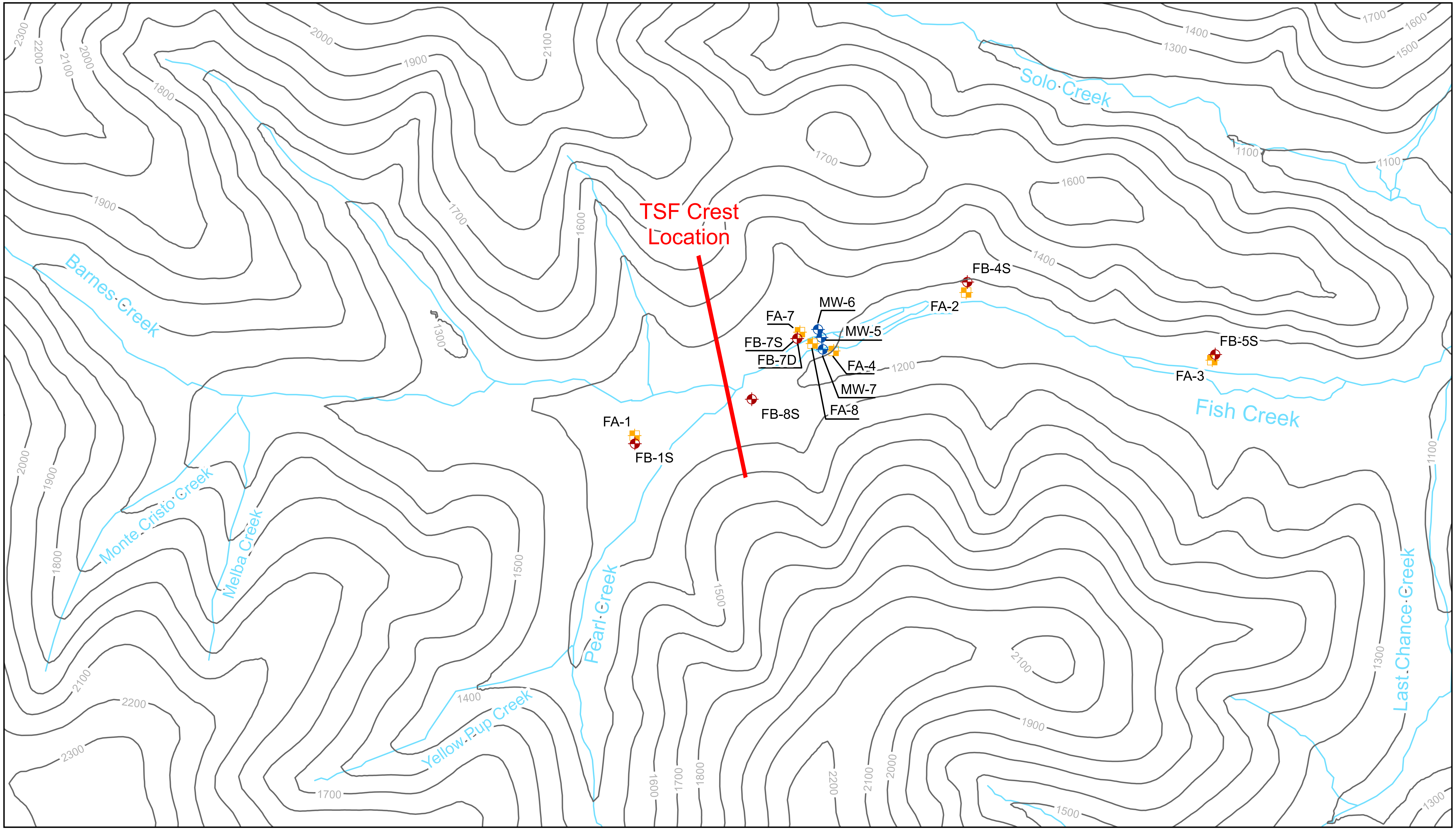
Table 3.2 Surface water summary statistics

Variable	# Detections	# Nondetects	% Nondetects	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	SD	Skewness	CV	Distribution
Fe (d)	114	0	0.0	0.085	3.16	0.603	0.449	0.5	2.038	0.829	Log-normal
Fe (t)	115	0	0.0	0.3	117	6.638	2.16	13.78	5.235	2.076	Non-normal
Mn (d)	114	0	0.0	0.015	0.409	0.115	0.0895	0.0802	1.151	0.699	Log-normal
Mn (t)	115	0	0.0	0.02	1.88	0.203	0.132	0.261	4.508	1.285	Non-normal
As (d)	41	73	64.04	0.001	0.009	0.00308	0.003	0.00178	1.018	0.577	Non-normal
As (t)	57	58	50.43	0.001	0.056	0.00774	0.004	0.0113	2.855	1.454	Non-normal
Sb (d)	18	93	83.78	0.003	0.05	0.00528	0.003	0.00877	4.899	1.661	Non-normal
Sb (t)	4	108	96.43	0.003	0.05	0.00683	0.003	0.0113	3.108	1.653	Non-normal

For summary statistics, all nondetects set to detection limits

CV – Coefficient of variation
SD – Standard deviation
(d) – Dissolved concentration
(t) – Total concentration

FIGURES



Legend

🟥 TSF Crest

Historic Alluvial Wells

Historic Bedrock Wells

Current Monitoring Wells

All Contours Reflect Pre-mining Conditions

N

~WMC

0 750 1,500 3,000

Feet

1:20,000

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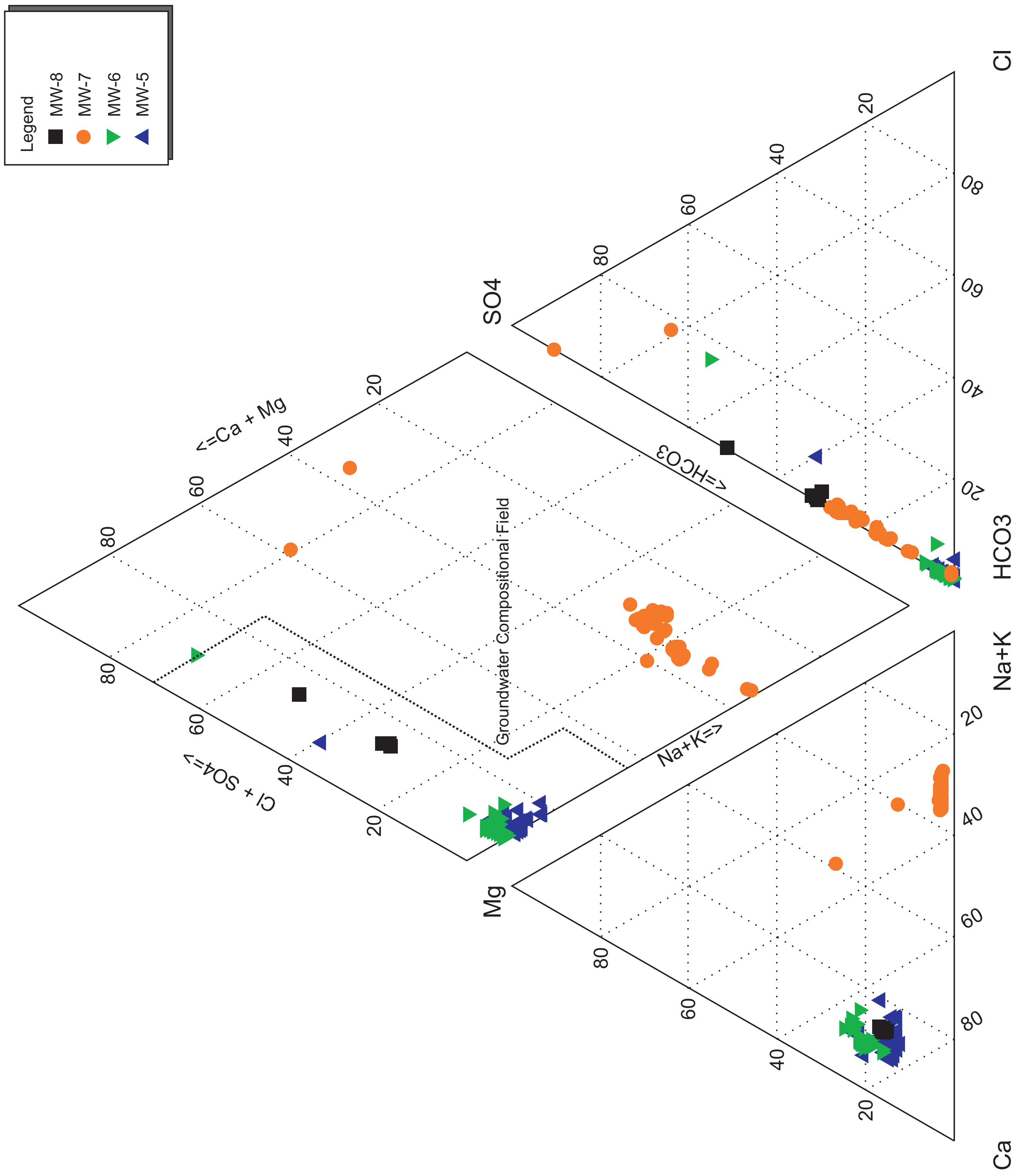
BASELINE WELL LOCATIONS

CLIENT: FGMI		PROJECT: Ft. Knox WQ evaluation
JOB: 2766	FILE: MW_COMPARISON.MXD	DRAWN: MG CHECKED: JC
DATE: January 2008		FIGURE 2.1



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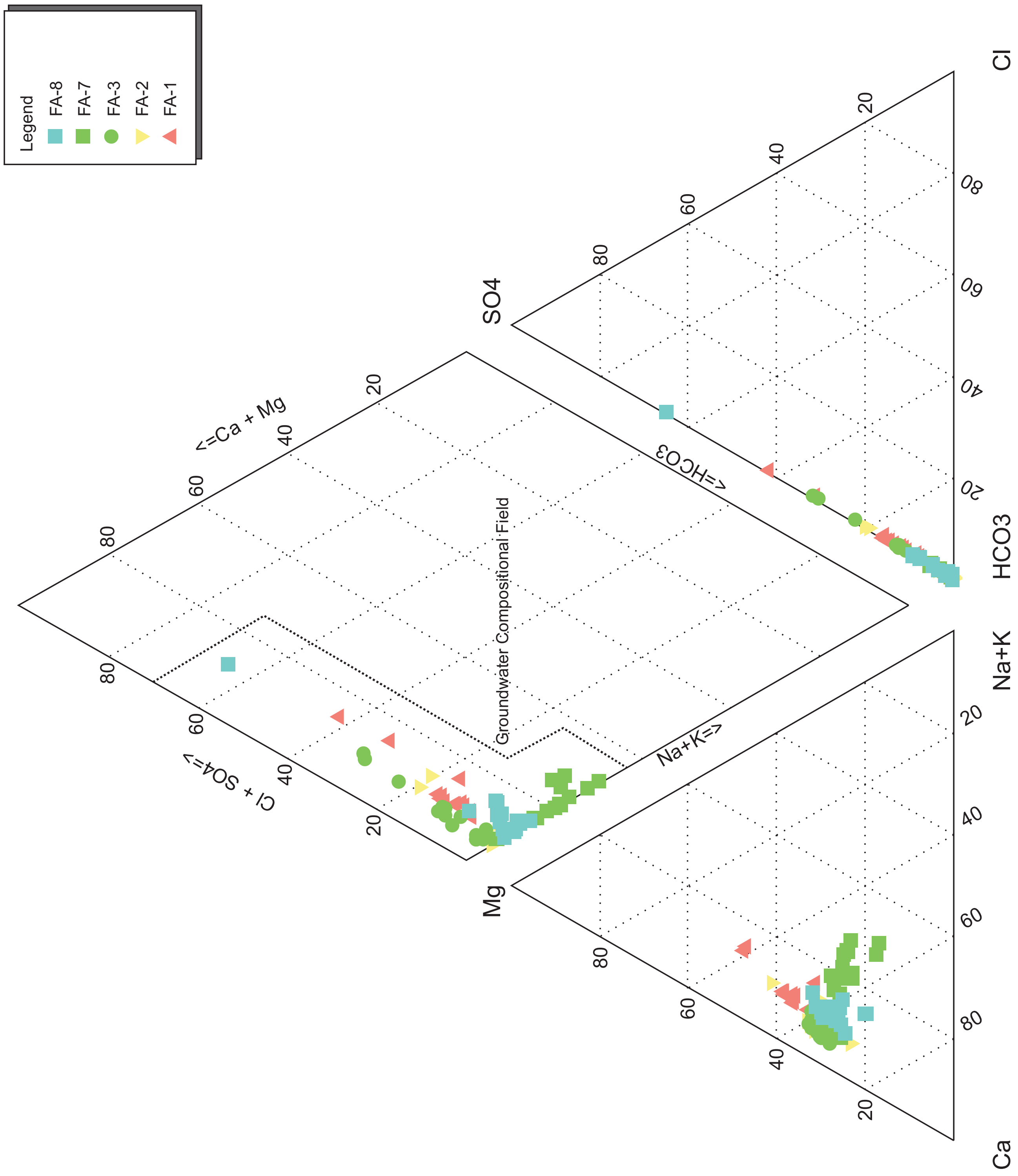
WATER COMPOSITION IN CURRENT MONITORING WELLS

CLIENT:	FGMI	PROJECT:	FT KNOX WQ EVALUATION
JOB: 2766	FILE: CurrentMWsPiper.cdr	DRAWN: MG	CHECKED: JC
DATE:	JANUARY 2008	FIGURE:	2.2



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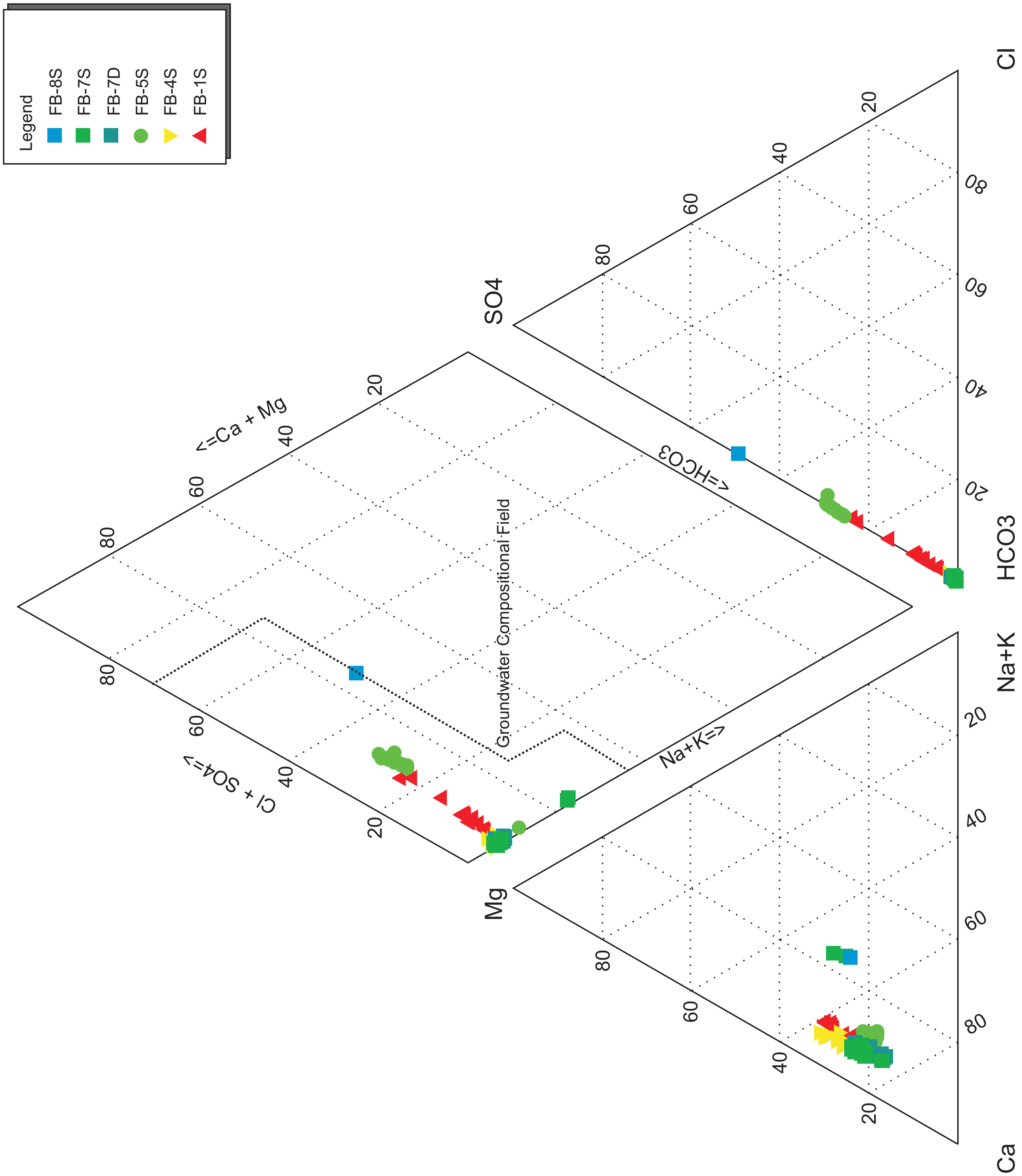
WATER COMPOSITION IN BASELINE ALLUVIAL WELLS

CLIENT: FGMI
PROJECT: FT KNOX WQ EVALUATION
JOB: 2766
FILE: AHistWellsPiper.cdr
DRAWN: MG
CHECKED: JC
DATE: JANUARY 2008
FIGURE: 2.3



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WATER COMPOSITION IN BASELINE BEDROCK WELLS

CLIENT: FGMI

PROJECT: FT KNOX WQ EVALUATION

JOB: 2766

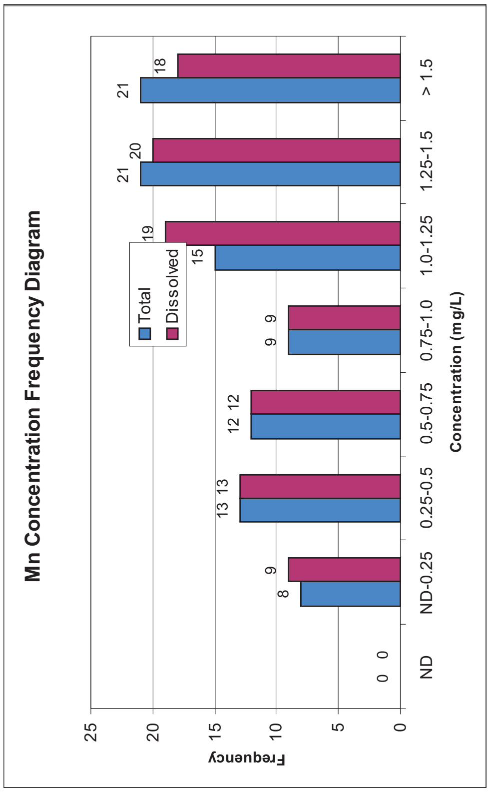
FILE: BHistWellsPiper.cdr

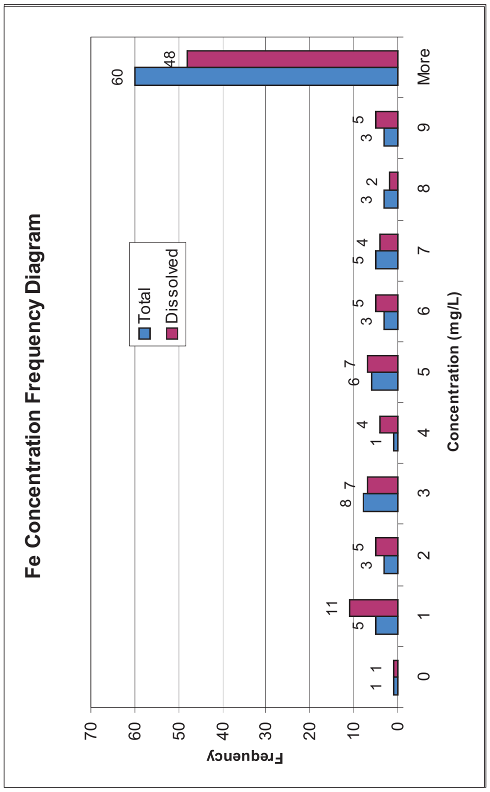
DRAWN: MG

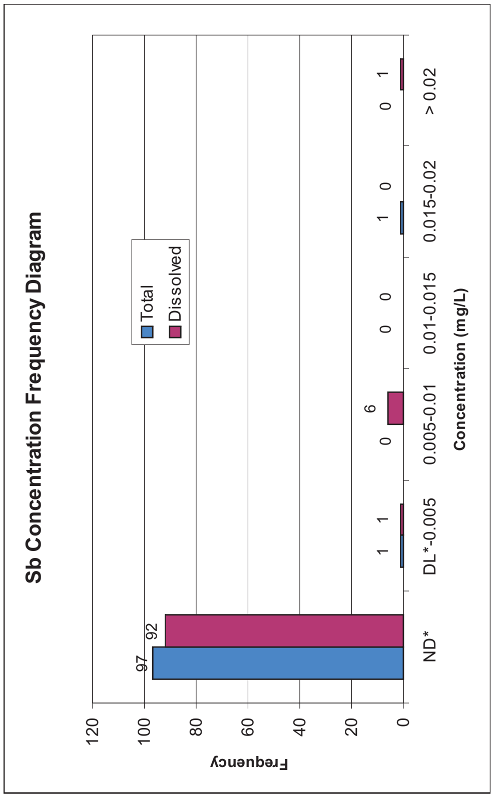
CHECKED: JC

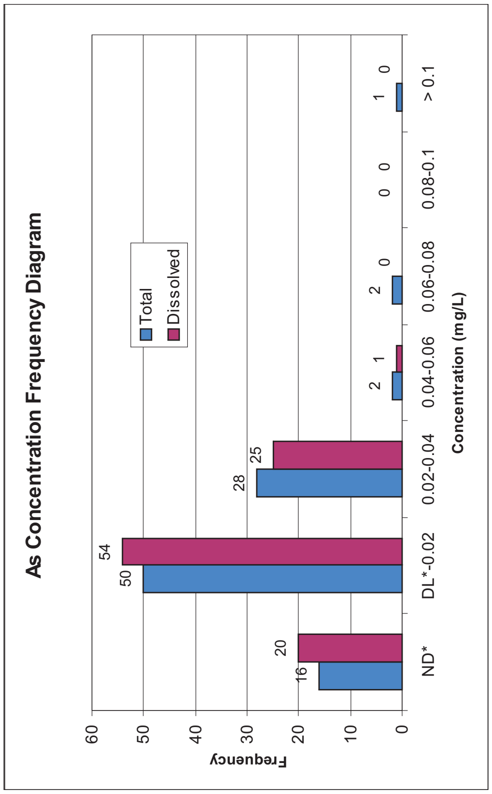
DATE: JANUARY 2008

FIGURE: 2.4









*Note: ND = Non-detect
DL = Detection limit

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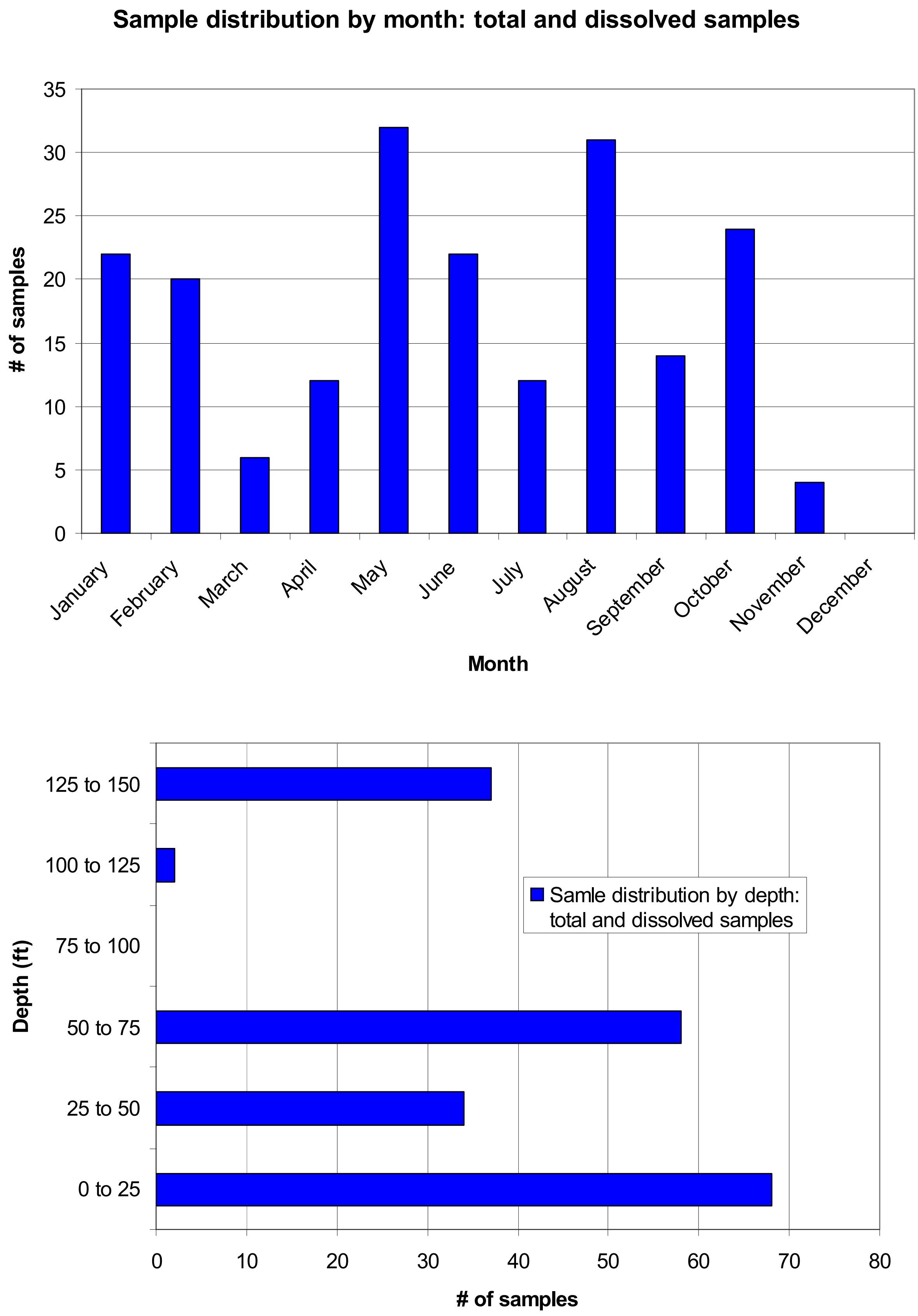
GROUNDWATER CONCENTRATION FREQUENCY DIAGRAMS

CLIENT: FGMI
PROJECT: FT. KNOX WQ EVALUATION
JOB: 2766
FILE: GW ProUCL Histo
DRAWN: LTSG
CHECKED: JC
DATE: JANUARY 2008
FIGURE: 2.5



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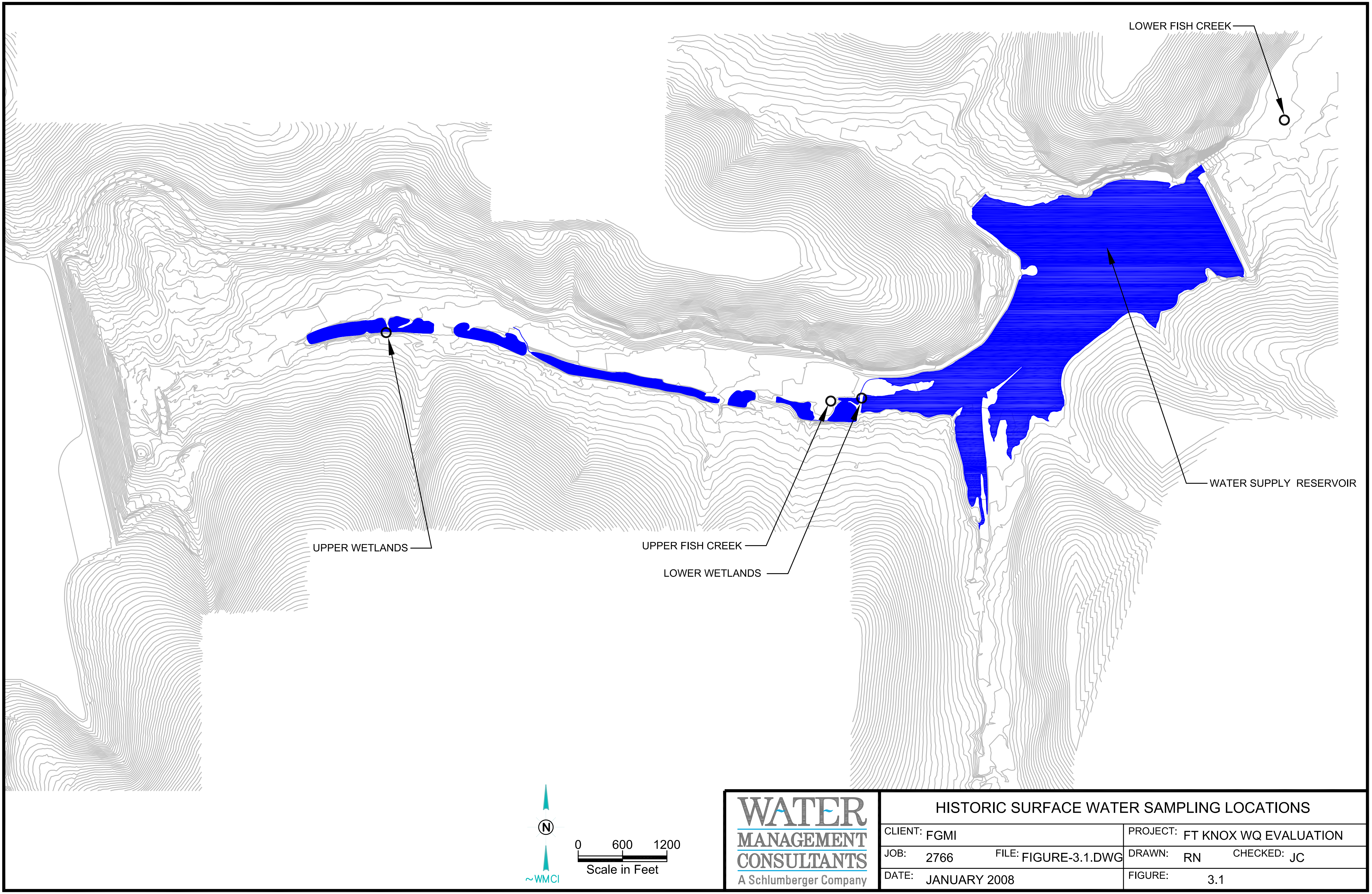
GROUNDWATER SAMPLE DISTRIBUTION BY MONTH AND DEPTH

CLIENT: FGMI		PROJECT: FGMI	
JOB: 2766	FILE: FIGURE-2.6.DWG	DRAWN: RN	CHECKED: MG
DATE: JANUARY 2008		FIGURE: 2.6	

P:\2766 - FT KNOX WQ EVALUATION\CAD\DWG\2766-R-JANUARY-2008\FIGURE-2.6.DWG



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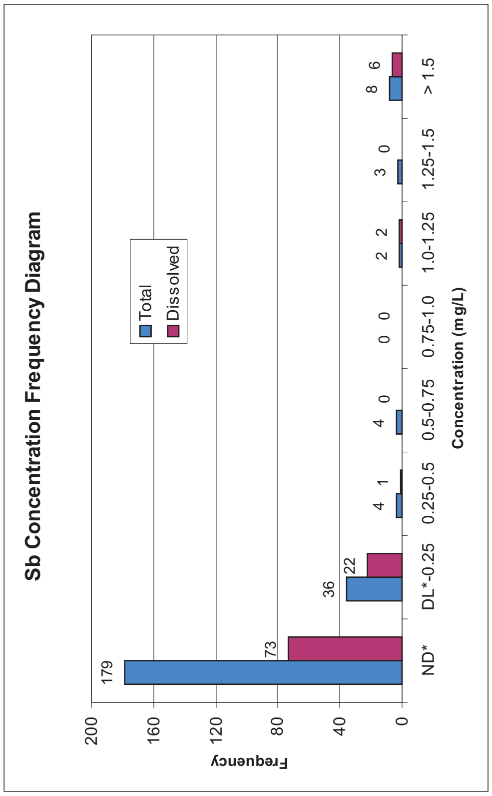
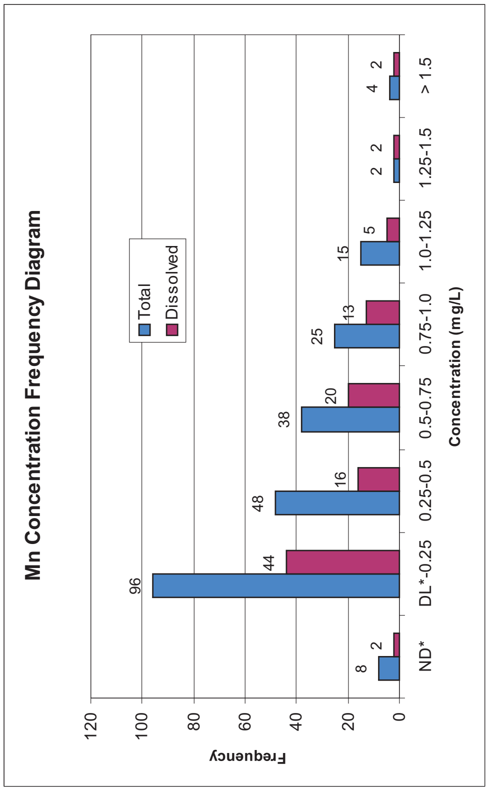
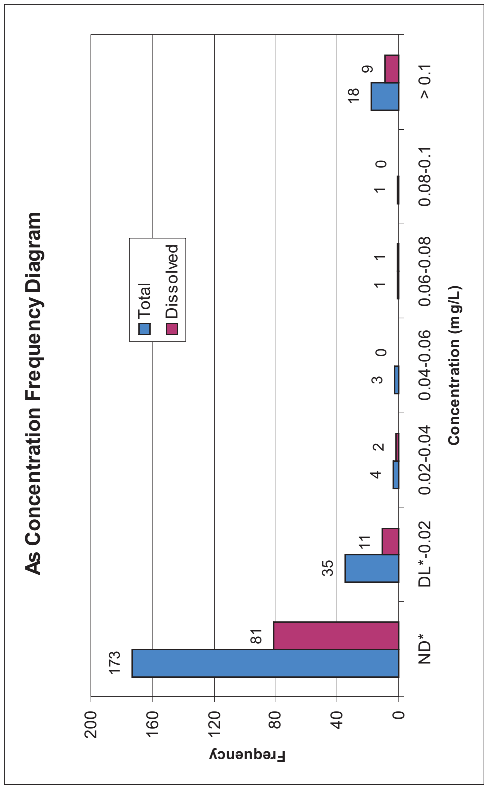
HISTORIC SURFACE WATER SAMPLING LOCATIONS

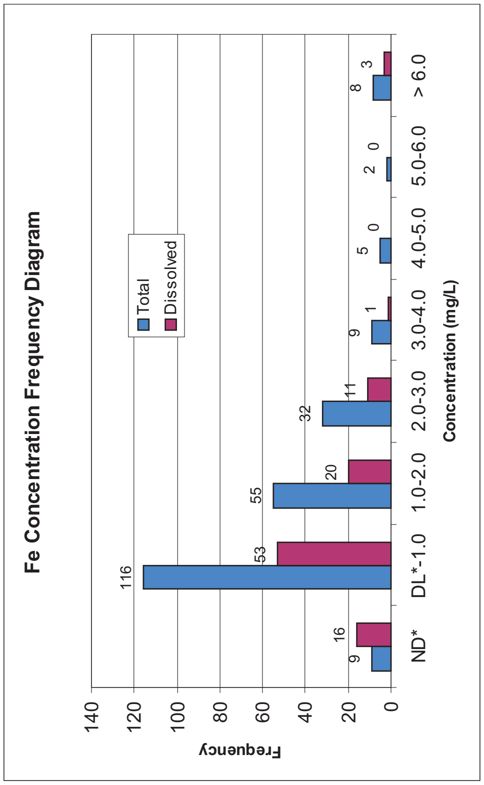
CLIENT: FGMI		PROJECT: FT KNOX WQ EVALUATION	
JOB: 2766	FILE: FIGURE-3.1.DWG	DRAWN: RN	CHECKED: JC
DATE: JANUARY 2008		FIGURE: 3.1	

P:\2766 - FT KNOX WQ EVALUATION\CAD\DWG\2766-R-JANUARY-2008\FIGURE-3.1.DWG









*Note: ND = Non-detect
DL = Detection limit

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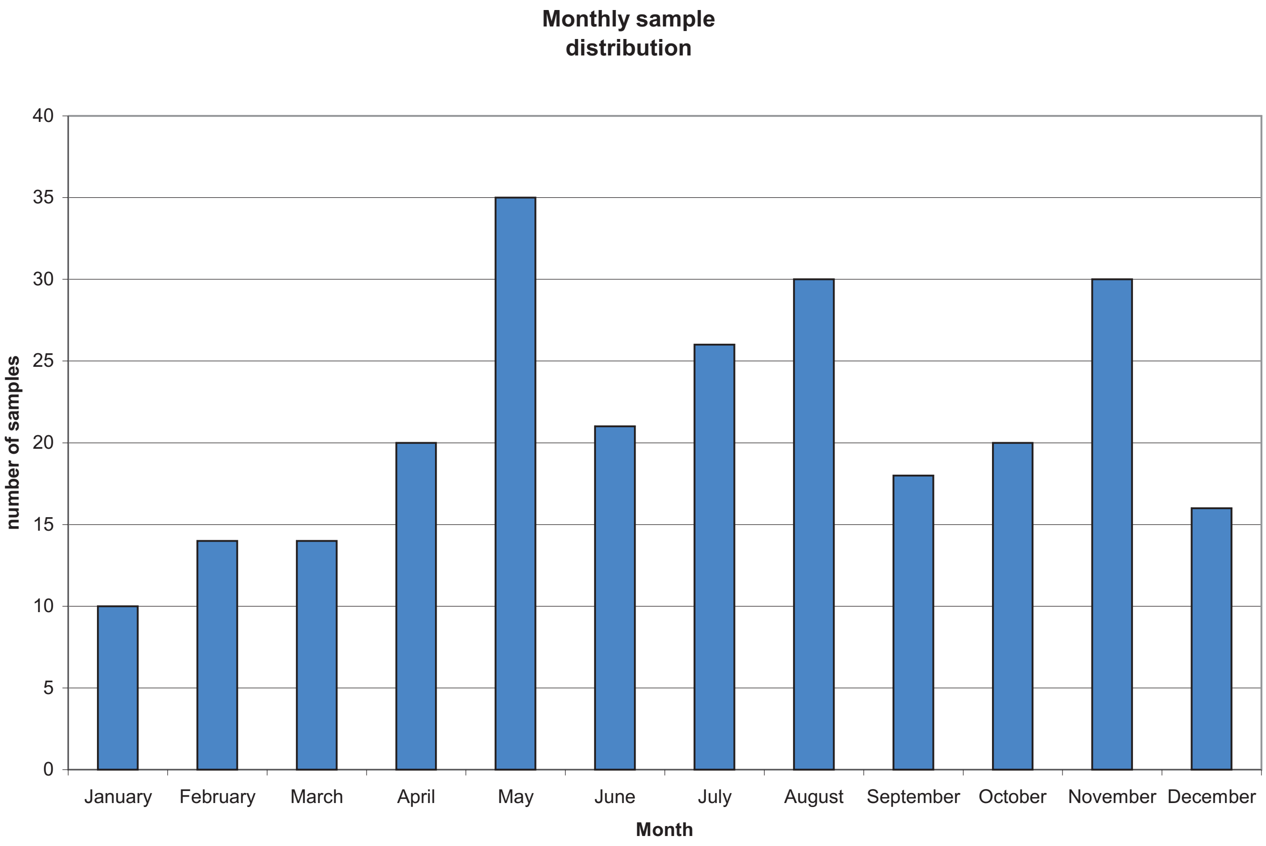
SURFACE WATER CONCENTRATION FREQUENCY DIAGRAMS

CLIENT: FGMI
PROJECT: FT. KNOX WQ EVALUATION
JOB: 2766
FILE: SW ProUCL Histo
DRAWN: LTSG
CHECKED: JC
DATE: JANUARY 2008
FIGURE: 3.2



WATER MANAGEMENT CONSULTANTS A Schlumberger Company	SURFACE WATER SAMPLE FREQUENCY BY MONTH		
	CLIENT: FGMI	PROJECT: FT. KNOX WQ EVALUATION	
	JOB: 2766 FILE: month_dis.xls	DRAWN:	CHECKED: JC
	DATE: JANUARY 2008	FIGURE: 3.3	

APPENDIX A.1

Baseline groundwater database

ID	Lab ID	Date	Sample .	Site Name	Depth	TorD	TDS	FE	MN	AS	SB
124		6/1/1992	1	FA-1	20	D		3.92	0.85	0.003	0.005
125		6/1/1992	1	FA-1	20	T	183	38.7	1.11	0.037	<0.003
126		7/1/1992	1	FA-1	20	D		3.6	0.848	0.001	<0.003
127		7/1/1992	1	FA-1	20	T	140	60.1	1.22	0.065	<0.003
128		9/23/1992	4	FA-1	20	D		8	1.36	0.005	<0.003
129		9/23/1992	4	FA-1	20	T	200	12.2	1.33	0.005	<0.003
130		2/10/1993	3	FA-1	20	D		5.8	1.85	0.004	<0.003
131		2/10/1993	3	FA-1	20	T	227	6.89	1.79	0.003	<0.003
132		5/28/1993	1	FA-1	20	D		4.07	1.73	<0.006	<0.003
133		5/28/1993	1	FA-1	20	T	264	4.33	1.87	<0.006	<0.003
134		8/4/1993	4	FA-1	20	T	214	11.6	1.59	0.009	<0.003
135		8/4/1993	4	FA-1	20	D		4.06	155	0.003	<0.003
136		10/19/1993	102	FA-1	20	D		3.32	1.56	0.006	0.008
137		10/19/1993	102	FA-1	20	T	199	5.01	1.6	<0.003	<0.003
138		5/19/1992	1	FA-2	21	T	279	55.7	1.65	0.03	<0.003
139		5/19/1992	1	FA-2	21	D		58.2	1.67	0.022	<0.003
140		6/27/1992	3	FA-2	21	D		46.4	1.43	0.021	<0.03
141		6/27/1992	3	FA-2	21	T	211	110	1.91	0.073	<0.033
142		10/1/1992	4	FA-2	21	T	227	44.4	1.12	0.031	<0.003
143		10/1/1992	4	FA-2	21	D		36.3	1.06	0.028	<0.003
144		2/10/1993	1	FA-2	21	D		57.5	1.41	0.031	<0.003
145		2/10/1993	1	FA-2	21	T	289	56.5	1.38	0.046	<0.003
146		6/1/1993	1	FA-2	21	T	254	53.4	1.41	0.036	<0.003
147		6/1/1993	1	FA-2	21	D		52.5	1.43	0.034	<0.003
148		8/5/1993	2	FA-2	21	T	264	46.7	1.29	0.037	<0.003
149		8/5/1993	2	FA-2	21	D		45.4	1.29	0.034	<0.003
150		10/28/1993	101	FA-2	21	D		12	0.384	0.015	<0.003
151		10/28/1993	101	FA-2	21	T	114	14.1	0.418	0.016	<0.003
152		5/21/1992	1	FA-3	26	T	279	3.77	1.36	0.004	<0.003
153		5/21/1992	1	FA-3	26	D		0.164	1.22	0.003	0.005
154		6/29/1992	1	FA-3	26	D		0.789	1.26	<0.001	<0.03
155		6/29/1992	1	FA-3	26	T	182	19	1.38	0.256	<0.033
156		10/15/1992	1	FA-3	26	D		4.01	1.63	0.003	<0.003
157		10/15/1992	1	FA-3	26	T	230	4.5	1.53	0.005	<0.003
158		2/16/1993	3	FA-3	26	D		17.1	1.91	0.002	<0.003
159		2/16/1993	3	FA-3	26	T	271	16.4	1.98	0.002	<0.003

ID	Lab ID	Date	Sample .	Site Name	Depth	TorD	TDS	FE	MN	AS	SB
160		6/4/1993	2	FA-3	26	D		0.564	1.42	0.004	<0.003
161		6/4/1993	2	FA-3	26	T	246	9.03	1.79	0.004	<0.003
162		9/23/1993	101	FA-3	26	T	321	49.5	2.4	0.023	<0.003
163		9/23/1993	101	FA-3	26	D		16.7	2.19	0.009	<0.003
184		5/20/1992	1	FA-7	30.5	D		13.8	1.3	0.003	<0.003
185		5/20/1992	1	FA-7	30.5	T	261	34.2	1.6	0.015	<0.003
186		7/1/1992	4	FA-7	30.5	D		19	1.69	0.002	<0.003
187		7/1/1992	4	FA-7	30.5	T	310	45.5	1.86	0.02	<0.003
188		9/24/1992	4	FA-7	30.5	D		23	1.85	<0.001	<0.003
189		9/24/1992	4	FA-7	30.5	T	260	55.9	1.96	0.039	<0.003
190		1/20/1993	2	FA-7	30.5	D		5.33	0.747	0.013	<0.017
191		1/20/1993	2	FA-7	30.5	T	239	5.32	0.767	0.013	<0.017
192		6/3/1993	1	FA-7	30.5	D		1.84	1.21	<0.006	<0.003
193		6/3/1993	1	FA-7	30.5	T	253	36.3	1.45	0.011	<0.003
194		8/5/1993	3	FA-7	30.5	T	267	27.4	1.43	0.009	<0.003
195		8/5/1993	3	FA-7	30.5	D		20.8	1.46	<0.003	<0.003
196		10/14/1993	102	FA-7	30.5	T	256	31.8	1.57	0.005	<0.003
197		10/14/1993	102	FA-7	30.5	D		22.4	1.56	0.005	<0.003
198		8/27/1992	1	FA-8	20	D		35.9	1.14	0.03	<0.003
199		8/27/1992	2	FA-8	20	T	183	40.2	1.28	0.032	<0.003
200		8/27/1992	2	FA-8	20	D		36.3	1.14	0.032	<0.003
201		8/27/1992	1	FA-8	20	T	184	39.6	1.23	0.027	<0.033
202		9/24/1992	3	FA-8	20	D		39.4	1.33	0.031	<0.003
203		9/24/1992	3	FA-8	20	T	174	37.8	1.3	0.036	<0.003
204		2/9/1993	2	FA-8	20	T	162	38	1.3	0.038	<0.003
205		2/9/1993	2	FA-8	20	D		38.1	1.3	0.033	<0.003
206		6/3/1993	3	FA-8	20	T	162	46.1	1.21	0.019	<0.003
207		6/3/1993	3	FA-8	20	D		30.3	1.09	0.023	<0.003
208		8/10/1993	1	FA-8	20	T	197	36.1	1.23	0.036	<0.003
209		8/10/1993	1	FA-8	20	D		34	1.22	0.034	<0.003
210		10/19/1993	101	FA-8	20	T	147	30.2	1.1	0.026	<0.003
211		10/19/1993	101	FA-8	20	D		29.5	1.09	0.03	0.005
222		5/14/1992	3	FB-1S	50	D		5.97	0.369	0.007	<0.003
223		5/14/1992	3	FB-1S	50	T	197	6.75	0.392	0.029	<0.003
224		7/1/1992	2	FB-1S	50	D		7.63	0.31	0.002	<0.003
225		7/1/1992	2	FB-1S	50	T	225	66.5	0.305	0.006	<0.003

ID	Lab ID	Date	Sample .	Site Name	Depth	TorD	TDS	FE	MN	AS	SB
226		9/23/1992	3	FB-1S	50	D		10.4	0.566	0.002	<0.003
227		9/23/1992	3	FB-1S	50	T	273	10.3	0.542	0.007	<0.003
228		2/10/1993	2	FB-1S	50	D		9.59	0.551	0.003	<0.003
229		2/10/1993	2	FB-1S	50	T	250	9.52	0.558	0.004	<0.003
230		5/28/1993	2	FB-1S	50	D		8.76	0.685	<0.006	<0.003
231		5/28/1993	2	FB-1S	50	T	268	8.99	0.699	<0.006	<0.003
232		8/5/1993	1	FB-1S	50	T	273	9.13	0.713	<0.003	<0.003
233		8/5/1993	1	FB-1S	50	D		9.12	0.716	<0.003	<0.003
234		10/19/1993	103	FB-1S	50	T	246	9.63	0.747	0.004	<0.003
235		10/19/1993	103	FB-1S	50	D		8.83	0.704	0.004	<0.003
255		5/13/1992	3	FB-4S	72	D		7.55	1.56	0.007	<0.003
256		5/13/1992	3	FB-4S	72	T	334	8.1	1.47	0.006	<0.003
257		6/28/1992	1	FB-4S	72	D		9.28	1.59	0.007	<0.03
258		6/28/1992	1	FB-4S	72	T	350	9.58	1.55	0.006	<0.017
259		10/1/1992	2	FB-4S	72	D		10.4	1.58	0.01	<0.003
260		10/1/1992	3	FB-4S	72	T	318	11.2	1.6	0.009	<0.003
261		10/1/1992	3	FB-4S	72	D		10.4	1.58	0.009	<0.003
262		10/1/1992	2	FB-4S	72	T	352	10.9	1.61	0.007	<0.003
263		1/12/1993	1	FB-4S	72	D		8.99	1.29	0.015	<0.017
264		1/12/1993	1	FB-4S	72	T	340	9.22	1.29	0.013	<0.003
265		6/1/1993	2	FB-4S	72	T	352	10.7	1.49	0.011	<0.003
266		6/1/1993	2	FB-4S	72	D		10.7	1.46	0.011	<0.003
267		8/30/1993	104	FB-4S	72	T	357	12.2	1.6	0.009	<0.003
268		8/30/1993	104	FB-4S	72	D		11.8	1.61	0.006	<0.003
269		10/28/1993	102	FB-4S	72	T	315	10.8	1.49	0.014	<0.003
270		10/28/1993	102	FB-4S	72	D		10.7	1.48	0.01	<0.003
271		5/14/1992	2	FB-5S	141	T	140	0.449	0.211	<0.001	<0.003
272		5/14/1992	2	FB-5S	141	D		0.034	0.206	<0.001	<0.003
273		5/14/1992	1	FB-5S	141	D		0.045	0.202	0.007	<0.003
274		5/14/1992	1	FB-5S	141	T	136	0.568	0.216	<0.001	<0.003
275		10/15/1992	2	FB-5S	141	D		0.033	0.211	<0.001	<0.003
276		10/15/1992	2	FB-5S	141	T	149	0.05	0.194	<0.001	<0.003
277		8/11/1993	301	FB-5S	141	T	156	0.125	0.224	0.004	0.005
278		8/11/1993	301	FB-5S	141	D		0.04	0.219	<0.003	<0.003
280		8/11/1993	101	FB-5S	141	D		0.019	0.219	0.006	0.005
303		5/12/1992	1	FB-7D	142	D		1.01	0.404	0.004	<0.003

ID	Lab ID	Date	Sample .	Site Name	Depth	TorD	TDS	FE	MN	AS	SB
304		5/12/1992	1	FB-7D	142	T	248	1.28	0.426	0.005	<0.003
305		7/6/1992	1	FB-7D	142	D		1.63	0.44	0.002	<0.003
306		7/6/1992	1	FB-7D	142	T	225	1.62	0.425	0.003	<0.003
307		9/24/1992	1	FB-7D	142	D		1.83	0.456	0.002	<0.003
308		9/24/1992	1	FB-7D	142	T	230	1.95	0.452	0.003	<0.003
309		2/9/1993	1	FB-7D	142	T	235	2.14	0.478	0.003	<0.003
310		2/9/1993	1	FB-7D	142	D		2.11	0.454	0.002	<0.003
311		6/4/1993	1	FB-7D	142	D		2.58	0.469	0.004	<0.003
312		6/4/1993	1	FB-7D	142	T	234	2.62	0.471	<0.003	<0.003
313		8/26/1993	101	FB-7D	142	T	243	2.51	0.466	<0.003	<0.003
314		8/26/1993	101	FB-7D	142	D		2.53	0.472	0.007	0.005
315		8/26/1993	301	FB-7D	142	T	236	2.55	0.47	0.006	<0.003
316		8/26/1993	301	FB-7D	142	D		2.58	0.47	0.009	<0.003
317		8/26/1993	302	FB-7D	142	T	242	2.11	0.38	<0.005	<0.1
318		8/26/1993	302	FB-7D	142	D		1.87	0.35	0.026	<0.1
319		11/24/1993	101	FB-7D	142	D		2.87	0.502	<0.003	<0.003
320		11/24/1993	101	FB-7D	142	T	190	2.92	0.5	0.003	<0.003
321		5/13/1992	1	FB-7S	53	D		4.04	0.696	0.006	<0.003
322		5/13/1992	1	FB-7S	53	T	238	4.06	0.676	0.006	<0.003
323		7/6/1992	3	FB-7S	53	D		4.45	0.838	0.012	<0.003
324		7/6/1992	2	FB-7S	53	D		4.56	0.871	0.011	<0.003
325		7/6/1992	2	FB-7S	53	T	268	4.21	0.803	0.01	<0.003
326		7/6/1992	3	FB-7S	53	T	259	4.22	0.803	0.01	<0.003
327		9/24/1992	2	FB-7S	53	D		5.61	0.848	0.002	<0.003
328		9/24/1992	2	FB-7S	53	T	264	5.34	0.845	0.012	<0.003
329		1/20/1993	1	FB-7S	53	T	253	31.1	1.57	0.016	<0.017
330		1/20/1993	1	FB-7S	53	D		23.9	1.54	0.008	<0.015
331		6/3/1993	2	FB-7S	53	D		5.99	0.734	<0.006	<0.003
332		6/3/1993	2	FB-7S	53	T	298	6	0.734	0.01	<0.003
333		8/4/1993	3	FB-7S	53	T	251	7.17	0.795	0.01	<0.003
334		8/4/1993	3	FB-7S	53	D		6.53	0.772	0.007	<0.003
335		10/14/1993	101	FB-7S	53	T	264	6.56	0.719	0.011	<0.003
336		10/14/1993	101	FB-7S	53	D		6.76	0.763	0.006	<0.003
337		5/11/1992	1	FB-8S	103	D		0.025	0.016	0.007	0.025
338		5/11/1992	1	FB-8S	103	T	84	15	0.237	0.024	0.02
501		4/19/1994	1	FB-7D	142	T	238	2.42	0.466	0.005	<0.003

ID	Lab ID	Date	Sample .	Site Name	Depth	TorD	TDS	FE	MN	AS	SB
502		4/19/1994	1	FB-7D	142	D		2.37	0.459	<0.003	<0.003
503		4/19/1994	2	FB-7S	53	T	262	7.15	0.732	0.007	<0.003
504		4/19/1994	2	FB-7S	53	D		6.96	0.706	0.009	<0.003
505		4/20/1994	1	FB-4S	72	T	320	9.21	1.26	0.012	<0.003
506		4/20/1994	1	FB-4S	72	D		9.3	1.26	0.014	<0.003
507		4/20/1994	2	FA-2	21	T	304	40	1.17	0.03	<0.003
508		4/20/1994	2	FA-2	21	D		39.8	1.15	0.033	<0.003
509		4/20/1994	3	FA-7	30.5	T	336	30.5	1.29	0.009	<0.003
510		4/20/1994	3	FA-7	30.5	D		27.7	1.22	0.008	<0.003
517		4/28/1994	1	FA-3	26	T	366	36.5	1.47	0.026	<0.003
518		4/28/1994	1	FA-3	26	D		29.3	1.45	0.021	<0.003
519		5/5/1994	1	FA-8	20	T	154	29.8	1.02	0.028	<0.003
520		5/5/1994	1	FA-8	20	D		29.6	1.01	0.028	<0.003
523		5/5/1994	3	FB-5S	141	T	156	0.033	0.202	<0.003	<0.003
524		5/5/1994	3	FB-5S	141	D		0.017	0.212	<0.003	<0.003
541		5/17/1994	1	FB-1S	50	T	268	9.35	0.801	<0.003	<0.003
542		5/17/1994	1	FB-1S	50	D		9.34	0.792	<0.003	<0.003
543		5/17/1994	2	FA-1	20	T	280	7.28	1.95	0.005	<0.003
544		5/17/1994	2	FA-1	20	D		4.75	1.9	0.006	<0.003
571		1/26/1994	103	FA-8	20	T	160	24.9	0.839	0.029	<0.003
572		1/26/1994	103	FA-8	20	D		24.5	0.839	0.03	<0.003
581		8/30/1994	101	FA-8	20	T	157	27	1.05	0.031	<0.05
582		8/30/1994	101	FA-8	20	D		28.3	1	0.03	<0.05
605		1/26/1994	101	FA-2	21	T	119	40.4	1.12	0.034	<0.003
606		1/26/1994	101	FA-2	21	D		39.2	1.1	0.033	<0.003
607		1/26/1994	102	FB-4S	72	T	159	9.83	1.29	0.01	<0.003
608		1/26/1994	102	FB-4S	73	D		9.63	1.26	0.009	<0.003
609		1/27/1994	101	FB-7D	142	T	228	2.41	0.42	<0.003	<0.003
610		1/27/1994	101	FB-7D	142	D		2.4	0.422	<0.003	0.004
611		1/27/1994	102	FB-7S	53	T	262	6.41	0.66	0.006	<0.003
612		1/27/1994	102	FB-7S	53	D		6.67	0.707	0.004	<0.003
613		1/27/1994	103	FA-7	30.5	T	256	30.9	1.05	0.014	<0.003
614		1/27/1994	103	FA-7	30.5	D		21.8	1.08	0.011	<0.003
615		1/31/1994	101	FB-1S	50	T	238	8.48	0.69	<0.003	<0.003
616		1/31/1994	101	FB-1S	50	D		8.42	0.685	<0.003	<0.003
617		1/31/1994	102	FA-1	20	T	182	4.05	1.46	0.004	<0.003

ID	Lab ID	Date	Sample .	Site Name	Depth	TorD	TDS	FE	MN	AS	SB
618		1/31/1994	102	FA-1	20	D		3.73	1.44	<0.003	<0.003
649		3/29/1994	101	FB-5S	141	T	154	<0.011	0.226	<0.003	<0.003
650		3/29/1994	101	FB-5S	141	D		<0.011	0.231	<0.003	<0.003
651		3/29/1994	301	FB-5S	141	T	150	0.028	0.243	<0.003	<0.003
652		3/29/1994	301	FB-5S	141	D		0.012	0.242	<0.003	<0.003
653		3/29/1994	102	FA-3	26	T	444	39.8	1.54	0.023	<0.003
654		3/29/1994	102	FA-3	26	D		24.1	1.39	0.016	<0.003
657		8/30/1994	301	FA-8	20	T	160	27.8	0.98	0.032	<0.05
658		8/30/1994	301	FA-8	20	D		29	1.03	0.03	<0.05
668		11/14/1994	101	FA-8	20	T	184	23.4	1.04	0.031	<0.005
669		11/14/1994	101	FA-8	20	D		30.7	1.04	0.029	<0.005
685		2/7/1995	101	FA-8	20	T	131	36.8	1.21	0.029	<0.005
686		2/7/1995	101	FA-8	20	D		38	1.2	0.029	<0.005
687		2/7/1995	301	FA-8	20	T	188	37.2	0.9	0.046	<0.1
688		2/7/1995	302	FA-8	20	T	151	35.9	1.21	0.037	<0.003
689		2/7/1995	301	FA-8	20	D		44.7	1.2	0.044	<0.1
690		2/7/1995	302	FA-8	20	D		35.8	1.21	0.036	<0.003
695		2/9/1995	101	FA-8	20	T	186	38.4	1.25	0.033	<0.005
696		2/9/1995	101	FA-8	20	D		38.8	1.26	0.033	<0.005

APPENDIX A.2

Baseline surface water database

ID	Lab ID	Date	Sample #	Site Name	TorD	FE	MN	AS	SB
127		12-May-93	1	LAST CHANCE CREEK	D	0.392	0.09	0.006	0.003
118		11-Nov-92	2	LAST CHANCE CREEK	T	0.445	0.046	<0.001	<0.003
119		11-Nov-92	2	LAST CHANCE CREEK	D	0.105	0.045	<0.001	<0.003
120		10-Dec-92	1	LAST CHANCE CREEK	T	0.549	0.061	0.004	<0.003
121		10-Dec-92	1	LAST CHANCE CREEK	D	0.217	0.063	0.002	0.007
122		10-Mar-93	1	LAST CHANCE CREEK	D	0.352	0.126	0.002	<0.003
123		10-Mar-93	1	LAST CHANCE CREEK	T	0.896	0.132	0.004	<0.003
124		29-Apr-93	1	LAST CHANCE CREEK	D	0.774	0.099	0.002	<0.003
126		12-May-93	1	LAST CHANCE CREEK	T	1.2	0.075	0.004	<0.003
114		01-Sep-92	203	LAST CHANCE CREEK	D	0.085	0.03	<0.001	<0.003
134		08-Jul-93	4	LAST CHANCE CREEK	D	0.144	0.02	<0.003	0.004
135		02-Aug-93	4	LAST CHANCE CREEK	T	0.918	0.028	<0.003	<0.003
125		29-Apr-93	1	LAST CHANCE CREEK	T	0.626	0.094	0.003	<0.003
93			101	LAST CHANCE CREEK	T	0.3	0.162	0.002	
94		22-Apr-92	101	LAST CHANCE CREEK	D	0.195	0.135	<0.001	<0.003
95		22-Apr-92	101	LAST CHANCE CREEK	T	0.315	0.147	<0.001	<0.003
96		14-May-92	103	LAST CHANCE CREEK	D	0.239	0.031	0.001	<0.003
97		14-May-92	103	LAST CHANCE CREEK	T	0.327	0.04	<0.001	<0.003
101		09-Jun-92	102	LAST CHANCE CREEK	D	0.662	0.071	0.001	0.009
117		08-Oct-92	104	LAST CHANCE CREEK	T	0.345	0.037	<0.001	<0.003
116		08-Oct-92	104	LAST CHANCE CREEK	D	0.101	0.04	<0.001	0.004
106		06-Jul-92	205	LAST CHANCE CREEK	D	0.2	0.075	<0.001	<0.003
109		06-Jul-92	205	LAST CHANCE CREEK	T	0.968	0.071	<0.001	<0.003
112		04-Aug-92	102	LAST CHANCE CREEK	D	0.256	0.042	0.001	<0.003
139		07-Sep-93	103	LAST CHANCE CREEK	D	0.249	0.023	<0.003	<0.003
102		09-Jun-92	102	LAST CHANCE CREEK	T	2.17	0.077	0.002	<0.033
403		02-Feb-95	102	LAST CHANCE CREEK	D	0.66	0.074	<0.005	<0.005
137		02-Aug-93	4	LAST CHANCE CREEK	D	0.186	0.018	<0.003	<0.003
164		25-Aug-94	102	LAST CHANCE CREEK	D	0.412	0.022	<0.005	<0.05
165		08-Nov-94	101	LAST CHANCE CREEK	T	2.11	0.104	<0.005	<0.005
166		08-Nov-94	101	LAST CHANCE CREEK	D	0.757	0.094	<0.005	<0.005
206		07-Dec-93	101	LAST CHANCE CREEK	T	0.677	0.066	<0.003	<0.003
273		08-Jul-93	4	LAST CHANCE CREEK	T	0.668	0.029	<0.003	<0.003
162		06-Jun-94	103	LAST CHANCE CREEK	D	0.385	0.028	<0.003	<0.003

402		02-Feb-95	102	LAST CHANCE CREEK	T	1.14	0.078	<0.005	<0.005
161		06-Jun-94	103	LAST CHANCE CREEK	T	0.834	0.056	<0.003	<0.003
416		10-May-95	101	LAST CHANCE CREEK	T	2.18	0.115	<0.005	<0.005
417		10-May-95	101	LAST CHANCE CREEK	D	1.07	0.089	<0.005	<0.005
422		25-Jul-95	102	LAST CHANCE CREEK	T	0.82	0.054	<0.005	<0.005
423		25-Jul-95	102	LAST CHANCE CREEK	D	0.64	0.05	<0.005	<0.005
464		06-Nov-95	101	LAST CHANCE CREEK	T	0.953	0.074	<0.003	0.004
465		06-Nov-95	101	LAST CHANCE CREEK	D	0.81	0.07	<0.003	<0.003
277		04-Nov-93	103	LAST CHANCE CREEK	T	0.492	0.053	<0.003	<0.003
152		09-Feb-94	102	LAST CHANCE CREEK	D	0.141	0.047	<0.003	<0.003
113		04-Aug-92	102	LAST CHANCE CREEK	T	0.858	0.044	0.002	<0.003
140		05-Oct-93	1	LAST CHANCE CREEK	T	0.496	0.038	0.005	<0.003
141		05-Oct-93	1	LAST CHANCE CREEK	D	0.154	0.035	<0.003	0.005
144		04-Nov-93	103	LAST CHANCE CREEK	D	0.446	0.054	<0.003	<0.003
147		07-Dec-93	101	LAST CHANCE CREEK	D	0.217	0.063	<0.003	<0.003
149		04-Jan-94	104	LAST CHANCE CREEK	T	0.714	0.082	0.006	<0.003
163		25-Aug-94	102	LAST CHANCE CREEK	T	1.1	0.066	<0.005	<0.05
151		09-Feb-94	102	LAST CHANCE CREEK	T	0.416	0.048	<0.003	<0.003
138		07-Sep-93	103	LAST CHANCE CREEK	T	0.648	0.026	<0.003	<0.003
153		14-Mar-94	101	LAST CHANCE CREEK	T	0.768	0.102	<0.003	<0.003
154		14-Mar-94	101	LAST CHANCE CREEK	D	0.346	0.098	<0.003	<0.003
157		21-Apr-94	102	LAST CHANCE CREEK	T	0.441	0.087	<0.003	<0.003
158		21-Apr-94	102	LAST CHANCE CREEK	D	0.202	0.082	<0.003	<0.003
159		04-May-94	102	LAST CHANCE CREEK	T	1.25	0.179	<0.003	<0.003
160		04-May-94	102	LAST CHANCE CREEK	D	0.72	0.164	<0.003	<0.003
150		04-Jan-94	104	LAST CHANCE CREEK	D	0.238	0.078	<0.003	<0.003
3		25-Aug-94	102	LAST CHANCE CREEK	T	1.1	0.066	<0.005	<0.05
115		01-Sep-92	203	LAST CHANCE CREEK	T	0.514	0.029	0.001	<0.003
418		26-Jul-95	101	LOWER FISH CREEK	T	14.9	0.331	<0.005	<0.005
414		08-May-95	102	LOWER FISH CREEK	T	9	0.274	<0.005	<0.005
415		08-May-95	102	LOWER FISH CREEK	D	1.44	0.141	<0.005	<0.005
9		14-May-92	101	LOWER FISH CREEK	D	0.79	0.186	<0.001	<0.003
419		26-Jul-95	101	LOWER FISH CREEK	D	3.16	0.187	<0.005	<0.005
7		22-Apr-92	103	LOWER FISH CREEK	T	15.6	0.528	0.018	<0.003
6		22-Apr-92	103	LOWER FISH CREEK	D	0.159	0.409	0.001	<0.003

5		19-Mar-92	101	LOWER FISH CREEK	T	2.01	0.32	0.004	
10		14-May-92	101	LOWER FISH CREEK	T	2.34	0.213	0.002	<0.003
18		05-Jun-92	201	LOWER FISH CREEK	T	41	0.788	0.054	<0.033
17		05-Jun-92	201	LOWER FISH CREEK	D	0.34	0.09	0.003	<0.003
170		07-Jul-93	1	LOWER FISH CREEK	T	8.35	0.194	0.014	<0.003
394		02-Feb-95	101	LOWER FISH CREEK	T	3.41	0.237	<0.005	<0.005
395		02-Feb-95	101	LOWER FISH CREEK	D	1.85	0.226	<0.005	<0.005
430		15-May-95	101	LOWER FISH CREEK	T				
454		21-Nov-95	101	LOWER FISH CREEK	T				
447		28-Sep-95	105	LOWER FISH CREEK	T				
448		05-Oct-95	101	LOWER FISH CREEK	T				
449		18-Oct-95	101	LOWER FISH CREEK	T				
450		24-Oct-95	101	LOWER FISH CREEK	T				
451		30-Oct-95	101	LOWER FISH CREEK	T				
428		04-May-95	101	LOWER FISH CREEK	T				
453		16-Nov-95	101	LOWER FISH CREEK	T				
444		22-Aug-95	101	LOWER FISH CREEK	T				
461		07-Nov-95	101	LOWER FISH CREEK	T	2.27	0.256	<0.003	<0.003
4		19-Mar-92	101	LOWER FISH CREEK	D	0.604	0.356	0.002	
438		11-Jul-95	101	LOWER FISH CREEK	T				
431		24-May-95	101	LOWER FISH CREEK	T				
432		01-Jun-95	101	LOWER FISH CREEK	T				
433		07-Jun-95	101	LOWER FISH CREEK	T				
434		13-Jun-95	101	LOWER FISH CREEK	T				
435		22-Jun-95	101	LOWER FISH CREEK	T				
446		06-Sep-95	101	LOWER FISH CREEK	T				
437		05-Jul-95	101	LOWER FISH CREEK	T				
445		31-Aug-95	101	LOWER FISH CREEK	T				
439		20-Jul-95	101	LOWER FISH CREEK	T				
440		26-Jul-95	102	LOWER FISH CREEK	T				
441		03-Aug-95	101	LOWER FISH CREEK	T				
442		09-Aug-95	103	LOWER FISH CREEK	T				
443		17-Aug-95	101	LOWER FISH CREEK	T				
429		10-May-95	101	LOWER FISH CREEK	T				
436		27-Jun-95	101	LOWER FISH CREEK	T				

466		07-Nov-95	101	LOWER FISH CREEK	D	1.6	0.239	<0.003	0.004
57		02-Aug-93	1	LOWER FISH CREEK	T	13.9	0.3	0.015	<0.003
72		04-Jan-94	103	LOWER FISH CREEK	T	2.56	0.221	<0.003	<0.003
70		02-Dec-93	103	LOWER FISH CREEK	D	0.452	0.191	<0.003	<0.003
67		07-Oct-93	101	LOWER FISH CREEK	D	0.482	0.183	<0.003	<0.003
66		08-Nov-93	101	LOWER FISH CREEK	D	1.71	0.208	<0.003	<0.003
74		08-Feb-94	101	LOWER FISH CREEK	T	2.58	0.251	0.004	0.004
65		08-Nov-93	101	LOWER FISH CREEK	T	3.06	0.214	0.004	<0.003
75		08-Feb-94	101	LOWER FISH CREEK	D	0.579	0.236	0.004	<0.003
63		08-Sep-93	103	LOWER FISH CREEK	D	0.423	0.168	0.009	<0.003
62		07-Oct-93	101	LOWER FISH CREEK	T	16.4	0.288	0.009	<0.003
61		08-Sep-93	103	LOWER FISH CREEK	T	31.1	0.393	0.041	<0.003
60		02-Aug-93	1	LOWER FISH CREEK	D	0.545	0.121	0.004	<0.003
23		06-Jul-92	203	LOWER FISH CREEK	D	0.683	0.129	0.002	<0.003
82		04-May-94	101	LOWER FISH CREEK	T	9.58	0.281	0.006	<0.003
90		09-Nov-94	101	LOWER FISH CREEK	T	6.57	0.263	<0.005	<0.005
91		09-Nov-94	101	LOWER FISH CREEK	D	1.82	0.199	<0.005	<0.005
86		25-Aug-94	101	LOWER FISH CREEK	T	3.87	0.166	<0.005	<0.05
85		06-Jun-94	102	LOWER FISH CREEK	D	1.29	0.135	<0.003	<0.003
73		04-Jan-94	103	LOWER FISH CREEK	D	0.41	0.214	0.006	<0.003
83		04-May-94	101	LOWER FISH CREEK	D	1.05	0.166	<0.003	<0.003
81		21-Apr-94	101	LOWER FISH CREEK	D	0.363	0.204	<0.003	<0.003
80		21-Apr-94	101	LOWER FISH CREEK	T	3.26	0.236	<0.003	<0.003
79		09-Mar-94	101	LOWER FISH CREEK	D	0.821	0.326	<0.003	<0.003
78		09-Mar-94	101	LOWER FISH CREEK	T	2.52	0.331	<0.003	<0.003
84		06-Jun-94	102	LOWER FISH CREEK	T	2.16	0.148	<0.003	<0.003
31		09-Oct-92	101	LOWER FISH CREEK	D	0.243	0.266	0.003	<0.003
58		07-Jul-93	1	LOWER FISH CREEK	D	0.41	0.102	<0.003	<0.003
36		09-Dec-92	1	LOWER FISH CREEK	D	0.225	0.28	0.001	<0.003
148		02-Dec-93	103	LOWER FISH CREEK	T	2.52	0.198	<0.003	<0.003
35		09-Dec-92	1	LOWER FISH CREEK	T	2.32	0.28	0.001	<0.003
34		13-Nov-92	1	LOWER FISH CREEK	T	4.21	0.285	0.004	<0.003
32		09-Oct-92	101	LOWER FISH CREEK	T	5.73	0.286	0.002	<0.003
30		01-Sep-92	201	LOWER FISH CREEK	T	5.93	0.225	0.005	<0.003
29		01-Sep-92	201	LOWER FISH CREEK	D	0.829	0.169	<0.001	0.008

28		04-Aug-92	101	LOWER FISH CREEK	T	31.8	0.373	0.045	<0.003
27		04-Aug-92	101	LOWER FISH CREEK	D	0.249	0.155	0.001	0.004
87		25-Aug-94	101	LOWER FISH CREEK	D	0.98	0.089	<0.005	<0.05
33		13-Nov-92	1	LOWER FISH CREEK	D	0.196	0.275	0.002	<0.003
47		13-May-93	1	LOWER FISH CREEK	T	9.21	0.221	0.011	<0.003
48		13-May-93	1	LOWER FISH CREEK	D	0.854	0.104	<0.001	0.005
24		06-Jul-92	203	LOWER FISH CREEK	T	26.6	0.376	0.036	<0.003
46		04-May-93	1	LOWER FISH CREEK	D	1.14	0.178	<0.001	<0.003
45		04-May-93	1	LOWER FISH CREEK	T	1.03	0.184	<0.001	0.006
44		09-Mar-92	1	LOWER FISH CREEK	D	0.489	0.249	0.003	0.004
43		08-Mar-93	1	LOWER FISH CREEK	T	1.93	0.268	0.004	<0.003
252		15-Dec-92	1	SOLO CREEK	T	1.1	0.061	<0.001	<0.003
409		08-May-95	101	SOLO CREEK	D	0.92	0.046	<0.005	<0.005
246		02-Sep-92	203	SOLO CREEK	D	0.387	0.05	<0.001	<0.003
247		02-Sep-92	203	SOLO CREEK	T	1.06	0.056	0.004	<0.003
248		13-Oct-92	101	SOLO CREEK	D	0.169	0.041	<0.001	<0.003
249		13-Oct-92	101	SOLO CREEK	T	0.981	0.047	<0.001	<0.003
420		25-Jul-95	101	SOLO CREEK	T	32.1	0.568	0.017	<0.005
421		25-Jul-95	101	SOLO CREEK	D	1.57	0.146	0.006	<0.005
265		04-Aug-93	1	SOLO CREEK	T	1.25	0.051	<0.003	<0.003
251		10-Nov-92	1	SOLO CREEK	D	0.184	0.042	0.002	0.004
405		02-Feb-95	103	SOLO CREEK	D	0.66	0.081	<0.005	<0.005
253		15-Dec-92	1	SOLO CREEK	D	0.163	0.05	<0.001	<0.003
254		09-Mar-93	1	SOLO CREEK	D	0.188	0.07	0.008	0.007
255		09-Mar-93	1	SOLO CREEK	T	1.2	0.075	0.004	<0.003
256		30-Apr-93	1	SOLO CREEK	D	0.489	0.058	<0.001	<0.003
258		19-May-93	1	SOLO CREEK	T	0.839	0.02	<0.006	<0.003
263		08-Jul-93	1	SOLO CREEK	D	0.459	0.028	<0.003	<0.003
250		10-Nov-92	1	SOLO CREEK	T	0.947	0.048	0.001	<0.003
234		09-Jun-92	103	SOLO CREEK	T	0.995	0.028	0.001	<0.033
224			101	SOLO CREEK	T	1.19	0.067	0.003	
226		20-Apr-92	101	SOLO CREEK	D	0.164	0.062	0.001	<0.003
369		08-Sep-93	101	SOLO CREEK	D	0.636	0.055	<0.003	<0.003
227		20-Apr-92	101	SOLO CREEK	T	1.44	0.077	<0.001	<0.003
376		04-Nov-93	102	SOLO CREEK	T	1.45	0.068	0.005	<0.003

229		21-May-92	103	SOLO CREEK	D	0.512	0.052	<0.001	<0.003
230		21-May-92	103	SOLO CREEK	T	1.27	0.069	0.001	<0.003
408		08-May-95	101	SOLO CREEK	T	2.69	0.102	<0.005	<0.005
69		08-Jul-93	1	SOLO CREEK	T	0.898	0.033	0.006	<0.003
238		06-Jul-92	202	SOLO CREEK	D	0.26	0.032	<0.001	<0.003
239		06-Jul-92	202	SOLO CREEK	T	6.25	0.103	0.006	<0.003
242		05-Aug-92	103	SOLO CREEK	T	3.16	0.067	0.002	<0.003
243		05-Aug-92	103	SOLO CREEK	D	0.413	0.038	0.001	<0.003
404		02-Feb-95	103	SOLO CREEK	T	1.01	0.083	<0.005	<0.005
259		19-May-93	1	SOLO CREEK	D	0.444	0.015	<0.006	<0.003
233		09-Jun-92	103	SOLO CREEK	D	0.509	0.023	<0.001	0.004
289		04-May-94	103	SOLO CREEK	D	0.782	0.138	<0.003	<0.003
295		25-Aug-94	103	SOLO CREEK	D	0.575	0.027	<0.005	<0.05
286		21-Apr-94	103	SOLO CREEK	T	4.84	0.19	0.006	<0.003
282		08-Feb-94	102	SOLO CREEK	T	2.13	0.118	<0.003	<0.003
279		04-Jan-94	101	SOLO CREEK	D	0.229	0.064	<0.003	<0.003
293		06-Jun-94	104	SOLO CREEK	D	0.635	0.05	<0.003	<0.003
292		06-Jun-94	104	SOLO CREEK	T	2.16	0.079	<0.003	<0.003
276		02-Dec-93	102	SOLO CREEK	D	0.267	0.046	<0.003	<0.003
294		25-Aug-94	103	SOLO CREEK	T	4.72	0.104	<0.005	<0.05
288		04-May-94	103	SOLO CREEK	T	7.75	0.322	0.004	<0.003
270		05-Oct-93	2	SOLO CREEK	T	1.1	0.059	<0.003	<0.003
287		21-Apr-94	103	SOLO CREEK	D	0.286	0.089	<0.003	<0.003
257		30-Apr-93	1	SOLO CREEK	T	0.403	0.056	<0.001	<0.003
285		14-Mar-94	102	SOLO CREEK	D	0.257	0.074	<0.003	<0.003
284		14-Mar-94	102	SOLO CREEK	T	0.973	0.083	<0.003	<0.003
283		08-Feb-94	102	SOLO CREEK	D	0.318	0.084	<0.003	<0.003
272		05-Oct-93	2	SOLO CREEK	D	0.188	0.05	<0.003	0.007
463		06-Nov-95	102	SOLO CREEK	D	1.87	0.09	<0.003	<0.003
462		06-Nov-95	102	SOLO CREEK	T	2.52	0.101	<0.003	<0.003
278		04-Jan-94	101	SOLO CREEK	T	2.21	0.101	<0.003	<0.003
275		02-Dec-93	102	SOLO CREEK	T	1.43	0.067	<0.003	<0.003
274		04-Nov-93	102	SOLO CREEK	D	1.27	0.062	0.004	<0.003
268		04-Aug-93	1	SOLO CREEK	D	0.445	0.044	<0.003	0.005
269		08-Sep-93	101	SOLO CREEK	T	1.27	0.063	<0.003	<0.003

297		07-Nov-94	101	SOLO CREEK	D	0.192	0.058	<0.005	<0.005
296		07-Nov-94	101	SOLO CREEK	T	1.42	0.069	<0.005	<0.005
314		19-May-93	1	SOLO CREEK	T				
346		28-Apr-93	1	UPPER FISH CREEK	D	0.581	0.207	0.003	<0.003
142		28-Apr-93	1	UPPER FISH CREEK	T	43	0.837	0.043	<0.017
202		04-Nov-93	101	UPPER FISH CREEK	T	2.23	0.206	<0.003	<0.003
195		02-Aug-93	1	UPPER FISH CREEK	T	29.3	0.469	0.049	<0.003
200		07-Sep-93	101	UPPER FISH CREEK	T	10.8	0.268	0.019	<0.003
360		06-Jul-93	1	UPPER FISH CREEK	T	12.6	0.24	0.024	<0.003
373		02-Dec-93	101	UPPER FISH CREEK	T	2.21	0.159	<0.003	<0.003
372		04-Nov-93	101	UPPER FISH CREEK	D	1.23	0.211	0.004	<0.003
368		07-Sep-93	101	UPPER FISH CREEK	D	1.01	0.133	0.004	<0.003
377		02-Dec-93	101	UPPER FISH CREEK	D	0.358	0.141	<0.003	<0.003
362		02-Aug-93	1	UPPER FISH CREEK	D	0.817	0.062	0.003	<0.003
378		04-Jan-94	102	UPPER FISH CREEK	T	1.85	0.157	0.007	<0.003
359		06-Jul-93	1	UPPER FISH CREEK	D	1.09	0.069	<0.003	<0.003
386		04-May-94	104	UPPER FISH CREEK	T	117	1.88	0.056	<0.003
271		05-Oct-93	3	UPPER FISH CREEK	T	3.72	0.206	<0.013	<0.003
344		14-Dec-92	1	UPPER FISH CREEK	D	0.122	0.197	0.001	<0.003
393		25-Aug-94	104	UPPER FISH CREEK	D	0.72	0.038	<0.005	<0.05
392		25-Aug-94	104	UPPER FISH CREEK	T	7.75	0.198	<0.005	<0.05
389		06-Jun-94	101	UPPER FISH CREEK	D	0.867	0.08	<0.003	<0.003
387		04-May-94	104	UPPER FISH CREEK	D	1.37	0.098	0.006	<0.003
383		25-Apr-94	101	UPPER FISH CREEK	D	0.49	0.098	<0.003	<0.003
382		25-Apr-94	101	UPPER FISH CREEK	T	12.4	0.267	0.006	<0.003
381		09-Feb-94	101	UPPER FISH CREEK	D	0.335	0.15	<0.003	<0.003
380		09-Feb-94	101	UPPER FISH CREEK	T	1.88	0.163	0.004	<0.003
379		04-Jan-94	102	UPPER FISH CREEK	D	0.308	0.141	<0.003	<0.003
388		06-Jun-94	101	UPPER FISH CREEK	T	2.09	0.103	<0.003	<0.003
329		06-Jul-92	201	UPPER FISH CREEK	T	26.7	0.488	0.033	<0.003
328		06-Jul-92	201	UPPER FISH CREEK	D	0.72	0.106	0.003	<0.003
332		10-Aug-92	101	UPPER FISH CREEK	T	7.3	0.294	0.01	<0.003
322		05-Jun-92	202	UPPER FISH CREEK	D	0.608	0.079	0.008	0.008
321		05-Jun-92	202	UPPER FISH CREEK	T	39.5	1.76	0.021	<0.033
351		11-May-93	2	UPPER FISH CREEK	D	0.94	0.111	0.009	<0.003

370		05-Oct-93	3	UPPER FISH CREEK	D	0.571	0.167	0.005	<0.003
333		10-Aug-92	101	UPPER FISH CREEK	D	0.694	0.223	0.003	<0.003
350		11-May-93	2	UPPER FISH CREEK	T	13.8	0.309	0.019	<0.003
345		14-Dec-92	1	UPPER FISH CREEK	T	2.39	0.207	<0.001	<0.003
343		09-Nov-92	1	UPPER FISH CREEK	T	3.91	0.23	0.006	<0.003
342		09-Nov-92	1	UPPER FISH CREEK	D	0.111	0.187	0.002	<0.003
338		08-Oct-92	101	UPPER FISH CREEK	D	1.99	0.287	0.001	0.003
336		02-Sep-92	201	UPPER FISH CREEK	T	10.8	0.247	0.018	<0.033
339		08-Oct-92	101	UPPER FISH CREEK	T	4.42	0.31	0.006	0.004
335		02-Sep-92	201	UPPER FISH CREEK	D	0.36	0.154	<0.001	<0.003

APPENDIX B.1

Groundwater statistics
PROUCL 4.0

```
              Nonparametric Background Statistics for Data Sets with Non-Detects
User Selected Options
                                 C:\Documents and Settings\mgrant\Desktop\Ft Know WQ\Stats\Dev
From File                        Tolerance Limits.wst
Full Precision                   OFF
Confidence Coefficient               95%
Coverage                             95%
Different or Future K Values           1


FE (d)

Total Number of Data                                   100
Number of Non-Detect Data                                1
Number of Detected Data                                 99
Minimum Detected                                     0.012
Maximum Detected                                      58.2
Percent Non-Detects                                  1.00%
Minimum Non-detect                                   0.011
Maximum Non-detect                                   0.011
Mean of Detected Data                                15.11
SD of Detected Data                                  15.19
Mean of Log-Transformed Detected Data                1.788
SD of Log-Transformed Detected Data                  1.979

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                         98
Achieved CC                                          0.963
UTL                                                   52.5
Largest Non-detect at Order                              1

  95% UPL
  95% UPL                                            45.37

Kaplan-Meier (KM) Method
Mean                                                 14.96
SD                                                   15.11
Standard Error of Mean                               1.519
  95% UTL 95% Coverage                               44.03
  95% KM Chebyshev UPL                               81.16
  95% KM UPL (t)                                     40.18
90% KM Percentile (z)                                34.33
95% KM Percentile (z)                                39.82
99% KM Percentile (z)                                50.12

Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
```

KM-UPL may be used when multiple detection limits are present

FE (t)

Total Number of Data	99
Number of Non-Detect Data	1
Number of Detected Data	98
Minimum Detected	0.028
Maximum Detected	110
Percent Non-Detects	1.01%
Minimum Non-detect	0.011
Maximum Non-detect	0.011
Mean of Detected Data	20.41
SD of Detected Data	19.84
Mean of Log-Transformed Detected Data	2.302
SD of Log-Transformed Detected Data	1.587

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

95% UTL with 95% Coverage

Order Statistic	97
Achieved CC	0.961
UTL	60.1
Largest Non-detect at Order	1

95% UPL

95% UPL	55.9

Kaplan-Meier (KM) Method

Mean	20.21
SD	19.74
Standard Error of Mean	1.994
95% UTL 95% Coverage	58.2
95% KM Chebyshev UPL	106.7
95% KM UPL (t)	53.15
90% KM Percentile (z)	45.5
95% KM Percentile (z)	52.67
99% KM Percentile (z)	66.13

Note: UPL (or upper percentile for gamma distributed data)
represents a preferred estimate of BTV. For an Example:
KM-UPL may be used when multiple detection limits are present

MN (d)

Some Non-Parametric Statistics	
Number of Valid Samples	100
Number of Unique Samples	80
Minimum	0.016
Maximum	2.19
Second Largest	1.91
Mean	1.019
First Quartile	0.596
Median	1.09
Third Quartile	1.428
SD	0.496
Variance	0.246
Coefficient of Variation	0.487
Skewness	-0.0688
Mean of Log-Transformed data	-0.166
SD of Log-Transformed data	0.733

Data do not follow a Discernable Distribution (0.05)

Non-Parametric Background Statistics	
90% Percentile	1.608
95% Percentile	1.844
99% Percentile	2.187
95% UTL with 95% Coverage	
Order Statistic	98
Achieved CC	0.963
UTL	1.9
95% BCA Bootstrap UTL with 95% Coverage	1.85
95% Percentile Bootstrap UTL with 95% Coverage	1.9
95% UPL	1.844
95% Chebyshev UPL	3.194
Upper Limit Based upon IQR	2.675

Note: UPL (or upper percentile for gamma distributed data) represents a preferred estimate of BTV

MN (t)

Some Non-Parametric Statistics	
Number of Valid Samples	99
Number of Unique Samples	80
Minimum	0.194
Maximum	2.4
Second Largest	1.98
Mean	1.062
First Quartile	0.66
Median	1.12
Third Quartile	1.47
SD	0.517
Variance	0.268
Coefficient of Variation	0.487
Skewness	0.0279
Mean of Log-Transformed data	-0.101
SD of Log-Transformed data	0.629

Data do not follow a Discernable Distribution (0.05)

Non-Parametric Background Statistics	
90% Percentile	1.65
95% Percentile	1.91
99% Percentile	2.4
95% UTL with 95% Coverage	
Order Statistic	97
Achieved CC	0.961
UTL	1.96
95% BCA Bootstrap UTL with 95% Coverage	1.96
95% Percentile Bootstrap UTL with 95% Coverage	1.96
95% UPL	1.91
95% Chebyshev UPL	3.328
Upper Limit Based upon IQR	2.685

Note: UPL (or upper percentile for gamma distributed data) represents a preferred estimate of BTV

AS (d)

Total Number of Data	100
Number of Non-Detect Data	20
Number of Detected Data	80
Minimum Detected	0.001
Maximum Detected	0.044
Percent Non-Detects	20.00%
Minimum Non-detect	0.001
Maximum Non-detect	0.006
Mean of Detected Data	0.0142
SD of Detected Data	0.0119
Mean of Log-Transformed Detected Data	-4.669
SD of Log-Transformed Detected Data	0.978

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

95% UTL with 95% Coverage	
Order Statistic	98
Achieved CC	0.963
UTL	0.034
Largest Non-detect at Order	43

95% UPL	
95% UPL	0.034

Kaplan-Meier (KM) Method	
Mean	0.0117
SD	0.0117
Standard Error of Mean	0.00118
95% UTL 95% Coverage	0.0343
95% KM Chebyshev UPL	0.0631
95% KM UPL (t)	0.0313
90% KM Percentile (z)	0.0268
95% KM Percentile (z)	0.031
99% KM Percentile (z)	0.039

Note: UPL (or upper percentile for gamma distributed data)
represents a preferred estimate of BTV. For an Example:
KM-UPL may be used when multiple detection limits are present

AS (t)

```
Total Number of Data                                 99
Number of Non-Detect Data                            16
Number of Detected Data                              83
Minimum Detected                                  0.002
Maximum Detected                                  0.256
Percent Non-Detects                              16.16%
Minimum Non-detect                                0.001
Maximum Non-detect                                0.006
Mean of Detected Data                            0.0211
SD of Detected Data                                0.03
Mean of Log-Transformed Detected Data            -4.326
SD of Log-Transformed Detected Data               0.943

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                      97
Achieved CC                                       0.961
UTL                                               0.065
Largest Non-detect at Order                          34

  95% UPL
  95% UPL                                         0.046

Kaplan-Meier (KM) Method
Mean                                              0.018
SD                                               0.0282
Standard Error of Mean                          0.00285
  95% UTL 95% Coverage                           0.0723
  95% KM Chebyshev UPL                            0.141
  95% KM UPL (t)                                 0.0651
90% KM Percentile (z)                            0.0541
95% KM Percentile (z)                            0.0644
99% KM Percentile (z)                            0.0836

Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
    KM-UPL may be used when multiple detection limits are present
```

SB (d)

```
Total Number of Data                                    100
Number of Non-Detect Data                                92
Number of Detected Data                                   8
Minimum Detected                                      0.004
Maximum Detected                                      0.025
Percent Non-Detects                                  92.00%
Minimum Non-detect                                    0.003
Maximum Non-detect                                      0.1
Mean of Detected Data                               0.00775
SD of Detected Data                                 0.00707
Mean of Log-Transformed Detected Data                -5.066
SD of Log-Transformed Detected Data                   0.589

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                          98
Achieved CC                                           0.963
UTL                                                    0.05
Warning: Largest Non-detect at Order                    100

  95% UPL
  95% UPL                                              0.03

Kaplan-Meier (KM) Method
Mean                                                0.00433
SD                                                  0.00221
Standard Error of Mean                             2.45E-04
  95% UTL 95% Coverage                              0.00857
  95% KM Chebyshev UPL                                0.014
  95% KM UPL (t)                                    0.00801
90% KM Percentile (z)                               0.00715
95% KM Percentile (z)                               0.00796
99% KM Percentile (z)                               0.00946

Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
    KM-UPL may be used when multiple detection limits are present
```

```
SB (t)

Total Number of Data                                        99
Number of Non-Detect Data                                   97
Number of Detected Data                                      2
Minimum Detected                                         0.005
Maximum Detected                                          0.02
Percent Non-Detects                                     97.98%
Minimum Non-detect                                       0.003
Maximum Non-detect                                         0.1
Mean of Detected Data                                   0.0125
SD of Detected Data                                     0.0106
Mean of Log-Transformed Detected Data                   -4.605
SD of Log-Transformed Detected Data                       0.98

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                             97
Achieved CC                                              0.961
UTL                                                       0.05
Warning: Largest Non-detect at Order                        99

  95% UPL
  95% UPL                                                0.033

Kaplan-Meier (KM) Method
Mean                                                   0.00516
SD                                                     0.00156
Standard Error of Mean                                2.29E-04
  95% UTL 95% Coverage                                 0.00816
  95% KM Chebyshev UPL                                   0.012
  95% KM UPL (t)                                       0.00776
90% KM Percentile (z)                                  0.00716
95% KM Percentile (z)                                  0.00772
99% KM Percentile (z)                                  0.00878

Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
    KM-UPL may be used when multiple detection limits are present
```

APPENDIX B.2

Surface water statistics
PROUCL 4.0

```
                              Lognormal Background Statistics for Data Sets with Non-Detects
User Selected Options

Full Precision                OFF
Confidence Coefficient            95%
Coverage                          95%
Different or Future K Values        1
Number of Bootstrap Operations   2000


FE (d)

Log-Transformed Statistics
Number of Valid Samples                                     114
Number of Unique Samples                                    106
Minimum                                                  -2.465
Maximum                                                   1.151
Second Largest                                            0.688
Mean                                                     -0.794
First Quartile                                           -1.432
Median                                                   -0.801
Third Quartile                                           -0.243
SD                                                        0.766

Lognormal Distribution Test
Lilliefors Test Statistic                                0.0718
5% Lilliefors Critical Value                              0.083
Data appear Lognormal at 5% Significance Level

Background Statistics Assuming Lognormal Distribution
90% Percentile (z)                                        1.205
95% Percentile (z)                                        1.592
99% Percentile (z)                                        2.682
  95% UPL                                                 1.617
  95% UTL with  95% Coverage                              1.941

Some Nonparametric Background Statistics
  95% Chebyshev UPL                                        2.79
  95% Bootstrap BCA UTL with  95% Coverage                1.856
  95% Percentile Bootstrap UTL with  95% Coverage         1.856

Note: UPL (or upper percentile for gamma distributed
    data) represents a preferred estimate of BTV


FE (t)

Log-Transformed Statistics
Total Number of Data                                        115
Number of Non-Detect Data                                     0
Number of Detected Data                                     115
Minimum Detected                                         -1.204
```

```
Maximum Detected                                         4.762
Percent Non-Detects                                      0.00%
Minimum Non-detect                                    N/A
Maximum Non-detect                                    N/A
Mean of Detected data                                    0.914
SD of Detected data                                      1.291

Lognormal Distribution Test with Detected Values Only
Lilliefors Test Statistic                                0.124
5% Lilliefors Critical Value                            0.0826
Data not Lognormal at 5% Significance Level

Background Statistics Assuming Lognormal Distribution
DL/2 Substitution Method
Mean (Log Scale)                                         0.914
SD (Log Scale)                                           1.291
  95% UTL 95% Coverage                                   29.08
  95% UPL                                                21.41
90% Percentile (z)                                       13.05
95% Percentile (z)                                       20.85
99% Percentile (z)                                       50.24
Note: DL/2 is not a recommended method.


Log ROS Method
Mean in Log Scale                                        0.603
SD in Log Scale                                          1.169
Mean in Orignal Scale                                    4.977
SD in Original Scale                                     13.03
  95% UTL 95% Coverage                                   16.89
  95% BCA UTL with  95% Coverage                         39.88
  95% Bootstrap (%) UTL with  95% Coverage               39.88
  95% UPL (t)                                             12.8
90% Percentile (z)                                       8.173
95% Percentile (z)                                        12.5
99% Percentile (z)                                       27.71


Kaplan Meier (KM) Method
Mean                                                     6.638
SD                                                       13.72
SE of Mean                                               1.285
  95% UTL 95% Coverage                                   32.74
  95% KM Chebyshev UPL                                   66.71
  95% KM UPL (t)                                         29.49
  95% KM Percentile (z)                                  29.21


Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
    KM-UPL may be used when multiple detection limits are present
```

```
MN (d)

Log-Transformed Statistics
Number of Valid Samples                                        114
Number of Unique Samples                                        88
Minimum                                                       -4.2
Maximum                                                     -0.894
Second Largest                                              -1.033
Mean                                                        -2.415
First Quartile                                              -2.996
Median                                                      -2.414
Third Quartile                                              -1.788
SD                                                           0.737

Lognormal Distribution Test
Lilliefors Test Statistic                                   0.0738
5% Lilliefors Critical Value                                 0.083
Data appear Lognormal at 5% Significance Level

Background Statistics Assuming Lognormal Distribution
90% Percentile (z)                                            0.23
95% Percentile (z)                                             0.3
99% Percentile (z)                                           0.496
  95% UPL                                                    0.305
  95% UTL with  95% Coverage                                 0.363

Some Nonparametric Background Statistics
  95% Chebyshev UPL                                          0.466
  95% Bootstrap BCA UTL with  95% Coverage                   0.299
  95% Percentile Bootstrap UTL with  95% Coverage            0.299

Note: UPL (or upper percentile for gamma distributed
    data) represents a preferred estimate of BTV


MN (t)

Log-Transformed Statistics
Total Number of Data                                           115
Number of Non-Detect Data                                        0
Number of Detected Data                                        115
Minimum Detected                                            -3.912
Maximum Detected                                             0.631
Percent Non-Detects                                          0.00%
Minimum Non-detect                                        N/A
Maximum Non-detect                                        N/A
Mean of Detected data                                       -2.025
SD of Detected data                                          0.893

Lognormal Distribution Test with Detected Values Only
Lilliefors Test Statistic                                   0.0897
```

```
5% Lilliefors Critical Value                                0.0826
Data not Lognormal at 5% Significance Level

Background Statistics Assuming Lognormal Distribution
DL/2 Substitution Method
Mean (Log Scale)                                            -2.025
SD (Log Scale)                                               0.893
  95% UTL 95% Coverage                                       0.722
  95% UPL                                                    0.584
90% Percentile (z)                                           0.414
95% Percentile (z)                                           0.573
99% Percentile (z)                                           1.053
Note: DL/2 is not a recommended method.


Log ROS Method
Mean in Log Scale                                           -2.263
SD in Log Scale                                              0.833
Mean in Orignal Scale                                        0.164
SD in Original Scale                                         0.258
  95% UTL 95% Coverage                                       0.508
  95% BCA UTL with  95% Coverage                               0.8
  95% Bootstrap (%) UTL with  95% Coverage                     0.8
  95% UPL (t)                                                0.417
90% Percentile (z)                                           0.303
95% Percentile (z)                                           0.409
99% Percentile (z)                                           0.722


Kaplan Meier (KM) Method
Mean                                                         0.203
SD                                                            0.26
SE of Mean                                                  0.0243
  95% UTL 95% Coverage                                       0.697
  95% KM Chebyshev UPL                                       1.339
  95% KM UPL (t)                                             0.635
  95% KM Percentile (z)                                       0.63


Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
    KM-UPL may be used when multiple detection limits are present
```

Nonparametric Background Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1

FE (d)

Some Non-Parametric Statistics

Number of Valid Samples	114
Number of Unique Samples	106
Minimum	0.085
Maximum	3.16
Second Largest	1.99
Mean	0.603
First Quartile	0.239
Median	0.449
Third Quartile	0.784
SD	0.5
Variance	0.25
Coefficient of Variation	0.829
Skewness	2.038
Mean of Log-Transformed data	-0.794
SD of Log-Transformed data	0.766

Data Follow Appr. Gamma Distribution at 5% Significance Level)

Non-Parametric Background Statistics

90% Percentile	1.28
95% Percentile	1.738
99% Percentile	2.984

95% UTL with 95% Coverage

Order Statistic	111
Achieved CC	0.928
UTL	1.85

95% BCA Bootstrap UTL with 95% Coverage	1.85
95% Percentile Bootstrap UTL with 95% Coverage	1.856

95% UPL	1.738
95% Chebyshev UPL	2.79

Upper Limit Based upon IQR	1.602

Note: UPL (or upper percentile for gamma distributed data) represents a preferred estimate of BTV

FE (t)

Total Number of Data	115
Number of Non-Detect Data	0
Number of Detected Data	115
Minimum Detected	0.3
Maximum Detected	117
Percent Non-Detects	0.00%
Minimum Non-detect	N/A
Maximum Non-detect	N/A
Mean of Detected Data	6.638
SD of Detected Data	13.78
Mean of Log-Transformed Detected Data	0.914
SD of Log-Transformed Detected Data	1.291

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

95% UTL with 95% Coverage	
Order Statistic	112
Achieved CC	0.931
UTL	39.5
Largest Non-detect at Order	0

95% UPL	
95% UPL	31.86

Kaplan-Meier (KM) Method	
Mean	6.638
SD	13.72
Standard Error of Mean	1.285
95% UTL 95% Coverage	32.74
95% KM Chebyshev UPL	66.71
95% KM UPL (t)	29.49
90% KM Percentile (z)	24.22
95% KM Percentile (z)	29.21
99% KM Percentile (z)	38.56

Note: UPL (or upper percentile for gamma distributed data)
represents a preferred estimate of BTV. For an Example:
KM-UPL may be used when multiple detection limits are present

MN (d)

Some Non-Parametric Statistics	
Number of Valid Samples	114
Number of Unique Samples	88
Minimum	0.015

```
Maximum                                                    0.409
Second Largest                                             0.356
Mean                                                       0.115
First Quartile                                              0.05
Median                                                    0.0895
Third Quartile                                             0.167
SD                                                        0.0802
Variance                                                 0.00643
Coefficient of Variation                                   0.699
Skewness                                                   1.151
Mean of Log-Transformed data                              -2.415
SD of Log-Transformed data                                 0.737

Data appear Gamma Distributed at 5% Significance Level

Non-Parametric Background Statistics
90% Percentile                                             0.225
95% Percentile                                             0.276
99% Percentile                                             0.401

  95% UTL with 95% Coverage
Order Statistic                                              111
Achieved CC                                                0.928
UTL                                                        0.287

  95% BCA Bootstrap UTL with 95% Coverage                  0.299
  95% Percentile Bootstrap UTL with 95% Coverage           0.299

  95% UPL                                                  0.276
  95% Chebyshev UPL                                        0.466

Upper Limit Based upon IQR                                 0.343

Note: UPL (or upper percentile for gamma distributed
    data) represents a preferred estimate of BTV


MN (t)

Total Number of Data                                         115
Number of Non-Detect Data                                      0
Number of Detected Data                                      115
Minimum Detected                                            0.02
Maximum Detected                                            1.88
Percent Non-Detects                                        0.00%
Minimum Non-detect                                       N/A
Maximum Non-detect                                       N/A
Mean of Detected Data                                      0.203
SD of Detected Data                                        0.261
Mean of Log-Transformed Detected Data                     -2.025
SD of Log-Transformed Detected Data                        0.893
```

```
Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                          112
Achieved CC                                            0.931
UTL                                                    0.788
Largest Non-detect at Order                                0

  95% UPL
  95% UPL                                              0.536

Kaplan-Meier (KM) Method
Mean                                                   0.203
SD                                                      0.26
Standard Error of Mean                                0.0243
  95% UTL 95% Coverage                                 0.697
  95% KM Chebyshev UPL                                 1.339
  95% KM UPL (t)                                       0.635
90% KM Percentile (z)                                  0.535
95% KM Percentile (z)                                   0.63
99% KM Percentile (z)                                  0.807

Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
    KM-UPL may be used when multiple detection limits are present


AS (d)

Total Number of Data                                     114
Number of Non-Detect Data                                 73
Number of Detected Data                                   41
Minimum Detected                                       0.001
Maximum Detected                                       0.009
Percent Non-Detects                                   64.04%
Minimum Non-detect                                     0.001
Maximum Non-detect                                     0.006
Mean of Detected Data                                0.00324
SD of Detected Data                                  0.00233
Mean of Log-Transformed Detected Data                 -5.976
SD of Log-Transformed Detected Data                    0.717

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                          111
```

```
Achieved CC                                                0.928
UTL                                                        0.008
Largest Non-detect at Order                                  106

  95% UPL
  95% UPL                                                  0.006

Kaplan-Meier (KM) Method
Mean                                                     0.00197
SD                                                       0.00174
Standard Error of Mean                                  1.73E-04
  95% UTL 95% Coverage                                   0.00527
  95% KM Chebyshev UPL                                   0.00957
  95% KM UPL (t)                                         0.00486
90% KM Percentile (z)                                    0.00419
95% KM Percentile (z)                                    0.00482
99% KM Percentile (z)                                    0.00601

Note: UPL (or upper percentile for gamma distributed data)
    represents a preferred estimate of BTV.  For an Example:
    KM-UPL may be used when multiple detection limits are present


AS (t)

Total Number of Data                                         115
Number of Non-Detect Data                                     58
Number of Detected Data                                       57
Minimum Detected                                           0.001
Maximum Detected                                           0.056
Percent Non-Detects                                       50.43%
Minimum Non-detect                                         0.001
Maximum Non-detect                                         0.013
Mean of Detected Data                                     0.0122
SD of Detected Data                                       0.0146
Mean of Log-Transformed Detected Data                     -5.025
SD of Log-Transformed Detected Data                        1.117

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                              112
Achieved CC                                                0.931
UTL                                                        0.045
Largest Non-detect at Order                                   98

  95% UPL
  95% UPL                                                 0.0414
```

Kaplan-Meier (KM) Method

Mean	0.00674
SD	0.0116
Standard Error of Mean	0.00109
95% UTL 95% Coverage	0.0287
95% KM Chebyshev UPL	0.0574
95% KM UPL (t)	0.026
90% KM Percentile (z)	0.0216
95% KM Percentile (z)	0.0258
99% KM Percentile (z)	0.0336

Note: UPL (or upper percentile for gamma distributed data)
represents a preferred estimate of BTV. For an Example:
KM-UPL may be used when multiple detection limits are present

SB (d)

Total Number of Data	111
Number of Non-Detect Data	93
Number of Detected Data	18
Minimum Detected	0.003
Maximum Detected	0.009
Percent Non-Detects	83.78%
Minimum Non-detect	0.003
Maximum Non-detect	0.05
Mean of Detected Data	0.00528
SD of Detected Data	0.00187
Mean of Log-Transformed Detected Data	-5.301
SD of Log-Transformed Detected Data	0.343

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

95% UTL with 95% Coverage

Order Statistic	109
Achieved CC	0.977
UTL	0.05
Warning: Largest Non-detect at Order	111

95% UPL

95% UPL	0.0084

Kaplan-Meier (KM) Method

Mean	0.00339
SD	0.00113
Standard Error of Mean	1.13E-04
95% UTL 95% Coverage	0.00556
95% KM Chebyshev UPL	0.00836
95% KM UPL (t)	0.00528

```
90% KM Percentile (z)                                        0.00485
95% KM Percentile (z)                                        0.00526
99% KM Percentile (z)                                        0.00603

Note: UPL (or upper percentile for gamma distributed data)
   represents a preferred estimate of BTV.  For an Example:
   KM-UPL may be used when multiple detection limits are present


SB (t)

Total Number of Data                                             112
Number of Non-Detect Data                                        108
Number of Detected Data                                            4
Minimum Detected                                               0.004
Maximum Detected                                               0.006
Percent Non-Detects                                           96.43%
Minimum Non-detect                                             0.003
Maximum Non-detect                                              0.05
Mean of Detected Data                                         0.0045
SD of Detected Data                                            0.001
Mean of Log-Transformed Detected Data                          -5.42
SD of Log-Transformed Detected Data                            0.203

Data do not follow a Discernable Distribution (0.05)

Nonparametric Background Statistics

  95% UTL with 95% Coverage
Order Statistic                                                  109
Achieved CC                                                    0.923
UTL                                                             0.05
Warning: Largest Non-detect at Order                             112

  95% UPL
  95% UPL                                                     0.0389

Kaplan-Meier (KM) Method
Mean                                                         0.00402
SD                                                          1.98E-04
Standard Error of Mean                                      2.28E-05
  95% UTL 95% Coverage                                        0.0044
  95% KM Chebyshev UPL                                       0.00489
  95% KM UPL (t)                                             0.00435
90% KM Percentile (z)                                        0.00427
95% KM Percentile (z)                                        0.00435
99% KM Percentile (z)                                        0.00448

Note: UPL (or upper percentile for gamma distributed data)
   represents a preferred estimate of BTV.  For an Example:
   KM-UPL may be used when multiple detection limits are present
```

Appendix B

Quality Assurance Project Plan

and

Field Procedures Manual

QUALITY ASSURANCE PROJECT PLAN
AND
FIELD PROCEDURES MANUAL

Prepared by:

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PO Box 73726
Fairbanks, Alaska 99707-3726

August 2019

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Tables

Appendices

1 INTRODUCTION

1.1 Objectives

This Water Monitoring QA/QC and Field Procedures Manual is for the use of Fairbanks Gold Mining, Inc. (FGMI) operating personnel. This manual will be used to maintain the quality of field activities, sample collection, sample handling, laboratory and data analyses, and to document the quality of data at each processing level. The QA/QC program identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project. Additionally, this manual will be used for training employees in approved field monitoring procedures (i.e. instrument calibrations, measurements, and maintenance).

This document will also serve as the Quality Assurance Project Plan (QAPP) for monitoring requirements specified in the Alaska Pollutant Discharge Elimination System Permit Number AK0053643, effective June 1, 2018. (also known in this document as the Discharge Project).

This document will be periodically reviewed and updated by site personnel to reflect actual site conditions and permit monitoring requirements as they change.

1.2 Quality Assurance / Quality Control Program

The QA/QC program consists of three components:

- **Field QA/QC** identifies the procedures to be used in the field to verify that water samples and field monitoring data are collected according to the requirements of the project. The objective of field QA/QC is to assure that both field measurements and samples collected for laboratory analyses can be demonstrated to be representative of the environment sampled and are of known and acceptable quality.

- **Laboratory QA/QC** identifies the protocols to be used by the laboratories to demonstrate that project data are analyzed according to U.S. Environmental Protection Agency (EPA)-acceptable methodologies, and that reported values are accurate. The objective of the laboratory QA/QC program is to produce data that will meet state and federal analytical requirements.

- **Data QA/QC** identifies the protocols to be used to verify that laboratory and field data have been reported accurately. The objective of the data QA/QC program is to demonstrate that the data reported meets the specified requirements, including comparability with data from previous years.

1.3 Data Uses and Data Quality Objectives

Quality assurance requirements are established in this QA/QC program to achieve the project objectives for the data uses. Applicable quality control procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for FGMI to comply with the analytical permit requirements during operation and ultimately closure. The analyses to be conducted on the various sample types have been presented in the project specific permit. Protocols and appropriate detection limits are included in the laboratory's QA/QC plan available to all FGMI environmental personnel.

Federal and state levels of concern (i.e. ambient water quality criteria or maximum contaminant levels) exist for many of the parameters being analysed in the water-monitoring program. EPA-approved analytical methods will always be used and will have detection limits low enough to determine if Alaska Water Quality Standards are being met.

1.4 Data Quality Parameters

The quality of laboratory data is measured by the precision, accuracy, representativeness, comparability, and completeness of the data. These parameters and the applicable quality control procedures and levels of effort are described below.

1.4.1 Precision

Precision is a qualitative measure of the reproducibility of a measurement under a given set of conditions. For duplicate measurements, analytical precision can be expressed as the relative percent difference. A quantitative definition of the relative percent difference is included in the current contract analytical laboratory's QA/QC Manual. Analytical laboratory uses a relative percent difference of 10% (+ or -) to determine their ability to accurately reproduce results. FMGI finds this level of relative percent difference acceptable, as it is the industry standard. The level of effort for precision measurement will be at a minimum frequency of one in 20 (5 percent) or one per batch, whichever is more frequent.

See Appendix B for quantitative definitions of data quality parameters.

1.4.2 Accuracy

For samples processed by the analytical laboratory, accuracy will be evaluated through the use of matrix spikes and standard reference materials (SRMs) to establish the average recovery. A quantitative definition of average recovery is included in the current contract analytical laboratory's QA/QC Manual. The laboratory will perform matrix spike and matrix spike duplicate measurements at a minimum frequency of one in 20 samples for organic parameters, and matrix spikes of one in 20 for inorganic or miscellaneous samples, or one per batch, whichever is more frequent.

1.4.3 Representativeness, Precision and Accuracy

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the soil and water sampled. Sampling plan design, sampling techniques, and sample handling protocols (e.g., storage, preservation, and transportation) have been developed and are discussed in other sections of this document. Proposed documentation will establish that protocols have been followed and sample identification and integrity assured. Field blanks (Profile III only) and field duplicates obtained at a minimum frequency of 5 percent or one per Sample event will be used to assess field and transport contamination and method variation. Laboratory sample retrieval, storage, and handling procedures have also been developed and are discussed in other sections of this document. Laboratory method blanks will be run at the minimum frequency of 5 percent or one per set to assess laboratory contamination.

1.4.4 Comparability

Comparability is the level of confidence with which one data set can be compared with another. Comparability of the data will be maintained by using EPA-defined procedures. If unavailable or inappropriate, FGMI and Alaska Department Environmental Conservation, will discuss using other than approved EPA methods before use. A 30% relative percent difference will be considered acceptable for comparing duplicate samples between different laboratories. Comparability will also be maintained by the use of consistent units.

1.4.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system. The target completeness objectives are approximately 90 percent for each analytical parameter; the actual completeness can vary with the intrinsic nature of the samples. The completeness of the data will be assessed during the data review.

1.5 Description of Duties

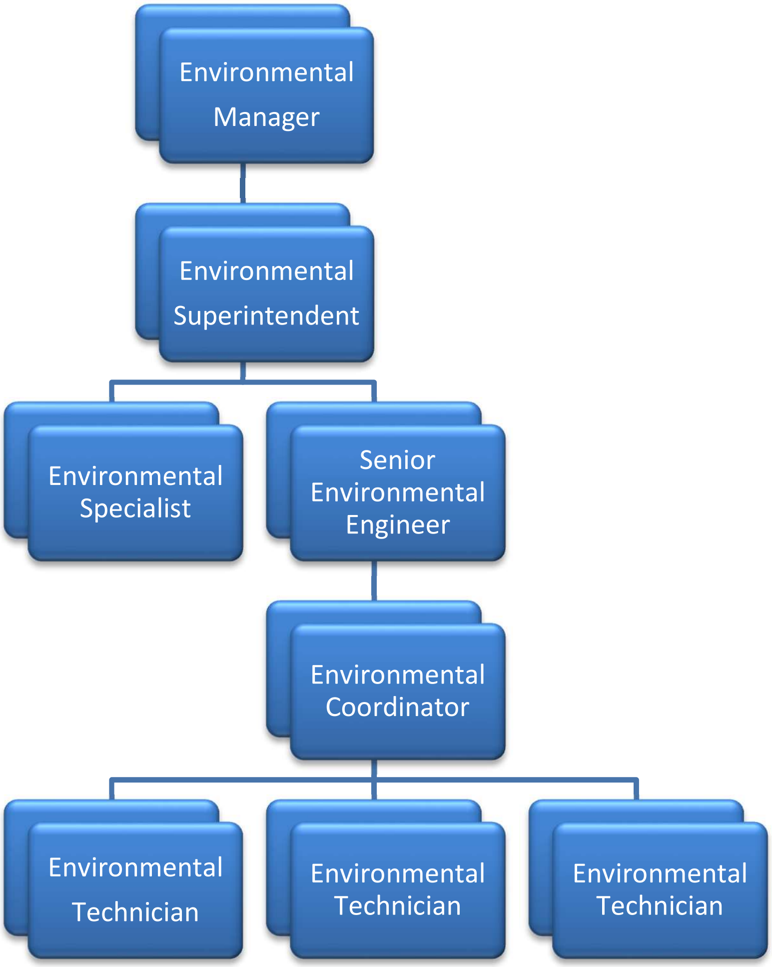
Environmental Manager
Maintains communication with outside agencies.

Environmental Superintendent
Communicates with outside agencies. Addresses data discrepancies and takes corrective measures.

Environmental Coordinator
Project manager, overseeing monitoring results. Acting as quality assurance officer, overseer data gathering protocols and verifying proper sample containers & preservatives. Responsible for maintaining close communication with analytical laboratories and tracking sample progress as well as verifying all data is within established parameters.

Environmental Technicians
Collecting samples according to approved methods as well as the collection of blank and duplicate samples. Labelling and packaging samples according to protocols to prevent leakage or cross-contamination. Properly completing chain of custody forms, and maintaining adequate documentation. Shipping samples at properly maintained temperatures and within holding times. Also responsible for field instrument calibration, decontamination, documentation, and operation and maintenance procedures.

Personnel performing activities related to this document will receive training by reading, understanding, and receive field training in order to be qualified to conduct monitoring activities in accordance with this document.


Environmental Manager
Environmental Superintendent
Environmental Specialist
Senior Environmental Engineer
Environmental Coordinator
Environmental Technician
Environmental Technician
Environmental Technician

2 FIELD QUALITY ASSURANCE / QUALITY CONTROL PROCEDURES

2.1 Purpose

Producing data of known quality that are considered representative of the sampling environment at an appropriate level of detail is achieved by establishing a QA/QC program with specified data gathering protocols overseen by an Environmental Supervisor. The main components of the proposed QAPP program include the following:

- Verification of use of proper sample containers and preservatives
- Collection and analysis of blank and duplicate samples
- Specific procedures for handling, labeling, and shipping samples
- Field equipment calibration
- Equipment decontamination
- Field documentation
- Field corrective action

Each Environmental Technician is responsible for implementing these components in the field. However, the Environmental supervisor will oversee each aspect of field operations to verify that these components are accomplished within the strict requirements of the project.

2.2 Quality Control Samples

To aid in evaluating the accuracy of the analytical data, a rinse blank and duplicate sample are collected and subjected to the same analyses as identified in task samples. One rinse blank and one duplicate sample will be collected and analysed quarterly.

Equipment blanks for surface water sampling are taken by pouring distilled water into a decontaminated sample collection bucket, then sample bottles are filled from the sample collection bucket with a decontaminated one-litre plastic pitcher. Blanks will be analyzed along with the unknown samples.

2.3 Sample Collection, Labelling and Handling Procedures

Sample collection, labelling, and handling procedures are periodically checked by the Environmental Coordinator to verify that the following conditions are being met:

- Collection - Samples are collected according to approved sampling methods.
- Labeling - Samples are uniquely labeled using a code that prohibits unauthorized personnel from knowing the sampling locations.
- Packaging - Samples are correctly packaged to prevent leakage or cross-contamination; Sample containers with proper preservatives are used; Amber sample bottles for UV protection are used when necessary.
- Chain-of-custody forms - Chain-of-custody forms are properly completed to assure sample custody can be adequately documented.
- Shipping - Samples are hand delivered to the laboratory or proper shipping procedures are used, including maintenance of proper temperatures and specified holding times.

Each Environmental Technician is responsible for implementing the proper sample collection, labelling, and handling procedures. The Environmental Coordinator will oversee these activities.

Acids are used in some sample bottles as preservative and it is important to use correct procedures to handle any corrosive substances safely. Some of the commonly used acids are:

- Sulfuric Acid
- Nitric Acid
- Zinc Acid
- Sodium Hydroxide (base)
- Hydrochloric Acid

Personal protective gear, safety glasses and latex gloves, will be worn when opening sample bottles. In some cases an apron may be necessary, or rain gear and a face shield, when handling large quantities of acid or preservatives.

Adequate amounts of clean water will be kept on hand in the field, available for flushing eyes or skin that may come in contact with acids.

It is important to remember, if acid needs to be diluted, never pour water into acid. It is standard procedure to dilute acid by slowly pouring the acid into water.

2.3.1 Sample Labelling

Each sample container will have a waterproof label large enough to contain the information needed to easily identify each sample. The information to be included on each label includes the project name, date, time, preservative (if added), and sampling code. The sample code will be formatted to indicate sample number and date. In the field record book, the sampler identifies each sampling location. Each sample will be identified with a multi-digit number, which includes the date, and identification number of the sample. An example of sample identification is as follows:

R1DS150401101

150401 = Date (April 1, 2015)

101 = Sequential sample number recorded in logbook for that date

All blanks and duplicates will be noted on field data sheets. Blanks and duplicates will be identified the same as other samples, including date and identification number.

2.3.2 Packaging

Each analytical sample bottle will be packed to prevent breakage and placed in an iced cooler to keep the samples cooled to 6°C. For hand delivered and shipped samples one copy of the chain-of-custody form will be placed in a sealed plastic bag. Additionally, for shipped samples, the cooler lid will be sealed with fiber tape and at least one chain-of-custody seal will be attached to the outside of the cooler so that this seal(s) must be broken if the cooler is opened.

2.3.3 Chain-of-Custody

Chain-of-custody forms will be used for all samples. Once collected, the samples will remain within the custody of the sampler or will be locked up until the samples are prepared for shipment. Each time the sample bottle or sample changes hands, both the sender and receiver will sign and date the chain-of-custody form and specify what samples have changed hands. The pink carbon copy of the chain-of-custody form is retained by FGMI and the original (white) and yellow carbon copy is sent to the laboratory.

The following information is to be included on the chain-of-custody form:

- Sample identification code
- Signature of sampler
- Date and time of collection
- Project name
- Type of sample
- Number and type of containers
- Sample analysis requested (Profile I, II, III, IV, V, VI, VII, VIII, Acid/Base Accounting, etc.)
- Inclusive dates of possession
- Signature of receiver

Other chain-of-custody components will include sample labels, sample seals, field data sheets and sample shipment receipts.

2.3.4 Shipping

FGMI personnel or courier will deliver samples to the designated laboratory as soon as feasible after collection.

2.3.5 Field Documentation

Field observations, field equipment calibration information, field measurements, and sample documentation, including sample identification, sample duplicates, and date and time the sample was collected, will be the responsibility of the entire sampling team.

Proper documentation for sample custody includes keeping records of all materials and procedures involved in sampling. Field data sheets will be used to record field data. The Environmental Technician will record all information on the sampling point and respective samples and replicates collected at each site. The Environmental Technician will review all data before leaving the sampling point. Completed field data sheets will be kept on file for any QA/QC checks. Additionally, the Environmental supervisor will inspect field documentation field data sheets regularly.

2.3.6 Corrections to Documentation

No accountable documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document assigned to one person, that person must make corrections by drawing a line through the error, initialling and dating the lined-out item, and entering the correct information. The erroneous information is not to be obliterated but is to remain legible. The person who made the entry will correct any subsequent error discovered on an accountable document. All such subsequent corrections will be initialled and dated.

2.3.7 Field Equipment Calibration

Field equipment used for collection, measurement, and testing is subject to a strict program of control, calibration, adjustment, and maintenance (See Appendix A). Portable water quality instruments will be used for the in situ measurement of pH, temperature, and conductivity. Calibrations will be performed daily prior to beginning any sample tasks. The standards of calibration are in accordance with applicable criteria such as the NIST (National Institute of Standards Technology), ASTM standards, or other accepted procedures outlined in the manufacturer's handbook of specifications. All calibration activities will be documented on Field Data Sheets.

The Environmental Technician will review data measured in the field, and final validation will be by the Environmental supervisor. Data validation will be completed by checking procedures used in the field and comparing the data with previous results. Data that cannot be validated will be so documented; corrective action may be required, as discussed later.

2.3.8 Decontamination Procedures

All sample processing equipment, such as buckets and hoses, which come into contact with a sample will be decontaminated by means of the following procedure:

1. Rinse in water
2. Wash with Alconox, or equivalent, in tap water
3. Double rinse in de-ionized water, and, if not to be used right away,
4. Air-dry
5. Place in plastic bag immediately after air-drying

The purpose of the water and Alconox, or equivalent, washes is to remove all visible particulate matter. This is followed by a de-ionized water rinse to remove the detergent

2.3.9 Field Corrective Action

Field sampling corrective actions includes procedures to follow when field data results are not within the acceptable error tolerance range. These procedures include the following:

- Comparing data readings being measured with readings previously recorded
- Recalibration of equipment (i.e., pH meters)
- Replacing or repairing faulty equipment
- Resampling when feasible

The Environmental Technician is responsible for ordering appropriate field corrective actions when deemed necessary. The Environmental supervisor will be responsible for overseeing these corrections. All field corrective actions will be recorded on the field data sheet.

3 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The laboratory QA/QC program is available to all FGMI personnel.

3.1 Data Quality Assurance/Quality Control Program

The data QA/QC program serves four major functions:

- Maintenance of a duplicate record of all field data
- Sample tracking through laboratory analysis
- Data validation
- Oversight of data management
- During field operations, the Environmental supervisor will receive copies of all field data sheets, which will then be filed in the Environmental Department Filing System. These duplicates will serve as a backup file and will be checked against the field data entered into the database management system.

The second major component of the data QAPP program is sample tracking throughout the laboratory analytical process. The Environmental supervisor will maintain close communication with all analytical laboratories to verify sample receipt, proper sample management, and strict adherence to sample holding times. The laboratories will immediately inform the Environmental supervisor of sample breakages, inadequate sample media to meet QA objectives, and other sample problems. The Environmental supervisor will then notify the Environmental Technician and the Environmental Superintendent; if needed, the Environmental Manager will be notified so that corrective action can be implemented as deemed necessary.

Following the receipt of the analytical data package, the Environmental supervisor will verify that all sample parameter data have been received and will compare detection limits and preliminary results with previous results. Should major discrepancies be found, the Environmental supervisor will communicate these to the Environmental Superintendent for forwarding to the Environmental Manager. Possible corrective measures will then be evaluated as deemed necessary.

A data review or validation process will also be performed on 20 percent of all analytical data received from the laboratories. Chemical data will be reviewed with regard to the following:

- Analytical methodology
- Detection limits
- Cross-contamination as indicated by blank data
- Accuracy and precision
- Adherence to holding times

Where data do not meet the requirements specified in this QAPP program, the data will be flagged with qualifiers. These reviews of data will be summarized and included in the report of sampling data.

3.2 Data Management and Reporting

On a monthly and yearly basis, all water quality data from discharge sampling will be compiled, reviewed and validated, and a report of results sent to the appropriate state agency. FGMI QA/QC documents and records are kept onsite and available for inspection upon request by regulators. The analytical laboratory has on file QC reports for all samples analysed and these are available for inspection, upon request, by regulators.

3.3 Analytical Laboratories

ACZ Laboratories, Inc.

2773 Downhill Drive
Steamboat Springs, CO 80487

970-879-6590

ALS Environmental

1317 South 13th Avenue
Kelso, WA 98626

360-501-3275

SVL Analytical, Inc.

One Government Gulch
Kellogg, Idaho 83837

800-597-7144

TRE Environmental Strategies, LLC.

100 Racquette Drive-Unit A
Ft Collins, Co. 80524

970-416-0916

Table 3-1 Discharge Sampling Requirements

Parameter	Maximum Daily Limit (MDL)	Average Monthly Limit (AML)	Units	Minimum Sample Frequency	Sample Type
antimony	monitor only		micrograms per liter (µg/L)	1/quarter	grab (total recoverable)
arsenic	monitor only		µg/L	1/quarter	grab (total recoverable)
cadmium	0.31	0.15	µg/L	1/week	grab (total recoverable)
chloride	monitor only		Milligrams per liter (mg/L)	1/quarter	grab
copper	8.7	3.1	µg/L	1/quarter	grab (total recoverable)
Cyanide, weak-acid dissociable (WAD)	8.7[b]	2.8[b]	µg/L	1/week	grab (total recoverable)
lead	2.9	0.92	µg/L	1/week	grab (total recoverable)
mercury	0.020	0.010	µg/L	1/week	grab (total recoverable)
Nitrite & nitrate as N	monitor only		mg/L	1/week	grab
pH	See Permit Part 1.3.1.		Standard units (s.u.)	1/week	grab
sulfate	monitor only		mg/L	1/quarter	grab
total suspended solids (TSS)	30	20	mg/L	1/week	Grab(total recoverable)
Volume, cumulative	See Permit Part 1.3.2.		gallons	continuous	meter
zinc	78	26	µg/L	1/week	grab (total recoverable)
Whole effluent toxicity (WET)	monitor only		Chronic toxic units (TUc)	annually	grab

a. Use the following test methods: EPA Method 200.8 for metals, Standard Method 4500 CN-1 for WAD cyanide, EPA Method 1631=E for mercury and EPA Method 300.0 for anions.

b. See Permit Part 1.2.8

Table 3-2 Sampling Details

Parameter	**Minimum Sample Frequency**	**Sample Containers**	**Preservative**	**Hold Times**	**Detection Limits**	
					MDL	**PQL**
antimony	1/quarter	HDPE	Nitric Acid	6 months	0.0004	0.002
arsenic	1/quarter	HDPE	Nitric Acid	6 months	0.0002	0.001
cadmium	1/week	HDPE	Nitric Acid	6 months	0.1	0.5
chloride	1/quarter	HDPE	Nitric Acid	6 months	.05 mg/L	2 mg/L
copper	1/quarter	HDPE	Nitric Acid	6 months	0.4	2
Cyanide, weak-acid dissociable (WAD)	1/week	HDPE	Sodium Hydroxide	14 days	3	10
lead	1/week	HDPE	Nitric Acid	6 months	0.1	0.5
mercury	1/week	HDPE	Hydrochloric Acid	28 days	0.0002	0.0005
Nitrite & nitrate as N	1/week	HDPE	Nitric Acid	28 days	0.02	0.1
pH	1/week	HDPE	None	24 hours	0.1	0.1
sulfate	1/quarter	HDPE	None	14 days	1 mg/L	5 mg/L
total suspended solids (TSS)	1/week	HDPE	None	7 days	5 mg/L	20 mg/L
zinc	1/week	HDPE	Nitric Acid	6 months	2	5
Whole effluent toxicity (WET)	annually					

a. Use the following test methods: EPA Method 200.8 for metals, Standard Method 4500 CN-1 for WAD cyanide, EPA Method 1631=E for mercury and EPA Method 300.0 for anions.
b. See Permit Part 1.2.8
c. Mercury samples will have one trip blank per cooler

Table 3-3 Receiving Water Monitoring Requirements

Parameter[a]	Units	Minimum Level of Quantification (ML)
cadmium	µg/L	0.5
copper	µg/L	3.1
cyanide, WAD	µg/L	10
lead	µg/L	1.4
mercury	µg/L	0.010
nitrite + nitrate as N	mg/L	10
pH	S.U.	±0.1
zinc	µg/L	78
hardness, calculated[b]	mg/L	-

a. Use the following test methods: EPA Method 200.8 for metals, Standard Method 4500 CN-I for WAD cyanide, and EPA Method 1631-E for mercury.
b. Hardness is calculated as follows: (2.497 x [Ca} + (4.118 x [Mg]).

4 INSTRUMENT CALIBRATION, OPERATION, AND MAINTENANCE

4.1 Electrical Conductance

4.1.1 Instrument Calibration

At the beginning of each day of sampling, check instrument linearity.

1. Rinse probe with deionized water.
2. Measure conductivity of two potassium chloride solution standards, which bracket expected sample values.
3. Measure temperature of both solution standards.

Calculate cell constant for each standard to determine if instrument linearity is reasonable. The cell constant is the ratio of the computed conductivity to the measured conductivity of the standard solution.

4.1.2 Maintenance

1. Store meter in its case during transport.
2. Check batteries before taking meter into the field. Carry spare batteries in the field (9 volt).
3. Inspect conductivity probe for cracks or other damage.

4.1.3 Field Measurement Procedures

1. Turn instrument on.
2. Rinse plastic beaker with approximately 50 milliliters of sample water three times.
3. Place water sample in plastic beaker (fill to at least 50 millimeters).
4. Rinse probe with deionized or sample water and place in sample water.
5. Immerse conductivity probe in sample so that vent hole is submerged. Move probe around in sample to displace any air bubbles. Turn instrument on to appropriate scale to measure conductivity. Record conductivity reading after a stable reading is obtained.
6. Remove probe from sample and turn off instrument.

4.2 Field pH

4.2.1 Instrument Calibration

1. Calibrate pH meter at the beginning of each day of fieldwork when pH will be measured, and whenever the standard check is out of acceptable bounds.
2. Rinse pH electrode probe with deionized water.

3. Immerse electrode and temperature probe in beaker of fresh commercial calibration solution of pH 4.0. Calibrate meter to solution.
4. Remove electrode and temperature probe from solution, and then rinse with deionized water.
5. Immerse electrode and temperature probe in fresh pH 10.0 solution. Calibrate meter to solution.
6. Remove electrode and temperature probe from solution, and rinse with deionized water.
7. Measure pH of a third fresh calibration solution at pH 7.0. If measured value differs from expected value by more than 0.1 units, obtain fresh calibration solutions and recalibrate. If discrepancy persists, begin trouble-shooting procedures following meter-operating instructions: check batteries, connections, probe, etc.

4.2.2 Maintenance

1. Store meter in its case with electrode immersed in a pH 7 buffer solution.
2. Inspect electrode prior to use.
3. Check glass electrode for cracks or scratches.
4. Check batteries each time meter is used. Carry a spare battery pack into the field in the pH meter case.

4.2.3 Field Measurement Procedures

1. Rinse decontaminated glass beaker or sample bottle with approximately 50 milliliters of sample water three times.
2. Rinse pH electrode with deionized water.
3. If measurement is read ex situ, fill beaker with sample water.
4. Immerse electrode and temperature probe in sample while swirling the sample to provide thorough mixing. Turn on meter. Read pH to nearest 0.1 until the reading has stabilized (when beaker icon stops flashing).
5. Record sample pH. Note any problems such as erratic readings.
6. Rinse probe with deionized water and store according to manufacturer's directions.

4.3 Water Temperature

4.3.1 Linearity and Field Measurement Procedures

1. Use either a National Institute of Standards and Technology (NIST)-calibrated thermometer or a digital temperature probe calibrated against a NIST-calibrated thermometer to measure temperature.
2. Check thermometers for cracks or gaps in the mercury. Do not use thermometers if either cracks or gaps are visible.

3. When possible, measure temperature of surface water at midstream by submersing the thermometer or electronic temperature probe for approximately 1 minute or until temperature stabilizes.
4. When in situ temperature measurements are not possible, draw sample of at least 200 ml into a decontaminated beaker or sample bottle as soon after sampling as possible.
5. Place thermometer or electronic temperature probe in sample and allow temperature to stabilize.
6. Record temperature to nearest 0.5°C in field logbook or on field data sheet.
7. Rinse thermometer or electronic temperature probe with deionized water.
8. Check field thermometers or digital temperature probes against a NIST-certified laboratory thermometer, on a quarterly basis. Agreement should be within 0.5°C.

4.4 Dissolved Metal Filtration Method for Groundwater

1. Place disposable, high capacity, pre-cleaned, vacuum-type, and 0.45-micron filter in two-way hose fitting/reducer fitting after restricting flow to one outlet.
2. After inserting filter firmly into the two-way hose fitting adjust valves so as to divert flow through the filter.
3. Let at least three filter volumes run through the filter before filling sample bottles.

5 QUANTITATIVE DEFINITIONS OF DATA QUALITY PARAMETERS

5.1 Quantitative Definitions of Data Quality Parameters

5.1.1 Precision

If calculated from duplicate measurements:

$$RPD = \frac{(C_1 - C_2) \text{ x } 100\%}{(C_1 + C_2) / 2}$$

RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = smaller of the two observed values

If calculated from three or more replicates, use relative standard (RSD) rather than RPD:

RSD = (s/y) x 100%
RSD = relative standard deviation
s = standard deviation
y = mean of replicate analyses

Standard deviation, s, is defined as follows:

$$S = \sqrt{\sum \frac{n - 1}{(y_I - y)^2}}$$

s = standard deviation
y_i = measured value of the i^{th} replicate
y = mean replicate measurements
n = number of replicates

5.1.2 Accuracy

For measurements where matrix spikes are used:

$$\%R = 100\% \text{ x } \left[\left(S - U \right) / C_{sa} \right]$$

%R = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added

For situations where standard reference material (SRM) is used instead of or in addition to matrix spikes:

$$\%R = 100\% \text{ x } \left(C_m / C_{srm} \right)$$

%R = percent recovery
C_m = measured concentration of SRM
C_{srm} = actual concentration of SRM Accuracy

5.1.3 Completeness (Statistical)

Defined as follows for all measurements:

$$\%C = 100\% \text{ x } \left(V/n \right)$$

%C = percent completeness
V = number of measurements judged valid
n = total number of measurements to achieve a specified statistical level of confidence in decision making

6 CASING VOLUMES TABLE

Table 6-1 Casing Volume Table

DIAMETER OF CASING (inches)	GALLONS PER LINEAR FOOT	LINEAR FEET PER GALLON
2.00	0.1632	6.1275
2.50	0.2550	3.9216
3.00	0.3672	2.7233
3.50	0.4998	2.0008
4.00	0.6528	1.5319
4.25	0.7369	1.3570
4.50	0.8362	1.2104
4.75	0.9206	1.0862
5.00	1.0200	0.9804
5.25	1.1246	0.8892
5.50	1.2342	0.8102
5.75	1.3489	0.7413
6.00	1.4688	0.6808
6.25	1.5938	0.6276
6.50	1.7238	0.5801
6.75	1.8590	0.5379
7.00	1.9992	0.5002
7.25	2.1445	0.4663
7.50	2.2950	0.4357
7.75	2.4505	0.4081
8.00	2.6112	0.3830

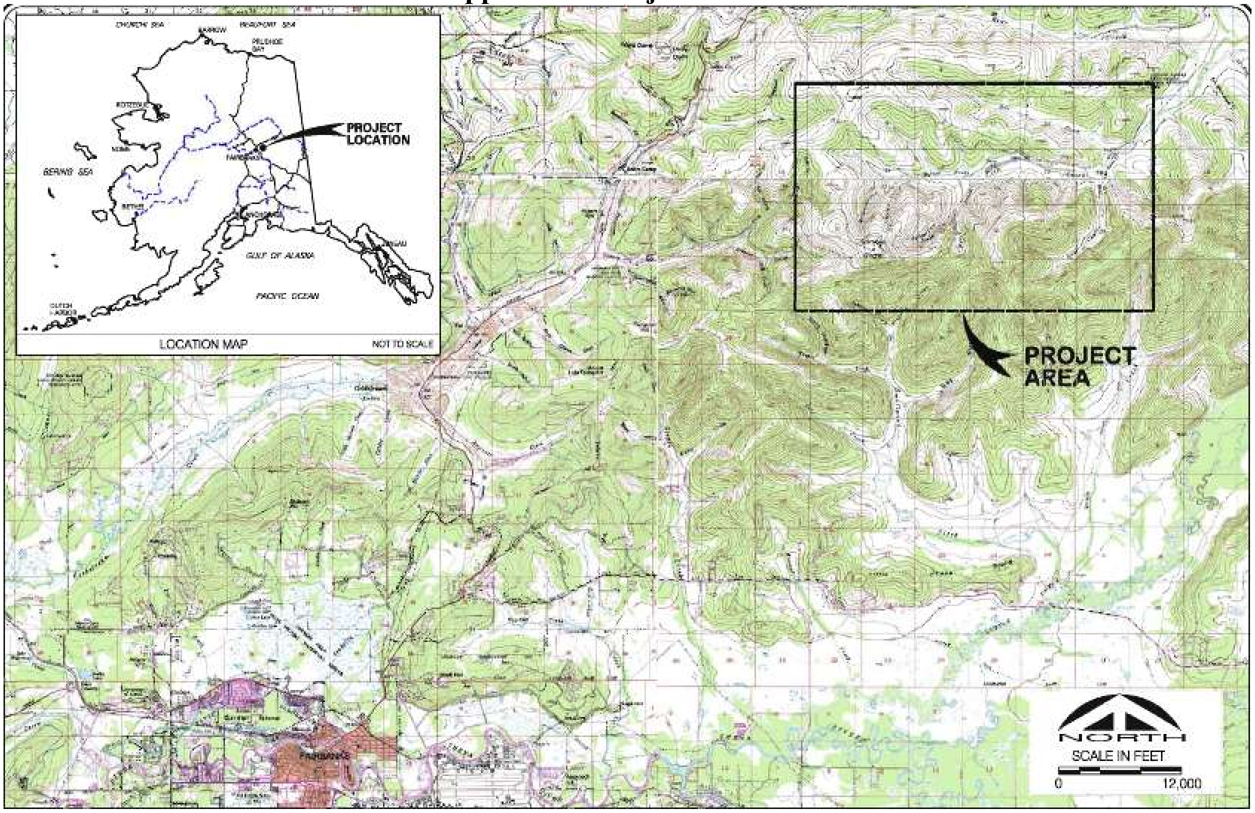
One Casing Volume = (Well Depth – Depth to Water) x Gallons per Linear Foot
One Purge Volume = One Casing Volume x 3.0

Note: Well Depth and Depth to Water are measured in feet!

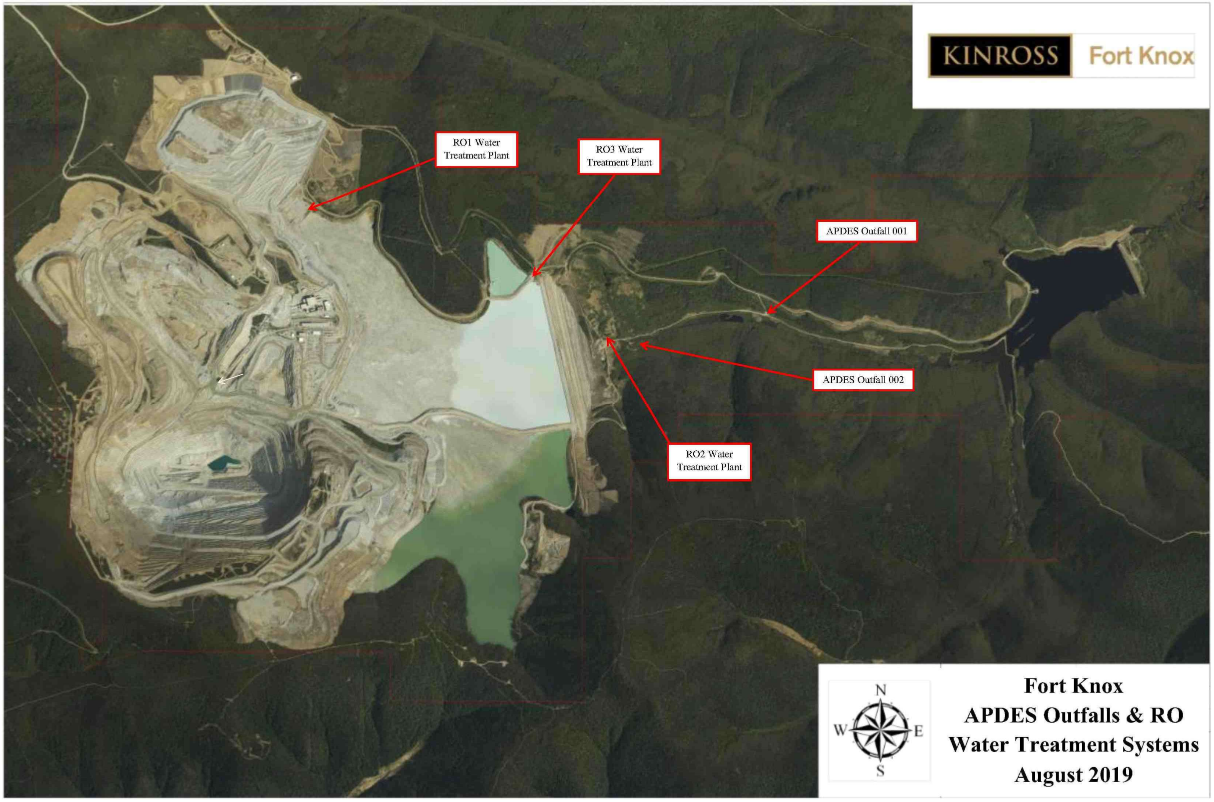
7 REFERENCE

Anderson, Keith E., 1989, “Water Well Handbook”, Missouri Water Well & Pump Contractors Assn Inc.

Appendix A Project Location



Appendix B APDES General Arrangement and Outfall Locations



Appendix C Profile Constituent Tables

Table 5: Analytical Profile II - Groundwater Inorganic Parameters

Major ion chemistry	Minor ion chemistry	Trace ion chemistry
Lab pH	* Arsenic	* Antimony
Lab Conductivity	Cyanide	* Aluminum
Temperature (field)	Total	* Barium
Turbidity	WAD	* Bismuth
Total Suspended Solids	Fluoride	* Cadmium
Total Dissolved Solids	*Iron	* Chromium
* Calcium	* Manganese	* Copper
* Magnesium	Nitrogen, Ammonia	* Lead
* Potassium	Nitrate as Nitrogen	* Mercury
* Silicon	Nitrite as Nitrogen	* Nickel
* Sodium	Total Phosphorus	* Selenium
Chloride	Sulfide	* Silver
Sulfate		* Zinc
Alkalinity (as CaCO3)		
Bicarbonate		
Total Hardness		

**Dissolved*

Table 5: Analytical Profile I - Surface Water Inorganic Parameters

Major ion chemistry	Minor ion chemistry	Trace ion chemistry
Lab pH	* Arsenic	* Antimony
Lab Conductivity	Cyanide	* Aluminum
Temperature (field)	Total	* Barium
Turbidity	WAD	* Bismuth
Settleable Solids	Fluoride	* Cadmium
Total Suspended Solids	*Iron	* Chromium
Total Dissolved Solids	* Manganese	* Copper
* Calcium	Nitrogen, Ammonia	* Lead
* Magnesium	Nitrate as Nitrogen	* Mercury
* Potassium	Nitrite as Nitrogen	* Nickel
* Silicon	Total Phosphorus	* Selenium
* Sodium	TPH	* Silver
Chloride		* Zinc
Sulfate		
Alkalinity (as CaCO3)		
Bicarbonate		
Total Hardness		

** Total recoverable*

Profile 6

Parameter
cadmium
copper
Cyanide, weak-acid dissociable (WAD)
lead
mercury
Nitrite & nitrate as N
pH
total suspended solids (TSS)
Volume, cumulative-continuous
zinc
Whole effluent toxicity (WET)-Yearly

Profile 7

Parameter
cadmium
copper
cyanide, WAD
lead
mercury
nitrite + nitrate as N
pH
zinc
hardness, calculated

Profile 8

Parameter
Antimony
Arsenic
Chloride
Sulfate

Appendix D Sample Event Standard Operating Procedures

Fairbanks Gold Mining, Inc.		
Field Documentation Procedures **FGMI-ENVSAMPLE-SOP-01**		
Management Endorsement:		**Synopsis:** This document defines the Fairbanks Gold Mining, Inc. minimum standards for field documentation of environmental sampling.
Bartly Kleven Environmental Manager Fairbanks Gold Mining, Inc. ______________________	______________________	**Published by:** Fairbanks Gold Mining, Inc.
		July 6, 2015

Revision Record			
Change Date	Remove	Insert	Description of Change(s)
	Page Number(s)		

TABLE OF CONTENTS

1.0 PURPOSE

This standard operating procedure (SOP) provides the general technical requirements and operational guidelines associated with documenting environmental compliance sampling activities associated with the Fairbanks Gold Mining, Inc. (FGMI) Alaska Pollutant Discharge Elimination System (APDES) and Waste Management permit requirements for the Fort Knox Mine, Fairbanks, Alaska. This SOP should be used in conjunction with other FGMI project record documents as necessary. The procedures described in the SOP are applicable to:

- Field logbooks.
- Field data sheets.
- Sample labels.
- Chain-of-Custody (COC) documentation.
- Forms or other documentation tools described in the Quality Assurance/Quality Control (QA/QC) Manual and the retention of these documents.

2.0 GENERAL CONSIDERATIONS

Proper documentation of field activities is a crucial part of the field sampling process. Proper documentation provides legally-defensible documentation of information regarding sampling locations, sampling methods and equipment, sample identification, sample collection date and time, and field personnel responsibilities (among other important information). Field documentation procedures are important from both a technical and a legal perspective.

This procedure describes the actions and protocols for field data entry into the field logbooks. These protocols are not typically discussed in recent regulatory guidance associated with field investigation activities because the protocols were addressed in detail during early policy development periods of the environmental industry. See references (Section 4.0) for examples of early US Environmental Protection Agency (US EPA) publications that address field documentation.

Lastly, this procedure explains the practice of document retention. Documents will be maintained according to the document retention policies established for this project. Project-related documents will be retained; no documents are to be discarded or destroyed.

2.1 Personnel Training

Personnel responsible for field documentation must read FGMI-ENVSAMPLE-SOP-01, understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel will sign the signature page (page 10) in order to document their review, willingness to comply and understanding of the SOP.

3.0 PROCEDURES

This section describes general operating procedures and methods associated with field documentation activities. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The Environmental Manager is responsible for determining whether the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

3.1 Field Logbook

Each sampling team conducting sampling activities will maintain a field logbook to document the activities performed by the sampling team each day that field work is conducted. At a minimum, the following information will be recorded in the field logbook as appropriate:

- Name and location of the site, including APDES permit number and sample location designation, if applicable.
- Date(s) of sample collection or event.
- Names of sampling team members and responsibilities.
- Daily time of arrival to the site.
- Daily weather conditions.
- Pertinent field observations.
  Note: Only objective field observations should be recorded in the field logbook; subjective observations should not be included. Opinions and speculations should also not be recorded in the field logbook.
- Record of daily phone calls and/or contact with individuals at or visitors to the site.
- Management or disposal of investigation-derived wastes.
- Daily summary of equipment used and preparation procedures, if appropriate.
- Time of sample collection (sample collection time is defined as the time when the first sample container is filled with sample material).
- Types of samples collected and sample identifications.
- A general description of sampling methodology, including references to project control documents.
- Specific sampling characteristics (*e.g.,* depth, temperature, turbidity) as outlined in the applicable project record documents, including any APDES permit requirements.
- A reference to Global Positioning System (GPS) data collected and coordinate system of collected data point.

Note: If the same logbook and equipment are used for a majority of the sampling events, an “equipment used” list with equipment model numbers and serial numbers can be used and referenced in daily entries to describe the equipment used during that sampling event.

The field logbooks for the Fort Knox project will incorporate field data sheets that have historically been kept by the project to record the above information. To the extent practicable, the forms included in the field logbooks have been developed to capture the required information. However, the Environmental Technicians will utilize the “notes” section as needed to document deviations from project document procedures and other anomalous field conditions and/or events. In the event these pre-printed logbooks are not available at the time of sample collection, the required information may be recorded on loose, single sheet versions of the field data forms used to develop the project field logbooks. When used, the loose, single sheet field data forms will be inserted into the project field logbooks and an explanation provided for the insertion will be noted on the field data sheet. Alternately, standard blank field logbooks may also be used if necessary.

Field logbooks will include contact information of the sampling team member(s) to facilitate retrieval of a misplaced field logbook. At a minimum, the name of the sampling team member(s) and the team's home office/company contact information will be recorded on the inside cover of the field logbook.

Key procedures of field documentation described in the reference documents (see Section 4.0) and other pertinent documents are provided below:

- Ensure field logbooks are bound.
- Consecutively number each page of the field logbook.
- Make the field logbook entries in chronological order such that a time notation introduces each entry.
- Use only indelible ink for field logbook entries.
- Record data directly and legibly in the field logbook.
- Line out errors in the field logbook (a single line strike-through) and initial and date the correction.
- Avoid leaving blank line(s) between field logbook entries. Cross out lines intentionally left blank with a single line and initial and date the cross-out.
- Cross out blank areas that exist with a single line and initial and date the cross-out.
- Multiple blank lines may be crossed out using a single diagonal line that passes from the top left of the first blank line to the bottom right of the last blank line.
- The person making entries will sign and date each page of the field logbook.

Field documentation is a crucial element of field activities and, therefore, sampling team members will strictly adhere to the field logbook entry protocol presented herein. Field logbook entries will include the information previously detailed and will be recorded in a manner consistent with this procedure. The Environmental Supervisor will review the field logbook entries prior to saving them to the Project Files. The logbooks will be reviewed for completeness, accuracy, and compliance with this SOP and the review will be indicated by initialing and dating the entries.

3.2 Sample Labeling

Sample containers will be pre-labeled before sample collection. The labels will be permanent and protected from the sample matrix by using waterproof labels or by covering with clear tape. Sample labels will include the following information:

- Project name
- Sample date and sample time (in military format; *i.e.*, HHMM)
- Preservative (if applicable)
- Unique sampling code

- Parameter sampled and method requested for analysis
- Company name (FGMI)

Each sample will be assigned a unique multi-digit number, which includes the date, and identification number of the sample. An example of the sampling code is as follows:

WWXXXXXYYYYZZZ

Where:

WW = Site Location
XXXXX = Sample collection date (month, day, year as four digits)
YYYY = Employee's identification number
ZZZ = Sequential sample number for that date

3.3 Label Correction Process

For instances when labeling errors have occurred and the label can be directly corrected, use an indelible ink pen to single line strike through the error. The sampler will then initial and date the correction and write the correct information in the space provided.

For instances when labeling errors have occurred and the label cannot support edits or the label has been taped, the label containing the error (including the tape) will be removed from the sample container. A new label with the correct information will be placed on the sample container. A new label will not be placed over an old or incorrect label nor will edits be made to the tape placed over a label.

3.4 Chain-of-Custody Documentation

The COC form is intended to be a legal record of possession of samples for analytical laboratory analysis. The field sampling team will use the specified COC form as required by FGMI. The COC form will be completed by the Environmental Technician at the time of sample collection and will bear the name of the person responsible for the secure and appropriate handling of the samples. The COC form will be filled out correctly and completely leaving no blank fields or blank spaces between entries.

Sampling personnel will maintain the COC form during sample collection activities. The following is the minimum information required on the COC form:

- Name and location of the site.
- Names (printed) of sample team members, if applicable.
- Name (printed), signature, and affiliation of sampler relinquishing samples.
- Sample identification number.
- Date and time of sample collection.
- Matrix and type of sample collected (such as grab or composite).
- Number and type of containers per sample.
- Preservatives and fixatives.
- Parameters to be analyzed.
- Identification of couriers.

- Identification of laboratory.
- Courier used, including package tracking information if available.
- Special Handling instructions (if applicable).
- Date and time samples were relinquished by sampler.

When completing COC forms, field personnel will employ the applicable field documentation techniques described previously for field logbooks. Blank spaces should be single-lined through, initialed, and dated, unless it is obvious from the nature of the form that the spaces may be left blank or are intended to be utilized during a subsequent step of the shipping and receiving process.

Other COC components will include sample labels, custody seals, field data sheets and sample shipment receipts from the laboratory.

3.5 Field Records Management

Field logbooks will have a unique identifier and pre-numbered pages. Logbooks that are carried into the field will have completed pages scanned to the project database and copied to Project Files weekly such that loss or accidental destruction in the field would involve a minimum of lost data. The copies will be reviewed by the Environmental Coordinator to ensure they are entirely legible. Completed field logbooks, and scanned duplicative copies, will be retained by FGMI and reside in the Project File. The original logbook will be maintained as the primary record though duplicative copies can become a working copy.

In addition, accompanying documents that are initiated or completed in the field, and are used as official records will be retained by FGMI and reside in the Project File.

In addition to the original COC that accompanies each sample shipment, a copy of each COC must be provided to Project Files. A working copy of the COC will be retained in working files in the field sampling work area for reference. The Environmental Manager or designee will maintain a list of personnel who require courtesy copies of the COC. Courtesy copies may be distributed by either hardcopy (mail) or electronic copy (e-mail) and will be distributed the next working day after sample collection. The receiving analytical laboratory will provide a completed copy of the COC as part of data deliverables and as part of routine sample receipt notification. A copy released as part of data deliverables will become part of Project Files.

All monitoring information associated with the Fort Knox Mine APDES permit will be retained for a minimum of 5 years.

4.0 REFERENCES

- US EPA. “A Compendium of Superfund Field Operations Methods.” Office of Solid Waste and Emergency Response. Directive 9355.0-14, 1987. http://www.hanford.gov/dqo/project/level5/Sfcompnd.pdf.
- US EPA. “Compliance-Focused Environmental Management System - Enforcement Agreement Guidance.” National Enforcement Investigations Center. EPA-330/9-97-002R, 2005. http://www.epa.gov/oecaerth/resources/policies/neic/cfems_05.pdf.

- US EPA. “Contract Laboratory Program Guidance for Field Samplers.” Office of Superfund Remediation and Technology Innovation. OSWER 9240.0-44, EPA 540-R-17-06, July 2007. http://www.epa.gov/superfund/programs/clp/download/sampler/clp_sampler_guidance.pdf.
- US EPA. “Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.” Office of Solid Waste and Emergency Response. Directive 9355.3-01, 1988. http://www.epa.gov/superfund/policy/remedy/pdfs/540g-89004-s.pdf.
- US EPA. “Guidance for Performing Preliminary Assessments Under CERCLA.” Office of Solid Waste and Emergency Response. Directive 9345.0-01A, 1991. http://www. epa.gov/superfund/sites/npl/hrsres/#PA%20Guidance.
- US EPA. “Guidance for Performing Site Inspections Under CERCLA.” Office of Solid Waste and Emergency Response. Directive 9345.1-05, 1991. http://www.epa.gov/ superfund/sites/npl/hrsres/#PA%20Guidance.
- US EPA. “Logbook Operating Procedure,” Region 4. Document # SESDPROC-010-R5, May 2013.

I have read FGMI-ENVSAMPLE-SOP-01, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	Signature	Company	Date

End of Procedure

Fairbanks Gold Mining, Inc.

Sample Handling, Packing, and Shipping Procedures
FGMI-ENVSAMPLE-SOP-02

Management Endorsement:

Synopsis:
This document defines Fairbanks Gold Mining, Inc. (subsidiary of Kinross Gold Mining Corporation) minimum procedures for sample handling, packing and shipping for the Fort Knox Mine, Fairbanks, Alaska.

Bartly Kleven
Environmental Manager
Fairbanks Gold Mining, Inc.

Published by:
Fairbanks Gold Mining, Inc.

July 6, 2015

Revision Record			
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1.0 PURPOSE

This standard operating procedure (SOP) provides general technical requirements and operational guidelines for the proper handling, packing, and shipping of environmental samples (samples) to a laboratory for analysis for the Fairbanks Gold Mining, Inc. (FGMI) Alaska Pollutant Discharge Elimination System (APDES) and Waste Management permit requirements for the Fort Knox Mine, Fairbanks, Alaska. These procedures have been developed to reduce the risk of damage to the samples (such as breakage of the sample containers), to maintain sample temperature preservation (as required) within the environmental sample cooler (sample cooler) used to transport and store collected samples, and to ensure and document sample custody from collection to receipt at the analytical laboratory. This SOP should be used in conjunction with other FGMI project record documents as necessary. Furthermore, ensure proper handling, packing, and shipping of samples classified as “hazardous materials” in accordance with the following documents:

a.

- 49 Code of Federal Regulations (CFR) Parts 171-180, Hazardous Material Regulations (HMR).
- International Air Transport Association (IATA) standards as detailed in the most current edition of the IATA Dangerous Goods Regulations.
- International Civil Air Organization (ICAO) Technical Instructions.

IATA and ICAO regulations apply to air transportation – both domestic and international.
49 CFR HMR apply to domestic and international hazardous material transportation originating in or imported to the United States.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

Personnel will wear powder-free nitrile gloves while performing the procedures described in this SOP. Specifically, powder-free nitrile gloves should be worn while preparing and handling sample containers and during sample collection and packing activities. Where appropriate, sample bottles will not come into contact with the exposed ground; new plastic sheeting may be placed on the ground surface as needed to prevent contact between sample bottles and the ground surface.

A Chain-of-Custody (COC) is intended to provide an accurate record to trace possessions of each sample from the time of collection to the completion of required analysis. Custody of a sample is defined as a sample that is:

- In someone’s physical possession.
- In someone’s view after being in that person’s physical possession.
- In a secured container with a completed custody seal.
- In a designated secure area under lock and key or that provides tampering evidence.

Protocols for sample temperature maintenance and sample packing will apply to the collection of samples year-round or as otherwise specified. The intent of these protocols is for samples to arrive at the designated analytical laboratory both physically intact and temperature preserved.

2.1 Personnel Training

Personnel responsible for conducting sample handling, packing, and shipping must read FGMI-ENVSAMPLE-SOP-02 understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel should sign the signature page (page 10) in order to document their review, willingness to comply with and understanding of the SOP.

3.0 PROCEDURES

This section describes general operating procedures and methods associated with field documentation activities. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the FGMI Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities. The FGMI Environmental Manager is responsible for determining whether the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

3.1 Pre-Job Preparation

The FGMI Environmental Manager is responsible for overall implementation of this procedure and ensuring compliance with current regulations and standards.

b.

a. Check with the sampling personnel regarding the equipment required, sample container types and preservatives, and anticipated range of contaminant concentrations.
b. Obtain labeling, packing, and shipping materials as listed in the example checklist provided on Table 1.
c. Verify methods to be used to transport materials (such as the courier or commercial delivery service). Identify the telephone numbers, locations, and special requirements of couriers that are used.
d. Prepare shipping documents in advance where practical.
e. Ensure that the laboratory or recipient is aware of the project schedule and requirements for receipt as specified in Section 3.5 below.

3.2 Sample Temperature Maintenance

In order to facilitate preservation of samples, samples requiring preservation by chilling will be cooled to an appropriate temperature. The Kinross Quality Assurance/Quality Control and Field Procedures Manual requires samples be cooled to 6°C. Cooling of the samples to an appropriate temperature (≤ 6°C) will begin immediately after sample collection and be maintained throughout transport and receipt at the analytical laboratory, as specified in the project record documents.

3.3 Chilling Samples (≤6°C)

Samples will be placed in a sample cooler immediately after collection. To ensure proper temperature preservation, the sample cooler will contain frozen water in Nalgene® bottles (or equivalent) to chill the samples. The samples will remain in sample coolers with these Nalgene® bottles (or equivalent), or in a refrigerator with monitored and controlled temperature, until delivery to the analytical laboratory.

c.

a. Immediately after sample collection, wipe off each sample container as necessary using a clean paper towel, and bag each sample container using new, appropriately sized, resealable plastic bags.
b. Place the bagged sample container(s) in a sample cooler. Sample containers will be placed in a manner that prevents breakage of glass sample containers by not placing too many sample containers in an ice bath at one time.
c. Fill the surrounding void space of the sample cooler with inert material.
d. Sample containers will be packed in a manner that prevents breakage of glass sample containers by using bubble-wrap/bag or other inert packing materials.

Note: Bagged or loose wet ice may be used instead of frozen water in Nalgene® bottles as necessary. "Blue" ice packs may be used as temperature preservation for solid samples when necessary.
Note: See Section 3.3 (Sample Packing) of this SOP for further details regarding sample container packing.

The method for temperature preservation described above will be utilized unless sample temperatures upon receipt at the laboratory begin to trend above 6°C. At that point alternative measures (such as the use of loose wet ice) will be considered.

d.

3.4 Sample Packing

Samples are collected as specified in the governing project record documents. The following is a summary of steps required for packing and sealing the samples for shipment to the analytical laboratory.

a. Verify the completeness and correctness of the sample identification information on the sample container label for agreement with the COC and information entered into the field logbook.
b. If packing aqueous samples or using wet ice for temperature preservation, place a new plastic bag or inert and impervious liner in the sample cooler.
c. Sample containers will be bagged using new clean resealable plastic bags. Individual bagging of sample bottles per analyte, per site is recommended. Use resealable bags and subsequently bubble-wrap/bags (as the outer packing material) when sample containers are made of glass or breakable material. Use caution to not over pack the resealable plastic bags (leave space in the bag), which can cause breakage. Place the bagged sample containers inside the sample cooler. Place a temperature blank in the center of the sample cooler, and on top of the sample containers, if provided by the analytical laboratory.

Note: Glass containers should be handled with extreme care; drying hands and bottles before handling may minimize the slipping and breakage potential.

e.

d. Place ample amounts inert material inside the sample cooler around the void space between sample containers.

e. As needed, place bubble-wrap or other inert packing material around the plastic bag/liner in the sample cooler to limit the empty space inside the cooler and to provide protection for glass containers.

f. If used, seal the plastic bag/liner using heavy industrial-grade tape (duct tape or similar), a zip-tie, or by tying a tight knot such that if the contents were to spill, the plastic bag/liner would contain the spill.

g. If samples are being transported by the sampling team directly to the analytical laboratory, the designated sampler must relinquish the samples on the COC Form by signing his/her name and providing the date and time when the samples are relinquished to the analytical laboratory (skip procedures in Section 3.3, Steps j through i listed below). Samplers will maintain custody in accordance with the definition in Section 2.0 above by utilizing custody seals or lock and key.

h. If samples are being transported by a commercial courier (*e.g.*, courier for hire, Fed-Ex®, UPS®), the sampler must relinquish the samples on the COC Form by signing his/her name and providing the date and time that the samples were packed in the sample cooler for shipment. Write the shipper's tracking number (such as courier name and courier airbill number) on the COC form when a commercial courier is used if available at the time the cooler is sealed.

i. Place the completed COC form in a large resealable plastic bag and tape to the inside lid of the sample cooler. In the event multiple sample coolers are required, copies of the original COC will preferably be placed in each of the sample coolers that contain samples included on the original COC. Copy COCs will be clearly marked as "COPY." If logistics prohibit the generation of a copy version of the COC, the original COC will be placed in one sample cooler of the cooler set and the COC must specify the total number of sample coolers that contain all samples listed on the COC.

Note: Sample custody is not transferred to a commercial courier when the samples are sealed inside a cooler. Therefore, commercial couriers will not write on a COC Form.

j. Place tamper-evident custody seals/tape on two sides of the sample cooler such that opening the cooler causes the custody seal/tape to break. Tamper-evident custody seals/tape must be able to indicate that the seal had been disturbed (such as leaving remnants of the seal or some type of ink residue on the surface when the seal is lifted). The sampler who relinquished the samples in Step i will sign and place the date on the custody seals. If serial numbers are included on the custody seals, record numbers in the field logbook.

k. The custody seal signature and dates should agree with the relinquished signature and dates as they appear on the COC form from Step i above.

3.5 Shipping Procedures for Samples

A trained FGMI transportation subject matter expert will be consulted to determine the proper shipping category for hazardous materials. Once the sample category has been determined, the following procedures are to be followed.

3.6 Samples Shipped as Non-Hazardous Material

Samples are shipped as non-hazardous material unless the samples meet the established 49 CFR HMR criteria for a “hazardous material” or the International Air Transport Association, ICAO Technical Instructions, and International Maritime Dangerous Goods (IMDG) Code definition of “dangerous goods” (see Section 3.4.2). When preparing the cooler for shipment, previously used shipping labels on the outside of the container will be removed before samples are placed in the container. When completing the paperwork for shipment, the standard non-hazardous shipping forms provided by the courier will be completed.

3.7 Samples Shipped as Dangerous Goods or Hazardous Material

49 CFR HMR and IATA regulations governing the shipment of hazardous materials and dangerous goods will be followed. These regulations (49 CFR Parts 171 – 180 HMR and the Dangerous Goods Regulations [DGR] for IATA) describe proper marking, labeling, placarding, packaging, and shipping of hazardous materials. IATA regulations apply to domestic and international air transportation. 49 CFR HMR regulations apply to domestic and international transportation originating in or imported to the United States. Consult a subject matter expert when shipping dangerous goods or hazardous material. It may be necessary or required to receive training from the transportation company before offering the material to the transporter.

3.8 Laboratory Receipt and Inspection

The FGMI Environmental Coordinator will notify the contract laboratories of the following requirements:

a. Upon receipt by the analytical laboratory, coolers are inspected for evidence of tampering (such as broken custody seals).
b. In the event custody seals are missing or broken, the laboratory will report this condition to the FGMI Environmental Coordinator.
c. The laboratory will record the condition of the sample containers upon receipt on the Sample Receipt Confirmation log and the COC form, and laboratory personnel will accept custody of the samples by signing the COC form, including the date, time, and company affiliation, in the appropriate location.
d. For sample shipments that require temperature preservation, the analytical laboratory personnel will measure and record the cooler temperature or temperature blank (if present) temperature upon receipt.
e. In the event sample coolers show evidence of tampering, sample containers are not intact, or the samples were received outside of the required temperature preservation range, the laboratory will report this condition to the FGMI Environmental Coordinator.

3.9 Documentation

The original COC Form and documented changes to the original COC form and a Sample Receipt Confirmation log will be included as part of the final analytical report from the laboratory to the FGMI Environmental Coordinator. The COC Form is used to document sample custody transfer from the sample team to the laboratory and will be retained by FGMI Environmental Department and reside in the project database.

Sample packaging and shipment tracking information will be maintained by the sampling personnel. The COC Form, courier waybill or Courier Documentation Form, and field logbook will be retained in the central data management files to maintain a complete record of the following information:

- Method of transportation.
- Courier tracking number.
- Material shipped (including, sample Identification (ID) as it appears on the COC and sample container label) associated with each courier tracking number.
- Date and time shipped.

4.0 REFERENCES

- Fairbanks Gold Mining. FGMI-*ENVSAMPLE-SOP-01 Field Documentation Procedures*. July 2015.
- International Air Transport Association (IATA). Dangerous Goods Regulations, 49th Edition, Montreal, 2008.
- International Civil Aviation Organization (ICAO). The ICAO Technical Instructions on the Safe Transport of Dangerous Goods by Air. 2007 - 2008 Edition.
- International Maritime Organization (IMO). International Maritime Dangerous Goods Code, 2006 Edition.
- Kinross. Quality Assurance/Quality Control and Field Procedures Manual. October 2012.
- Office of the Federal Register, National Archives and Records Administration, 49 Code of Federal Regulations Parts 171-180, US Government Printing Office. Washington, DC, 2012.
- United States Environmental Protection Agency (US EPA), Region 4, "Packing, Marking, Labeling and Shipping of Environmental and Waste Samples Operating Procedure." Document Number SESDPROC-209-R3, February 2015.
- United States Environmental Protection Agency (US EPA), Region 4, "Sample and Evidence Management." Document Number SESDPROC-005-R2, January 2013.

I have read FGMI-ENVSAMPLE-SOP-02, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the project FGMI Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	**Signature**	**Company**	**Date**

Table 1: Sample Handling, Packing, and Transport Equipment and Material Checklist

Item Description	Check☐
Health and Safety	
Nitrile gloves	
Hard hat (If necessary)	
Steel-toed boots	
Field first-aid kit	
Eyewash	
Safety glasses	
Paperwork	
Project record documents	
Courier Documentation Form	
Chain-of-Custody forms	
Field logbook	
Appropriate SOP for field work being completed	
Indelible ink pens	
Packing and Shipping Supplies	
Packing tape	
Bubble-wrap/packaging material	
Cardboard	
Tamper-evident custody seals/tape	
Environmental sample coolers	
Cooling Material	
Permanent markers	
Shipping labels	
Resealable plastic bags (gallon and pint sizes)	
Shipping forms (or courier forms)	

End of Procedure

Fairbanks Gold Mining, Inc.

Quality Control Sampling Procedures
FGMI-ENVSAMPE-SOP-03

Management Endorsement:

Synopsis:
This document defines the Fairbanks Gold Mining, Inc. minimum procedures for quality control sampling.

Bartly Kleven
Environmental Manager
Fairbanks Gold Mining, Inc.

Published by:
Fairbanks Gold Mining, Inc.

July 6, 2015

Revision Record			
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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the methods for the proper collection of field quality control (QC) samples. The purposes of QC samples are to provide information on background conditions, isolate site effects, and evaluate contamination during sample transit or to evaluate field and laboratory variability. This SOP is applicable to field QC sample collection activities associated with the Fairbanks Gold Mining, Inc. (FGMI) Alaska Pollutant Discharge Elimination System (APDES) and Waste Management permit requirements for the Fort Knox Mine, Fairbanks, Alaska. This SOP should be used in conjunction with other FGMI project record documents as necessary. The requirements of this SOP are applicable to collection of field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples and equipment rinsate blanks.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

Personnel should wear proper personal protective equipment (PPE) while performing the procedures described in this SOP. Specifically, powder-free nitrile gloves and safety glasses should be worn while preparing and handling sample bottleware, and during sample collection and packing. Sample labeling, packing, and shipping will be conducted in accordance with FGMI-ENVSAMPLE-SOP-02 (Sample Handling, Packing, and Shipping Procedures).

Reusable field sampling equipment should be decontaminated in accordance with FGMI-ENVSAMPLE-SOP-05 (Decontamination of Sampling Equipment Procedures) prior to use.

Quality assurance (QA) will be verified by maintaining site logs, by documenting field activities, and by collecting and analyzing QC samples. QC samples will be used to assess laboratory performance and to evaluate the potential for cross-contamination associated with both field and laboratory activities and sample transport. QC samples will be collected and analyzed in conjunction with samples designated for laboratory analysis using US Environmental Protection Agency (US EPA) methods.

The QC samples and associated frequencies presented in this SOP are to be used as guidance. The specific type of QC samples and their frequencies will be presented in the governing project control documents to meet project-specific data quality objectives and regulatory requirements.

2.1 Personnel Training

Personnel responsible for conducting QC sampling must read FGMI-ENVSAMPLE-SOP-03, understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel should sign the signature page (page 8) to document their review willingness to comply and understanding of the SOP.

3.0 PROCEDURES

This section documents general operating procedures and methods associated with potable water supply and surface water sampling activities. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The Environmental Manager is responsible for determining whether or not the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

This SOP describes the requirements associated with field QC sampling. Standard analytical QC checks that will be instituted by field personnel include the following:

- Field duplicate samples.
- MS/MSD samples.
- Equipment rinsate blanks.

Note: A temperature blank may be used to estimate the sample temperature at the time the sample is received by the laboratory. The temperature blank is supplied by the laboratory.

3.1 Field Duplicate Samples

Field duplicate samples are used to assess the reproducibility of laboratory analytical results and reproducibility of field sampling techniques. Duplicate samples are collected simultaneously with the associated compliance sample - one parameter at a time. The procedures for collecting duplicate samples in aqueous and solid media are as follows:

a. Aqueous Samples - Alternately fill by thirds (by parameter) the compliance sample and duplicate sample bottleware until both sets of bottleware are filled. If a temporary transfer container is being used for aqueous sample collection, then agitate the sample between filling each third (at a minimum) to help keep the sample homogenized.
b. Solid Samples - Prior to collecting compliance and duplicate samples, soil will be thoroughly homogenized until the material is visibly consistent. Fill the compliance sample and duplicate sample bottleware from the homogenized material.
c. After sample collection, seal the containers properly and immediately place upright in a sample cooler as described in FGMI-ENVSAMPLE-SOP-02.
d. Field duplicate samples can either be labeled as such, or submitted to the laboratory as “blind” duplicates.
e. Ship the field duplicate sample(s) with the associated compliance samples to the analytical laboratory.

Field duplicate samples will be collected at a minimum frequency of one per 20 compliance samples, or one per quarter, whichever is more frequent. At the discretion of the Environmental Manager, or designee, field duplicate samples may be collected at a greater frequency. Field duplicate samples will be analyzed for the same analyses as the compliance samples.

3.2 Matrix Spike/Matrix Spike Duplicate

MS/MSD samples are compliance samples to which known amounts of compounds are added in the laboratory before extraction and analysis. The recoveries for spiked compounds can be used to assess how well the method used for analysis recovers target compounds in the site-specific sample matrices.

a. Collect MS/MSD samples by collecting triple volume of a compliance sample.
b. Aqueous Samples - Alternately fill by thirds (by parameter) the compliance sample the MS sample and MSD sample bottleware until all sets of bottleware are filled. If a temporary transfer container is being used for aqueous sample collection, then agitate the sample between filling each third (at a minimum) to help keep the sample homogenized.
c. Solid Samples - Prior to collecting compliance and duplicate samples, soil will be thoroughly homogenized until the material is visibly consistent. Fill the compliance sample and duplicate sample bottleware from the homogenized material.
d. MS/MSD samples will be labeled as such when submitted to the analytical laboratory.
e. After sample collection, seal the containers properly and immediately place upright in an iced cooler.
f. Ship the MS/MSD samples with the associated compliance samples to the analytical laboratory.

If required by the site QA/QC Manual, or requested by the Environmental Manager, collect MS/MSD samples at a minimum frequency of one per 20 compliance samples or one per quarter, whichever is more frequent. At the discretion of the Environmental Manager, MS/MSD samples may be collected at a lesser frequency once confidence in the reproducibility of results has been established. MS/MSD samples will be analyzed for the same analyses as the compliance samples.

3.3 Equipment Rinsate Blanks

Equipment rinsate blanks are used to assess the effectiveness of field equipment decontamination procedures in preventing cross-contamination between samples. The procedures for collecting equipment rinsate blanks are as follows:

a. Collect equipment rinsate blanks by pouring deionized water into, through, and/or over clean (properly decontaminated) sampling equipment.
b. Collect and containerize the rinsate that has contacted the sampling equipment surfaces in appropriate certified-clean, laboratory-supplied, preserved (if necessary) bottleware.
c. Label equipment rinsate blank samples as such when submitted to the analytical laboratory.
d. After sample collection, seal the containers properly and immediately place upright in a sample cooler as described in FGMI-ENVSAMPLE-SOP-02.
e. Ship the equipment rinsate blank(s) with the associated compliance samples to the analytical laboratory.

Equipment rinsate blanks will be collected at a minimum frequency of one per 20 compliance samples or one per quarter, whichever is more frequent, if equipment is decontaminated and reused. Collect a minimum of one equipment rinsate blank for equipment that is disposable, but is not certified clean for compliance analytes. At the discretion of the Environmental Manager, or designee, equipment rinsate samples may be collected at a greater frequency. Equipment rinsate blanks will be analyzed for the same analyses as the compliance samples.

3.4 Field Logbook Documentation

Field logbooks will be maintained by the Environmental Technician to record daily activities. The minimum requirements for field logbook documentation, and format of field logbooks, are discussed in FGMI-ENVSAMPLE-SOP-01 (Field Documentation Procedures). The Environmental Coordinator will review the field logbook entries for completeness and accuracy and will indicate this review by initialing each page of the logbook. A photocopy or scan will be made of the field logbook record to protect existing data from loss; the copy will be retained in the project files.

4.0 REFERENCES

- Fairbanks Gold Mining, Inc. *FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI –ENVSAMPLE-SOP-02 Sampling Handling, Packing, and Shipping Procedures*, July2015.
- Fairbanks Gold Mining, Inc. *FGMI –ENVSAMPLE-SOP-05 Decontamination of Equipment Procedures*, July 2015.
- US EPA. Region 4, Field Sampling Quality Control. Document Number SESDPROC-011-R4, February 2013

I have read FGMI-SOP-03, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	Signature	Company	Date

Table 1: Quality Control Sampling Equipment and Material Checklist	
Item Description	**Check ☐**
Health and Safety	
Nitrile gloves	
Hard hat (if necessary)	
Steel-toed boots	
Hearing protection (if necessary)	
Field first-aid kit	
Eyewash	
Safety glasses	
Respirator and cartridges (if necessary)	
Sampling Equipment	
Plastic sheeting (if necessary)	
Analyte-free (deionized) water	
Water sampling equipment	
Laboratory-supplied bottleware	
Chain-of-Custody forms and custody seals	
Packing tape	
Field logbook	
Permanent marker	
Trash bags	
Paper towels	

End of Procedure

Fairbanks Gold Mining, Inc.		
Field Instrumentation Operation and Calibration Procedures **FGMI-ENVSAMPLE-SOP-04**		
Management Endorsement:		**Synopsis:** This document defines Fairbanks Gold Mining, Inc. (subsidiary of Kinross Gold Mining Corporation) minimum procedures for field instrumentation operation and calibration for the Fort Knox Mine, Fairbanks, Alaska.
Bartly Kleven Environmental Manager Fairbanks Gold Mining, Inc. ____________________	____________________	**Published by:** Fairbanks Gold Mining, Inc.
		July 6, 2015

Revision Record			
Change Date	**Remove**	**Insert**	**Description of Change(s)**
	Page Number(s)		

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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the general operation, calibration, maintenance, and storage of field instruments for monitoring as required by the Fairbanks Gold Mining, Inc. (FGMI) Alaska Pollutant Discharge Elimination System (APDES) and Waste Management permit requirements for the Fort Knox Mine, Fairbanks, Alaska. This SOP should be used in conjunction with other FGMI project record documents as necessary. The field instruments are used to collect quantitative and semi-quantitative field measurements. Specifically, this SOP details operation, calibration, maintenance, and storage of the following field instruments:

- HACH HQ30d and HQ40d pH, Conductivity, and Temperature Meter.
- Hannah HI98129 pH, Conductivity, and Temperature Meter.
- Oakton TEMP 5 Acorn Series Temperature Meter.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

Personnel will wear powder-free nitrile gloves while performing the procedures described in this SOP. Specifically, powder-free nitrile gloves are worn while preparing and handling field equipment, during sample collection, and equipment decontamination.

Although this SOP provides general procedures for the use of field instruments, specific instruments' User's Manuals were consulted in preparation of this SOP. It is important to maintain and review the specific instruments' User's Manual for manufacturer's recommendations regarding assembly, operation, calibration, maintenance, and storage.

Note: The glass bulb at the end of the HI98129 electrode is sensitive to electrostatic discharges. Avoid touching the glass bulb at all times. Additionally, the HI98129 owner's manual recommends that calibration for conductivity be performed using a plastic container to minimize electromagnetic interferences.

2.1 Personnel Training

Personnel responsible for using field instruments in conjunction with a field sampling activity must read FGMI-ENVSAMPLE-SOP-04, understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel should sign the signature page (page 13) in order to document their review and understanding of the SOP.

3.0 PROCEDURES

This section describes general operating procedures and methods associated with field documentation activities. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the FGMI Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The FGMI Environmental Manager is responsible for determining whether or not the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

3.1 Office Preparation

3.1.1 Field Instrument Logs and Records

Field instrument logs and records will be maintained for each instrument and the logs for each instrument will, at a minimum, contain the following:

- Identity of the device as appropriate.
- Manufacturer’s name, type identification, and serial number (or other unique identifier).
- Calibration and verification details or the ability to cross-reference to a calibration and verification record.
- Document information about calibration solutions and standards; date received, lot number, and expiration date.
- Maintenance plan/schedule containing records of maintenance and field repair.
- Records of routine maintenance, non-routine maintenance, or repair activities including the change out of sensors, probes, or other instrument components with serial numbers as appropriate.
- Notes regarding damage, malfunction, modification, or repair to the device or its sensors.

The annotations in the field instrument logs and field data sheets regarding maintenance, repair, damage, or malfunction will have date and initials (or signatures). The instrument maintenance and calibration logs and field data sheets will be maintained as a quality assurance record. Calibration failure or instrument malfunction status will be noted on the instrument so field sampling personnel do not take the instrument into the field for use until repaired. Calibration failure or instrument malfunction notes will also be readily available in the field instrument logs. Field instrument logs and copies of field data sheets should be stored with or near the instruments so they are readily available to meet documentation requirements of this SOP. Additionally, the field instrument logs and field data sheets will be maintained in accordance with FGMI-ENVSAMPLE-SOP-01 (Field Documentation Procedures).

3.1.2 Calibration Solutions and Standards

Calibration solutions and standards will be stored out of direct sunlight and in a dry location not subject to extreme temperatures or large temperature changes, in accordance with the requirements of the product safety data sheet (SDS) and manufacturer's recommendations. An SDS for each calibration standard will be readily available and stored near the calibration standard solutions. Calibration solutions and standards must not be used beyond the manufacturer's expiration date. Calibration solutions will be properly discarded and not reused after use. Additionally, the Kinross Quality Assurance Quality Control and Field Procedures Manual requires standards of calibration to be in accordance with applicable criteria including NIST standards, American Society of Testing Materials standards, or other accepted procedures outlined in the manufacturer's handbook of specifications.

3.2 Field Preparation

Ensure that the field instrumentation is properly serviced and that the required fields are displayed and the instrument is operating properly. The instrument's probes will be rinsed thoroughly with potable water (if applicable), and the instruments are equilibrated to ambient conditions after calibration and between each use.

3.3 pH Meter

The pH meter will be capable of the following:

- Provision of real-time field measurements.
- Ability to accurately measure pH within the instrument's accuracy and precision specifications or regulatory agency accuracy requirements (if applicable).
- Ability to be calibrated to meet acceptance criteria detailed in Section 3.3.1 of this SOP.

3.3.1 pH Meter Calibration Procedures

An FGMI Environmental Technician must calibrate the pH meters prior to each day of use and whenever the calibration verification check is out of acceptable range. The calibration standards used must bracket the expected range of field pH values. Calibration is considered complete once the pH meters have been calibrated using appropriate calibration solutions. Record the "Pre" and "Post" calibration readings for the calibration parameters in the field instruments' log or an equivalent calibration record. A three-point calibration is recommended if the pH meter is capable. When a three-point calibration is an option, ensure that the instrument is programmed to perform this method of calibration.

Note: The HI98129 is capable of a two-point calibration and it is recommended that pH 4 and pH 10 calibration standards are used to complete the two-point calibration.

The methods and steps needed to calibrate the pH meters are described below as well as in the instruments User's Manuals.

Hannah HI98129 Meter

a. Rinse pH electrode probe with deionized water.
b. Immerse electrode and temperature probe in beaker of fresh commercial calibration solution of pH 7.0. Calibrate meter to solution.
c. After first calibration point is accepted, remove electrode and temperature probe from solution, and then rinse with deionized water.
d. Immerse electrode and temperature probe in second known solution (fresh pH 4.01 or ph 10.01 depending on expected range of pH in water to be monitored) solution. Calibrate meter to solution.
e. Remove electrode and temperature probe from solution, and rinse with deionized water.

Hach HQ30d Meter

a. Use the 7.0 pH buffer solution first.
b. Push the “Calibrate” button. The display will show the buffers necessary for calibration.
c. Rinse the probe with DI water. Blot dry with a lint-free cloth.
d. Place the probe in the buffer solution. Use enough buffer solution to adequately cover the pH sensor. Shake the probe from side to side in the solution.
e. Press the “Read” button. Stir the probe in the solution gently. The display will show the buffer that has been read and the temperature correct pH value when the reading is stable.
f. Rinse the probe with deionized water and blot dry prior to placing probe in the subsequent buffer solutions.
g. Repeat steps *e* through *g* for the second and third buffer solutions.

After completing the steps described above, the water-quality meter’s calibrations will be checked or verified directly following the initial calibrations by measuring a pH 7 calibration standard as if it were a sample. The acceptance criterion is ± 0.1 standard pH units of the known standard. Do not reuse standards from the initial calibration during the calibration verification. Typically, confidence solutions are available from calibration solution manufacturers and can be used for calibration verification. Verify that pH standards are within use dates (do not exceed expiration date).

Parameter	**Acceptance Criteria**
pH	± 0.1 Standard pH Units of buffer or more stringent

If calibration verification fails to meet acceptance criteria, immediately recalibrate the instrument or remove the instrument from service.

3.3.2 pH Meter Field Instrument Operation Procedures

The pH Meter will be thoroughly rinsed with deionized water prior to collecting field measurements and between taking measurements from different samples or locations. Prior to use, ensure that the glass electrode is not cracked, scratched, check the batteries, verify the presence of spare batteries in the instruments case, and that air bubbles are not under the probe tip.

a. Rinse the pH electrode with deionized water, turn on the meter, submerge the instruments' probes into sample water and allow the instruments to equilibrate for 1 minute.
b. When collecting *in-situ* measurements, submerge the probe into the surface water at midstream for until pH readings stabilize. Do not allow the probe to contact the side of the container or bottom of the waterbody during measurement readings.
c. If in-situ measurements are not possible, a certified clean glass or certified clean HDPE beaker are to be used for pH measurement, rinse the certified clean glass or HDPE beaker with approximately 50 milliliters (mL) of sample water three times before submerging the pH probe into the sample water to be measured.
d. Fill beaker with sample water.
e. Immerse pH probe in sample while swirling the sample to provide thorough mixing. Do not allow the probe to contact the side of the container during measurement readings.
f. Turn on meter. Read pH to nearest 0.1 until the reading has stabilized (when beaker icon stops flashing).
g. Record the reading to the nearest 0.1 standard unit in the field logbook or field data sheet in accordance with FGMI-ENVSAMPLE-SOP-01 (Field Documentation Procedures). Also, note any problems such as erratic readings.
h. Rinse probe with deionized water and store according to manufacturer's directions.

3.3.3 pH Meter Maintenance and Storage

The pH meters will be returned to the manufacturers for routine scheduled maintenance at a frequency specified in the instruments' User's Manuals or as otherwise directed. Additionally, the meters will be sent to the manufacturers for any non-routine maintenance whenever the instruments cannot properly perform the functions previously discussed.

It is imperative that the pH meters are stored in an area where freezing will not occur. The pH meter will be turned off and stored in its case with the electrode immersed in a solution and in a secure location in the field office when not in use. The instruments' logs and records and any spare parts will be stored in close proximity to each instrument to enable field sample team members to easily obtain necessary items.

For long-term storage, remove the batteries from the instruments. The instruments' User's Manuals will be consulted for any special considerations for the storage of probes or other sensitive components. Specifically, the HACH HQ30d pH probe will be cleaned with distilled water and the probe soaker bottle will be filled half-full with HACH electrode storage solution of 3M KCl solution. Ensure that the soaker bottle is secure to the probe and submerge the glass bulb and reference junction holes in the KCl solution.

Notes: Do not use distilled or deionized water for storage of the HI98129 pH meter. Rinse the electrode with deionized water to minimize contamination and store it with a few drops of storage (HI 70300) or pH 7 (HI 7007) solution in the protective cap. Also, to prolong the life of the pH electrode, the instrument manual recommends cleaning it monthly by immersing it in HI7061 cleaning solution for half an hour. Afterwards, rinse the probe thoroughly with deionized water and re-calibrate the instrument.

3.4 Electrical Conductance Meter

The electrical conductance meter (conductivity meter) will be capable of the following:

- Ability to provide real-time conductivity measurements.
- Ability to accurately measure electrical conductance within the instrument's accuracy and precision specifications or regulatory agency accuracy requirements (if applicable).
- Ability to be calibrated to meet acceptance criteria detailed in Section 3.4.1 of this SOP.

3.4.1 Electrical Conductance Meter Calibration Procedures

An FGMI Environmental Technician must calibrate the electrical conductance meter prior to each day of use. Calibration is considered complete once specific conductivity probe has been calibrated using appropriate calibration solutions. Two calibration solutions of a known conductivity are needed to calibrate the probe and the solutions should bracket the conductivity of the water to be measured if possible. Record the "Pre" and "Post" calibration readings in the field instrument log or an equivalent calibration record. The methods and steps needed to calibrate the electrical conductivity meter are summarized below and described in more detail in the User's Manual.

At the beginning of each day of sampling, check instrument linearity.

a. Rinse probe with deionized water.
b. Measure conductivity of two potassium chloride solution standards, which bracket expected sample values.
c. Measure temperature of both solution standards.

Calculate cell constant for each standard to determine if instrument linearity is reasonable. The cell constant is the ratio of the computed conductivity to the measured conductivity of the standard solution.

The electrical conductivity meter calibration will be checked or verified directly following initial calibration by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria listed below. Do not reuse standards from the initial calibration during the calibration verification. Typically, multi-parameter confidence solutions are available from calibration solution manufacturers and can be used for calibration verification.

Parameter	**Acceptance Criteria**
Specific Conductance	± 5 % of standard value

If calibration verification fails to meet acceptance criteria, immediately recalibrate the instrument using the applicable initial calibration procedure or remove the instrument from service.

3.4.2 Electrical Conductance Meter Field Instrument Operation Procedures

The electrical conductance instrument will be thoroughly rinsed with deionized water prior to collecting field measurements.

a. Turn instrument on.
b. Ensure that the meter displays the appropriate reporting units to be measured.
c. When collecting *in-situ* measurements, submerge the probe into the surface water at midstream for until temperature readings stabilize.
d. If in-situ measurements are not possible, rinse a new disposable or certified clean plastic beaker with approximately 50 milliliters of sample water three times.
e. Place water sample in new disposable or certified clean plastic beaker (fill to at least 50 millimeters).
f. Rinse probe with deionized or sample water and place in sample water.
g. Immerse conductivity probe in sample so that vent hole is submerged. Move probe around in sample to displace any air bubbles. Turn instrument on to appropriate scale to measure conductivity.
h. Allow the instrument to equilibrate for 1 minute.
i. Ensure air bubbles are not under the probe tip and do not allow the probe to contact the side or bottom of the container.
j. Record conductivity reading after a stable reading is obtained. Stabilization has occurred when the parameter reading does not fluctuate for 15 to 20 seconds.
k. Remove probe from sample and turn off instrument. Ensure air bubbles are not under the probe tip and do not allow the probe to contact the side or bottom of the container. Begin collecting measurements after the electrical conductivity has stabilized, or as specified in the Kinross Quality Assurance/Quality Control and Field Procedures Manual. Stabilization has occurred when the parameter reading does not fluctuate for 15 to 20 seconds.

3.4.3 Electrical Conductivity Meter Maintenance and Storage

Maintenance and certification will be kept current and performed in accordance with the manufacturer’s recommendations. The electrical conductivity meter will be returned to the manufacturer for routine scheduled maintenance at a frequency specified in the instruments’ User’s Manual. Additionally, the meter will be sent to the manufacturer for any non-routine maintenance whenever the instrument cannot properly perform the functions previously discussed.

It is imperative that the electrical conductivity meter is stored in its pre-manufactured case and located in an area where freezing will not occur. Check the batteries prior to taking the instrument into the field each day and carry spare batteries with the instrument.

The electrical conductivity meter will be turned off and stored in its case and in a secure location in the field office when not in use. The instruments’ User’s Manual will be consulted for any special considerations for the storage of probes or other sensitive components.

The instruments’ logs and records and any spare parts will be stored in close proximity to each instrument to enable field sample team members to easily obtain necessary items. For long-term storage, remove the batteries from the instruments.

Note: Do not use distilled or deionized water for storage of the HI98129 conductivity meter.

When retrieved from storage and prior to calibrating, check the electrical conductivity probe for cracks or other damage.

3.5 Water Temperature Meter

The temperature meter will be capable of the following:

- Ability to provide real-time temperature measurements.
- Ability to accurately measure temperature within the instrument's accuracy and precision specifications or regulatory agency accuracy requirements (if applicable).
- Ability to be calibrated to meet acceptance criteria detailed in Section 3.5.1 of this SOP.

Use either a National Institute of Standards and Technology (NIST) calibrated thermometer or a digital temperature probe calibrate against a NIST-calibrated thermometer to measure water temperature.

3.5.1 Water Temperature Meter Calibration Procedures

Temperature meters or probes will be calibrated by an FGMI Environmental Technician by verifying the readings against a NIST certified thermometer. If temperature fails to be within the acceptance criteria (± 0.5 ° C) relative to the NIST thermometer, apply a correction factor equal to the difference between the NIST thermometer and the instrument's reading (correction factor = NIST thermometer reading - instrument temperature). The correction factor must be applied to temperature measurements recorded by that multi-parameter water-quality meter during field use.

Parameter	Acceptance Criteria
Temperature	± 0.5°C

3.5.2 Water Temperature Meter Operation Procedures

Once the calibration requirements have been met, check the thermometer for cracks or gaps in the mercury. Do not use thermometers if either cracks or gaps are visible.

When collecting *in-situ* measurements, submerge the thermometer or water temperature probe into the surface water at midstream for approximately 1 minute or until temperature readings stabilize. Stabilization has occurred when the temperature reading does not fluctuate for 15 to 20 seconds.

If *in-situ* measurements cannot be performed, obtain at least 200 ml of sample water into a decontaminated beaker or new certified clean sample container as soon after sampling as possible. Submerge the thermometer or temperature meter's probe into the sample water, allow the temperature readings to stabilize based on the above criteria, and record the temperature to the nearest 0.5°C in the field logbook or on the field datasheet.

Rinse the thermometer or electronic temperature probe with deionized water.

3.5.3 Water Temperature Meter Maintenance and Storage

It is imperative that the water temperature meter is stored in an area where freezing will not occur. The water temperature meter will be turned off and stored in its case and in a secure location in the field office when not in use. The instruments' User's Manual will be consulted for any special considerations for the storage of probes or other sensitive components. The instruments' logs and records and any spare parts will be stored in close proximity to each instrument to enable field sample team members to easily obtain necessary items. For long-term storage, remove the batteries from the instruments.

Note: Do not use distilled or deionized water for storage of the HI98129 temperature probe.

4.0 REFERENCES

- Field Instrument User's Manuals:
- HACH HQd Portable Meter. DOC022.53.80017, 2013 Edition 4.
- Hanna Instruments HI 98129 Waterproof pH, EC/TDS, & Temperature Meter. ISTR98129R2, January 2002.
- Oakton TEMP 5 Acorn Series Meter. OAKTON WD-35626-00, -10, -20, June, 1999.
- Fairbanks Gold Mining. *FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures*, July 2015.
- Kinross. Quality Assurance/Quality Control and Field Procedures Manual. October 2012.

I have read FGMI-ENVSAMPLE-SOP-04, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the FGMI Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	**Signature**	**Company**	**Date**

Table 1: Field Instrumentation Equipment & Material Checklist

Item Description	**Check☐**
Health & Safety	
Nitrile gloves	
Field first-aid kit	
Eyewash	
Safety glasses	
Paperwork	
Field Instruments User's Manuals	
Project Record Documents	
Logbook or field data sheet and indelible ink marker	
SDS for calibration solutions and standards	
Applicable sampling SOPs	
Equipment	
Field Instruments	
Calibration solutions and standards	
Spare parts, particularly for sensitive components	
Paper towels	
Spare batteries	
Deionized water	
Spray bottle	
Tool kit	
Additional items required for particular instrument calibration	

End of Procedure

Fairbanks Gold Mining, Inc.

Decontamination of Sampling Equipment Procedures
FGMI-ENVSAMPLE-SOP-05

Management Endorsement:

Synopsis:
This document defines the Fairbanks Gold Mining, Inc. minimum procedures for decontamination of sampling equipment.

Bartly Kleven
Environmental Manager
Fairbanks Gold Mining, Inc.

Published by:
Fairbanks Gold Mining, Inc.

July 6, 2015

Revision Record			
Change Date	**Remove**	**Insert**	**Description of Change(s)**
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1.0 PURPOSE

This standard operating procedure (SOP) provides the general technical requirements and operational guidelines associated with decontamination of field sampling equipment associated with the Fairbanks Gold Mining, Inc. (FGMI) Alaska Pollutant Discharge Elimination System (APDES) and Waste Management permit requirements. The procedures described in this SOP are applicable to decontaminating field sampling equipment that may contact sampled media (including soil, groundwater, surface water, soil and other media). This SOP should be used in conjunction with other FGMI project record documents as necessary. It is important to follow these procedures from a quality control perspective to help ensure that samples are not subjected to cross-contamination.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

Proper decontamination of field equipment is a crucial part of the field investigation process. Consideration should be given to the order in which the samples are collected. In general, samples should be collected in a clean to dirty manner, thereby minimizing the potential for cross-contamination.

Sampling personnel must wear powder-free nitrile gloves while performing the procedures described in this SOP. Specifically, nitrile gloves must be worn while preparing and decontaminating field equipment. At a minimum, nitrile gloves must be changed following decontamination of field equipment and prior to use of the field equipment for sample collection activities to prevent the possibility of cross-contamination.

Prior to field activities, the field team should consider how investigation-derived waste (*i.e.*, decontamination fluids and disposable personal protective equipment) is to be handled. Avoid the use of methanol – according to US EPA RCRA regulations, Methanol; “upon use” is an F-listed waste. Thus the decontamination fluid immediately becomes a RCRA waste if it contains “used” methanol.

2.1 Personnel Training

Personnel responsible for equipment decontamination must read FGMI-SOP-05, understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel will sign the signature page (page 8) in order to document their review, willingness to comply and understanding of the SOP.

3.0 PROCEDURES

This section describes general operating procedures and methods associated with field decontamination activities. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The Environmental Manager is responsible for determining whether or not the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

3.1 Pre-Job Preparation

Prior to initiating sampling activities, the sampling personnel will ensure that the following activities have been completed.

a. Verify that adequate supplies of equipment necessary for completing decontamination are available for the planned sampling activities at the site. Refer to Table 1 for an example checklist of decontamination equipment and materials.
b. Review project record documents in an effort to determine the project-specific requirements, procedures, and goals.

3.2 Set-Up

The set-up for decontamination will vary depending on the type of equipment to be used.

For decontamination of hand-held sampling equipment, spread plastic sheeting on the ground and place the decontamination tubs and/or buckets and rinse bottles in order on top of the plastic. Prepare an ample volume of decontamination solution containing a non-phosphate detergent such as Liquinox® (detergent solution) and use water from a public water system, store-bought distilled or spring water, or deionized water. The source of the water should be recorded in the field logbook.

3.3 Decontamination

Equipment used for sampling, testing, or measuring that comes in contact with potentially sampled media will be decontaminated prior to use, unless the equipment is prepackaged and certified clean by a manufacturer. Reusable sampling equipment will also be decontaminated between sampling locations. If disposable sampling equipment (certified clean, prepackaged materials) is used, this equipment will not be decontaminated before use and will be disposed of properly after one use. Disposable equipment will not be used at more than one sampling location.

Dedicated sampling equipment, such as individual sampling/purging pumps that are used to sample one well, will be decontaminated prior to first use, but will not require decontamination between uses at the same well. Dedicated sampling equipment will be secured in clean, resealable plastic bags between uses. Replace dedicated sampling equipment if visual indications of stains are observed or there are indications of contamination from equipment rinsate blanks.

The following section presents decontamination procedures for manual sampling equipment.

3.4 Manual Sampling Equipment

The following general decontamination steps should be applied to all sampling equipment that has had or will have contact with potentially impacted media. Site-specific project control documents may specify modifications to these procedures and should be followed when applicable. It is important to note that no acids will be used to decontaminate any electrical or electronic instrumentation, unless specified by the manufacturer.

a. Physically remove visible material from the sampling equipment to the extent practicable before decontaminating the equipment with decontamination fluids.
b. Immerse (to the extent practicable) the equipment in the non-phosphate detergent solution and scrub the equipment thoroughly with a stiff brush until visible residual material is removed and the equipment is visibly clean. Detergent solution should be circulated through equipment that cannot be disassembled, such as submersible pumps (ASTM, 2008).
c. Rinse the equipment thoroughly with control water.
d. Rinse the equipment with deionized (DI) water (use reagent-grade DI water from a known source).
e. To the extent practicable, allow the equipment to air dry in a clean area (equipment does not need to be completely dry before reuse; under certain weather conditions, complete air-drying may not be possible).

If decontaminated equipment will not be used immediately, the equipment may be sealed in a plastic bag for storage. Decontamination activities, including date, time, and reagents used, should be documented in the field logbook or field data sheet.

The non-phosphate detergent solution will be changed daily and/or between sites at a minimum and more frequently as needed. If used, decontamination solvents will be collected in a separate container from water/detergent solutions and disposed of in accordance with FGMI waste handling procedures.

3.5 Documentation

Field logbooks will be maintained by the designated field personnel to record daily activities. The minimum requirements for field documentation are discussed in FGMI-ENVSAMPLE-SOP-01 (Field Documentation Procedures).

4.0 REFERENCES

- American Society for Testing and Materials (ASTM) International, *Standard Practice for Decontamination of Field Equipment Used at Waste Sites*: D 5088-02. 2008.
- Fairbanks Gold Mining, Inc. *FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures*, July 2015.
- United States Environmental Protection Agency (US EPA), Region 4. *Field Equipment Cleaning and Decontamination Operating Procedure.* Document # SESDPROC-205-R2, December 2011.

I have read FGMI-ENVSMPLE-SOP-05, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	**Signature**	**Company**	**Date**

Table 1: Decontamination of Equipment - Equipment & Material Checklist	
Item Description	**CHECK☐**
Health and Safety	
Nitrile gloves	
Hard hat	
Steel-toed boots	
Hearing protection	
Field first-aid kit	
Eyewash	
Safety glasses	
Barricades, cones, flashing lights, signs	
Paperwork	
Project Record documents	
Well construction data, location map, field data from previous sampling events	
Field logbook or Field Data Sheets	
Equipment	
Non-phosphate detergent (Liquinox or Alconox)	
Buckets or washtubs	
Spray bottles	
Plastic sheeting	
Plastic bags	
Brushes	
Deionized water	
Control water	

End of Procedure

<table>
<tr><td colspan="3">Fairbanks Gold Mining, Inc.</td></tr>
<tr><td colspan="3">Groundwater Sampling Procedures
FGMI-ENVSAMPLE-SOP-06</td></tr>
<tr><td colspan="2">Management Endorsement:</td><td>Synopsis:
This document defines the Fairbanks Gold Mining, Inc. (subsidiary of Kinross Gold Mining Corporation) minimum procedures for groundwater sampling for the Fort Knox Mine, Fairbanks, Alaska.</td></tr>
<tr><td rowspan="3">Bartly Kleven
Environmental Manager
Fairbanks Gold Mining, Inc.

______________________</td><td rowspan="3">

______________________</td><td>Published by:
Fairbanks Gold Mining, Inc.</td></tr>
<tr><td></td></tr>
<tr><td>July 6, 2015</td></tr>
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Revision Record			
Change Date	**Remove**	**Insert**	**Description of Change(s)**
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1.0 PURPOSE

This standard operating procedure (SOP) provides the general technical requirements and operational guidelines for groundwater sample collection procedures associated with the Fairbanks Gold Mining, Inc. (FGMI) Alaska Waste Management permit requirements for the Fort Knox Mine, Fairbanks, Alaska. This SOP should be used in conjunction with other FGMI project record documents as necessary. The procedures described in this SOP are applicable to groundwater sample collection from groundwater monitoring wells.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

Sampling personnel must wear proper personal protective equipment (PPE) while performing the procedures described in this SOP. Specifically, powder-free nitrile gloves must be worn while preparing sample bottleware, collecting and processing samples, decontaminating sample equipment, and packing samples. At a minimum, nitrile gloves must be changed prior to the collection of each sample or as necessary to prevent the possibility of cross-contamination with the sample, the sample bottleware, or the sampling equipment.

Field sampling equipment should be decontaminated in accordance with FGMI-ENVSAMPLE-SOP-05 (Decontamination of Sampling Equipment Procedures) prior to use. Although sampling should typically be conducted from least impacted well to the most impacted well, field logistics may necessitate other sample collection orders. When ground water well sampling does not proceed from least to most impacted, extra precautions must be taken to ensure that appropriate levels of decontamination are achieved.

Equipment that could come into contact with the groundwater should be covered and stored off the ground to avoid potential cross-contamination. If clean plastic sheeting is placed on the ground to help prevent contamination of equipment, then care should be taken to prevent slips, trips, or falls. Any plastic sheeting should be disposed of properly following completion of sampling at each well.

Prior to field activities, the field team should consider how investigation-derived waste (*i.e.*, excess groundwater, disposable sampling equipment, and disposable PPE) is to be handled.

2.1 Personnel Training

Personnel responsible for groundwater sampling must read FGMI-ENVSAMPLE-SOP-06, understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel will sign the signature page (page 12) in order to document their review, willingness to comply with, and understanding of the SOP.

3.0 PROCEDURES

The following sections describe the volume-averaging purging and sampling methods. A description of bailer sampling is also provided as an alternative in the event this sampling method is necessary. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the FGMI Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The FGMI Environmental Manager is responsible for determining whether or not the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

3.1 Pre-Job Preparation

The following information should be reviewed prior to sampling activities and should be made available for reference in the field as necessary. This information is useful when determining the sampling order, pump intake depth, purge and recharge rates, and it can facilitate troubleshooting.

- A list specifying the monitoring wells to be sampled.
- Information describing well location, using site-specific or topographic maps and descriptions tied directly to prominent field markers (positional information or maps are also valuable under severe weather conditions).
- A list of the analytical requirements for each sampling location.
- Boring logs and well construction details.
- Survey data that identify the documented point of reference (V-notch or other mark on well casing).
- Prior depth-to-groundwater measurements.
- Previous pump placement depths for each sampling location.
- Previous pump settings and pumping and drawdown rates.
- Previous analytical results for each monitoring well, if known.

Prior to initiating sampling activities, the sample collection team will ensure that the following activities have been completed:

a. Verify that an adequate supply of equipment and materials, necessary for completing the planned sampling activities, is available. Refer to Table 1 for an example checklist of purging and sampling equipment and materials.
b. Ensure appropriate laboratory-provided bottleware is available for both the compliance samples and for Quality Control (QC) samples, and that there has been thorough coordination with the analytical laboratory.
c. Review project record documents in an effort to determine the project-specific requirements, procedures, and goals.

3.2 Water-Level Measurements

Prior to pump placement, an initial depth-to-water (DTW) level will be measured. For monitoring wells screened across the water table, this measurement will be used to determine the required depth of the pump intake (typically, mid-point of the saturated screen length). The following procedure will be used to measure the water levels:

a. Inspect the well head area for evidence of damage or disturbance. Record notable observations in the field logbook.

b. Open the protective outer cover of the monitoring well. Remove debris that has accumulated around the riser near the well plug. If water is present above the top of the riser and well plug, then remove the water prior to opening the well plug. Do not open the well until the water above the well head has been removed.
c. Well plugs will be left open for an adequate time period to allow the water level to equilibrate prior to measuring the water level. The amount of time is dependent on groundwater recharge rates (5 minutes - 10 minutes is usually sufficient).
d. Using an electronic water-level indicator, accurate to 0.01, determine the distance between the top of the well casing (or established point of reference, usually a V-notch or indelible mark on the well riser) and the surface of the standing water present in the well. If no mark is visible on the well riser, take water level measurements from the north side of the riser.
e. Document the DTW reading in the field logbook.
f. Decontaminate the water-level indicator in accordance with FGMI-ENVSAMPLE-SOP-05.

3.3 Well Purging

Wells must be purged prior to sampling to ensure that representative groundwater is obtained from the water-bearing unit. If the well has been previously sampled in accordance with this SOP, then the depth to the pump intake and the pumping rates will be duplicated to the maximum extent practical during subsequent sampling events.

3.3.1 Calculate Purge Volumes

Based on DTW measurements and total well depth (TWD) measurements, the volume of standing water in the well must be calculated using the following procedures.

a. Subtract DTW from TWD to calculate the length of the standing water column in the well.
b. Multiply the length of the standing water column by the volume calculation (gallons per linear feet of depth) based on the inner casing diameter (see example list below) to determine the total standing water volume; this represents one well volume.

DIAMETER OF CASING (inches)	GALLONS PER LINEAR FOOT	LINEAR FEET PER GALLON
1.00	0.041	0.509
2.00	0.1632	6.1275
2.50	0.2550	3.9216
3.00	0.3672	2.7233
3.50	0.4998	2.0008
4.00	0.6528	1.5319
4.25	0.7369	1.3570
4.50	0.8362	1.2104
4.75	0.9206	1.0862
5.00	1.0200	0.9804
5.25	1.1246	0.8892
5.50	1.2342	0.8102
5.75	1.3489	0.7413
6.00	1.4688	0.6808
6.25	1.5938	0.6276
6.50	1.7238	0.5801
6.75	1.8590	0.5379
7.00	1.9992	0.5002
7.25	2.1445	0.4663
7.50	2.2950	0.4357
7.75	2.4505	0.4081
8.00	2.6112	0.3830

d. Multiply the well volume calculated in the previous step by 3 in order to obtain the respective total purge volume (the minimum volume is three standing well volumes) (ADEC, 2010). For wells with multiple casing diameters (such as open bedrock holes), calculate the volume for each segment. Take the sum of the values and multiply by 3 to determine the minimum and maximum purge volumes, respectively.
e. Although volume-averaged sampling involves purging a specified volume of water rather than basing purge completion on the stabilization of water quality indicator parameters, measuring and recording water-quality indicator parameters during purging provides information that can be used for assessment and remedial decision-making purposes. Indicator parameters are pH, specific conductance, and temperature.
d. Fully document the volume calculation in the field logbook.

3.3.2 Purge the Monitoring Well

a. Determine the appropriate pump to be used for purging for monitoring wells that do not have permanently installed or dedicated pumps; when there is a large volume of water to be purged, use of a variable speed electric submersible pump is preferred (US EPA, 2013). A surface centrifugal or peristaltic pump may be used whenever the head difference between the sampling location and the water level is less than the limit of suction (typically less than 26 feet) and the volume to be removed is reasonably small. In some cases (willow wells with small purge volumes), purging with a disposable bailer may be appropriate.

b. Adjust the reel support pins (on bar below roller) so that the roller is centered over the well opening. Lift and hang the portable pump on the well casing by resting the support pins against the inside of the well casing.
c. Unlock the reel by pulling the pin lock mechanism outward and turning.
d. Using the operating handle, gently reel down the pump to the necessary level and lock the reel in place. The cable is marked every five feet.
e. DO NOT power the converter until the extension cord is connected. Connect the extension cord to the electrical box. Connect the other end of the extension cable to the converter.
f. Connect the discharge hose to the discharge port.
g. Power up the converter (220/240 V generator), turn the frequency control knob to approximately mid-range (12 o'clock position) and start the pump by moving the start/stop switch to the "start" position. Adjust the speed dial to the desired frequency or flow rate.
h. Set the pump immediately above the top of the well screen or 1 – 1 ½ meters (3 - 5 feet) below the top of the water table (US EPA, 2013). Lower the pump if the water level drops during purging.

Note: Use only new or decontaminated tubing.

i. During well purging, monitor the discharge rate using a graduated cylinder or other measuring device, water-quality indicator parameters, and DTW as follows:
    1. Initially, within 3 minutes of startup.
    2. After each well volume is purged, and then
    3. Immediately before purge completion.
j. Record the pump discharge rates (gpm) and pump settings in the field logbook. Also, record any changes in the pump settings and the time at which the changes were made.
k. Maintain controlled pumping rates to avoid over pumping or pumping the well to dryness, if possible. If necessary, adjust pumping rates, pump set depth, or extend pumping times to remove the desired volume of water (US EPA, 2013).
l. Upon reaching the desired purge water volume, turn off the purge pump. It is preferred to collect samples within 1 hour of purging (ADEC, 2010), but acceptable for collection up to 24 hours after purging. Do not collect samples more than 24 hours after completion of purging (US EPA, 2013).

Note: The removal of three well volumes of water may not be practical in wells with slow recovery rates. If a well is pumped to near dryness at a rate less than 1.9 L/min (0.5 gpm), the well will be allowed to completely recover prior to sampling. If necessary, the preferred 1-hour limit may be exceeded to allow for sufficient recovery, but samples must be collected within 24 hours of purge completion.

3.4 Sampling

Samples should be collected as soon as possible after purging so that possible well casing or other influences are minimized. At no time should there be more than 24 hours between purging and sampling. Sample the least contaminated wells first and the most contaminated wells last to minimize the possibility of cross-contamination. If contamination levels are unknown, sample the up-gradient wells first and then the down gradient wells. The following procedure will be followed for the collection of groundwater samples.

3.4.1 Sampling with Submersible Pump (permanent or portable pump)

a. Remove the end of the tubing from the flow-through cell or over-topping cell used to measure water quality parameters, if applicable.
b. Take care to minimize purge water descending back into the well through the pump tubing. Minimize turbulence when filling sample containers by allowing the liquid to run gently down the inside of the bottle.
c. Immediately seal each sample and when all bottles are filled, place the samples on ice in a cooler to maintain sample temperature preservation requirements in accordance with procedures outlined in the FGMI-ENVSAMPLE-SOP-02 (Sample Handling, Packing, and Shipping).
d. Note the sample identification and sample collection time on field logbook, or data sheet and, on Chain-of-Custody Record (refer to FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures).
e. Once sampling is complete, retrieve the sample pump and associated sampling equipment and decontaminate in accordance with procedures outlined in the FGMI-ENVSAMPLE-SOP-05.
f. Close and secure the well. Clean up and remove debris left from the sampling event.

3.4.2 Sampling with a Bailer

a. Attach new or decontaminated bailer (see FGMI-ENVSAMPLE-SOP-05) to the rope. Rope used will be new and disposed of after use.
b. Ensure the bailer is appropriately sized to fit into the well without binding on the well casing. If the well was purged using a bailer, the same bailer used for purging may be used for sampling within the same well.
c. Remove bailer from protective sleeve while retaining the cover and removable drain tip.
d. Securely attach a line (wire, chord, or rope) to the top of the bailer ensuring that the line is of sufficient length for the bailer to reach the desired water level.
e. Lower the bailer into the well until the bailer contacts the surface of the water.
f. Allow the bailer to sink until the unit is filled with water or until the unit touches the well bottom.
g. Retrieve the bailer to the top of the well while listening to ensure the check valve is not leaking water back into the well. If the check valve is leaking it may be necessary to bounce the unit up and down on the line to seal the valve.
h. With the bailer stopcock closed, insert the drain tube to displace the ball valve. Carefully fill each sample bottle from the drain using the stopcock to meter the flow.
i. Immediately seal each sample and when all bottles are filled, place the samples on ice in a cooler to maintain sample temperature preservation requirements in accordance with procedures outlined in the FGMI-ENVSAMPLE-SOP-02 (Sample Handling, Packing, and Shipping).
j. Note the sample identification and sample collection time on field logbook, or data sheet and, on Chain-of-Custody Record (refer to FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures).

k. Once sampling is complete, place used bailer back into sleeve and dispose of properly.
l. Close and secure the well. Clean up and remove debris left from the sampling event.

3.4.3 Filtration of Groundwater Samples

It may be necessary to collect dissolved inorganic constituents samples. The collection of dissolved inorganic samples will be collected as determined by the Environmental Manager or designee. This is accomplished by filtering the sample as follows.

a. After collecting samples utilizing a pump as described in Section 3.4.1, attach a disposable in-line 0.45 μm filter to the tubing.
b. Allow a minimum of three filter volumes of groundwater to run through filter.
c. Fill sample bottle(s).
d. Ensure bottle(s) is labeled correctly and marked as a filtered sample.
e. After filtered samples have been collected, close and secure well as detailed in Section 3.4.1.

3.5 Investigation-Derived Waste

Investigation-Derived Waste (IDW) associated with sampling activities includes excess purge water, decontamination fluids, disposable sampling equipment, and disposable PPE. These materials must be disposed of properly and in accordance with applicable project record documents, laws, regulations, and guidance.

3.6 Sample Handling, Packing, and Shipping

Samples will be marked, labeled, packaged, and shipped in accordance with FGMI-ENVSAMPLE-SOP-02.

3.7 Field Quality Control Samples

Field QC samples may include equipment rinsate blanks, and field duplicate samples. Refer to FGMI-SOP-03 (Quality Control Sampling Procedures) for a description of common field QC samples, the associated collection method, and the applicable QC sample frequency.

3.8 Field Logbook Documentation

Field logbooks will be maintained by the FGMI Environmental Technician to record daily activities. The minimum requirements for field documentation are discussed in FGMI-ENVSAMPLE-SOP-01.

The FGMI Environmental Supervisor will review the field logbook entries for completeness and accuracy and will indicate this review by initialing each page of the logbook. The Field Team Leader is responsible for completion of the required data collection forms.

3.9 Decontamination and Cleanup

Decontamination of sampling equipment will be performed in a manner consistent with FGMI-ENVSAMPLE-SOP-05.

4.0 REFERENCES

- Alaska Department of Environmental Conservation (ADEC). Division of Spill Prevention and Response Contaminated Sites Program. *Draft Field Sampling Guidance.* May 2010.
- Fairbanks Gold Mining, Inc. *FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-02 Sample Handling, Packing, and Shipping Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-03 Quality Control Sampling Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-05 Decontamination of Equipment Procedures*, July 2015.
- US EPA. Region 4, Groundwater Sampling Operating Procedure. Document Number SESDPROC-301-R3, March 2013.

I have read FGMI-ENVSAMPLE-SOP-06, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the FGMI Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	**Signature**	**Company**	**Date**

Table 1: Groundwater Sampling Equipment & Material Checklist	
Item Description	**CHECK☐**
Health & Safety	
Nitrile gloves	
Hard hat	
Steel-toed boots	
Hearing protection	
Field first-aid kit	
Eyewash	
Safety glasses	
Paperwork	
Project record documents	
Well construction data, location map, field data from previous sampling events	
Chain-of-Custody forms and custody seals	
Field logbook	
Measuring Equipment	
Flow measurement supplies (*e.g.*, graduated cylinder and stop watch)	
Electronic water-level indicator	
Sampling Equipment	
Monitoring well keys	
Tools for well access (*e.g.,* socket set, wrench, screw driver, t-wrench)	
Laboratory-supplied certified-clean bottleware, preserved by laboratory (if necessary)	
Sample filtration device and filters	
Submersible pump	
Stainless steel clamps to attach sample lines to pump	
Decontamination and Waste Management Equipment	
Decontamination equipment and supplies (See FGMI-SOP-05)	
Packaging and shipping supplies (See FGMI-SOP-02)	

End of Procedure

<table>
<tr><td colspan="3">Fairbanks Gold Mining, Inc.</td></tr>
<tr><td colspan="3">Surface Water Sampling Procedures
FGMI-ENVSAMPLE-SOP-07</td></tr>
<tr><td colspan="2">Management Endorsement:</td><td>Synopsis:
This document defines the Fairbanks Gold Mining, Inc.(subsidiary of Kinross Gold Mining Corporation) minimum procedures for surface water sampling for the Fort Knox Mine, Fairbanks, Alaska.</td></tr>
<tr><td rowspan="3">Bartly Kleven
Environmental Manager
Fairbanks Gold Mining, Inc.
______________________</td><td rowspan="3"></td><td>Published by:
Fairbanks Gold Mining, Inc.</td></tr>
<tr><td>Copyright is owned by Fairbanks Gold Mining,</td></tr>
<tr><td>May 18, 2015</td></tr>
</table>

Revision Record

Change Date	Remove	Insert	Description of Change(s)
	Page Number(s)		

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide technical requirements and operational guidelines for surface water sampling activities associated with Fairbanks Gold Mining, Inc. (FGMI) Alaska Pollutant Discharge Elimination System (APDES) and Waste Management permit requirements. The SOP is applicable for sampling streams, wastewater conveyances, lakes, ponds, and shallow areas, such as wetlands or drainage ditches and can also apply to sampling large-body surface waters (where applicable). This SOP should be used in conjunction with other FGMI project record documents as necessary.

Surface waters generally fall into two categories - flowing surface waters and still or stagnant waters. APDES and Waste Management permit samples will be collected from both of these categories of surface water as described in this SOP. Specific considerations associated with sampling each type of surface water encountered are discussed in the following sections. Sampling situations vary widely; therefore, the FGMI Environmental Manager must determine the appropriate method for collecting representative surface water samples.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

It is preferred that personnel do not enter waterways to collect samples. However, if conditions require entering a waterway, personnel should use the United States Geological Survey (USGS) rule of thumb - do not wade into flowing water when the product of depth (in feet) and velocity (in feet per second) equals 10 or greater (US Geological Survey, variously dated). If flow data are unavailable, personnel should not exceed a water depth of knee height. Every attempt should be made to utilize a sampling device, such that personnel entry into the waterbody is avoided. A dock or bridge may be employed for sample locations a considerable distance from the shoreline. Water safety hazards and associated precautions should be thoroughly considered and understood prior to conducting sampling activities in the vicinity of surface water of any type (moving, still or frozen).

Personnel will wear powder-free nitrile gloves while performing the procedures described in this SOP. Specifically, powder-free nitrile gloves will be worn while preparing and handling sample bottleware and during sample collection and packing. Sample labeling, packing, and shipping will be conducted in accordance with FGMI-ENVSAMPLE-SOP-02 (Sample Handling, Packing, and Shipping Procedures).

Reusable field sampling equipment should be decontaminated in accordance with FGMI-ENVSAMPLESOP-05 (Decontamination of Sampling Equipment Procedures) prior to use.

2.1 Personnel Training

Personnel responsible for conducting surface water sampling must read FGMI-ENVSAMPLE-SOP-07, understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel will sign the signature page (page 10) in order to document their review willingness to comply and understanding of the SOP.

3.0 PROCEDURES

This section describes general operating procedures and methods associated with field documentation activities. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the FGMI Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The FGMI Environmental Manager is responsible for determining whether or not the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

Surface water samples will be collected at locations that are specified in APDES or Waste Management permits. Surface water samples will be collected prior to the collection of any sediment, benthic, or fish samples to avoid contamination of the sample by agitation of the bottom sediments. Consideration should be given to using a container large enough to collect samples for both field and laboratory analysis. Do not pre-rinse laboratory-provided, certified-clean, sample containers. The following devices are generally used for surface water sampling:

- Laboratory-supplied sample bottle.
- Extended pond dipper sampler.
- Flow/Velocity meter.
- Water quality parameter measurement instrumentation.
- Water bottle sampler.
- Handheld or portable Global Positioning System (GPS), to identify sample location.

In addition, the following equipment may be needed for surface water sampling:

- Peristaltic pump and associated tubing.
- Kemmerer depth sampler.

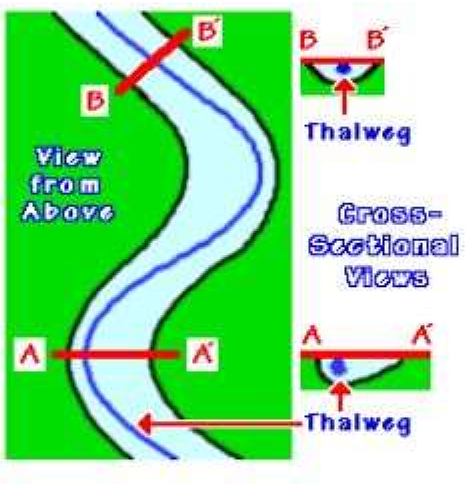
3.1 Pre-Job Preparation

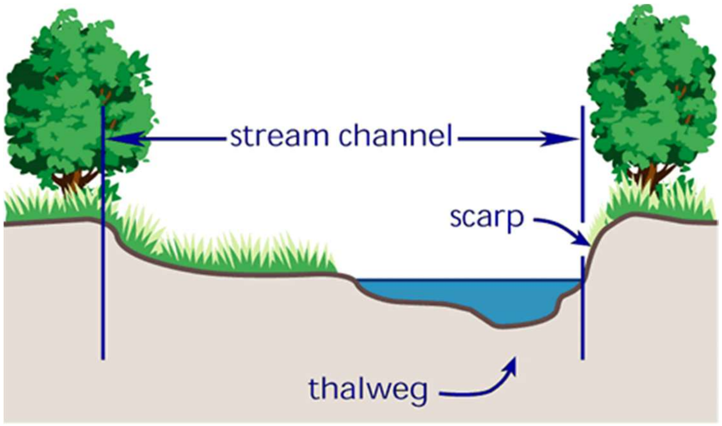
The sample collection personnel will ensure that the following activities have been completed prior to mobilizing to the site:

a. Evaluate weather conditions and adjust equipment and plans accordingly.
b. Obtain equipment necessary for completing the sampling activities (see Table 1 for an example checklist of equipment and materials needed for sampling).
c. Ensure appropriate laboratory-provided bottleware is available for both the required analyses and for quality control (QC) samples and that there has been appropriate coordination with the analytical laboratory.
d. Obtain location and coordinates of the permit specified sampling location.
e. Conduct a site reconnaissance to identify points of entry/access limitations, health and safety concerns, and sample locations.
f. Review FGMI-ENVSAMPLE-SOP-04 (Field Instrumentation Operation and Calibration Procedures) if field parameters need to be collected as part of the surface water sampling.

3.2 Sampling Flowing Surface Waters (Rivers, Streams, or Drainage Ditches)

Consult the applicable permit to determine sample collection location. If project-specific requirements do not specify a sampling location, the preferable sampling location of flowing water bodies is where the water is well mixed laterally and vertically. These locations are characterized by fast moving or turbulent waters. Sites immediately below riffle areas are generally representative of the entire flow. In the case of calmer waters, the preferred sampling location is the thalweg (area of highest flow rate).





a. Begin by selecting the farthest downstream sampling location. In general, downstream samples should be collected first, followed by upstream samples. This order minimizes the disturbance of bottom sediments impacting subsequent sample locations.
b. A single sample at mid-depth and the mid-point of the main current, conditions permitting is adequate for most streams where there is good lateral and vertical mixing.
c. Prior to sample collection, measure the required field parameters at each sample location as described in FGMI-ENVSAMPLE-SOP-04. Samples should be collected as close to the same location as possible from one sampling event to the next.
d. Measured field parameters will be recorded in the field logbook.

c.

3.2.1 Grab (or Discrete) Sample Collection

3.2.1.1 Water Bottle Sampler or Dip Sampler

Whenever practicable grab samples should be collected directly into a laboratory-supplied sample bottle which is referred to as a water bottle sampler. It may be necessary at times to utilize a dip sampler, which is a fixed length or extendable pole which is able to secure the laboratory-supplied sample bottle and allows the sampler to safely collect the sample into the laboratory-supplied sample bottles. A water bottle sampler or dip sampler may be used to collect surface water samples at a limited depth or at the surface. When the laboratory-supplied sample bottle is unpreserved, proceed as follows.

a. Prior to sample collection inspect the sampling point for evidence of visible debris or material that may inadvertently impact the sample. Remove if present and document in the field logbook. Samples should be collected as close to the same location as possible from one sampling event to the next.
b. Lower the capped unpreserved sample container to the desired depth. Point mouth of sample container upstream/against the flow. Use caution not to disturb sediment during sample collection.
c. Remove the cap allowing the sample container to fill.
d. Replace the cap and remove the container from the water.

Note: When using sample bottles containing preservatives, first fill a separate, clean, unpreserved bottle as defined in steps a through c above, then follow the step below.

e. Immediately decant from the clean, unpreserved bottle or dip sampler into the sample bottle containing preservative.
f. Secure the lid and complete the sample label in accordance with FGMI-ENVSAMPLE-SOP-01 (Field Documentation Procedures).
g. Immediately place the sample in the sample cooler as described in FGMI-ENVSAMPLE-SOP-02.

In the winter months, it may be necessary to remove ice prior to sample collection as described below:

h. Clear snow from an area of the ice large enough for the sampling equipment.
i. Drill or chisel a hole in the ice, periodically cleaning ice chips from the hole.
j. After breaking through the ice, cut an area large enough for proper sample collection.
k. Remove three hole volumes of water with a properly decontaminated container or laboratory-supplied sample bottle. Approximate this volume based on the dimensions of the hole cut through the ice and the ice thickness.
l. Follow steps *a-g* above for sampled collection.

Note: If a surface film is suspected (or visible), the surface of the water will be sampled by gently lowering the sample bottle horizontally into the water with the mouth of the bottle directed upstream, taking reasonable measures to avoid suspended/floating debris.

If any other container is used to retrieve water from the designated location for sampling, this container will be decontaminated in accordance with FGMI-ENVSAMPLE-SOP-05. This container will also be included in the collection of the rinsate blank as described in FGMI-ENVSAMPLE-SOP-03 (Quality Control Sampling Procedures).

Discrete Samples at a Specified Depth

In the event the collection of a discrete sample at a certain depth is required, a Kemmerer depth sampler or peristaltic pump and associated tubing should be used. A Kemmerer depth sampler is comprised of an open tube that is allowed to float between its top and bottom caps. At a desired sample depth, a weighted messenger is sent down the associated towline compressing the top cap into the tube and into the bottom cap, thereby closing the sample tube on both ends. A peristaltic pump is comprised of a flexible tube fitted inside a circular pump casing (though linear peristaltic pumps have been made). A rotor with a number of "rollers" attached to the external circumference compresses the flexible tube. As the rotor turns, the part of tube under compression closes, thereby forcing the fluid to be pumped to move through the tube.

If a depth-specific sample is not required, a water bottle sampler or dip sampler may be used to collect surface water samples.

3.2.1.2 Kemmerer (or equivalent) Depth Sampler

a. Lower the properly decontaminated Kemmerer depth sampler to the appropriate depth.
b. Once at the desired depth, use the weighted messenger or similar trigger to close the sampling device.
c. Fill the appropriate certified-clean bottleware.
d. Secure the lid and complete the sample label in accordance with FGMI-ENVSAMPLE-SOP-01.
e. Immediately place the sample in the sample cooler as described in FGMI-ENVSAMPLE-SOP-02.

3.2.1.3 Peristaltic Pump (or equivalent) Sampler (For Inorganic Sampling)

a. Use new, certified-clean, disposable Silastic®, Teflon®, Tygon®, or equivalent tubing.
b. Use dedicated tubing and inert weights at each sampling location. Inert weights must be constructed of solid PVC so there is no potential to cross-contaminate the sample.
c. Lower the weighted peristaltic pump tubing to the appropriate depth.
d. Once at the desired depth, turn on the pump and begin purging for approximately 1 minute to 2 minutes before sampling.
e. Fill the appropriate certified-clean bottleware.
f. Secure the lid and complete the sample label in accordance with FGMI-ENVSAMPLE-SOP-01.
g. Immediately place the sample in the sample cooler as described in FGMI-ENVSAMPLE-SOP-02.

3.3 Special Sampling Considerations

Whole Effluent Toxicity Samples
Whole effluent toxicity (WET) samples are collected and used to conduct chronic toxicity tests on a specific species. Collect WET samples in laboratory provided containers as grab samples. Triple rinse the containers with source (sample) water before filling with sample water. To minimize the loss of toxicity due to volatilization of constituents, fill the containers in a manner that leaves no headspace between the contents and the lid.

3.4 Sample Documentation

Field logbooks to record daily activities, including sample collection and tracking information, will be maintained by the sampling team. Information will be entered into the field logbook by the appropriate field team member. Entries will be made in indelible ink.

In addition to the minimum requirements discussed in FGMI-SOP-01, the field logbooks will contain the following:

- Sample identification code and/or number.
- Water depth and location of sample (*e.g.*, surface, mid-depth).
- Water characteristics (*e.g.*, turbidity, color, temperature, flow rate, ice).
- Description and sketch of sample locations in the water body.
- Any changes in sampling locations and reasons (these changes are also to be annotated on maps).
- Description of any photographs should they be taken.

3.5 Investigation-Derived Waste

Investigation-Derived Waste (IDW) associated with sampling activities includes decontamination fluids, disposable sampling equipment, and disposable Personal Protective Equipment (PPE).

3.6 Sample Handling, Packing, and Shipping

Samples will be marked, labeled, packaged, and shipped in accordance with FGMI-ENVSAMPLE-SOP-02.

3.7 Field Quality Control Samples

Field quality control (QC) samples include equipment rinsate blanks, and field duplicate samples. Refer to FGMI-ENVSAMPLE-SOP-03 for a description of common field QC samples, the associated collection method, and the applicable QC sample frequency.

3.8 Decontamination and Cleanup

Decontamination of sampling equipment will be performed in a manner consistent with FGMI-ENVSAMPLE-SOP-05.

4.0 REFERENCES

- US Geological Survey, variously dated*, National Field Manual for the Collection of Water-Quality Data: US Geological Survey Techniques of Water-Resources Investigations, Book 9, Chaps. A1-A9.
- US EPA. Region 4, Surface Water Sampling. Document Number SESDPROC-201-R3, February 2013.
- Fairbanks Gold Mining, Inc. *FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures,* July 2015.
- Fairbanks Gold Mining, Inc. *FGMI- ENVSAMPLE-SOP-02 Sample Handling, Packing, and Shipping Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-03 Quality Control Sampling Procedures*, July 2015
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-04 Field Instrumentation Operation and Calibration Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-05 Decontamination of Sampling Equipment Procedures*,July 2015.
- US EPA Region 4, Wastewater Sampling. Document # SESDPRCO-306-R3. February 2013.
  d.

*Citation information is for the online manual and its individually updated chapters. All versions that were published previously in a printed format have been superseded by the online manual (http://pubs.water.usgs.gov/twri9A).

I have read FGMI-ENVSAMPLE-SOP-07, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the FGMI Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	**Signature**	**Company**	**Date**

Table 1: Surface Water Sampling Equipment & Materials Checklist	
Item Description	**CHECK☐**
Health & Safety	
Nitrile gloves	
Hard hat	
Steel-toed boots	
Hearing protection	
Field first-aid kit	
Eyewash	
Safety glasses	
US Coast Guard-approved flotation device	
Sufficient length of rescue line	
Paperwork	
Sampling plan/Scope-of-Work/project guidance documents	
Location map, field data from previous sampling events	
Field logbook	
Chain-of-Custody forms and custody seals	
Equipment	
Laboratory-Supplied Sample Bottles	
Dip Sampler	
Ice Chisel or Ice Auger	
Kemmerer Depth Sampler	
Peristaltic Pump	

End of Procedure

<table>
<tr><td colspan="3">Fairbanks Gold Mining, Inc.</td></tr>
<tr><td colspan="3">Rock and Soil Composite Sampling Procedures
FGMI-ENVSAMPLE-SOP-08</td></tr>
<tr><td colspan="2">Management Endorsement:</td><td>Synopsis:
This document defines Fairbanks Gold Mining, Inc. (subsidiary of Kinross Gold Mining Corporation) minimum procedures for rock and soil composite sampling for the Fort Knox Mine, Fairbanks, Alaska.</td></tr>
<tr><td rowspan="3">Bartly Kleven
Environmental Manager
Fairbanks Gold Mining, Inc.
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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide technical requirements and operational guidelines for rock composite and soil composite sampling activities associated with environmental and/or compliance sampling activities associated with the Fairbanks Gold Mining, Inc. (FGMI) Waste Management permit. These requirements are for the Fort Knox Mine, Fairbanks, Alaska. This SOP should be used in conjunction with other FGMI project record documents as necessary.

The SOP is applicable for collection of rock and soil composite samples for chemical analysis using manual collection methods.

Field personnel conducting the composite sampling activities are required to be familiar with the procedures provided in this SOP, as well as standard industry practices. Sampling situations vary widely; therefore, the FGMI Environmental Manager must determine the appropriate method for collecting representative samples.

2.0 GENERAL CONSIDERATIONS

Rock and soil composite sampling is to be conducted for acid/base accounting by the Meteoric Water Mobility Procedure. Rock samples for this analysis are generated annually by compositing four quarterly-collected sub-samples from the A-Stockpile (A ore), the B-Stockpile (B/low-grade ore) and the Waste Rock Stockpile. Soil samples collected for this analysis are generated annually by compositing 4-quarterly sub-samples from the Growth Media Stockpile. Quarterly sub-samples and subsequent annual samples will be collected from each of these stockpiles. If future mining operations dictate the generation of other rock stockpiles, these will be sampled in the same manner described in this SOP.

Selection of sampling locations has important implications on the outcome of the acid/base accounting testing. Sampling locations should be selected to characterize both the type and volume of rock materials and to account for the variability of materials that will be exposed during mining (US EPA, 1994). Communication with the mine geologist is imperative to selection of proper sampling locations.

Potential safety hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

Personnel will wear powder-free nitrile gloves and safety glasses while performing the procedures described in this SOP. Powder-free nitrile gloves will be worn while preparing and handling sample containers and during sample collection and packing. At a minimum, nitrile gloves must be changed prior to the collection of each sample or as necessary to prevent the possibility of cross-contamination with the sample, the sample bottleware, or the sampling equipment. This not only protects the sample from contamination, it protects the sampler from any potential contamination present in the sample.

Reusable field sampling equipment should be decontaminated in accordance with FGMI-ENVSAMPLE-SOP-05 (Decontamination of Sampling Equipment Procedures) prior to use.

2.1 Personnel Training

Personnel responsible for conducting rock and soil composite sampling must read FGMI-ENVSAMPLE-SOP-08, understand the contents of this SOP, and agree to comply with the SOP. After reviewing this SOP, personnel will sign the signature page (page 10) in order to document their review and understanding of the SOP.

3.0 PROCEDURES

This section documents general operating procedures and methods associated with rock and soil composite sampling activities. In the event these procedures cannot be performed as written in this SOP, field personnel must contact the FGMI Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The FGMI Environmental Manager is responsible for determining whether or not the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

3.1 Manual Rock Composite Sampling

Rock samples will be collected manually. The manual method involves the use of decontaminated hand equipment such as trowels, shovels or gloved hands. The following section describes the manual sampling method.

3.1.1 Quarterly Rock Stockpile Sample Collection

a. Consult with the mine geologist to determine the most recently active portion of the rock stockpiles. In addition, geologic variation encountered during the quarterly stockpiling will be considered when selecting sampling locations.
b. Prior to sampling, remove vegetation, leaves, debris, or other obstructions that interfere with sample collection. If it is necessary to relocate a sampling point, consult with the mine geologist to identify an appropriate sampling point, document the reason for the relocation and the new sample location in the field logbook.
c. Using a manual collection device, collect the rock sample from the pre-determined portion of the stockpile. New, certified clean disposable sample scoops or clean and decontaminated trowels, shovels, or a gloved hand will be used to collect rock samples.
d. Collect approximately 10-12 pounds of rock from each stockpile each quarter in clean and rock sample bags. The maximum particle size for the rock sample is 2 inches.
e. label the sample bags with the collection date, time, and location.
f. Transport the collected material to the storage area and stage until additional quarterly samples are collected and ready for homogenization (See section 3.1.1.1). Samples will be stored in a manner that limits exposure to the environment which could affect the physical and chemical characteristics of the samples (US EPA 1994).
g. Ensure custody of samples is maintained by either applying signed and dated custody seals on the rock sample bags or by storing the samples in a secure, access controlled area. Custody seals will be placed in such a manner that if the bags are opened the custody seals will tear to indicate tampering.
h. Note the sample collection date, time, and location in the field logbook in accordance with FGMI-ENVSAMPLE-SOP-01 (Field Documentation Procedures).

i. Rock samples will only be collected or handled while wearing clean nitrile gloves. Nitrile gloves will be donned before collection of the first sample and changed between samples and sampling locations, and prior to handling samples for packing and shipping purposes.

3.1.1.1 Collection of Annual Composite Rock Samples

a. Transfer the four quarterly samples to the Knox Mine on-site laboratory for drying prior to pulverization (processing), homogenization, and sub-sampling.
b. Prior to processing the four quarterly rock samples, ensure the rock crusher is free from visible contaminants including previously crushed materials.
c. Annual composite rock samples will be collected from the processed material. To the degree possible, annual composite rock samples will be homogenized to create a representative sample prior to transferring the soil into sample jars.
d. The goal of homogenization is to achieve a consistent physical appearance and texture over the entire sample to eliminate or minimize analytical bias.
e. Ensure a properly sized and decontaminated (in accordance with FGMI-ENVSAMPLE-SOP-05) homogenization is available for use.
f. Thoroughly homogenize the processed rock sample until a consistent physical appearance has been obtained. Care should be taken to minimize contact of the sampler's disposable gloves with material to be sent to the laboratory.
g. Following homogenization, transfer appropriate volumes of material into certified-clean, laboratory-supplied bottleware with either a decontaminated stainless steel scoop/spatula, or a new, certified-clean disposable plastic sampling scoop.
h. Seal the containers properly, place them in resealable plastic bags, and immediately store them upright in a sample cooler.

Note: Temperature preservation is not required for samples collected for acid/base accounting.

i. Note the sample identification and sample collection time in the field logbook and on the Chain-of-Custody (COC) form in accordance with FGMI-ENVSAMPLE-SOP-01. Sample identifications, names, and numbers should be consistent throughout the COC protocol and field documentation, including, site maps, data tables, *etc*.

3.2 Manual Soil Sampling

Soil samples will be collected manually. The manual method involves the use of hand equipment such as hand augers, trowels, or core samplers. The following section describes the manual sampling method.

3.2.1 Quarterly Growth Media Stockpile Sample Collection

a. To select the proper sampling location, consult with the mine geologist to determine the most recently active portion of the growth media stockpile.
b. Prior to sampling, remove vegetation, rocks, leaves, debris, or other obstructions that interfere with soil sample collection. If it is necessary to relocate a sampling point, document the reason for the relocation and the new sample location in the field logbook.

c. Using a manual collection device, collect the soil sample from the active portion of the stockpile. New, certified clean disposable sample scoops or clean and decontaminated stainless steel shovels, trowels, hand augers, or split-spoon samplers should be used to collect soil samples.
d. Collect approximately 10-12 pounds of soil from the stockpile each quarter. Soil stockpile samples will be placed into new rock sample bags.
e. Label the sample bags with the collection date, time and location.
f. Transport the collected material to the storage area and stage until additional quarterly samples are collected and ready for homogenization (See section 3.1.1.1). Ensure custody of samples is maintained by either applying signed and dated custody seals on the rock sample bags or by storing the samples in a secure, access controlled area. Custody seals will be placed in a manner that if the bags were opened the custody seals would break to indicate tampering.
g. Samples will be stored in a manner that limits exposure to the environment which could affect the physical and chemical characteristics of the samples (US EPA 1994).
h. Note the sample collection date, time and location in the field logbook or field data sheet in accordance with FGMI-ENVSAMPLE-SOP-01.
i. Soil samples will only be collected or handled while wearing clean nitrile gloves. Nitrile gloves will be donned before collection of the first sample and changed between samples and sampling locations, and prior to handling samples for packing and shipping purposes.

3.2.1.1 Collection of Annual Composite Soil Samples

a. Transfer the four quarterly samples to the Knox Mine onsite laboratory for drying prior to homogenization and sub-sampling.
b. Composite soil samples must be homogenized to create a representative sample prior to transferring the soil into sample jars.
c. The goal of homogenization is to achieve a consistent physical appearance and texture over the entire sample to eliminate or minimize analytical bias. Therefore, the homogenization container will be large enough to contain 50 pounds of sampled material and have enough free space to properly homogenize the sampled material as described below.
d. Prior to homogenization, twigs, roots, leaves, rocks, and miscellaneous debris will be removed from the sample using a decontaminated stainless steel spoon/scoop/spatula or a new certified clean disposable plastic sampling scoop.
e. Thoroughly homogenize the sample until a consistent physical appearance has been obtained. Care should be taken to minimize contact of the sampler's disposable gloves with soil to be sent to the laboratory.
f. Following homogenization, transfer appropriate volumes of soil into certified-clean, laboratory-supplied preserved (if required) bottleware with either a decontaminated stainless steel or glass spoon/scoop/spatula or a new certified clean disposable plastic sampling scoop.
g. Seal the containers properly, place them in resealable plastic bags, and immediately store them upright in a sample cooler.

Note: Temperature preservation is not required for samples collected for acid/base accounting.

h. Note the sample identification and sample collection time in the field logbook or field data sheet and on the COC form in accordance with FGMI-ENVSAMPLE-SOP-01. Sample identifications, names and numbers should be consistent throughout the COC protocol and field documentation, including, site maps, data tables, *etc*.

3.3 Sample Documentation

Field logbooks to record daily activities, including sample collection and tracking information, will be maintained by the Environmental Technician. It is the responsibility of the Environmental Technician to complete the field logbook. Information will be entered into the field logbook by the appropriate Environmental Technician and entries will be made in indelible ink.

In addition to the minimum requirements discussed in FGMI-ENVSAMPLE-SOP-01, the field logbooks will contain the following:

- Sample identification code and/or number.
- Location of sample (*e.g.*, location of quarterly sample locations).
- Rock characteristics (*e.g.*, rock type, color, texture (grain size, crystallization), hardness, and when distinguishable, characteristics such as luster, cleavage, staining, secondary mineralization).
- Description and sketch of sample locations.
- Any changes in sampling locations and reasons (these changes are also to be annotated on maps).
- Description of photographs taken, if applicable.

To the degree possible, if any one of the materials used in compositing has unusual characteristics (colors, odors, textures, *etc.*) relative to the other samples, or relative to what has been observed in the past, a note should be made in the field book of the nature of that characteristic.

3.4 Investigation-Derived Waste

Investigation derived waste (IDW) associated with sampling activities includes excess decontamination fluids, disposable sampling equipment, and disposable Personal Protective Equipment (PPE).

3.5 Sample Handling, Packing, and Shipping

Samples will be marked, labeled, packaged, and shipped in accordance with FGMI-ENVSAMPLE-SOP-01 and FGMI-ENVSAMPLE-SOP-02 (Sample Handling, Packing and Shipping Procedures).

3.6 Field Quality Control Samples

Field quality control (QC) samples may include, equipment rinsate blanks, and field duplicate samples. Refer to FGMI-SOP-03 (QC Sampling Procedures) for a description of common field QC samples, the associated collection method, and the applicable QC sample frequency.

3.7 Decontamination and Cleanup

Decontamination of sampling equipment will be performed in a manner consistent with FGMI-ENVSAMPLE-SOP-05.

4.0 REFERENCES

- ASTM International (ASTM). Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations - D6282-98(2005). 2005.
- US EPA Office of Solid Waste Special Waste Branch. Technical Document - Acid Mine Drainage Prediction. Document Number EPA530-R-94-036. December 1994.
- US EPA, Test Methods for Evaluating Solid Waste Physical/Chemical Analysis (SW-846).
- Fairbanks Gold Mining. *FGMI-ENVSAMPLE-SOP-01 Field Documentation Procedures,* July 2015.
- Fairbanks Gold Mining. *FGMI- ENVSAMPLE-SOP-02 Sample Handling, Packing, and Shipping Procedures*, July 2015.
- Fairbanks Gold Mining. *FGMI- ENVSAMPLE-SOP-03 Quality Control Sampling Procedures*, July 2015.
- Fairbanks Gold Mining. *FGMI- ENVSAMPLE-SOP-04 Field Instrument Operation and Calibration Procedures*, July 2015.
- Fairbanks Gold Mining. *FGMI- ENVSAMPLE-SOP-05 Decontamination of Sampling Equipment Procedures* July 2015.

I have read FGMI-ENVSAMPLE-SOP-08, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the Fairbanks Gold Mining Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	**Signature**	**Company**	**Date**

Table 1: Rock and Soil Composite Sampling Equipment and Materials Checklist	
Item Description	**CHECK** ✓
Health and Safety	
Nitrile gloves	
Hard hat	
Steel-toed boots	
Hearing protection	
Field first-aid kit	
Eyewash	
Safety glasses	
Saranex/Tyvek suits and booties (if necessary)	
Paperwork	
Applicable SOPs	
Location map	
Field logbook	
Chain-of-Custody forms and custody seals	
Equipment – Rock Composite Sampling	
Rock Sample Bags	
Trowels or shovels	
Global positioning system device	
Digital camera	
Hand auger system	
Sampling scoops or trowels	
Homogenization vessel	
Rock Hammer	

End of Procedure

Fairbanks Gold Mining, Inc.

Potable Water Sampling Procedures
FGMI-ENVSAMPLE-SOP-09

Management Endorsement:

Synopsis:
This document defines the Fairbanks Gold Mining, Inc. (subsidiary of Kinross Gold Mining Corporation) minimum procedures for potable water sampling for the Fort Knox Mine, Fairbanks, Alaska.

Bartly Kleven
Environmental Manager
Fairbanks Gold Mining, Inc.

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Published by:
Fairbanks Gold Mining, Inc.

July 6, 2015

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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide technical requirements and operational guidelines for potable water sampling activities associated with Fairbanks Gold Mining, Inc. (FGMI) Fort Knox Mine Public Water System Monitoring Summary requirements. The SOP is applicable for sampling the potable water supply utilized by the Fort Knox Mine, as well as other industrial, public, and private (residential) water supplies as needed. This SOP should be used in conjunction with other FGMI project record documents as necessary.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks should be thoroughly evaluated prior to conducting field activities.

Personnel shall wear powder-free nitrile gloves while performing the procedures described in this SOP. Specifically, powder-free nitrile gloves shall be worn while preparing and handling sample bottleware and during sample collection and packing. Sample labeling, packing, and shipping will be conducted in accordance with FGMI-ENVSAMPLE-SOP-02 (*Sample Handling, Packing, and Shipping Procedures*).

Reusable field sampling equipment, if used, should be decontaminated in accordance with FGMI-SOP-05 (*Decontamination of Sampling Equipment Procedures*) prior to use.

2.1 Personnel Training

Personnel responsible for conducting potable water sampling must read FGMI- ENVSAMPLE-SOP-09, understand the SOP contents, and agree to comply with the SOP. After reviewing this SOP, personnel shall sign the signature page (page 7) in order to document their review, willingness to comply, and understanding of the SOP.

3.0 PROCEDURES

This section describes general operating procedures and methods associated with potable water sampling activities. In the event that these procedures cannot be performed as written in this SOP, field personnel must contact the FGMI Environmental Manager to obtain approval for the deviation to the procedure prior to conducting sampling activities to the extent practicable. The FGMI Environmental Manager is responsible for determining whether or not the deviation has the potential to affect data reliability. Documentation of approved deviations will be recorded in the field logbook.

Potable water samples shall be collected at locations and frequencies specified in Fort Knox Mine Public Water System Monitoring Summary. Do not pre-rinse laboratory-provided, certified-clean, sample containers prior to use.

3.1 Pre-Job Preparation

The sample collection personnel will ensure that the following activities have been completed prior to mobilizing to the site:

a. Obtain equipment necessary to complete the sampling activities (see Table 1).
b. Gather the appropriate laboratory-provided bottleware for both the required analyses and for quality control (QC) samples and verify that the analytical laboratory is aware of the sampling schedule. Laboratory must receive the samples within 30 hours of collection.
c. Consult the most recent version of the Monitoring Summary to determine required sample collection locations.
d. Review the project guidance documents and procedures to determine project-specific sampling requirements.
e. Set-up and calibrate the water quality meters, in accordance with the FGMI-ENVSAMPLE-SOP-04 (*Field Instrumentation Operation and Calibration Procedures)*.
f. Identify and record the following information in the field logbook:
   1. Site/location (including sketch if necessary).
   2. Sample collection location.
   3. Filtration or water softening system information (if present).
   4. Additional project information as required in the FGMI- ENVSAMPLE-SOP-01 *(Field Documentation Procedures).*

3.2 Potable Water Sampling

a. Collect potable water samples from a discharge pipe valve or water faucet. Under no circumstances will the field team “pull” a pump or insert any sampling device directly into the potable water supply.
b. Remove all hoses, aerators, or screens from the faucet.
c. Disinfect the faucet by submerging the sample port (valve or faucet) in bleach for 30 seconds.
d. Open the tap and maintain a smooth flowing water stream at moderate pressure without splashing.
e. Allow the water to run for 3-5 minutes to make sure that all pipes have been thoroughly flushed (ADEC).
f. Before collecting the potable water sample, measure water quality parameters by submerging the instrument directly into continuously flowing sample water or by submerging the instrument into a collected aliquot of the sample water and monitoring the instrument until no major fluctuation in the readings are observed. Record measurements in the field logbook.
g. Collect and handle potable water samples with clean, gloved (nitrile) hands. Change nitrile gloves between sampling locations.
h. Collect the potable water samples directly into the laboratory-provided sample containers.
i. Secure the lid and complete the sample label and Chain-of-Custody in accordance with FGMI-SOP-01.
j. Place the sample on ice immediately after collection as described in FGMI- ENVSAMPLE-SOP-02.

3.3 Sample Documentation

Field logbooks to record daily activities, including sample collection and tracking information, will be maintained by the sampling team. Information will be entered into the field logbook by the appropriate field team member. Entries will be made in indelible ink. The minimum requirements for field logbook documentation are addressed in FGMI-SOP-01.

3.4 Investigation-Derived Waste

Investigation-Derived Waste (IDW) associated with sampling activities includes decontamination fluids, disposable sampling equipment, and disposable Personal Protective Equipment (PPE).

3.5 Sample Handling, Packing, and Shipping

Samples will be marked, labeled, packaged, and shipped in accordance with FGMI-SOP-02.

3.6 Field Quality Control Samples

Field QC samples include equipment rinsate blanks, and field duplicate samples. Refer to FGMI- ENVSAMPLE-SOP-03 *(Quality Control Sampling Procedures)* for a description of common field QC samples, the associated collection method, and the applicable QC sample frequency.

3.7 Decontamination and Cleanup

Decontamination of sampling equipment will be performed in a manner consistent with FGMI-SOP-05.

4.0 REFERENCES

- Alaska Department of Environment and Conservation. *Taking a Total Coliform Bacteria Sample Properly*. http://dec.alaska.gov/eh/docs/dw/NorthernFlows/sampling.pdf. May 2013.
- Fairbanks Gold Mining, Inc. *FGMI- ENVSAMPLE-SOP-01 Field Documentation Procedures,* July 2015.
- Fairbanks Gold Mining, Inc. *FGMI- ENVSAMPLE-SOP-02 Sample Handling, Packing, and Shipping Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-03 Quality Control Sampling Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-04 Field Instrumentation Operation and Calibration Procedures*, July 2015.
- Fairbanks Gold Mining, Inc. *FGMI - ENVSAMPLE-SOP-05 Decontamination of Sampling Equipment Procedures*, July 2015.

I have read FGMI-SOP-10, understand the SOP contents, and agree to comply with the SOP. In the event I notice activities that are non-compliant with the SOP, I will bring the non-compliance issues forward to the FGMI Environmental Manager. A copy of this page will be distributed to the Fairbanks Gold Mining, Inc. Project File.

Printed Name	**Signature**	**Company**	**Date**

Table 1: Potable Water Sampling Equipment & Materials Checklist	
Item Description	**CHECK**
Health & Safety	
Nitrile gloves	
Hard hat	
Steel-toed boots	
Hearing protection	
Field first-aid kit	
Eyewash	
Safety glasses	
Paperwork	
Project guidance documents	
Location map, field data from previous sampling events	
Field logbook	
Chain-of-Custody forms and custody seals	
Equipment	
Laboratory-supplied sample bottles	
Sample cooler	
Ice	
Water quality meters	

End of Procedure

Appendix C

Wildlife Mortality Reporting Form

WILDLIFE MORTALITY REPORT FORM

Fairbanks Gold Mining Inc.
Fort Knox Mine
P.O. Box 73726
Fairbanks, Alaska 99707-3726

Date:

WAD Cyanide:

Identification	Number	Species Identification
Raptors		
Songbird		
Upland Game		
Waterfowl		
Shorebird		
Mammal		
Other		

Reporter:

Title:

Phone:

Email To:

U.S. Fish & Wildlife Service
1412 Airport Way
Fairbanks, Alaska 99701
ryan_cote@fws.gov

Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701-1599
audra.brase@alaska.gov

Alaska Department of Environmental Conservation
Northern Regional Office
610 University Avenue
Fairbanks, Alaska 99709
tim.pilon@alaska.gov