FINAL

FIVE-YEAR ENVIRONMENTAL AUDIT
FORT KNOX MINE, TRUE NORTH MINE AND TWIN CREEK ROAD

Submitted to:

Fairbanks Gold Mining, Inc.
State of Alaska, Department of Natural Resources
State of Alaska, Department of Environmental Conservation

Submitted by:

Golder Associates Inc.
1750 Abbot Rd., Suite 200
Anchorage, Alaska 99507

Distribution:

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EXECUTIVE SUMMARY - FIVE YEAR ENVIRONMENTAL AUDIT FORT KNOX MINE TRUE NORTH MINE AND TWIN CREEK ROAD

ES 1.0 Introduction

The Alaska Department of Natural Resources (DNR) and the Alaska Department of Conservation (DEC) require Fairbanks Gold Mining Company, Inc. (FGMI) to have third party audits conducted every five years at the Fort Knox Mine in accordance with the issued Millsite Leases (ADL Nos. 414960 and 414961) and the Solid Waste Disposal Permit (No. 0031-BA008). Third-party audits are also required for the True North Mine and issued Millsite Lease (ADL#416509) and the Twin Creek Road. The last Audit was conducted in 1998 by TRC and the report produced in March 1999. In compliance with the regulatory requirements, Golder Associates Inc. (Golder) performed an environmental audit (Audit) of the Fort Knox and True North Mines and the associated haul road (Twin Creek Road) near Fairbanks, Alaska. The Audit included a site visit by three Golder professionals from July 28th to July 31st 2003, with an additional two days of wetland delineation field work.

The Audit was objective, systematic, and documented review of the conditions, operations, and practices related to environmental requirements and environmental management of the FGMI operations. The objective of this Audit is to assist DNR and DEC in determining if FGMI's environmental management systems and the regulatory controls applicable to the mine provide reasonable assurance that environmental objectives are being met and that the systems and controls are functioning as intended. The Audit results will be used by FGMI and the state of Alaska to assist in updating, renewing, or issuing authorization and permits, in updating policies, plans and procedures, and in determining compliance with permits and authorization.

The recommendations provided in this Audit are our best professional judgment based on the site visit and information review. Due to limitations in time and budget, detailed scientific and engineering analyses are not included. These recommendations, therefore are provided to the Large Mine Permitting Team as suggested solutions (or alternatives) to the potential audit issues or concerns. It is anticipated that FGMI may develop alternative, but acceptable responses to the audit issues or concerns based on more detailed analyses.

This executive summary is a concise discussion of all environmental concerns, recommended mitigation measures and their priority related to the Fort Knox Mine and Milling Operations, the True North Mine and associated haul road.

ES 2.0 Audit Procedures and Field Activities

The audit included the following activities in order to complete the scope of work:

- Review of key project permits and environmental plans.
- Interviews with Agency Personnel.
- Review of agency records.
- Kick-off meeting with FGMI personnel.
- Inspection of mines and processing facilities, access road, hazardous material storage and handling, general waste management areas, environmental controls and waste containment, topsoil stock piles, reclamation trial area, wetlands, fresh water reservoir, interceptor well system, data collection procedures and the environmental files.
- Review of environmental files for monitoring and reporting, environmental compliance, bonding and reclamation costs. This also involved interaction with the FGMI personnel.
- Technical evaluation of key issues and concerns that were identified during the previous audit and new findings from this audit.
- Follow-up telephone conversations with FGMI personnel.
- Preparation of a Draft Audit Report.
- Preparation of a Final Audit Report.

ES 3.0 Results of the Audit

Twelve tasks were completed for this audit and a summary of the results of each task is presented below.

ES 3.1 Task 1. FGMI's Compliance with Federal, State, Local Permits and Authorization

FGMI is in compliance with federal, state, local permits and authorizations. A thorough review of the existing project environmental management systems, key permits, relevant procedures, policies, and guidelines, project commitments to the agencies and federal, state and local regulations was conducted prior to and during the audit. While on site, Golder reviewed those documents for compliance, expiration, and renewal requirements. The implementation of each of the documents' terms were checked during the field audit and found to be in compliance.

ES 3.2 Task 2. FGMI's Compliance with Specialized Environmental Plans

Golder reviewed the specialized environmental plans for the Fort Knox Mine and the True North Mine and determined that FGMI is in compliance with those plans. Golder interviewed FGMI operations personnel on the mining and process operations, permits and regulatory requirements, chemical containment structures, monitoring and environmental controls and procedures, data collection and environmental reporting. The audit team systematically addressed the adequacy of the plans, whether the plans are being followed, and documented the performance of the environmental programs. A tour of the facilities revealed that the site specific environmental systems are being followed. FGMI has implemented sound environmental standards and guidelines that are equal to or above those normally found in the mining industry.

ES 3.3 Task 3. The Reliability and Integrity of Information Relating to Environmental Reporting and Compliance

Direct field observations were completed to determine the reliability of reported information and to verify additional information provided through interviews with key mine personnel. Site observations focused on the environmental controls, reclamation activities, and monitoring systems.

Mine operations and facilities that were inspected include the following:

- Open pit areas at Fort Knox and True North
- Milling and beneficiation facilities
- Processing and maintenance operations

- Waste management and containment facilities, including the tailing storage facility
- Seepage and ground water collection facilities
- Access roads
- Fresh Water Reservoir and water supply facilities
- Overburden, low grade ore, and growth media stockpiles
- Reclamation trail demonstration area
- Wetlands
- Monitoring facilities, and
- File system.

The reliability and integrity of information for reporting and compliance is adequate. FGMI has an environmental management plan which includes protocols for reporting, data QA/QC, instrument calibration, and monitoring requirements in place. The FGMI staff is well organized, knowledgeable, and well-trained on environmental management for mines.

ES 3.4 Task 4. The Adequacy of State Oversight to Protect State Resources

In order to determine the adequacy of state oversight to protect state resources Golder interviewed staff from the following agencies:

- Alaska Department of Natural Resources (DNR), Anchorage
- DNR, Fairbanks
- Alaska Department of Environmental Conservation (DEC)
- U.S. Army Corp of Engineers (Corps)
- U.S. Fish and Wildlife Service

- Alaska Department of Fish and Game
- Alaska Mental Health Trust Land Office.

The previous audit recommended several recommendations to facilitate continued communication between agencies and FGMI and to streamline future audits. Golder determined that the recommendations were implemented and have facilitated the communication process. Golder inspected the filing system and reviewed project related files at the DNR. The files were organized in chronological order and fairly easy to review. The regulatory agencies for this project appear knowledgeable and have sufficient understanding of mining practices, environmental mitigation measures and the state and federal regulations.

ES 3.5 Task 5. Changes in Tailing Impoundment Geochemistry Due to Processing to True North Ore

Spigotting of a combined Fort Knox and True North tailings has resulted in increases in tailings decant antimony, arsenic, copper, nitrate, phosphate, and selenium concentrations.

The tailings decant concentration plot shows a change in slope, indicative of a decline in the rate of concentration increase, in August 2001. A change in slope for the tailings seepage is observed in May 2002, 9 months following the observed change in tailings decant. Tailings pond water copper concentrations have increased as well, reflecting an increase in copper sulfate use. The gradual rise in tailings decant nitrate concentrations has continued over the life of the operation. Completion of a nitrogen balance of the cyanide and other nitrogen compounds may provide insight on the increasing nitrate trends.

Speciation modeling using PHREEQC identified potential mineral solubility controls on tailings decant water chemistry and indicated a mineral solubility control on arsenic, selenium and antimony in tailings decant waters is unlikely. Adsorption onto ferrihydrite (supersaturated in decant water assuming dissolved iron is present) is a possible attenuation mechanism for arsenic, copper and antimony. Selenium present as selenite (Se^{4+}) may also adsorb to iron oxides.

Pond Cyanide and Cyanide Degradation Product Concentrations

Prior to processing of the True North ore, tailings decant total cyanide concentrations were relatively low with seasonal variability. After the start of the processing of the True North ore, changes in operating practices resulted in a seasonal increase in cyanide concentrations. Concentrations of nitrate, a cyanide degradation product, are expected to continue to increase (Note: please see Task 7 analysis related to cyanide recycling in the process circuit). A better understanding of the various nitrogen species and their longevity/mobility in the tailings water and groundwater system would assist in developing appropriate control features, if needed.

ES 3.6 Task 6. Changes in Tailing Impoundment Geochemistry Due to the Lead Nitrate Addition to the Milling Circuit

The addition of lead nitrate in tailings processing is intended to remove sulfur from solution through the precipitation of a lead sulfate, thereby preventing the formation of thiocyanate (SCN). The use of lead nitrate in tailings processing since April 2001 has not resulted in significant increases in tailings decant lead concentrations. The increase in peak nitrate levels in 2003 relative to previous years is likely only in part attributable to the use of lead nitrate. Higher cyanide use would also contribute to higher tailings decant nitrate concentrations through natural decay of cyanide.

ES 3.7 Task 7. Changes in Tailings Impoundment Geochemistry Due to Operation of the New Tailings Thickener

On October 17, 2002 the Fort Knox mill commissioned the operation of the new tailings thickener as part of the ore processing circuit. The changes to tailings impoundment geochemistry are considered to be beneficial due to the reduction of reagent usage (cyanide, ammonium bisulfite, and copper sulfate) and cyanide recycling. Cyanide is recycled as process water is removed directly from the tailings prior to detoxification. The tailings are further diluted with decant water to reduce or eliminate the need for detoxification resulting in significant reduction in the use of ABS and copper sulfate.

Another distinct advantage to the thickener is during the last year of operations, thickened tailings can be spigotted to the tailings impoundment to shape the surface of the impoundment reducing the potential grading requirements for reclamation.

ES 3.8 Task 8. Operation of the Interceptor Well System to Maintain a Zero Discharge from the Tailings Impoundment

The last audit identified water quality changes in a monitoring well located downgradient from the Tailings Storage Facility (TSF). The changes were due to migration of seepage and indicated the well interceptor system may not have been operating effectively. Records from the pump back system, the tailings underdrain seepage and the water quality downgradient from the tailing storage facility were reviewed.

FGMI conducted a drilling program to further characterize the hydrogeology in the area of the interceptor well system, installed additional interceptor wells, and installed additional downgradient monitoring wells. FGMI has increased pumping rates at the seepage interceptor system to improve capture of tailings seepage in bedrock. In order to confirm the operational adequacy of the system, Golder analyzed water quality over time and the results from the hydraulics of the system (i.e., Surfer modeling results). This program has improved the efficiency of the interceptor/pumpback system as evidenced by the monitoring data.

Groundwater elevation contour maps have been developed by FGMI to demonstrate that the pumping wells create a hydraulic barrier or capture zone down gradient of the tailings dam. These contour maps are based on water level measurement from the pumping wells and the groundwater monitoring well network. Golder reviewed the data and parameters used for the model in order to assess the basis for the water contour maps contained in the reports The water level contour maps presented in various documents show that the draw-down cones from the pumping wells intercept and create a continuous hydraulic barrier across the area of interest below the tailings dam. The water elevation data for the November 2002 and June 2003 maps were reviewed in more detail and were found to be consistent with and support the associated water level contour maps presented in the various reviewed documents.

The second quarter 2003 report in compliance with Solid Waste Permit #0031-BA008, confirmed that the tailings impoundment is operating as a zero discharge facility. The interceptor well system was performing well in the report and a cone of depression was being maintained. The system is being monitored and adjusted to assure proper performance. This monitoring and adjustment will continue as required.

It is Golder's opinion that the Interceptor System is performing adequately and that it should continue to perform well with minor modifications and adjustments as indicated by the monitoring systems in place. With proper attention to the system and any required maintenance, operations as a zero discharge facility should continue.

ES 3.9 Task 9. Reclamation Plan Alternatives Proposed for the Tailing Impoundment and Critical Areas at Both Fort Knox and True North

The reclamation planning for the Fort Knox and True North Mines is preliminary, as is appropriate for this stage of the mine life. A reclamation schedule is needed to support coordination of future studies and the sequencing of the TSF reclamation in relation to other project components. Based on the review of the reclamation approach and the operating history there are no major concerns related to meeting the reclamation goals for the waste rock dumps, roads, process plant areas, wetlands, and water storage reservoir (WSR). Areas of concern do exist for the demolition, open pit, and TSF and consist of the following:

- Process Plant Demolition: No plans for building and equipment demolition were evaluated for this audit and may not currently exist. It is anticipated by FGMI that equipment and structural steel salvage credits will cover all demolition costs. This analysis needs to be completed and a demolition plan prepared. A plan to deal with mill and process area cleanout and remediation of contaminated soils will be needed for final reclamation.

- Open Pit: The post-reclamation land use objectives for the open pit include a recreational lake. Based on the existing water quality information, this plan should be compatible with a recreational use. However, the pit highwalls will provide a potential long-term rockfall hazard. While the pit highwalls may be stable on the macro-scale, small raveling failures will continue. The pit highwalls have been designed for operational stability in a dewatered condition and are not designed for rising groundwater elevations, which may lead to some larger-scale instability associated with the schist rock slope areas. A stability review of the flooded pit may be warranted to define the long-term stability given the proposed post-mining land use.

- TSF: A consolidation analysis of the tailings is needed to support final design and planning of the post-reclamation topography, surface water management plan and spillway design. Establishment of a final TSF topography during operations that accounts for future consolidation can greatly reduce closure costs but can increase operating costs during the later phases of mill operations. The TSF closure incorporates the use of a large volume of riprap (60,000 cubic yards) that will be sourced from the waste rock dumps. This material will have processed and stockpiled during the later stages of operations or during the waste dump reclamation. Water quality predictions for the reclaimed TSF seepage should be

developed based on the water quality data currently be collected, to determine the potential loading rates to wetland areas and receiving waters.

True North

True North is approximately 15 months from the completion of mining. A detail-level reclamation plan that addresses backfill, grading plans, highwall stability, cover thickness, and surface water drainage is in development by FGMI.

ES 3.10 Task 10. Adequacy of the Reclamation Financial Sureties for Both Sites

The reclamation sureties as prepared by FGMI are based on reasonable and proven reclamation concepts and have well documented cost backup. Production rates and equipment selection will be adjusted to be in line with equipment available in Alaska. Unit rates provided by FGMI for the TSF are in line with anticipated third party contractor costs, but the Fort Knox and True North cost estimates will need to be updated with new rates for the next permit renewal. A demolition plan that includes cost estimates and equipment salvage value is lacking and should therefore be completed. The estimated indirect costs are generally consistent with industry standards for Mobilization/Demobilization and Contract Administration costs but are low or not estimated for Engineering, Contractor Profit and Overhead, Performance and Payment Bonds, Contingencies and Inflation costs.

ES 3.11 Task 11. Evaluate: the Extent and Functional Value of Developed Wetlands Created by FGMI as Mitigation for Lost Acres Beneath the Tailings Impoundment

Wetlands and other aquatic sites created by FGMI as mitigation for lost acres beneath the tailings impoundment are presently 24.5 acres less than acres prescribed. Wetland and aquatic sites created by FGMI exceed the prescribed amount by 19.3 acres for the water reservoir and associated wetland acres. Lake area within the pit and wetlands on the reclaimed tailings bench as prescribed have not yet been created and are anticipated to be created upon mine closure.

In terms of overall wetlands and other aquatic sites created, FGMI has to date developed a total of 204.8 acres, including wetlands below the tailings dam and the water reservoir and associated wetlands. Wetlands and other aquatic sites created by FGMI below the tailings dam are primarily aquatic (pond) sites surrounded by palustrine scrub-shrub (PSS) wetlands. These presently constitute

20.5 acres (24.5 total acres less than the prescribed amount). The water reservoir and associated wetlands are primarily open water sites surrounded by Palustrine Forested wetlands (PFO) and Palustrine Scrub-shrub wetlands (PSS). The water reservoir and associated sites created by FGMI total 184.3 acres and exceed the prescribed amount of 165 acres by 19.3 acres. Additional habitat enhancement on Last Chance Creek completed by FGMI was non-prescribed. Lake area within the pit (148 acres) and wetlands/ponds/uplands (425/425/365) on the reclaimed tailings impoundment as prescribed have not yet been created and are anticipated to be created upon mine closure

This delineation did not include a functional assessment of created wetlands. A functional assessment is recommended for the Fort Knox Mine site to assess the relationship between wetland areas created and those filled and/or cleared.

ES 3.12 Task 12. Compliance with Recommendations Made in the Last Audit

The previous audit made ten recommendations to FGMI. They are summarized below in italics with Golder's audit findings following.

"…*optimize capture of tailings water seepage*…" Response: Since the last audit, the system has been further optimized by a program that included installation of several new interceptor wells and a better understanding of the hydrogeological environment downstream from the tailings impoundment.

"…*consider issues related to tailings water management and disposal at mine closure*…" Response: FGMI has developed a conceptual/preliminary level reclamation and closure plan for the TSF. FGMI is collecting water quality information and has reduced reagent loading coming into the impoundment by the installation of the new thickener.

"…*reclamation cost estimate and closure bond should be updated*…" Response: FGMI has updated them and Golder reviewed them as part of this audit.

"…*FGMI should further evaluate the potential seepage impacts that may occur due to construction of a permanent wetland on the tailings surface following mine closure*..." Response: FGMI is collecting water quality data to support this assessment and have developed water management strategies for seepage treatments should this occur.

"*Update of the reclamation cost estimate and financial sureties should consider...*" Response: FGMI has included the audit recommendation in the reclamation plans reviewed for this audit, with the exception of the development of the demolition plans.

"*...optimization of water quality monitoring is recommended….*" Response: FGMI did not reduce any of the constituents of concern analyses. FGMI did reduce organic testing since it was identified as a non-issue.

"*Further optimization of the monitoring program could be considered….with reduced monitoring frequency…*" FGMI has implemented this where and when it is appropriate and the criteria, based on consistent analysis results below detection limits, is met.

"*Additional recommendation regarding the monitoring program…..include trend plots…. Review lab data for potential reporting errors…Complete the update of the FGMI water quality monitoring plan revision…..Measure surface water flows at wetland monitoring stations and perform annual evaluation of groundwater levels. Include groundwater elevations and surface water flow rates to monitoring reports.*" Response: FGMI has implemented these recommendations.

"*ADF&G should continue monitoring of fish populations and water quality in the water supply reservoir (WSR) ….and consider monitoring of Fish Creek and other tributaries to the WSR to monitor arctic grayling spawning habitat….in evaluation of tailings water disposal and wetland restoration at closure*." Response: ADF&G has been doing this for the past five years.

"...recommendations…to facilitate continued communication between the agencies and FGMI…Encourage approaches to improve continuity of ADEC interactions with FGMI…designating one of the current ADEC staff members as coordinator…..Schedule the next ..audit during the summer of 2003….Provide detailed cost estimate backups for the auditors that can be related directly to the bond amount…." Response: FGMI has implemented all of these recommendations.

ES 4.0 Mitigation and Recommendations

ES 4.1 Monitoring Optimization

The tailings decant and seepage are sampled quarterly. This frequency of monitoring is considered adequate to characterize tailings water and groundwater quality and capture seasonal trends. Quarterly monitoring should be continued.

Both the tailings decant and seepage samples are collected from areas where the water is in contact with the atmosphere. Tailings decant water is collected from the surface of the tailings pond from a barge, and is therefore representative of near-surface conditions in the tailings pond. Tailings seepage samples are collected from a sump open to the atmosphere. The four trace metals of interest in tailings water (arsenic, copper, selenium, and antimony) are all redox species. As such, redox conditions will influence the mobility of these metals. To characterize tailings water at depth, a pond water sample could be collected from the base of the tailings pond using a depth sampling bomb. This sample is expected to be more representative of pore water conditions within the tailings and therefore more representative of tailings seepage water quality. Comparison of the composition of tailings water at surface and at depth will provide insight into the homogeneity of the tailings pond water (i.e., if the pond water is a well mixed system). Such a comparison will also assist in identifying whether samples collected at surface are representative of the entire pond water chemistry.

Monitoring of the wells should continue. Golder recommends that the monitoring data be presented as Piper Diagrams so that trends and changes of water quality "signatures" can readily be compared to tailings seepage and the IW-series wells to evaluate specific concerns during the future audits or as requested by the agencies.

ES 4.2 Reclamation

The reclamation planning for Fort Knox and the TSF are at an appropriate level for this stage of the project. Additional design detail will be necessary over the next five years. The True North Project has an immediate need for development of detailed reclamation plans. Specific recommendations for the reclamation plans are to develop:

- Demolition plans for the processing plant and mill.

- A consolidation model for the TSF and finalize the surface water management plan, grading plan, and cover concepts. It is recommended that the TSF reclamation plan include a small surface water pond near the spillway and that surface recontouring occur during the latter stages of operations using thickened tailings. Additional study and documentation of the direct revegetation of the tailings is required to support this concept.

- Detail-level reclamation plans for True North that incorporate the results of the infiltration estimates developed in the lysimeter field studies.

- Project reclamation schedule that considers that the reclamation and closure of the TSF will occur a period of years after the reclamation of the pits, dumps, and mill site demolition.

- A predictive water quality assessment of the TSF to define a long-term tailings seepage management strategy. In addition a site-wide water quality assessment that incorporates the predicted water quality from pit wall and lake, waste rock dumps and TSF pond water should be prepared to assess the long-term water quality associated with the post-closure conditions. The study should also consider the beneficial affects of the wetland and reservoir system downstream of the reclaimed mine facilities.

Additional closure planning and assessment of the water quality data is needed after the completion of the True North ore milling to assess the current concepts.

ES 4.3 Reclamation Sureties

The reclamation sureties for the Fort Knox and True North projects are calculated on reasonable assumptions and approaches for FGMI to complete the reclamation. Recommendations for refinement of the reclamation sureties include:

- Prepare a demolition cost estimate that includes time for mill cleanout and contamination soils remediation.

- Refine production rate estimates to reflect third-party contractor rates.

- Update unit rates for equipment in the Fort Knox and True North reclamation plans.

- Review and update indirect costs as needed.

- Re-evaluate riprap processing, stockpiling, hauling, and placement costs and equipment selection.

ES 4.4 Dust Control

FGMI needs to maintain dust control program on the haul road.

ES 4.5 Noise Control

FGMI has implemented noise certification for new trucks as well as operational monitoring. Follow up testing completed by FGMI and reviewed by DEC and residents indicates operational compliance.

FGMI needs to maintain the noise monitoring program and continue to remove trucks which fail the compliance from operation until the trucks meet compliance standards (82 decibels (dBA) at a distance of 50-feet from the roadway).

ES 4.6 Wetlands

FGMI is not yet in full compliance of wetland mitigation with regards to replacement of acres between the tailings dam and the water supply reservoir. Additional wetland acres need to be developed below the tailings dam.

No functional assessment was performed in this wetland evaluation. It would be important to determine the functions and values of the created wetlands with respect to acres lost. A functional assessment of these wetland areas is warranted. It would be most useful if the methodologies utilized in a new functional assessment were comparative to those used in the initial jurisdictional wetland functional assessment.

Detailed hydrological and hydraulic analyses are necessary to determine the capacity of the wetland impoundments and the channels upon mine closure for long term maintenance of the ponds. A review of the ponds vegetation establishment should be conducted prior to mine closure also to determine any long term vegetation maintenance necessary.

Fish habitat monitoring should continue on an annual basis to continue to document Arctic Grayling and burbot uses of the wetlands and reservoir.

Additional shrub habitat could be increased through plantings on Pond C now that it has assumed a riffle/pool form. Additional shrub habitat would provide shade, canopy cover and bank stabilizing effect on this area.

Assorted metal pieces should be removed from the ponded areas. These rusting metals, especially in Pond B may be degrading water quality in some portions of the ponds.

Planting and seedings of the Last Chance Creek enhancement area should be reviewed and supplemented. These areas have experienced 1.5 growing seasons since planting and vegetative cover is currently very low.

TABLE ES-1 AUDIT ISSUES

Task	Audit Issue	Recommended Action
• Task 1. FGMI's Compliance with Federal, State, Local Permits and Authorization	In compliance	No action recommended.
• Task 2. FGMI's Compliance with Specialized Environmental Plans	In compliance	No action recommended.
• Task 3. The Reliability and Integrity of Information Relating to Environmental Reporting and Compliance	In compliance	No action recommended.
• Task 4. The Adequacy of State Oversight to Protect State Resources	In compliance	No action recommended.
• Task 5. Changes in Tailing Impoundment Geochemistry Due to Processing to True North Ore	The increased concentrations associated with the True North ore have resulted in short-term, defined changes in the decant and related seepage quality with a known travel time.	The concentration increases may have a longer-term impact on seepage quality than the 9 (or 6)-month travel time, due to dispersion, attenuation and chemical controls as these constituents move from the pond water through the tailings. The time frame for the elevated constituents to migrate through the system or until there is no impact to seepage quality is not well defined and is recommended to be addressed with site specific studies.
• Task 6. Changes in Tailing Impoundment	Changes noted with increasing nitrate	Concentrations of nitrate, a cyanide degradation product, are expected to continue to increase. The

Task	Audit Issue	Recommended Action
Geochemistry Due to the Lead Nitrate Addition to the Milling Circuit	concentration is pond water.	increasing nitrate concentrations may require modification of the water management measures at closure to avoid potential impacts to groundwater. A better understanding of the various nitrogen species and their longevity/mobility in the tailings water and groundwater system would assist in modifying the existing control features, if needed for closure conditions. Completion of a nitrogen balance of the cyanide and other nitrogen compounds may provide insight on the increasing nitrate trends.
• Task 7. Changes in Tailings Impoundment Geochemistry Due to Operation of the New Tailings Thickener	Changes noted.	No action recommended.
• Task 8. Operation of the Interceptor Well System to Maintain a Zero Discharge from the Tailings Impoundment	Significant improvement from last Audit results.	Continued monitoring and system analysis recommended.
• Task 9. Reclamation Plan Alternatives Proposed for the Tailing Impoundment and Critical Areas at Both Fort Knox and True North	Preliminary planning is complete for TSF, waste rock disposal areas, and open pit. Detail-level design is required for True North. Demolition plans for the process area required.	Specific recommendations for the reclamation plans are presented below: • Develop demolition plans for the processing plant and mill. • Develop a consolidation model for the TSF and finalize the surface water management plan, grading plan, and cover concepts. It is recommended that the TSF reclamation plan include a small surface water pond near the spillway and that surface recontouring occur during the latter stages of operations using thickened tailings. Additional study and documentation of the direct revegetation of the tailings is recommended to support this concept. • Develop detail-level reclamation plans for True North that incorporate the results of the infiltration studies. • Develop a project reclamation schedule that considers that the reclamation and closure of the TSF considering the consolidation duration of the tailings, could occur a period of years after the reclamation of the pits, dumps, and mill site demolition.
• Task 10. Adequacy of the Reclamation	The reclamation sureties as prepared by	Recommendations for refinement of the reclamation sureties include:

Task	Audit Issue	Recommended Action
Financial Sureties for Both Sites	FGMI are based on reasonable and proven reclamation concepts and have well documented cost backup. Future updates are recommended as closure planning advances.	• Prepare a demolition cost estimate that includes time for mill cleanout and contamination soils remediation. • Refine production rate estimates. • Update unit rates for equipment in the Fort Knox and True North reclamation plans. • Review and update indirect costs as needed. • Re-evaluate riprap processing, stockpiling hauling and placement costs and equipment selection.
• Task 11. Evaluate: the Extent and Functional Value of Developed Wetlands Created by FGMI as Mitigation for Lost Acres Beneath the Tailings Impoundment	FGMI is not yet in full compliance of wetland mitigation with regards to replacement of acres between the tailings dam and the water supply reservoir.	A detailed hydrological/engineering analyses will be needed if flow is directed through the created wetlands upon mine closure. If an alternative plan to create a north valley stream/wetlands complex is desired, hydrological/engineering analysis will need to be conducted to determine size and shape of channels to handle flow. Long term monitoring and maintenance of the structural integrity of the dikes on the existing created wetlands is necessary.
• Task 12. Compliance with Recommendations Made in the Last Audit	Audit found compliance with previous Audit Recommendations	No action recommended.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF APPENDICES

1.0 PURPOSE AND OBJECTIVES OF THE AUDIT

The Alaska Department of Natural Resources (DNR) and the Alaska Department of Conservation (DEC) require Fairbanks Gold Mining Company, Inc. (FGMI) to have third party audits conducted every five years in accordance with the issued Millsite Leases (ADL Nos. 414960 and 414961) and the Solid Waste Disposal Permit (No. 0031-BA008). Third-party audits are also required for the True North Mine and issued Millsite Lease (ADL No. 416509) and the Twin Creek Road. In compliance with the regulatory requirements Golder Associates performed an environmental audit (Audit) of the Fort Knox Mine and True North Mine, and the associated haul road near Fairbanks, Alaska. This report presents the results from that Audit, in the following sections:

- Executive Summary
- Project Description
- Regulatory Setting
- Audit Procedure and Field Activities
- Areas of Concern
- Mitigation Measures and Recommendations
- Annexes

The Audit was objective, systematic, and documented review of the conditions, operations, and practices related to environmental requirements and environmental management of the FGMI operations. The Audit results will be used by FGMI and the state of Alaska to assist in updating, renewing, or issuing authorization and permits, in updating policies, plans and procedures, and in determining compliance with permits and authorization. The Audit covers the following tasks and scope of work related to completing those tasks:

- Task 1. FGMI's Compliance with Federal, State, Local Permits and Authorization
- Task 2. FGMI's Compliance with Specialized Environmental Plans

- Task 3. The Reliability and Integrity of Information Relating to Environmental Reporting and Compliance
- Task 4. The Adequacy of State Oversight to Protect State Resources
- Task 5. Changes in Tailing Impoundment Geochemistry Due to Processing True North Ore
- Task 6. Changes in Tailing Impoundment Geochemistry Due to the Lead Nitrate Addition to the Milling Circuit
- Task 7. Changes in Tailings Impoundment Geochemistry Due to Operation of the New Tailings Thickener
- Task 8. Operation of the Interceptor Well System to Maintain a Zero Discharge from the Tailings Impoundment
- Task 9. Reclamation Plan Alternatives Proposed for the Tailing Impoundment and Critical Areas at Both Fort Knox and True North
- Task 10. Adequacy of the Reclamation Financial Sureties for Both Sites
- Task 11. Evaluate: the Extent and Functional Value of Developed Wetlands Created by FGMI as Mitigation for Lost Acres Beneath the Tailings Impoundment
- Task 12. Compliance with Recommendations Made in the Last Audit

The scope of work includes the following activities for each of the Tasks 1 through 12.

- Desk Review
- Agency Interviews
- Facility Audit and Site Interviews
- Production of Audit Report

The Audit was conducted with an independent and objective approach following systematic procedures. Regular interaction with the FGMI senior personnel was a requirement to assure accessibility and reliability of information collected.

The recommendations provided in this Audit are our best professional judgment based on the site visit and information review. Due to limitations in time and budget, detailed scientific and engineering analyses are not included. These recommendations, therefore are provided to the Large Mine Permitting Team as suggested solutions (or alternatives) to the potential audit issues or concerns. It is anticipated that FGMI may develop alternative, but acceptable responses to the audit issues or concerns based on more detailed analyses.

1.1 Desk Review

A thorough review of the existing project environmental management plans, relevant procedures, policies, and guidelines, project commitments to the agencies and federal, state and local regulations was conducted. FGMI provided copies of relevant background information and project specific documents prior to the field audit.

Compliance information with respect to facilities are summarized in Tables 1 and 2 to support the comprehensive and systematic auditing of the facilities and programs. Task 1 (Section 4.1) describes this information in detail.

1.2 Agency Interviews

Regulatory agency interviews were conducted both in Anchorage and in Fairbanks to discuss perceptions and expectations of the mine, and to determine the agencies' adequacy to protect Alaskan resources. Task 4 (Section 4.4) identifies which agencies and personnel were interviewed and a summary of those meetings.

1.3 Facility Audit and Site Interviews

An Audit of the facilities was conducted to characterise the compliance with the site environmental management systems. The audit team consisted of specialists in mining environmental issues, wetland delineation, and closure/reclamation issues. The audit team used protocols which Golder has developed for auditing projects and then tailored to meet the specific needs of this project. The protocols include checklists, questions for site personnel, and compliance references.

For those areas that have not met compliance the following details are provided:

- Explanation of the reasons of failing to implement the appropriate management practices
- Explanation of the implications for failing to implement the management practice
- Present the corrective action.

As with all successful audits, there was considerable interaction between the FGMI staff, the regulatory agencies, and the audit team. We conducted interviews with key individuals in addition to the site visits and data collection. Golder's preliminary review and interpretations were discussed with the staff in an interactive fashion during the audit. Direct observation, field reviews, interviews with key personnel, technical evaluations and other activities were conducted for all tasks. Task 2 (Section 4.2) describes which mine components were audited and the FGMI staff interviewed.

1.4 Production of Audit Report

The production of this report was the culmination of the following professionals' analyses, internal communications, and specific task responsibilities:

- Mr. Thomas Krzewinski, P.E. Alaska, Geotechnical Engineer: Tasks 2 and 8, site visit
- Ms. Pamela Stella, M.Sc., Hydrogeologist: Tasks 1, 2, 3, 4 and 12, site visit, agency interviews at DEC and DNR (Fairbanks)
- Mr. Scott Miller, M.Sc., P.G., Geologist: Task 2, 7, 9, 10, and 12, site visit
- Ms. Donna DeFrancesco, Biologist: Tasks 11 and 12, site visit, telephone interview with Al Ott
- Ms. Cheryl Ross, M.Sc., Geochemist: Tasks 5, 6, and 12
- Mr. Rens Verburg, Ph.D., Geochemist: Tasks 5, 6, and 12
- Mr. Robert Dugan, Registered Professional Geologist, Alaska: Tasks 1 and 4, agency interviews at DNR (Anchorage)

2.0 PROJECT DESCRIPTION

This section is a concise description of the project, including both past and current operations, that focuses on project components with potential environmental concerns.

The Fort Knox Mine complex is located in the Fairbanks North Star Borough, approximately 26-road miles northeast of Fairbanks, Alaska in the Fish Creek drainage (Figure 1). Access is via the Steese Highway for approximately ten miles to the town of Fox and then northeast on Alaska Highway 2 for approximately ten miles to Cleary Summit. Near the top of Cleary Summit travel southeast on the Twin Creek Road and Fish Creek Road for approximately six miles to the site. Access to the True North Mine is via the same route exiting the Steese Highway in the same location and traveling to west on the Twin Creek Road for approximately six miles (Figure 2).

Fairbanks Gold Mining, Inc. (FGMI), a wholly owned subsidiary of Kinross Gold Corporation (Kinross), operates two open pit gold mines and a processing plant at its Fairbanks, Alaska property. The two mines, Fort Knox and True North, provide the feed for the Fort Knox mill, a large and modern carbon-in-pulp gold extraction plant that has a capacity of between 36,000 to 50,000 short tons (32,658 to 45,359 tonnes) per day. Figure 1 is the Fort Knox Mine and facilities layout and Figure 2 presents the True North Mine. Major mine components include:

- Fort Knox open pit
- True North open pits
- Milling and beneficiation Facilities
- INCO SO_2/Air cyanide destruction process
- Tailings Storage Facility (TSF)
- Seepage and groundwater collection (interceptor) system
- Twin Creek Access Road
- Administration and security buildings at Fort Knox and True North
- Maintenance facility

- Fresh water reservoir
- Overburden/waste rock
- Coarse ore stockpile
- Low-grade ore
- Stockpiled growth media, and
- Wetlands.

Fort Knox and True North are currently being mined as conventional truck–and-shovel open pit mines and operate year-round. Ore from both deposits is processed at FGMI's mill complex adjacent to the Fort Knox Mine. Processing of the ore begins with a one stage crushing, conveyance to the mill on belt conveyors, crushing by SAG and ball mill grinding, ending in a suspended water slurry. The slurry passes through a gravity separation circuit, thickened to a 55 percent solids and processed through a cyanide leaching circuit. Gold is recovered from a Carbon in Pulp (CIP) solution followed by carbon stripping, electrowinning and refining. The CIP discharge is treated using the patented INCO SO_2/Air process to detoxify any cyanide that is not consumed in the leaching process. The slurry is gravity fed to the tailing disposal system with controlled deposition in order to control the size and location of the supernantant pond.

The Fort Knox Mine was permitted in early 1994, construction began in March 1995 and gold has been produced on a continuous basis since 1996. Fort Knox has produced slightly more than 2.5 million ounces of gold (370,000 ozs on an annual average) from 95 million tons of ore (14.2 million tons on an annual average). Production from the True North deposit commenced in 2001 and also operates year-round averaging 30,000 tons per day mined and 10,000 tons per day of ore shipped to Fort Knox for processing. Tasks 5, 6, and 7 discuss the geochemistry of the tailings since True North ore has been processed and amendments to the thickener and milling circuit were required in order to process that ore and to maximize recovery.

The Fort Knox tailings management is a zero discharge system consisting of 1,147-acre tailing storage facility located 1.5 miles from the Fort Knox open pit mine. The tailing dam is an earthen-filled structure designed to contain all process water from the mill, as well as surface water runoff. The dam is designed and maintained to contain the 100-year, 24-hour storm event in addition to the

average 30-day spring breakup. Impoundment water is not discharged to the environment but is recycled to the mill for reuse in the beneficiation process. The impoundment is built within the upper reaches of Fish Creek.

To ensure zero discharge, a seepage collection system at the toe of the dam collects seepage and returns it to the tailings impoundment. A series of groundwater pump-back (interceptor) wells, just downgradient of the seepage control system, is designed to intercept groundwater and seepage and pump the water back into the tailings impoundment. Observation wells were installed to monitor groundwater quality downstream of the interceptor wells. Task 8 (Section 4.8) describes and evaluates the performance of this system.

The mining operations are located on private and Mental Health Trust State lands and legally filed and held State mining claims. The state mining claims are on land administered by DNR. State water rights are held by FGMI for the entire upper drainage of Fish, Solo, and Last Chance Creeks with the point use identified as the fresh water supply reservoir (WSR). The water dam is located in the Fish Creek valley, three miles downstream from the tailings dam, and below the confluences of Solo Creek and Last Chance Creek

Early in the planning process, opportunities were identified to enhance post-mining sustainable land uses. In particular, the water supply reservoir for the mine was planned and constructed as a permanent structure, to be transferred for public use when mining ends. The reservoir is approximately 175 acres. Fresh water from the WSR is supplied to the mill for milling process when necessary.

In addition, reclamation of pre-existing placer mining disturbance as wetlands has created high-quality spawning grounds and habitat for native fish species. The research done on these wetlands, as they were developed, has contributed long-term data that will aid future efforts in wetland rehabilitation. Task 11 evaluates the extent and functional value to the wetlands created by FGMI for compensation of lost wetlands within the tailings storage facility footprint.

The Fish Creek drainage has been a focus of mining activity since 1902. Placer mining activity continued into the 1980s when fifty-three more placer mining claims were staked. Although no high-grade sources were discovered, trenching and panning of soils indicate that gold mineralization was

widespread. The Fort Knox gold deposit is hosted in a granitic intrusive complex with gold occurring in and along margins of stockwork veins and veinlets.

The True North project area lies within the Chatanika River watershed located on the northwest flank of Pedro Dome. The ridgelines drain into Murray Creek, a tributary of Dome Creek to the south; and Louis Creek, Whiskey Gulch, and Spruce Creek, tributaries to Little Eldorado Creek to the north. The True North deposit has been explored and mined sporadically since 1916.

3.0 REGULATORY SETTING

This section details the federal, state and local applicable environmental laws, regulations, guidelines, and policies as they directly pertain to the FGMI properties.

The main regulatory drivers for the project are:

- Millsite Leases (ADL Nos. 414960 and 414961 for Fort Knox and ADL No. 416509 for True North) issued by the Alaska DNR
- Alaska DNR Plan of Operations Approval
- True North Mine Right-Of-Way Approval
- Solid Waste Disposal Permit (Permit No. 0031-BA008) issued by the Alaska DEC for the tailings disposal
- Solid Waste Disposal Permit (Permit No. 9931-BA001) issued by the Alaska DEC for disposal of construction debris and garbage
- 404 Permit Issued by the U.S. Army Corps of Engineers (Corps)
- Fort Knox Gold Project Technical Assistance Report prepared by the U.S. Environmental Protection Agency Region 10 for the Corps

A list of all the permits and environmental plans are presented in Tables 1 through 4.

The main regulatory agencies responsible for regulating the project are:

- Alaska Department of Natural Resources (DNR)
- Alaska Department of Environmental Conservation (DEC)
- U.S. Environmental Protection Agency Region 10 (EPA)
- U.S. Army Corps of Engineers (Corps).

There is a Large Mine Permitting Team formed specifically for the Fort Knox Project and includes the following agencies and key personnel:

- DNR - Ed Fogels
- DEC - Pete Mcgee
- DNR, Habitat - Al Ott
- Corps - Victor Ross
- EPA - Cindy Godsey
- US Fish & Game-Area supervisor - Steve Lewis

Mining is regulated under the Mine Safety and Health Administration (MSHA).

DNR is the lead agency for the Large Mine Permitting Team. The DNR and DEC compliance requirements for FGMI are:

- Quarterly reports
- Annual report and meeting
- Monthly seepage monitoring reports
- Inspections
- Weekly Large Mine Project Team telephone conference call
- Quality Assurance Project Plan (QAPP) review.

As the lead agency for the Large Mine Permitting Team, the DNR coordinates with other federal and state agencies (Corp of Engineers, Fish and Wildlife and Environmental Protection Agency).

A thorough review of the existing project environmental management systems, relevant procedures, policies, and guidelines, project commitments to the agencies and federal, state and local regulations was conducted prior to and during the audit. Compliance information with respect to the facilities is summarized in Tables 1 and 2.

FGMI provided key permits, plans, and other information prior to the field audit. The information included the federal, state, and local agencies permits, licenses, and authorizations for the project. While on site, Golder reviewed those documents for compliance, expiration, and renewal requirements. Implementation of the documents' terms was checked during the field audit. FGMI produces monthly calendars with the dates to conduct the required elements of those documents, including monitoring requirements and report submittal dates. The calendars are reviewed by FGMI daily in order to be certain that those elements are completed according to schedule.

In order for the environmental management systems to serve as useful tools, routine updates to reflect new information and circumstances are required. At a minimum, the environmental manager will review the systems on an annual basis and update it as necessary to reflect current activities and operations at the mine. The environmental management systems in place include concise summaries of environmental management requirements intended to provide guidance for site implementation of the Kinross Environmental Policy and Framework. The Kinross systems include: environmental tasks; lists of environmental permits, licenses, authorizations and corresponding obligations; inspection and monitoring routines and checklists; and reporting and environmental management procedures for the site. The environmental management systems will be used for on-going compliance assurance, training, environmental auditing, and budgeting.

The environmental management system applies to all aspects of the Fort Knox operation, including but not limited to, mining, milling, maintenance, tailing disposal, construction activities, and administrative functions. The document will routinely be updated to reflect changes at the site.

4.0 AUDIT PROCEDURE AND FIELD ACTIVITIES

In accordance with the requirements in the Millsite Permit and the Solid Waste Disposal Permit an audit of the Fort Knox Mining facility, True North Mine, and Twin Creek Road is required every five years. An audit of the facilities was conducted from July 28th through July 30th, 2003 to characterise the compliance with the approved environmental permits and to address specific concerns that were detailed during the previous audit in 1998. The audit team consisted of specialists in mining environmental and compliance issues (Pamela Stella), wetland delineation (Donna DeFrancesco) and closure/reclamation/geochemical issues (Scott Miller). A Golder Geotechnical Engineer (Tom Krzewinski) conducted a site visit in early June to focus on the tailings disposal facility management and the effectiveness of the interceptor well system. The audit team used protocols Golder developed for auditing projects and tailored to meet the specific needs of this project. These protocols included checklists, questions for site personnel, and compliance references.

The team was to highlight areas where implementation of management plans and compliance had been successful. For those areas that have not met compliance the following details were to be provided:

- Explanation of the reasons of failing to implement the appropriate management practices
- Explanation of the implications for failing to implement the management practice and
- Present the mitigation measures.

Golder believes that the audit process is most successful when preliminary review and interpretations are discussed with the staff in an interactive fashion during the audit. A kickoff meeting with FGMI's key personnel and Golder was conducted on July 28th to discuss the purpose of the audit, request the assistance of FGMI in obtaining additional data in their files, conducting interviews, and conducting tours of key facilities at both mines. The audit process was conducted in a completely transparent manner to all involved.

In order to have a successful audit, there was considerable interaction between the FGMI staff, the regulatory agencies and the Golder audit team. Golder conducted interviews with key individuals in

addition to the site audit and data collection. The FGMI professionals who were interviewed included:

- Environmental Manager, Clyde Gillespie
- Operations Manager, John Wild
- Mill Manager, John Hollow (on vacation, not available)
- Environmental Specialist, Stacy Staley
- Environmental Technician, David Stewart
- Environmental Technician, Jerome Baxter
- Environmental Engineer, Larry Jackson
- Administrative Manager, Eric Edward
- Maintenance Manger, Tim Dake

Direct observation, field reviews, interviews with key personnel, technical evaluations and other activities were conducted for all tasks.

The Audit covered the following facilities:

- Fort Knox Mine Facilities and Operations
- True North Mine Facilities and Operations
- Associated Twin Creek Haul Road.

The following sections summarize the twelve tasks required for this audit, the information reviewed for each task and a description of the results from each task. Section 5.0, Areas of Concern, describes any areas of concern identified during the auditing for each task. Any recommendation for additional work (i.e., data collection, sampling alternatives) related to each task is presented in Section 6.0, Mitigation and Recommendations.

4.1 Task 1. FGMI's Compliance with Federal, State, Local Permits and Authorization

FGMI is in compliance with federal, state, local permits and authorizations. A thorough review of the existing project environmental management plans, relevant procedures, policies, and guidelines, project commitments to the agencies and federal, state and local regulations was conducted prior to and during the audit. FMGI has a designated Fort Knox Environmental Filing System file room for all environmental reports and studies, permits and compliance data and reports, and agency correspondences related to the project. The filing system is well organized and has a systematic index to the files which facilitated record auditing. The files were found to be complete and in order.

The main outline of the filing system related to the environmental component of the Fort Knox and True North mines is presented in Table 5.

Compliance information according to facility is summarized in Tables 1 and 2 to support the comprehensive and systematic auditing of the facilities and programs. FGMI provided key permits, plans, and other information prior to the field audit. The information included the federal, state, and local agencies permits, licenses, and authorizations for the project. While on site, Golder reviewed those documents for compliance, expiration, and renewal requirements. The implementation of each document terms was checked during the field audit and found to be in compliance. FGMI produces monthly calendars with the dates to conduct the required elements of those documents, including monitoring requirements, permit renewals, and report submittals. The calendars are reviewed by FGMI daily in order to be certain that those elements are completed according to schedule.

4.2 Task 2. FGMI's Compliance with Specialized Environmental Plans

Tables 3 and 4 list the specialized environmental plans for the Fort Knox Mine and the True North Mine. Golder reviewed those plans and determined that FGMI is in compliance with those plans. Golder interviewed FGMI operations personnel on the mining and process operations, permits and regulatory requirements, chemical containment structures, monitoring and environmental controls and procedures, data collection, and environmental reporting. The audit team systematically addressed the adequacy of the plans, whether the plans are being followed, and documented the performance of the environmental programs. A tour of the facilities revealed that the site-specific environmental systems are being followed.

The Tailings Dam Operation and Maintenance Manual was reviewed by Tom Krzewinski. The Reclamation plans for both mines were reviewed by Scott Miller and results are in Sections 4.3 and 4.5.

In addition to the plans listed in Tables 3 and 4, Golder also reviewed the following:

- Background and history of sites
- Review of baseline physical, biological conditions
- Critical review of existing data, relevant studies and action plans
- Broad review of current process technologies and operating practices
- Review of environmental management practice
- All existing discharges and emissions: air, water, waste
- Raw materials management
- Solid waste management and identification of significant waste streams
- Description of waste, chemicals, fuel and other storage areas, including chemicals handing, storage, and disposal at the central site, and
- Emergency response.

Mr. Clyde Gillispie, FGMI's Environmental Manager, has implemented sound environmental standards and guidelines that are equal to or above those normally found in the mining industry. Communication and division of responsibilities within the environmental group is excellent. Weekly staff meetings are conducted within the compliance group to discuss schedules, workloads, and events.

Fort Knox is very proactive in reducing waste streams and recycling whenever possible. A used oil boiler heats the administration building and a coolant recycler has been installed. In the mill a thickener has been built that will reduce reagent use, especially cyanide. Personnel receive regular training in order to properly handle hazardous materials and waste. Inspections/checklists of all hazardous and non-hazardous waste storage are performed weekly, including: drum integrity, proper

spacing, and segregating, and emergency spill readiness. A detailed electronic spreadsheet tracking system allows "cradle to grave" accountability for all wastes generated on site. The environmental department is dedicated to keeping open lines of communication within the mine to help ensure proper waste drum labeling, storage and disposal as well as constantly reinforcing spill reporting and clean-up procedures.

4.3 Task 3. The Reliability and Integrity of Information Relating to Environmental Reporting and Compliance

Direct field observations were completed to determine the reliability of reported information and to verify additional information provided through interviews with key mine personnel. Site observations focused on the environmental controls, reclamation activities, and monitoring systems.

Mine operations and facilities that were inspected and included the following:

- Open pit areas at Fort Knox and True North
- Milling and beneficiation facilities
- Processing and maintenance operations
- Waste management and containment facilities, including the tailing storage facility
- Seepage and ground water collection facilities
- Access roads
- Fresh Water Reservoir and water supply facilities
- Overburden, low grade ore, and growth media stockpiles
- Reclamation trial demonstration area
- Wetlands
- Monitoring facilities, and
- File system.

The reliability and integrity of information for reporting and compliance is adequate. FGMI has an environmental management plan that includes protocols for reporting, data QA/QC, instrument calibration, spreadsheets for dust monitoring, noise monitoring, waste management tracking and monitoring requirements in place. The staff is well organized, knowledgeable, and well-trained on environmental management for mines.

A compliance example follows:

> On May 7, 2001 the WAD cyanide limit was exceeded in the composite sample on the day and night shift. Measured concentrations were 40.5 and 43.9 mg/l. Due to the increased throughput (over 50,000 tons for the day) and elevated cyanide concentration in the leach and carbon-in-pulp tanks to accommodate required recovery of elevated gold concentrations in the ore being processed, the overall cyanide load to the detoxification circuit increased significantly. FGMI discovered the distributed control system (DCS) had a maximum allowable flow rate for the ammonium bisulfite (ABS) programmed into the control strategy. The threshold was insufficient to maintain the desired WAD cyanide concentrations in the tailings slurry exiting the detox circuit under the increased cyanide load conditions. The issue with the DCS was corrected within 3 hours and the WAD cyanide levels in the tailing slurry exiting the circuit appeared to be trending toward the desired concentration. Immediately FGMI took several environmental steps (visual survey of the impoundment for wildlife; measure WAD cyanide in the tailings decant water pool) and implemented two process changes (DCS control strategy modified and increased the volume of air into the leach, carbon-in-pulp, and detoxification circuit). Monitoring indicated that the issues contributing to the elevated WAD cyanide levels in the tailing slurry exiting the detox circuit were successfully corrected. FGMI contacted by phone the DEC to explain the problem and sent a letter to the DEC for their records.

4.4 Task 4. The Adequacy of State Oversight to Protect State Resources

In order to determine the adequacy of state oversight to protect state resources Golder interviewed staff from the following agencies:

- Alaska Division of Natural Resources (DNR), Anchorage
- DNR, Fairbanks
- Alaska Division of Environmental Conservation (DEC)
- U.S. Army Corp of Engineers (Corps)

- U.S. Fish and Wildlife Service
- Alaska Department of Fish and Game
- Alaska Mental Health Trust Land Office.

A complete list of individuals and the agencies they represent is presented below. All personnel, except Mr. Al Ott, were personally interviewed. Mr. Ott was interviewed via the telephone.

- Ed Fogels, Project Manager, Anchorage, DNR, Office of Project Management and Permitting
- Steve McGroarty, Fairbanks, DNR, Division of Mining, Land and Water Management
- Brent Martellaro, Fairbanks, DNR, Division of Mining, Land and Water Management
- Mike Franger, Anchorage, DNR, Mental Health Trust
- Charles Cobb, Anchorage, DNR, Dam Safety
- Al Ott, Fairbanks, DNR, Office of Habitat Management and Permitting
- Luke Boles, Fairbanks, DEC, Division of Water
- Ed Meggert, Fairbanks , DEC, Division of Spill Prevention and Response
- Tim Pilon, Fairbanks, DEC, Air Compliance
- Pete McGee, Fairbanks, DEC, Division of Water

The previous audit recommended several means to facilitate continued communication between agencies and FGMI and to streamline future audits. Golder determined that the recommendations were implemented and have facilitated the communication process. Summaries of the agency interviews are provided as Appendix A.

Golder inspected the filing system and reviewed project related files at the DNR. The files were organized in chronological order and fairly easy to review. The regulatory agencies for this project

appear knowledgeable and have sufficient understanding of mining practices, environmental mitigation measures and the state and federal regulations.

4.5 Task 5. Changes in Tailings Impoundment Geochemistry Due to Processing to True North Ore

Processing of True North ore at the Fort Knox Mine may have resulted in changes in tailings impoundment chemistry relative to the period of operation during which only Fort Knox tailings were discharged. In addition, concurrently with the inclusion of True North ore, lead nitrate was added to the process to minimize formation of thiocyanate and increased consumption of cyanide through precipitation of stable lead sulfate.

Tailings decant and seepage water chemistry data were reviewed to identify the following:

- Changes in tailings impoundment geochemistry due to the processing of True North ore (Task 5), and
- Changes in tailings impoundment geochemistry due to the addition of lead nitrate to the milling circuit (Task 6).

4.5.1 Tailings Impoundment Water Quality

Since March 31, 2001, ore from the True North Project has been blended with Fort Knox ore and the resultant combined tailings deposited in the Fort Knox Tailings Storage Facility (TSF). The ratio of Fort Knox to True North tailings is estimated at 0.75 to 0.25.

The host rock of the True North ore is a calcareous and carbonate-altered schist. The ore occurs in both an oxidized and unoxidized state, the former being the result of natural weathering. In the unoxidized ore, gold occurs in association with pyrite [FeS_2], arsenopyrite [FeAsS] and stibnite [Sb_2S_3]. In the oxidized ore, the sulfides have been replaced by goethite [FeOOH], scorodite [$FeAsO_4 \bullet 2H_2O$] and antimony oxide [SbO_2]. Other trace elements include copper and zinc, which occur as sulfides (chalcopyrite [$CuFeS_2$] and sphalerite [ZnS], respectively), and in association with ferric oxy-hydroxides (SRK 2000).

Steffen Robertson and Kirsten (SRK 2000) assessed spatial trends in True North ore element concentrations based on the results of 138 samples from diamond drill cores (representing 132 and

6 samples from the Hindenburg Pit and East Pit, respectively). SRK noted increases in sulfur concentrations with depth. No apparent increase in arsenic concentrations was observed with depth; however, core examination indicated that at depth arsenic is likely associated with sulfide minerals rather than ferric oxides.

The best and most straightforward way to evaluate changes in tailings water chemistry due to the processing of True North ore is through the evaluation of on-site monitoring data. Tailings decant and seepage water qualities are monitored quarterly. The decant water sample is taken from the surface of the pond using a barge. The tailings seepage sample is collected from a sump. Water quality data from December 1996 through May 2003 were evaluated for the current study. Water quality data prior to April 2001 were compared to post-April 2001 data to identify chemical changes. Figures 3 through 15 present concentration trends for diagnostic parameters using the quarterly monitoring data. Graphs of tailings decant and seepage water quality through time for constituents not highlighted in the text are provided in Figures B-1 through B-17 as presented in Appendix B. The following observations are made with respect to tailings pond chemistry following blending of Fort Knox and True North ore.

Conventional Constituents and Major Ions

- **Conductivity and TDS** - Tailings decant and seepage conductivity and total dissolved solids (TDS)[1] concentrations are consistent with the range of values observed for the Fort Knox ore.

- **pH** - Over the period of record, tailings decant pH (field measured) has ranged from 7.5 to 10.7, reporting an average value of 8.4. Since April 2001, decant pH has been relatively stable ranging from 8.2 to 8.8. Since addition of the True North ore, decant pH has remained within 0.4 pH units of the historical average. Tailings seepage pH since April 2001 has ranged from 6.3 to 7.2, currently demonstrating a decreasing trend. The lowest pH recorded prior to April 2001 was 6.7 (Figure 3).

- **Major Ions** - No significant changes are observed in tailings decant and seepage major ion concentrations (i.e., calcium, magnesium, potassium, sodium, chloride, sulfate and bicarbonate). Bicarbonate currently demonstrates an increasing trend in tailings decant water; however, current concentrations fall within the historical range. Piper plots, which present the relative concentrations of major cations (calcium, magnesium and sodium) and anions (chloride, sulfate and bicarbonate) in milliequivalents per liter, are a graphical representation of major ion

[1] Decant TDS measurement from April 2001 identified as anomalous (see Figure B-16).

chemistry. A Piper diagram (Figure 4) of tailings decant and seepage water qualities shows a slight bicarbonate enrichment in recent tailings pond decant water samples[2]. With the exception of the initial tailings water sampling events, tailings decant waters are generally classified as Ca-Na-SO_4 type waters.

Trace Metals

- **Arsenic** - Tailings decant arsenic concentrations have increased since the addition of the True North ore (Figure 5). Average total arsenic has increased from 0.01 mg/L to 0.71 mg/L[3]. Arsenic in tailings seepage has remained below detectable limits (<0.005 mg/L).

- **Antimony** – Tailings decant and seepage antimony concentrations have increased since addition of the True North ore (Figure 6). A rapid increase was observed in tailings decant concentrations followed by a more gradual rise in seepage concentrations. Average total antimony decant concentrations have increased from 0.005 to 1.3 mg/L. Prior to April 2001, antimony was below detectable limits in tailings seepage (<0.005 mg/L). Since April 2001, total antimony in tailings seepage has steadily increased to a peak value of 0.06 mg/L.

- **Selenium** - Tailings decant and seepage selenium concentrations have increased since addition of the True North ore (Figure 7). Prior to April 2001, selenium was generally below detectable limits in both tailings decant and seepage. Since April 2001, total selenium concentrations have steadily increased to 0.04 mg/L and 0.02 mg/L in the tailings decant and seepage, respectively.

- **Iron** – No change is observed in tailings decant dissolved iron concentrations following addition of the True North ore. Dissolved iron concentrations are typically low in tailings decant (<0.1 mg/L). Dissolved iron concentrations in tailings seepage are slightly higher than in decant waters. A small decrease was observed in tailings seepage average dissolved iron after April 2001 (from 0.1 mg/L to 0.05 mg/L). Average total iron concentrations in tailings decant and seepage since April 2001 are 0.4 mg/L and 0.1 mg/L, slightly lower than average concentrations prior to April 2001 (0.7 and 0.1 mg/L for decant and seepage, respectively).

- **Manganese** – No change is observed in tailings decant manganese concentrations. Manganese concentrations in tailings seepage are higher than the tailings decant. The general increasing trend observed in seepage manganese concentrations during processing of Fort Knox ore has continued following the addition of True North ore (Figure 8). A peak in manganese tailings seepage concentrations was observed in August 2001.

[2] A charge balance acceptability criterion of less than 15% was applied to all data included in the Piper Plot.
[3] Average arsenic, antimony and selenium concentrations calculated from quarterly monitoring results. Non-detect values assumed equal to the detection limit in calculation of averages.

- **Lead** – Total lead in tailings decant has been detected at a greater frequency since the addition of the True North ore. Total lead concentrations have remained low (up to 0.005 mg/L). Total lead in tailings seepage has generally been below detectable limits (<0.002 mg/L) since April 2001. Dissolved lead has remained below 0.002 mg/L in tailings decant and seepage over the period of record.

- **Zinc** – Zinc concentrations have remained low (<0.03 mg/L) in tailings decant over the period of record. Zinc concentrations in tailings seepage following addition of the True North ore are lower than during prior monitoring.

- **Copper** – Peak copper concentrations in tailings pond decant have increased since the addition of True North ore (Figure 9). The presence of copper in tailings decant is attributed to the use of copper sulfate [$CuSO_4$] in the cyanide destruction process. Copper concentrations in tailings decant follow the same trends as cyanide (Figure 10). Total copper is generally below detectable limits (<0.01 mg/L) in tailings seepage.

- **Other** - No change has been observed in the concentrations of the following metals: cadmium, chromium, silver, bismuth, and mercury. These metals are generally below detectable limits in tailings waters.

Cyanide

- **WAD and Total Cyanide** - Peak tailings decant cyanide concentrations have seasonally increased over the life of operation due to a change in operating practices. Cyanide concentrations show a cyclical pattern, reporting the highest concentrations in the winter months and the lowest concentrations in the summer (Figures 11 and 12). Ice cover during the winter prevents the degradation of cyanide by volatilization. Cyanide concentrations have generally remained below 0.05 mg/L in tailings seepage over the entire monitoring record.

Nutrients

- **Nitrogen –** Ammonia concentrations in tailings decant and seepage since April 2001 are consistent with levels measured in 1999 and 2000. The overall increasing trend observed in decant nitrate since the start of monitoring has continued since the addition of True North ore; however the rate of increase has increased relative to 1999 and 2000. The peak nitrate concentration measured in tailings seepage since April 2001 (approximately 11 mg/L) is consistent with peak concentrations in 1998 and 2000 (Figure 13).

- **Phosphate** - Since May 2002, phosphate concentrations in tailings decant water have ranged from 0.1 mg/L to 0.4 mg/L. Previously, tailings decant water phosphate concentrations remained low (<0.09 mg/L), and were generally below

detectable limits (<0.05 mg/L). Phosphate currently demonstrates an increasing trend in the tailings decant (Figure 14). Despite the occurrence of phosphate in the tailings decant, seepage concentrations remain low, remaining below detectable limits since May 2002 (<0.05 mg/L).

4.5.2 Summary of Changes

Spigotting of a combined Fort Knox and True North tailings to the TSF has resulted in increases in tailings decant antimony, arsenic, copper, nitrate, phosphate, and selenium concentrations.

A concurrent increase in antimony and selenium concentrations in tailings seepage suggests that the travel time though the tailings is on the order of months. On the basis of antimony decant and seepage concentrations, a travel time of approximately 9 months through the tailings is estimated. Figure 6 shows a rapid rise in antimony concentrations in both tailings decant and seepage following addition of the True North tailings. The tailings decant concentration plot shows a change in slope, indicative of a decline in the rate of concentration increase, in August 2001. A change in slope for the tailings seepage is observed in May 2002, 9 months following the observed change in tailings decant. Golder has been advised by FGMI that more detailed modeling of the travel time from the decant to the seepage collection point indicates a 182-day duration.

Tailings pond water copper and cyanide concentrations have increased as well, reflecting an increase in copper sulfate use. The gradual rise in tailings decant nitrate concentrations has continued since addition of True North ore. The cause of an increase in phosphate concentrations in tailings decant in May 2002 is unknown.

The increased concentrations of constituents in tailings pond decant and seepage have the following potential short- and long-term ramifications:

- The increased concentrations associated with the True North ore have resulted in short-term, defined changes in the decant and related seepage quality with a known travel time.

- The concentration increases may have a longer-term impact on seepage quality than the 9 (or 6)-month travel time, due to dispersion, attenuation and chemical controls as these constituents move from the pond water through the tailings. The time frame for the elevated constituents to migrate through the system or until there is no impact to seepage quality is not well defined and should be addressed with site specific studies.

4.5.3 Geochemical Controls on Pond Water Chemistry

Speciation modeling using PHREEQC was conducted to identify potential mineral solubility controls on tailings decant water chemistry. The potential for mineral precipitation was assessed using the saturation index (SI) calculated according to Equation 1.

$$SI = \log (IAP/K_{sp}) \qquad \text{(Equation 1)}$$

The saturation index is the ratio of the ion activity product (IAP) of a mineral and the solubility product (K_{sp}). An SI greater than zero indicates that the water is supersaturated with respect to a particular mineral phase and therefore mineral precipitation may occur. Supersaturated mineral phases were identified and evaluated for their likelihood to precipitate from the solution. This evaluation was based on considerations related to precipitation kinetics, experience, and observational evidence at similar sites, and best professional judgment.

Speciation modeling was conducted on the last year of tailings decant water quality data (4 samples). A redox potential (Eh) of 600 mV, indicative of oxidizing conditions, was assumed.

The modeling shows that tailings decant water is near equilibrium (or slightly supersaturated) with respect to dolomite, barite, and calcite (Table 6). Malachite is identified as a possible control on aqueous copper concentrations in tailings decant. The February and May 2003 water qualities indicate equilibrium with respect to chloropyromorphite; however, lead was assumed equal to the detection limit in both speciation calculations.

A mineral solubility control on arsenic, selenium and antimony in tailings decant waters is unlikely. Adsorption onto ferrihydrite (supersaturated in decant water assuming dissolved iron is present at the detection limit of 0.03 mg/L) is a possible attenuation mechanism for arsenic, copper and antimony. Selenium present as selenite (Se^{4+}) may adsorb to iron oxides; however, selenate adsorption is less effective (Beak International Inc. 2002).

Table 6

Tailings Decant Saturation Indices

Mineral Phase		Saturation Index			
		Aug. 2002	**Oct. 2002**	**Feb. 2003**	**May 2003**
Barite	$BaSO_4$	**0.5**	0.7	0.7	**0.5**
Calcite	$CaCO_3$	0.6	0.9	**0.5**	0.8
Cerrusite	$PbCO_3$	-3.1	-1.9	-1.9	-1.9
ClPyromorphite	$Pb_5(PO_4)_3Cl$	-6.8	-0.7	**-0.4**	**-0.3**
Dolomite	$CaMg(CO_3)_2$	**0.3**	**0.4**	**-0.1**	**0.3**
Ferrihydrite	$Fe(OH)_3$	1.9	1.4	-9.5	1.2
Gypsum	$CaSO_4{:}2H_2O$	-1.1	-1.0	-1.0	-0.9
Malachite	$Cu_2(OH)_2CO_3$	**-0.1**	-0.7	-7.9	**0.3**
Antimony Oxide	SbO_2	-6.8	-8.1	-7.1	-7.8

4.6 Task 6. Changes in Tailing Impoundment Geochemistry Due to the Lead Nitrate Addition to the Milling Circuit

The addition of lead nitrate in tailings processing is intended to remove sulfur from solution through the precipitation of a lead sulfate, thereby preventing the formation of thiocyanate (SCN). The use of lead nitrate in tailings processing since April 2001 has not resulted in significant increases in tailings decant lead concentrations. The increase in peak nitrate levels in 2003 relative to previous years is likely only in part attributable to the use of lead nitrate. Higher cyanide use would also contribute to higher tailings decant nitrate concentrations through natural decay of cyanide.

4.7 Task 7. Changes in Tailings Impoundment Geochemistry Due to Operation of the New Tailings Thickener

On October 17, 2002 the Fort Knox mill commissioned the operation of the new tailings thickener as part of the ore processing circuit. This audit task was undertaken to evaluate the potential changes in tailings impoundment geochemistry related to this new process component. Potential changes in the tailings impoundment geochemistry considered for this analysis include changes in tailings solids to water content and changes in the reagent usage. Prior to the commissioning of the thickener, the tailings solid content discharged to the tailings storage facility (TSF) was approximately 50 percent by weight. With the commissioning of the thickener, a higher tailings solid content of 65 percent can be achieved. This analysis was based on interviews with Mr. Clyde Gillespie, our visit to the mill,

review of the tailings discharge information, and review of the reagent consumption data. The audit analysis is presented below in the following format:

- Overview of the thickener system
- Solids content
- Reagent uses
- Summary of potential changes to impoundment geochemistry

4.7.1 Overview of the Thickener System

The thickener was added to the process circuit to increase process water operational temperatures and reduce reagent usage. The process water temperature has a direct affect on the gold recovery and was considered to be a primary factor in the project implementation. The new thickener at the Fort Knox mill consists of a wide cylindrical vessel with a tapered base, with rakes rotating within the lower sections of the vessel, extending throughout the entire diameter of the vessel. Flocculant is added to the incoming tailings suspension in a feed-well in the center of the thickener. The resulting flocs settle to the bottom of the vessel, and are dragged towards the central discharge point at the base of the thickener by the rakes. The action of the rakes improve dewatering of the tails through the openings in the thickened suspension behind the rakes acting as conduits for fluid to escape from the flocculated bulk. The thickened tailings suspension is removed as underflow and sent to cyanide detoxification circuit and then to the TSF for disposal. The clear process water at the top of the vessel is decanted as overflow, and is stored for reuse in the milling and gold extraction process. This clear process water is at the process water temperature and significantly above the temperature of the water recycled from the TSF decant system. The clear process water also contains cyanide concentrations that can be re-introduced to the process circuit minimizing the addition of cyanide. Tailings are thickened up to a density of 65 percent solids by weight in this manner. The thickened tailings then are mixed with tailings pond water to dilute the remaining cyanide concentrations.

The thickener system at Fort Knox offers several advantages to the operation including:

- The water removed from the thickener is at process water temperature, significantly warmer than the decant water brought into the mill recycled from

the TSF. This minimizes the impact to the process circuit temperatures by reducing the amount of cold water introduced from the decant system.

- The thickened tailings generally achieve a solids content of approximately 65 percent and have cyanide concentrations generally above the monthly average of 10 mg/L and the maximum of 25 mg/L prior to detoxification. At this stage the thickened tailings are mixed with the cold decant water from the tailings impoundment prior to cyanide detoxification. The tailings solids content is reduced to approximately 45 percent by adding process water, thereby diluting the cyanide concentrations. The decant water blended with the thickened tailings has cyanide concentrations that are below the discharge concentrations and dilute the cyanide concentrations in the tailings resulting in less detoxification and lower reagent usage.

- The water removed from the thickener has process levels of cyanide which are reused in the milling and extraction circuit, reducing the cyanide consumption.

4.7.2 Solid Content

As discussed above, the tailings solids content reporting to the TSF prior to the addition of the thickener averaged about 50 percent by weight. After the commissioning of the thickener the average solids content is 45 percent. The tailings are diluted with recycled tailings pond water and there is no change in the tailings impoundment geochemistry related to the tailings solids content.

4.7.3 Reagent Use

Use of the thickener has reduced the consumption of a number of reagents including:

- Cyanide, due to the capture and reuse of process water from the thickener
- Ammonium bisulfite (ABS), due to reduced cyanide detoxification
- Copper sulfate, due to reduced cyanide detoxification

A comparison between 2002 and 2003 production reports before and after the commissioning of the thickener are summarized below on Table 7.

Table 7

Reagent Consumption

Reagent Consumed	Average Year to Date 2002 Prior to Thickener (Lbs per Ton)	Average Year to Date 2003 After Thickener (Lbs per Ton)	Mass of Reagent Reduced per Day[4] (Lbs)
Cyanide	0.226	0.153	3,066
ABS	0.556	0.144	17,304
Copper Sulfate	0.130	0.042	3,696

Reduction in cyanide consumption reduces the detoxification requirements, which has a direct bearing on the quantities of ABS and copper sulfate that report to the impoundment. As shown in Table 7, the reductions in reagent quantities are significant and result in less chemical loading to the impoundment.

4.7.4 Summary of Potential Changes to the Tailings Impoundment Geochemistry

Based on the results of this audit, the changes to tailings impoundment geochemistry are considered to be beneficial due to the reduction of reagent usage and cyanide recycling. Cyanide is recycled as process water is removed directly from the tailings prior to detoxification. The tailings are further diluted with decant water to reduce or eliminate the need for detoxification resulting in significant reduction in the use of ABS and copper sulfate.

Another distinct advantage to the thickener is during the last year of operations, thickened tailings can be spigotted to the tailings impoundment to shape the surface of the impoundment reducing the potential grading requirements. The pumping and spigotting the tailings to reshape and achieved the desired the final surface contour will require significant engineering analysis to demonstrate the feasibility. This concept is discussed further under Task 9.

[4] Based on nominal milling rate of 42,000 tons per day

4.8 Task 8. Operation of the Interceptor Well System to Maintain a Zero Discharge from the Tailings Impoundment

The last audit (TRC 1999) identified water quality changes downgradient from the TSF due to the migration of seepage. FGMI has increased pumping rates at the seepage interceptor system to improve capture of tailings seepage in bedrock. Records from the pump back system and the tailings underdrain seepage and the water quality downgradient from the tailing storage facility were reviewed. Water balances for the tailing facility and piezometer reading from the embankment were also reviewed. Records included time periods prior to and following the completion of the system improvement

The TSF is permitted as a no-discharge facility. To achieve this, it was necessary to install a seepage collection system at the downstream toe of the TSF dam embankment to control flow through the structure. The seepage collection system consists of drain lines that are installed across-valley at the alluvium/bedrock contact which drains to a central water collection sump. In addition to the seepage collection system to control flows in the unconsolidated deposits, a series of interceptor wells were completed in the fractured bedrock underlying the unconsolidated deposits. Interceptor wells IW-1 through IW-4 were designed to create a hydraulic barrier to flow through the bedrock so that seepage from the TSF into the bedrock aquifer would be hydraulically controlled, routed back to the seepage collection system, and then pumped back to the TSF.

To demonstrate that both the seepage collection system and the interceptor wells were controlling all seepage so the TSF would operate as a zero-discharge facility, a series of monitoring wells were installed downgradient of the interceptor wells (MW-1 through MW-3). These monitoring wells show hydraulic control by demonstrating hydraulic gradients back to the interceptor wells, but also were completed to collect water quality data, to demonstrate that downgradient water quality was not being degraded as a result of seepage from the TSF. This system was installed in late 1996 and in early 1999 FGMI identified changing water quality in one of the monitoring wells (MW-2) that may have indicated that the seepage from the TSF was not being completely controlled by the seepage collection system and the interceptor wells. Analysis of the water levels indicated that hydraulic control was maintained by the interceptor wells in the bedrock.

In July of 1999, an action plan entitled, “Fort Knox Mine Tailing Storage Facility Seepage Collection and Interceptor Well System Action Plan (July 28, 1999)” was submitted to the DEC. The action plan was to maintain compliance with “Solid Waste Disposal Permit #0031-BA008”. FGMI

conducted a drilling program to further characterize the hydrogeology in the area of the interceptor well system, installed two additional interceptor wells, seven angled hole piezometers, and installed an additional three downgradient monitoring wells. In February of 2000, FGMI completed a new monitoring well (MW-5) downstream of the interceptor well system. This well provided additional gradient data which confirmed that the interceptor system was maintaining the required drawdown and water samples from MW-5 tested as being representative of background water quality rather then seepage water. Several improvements were made to the efficiency of the interceptor/pumpback system which were evident in the monitoring data.

In order to confirm the operational adequacy of the system, Golder analyzed water quality over time and the results from the hydraulics of the system (i.e., surfer modeling results).

4.8.1 Water Quality

Water quality data from interceptor wells IW-1, IW-2, and IW-3, tailings seepage, and monitoring wells MW-5, MW-6, and MW-7 were plotted on a Piper diagram and compared. Figure 16 indicates that there are three discrete water types. The tailings seepage is calcium sulfate rich, but bicarbonate and chloride poor. The monitoring wells (MW-5, 6, and 7) are bicarbonate rich, and sulfate chloride poor, indicative of background groundwater quality. Monitoring wells MW-5 and MW-6 are calcium bicarbonate type and monitoring well MW-7 is sodium bicarbonate type. The interceptor wells (IW-1, 2, and 3) are a mixture of the other two types of waters. This correlation is valid since all the wells are completed in bedrock material.

Since well MW-2 was the well that possibly detected tailing seepage, sulfate concentrations from that well were plotted over time (Figure 17). The plot clearly indicates background sulfate concentrations then peak sulfate concentrations in 1998 followed by a drop in sulfate concentrations back to background levels. Figure 18 is a Piper diagram of MW-2 water analyses over time. Water quality in 1996 is the same water type as background and current monitoring wells MW-5, 6, and 7 water type. MW-2 chemistry changes over time during 1997 and in 1998 it had a water type similar to tailings seepage. The water quality in MW-2 changed after the hydrogeological study was completed and additional interceptor wells were installed. The most recent water (5/19/2003) quality in MW-2 is almost identical to its original background concentrations from 1996 and the water type of the current monitoring wells (MW-5, 6 and 7).

4.8.2 Hydraulic Barrier/Capture Zone

Groundwater elevation contour maps developed by FGMI demonstrate that the pumping wells create a capture zone down gradient of the tailings dam. These contour maps are based on water level measurement from the pumping wells and the groundwater monitoring well network. The water level contours are computer generated using Surfer Contouring and 3-D Surface Mapping software by, Golden Software, Inc., Golden Colorado. Surfer is a grid-based contouring program with three-dimensional plotting capabilities of the contoured surface. The program interpolates irregularly spaced XY location and associated elevation (Z) data from an input file and creates a regularly spaced grid with a calculated elevation at each intersecting grid line or node per user defined and/or default grid parameters and methods (i.e. search radius and statistical methods). The contouring program is then used to create a contour map from the resultant grid file.

A review of the computer-generated water contour maps should include a review of the XYZ data and the user defined and/or default grid parameters used by the software to create the grid and maps. This information is important to assess the basis for the water contour maps contained in the reports reviewed by Golder. FGMI supplied the water level data and software parameter information to Golder for our review.

The water level contour maps presented in various documents show that the draw-down cones from the pumping wells intercept and create a continuous hydraulic barrier across the area of interest below the tailings dam. The water elevation data for the November 2002 and June 2003 maps were reviewed in more detail and were found to be consistent with and support the associated water level contour maps generated by Surfer and presented in the various reviewed documents.

The Surfer Data Filter Report and water level data set was provided by FGMI used to create the June 2003 Map. This report shows the user defined and default input parameters used by the grid program to create the regularly spaced grid. No irregularities were observed concerning the user defined and default parameters in the Data Filter Report. It is Golder's opinion that the user defined parameters and software default parameters are appropriate, given the site conditions and available data. These data and parameters utilized by the software are presented in Appendix C.

The second quarter 2003 report in compliance with Solid Waste Permit #0031-BA008, confirmed that the tailings impoundment is operating as a zero discharge facility. The interceptor well system was

performing well in the report and a cone of depression was being maintained. The system is being monitored and adjusted to assure proper performance. This monitoring and adjustment will continue as required.

It is Golder's opinion that the Interceptor System is performing adequately and that it should continue to perform well with minor modifications and adjustments as indicated by the monitoring systems in place. With proper attention to the system and any required maintenance, operations as a zero discharge facility should continue.

4.9 Task 9. Reclamation Plan Alternatives Proposed for the Tailing Impoundment and Critical Areas at Both Fort Knox and True North

Three reclamation plans prepared by FGMI have been reviewed for this Audit including:

- Fort Knox Mine Reclamation Plan dated April 2001
- True North Project Reclamation Plan dated December 2000
- Solid Waste Disposal Permit for the Mine Tailings Disposal #0031-BA008 including the supporting cost estimate backup

Additionally the United States Army Corps of Engineers (Corps) 404 Permit and correspondence from the Corps to the mine concerning potential revisions to the TSF reclamation were reviewed. This audit section reviews and evaluates the adequacy of the proposed approach and concepts for reclamation of the project components. Comments on the level of detail for the various stages in the life of mine are provided below. The adequacy of the reclamation surety is discussed in under Task 10.

The level of reclamation design accuracy should be advanced over the mine life as summarized below on Table 8.

Table 8

Reclamation Design Level

Stage of Mining Life	Type of Design Level For Reclamation / Closure	Accuracy +/- (%)	Completion of Engineering Level (%)
Feasibility / Permitting	Order of Magnitude	30-50	5
Operations	Conceptual / Preliminary	15-30	20
1 to 5 Years before the end of Operations	Feasibility Level Planning	10-15	50
End of Mining	Detailed / Construction Ready	<10	100

4.9.1 Adequacy of Reclamation Plans

The current reclamation plans for the Fort Knox Mine, True North Project, and Tailings Storage Facility (TSF) are conceptual / preliminary in nature and provide an approach for achieving the post-mining land uses and the reclamation objectives. The reclamation plans follow proven approaches and provide the growth media salvage estimates and the required volumes for reclamation. The reclamation plans includes provisions for concurrent reclamation of facilities where practical, unfortunately with waste dump construction designs (top-down) large-scale concurrent reclamation is not practical and therefore the majority of the earthworks and reclamation will occur at the end of mine life.

The reclamation plans are general in nature and provide concepts for the future activities. This level of detail is appropriate for this stage of the mine life (year 7 of a 15-year mine operating period). However, the development of formal designs including design criteria for storm water conveyance, channel designs and locations, grading plans, and growth media thickness will be required at least one year prior to the cessation of mining. The True North Project is approximately 15 months from completion and it is recommended that final level designs be developed as discussed below.

Specific comments related to each of the reclamation plans follows.

4.9.2 Fort Knox Reclamation Plan

The Fort Knox Reclamation Plan dated April 2001 provides the five-year plan for disturbance areas through 2005. The reclamation plan includes the reclamation procedures and the site specific conceptual reclamation plans. The April 2001 Reclamation Plan addresses the following key issues:

- Roads
- Open pit
- Waste dump grading and reclamation
- TSF reclamation and surface water spillway, channeling, and ponding
- TSF wetlands and ponds
- Wetland complex below the TSF
- Water Supply Reservoir (WSR)
- Buildings and equipment sites
- Long-term maintenance obligations

4.9.2.1 Roads

The proposed reclamation plans for roads are consistent with industry standards. It is the intent at mine closure that all culverts from the access road that traverses the lower part of the valley from the tailings dam to the Water Supply Reservoir and from the Gil Causeway will be removed

4.9.2.2 Open Pit

The reclamation of the open pit includes establishment of stable wall configuration and constructing a safety berm around the outside of the pit. The open pit walls appeared to be stable with benches intact during our visit. The proposed plan to convert the flooded open pit to a recreational lake is consistent with the desired land use. Consideration should be given to the potential risks associated with high wall for future recreational or other access. While the pit walls will likely be stable on

macro-scale, rock fall is expected and as the benches fill with debris or fail this rock fall could strike the pit lake. The open pit stability achieved during the operation of the mine incorporates the depressurizing of the rock mass by lowering the groundwater elevation below the pit slopes. Post-mining stability may be impacted as the groundwater levels rise, particularly for the pit slopes comprised of schist. It is recommended that a geotechnical review be completed that evaluates the impact of the rising groundwater elevations on the large scale slope stability.

The Fort Knox pit dewatering program includes water quality monitoring. Review of these results indicate generally good water quality. Continued monitoring of water quality is recommended to support the future determination of the ultimate post-mining water quality in the pit lake.

4.9.2.3 Waste Dump Grading and Reclamation

Preliminary volume estimates based on typical cross-sections have been calculated for the waste dump grading estimates. No formal grading plans or ultimate surface water management drainage layouts have been developed. Grading should be designed to minimize ponding of precipitation and runon. As discussed above, at this stage of the project, conceptual-level analysis as currently exists is appropriate and detailed designs are not necessary nor recommended due to the number of subtle changes in dump layout that are expected over the remaining mine life. Preliminary estimates call for 0.5 foot of growth media over the waste rock. While revegetation success does not appear to be of concern at the site based on visual observations by the audit team, it is still recommended that the concurrently reclaimed waste dump areas be documented as they mature to support the proposed cover thickness and ability to meet the 70 percent cover requirement. The audit team observed rapid revegetation of disturbed areas, but did not directly observe the successful revegetation of waste rock surfaces as the dump areas are still active. The next iteration of the reclamation plan should provide additional detail on the following:

- Grading plans
- Stormwater routing off waste dump benches and connection with natural channels
- Stormwater channel details and typical sections

4.9.2.4 TSF reclamation and surface water spillway, channeling, and ponding

The TSF reclamation and water management strategy has been conceptualized in the April 2001 Reclamation Plan by FGMI. This strategy consists of a dry revegetated closure with engineered surface water channels to carry surface water across the tailings to a small pond against the northern abutement area and spillway location. This concept contrasts with the approved plan in the Corps 404 Permit that contemplates a mixture of aquatic sites including 35 percent wetlands, 35 percent ponds, and 30 percent uplands. Also we understand based on interviews with the Dam Safety Program (Charlie Cobb) and DNR (Ed Fogels) that a dry closure may be preferred due to concerns related to long-term maintenance obligations of a jurisdictional dam and location of the residual ponds. Based on our experience with tailings impoundment closure design, the following issues must be addressed in the reclamation plan:

- Consolidation of the tailings will be greatest in the slimes areas in the center of the impoundment and will create a depression in the center of the impoundment near the dam. Developing surface water drainage off the impoundment surface requires one of the following approaches: 1) a wet closure with a large pond against the dam and spillway area; 2) reshaping of the tailings surface to create a small pond area away from the dam and against the spillway; or 3) a dry closure with substantial surface recontouring to route surface water to an abutement spillway or by creating an engineered concrete spillway down the center of the dam.

- A discharge spillway for the reclaimed TSF that is not subject to damming or receives regular inspections and maintenance to prevent overtopping is required.

- Consolidation of the tailings will require years delaying the closure of a substantial portion of the TSF. A preliminary schedule for TSF closure should be developed once the consolidation modeling is complete.

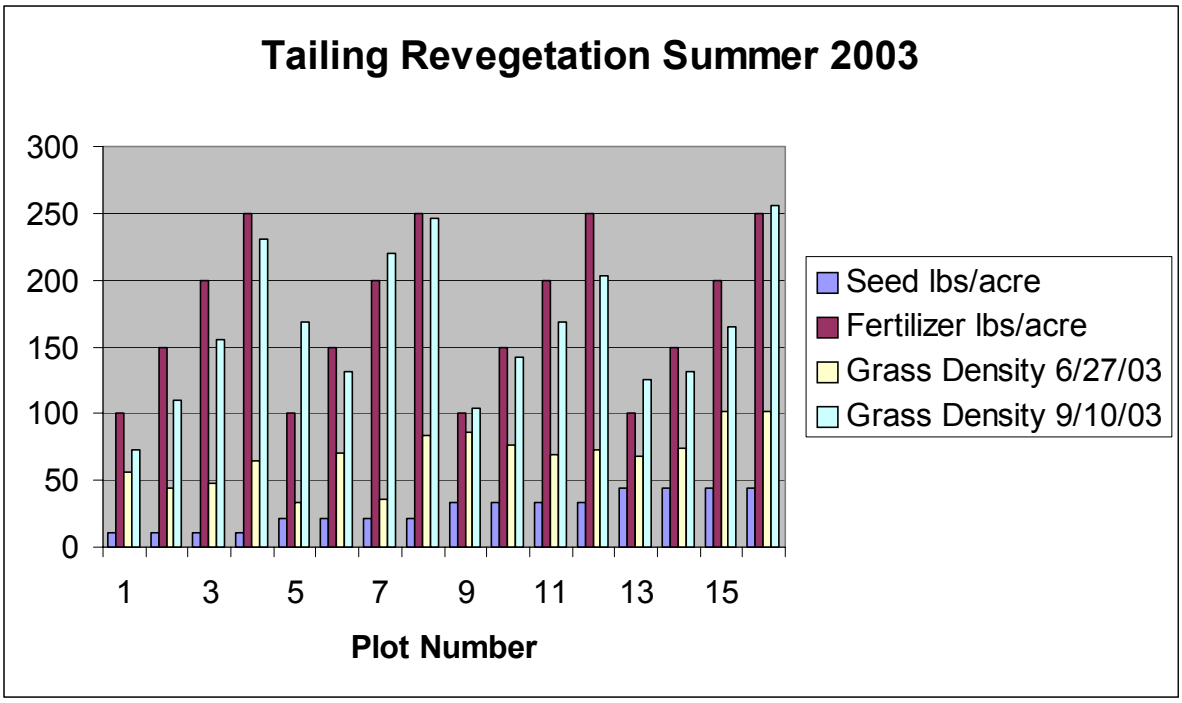
- Current plans and cost estimates call for the placement of one foot of growth media over the tailings. Direct revegetation of the tailings is a possibility at Fort Knox but the long-term ability to generate a self-sustaining soil and vegetation on the tailings needs to be demonstrated or growth media will be required.

- The engineered channels, as currently envisioned require a significant volume of riprap that needs to be developed and stockpiled prior to waste dump reclamation.

FGMI has implemented a test plot study in the summer of 2002 to evaluate the effectiveness of direct revegetation of tailings without the addition of organic matter. The test plots were constructed on the

Barnes Creek waste rock dump by placing a layer of tailings over approximately 2,800 square feet. 16 test plots are in progress with differing seed and fertilizer application rates. FGMI is documenting revegetation success using the Transect Intercept Method. The test plot seed mix was provided by the Alaska Plant Materials Center. Our review of the test plots indicated that revegetation success was related directly to fertilizer and seed addition rates as shown on Figure 19. Photographs of the test plots are included in Appendix E. These results are short-term (one season) and long-term success (3 to 5 years) must be demonstrated to justify this approach. Furthermore, it is our understanding that FGMI will be contacting the Alaska Plant Materials Center to follow up on their original recommendations and for study review.

Figure 19



Note: Figure provided by FGMI. Grass density measured using the Transect Intercept Method (e.g. number of grass leaves in contact with a 1-meter transect).

One of the most significant issues related to the TSF reclamation is developing a surface contour that allows free draining conditions to the spillway. The operational placement of the tailings creates slimes areas next to the dam area. Consolidation of the slimes will likely exceed 15 percent of the

depth of the materials and will create a large depression. To address these issues, the following closure approach is one alternative that can be evaluated:

- Reshape the surface of the impoundment near the dam during the last 18 to 12 months of operations using the thickened tailings to fill the pond area in the center of the impoundment to move the pond to the north abutement near the propose spillway location. This can be accomplished by creating rotating discharge points from the dam. Because of the scale of the impoundment, deferring recontouring until after operations can be costly and access to the slimes difficult. The thickened tailings provides an ideal opportunity to approximate the final contouring of the facility, minimizing the amount of earthworks required during reclamation.

- Establish a small pond area adjacent to the spillway and away from the dam for sediment control, habitat development, and storm event attenuation.

- Reclaim upland areas by direct revegetation or placement of growth media and construct engineered channels with appropriate erosion protection.

- Monitor consolidation and provide surface recontouring as necessary to prevent ponding adjacent to the dam.

- A prediction of the water quality associated with the tailings pond water and long-term seepage is recommended to be conducted as a part of the closure plan and include an analysis of the various alternatives (i.e. wet closure vs. dry closure options).

To support closure planning of the TSF the following analysis is recommended:

- Consolidation model and surface recontouring plan.

- Revegetation plan based on the results of the test plots.

- Reclamation schedule incorporating the results of the consolidation model.

- Post-reclamation water balance to support design storm event criteria and channel sizing.

- Post closure maintenance plan.

- Design channel/pond system to manage TSF surface flow in lower wetland areas.

- Water quality associated with tailings pond water and long-term seepage is being adequately monitored and the proposed approaches with the contingent plans for water treatment if needed seem appropriate.

Tailings Consolidation

Prediction of tailings consolidation rates is usually based on a combination of in situ data collection (cone penetrometers and piezometers), laboratory testing, and modeling. The consolidation model results can provide important information to support closure planning, schedule and cost estimation. The actual consolidation will depend on operational practices as well as the actual tailings and drainage characteristics. Accurate prediction of tailings surface settlement requires an understanding of the following site conditions and/or proposed closure activities:

- Tailings thickness;
- Geotechnical properties of the tailings, including anisotropy of hydraulic conductivity;
- The current state of stress and void ratio of the tailings throughout the impoundment;
- Variability of the tailings properties, both spatially and with depth;
- Filling history of the impoundment;
- The drainage conditions at the base of the tailings;
- A closure plan describing reclamation and closure activities that will be conducted on the tailings surface (including regrading and capping), plans for mechanical drainage of the tailings mass (if any), and the extent to which the tailings surface topography will allow water to pond or will allow surface runoff to prevent ponding;
- The closure water balance model if water is allowed to pool on the tailings during closure and, more specifically, the predicted limits of the water pool on the tailings surface; and
- Field data points that allow calibration of the model.

As with any geotechnical/hydrologic modeling effort, the larger the database the higher the level of confidence in the model results. The data requirements to develop a highly reliable predictive

settlement model are dependent on the variability and types of tailings materials in the impoundment. Given the scale of the impoundment and changing operating history, it is impractical to expect that all material types and variability have been defined.

A typical approach would use the limited available data to build a model that can be calibrated to future field monitoring, test the sensitivity of model input parameters to identify those most sensitive to variability, and present an upper- and lower-bound range of predicted tailings surface settlements. The model predictions can then be compared during the closure period with settlement monitoring (calibration points) and modified, if necessary, for subsequent refinement of prediction. The recommended approach would include refining the existing stratigraphic model of the tailings using the data from geotechnical investigations (cone penetrameter tests and piezometers), coupled with making assumptions of tailings variability based on review of operating records and depositional methods used during filling. Laboratory testing to support the consolidation modeling could include slurry consolidation and classification testing on representative samples.

Samples should be tested using test high-strain consolidation of tailings subjected to low effective normal (vertical downward) stresses, such as those tailings that are in close proximity to the tailings surface. A rigid-wall slurry consolidometer could be used to test the stress-strain characteristics of tailings at higher pressures.

Classification testing could include grain-size analyses, Atterberg limits (plasticity indices), shrinkage and cracking limits, and specific gravity.

Tailings Revegetation

Direct revegetation of tailings has been a subject of considerable interest in the Western U.S., due to the number of facilities developed prior to the implementation of modern reclamation techniques using stockpiled topsoil or other growth media. Success in direct revegetation requires the development of a self-sustaining organic soil. The Fort Knox tailings are a potential candidate for direct revegetation due to the lack of phytotoxic constituents such as acidity and high metals content. Direct revegetation of tailings typically requires amendment with organics, fertilization, seeding, and inoculation with bacteria to stimulate the soil properties. This can be accomplished by a couple of different methods such as:

1. Agricultural amendment – addition and blending of organics and other amendments to create a self-sustaining soil

2. Green manure – sequential growth of annual crops that is plowed under to provide increasing amounts of organics to the tailings ultimately leading to the development of self-sustaining soil

FGMI has implemented a series of test plots (Appendix D) to evaluate the feasibility of direct revegetation. These test plots have been developed in association with DNR – Plant Materials Center.

4.9.2.5 TSF Wetland and Pond Complex

As discussed above, the approved plan for mixture of wetlands, ponds, and uplands is not recommended because of the long-term maintenance obligations of a jurisdictional dam. This approach may be viable but will require dam safety analysis and provisions to the meet the long-term maintenance obligations. Additionally, wet closure of the tailings will increase the long-term seepage rate out of the facility, which may also have water quality implications due to increased chemical loads reporting downstream.

4.9.2.6 Developed Wetland below Tailings Dam

The developed wetland/ponds below the tailings dam have been constructed and by all accounts are exceeding the expectations for ecological restoration. Specific details of this program are presented in *Delineation of Ft. Knox Mine Created Wetlands* (Golder 2004) and summarized under Task 11. As this system is functioning exceptionally well for the establishment of aquatic life with the existing flow rates, an analysis and design to manage the post-reclamation flows from the TSF will be required. Detailed hydrological /engineering analyses for the current south valley wetland complex may not be needed if the main flow of Fish Creek post mining is directed to the north side of the valley. If a north valley stream/wetlands complex is created, a hydrological/engineering analyses would need to be conducted to determine size and shape of channels to handle flow from the tailing impoundment. Continued monitoring and maintenance of the structural integrity of the dikes on the current wetland system will need to be conducted.

4.9.2.7 Water Supply Reservoir

FGMI has proposed to leave the WSR for the long-term use and maintenance of DNR and Fish & Game (F&G). The WSR was designed and constructed to meet this objective. An agreement is in place for the establishment of funding mechanism to cover the long-term operation and maintenance of the dam, access road and causeway. It is the intent at mine closure to remove all culverts from the access road that traverses the lower part of the valley from the tailings dam to the WSR. There is also a rehabilitation plan in place for the Gil Causeway that crosses the WSR that includes scarification and removal of culverts thus providing more habitat diversification in that area and better water exchange between the portions of the WSR upstream and downstream of Gil Causeway. The maintenance activities have been identified as shown on Table 9 and appear to be consistent with the long-term requirements.

4.9.2.8 Buildings and Equipment Sites

The reclamation plan calls for leaving a recreational management facility, but removing all other mine facilities, building and equipment sites. Plans call for the salvage or sale of all usable equipment and materials and the on-site disposal of non-hazardous and nontoxic demolition debris. Foundations will be broken up and buried in place.

Equipment and structural steel salvage is the normal practice at mine sites. A discussion of the use of salvage credit to cover demolition costs for sureties is discussed in the next section. One significant aspect of the demolition is the need to remove hazardous and toxic materials from the buildings and equipment. This requires cleanup and disposal of significant quantities of materials, some of which can be disposed of within the TSF during flushing of the mill and process system with clean water, other materials will require offsite shipment. Also remediation of contaminated shallow soils in and around process areas as the building are removed is generally required. Therefore, it is recommended that the next version of the reclamation include a task description of mill site cleanup, offsite hazardous material disposal, and characterization and remediation of contaminated soils.

Demolition of the processing facilities is a significant undertaking and depending on the mining equipment / structural salvage steel market may require substantial landfilling of materials. A demolition plan should be developed that identifies the equipment and facilities suitable for salvage.

Other materials will have to demolished and landfilled. The demolition plan should include hazardous materials surveys and contaminated soil investigations and mitigation plans.

4.9.2.9 TSF Long-term Maintenance Obligations

Long-term maintenance plans have been developed in concept for the TSF over a twenty-year period and appear to be complete given the preliminary concepts for TSF closure. These conceptual plans include provisions for long-term water quality monitoring, piezometer and dam monitoring, and limited maintenance activities including grading and concrete repair. Typical maintenance issues at closed tailings impoundments include:

- Grading and fill of settled areas to maintain positive drainage
- Erosion control on the reclaimed surface
- Surface water channel and sedimentation control structure maintenance
- Spillway cleanout and maintenance
- Dam stability and piezometer review

Financial provisions for the long-term maintenance should be incorporated into the project financial assurance.

Water treatment concepts for the treatment of arsenic and antimony have been developed to support the temporary treatment of the tailings pond water should shut down occur during the milling of the True North ore. Additionally, concepts to support the long-term treatment of seepage have been developed to meet the water quality standards. The continued water quality monitoring and assessment is recommended to evaluate the potential long-term need for water treatment due to the True North tailings. After the completion of the True North ore processing it is recommended that an analysis of the water quality predictions and monitoring results be updated to provide an assessment of whether water treatment will be required post-closure. This assessment should consider long-term loading rates to the downstream receiving waters incorporating the predicted post-reclamation discharge of seepage. A prediction of the long-term seepage rates from the TSF based on the consolidation of the tailings will provide important data for closure planning of the impoundment.

4.9.3 True North Project

The True North Reclamation Plan dated December 2000 provides the plan for disturbance areas. The reclamation plan includes the reclamation procedures and the site specific conceptual reclamation plans. The December 2000 Reclamation Plan addresses the following key issues:

- Roads
- Open pits including backfill
- Waste dump grading and reclamation
- Buildings and Equipment Sites

4.9.3.1 Roads

The proposed reclamation plans for roads are consistent with industry standards.

4.9.3.2 Open Pits

Reclamation of the open pits includes conceptual discussion of the backfill of the East Pit and establishment of the free draining conditions for the Hindenburg Pit. Establishment of stable highwall configurations will be accomplished by backfill, blasting down of the slopes or other engineered options. The True North Project has been amended to include three additional pits. A detailed backfill and slope stability analysis is required to support the final reclamation plan and cost estimate. It is recommended that detailed level plans and engineering design of backfill and pit staging be implemented as soon as practical to support design and planning of the True North reclamation. It is our understanding that the mine life for the True North Project is approximately 15 more months.

Additionally, an infiltration and seepage analysis is required to support the evaluation and selection of cover thickness for backfill areas. Currently, reclamation plans call for one foot of topsoil and revegetation. A lysimeter field study has been proposed to evaluate the infiltration and seepage quality. The results of this study along with the quarterly water quality monitoring program should be used to evaluate and provide recommendation on the final reclamation cover specifications. The

current designs proposed by FGMI are stand pipes and are not well suited for the quantitative assessment of infiltration. Lysimeters to evaluate cover infiltration performance at mine waste facilities are typically constructed using "barrel" lysimeters. Figure 20 presents a construction detail for a barrel lysimeter and sampling manhole. The design presented on Figure 20 provides a general approach, but proper design should consider depth of the barrel below the reclaimed surface, the height of the barrel sides, and the diameter of the barrel in relation to particle size. Depth of the barrel should be at least twice the diameter of the barrel to prevent short-circuiting. Likewise the barrel height and diameter should be large enough that the particle grain size and distribution are not affected. Lysimeter tests typically provide the best results when run as long-term tests (i.e. one or more seasons) and when comparing the relative effectiveness of different reclamation cover types. The tests at True North should, if possible, be designed to evaluate the available soil for differing thicknesses and compaction rates to determine the optimal placement to minimize infiltration.

Due to the poor rock mass quality, slope instability is expected at the True North highwalls after reclamation. Long-term maintenance of the True North pit highwalls may be required to provide stable slopes. Maintenance activities may include uphill stormwater control and rock scaling. Depending on the proposed post-mining land use and access, the level of maintenance required should be addressed in the closure plan.

Due to the presence of potentially leachable sulfides in the True North pit walls, it is recommended that the backfill and waste rock, reclamation and surface water controls be designed to minimize infiltration through these materials. Controls should include promoting positive drainage from all areas while preventing the erosion of the cover. Isolation of these materials from stormwater runoff, shallow groundwater and infiltration will minimize or eliminate the migration of the metals/sulfates that are potentially leachable.

4.9.3.3 Waste Dump Grading and Reclamation

Preliminary volume estimates based on typical cross-sections have been calculated for the waste dump grading estimates for the East and Hindenburg Pits. No formal grading plans or ultimate surface water management drainage layouts have been developed. Backfill and grading should be designed to minimize ponding of precipitation and runon. At this stage of the project, detailed-level analysis is recommended due to the relatively short remaining mine life. Preliminary estimates call for one foot of growth media over the waste rock. While revegetation does not appear to be of

concern at the site, it is still recommended that the revegetation of disturbed areas be documented. Revegetation does not appear to be a significant concern at the site due to relatively high precipitation and low phytoxicity of the materials to be reclaimed. The disturbed are revegetation is not impacted by the presence of phytotoxic soils, based on visual observations of vegetation density and health. However, the reclamation requirements in the permits are quantitative and the analysis of the revegetation success should begin as soon as areas are reclaimed to allow an assessment of the timing and ability to met the objectives. The next iteration of the reclamation plan should provide additional detail on the following:

- Grading plans
- Stormwater routing off waste dump benches and connection with natural channels
- Stormwater details and typical sections
- Cover thickness design based on requirements for seepage control as determined from the lysimeter tests (see discussion above in Section 4.9.3.2 for recommendations on lysimeter testing)

The geochemistry of the True North waste rock and pit backfill material has been characterized by SRK (2000). Based on this analysis a number of constituents (antimony, arsenic, selenium, and sulfate) are potentially leachable and may impact shallow groundwater and surface water runoff.

4.10 Task 10. Adequacy of the Reclamation Financial Sureties for Both Sites

This task reviews the adequacy of the reclamation sureties for the Fort Knox and True North Projects. It is our opinion that any surety cost estimation prepared by mining companies cannot help but be slightly biased due to taking an optimistic view for the inherent uncertainty associated with long-term closure planning along with concerns over the capital costs associated with reclamation bonds. Our review indicates that while there are differences between the FGMI estimate and an agency administrated mine reclamation as discussed below, the FGMI cost estimates provide a starting point for the calculation of the project sureties at this stage of the life-of-mine. The intent of the comments in this section is to provide additional information for improvement of the accuracy of future surety estimates. The available information reviewed for this task includes:

- Fort Knox Mine Reclamation Plan, dated April 2001
- True North Project Reclamation Plan, dated December 2000
- Solid Waste Permit #0031-BA008, with supporting TSF Reclamation Cost Estimate
- DNR files.

The review of the surety estimates covers the following general topics as listed below:

- Adequacy and issues associated with specific reclamation activities – direct costs
- Adequacy and issues associated with indirect costs
- Long-term maintenance obligation cost estimates.

The determination of adequacy of the reclamation sureties for the Fort Knox and True North Projects considers both the direct costs (i.e. labor, equipment, and supplies) associated with the specific reclamation activities as described in the reclamation plans and the indirect costs (profit, engineering, construction management, bond costs, administration, and contingency) associated with completion of the work by outside contractors under the administration of the agencies. Increasingly, reclamation sureties are structured to cover completion of the work assuming that the mining company is walking away from the obligations and not on the assumption that the mining company will complete the work. Generally, the mobile mine equipment is not available for reclamation under the assumption of a bankruptcy. FGMI estimated sureties are well documented and supported with reasonable assumptions, assuming that FGMI completes the reclamation activities. The sureties are optimistic if the reclamation were to be completed by third-party contractors administrated by the agencies.

The calculation of the Fort Knox and True North reclamation sureties by FGMI include some appropriately conservative estimates for reclamation/closure activities where design or predictive uncertainty exists. Currently, the sureties include costs for contingent items that FGMI would consider unnecessary (such as the need for grow media on the tailings, water treatment of the tailings pond water, and long-term seepage treatment). These are generally significant reclamation/closure issues at other mines and including these activities is appropriate until further analysis is completed to justify a lower or higher surety. There is an ongoing study to characterize the potential for direct revegetation of the tailings in conjunction with the Alaska Plant Materials Center, which if successful

could substantially reduce the estimated cost for impoundment reclamation. Likewise, water quality data being collected will provide key information to support the predictive models for long-term water quality from the seepage and the impoundment. These contingent items were included to cover the unknowns that are typically associated with conceptual designs and pre-mining water quality predictions. The reclamation sureties should be updated with new design information as it becomes available for the five-year permit renewals. Once additional information is available on these issues and a formal design developed for activities like the tailings revegetation performance or the tailings pond water quality after the True North processing, the estimated costs for these activities may not be necessary and should be reviewed for potential surety reduction.

Conversely, the Fort Knox and True North reclamation sureties are non-conservative in other respects related to the direct and indirect costs. As discussed below in more detail, the production rates are high in comparison with that achievable by third-party contractors using mobilized equipment to the site. Likewise the indirect costs are low for a situation where the agencies are assuming the management responsibility for the mine reclamation.

These aspects of the reclamation sureties are discussed in more detail below.

Adequacy and Issues Associated with Specific Reclamation Activities

As discussed above under Task 9, the general approach to reclamation planning for the Fort Knox and True North Projects are appropriate. This subsection considers the specifics of cost estimate assumptions and provides a review of the key issues. The backup cost documentation prepared by FGMI provides an appropriate level of detail and the approach and assumptions are understandable based on the reclamation plans and cost detail. This analysis focuses on review of some key assumptions that drive the direct cost estimate.

The most significant earthworks tasks from the Fort Knox and True North reclamation include regrading of the dumps, roads, and borrow areas followed by topsoiling and revegetation. The tailings impoundment closure also includes grading for channels, erosion protection, surface topsoiling, and revegetation. These earthworks activities roughly account for the following percentages of the total direct cost estimates:

- Fort Knox Mine: 75% ($1.2 Million of $1.6 Million)

- Tailings Impoundment: 37% ($2.5 Million out of $6.8 Million)
- True North Mine: 68% ($0.68 Million out of $1.0 Million)

The earthworks costs relate primarily to grading of waste rock dumps and loading, hauling, and placement of topsoil. FGMI has estimated these activities using dozers and scrapers. Analysis of the cost estimate assumptions is presented to evaluate the adequacy of the surety calculations for the earthworks. Reclamation costing includes a very simple approach:

(Volume or Area / Production Rate) x Unit Cost = Direct Cost.

The volume and area calculations completed for the estimate are based on typical sections and measured areas. This volume calculation method is appropriate for conceptual level design but should be updated at least two years prior to the initiation of reclamation with engineered grading plans and surface control structures.

For surety estimates, production rates are generally estimated on a site-specific basis using professional judgment, data from contractors or by adjusting information from CAT ® Handbook, RS Means ® Heavy Construction Cost Data, and Western Mine Engineering Mining Cost Service to meet the site specific design requirements. Earthmoving equipment performance information, furnished by equipment manufactures, should only be used as a check reference. The production rates in the Fort Knox and True North reclamation plans are adjusted from the CAT ® Handbook based on FGMI experience. Based on the review of the previously noted documents, these production rates are optimistic and are more reflective of the unit costs, equipment selection and production rates associated with a mine fleet than would be achievable by a third-party contractor. The use of CAT ® 657E scrapers is equipment that most contractors would not mobilize to a site for a short-term reclamation project, but these units are available to FGMI.

A review of assumptions used by FGMI for the corrected production rates are found in Table 10.

In general the correction factors are optimistic but not unreasonable at this stage of the planning (conceptual/preliminary engineering). As discussed above some elements of the cost estimate are non-conservative, which should be addressed in the next iteration of the reclamation cost estimate. FGMI assumed excellent operators and has not considered frozen material, inconsistency in material

cohesiveness, or weather. The FGMI estimate and supporting cost data documents the assumptions and is consistent in approach.

Table 10

Job Condition Correction Factors

Assumption	FGMI Correction Factor (Track Equipment)	Comments
Operator	1.00	This indicates an excellent operator, which is typical for mine sites but a contractor would generally have operators in the average category at 0.75
Material	Material Specific 1.2 for topsoil 0.7 for rock	1.2 represents loose stockpile material which is probably a good assumption for most topsoil material at Fort Knox, less so at True North. Frozen, wet, sticky or non-cohesive material can be range from 0.7 to 0.8. A variety of conditions would be expected.
Density	Material Specific	FGMI appropriately used density adjustments based on site specific characteristics.
Job Efficiency	0.83	Represents 50 minutes per hour and is typical.
Grade	Site Specific	Calculated on a facility by facility basis using the conceptual design information.
Production	Site Specific (D10R dozer examples) 1027 LCY/Hr for pushing down waste rock crests (1.3H:1V to 2.5H:1V) 2519 LCY/Hr for pushing topsoil on slopes 1575 LCY/Hr for pushing topsoil on flat	Calculated on a facility by facility basis using the conceptual design and CAT ® Handbook production rates for estimated hauls/pushes. These corrected production rates are very optimistic and probably not achievable on a consistent basis by a contractor due to weather, double handling, material characteristics etc.

The starting production rate (before adjustment according to the above factors) of 1,700 loose cubic yards (LCY) per hour for the D10R dozers pushing down waste rock slopes or spreading topsoil appears to be, in general, optimistic for the anticipated application. The FGMI estimated an average 100 ft push distance on the regrading of the waste rock dumps the average push expected on the slopes between benches on the waste dump. The production rate from the CAT ® Handbook indicates starting rate of approximately 1,700 LCY proposed by FGMI for the 100 ft push. Adjusting this production rate for the site specific conditions and activities gives the following comparison for FGMI estimate and production for the slope length (Table 11). FGMI has estimated a production rate

of 1,027 CY per hour, while based on our experience more typical contractor production rates would be 700 to 800 CY per hour.

Double handling of materials has not been incorporated into the correction factors and this issue should be addressed in the closure plan. This factor can be addressed and minimized through appropriate project design. Therefore, it not expected that FGMI would explicitly address this correction factor in their estimate with the assumption that double handling of topsoil and waste rock grading will be minimized through adequate design.

Table 11

Production Rate Comparison

	FGMI Estimate		**Golder Estimate**	
	PUSHING DOWN BENCH CRESTS		PUSHING DOWN BENCH CRESTS	
CAT D10R DOZER	ANGLE OF REPOSE TO 2.5:1		ANGLE OF REPOSE TO 2.5:1	
	(100 ft PUSH)		(100 ft PUSH)	
EQUIPMENT				
Average Dozer Push	(ft)	100	(ft)	100
Maximum Production	(CY/hr)	1,700	(CY/hr)	1,700
CORRECTION FACTORS				
Operator Efficiency	Excellent	1	Average	0.75
Material	Loose Rock	0.7	Loose Rock	0.7
Job Efficiency	50 min/hr	0.83	50 min/hr	0.83
Density Correction		0.65		0.65
Grade Correction	-1.4H:1V to -2.5H:1V	1.6	-1.4H:1V to -2.5H:1V	1.6
TOTAL CORRECTION FACTOR		0.60		0.45
FACTORED PRODUCTION RATE	(CY/hr)	1,027	(CY/hr)	765

The corrected D10R production rates estimated by FGMI for the spreading of topsoil on the waste rock dump slopes and flat areas are also quite optimistic at 2,519 LCY/hr (0.32 hrs/ac slopes) and 1,574 LCY/hr (0.51 hrs/ac flats). Based on our experience finish grading work like spreading topsoil is generally 0.5 to 1.0 hours per acre depending on material consistency, location of stockpiles, slope, and final grading.

The use of the 657E scraper for moving topsoil from the stockpiles to the reclamation areas is entirely consistent and appropriate for FGMI planning assuming they will conduct the reclamation. This equipment is not likely consistent with the size or approach by a third-party contractor because of the

size and difficulty in moving these pieces of equipment for a short-term job. However, given the familiarity with the equipment by the mine, this assumption is considered appropriate for this level of cost estimation. As discussed above some elements of the cost estimate are non-conservative such as the use of 657E scrapers, which should be addressed in the next iteration of the reclamation cost estimate. Additional refinements to future estimates include correction of scraper productions rates using total resistance (grade plus rolling resistance) to determine cycle times. Currently only rolling resistance cycle times have been used.

Another cost item that should be addressed in the next reclamation analysis is the processing of riprap for the channel lining. These materials will need to be processed and stockpiled during the waste rock dump reclamation activities and a cost estimated for this step. Additionally, riprap placement in the channels is currently estimated for the TSF cost estimate using a D10R dozer. This activity should include load and haul from the stockpile and placement of the riprap in channels with a track excavator. Riprap costs including processing, stockpiling, loading, and placement in the channels will likely be in the range of $20 to $30 per CY.

The unit rates as provided by FGMI for the Fort Knox and True North cost estimates are likely based on long-term lease rates available to a mining company and do not necessarily relate to those available to a third-party contractor. Also the operating and maintenance costs as provided by FGMI are approximately two-thirds of those typically used by a contractor. Again a comparison using the example of the CAT D10R Dozer is presented below on Table 12.

Table 12

Dozer Costs

Equipment	Hourly Rate ($/Hr)	Operating Costs ($/Hr)	Total Equipment Rate ($/Hr)
CAT D10R - FGMI	$105	$60.90	$165.90
CAT D10R – RS Means 2003 (Lower 48 No Region Correction)	$129	$90	$219

It should be noted that the TSF reclamation unit rates ($248/hr for the D10R dozer) have been updated and are consistent with our expectations for the proposed equipment.

Adequacy and Issues Associated with Indirect Costs

Indirect costs include those costs over and above the completion of the physical work. These costs generally are related to planning, design, contracting, mobilization/demobilization, inflation related to multi-year projects, contractor profit, contingencies, administration, and management of the reclamation. A comparison of FGMI indirect costs and the range of indirect costs expected for a third-party contract are summarized below in Table 13.

Table 13

Indirect Cost Comparison

Indirect Cost Item	FGMI Estimate	Typical Range of Costs	Comments
Mobilization/Demobilization	5 % of Contract	5-10 %	
Engineering / Redesign	Not Estimated	2 to 10 %	Engineering costs associated with taking conceptual/preliminary designs to construction level
Contractor Profit and Overhead	10 % of Contract	15 to 30 %	Related to the size of the contract with 15 % typical for the contract range at FGMI
Performance and Payment Bond	Not Estimated	1.5 each %	Required for contracts with federal agencies
Contract Administration	5 % of Contract	2 to 7 %	Covers agency contract administration and project management
Contingencies	5 % of Contract	5 to 30 %	Contingency related to level of design: Detailed Design – 5 to 15 %; Conceptual or Preliminary Design – 10 to 20 %; and Order of Magnitude – 20 to 30 %
Inflation	1.5 % of Contract per year	2 to 3% per year	

The indirect costs as presented by FGMI for the most part agree with other typical estimates, with the exception of contingencies and engineering costs. The estimate of contingencies should be based on the level of design, with 5 percent contingency reflecting a construction level final design. Based on our review, we estimate that FGMI is currently at the conceptual / preliminary design level for reclamation planning and that engineering costs are appropriate for inclusion in the indirect costs. A contingency of 15 percent is appropriate given the current level of design.

Long-Term Maintenance Obligation Cost Estimates

FGMI has included cost estimates for the long-term maintenance obligations expected at the TSF and WSR. The long-term maintenance closure cost estimates provided by FGMI for review (Excel ® file name: FTKXTAILRECSUM102700.xls for the TSF) include monitoring, inspections, and maintenance costs with inflation included. The estimates and assumptions seem appropriate but should be updated with actual data for the next estimate.

Water treatment cost estimates are based on the need for arsenic and antimony treatment of the tailings pond water (short-term) and long-term (10 years) seepage. With the available water quality data, these assumptions are responsible and consistent with the issues expected at the site. A conceptual design of the treatment system flowsheet and presentation of treatability information should be prepared for inclusion in the next reclamation analysis.

4.11 Task 11. Evaluate: the Extent and Functional Value of Developed Wetlands Created by FGMI as Mitigation for Lost Acres Beneath the Tailings Impoundment

Clearing and filling of water of the United States (including wetlands) have occurred on the Fort Knox site as a result of mining and exploratory activities. Department of the Army (DA) permit number 4-920574, Fish Creek 23, was issued to FGMI to conduct mechanized landclearing and excavation of up to approximately 377 acres of Palustrine Scrub-shrub (PSS) wetlands and discharge of fill into approximately 103 acres of waters (mostly PSS wetlands) of the United States. Specific activities by FGMI on the Fort Knox Mine site causing discharge of dredged or fill material into waters of the US included: land clearing and/or excavation activities in waters of the US, placement of rock dumps and stockpiles, road crossings, and reclamation and mitigation activities (EPA 1993).

Based on a review of communications between FGMI and the Army Corps of Engineers (Corps), FGMI has been in compliance with their DA permit to date. Based on discussions with the regulating agency, FGMI communication with Corps has been good, as has been responsiveness to Corps requests (V. Ross pers. comm. 2003). Modifications to the DA permit for additional disturbances to wetlands have been filed and approved accordingly. The Corps does one to two site inspections of the site per year (V. Ross pers. comm. 2003).

The objective of Task 11 was to identify, delineate, and generally describe wetlands and other waters created for mitigation within the Fort Knox Project area as part of an environmental audit of the mine.

Specific to the scope of work of this effort, no wetland functional assessment was conducted to determine the functions and values of wetlands created compared to those removed. A detailed summary of the wetland delineation of Fort Knox mine is provided in Golder (2004).

Wetland mitigation is defined in 40 CFR 1508.20 (a-e). Mitigation is generally defined as avoiding wetland impacts where possible and compensating for wetland impacts that are unavoidable through offsite replacement, restoration, or creation. Mitigation acres of waters of the US (including special aquatic sites) were proposed in the Fort Knox Gold Mine Technical Assistance Report (EPA 1993) as mitigation for lost wetland acres. These wetland mitigation prescriptions were grouped by various areas as follows:

On the Reclaimed Tailings Impoundment	87 acres
Below the Tailings Dam	45 acres
Lake within pit	148 acres
Water Reservoir and Associated Wetland Areas	165 acres

To further compensate for adverse impacts to aquatic resources, the DA permit was conditioned to revise the amount of acres of wetlands for the reclaimed tailings impoundment to provide a mixture of aquatic sites (ponds, wetlands, and streams) and uplands (to include islands in the middle of ponds).

As a result, the following special conditions 9 a and b were appended to the DA permit: Special conditions 9 a and b of the DA permit stated that "permittee shall, in cooperation with the Alaska Department of Natural Resources, Alaska Fish and Game, U.S. Fish and Wildlife, National Marine Fisheries Service, Environmental Protection Agency, and the Corps design a reclamation plan specific to the top of the tailings bench; which would be implemented and completed to the satisfaction of the DE prior to final closure and would include at a minimum: a mixture of aquatic sites (ponds, streams and wetlands in the following proportions : 35% wetlands (424.5 acres), 35% ponds (424.5 acres) and 30% uplands (364 acres) for a total of 1,213 reclaimed acres. At present time, the DNR prefers a dry closure to the tailings impoundment. This is contrary to the permit plan for 425/425/364 reclamation.

Reclamation of the tailings impoundment will occur at mine closure. There is a likelihood that this Corp requirement would change because State Dam Safety sees a long-term maintenance issue with a large pond on the tailings.

To begin fulfilling mitigation requirements, creation, and enhancement of wetland and other waters on the Fort Knox Mine site began in 1995. These wetland creation and enhancement activities included:

- A series of wetlands and connecting channels created in the Fish Creek valley between the tailings dam and the water supply reservoir
- The water supply reservoir and stilling basin
- Last Chance Creek floodplain enhancement activities

Before performing the onsite assessment, Golder reviewed available documentation describing site conditions and the various mitigation projects that have been implemented to date. Golder performed the delineation of created wetlands during the periods of July 29 through July 31, 2003 and August 6 through 8, 2003, in accordance with the US Army Corps of Engineers *Wetlands Delineation Manual January 1987*.

Wetland areas, labeled by FGMI as "Ponds A – F", were created in the area of the Fish Creek Valley between the tailings dam and water supply reservoir, beginning in 1996. These wetland areas were created by placing five earthen berms across the drainage to impound water. The water supply reservoir and spillway were completed in 1996 (in the Fish Creek valley), which also includes several bays. The water dam is located in Fish Creek approximately five miles downstream of the ore body and mill plant site. Last Chance Creek rehabilitation was done during fall 2001 at two locations (lower end and about 1.6 km upstream of the mouth). Golder (2004) includes figures of the extent of wetlands created. The total amount of wetland acreage created is:

- Pond A: 6.1 acres
- Pond B: 1.2 acres
- Pond C: 4.6 acres

- Pond D: 1.3 acres
- Pond E and F: 6.5 acres
- Additional wetland area between Ponds A and B: 0.3 acres
- Channels: 0.45 acres
- Reservoir and associated wetland areas: 184.3 acres

In the Last Chance Creek enhancement 1.6 acres were specifically recontoured/reseeded to provide fish passage for Arctic Grayling up into the watershed for spring spawning. The actual direct benefit to habitat improvement for this action is difficult to quantify. However, the ramifications of the habitat enhancement value to allow fish passage are at a watershed scale rather than the 1.6 acres directly affected.

Table 14

Comparison of Acres Created/Enhanced and Prescribed Mitigation Acres

Reclamation Type	Prescribed Acres[1]	Created Acres	Additional Acres Needed
DA Permit Special Conditions for Reclaimed Tailings Impoundment (combination of wetlands/ponds)	425/425	*	425/425
Below the Tailings Dam	45 acres	20.5	24.5
Lake within Pit	148 acres	*	148
Water Reservoir and Associated Wetland Areas	165 acres	184.3	-19.3
Additional Habitat Enhancement (Last Chance Creek)	NA	Fish passage improvements	NA

[1] Prescribed acres as defined in DA permit *indicates activity not yet completed by FGMI.

Four of the wetland areas created (Ponds A, B, D, E) have Palustrine Scrub Shrub (PSS) types as defined by Cowardin (1979) around the aquatic (pond) wetland margin. Pond C now functions more as riffle/pool habitat. All areas except Pond C (which suffered a dam breach) impound water. After the failure of the dike at the downstream end of Pond C, this area was characterized as a shallow glide with some pool/riffle habitat near the upper most portion of the pond (DNR 2003). A more defined stream channel with pool/riffle habitat has developed over the past four to five years and now extends from the upper end about 50% of the way to the original dike. Flood events during summer 2003

added to the stream length with a better defined channel and natural vegetation recurring. The primary factor affecting revegetation in Pond C is aufeis and the degree to which it grows each winter. As the channel becomes better developed, aufeis growth in winter may be reduced (E. Fogels pers. comm. 2003).

The boundaries for the water supply reservoir as described in this audit were based on the ordinary high water mark observed in the field. Golder completed 18 detailed field plots in areas delineating the reservoir boundary, including bays and the ponded extension area beyond the Solo Creek Causeway. The stilling basin was another aquatic pond wetland immediately below the water supply reservoir spillway. The water level of the reservoir is regulated by the elevation of the spillway.

The margins of the reservoir were highly variable and included mostly barren, highly disturbed areas on the southern and western margins, and undisturbed wetlands comprised of black spruce needleaf woodland containing scattered stands of paper birch, willow, blueberry, and Labrador tea Surrounding wetland areas enhanced by the development of the water reservoir include both PSS wetlands and PFO (Palustrine Forested) wetlands. These enhanced wetland areas were primarily located surrounding the Last Chance Bay inundation area and the Solo Creek inundation area. Remaining wetland areas surrounding the water reservoir are pre-existing undisturbed PSS and PFO wetlands.

At present both the pond wetlands and the water supply reservoir and associated wetlands are providing high quality fish habitat. Channels connecting the ponds and Pond C provide riffle habitat. ADFG has conducted annual monitoring of arctic grayling and burbot populations in the water supply reservoir, stilling basin, and created wetlands in Fish Creek since creation of the wetlands and reservoir. These activities are documented in: Arctic Grayling and Burbot Studies in Fort Knox Water Supply Reservoir, Stilling Basin and Developed Wetlands (Ott and Morris 1999, 2000, 2001, 2002, 2003) (Alaska Dept. of Fish and Game Tech Report 00-1, 01-02, 02-1, and 02-06). This effort has resulted in an ongoing study that provides valuable habitat data. Successful spawning and survival of age-0 Arctic grayling has been documented every year since 1999 and there is evidence of substantial recruitment to the population. Substantial out migration of arctic grayling is also occurring to the China River system (A. Ott pers. Comm. 2003). Burbot are being studied through a spring mark, fall recapture by ADFG. Burbot population dropped 50% in 2002 since 1999, with the drop occurring mostly in smaller fish. Larger fish populations appear to be stable (A. Ott 2003 pers. comm.). This effect could potentially be due to low dissolved oxygen concentrations due to

permafrost and large floating mats of organics (A. Ott 2003 pers. comm.). Burbot catches in spring 2003 indicate reproductive success is still occurring. Based on radio telemetry data collected by ADFG, in all likelihood, the spawning is occurring in the WSR in the area directly influenced by freshwater input from Solo Creek (DNR 2003).

Numerous wildlife species have also been documented using the areas in and around the created wetland sites. During the wetland delineation, moose, several species of waterfowl and shorebirds, as well as signs of beaver activity were seen on the sites.

No detailed hydrological or engineering analyses were conducted in this Audit with regards to structural integrity of the created ponds. No detailed engineering drawings of the created interconnecting channels were available for review. Observational accounts indicate that dam breach has occurred in one pond (Pond C) to date, likely due to settling and thawing of permafrost soils. Open channels connect the majority of the ponds. Based on the observed size and width of these interconnecting channels (and associated culverts in some cases) it does not appear that these channels would be able to convey large quantities of water related to a high peak flow events (50- or 100 year event) of the full drainage area. The peak flow events on the Fish Creek system are currently withheld by the tailings dam located upstream. A detailed hydrological/engineering analyses will be needed if flow is directed through these wetlands upon mine closure. If an alternative plan to create a north valley stream/wetlands complex is desired, hydrological/engineering analysis will need to be conducted to determine size and shape of channels to handle flow. Long term monitoring and maintenance of the structural integrity of the dikes on the existing created wetlands is necessary.

Several areas of the ponded wetlands upstream of the freshwater reservoir contained large pieces of rusted metals, left over from previous mining operations. Several pieces in Pond B appear to be negatively affecting the water quality of this pond.

Three areas on the eastern side of the Last Chance Creek floodplain were rehabilitated by FGMI in 2001. Rehabilitation was designed to limit growth of aufeis during winter and to keep the creek in its channel during breakup. Work in these areas included re-directing the stream into a single thread channel through the placement of a berm, general clean-up of the floodplain from placer mining activities, recontouring of floodplain areas, and seeding the floodplain with native grass cultivars. Re-countering these areas and redirecting the channel increases the ability for fish (Arctic grayling)

passage that may have been previously limited due to low multiple channel flows that were restricted by ice flows in winter. Aufeis during the winter of 2001/2002 was extensive throughout the lower portion of Last Chance Creek, but in winter 2002/2003 aufeis was not present in lower sections. DNR will continue to monitor Last Chance Creek and additional work may be suggested based on results of the monitoring (DNR 2003).

At present, the non-riverine areas of Last Chance Creek do not exhibit any of the three characteristics (hydrology, vegetation, or hydric soils) necessary for the classification of wetlands. Vegetation cover in these areas is very sparse and consists of sporadic individuals of Sandbar *Salix exigua*) and Gray-leaf willow (*Salix glauca*) some of which were planted as willow cuttings and grasses from the planted grass mixture. Enhancement activities in this area have provided aquatic habitat improvement by allowing greater opportunity for fish passage in the now single thread channel and floodplain habitat should develop once vegetation becomes more established. If additional re-vegetation is to occur in Last Chance Creek, existing overburden from sources in the Last Chance Creek valley can be scarified/mixed into the rock and gravels present.

In terms of overall wetlands and other aquatic sites created, FGMI has to date developed a total of 204.8 acres, including wetlands below the tailings dam and the water reservoir and associated wetlands. Wetlands and other aquatic sites created by FGMI below the tailings dam are primarily aquatic (pond) sites surrounded by palustrine scrub-shrub (PSS) wetlands. These presently constitute 20.5 acres (24.5 total acres less than the prescribed amount). The water reservoir and associated wetlands are primarily open water sites surrounded by Palustrine Forested wetlands (PFO) and Palustrine Scrub-shrub wetlands (PSS). The water reservoir and associated sites created by FGMI total 184.3 acres and exceed the prescribed amount of 165 acres by 19.3 acres. Additional habitat enhancement on Last Chance Creek completed by FGMI was non-prescribed.

Lake area within the pit (148 acres) and wetlands/ponds/uplands (425/425/365) on the reclaimed tailings impoundment as prescribed have not yet been created and are anticipated to be created upon mine closure as prescribed in the current mine reclamation plan and DA permit.

As mentioned previously, this delineation did not include a functional assessment of created wetlands. A functional assessment is recommended for the Fort Knox Mine site to assess the relationship between wetland areas created and those filled and/or cleared.

4.12 Task 12. Compliance with Recommendations Made in the Last Audit

The previous audit made ten recommendations which are listed below in italics. Compliance with those recommendations and Golder's response to them follow:

1) *FGMI should continue to optimize capture of tailings water seepage with the interceptor well system and should continue to closely monitor the downgradient groundwater chemistry. In addition, fate and transport of tailings seepage should be evaluated, including multi-year projections of tailings water quality and seepage generation rates and evaluation of future impacts under various operating scenarios. Water quality objectives for ground water and surface water in the immediate vicinity (i.e. in Fish Creek above fresh water reservoir) should be verified by both ADEC and FGMI with regard to actual beneficial uses determined from baseline water quality. These evaluations are not likely necessary prior to the upcoming renewal of the permits, but should be performed soon (e.g. within the next year) to allow adequate planning and response.*

   Response: Optimization of seepage capture has been on-going and appears to be effective in creating a cone of depression sufficient to capture seepage. Since the last audit, the system has been further optimized by a program that included the installation of several new interceptor wells and a better understanding of the hydrogeological environment downstream from the tailings impoundment. Fate and transport modelling of the tailing seepage is not indicated. The tailing seepage is a transitory system and modelling would be difficult to accomplish and unnecessarily costly. The system appears to be back to an equilibrium system. Water quality should be evaluated for post closure system impacts because at some time after processing stops, the dewater system will be disconnected.

2) *It is recommended that FGMI further consider issues related to tailings water management and disposal at mine closure, and prepare a more detailed plan for this aspect of closure. The plan should be based on detailed water and dissolved constituent mass balance analyses, water quality objectives, and applicable treatments (i.e., discharge) standards. In addition, FGMI should consider means to minimize the amount of tailings pond water present during operations and at closure to the extent that is consistent with efficient mine operations*.

   Response: FGMI has developed a conceptual / preliminary level reclamation and closure plan for the TSF. FGMI is collecting water quality information and has reduced the reagent loading coming into the impoundment by the installation of the new thickener. Additional closure planning and assessment of the water quality data is needed by FGMI after the completion of the True North ore milling to assess the current concepts.

3) *The reclamation cost estimate and closure bond should be updated based on the above water disposal plan, if necessary. However, since this water management*

concern is related to closure, which is not anticipated to occur before the next five year review, completion of this plan and cost estimate updates prior to the 1999 update of the reclamation bonds is likely not necessary. However, a preliminary plan should be completed soon (e.g., within the next year), and a final plan acceptable to the agencies should be completed with updates to the reclamation plan, cost estimates, and bonding prior to the next five-year review.

Response: Updated reclamation plans and cost estimates were developed by FMGI and reviewed as part of the audit. FGMI met the recommendations of the previous audit. The audit findings presented in this report present some additional recommendations for updating the reclamation plans before the next audit.

4) *In conjunction with the above plan for tailings water disposal, FGMI should further evaluate the potential seepage impacts that may occur due to construction of a permanent wetland on the tailings surface following mine closure. If the results of the evaluation indicate that the wetlands would create an unacceptable long-term water management or quality impact, an alternative plan for restoration of wetlands should be developed. These evaluations and plans should be completed within the same timeframe as the water management plans discussed above.*

Response: FGMI is collecting the water quality data to support this assessment and have developed water management strategies for seepage treatment should this be required. It is recommended that a water quality assessment be developed at least two years prior to reclamation to support selection of the long-term tailings seepage management strategy.

5) *Update of the reclamation cost estimate and financial assurances should consider:*

- Cost of hauling and placing some growth media for reclamation (pending the results of direct revegetation testing and evaluation). FGMI may want to consider revegetation test plots on the tailings, borrow areas, and overburden piles as part of the direct revegetation evaluations.
- Increased cost of demolition of large concrete foundations.
- Cost of plant and crusher building demolition.
- Closure engineering, design and mobilization costs.
- Local offsite contractor costs instead of FGMI labor and equipment rates.

The changes may be appropriate to incorporate for the reclamation bond update in early 1999.

Response: FGMI has included the audit recommendations in the reclamation plans reviewed for this audit, with the exception of the development of demolition plans.

6) *"For the environmental monitoring program, optimization of water quality monitoring is recommended. The number of constituents currently monitored is excessive and a significant amount of data generated is not very useful. Based on review of baseline water quality, rock and ore geochemistry, and mining and beneficiation processes, the following monitoring constituents are considered to be the most useful*:……"

Response: This recommendation was not implemented except for the reduction of organic testing since it was identified as a non-issue. FGMI decided not to reduce any of the constituents of concern analysis.

7) *Further optimization of the monitoring program could be considered in the future with reduced monitoring frequency at selected locations (i.e., from quarterly to semiannually). Such reductions could be considered for baseline wells, locations where there is little risk of impact or concentrations are unchanging, or for selected constituents*.

Response: FGMI has implemented monitoring frequency reduction and additions where and when appropriate. The criteria for reducing parameters is based on consistent result of analysis below the detection limit and the potential for changes that could result in water quality concerns. In events where the monitoring frequency changes occur, FGMI notifies the DEC and when appropriate, gets DEC Approval.

8) Additional recommendations regarding the monitoring program are the following:

- *Include trend plots for key constituents (e.g., TDS, sulphate, chloride, nitrate, ammonia, copper and zinc) in the annual monitoring reports. Water quality monitoring data is currently made available to the state in electronic format to facilitate graphic presentation*

Response: FGMI has implemented this.

- *Data received from the laboratory should be reviewed for potential reporting (e.g., decimal place) errors. Values that appear anomalous should be questioned through inquiry to the laboratory to assure accuracy of the database.*

Response: FGMI has implemented a data QA/QC program through the development of a 'Quality Assurance/Quality Control and Field Procedures Manual' dated March 2003. The DEC approved the Manual in March 2003.

- *Complete the update of the FGMI water quality monitoring plan revision.*

Response: FGMI has completed the plan revision.

- *Measure surface water flows at wetland monitoring locations and perform annual evaluations of groundwater levels.*

Response: FGMI has implemented this. Surface water flows are measured at the inflow (upper developed wetland) and outflow (lower developed wetland) of the wetlands. Sampling of the upper wetland station began in the second quarter of 1999. Profile I parameters of both stations are monitored quarterly.

- *Include groundwater elevations and surface water flow rates to monitoring reports.*

Response: FGMI has implemented this.

9) *ADF&G should continue annual monitoring of fish populations and water quality in the WSR for a minimum of two years (i.e., while the lake becomes hydrodynamically stable or seasonally consistent). ADF&G may also want to consider monitoring of Fish Creek and the other tributaries to the WSR to monitor arctic grayling spawning habitat. The information on spawning habitat could become important in evaluation of tailings water disposal and wetlands restoration at closure.*

Response: Per this recommendation, ADFG has conducted annual monitoring of arctic grayling and burbot populations in the water supply reservoir, stilling basin, and created wetlands in Fish Creek for the last 5 years. These activities are documented in: Arctic Grayling and Burbot Studies in Fort Knox Water Supply Reservoir, Stilling Basin, and Developed Wetlands (Ott and Morris 1999, 2000, 2001, 2002, 2003) (Alaska Dept. of Fish and Game Tech Report 00-1, 01-02, 02-1, and 02-06). This effort has resulted in an ongoing study that provides valuable habitat data. Successful spawning and survival of age-0 Arctic grayling has been documented every year since 1999 and there is evidence of substantial recruitment to the population. Substantial outmigration of arctic grayling is also occurring to the Chena River system (A. Ott pers. Comm. 2003). Burbot are being studied through a spring mark, fall recapture by ADFG. Burbot population dropped 50% in 2002 since 1999, with the drop occurring mostly in smaller fish. Larger fish populations appear to be stable (A. Ott 2003 pers. comm.). This effect could potentially be due to low dissolved oxygen concentrations due to permafrost and large floating mats of organics (A. Ott 2003 pers. comm.) Burbot catches in spring 2003 indicate reproductive success is still occurring. Based on radiotelemetry data collected by ADFG, in all likelihood, the spawning is occurring in the WSR in the area directly influenced by freshwater input from Solo Creek (DNR 2003).

10) The following recommendations are included to facilitate continued communications between the agencies and FGMI, and to streamline future auditing:

- *Continue annual report meetings attended by responsible agencies (i.e., ADEC, DNR, ADF&G, Corps, USF&W and North Star Borough) and FGMI*

Response: Annual meetings are held between the FMGI and the above mentioned agencies. The following is a list of attendees for the last annual meeting.

FGMI Personnel Rick Dye (GM) Clyde Gillespie Stacy Staley Dave Stewart Jerome Baxter	**DNR** Steve McGroarty Ed Fogels Jim Voden Al Ott, Office of Habitat Management and Permitting
Mental Health Trust Mike Franger Steve Planchon	**ADEC** Luke Boles, **Corp of Engineers** Victor Ross
Northern Alaska Environmental Center Mara Bacsujlaky	**Private Citizens**, (Neighbors) Tom Walyer Chuck Johnson

- *Encourage approaches to improve continuity of ADEC interactions with FGMI. It is recommended that consideration be given to designating one of the current ADEC staff members as coordinator or "project agent." This person could act as the main point of ADEC contact with FMGI. They could be copied for review on all correspondences between the various ADEC divisions and FGMI, and could assure coordinated response to ADEC issues related to the mine. This appears to be an effective coordination approach. The Alaska Mental Health Trust Land office has indicated that they have not always been copied on quarterly reports containing information as the titleholder for certain lands on the site. The recommended "project agent" concept may be useful for assuring that all appropriate parties receive important reports and information.*

  Response: The DEC has selected Mr. Peter McGee to be the Project Technical Leader. He communicates project information as necessary to various other DEC personnel. Mr. Clyde Gillispie of FGMI states that the Mental Health Trust are copied on all appropriate reports and correspondences.

- *Schedule the next five-year environmental review during the summer of 2003. This would allow inspection of site facilities without winter snow cover, and*

would allow more time to respond to recommendations before permit renewal.

Response: FGMI complied with this recommendation and scheduled this audit for the summer of 2003. The scope of work for this audit was completed at the end of July 2003 and early August 2003.

- *Provide detailed cost estimate backup for the auditors that can be related directly to the bond amounts. This would facilitate review of the sufficiency of financial assurances for the mine.*

  Response: FGMI provided the detailed cost estimate backup for the auditors prior to the site visit as suggested.

5.0 AREAS OF CONCERN

5.1 Geochemical

5.1.1 True North Pits, Pit Backfill, Waste Rock Dumps and Low-Grade Stockpiles

SRK (2000) developed predictions for the potential impacts to groundwater and surface water associated with the True North open pits, pit backfill, and waste rock dumps. Their analysis indicated that while acid rock drainage (ARD) is unlikely, arsenic, antimony, sulfate and selenium may be leachable and locally impact groundwater quality from waste rock seepage and pit ponds or backfill. SRK (2000) indicated that surface water would not be impacted given the proposed reclamation and stormwater management programs. Based on our review of the previous geochemical testing and True North operations, we recommend that quantitative water quality data be collected from the lysimeter monitoring program proposed for the waste rock dumps to evaluate the predictions by SRK (2000) and provide data on the longer term environmental performance related to the potential for ARD development and/or metals leachability.

5.1.2 Tailings Geochemistry

Arsenic Mobility

Processing of True North ore has resulted in a large increase in tailings decant arsenic concentrations (from less than 0.05 mg/L to a peak concentration of 1 mg/L). Dissolved arsenic concentrations in tailings seepage and downgradient groundwater (interceptor wells IW-1, 2, 3, 4, 5 and 6 and monitoring wells MW-1, 3, 4, 5, 6 and 7) are generally below detectable limits (<0.005 mg/L), suggesting limited arsenic mobility. In the early stages of monitoring (September 1996 to May 1997), arsenic was consistently detected in MW-2 at low concentrations (up to 0.011 mg/L). Since then, arsenic has generally remained below detectable limits. Continued groundwater monitoring will ensure that arsenic is not being transported off site. If arsenic release to groundwater was to occur, adsorption is considered the only likely control on arsenic mobility in groundwater.

Antimony Mobility

The addition of True North ore has resulted in an increase in tailings decant antimony concentrations. An increase in antimony concentrations has also been observed in tailings seepage indicating that antimony is mobile. Antimony has generally remained below detectable limits in downgradient monitoring and interceptor wells. A slight increase in antimony was observed at IW-5 in May 2002 (Figure 15).

Tailings decant antimony concentrations are currently relatively stable at approximately 2 mg/L. Hazen (2000) reported antimony concentrations of 3.91 mg/L and 0.267 mg/L for Meteoric Water Mobility Procedure (MWMP) tests conducted on the Fort Knox and sulfide and oxide True North tailings blends. Based on these results, SRK (2000) predicted a tailings pond antimony concentration of 3.9 mg/L. Because the sulfide content of the ore increases with depth, antimony concentrations will likely continue to increase in the pond as more True North tailings are placed in the impoundment. Antimony concentrations are also expected to increase in tailings seepage. Continued hydraulic control of tailings seepage will be required to control antimony migration off site. An update and review of the antimony migration predictions should be completed using the recent data to allow an assessment of how long the seepage controls will be required.

Selenium Mobility

The addition of True North ore has resulted in an increase in tailings decant selenium concentrations. An increase in selenium concentrations has also been observed in tailings seepage indicating that selenium is mobile. However, selenium is less of a concern than arsenic and antimony due to its lower concentrations in tailings waters. Selenium has also generally remained below detectable limits in downgradient groundwater (<0.005 mg/L). Current decant selenium concentrations exceed the values measured in MWMP tests conducted by Hazen (2000) (0.017 mg/L and <0.01 mg/L for the sulfide and oxide blends, respectively). Current hydraulic controls aimed at reducing tailings seepage mobility will address potential selenium migration off site. An update and review of the selenium migration predictions should be completed using the recent data to allow an assessment of how long the seepage controls will be required.

Copper Mobility

Despite increases in tailing decant copper concentrations, tailings seepage and groundwater dissolved copper concentrations have generally remained below detectable limits. These results suggest limited copper mobility.

Pond Cyanide and Cyanide Degradation Product Concentrations

Prior to processing of the True North ore, tailings decant total cyanide concentrations were relatively low. A change in operating practices resulted in a seasonal increase in cyanide concentrations. Concentrations of nitrate, a cyanide degradation product, are expected to continue to increase. The increasing nitrate concentrations may require implementation of water management measures to avoid potential impacts to groundwater. A better understanding of the various nitrogen species and their longevity/mobility in the tailings water and groundwater system would assist in developing appropriate control features, if needed. Completion of a nitrogen balance of the cyanide and other nitrogen compounds may provide insight on the increasing nitrate trends.

5.2 Reclamation

Fort Knox

The reclamation planning for Fort Knox is preliminary, as is appropriate for this stage of the mine life. A reclamation schedule is needed to support coordination of future studies and the sequencing of the TSF reclamation in relation to other project components. Based on the review of the reclamation approach and the operating history there are no major concerns related to meeting the reclamation goals for the waste rock dumps, roads, process plant areas, wetlands, and water storage reservoir (WSR). Areas of concern do exist for the demolition, open pit, and TSF and consist of the following:

- Process Plant Demolition: No plans for building and equipment demolition were evaluated for this audit and may not currently exist. It is anticipated by FGMI that equipment and structural steel salvage credits will cover all demolition costs. This analysis needs to be completed and a demolition plan prepared. A plan to deal with mill and process area cleanout and remediation of contaminated soils will be needed for final reclamation.

- Open Pit: The post-reclamation land use objectives for the open pit include a recreational lake. Based on the existing water quality information, this plan should be compatible with a recreational use. However, the pit highwalls will provide a potential long-term rockfall hazard. While the pit highwalls may stable on the macro-scale, small raveling failures will continue. The pit highwalls have been designed for operational stability in a dewatered condition and are not designed for rising groundwater elevations, which may lead to some larger-scale instability associated with the schist rock slope areas. A stability review of the flooded pit may be warranted to define the long-term stability given the proposed post-mining land use.

- TSF: A consolidation analysis of the tailings is needed to support final design and planning of the post-reclamation topography, surface water management plan and spillway design. Establishment of a final TSF topography during operations that accounts for future consolidation can greatly reduce closure costs but can increase operating costs during the later phases of mill operations. The TSF closure incorporates the use of a large volume of riprap (60,000 cubic yards) that will be sourced from the waste rock dumps. This material will have processed and stockpiled during the later stages of operations or during the waste dump reclamation. Water quality predictions for the reclaimed TSF seepage should be developed based on the water quality data currently being collected, to determine the potential loading rates to wetland areas and receiving waters.

True North

True North is approximately 15 months from the completion of mining. A detailed level reclamation plan that addresses backfill, grading plans, highwall stability, cover thickness, and surface water drainage is in development by FGMI.

5.3 Reclamation Sureties

The reclamation sureties as prepared by FGMI are based on reasonable and proven reclamation concepts and have well documented cost backup. Production rates and equipment selection as presented by FGMI are more consistent with a mining company completing the reclamation than a third-party contractor. Unit rates provided by FGMI for the TSF are in line with anticipated third party contractor costs, but the Fort Knox and True North cost estimates will need to be updated with new rates for the next permit renewal. A demolition plan that includes cost estimates and equipment salvage value is lacking. The estimated indirect costs are generally consistent with industry standards with the exception of the contingencies estimate. Based on our review, we estimate that FGMI is currently at the conceptual / preliminary design level for reclamation planning and that engineering

costs are appropriate for inclusion in the indirect costs. A contingency of 15 percent is appropriate given the current level of design.

5.4 Air Quality and Dust Control

FGMI environmental personnel have received training and certification as visible omissions evaluators (smoke school). The Fugitive Particulate Emissions Control Plan was review for this audit (FGMI 2002a). FGMI has a program in place that carefully monitors stack emissions and fugitive dust. A tracking spreadsheet insures timely opacity readings at over thirty possible points of emission.

A new alignment for the access and haul road was constructed (Driveway Permit issued by Alaska Department of Transportation and Public Facilities) which passes under the Steese highway at a 90-degree angle and circumnavigates a large topographic feature on the east side of the Steese highway and before joining the Fish Creek Road. This intersection is approximately 2,500 feet south of the nearest residence of the Cleary Summit Subdivision. The True North Transportation Plan addresses operating conditions, safety, signage, snow removal, spill response, road maintenance, lights, noise, and viable alternatives to minimize dust from traffic including: water, chemical treatment (calcium chloride), chip seal, or asphalt.

Dust control on the access and ore haul roads to the mine is a high priority. High-float has been applied twice to surface portions of the road near residential developments without much reduction in dust. Chip seal should be less effective than high-float and is not considered appropriate for this application. Calcium chloride is also applied regularly in the summer. Two water trucks are dedicated to keeping the roads as dust free as possible. New and closer water sources are currently being developed to decrease refilling time for water trucks. The environmental department oversees dust control, monitoring and photographing road conditions. Although FGMI has a dust control monitoring plan in effect and have reportedly not exceeded maximum emissions, neighbors of the mine have on-going complaints to the DEC about dust from the haul road. DEC also performs dust monitoring and photographing. FGMI in an effort to better control dust problems associated with the road in accordance with their permit have implemented the following actions:

- Dust from the road must be controlled/minimized. Water, calcium chloride, and other dust suppressants will be used and tested to determine the best method for controlling fugitive dust. A street sweeper with dust suppressing equipment or a

water truck (using the water cannon to wash the material off the road) will be used to remove material collecting on the asphalt portions of the road that may be a source of fugitive dust.

- If the current tanks and standpipes used for loading water into the water trucks prove to be inadequate, additional tanks and standpipes must be constructed. One means of filling water trucks must be maintained through the winter months. The tanks and standpipes must be operational as soon as weather conditions dictate in the spring.

- Water trucks must be run as needed to control dust. If necessary, additional operators will be utilized during lunch and shift change to provide continuous operation of the water trucks. Additionally, if the FGMI water trucks prove to be inadequate, additional water trucks will be rented or leased to provide adequate water for controlling dust. Water trucks will prioritize their watering to focus on the more sensitive sections of the roads, i.e., the sections near the Clearly Summit residents.

- Calcium chloride or other chemical dust suppressant will be placed on the access/haul road as soon as weather permits in the spring to help control fugitive dust. Maintenance applications will be made as needed through the summer months.

- New or additional chemical dust suppressant products will be tested to determine the most effective means of controlling fugitive dust.

- During winter months, water or pulling snow back on the road will be used to control fugitive dust.

- Ore haul truck drivers are expected to report dusty conditions to their supervisor and their supervisor must take appropriate action to control the dust.

Due to wet conditions encountered during the site visit, an assessment of the dust control practices was not possible. A review of the actions proposed for the haul road indicate that FGMI is taking appropriate steps to reduce any dust problems.

5.5 Noise Control

The True North Project, Ore Haul Truck Noise Monitoring Plan (FGMI 2002b) presents the project noise control program. FGMI is authorized to operate no more than 15 trucks during the 7 A.M. to 7 P.M. time frame and no more than 9 trucks during the 7 P.M. to 7 A.M. time frame. Prior to operating on the Twin Creek road, ore haul trucks must be initially tested by FGMI personnel to

certify the trucks are operating at a noise level less than 82 dBA. FGMI also requires annual noise re-certification of the trucks. If a truck fails a noise test then the truck must cease operation, be inspected by maintenance personnel to determine the source of the excess noise, repaired as needed, and be re-tested demonstrating compliance with the noise standard prior to continued operation. Trucks are tested under loaded and unloaded conditions at a distance of 50-feet while traveling between 25 and 35 miles per hour. Copies of the noise testing certifications are included in the quarterly monitoring plan report sent to the DNR. Results and frequency of the noise testing demonstrates that FGMI operates the ore haul trucks in conformance with the requirements described in the True North Project, Ore Haul Truck Noise Monitoring Plan (FGMI 2002). Records were reviewed for this Audit for the time period of January 2002 through June 2003. There were a total of 16 recorded average measurements exceedances during that time. Records further indicate that those trucks were removed from service and repaired/maintained until they could perform below the 82 dBA requirement. The maximum average exceedance measurement was 85.3 dBA.

Two local residents have filed complaints to the DEC regarding noise from haul trucks on the access road. Three residential noise tests were conducted in January 2002 at private residences closest to the mine to evaluate noise level compliance all three tests indicated compliance. DNR and FGMI personnel as well as the residents were present at various times during the testing. Review of testing program was completed for this Audit to determine compliance with the residential noise standards identified in Stipulation #33 of DNR's right-of-way permit for the True North Project Road. The test consisted of daytime testing (12 P.M. to 3 P.M.) and nighttime testing (12 A.M. to 3 A.M.) with monitoring at each of the complaintents' residents. The testing was completed by a qualified third-party contractor using ANSI Type 1 Sound Level Meters. The compliance parameters for residential areas are the following:

Descriptor	Nighttime	Daytime	Total Duration
Units	dBA	dBA	seconds
L01	55	75	36
L10	50	60	360
L50	45	55	1800

Based on the assessment from the third-party of site conditions (i.e. barking dog) and the recorded measurements, the ore haul truck traffic was determined to be in compliance with the parameters established for the project. This test followed industry standards for performing the testing and

analysis, therefore it is likely that the test conditions and results are representative of daytime and nighttime noise conditions normally occurring at the residents that were tested. Additionally, FGMI has established a program to monitor truck noise before acquisition to certify all trucks are below 82 dBA. Ongoing monitoring is conducted on all operating trucks to assure compliance.

A record inspection by the DNR on September 5, 2002 concluded that there were no day shifts violations for number of haul trucks operated during the month of July. As noted above 15 trucks are allowed during the day shift and 9 trucks are allowed during the night shift. DNR also reported that it was unclear but appeared that 10 to 11 trucks were hauling ore for a significant portion of the shift for the first eleven nights of July 2002. This represents a potential exceedance in the number of trucks allowed by permit stipulations. The DNR stated to FGMI that they will continue to monitor the number of trucks and will require future periodic reviews of shift reports and haul truck tonnage records. The DNR has made several site visits since the September 2002 inspection and have found no exceedances to the haul truck requirements.

An internal FGMI memorandum (memo) to the operators on the True North Ore Haul Road was issued in August 2002 to assist in complying with the requirements of the permits and associated plans. The memo included a list of the requirements pertaining to the True North Ore haulage (i.e. truck certification criteria, best operating practices related to noise and dust suppression). Every operator had to sign a certification statement stating that they read the requirements and agreed to abide by the requirements.

FGMI's internal requirements, practices, and compliance reporting coupled with the permit requirements are adequate to ensure that the noise emissions from the haul trucks will continue to comply with the noise standard of 82 dBA.

5.6 Wetlands

FGMI is not yet in full compliance of wetland mitigation with regards to replacement of acres between the tailings dam and the water supply reservoir. Additional wetland acres need to be developed below the tailings dam. Discussion of creation of a stream habitat and associated wetlands to the north of the existing created wetlands has been ongoing between FGMI, Corps, and ADFG. If implemented such an area could increase the number of wetland acres to the prescribed amounts.

6.0 MITIGATION & RECOMMENDATIONS

6.1 Monitoring Program Optimization

The tailings decant and seepage are sampled quarterly. This frequency of monitoring is considered adequate to characterize tailings water and groundwater quality and capture seasonal trends. Quarterly monitoring should be continued.

Both the tailings decant and seepage samples are collected from areas where the water is in contact with the atmosphere. Tailings decant water is collected from the surface of the tailings pond from a barge, and is therefore representative of near-surface conditions in the tailings pond.

The four trace metals of interest in tailings water (arsenic, copper, selenium, and antimony) are all redox species. As such, redox conditions will influence the mobility of these metals. To characterize tailings water at depth, a pond water sample should be collected from the base of the tailings pond. This sample is expected to be more representative of pore water conditions within the tailings and therefore more representative of tailings seepage water quality.

Comparison of the composition of tailings water at surface and at depth will provide insight into the homogeneity of the tailings pond water (i.e., if the pond water is a well mixed system). Such a comparison will also assist in identifying whether samples collected at surface are representative of the entire pond water chemistry.

Monitoring of the wells should continue. Golder recommends that the monitoring data for the audits and at the request of agencies be presented in Piper Diagram format so that trends and changes of water quality “signatures” can readily be compared to tailings seepage and the IW-series wells.

6.2 Reclamation

The reclamation planning for Fort Knox and the TSF are at an appropriate level for this stage of the project. Additional design detail will be necessary over the next five years. The True North Project has an immediate need for development of detailed reclamation plans. Specific recommendations for the reclamation plans are presented below:

- Develop demolition plans for the processing plant and mill.

- Develop a consolidation model for the TSF and finalize the surface water management plan, grading plan, and cover concepts. It is recommended that the TSF reclamation plan include a small surface water pond near the spillway and that surface recontouring occur during the latter stages of operations using thickened tailings. Additional study and documentation of the direct revegetation of the tailings is required to support this concept.

- Develop detail-level reclamation plans for True North that incorporate the results of the infiltration studies.

- Develop a project reclamation schedule that considers that the reclamation and closure of the TSF considering the consolidation duration of the tailings, could occur a period of years after the reclamation of the pits, dumps, and mill site demolition.

6.3 Reclamation Sureties

The reclamation sureties for the Fort Knox and True North Projects are calculated on reasonable assumptions and approaches for FGMI to complete the reclamation. Recommendations for refinement of the reclamation sureties include:

- Prepare a demolition cost estimate that includes time for mill cleanout and contamination soils remediation.

- Refine production rate estimates.

- Update unit rates for equipment in the Fort Knox and True North reclamation plans.

- Review and update indirect costs as needed.

- Re-evaluate riprap processing, stockpiling hauling and placement costs and equipment selection.

6.4 Dust Control

FGMI needs to maintain dust control program on the haul road.

6.5 Noise Control

FGMI needs to maintain the noise monitoring program and continue to remove trucks which fail the compliance from operation until the trucks meet compliance standards (82 dBA at a distance of 50-feet from the roadway).

6.6 Wetlands

FGMI is not yet in full compliance of wetland mitigation with regards to replacement of acres between the tailings dam and the water supply reservoir. In terms of overall wetlands and other aquatic sites created, FGMI has to date developed a total of 204.8 acres, including wetlands below the tailings dam and the water reservoir and associated wetlands. Wetlands and other aquatic sites created by FGMI below the tailings dam are primarily aquatic (pond) sites surrounded by palustrine scrub-shrub (PSS) wetlands. These presently constitute 20.5 acres (24.5 total acres less than the prescribed amount). The water reservoir and associated wetlands are primarily open water sites surrounded by Palustrine Forested wetlands (PFO) and Palustrine Scrub-shrub wetlands (PSS). The water reservoir and associated sites created by FGMI total 184.3 acres and exceed the prescribed amount of 165 acres by 19.3 acres. The total difference of wetlands that still need to be created in these combined areas is 5.2 acres.

No wetlands have yet been created for the lake area within the pit and wetlands on the reclaimed tailings impoundment as prescribed, as this was anticipated to be done at mine closure. A total of 148 acres for the lake within the pit and a combination of 425/425/365 ponds/wetlands/uplands acres for the reclaimed tailings impoundment are prescribed. As discussed previously in this audit, the approved plan for mixture of wetlands, ponds, and uplands is not recommended because of the long-term maintenance obligations of a jurisdictional dam. This approach may be viable but will require dam safety analysis and provisions to meet the long-term maintenance obligations. Additionally, wet closure of the tailings will increase the long-term seepage rate out of the facility, which may also have water quality implications due to increased chemical loads reporting downstream.

No functional assessment was performed in this wetland evaluation. It is important to determine the functions and values of the created wetlands with respect to acres lost. A functional assessment of these wetland areas is warranted. It would be most useful if the methodologies utilized in a new

functional assessment were comparative to those used in the initial jurisdictional wetland functional assessment.

Detailed hydrological and hydraulic analyses are necessary to determine the capacity of the wetland impoundments and the channels upon mine closure for long term maintenance of the ponds. A detailed hydrological/engineering analyses will be needed if flow is directed through these wetlands upon mine closure. If an alternative plan to create a north valley stream/wetlands complex is desired, hydrological/engineering analysis will need to be conducted to determine size and shape of channels to handle flow. Long term monitoring and maintenance of the structural integrity of the dikes on the existing created wetlands is necessary. A review of the ponds vegetation establishment should be conducted prior to mine closure also to determine any long term vegetation maintenance necessary.

Fish habitat monitoring should continue on an annual basis to continue to document Arctic grayling and burbot uses of the wetlands and reservoir.

Riparian shrub vegetation is currently limited on Pond C due to aufeis and the degree to which it grows each winter. Overburden could be added to those areas with sparse vegetation in the valley.

Assorted metal pieces should be removed from the ponded areas. These rusting metals, especially in Pond B may be degrading water quality in some portions of the ponds.

Planting and seedings of the Last Chance Creek enhancement area should be reviewed and supplemented. These areas have experienced 1.5 growing seasons since planting and vegetative cover is currently very low. Overburden from existing sources in the Last Chance Creek valley can be used to mix into the rock and gravel present and thus create a substrate more suitable for vegetation establishment. Continued monitoring of this area is suggested.

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TABLES

TABLE 1

TRUE NORTH MINE
PERMITS, LICENSES AND AUTHORIZATIONS

AGENCY	PERMIT #	DESCRIPTION	DATE ISSUED	TERM/EXPIRATION	LOCATION OF DOCUMENT
FEDERAL					
US Army Corp of Engineers (Corps)	R-1994-0742Murray Creek 2	CWA 404 Permit to expand mining operations at True North Mine. Total of 193 acres of wetlands affected by roads, and mining operations. New roads = 145 acres, Mine pits = 48	January 7, 2002	Expires December 31, 2005	True North Permit Book / Original Posted in Manager-Environmental Services Office
EPA	AKR05A472	EPA's NPDES Storm Water Multi-Sector Permit	June 27, 2001	Expires mid-night October 30, 2005	True North Permit Book / Original Posted in Manager – Environmental Services Office
STATE/PROVINCE/REGION					
Alaska Dept Environmental Conservation (ADEC)	CWA §401 Certification of Reasonable Assurance – Murray Creek 2, NPACO No. Q-940742	State certification under CWA §401 for issuance of the CWA 404 permit by Corps Amendment to allow 78 acres total disturbance of wetlands.	December 8, 2000	Same as Corps permit	True North Permit Book

AGENCY	PERMIT #	DESCRIPTION	DATE ISSUED	TERM/EXPIRATION	LOCATION OF DOCUMENT
Alaska Department of Natural Resources – Division of Mining, Land and Water Management (DNR)	TWUP A2001-96	Temporary Water Use Authorization for water well at True North Mine. Seasonal use May 1 through September 30 each permitted year for 240,000 gallons/day (110.48 afy) for 150 days/yr for dust control	September 6, 2001	August 30, 2006	"
DNR	ADL No. 414960ADL No. 414961	Modification to Fort Knox Millsite Permit to allow processing of True North Mine ore through Fort Knox Mill, and updates insurance requirements, annual use charges, annual tipping fees and dates payments are due.	January 1, 2002	None given	"
DNR	Plan of Operations Approval	Amendment to operating plans for True North Mine. Includes Reclamation Plan, Monitoring Plan, etc.	June 12, 2002	June 12, 2007	"
DNR	ADL No. 416509	Lease - Millsite Lease to allow development of the Hindenburg and East pits	December 20, 2000	December 20, 2003	True North Permit Book
Alaska Mental Health Trust Land Office (TLO)	MHT 9400109	Reconstruction of existing, historic road(s) and construction of new sections of roadway between True North and Ft Knox - 34.1 acres. Easement for road use, maintenance and reconstruction activities associated with Easement Area	January 20, 2001	Perpetual unless surrendered or terminated	"
DNR, TLO & FGMI	Reference: Millsite Lease ADL No. 416509	Agreement among parties for the construction, upgrade, use and maintenance of the True North Project Road	January 20, 2001	Until completion of final reclamation as required by millsite lease	"

AGENCY	PERMIT #	DESCRIPTION	DATE ISSUED	TERM/EXPIRATION	LOCATION OF DOCUMENT
DNR	ADL 416471	Land Use Permit – Construction and use of True North Haul Road, including upgrading and use portions of existing trails/roads on Mental Health Trust Lands	January 20, 2001	January 20, 2011	"
DNR Burning Permit					
DNR – Div of Forestry	F12304	Permit to burn trash and brush	May 4, 2001	September 30, 2003	True North Permit Book
LOCAL					

TABLE 2

FORT KNOX MINE
PERMITS, LICENSES AND AUTHORIZATIONS

AGENCY	PERMIT #	DESCRIPTION	DATE ISSUED	TERM/ EXPIRATION	LOCATION OF DOCUMENT
FEDERAL					
FCC	WPIT423	Fort Knox Telemetry/Mobile	11/8/2000	11/8/2010	Permit Book Volume 2
FCC	KNNQ278	Fort Knox Mobile Crane	Pending	Pending	Permit Book Volume 2
FCC	WPRW650	Fort Knox Base Radio & Repeater	3/2/2001	3/2/2011	Permit Book Volume 2
FCC	WPMS661	Fort Knox Blasting Horn	12/2/1998	12/2/2003	Permit Book Volume 2
FCC	WPNZ827	Fort Knox Survey GPS	8/16/1999	8/16/2004	Permit Book Volume 2
Nuclear Regulatory Commission	50-29098-01 Amendment No. 2	Radioactive Materials License	4/12/2002	8/31/2011	Permit Book Volume 2
Bureau Of Alcohol, Tobacco, And Firearms	9-AK-090-22-6A-12031	License For Use Of Explosives	1/1/03	1/1/06	Permit Book Volume 2
Fort Knox Mine Environmental Assessment	N/A	Environmental Assessment for the Initial Corps permitting process	August 1993	Life of the Project	Library
Corps of Engineers	N-920574	404 Permit For Discharge f Dredge or Fill Materials Into Waters of the US (Fish Creek)	4/1999	4/2004	Permit Book Volume 2
STATE					
ADEC	#53TVPO1	FORT KNOX TITLE V AIR QUALITY PERMIT	10/19/2000	10/18/2005	PERMIT BOOK VOLUME 1
ADEC	0031-BA008	Solid Waste Disposal Permit For Mine Tailing Disposal	8/24/1999 (as modified 12/19/2000)	12/19/2005	Permit Book Volume 1
ADEC	9931-BA001	Solid Waste Disposal For Construction & Demolition Debris Landfills	2/23/1999	2/15/2004	Permit Book Volume 1

AGENCY	PERMIT #	DESCRIPTION	DATE ISSUED	TERM/ EXPIRATION	LOCATION OF DOCUMENT
ADEC	PWSID #314093	Fort Knox Mine Potable Water System Approval To Operate	8/26/1997	N/A	Permit Book Volume 1
ADEC	N/A	Plan Review For Non Domestic Wastewater Treatment System	1994	N/A	Permit Book Volume 1
Dept Of Fish & Game	FG93-III-0201	Fish Habitat Permit Water Supply Dam	2/15/1994	When Water Dam is Completed	Permit Book Volume 1
Dept Of Fish & Game	FG93-III-0202	Fish Habitat Permit Solo Creek Culvert	2/15/1994	Third Party Transfer	Permit Book Volume 1
Dept Of Fish & Game	FG93-III-0203	Fish Habitat Permit Wetlands	2/15/1994	When Developed Wetlands are Complete	Permit Book Volume 1
Dept Of Fish & Game	FG98-III-0109	Fish Habitat Permit Water Reservoir Causeway To Gil Exploration Area	5/6/1998	Upon Completion of Rehabilitation	Permit Book Volume 1
Dept Of Fish & Game	FG99-III-0097, 0098, 0099, 0100, 0101	Fish Habitat Permit Wetlands Channel #1, #2, #3, #4, #5	5/14/1999, 5/15/1999	EXPIRES UPON COMPLETION	Permit Book Volume 1
DNR	ADL 47229	Lease Of Water Rights, Fish Creek-Water Supply Reservoir	2/15/1994	2/15/2019	Permit Book Volume 2
DNR	LAS 13989	PERMIT TO APPROPRIATE WATER, DEWATERING	2/11/1994	Permit is in the Renewal Process	Permit Book Volume 2
DNR	LAS 13988	Permit to Appropriate Water, Tailing Impoundment	2/11/1994	Permit is in the Renewal Process	Permit Book Volume 2
DNR	LAS 13987	Permit to Appropriate Water, Interceptor Wells	2/11/1994	Permit is in the Renewal Process	Permit Book Volume 2
DNR	LAS 13986	Permit to Appropriate Water, Water Supply Reservoir	2/11/1994	Permit is in the Renewal Process	PERMIT BOOK VOLUME 2

AGENCY	PERMIT #	DESCRIPTION	DATE ISSUED	TERM/ EXPIRATION	LOCATION OF DOCUMENT
DNR	LAS 21760	Permit to Appropriate Water, Dewatering Wells	4/3/98	Permit is in the Renewal Process	PERMIT BOOK VOLUME 2
DNR	AK00212	Certificate Of Approval To Operate A Dam (Tailing Storage Facility)	12/07/1999	10/07/2004	Permit Book Volume 2
DNR	AK00211	Certificate Of Approval To Operate A Dam (Water Storage Reservoir)	02/01/2000	10/08/2004	Permit Book Volume 2
DNR	ADL 535408	Fort Knox Upland Mining Lease	2/15/94	Annually	PERMIT BOOK VOLUME 2
DNR	ADL 414960 ADL 414961	Fort Knox Millsite Permit	2/15/94	Annually	PERMIT BOOK VOLUME 2
DNR	ADL415405	Agreement For Reconstruction & Maintenance Of Fish Creek Road	4/20/1995	N/A	PERMIT BOOK VOLUME 2
DNR	ADL415405	LAND USE PERMIT FISH CREEK AND FAIRBANKS CREEK ROAD RIGHT OF WAY	3/7/1995	3/6/1996	Permit Book Volume 2
Dept. Of Transportation	051601 550 014IK	Approval To Transport Hazardous Materials	5/22/01	6/30/03	Permit Book Volume 1
Dept. Of Public Safety	N/A	Life And Fire Safety Plan Check	6/29/1999	UPDATE AS NEEDED	Permit Book Volume 1
Mental Health Trust Land	ADL 535408 ADL 414961	Mental Health Land Unit Approval	2/15/94	Annually	PERMIT BOOK VOLUME 1
Dept Of Labor	SEE FILES	Certificate Of Inspection For Fired And Unfired Pressure Vessel (S)	See Files	As Required	Permit Book Volume 1
Dept Of Labor	EIN 061325565	Employer Identification	9/91	NA	PERMIT BOOK VOLUME 1
Dept Of Community & Economic Dev.	BL 272545	Business License	11/21/2001	12/21/2003	PERMIT BOOK VOLUME 1
Div Of Forestry	No F12303	Fort Knox Burn Pit Permit	05/04/2001	9/30/2003	PERMIT BOOK VOLUME 1

AGENCY	PERMIT #	DESCRIPTION	DATE ISSUED	TERM/ EXPIRATION	LOCATION OF DOCUMENT
LOCAL					
FNSB	NA	FNSB FLOODPLAIN PERMIT	4/28/1994	NA	PERMIT BOOK VOLUME 2
FNSB	CUO13-94	Conditional Use Permit (Tailing Disposal)	3/1/1994	NA	PERMIT BOOK VOLUME 2
FNSB	CUO14-94	CONDITIONAL USE PERMIT (SOLID WASTE LANDFILL)	3/1/1994	NA	Permit Book Volume 2
FNSB	12441	Zoning Permit	4/21/94	NA	Permit Book Volume 2

TABLE 3

TRUE NORTH MINE
LIST OF SPECIALIZED ENVIRONMENTAL PLANS

Plan	Description	Plan Location	Expiration/Renewal
Emergence Response Plan	Covers both Fort Knox and True North Operations	True North and Fort Knox Mine Offices	Life of Mine
Spill Prevention, Control and Countermeasures Plan	Includes storage of oil and oil products and spill reporting procedures	True North Mine Office	Renewal every 3 years, next renewal 2004
Storm Water Pollution Prevention Plan	Requirements to meet conditions of the EPA Multi-Sector General Permit of October 2000	True North and Fort Knox Mine Offices	Review Annually / Expiration October 30, 2005
Waste Disposal and Spill Reporting Procedures	List of waste materials and disposal methods for each	Distributed handbook to all TN employees	Periodic review and amendment as required
Reclamation Plan	Project description and plans for potential temporary closure and concurrent and final reclamation	True North Permit Book	Periodic review and amendment as required
Monitoring Plan	Monitoring Plan addressing surface, ground and potable water, waste rock and overburden and characterization for ARD, wildlife; QA/QC plus schedules and reporting	True North Permit Book	Periodic review and amendment as required
Transportation and Maintenance Plan	Provides information on operation of the True North access haul road	True North Permit Book	Periodic review and amendment as required
Ore Haul Truck Noise Monitoring Plan	Monitoring of noise levels from operation of haul trucks on access haul road	True North Permit Book	March 2004

TABLE 4

FORT KNOX MINE
LIST OF SPECIALIZED ENVIRONMENTAL PLANS

Plan	Description	Latest Revision	Expiration/Renewal
Emergency Response Plan	Includes emergency response procedures and contact lists for the site.	September 2002	As Needed
Spill Prevention Control and Countermeasures Plan	Includes storage of oil and oil products and spill reporting procedures.	February 2001	February 2002
Solid Waste Management Plan	Landfill design, construction, operation, and closure along with waste management procedures.	February 1999	As Needed
Emergency Action Plan	Describes actions to be taken in the event of an embankment failure at the Water Storage Reservoir.	September 1999	As Needed
Water Balance	Site water balance includes mill, tailing impoundment, water reservoir, dewatering, and runoff.	Updated Monthly	N/A
Tailing Dam Operation and Maintenance Manual	Includes operation, maintenance, inspection, and record keeping procedures along with contingency plans for the tailing impoundment.	August 1998	As Needed
Water Dam Operation and Maintenance Manual	Includes inspection, monitoring, operating, and maintenance procedures along with contingency plans and an overview of the water dam.	March 1997	As Needed
PM10 Sampling & Meteorological Monitoring Plan	Utilized for PM10 monitoring during the first year of operation of the Fort Knox Mine.	April 1997	N/A
Fort Knox Mine Monitoring Plan	Describes monitoring procedures, analytes, and locations monitoring is completed for the entire site.	February 2001	N/A
Fort Knox Mine Quality Assurance/Quality Control and Field Procedures Manual	Includes field and laboratory QA/QC procedures for environmental sample collection, chain-of-custody, shipment, and analysis.	March 2003	As Needed
Fort Knox Project Water Resources Management Plan	Management of water and wastewater at the site.	March 1994	N/A
Fort Knox Project Description	Integral part of the Plan of Operations for the site.	July 1997	As Needed
Fort Knox Project Reclamation Plan	Includes the reclamation and closure plans for the entire site.	April 2001	January 2005

TABLE 5

MAIN OUTLINE OF THE FILING SYSTEM RELATED TO THE ENVIRONMENTAL COMPONENT OF THE FORT KNOX AND TRUE NORTH MINES

Permits

- Federal
- State
- Local
- Miscellaneous Permits

Plans

Design/Construction

Claims

Hazardous Materials/Waste

Spill Reporting

Toxic Release Inventory

Studies

Monitoring

Administrations

- Agencies
- Environmental
- Organizations
- Miscellaneous

Reports

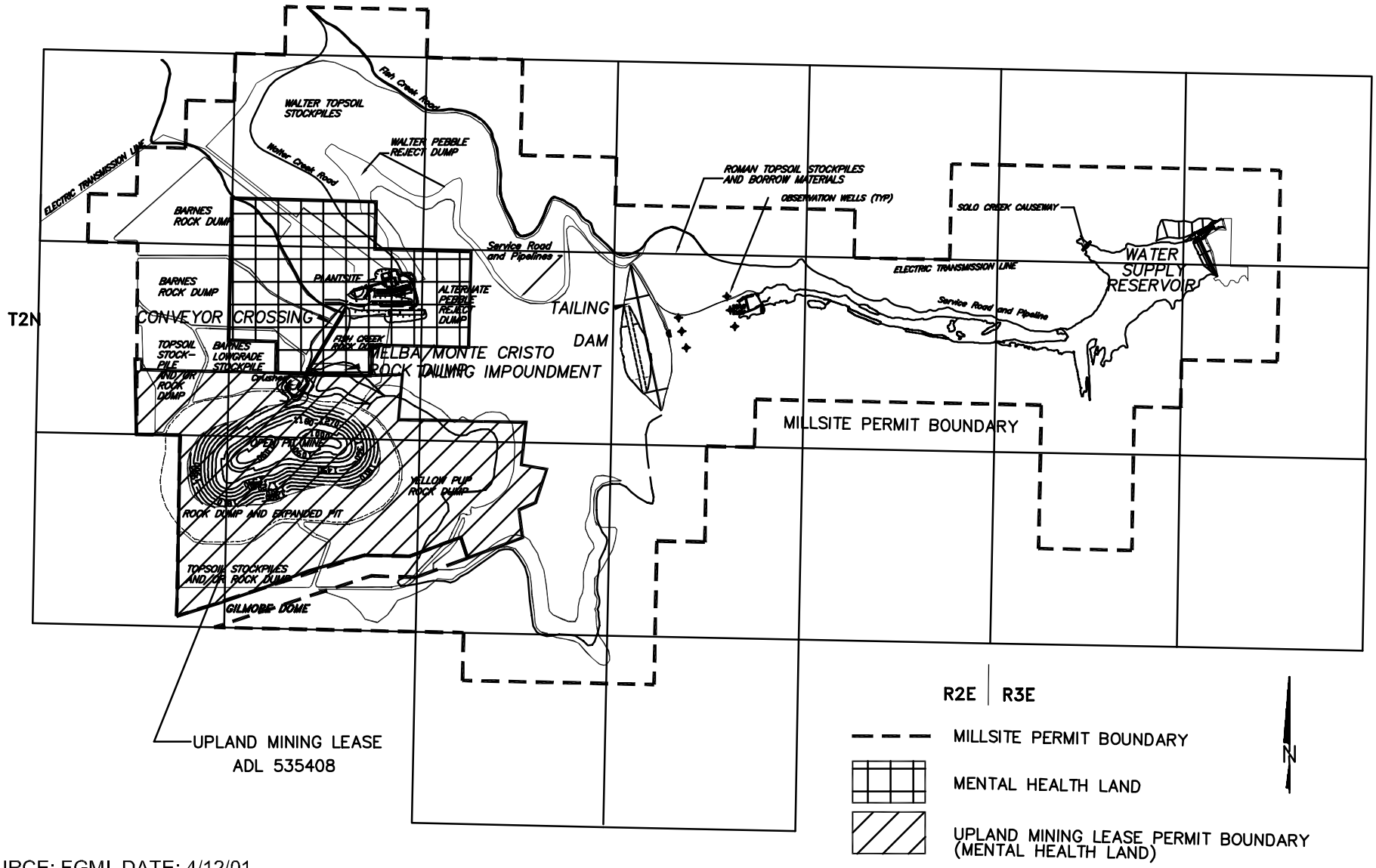
- Tailing Dam and Water Reservoir
- Ft. Knox Environmental Permitting and Baseline Studies
- Ft. Knox Power Supply and Distribution
- Ft. Knox Cultural Resources
- Ft. Knox Air Quality-Particulate Matter Monitoring and Modelling
  - Ft. Knox Land Appraisals
  - True North

TABLE 9

WATER STORAGE RESERVOIR MAINTENANCE REQUIREMENTS

Check to the extent possible prior to breakup, during breakup, and immediately after breakup, as well as annually in September	
Item	**Maintenance**
Roadways, culverts and ditches	• Clean out and regrade as necessary • Maintain safety berms. • Maintain buried equipment marker posts. • Maintain snow fences • Repair riprap.
Dam embankment	• Maintain riprap • Clear debris from spillway. • Lubricate and winterize slide gate lift housing and downstream valve from surface
Fresh water pipeline	• Check all exposed valves, connections and anchor points. • Ensure pipeline remains on grade and will fully drain; regrade low spots as required. • Maintain marker posts. • Ensure pipeline is adequately restrained against thermal contraction.
Pump Station	• Winterize in accordance with manufacturer's recommendations.
Seepage Reclaim Sump	• Winterize pump (if installed) in accordance with manufacturer's instructions. • Check heat tracing on valves and pipelines and water level indicators (if installed). • Check pump operating sequence and water level probe settings for winter operation (if installed).

FIGURES



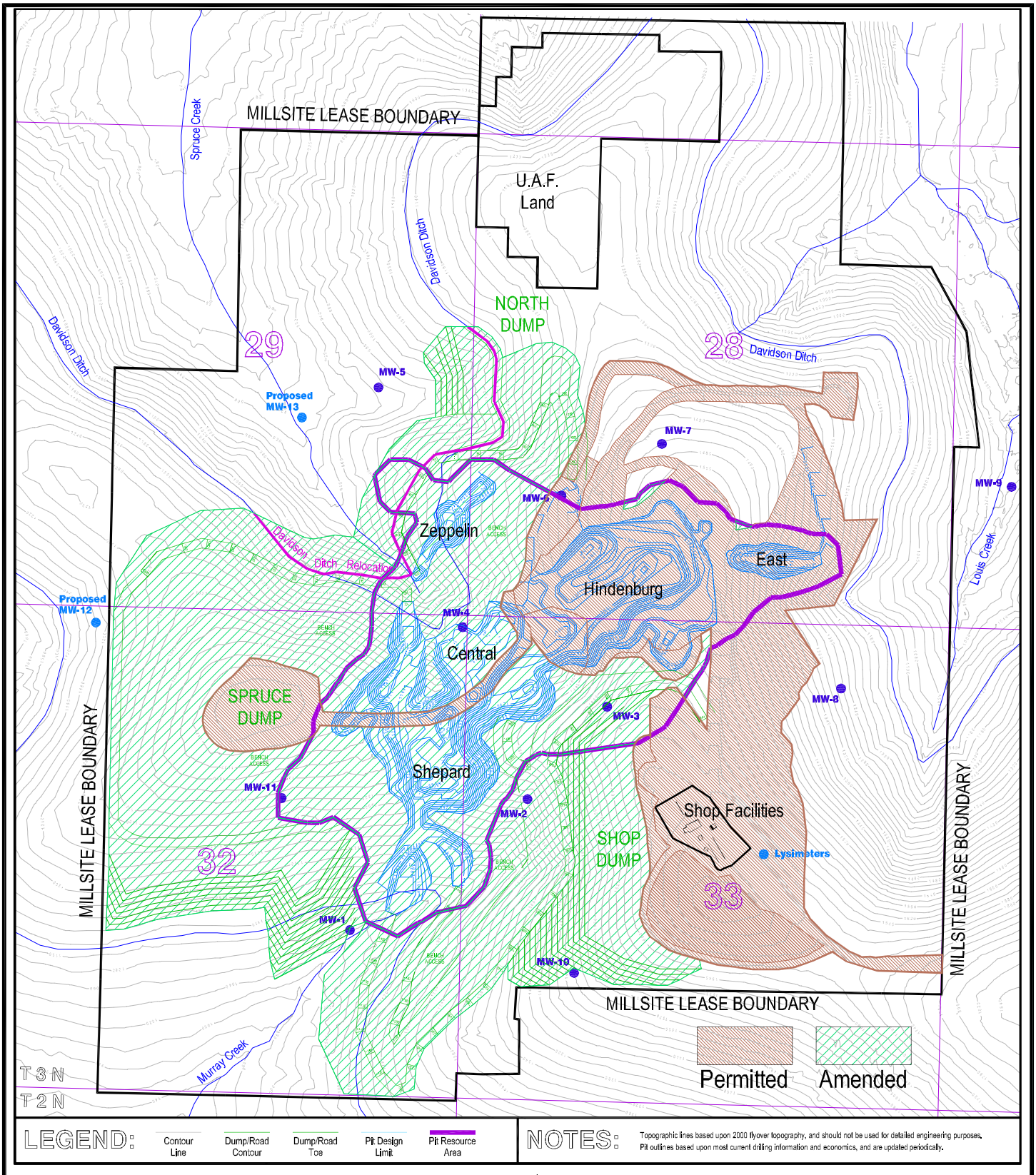
SOURCE: FGMI, DATE: 4/12/01

FORT KNOX MINE AND FACILITIES LAYOUT MAP

FIGURE 1

Golder Associates
Denver, Colorado

PROJECT No. 033-5601 FILE No. 0335601A001.dwg CADD SB DATE 08/21/03

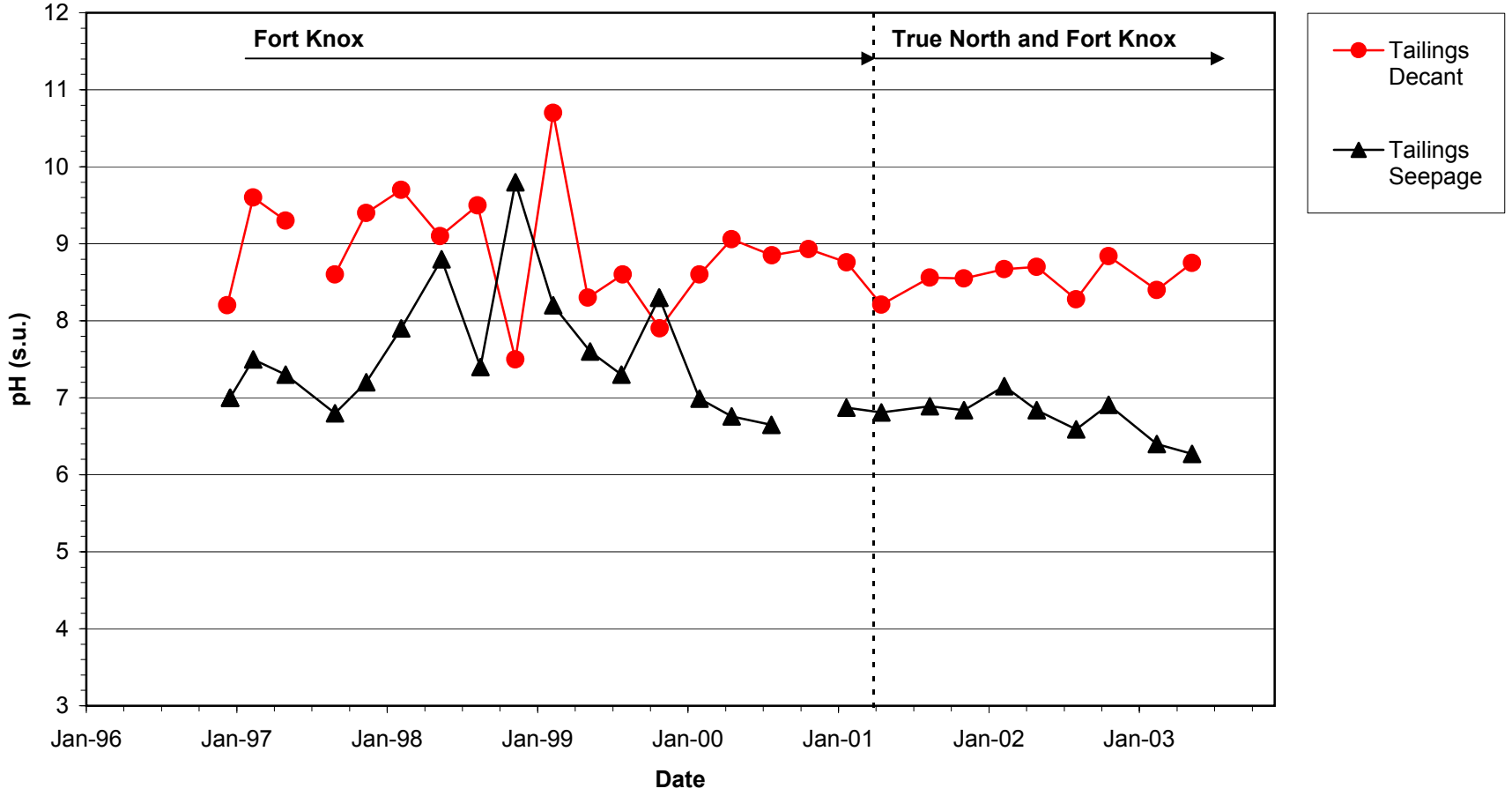


TRUE NORTH MINE LAYOUT MAP

FIGURE 2

Golder Associates
Denver, Colorado

PROJECT No. 033-5601 FILE No. 0335601A002.dwg CADD SB DATE 8/21/03



Golder Associates

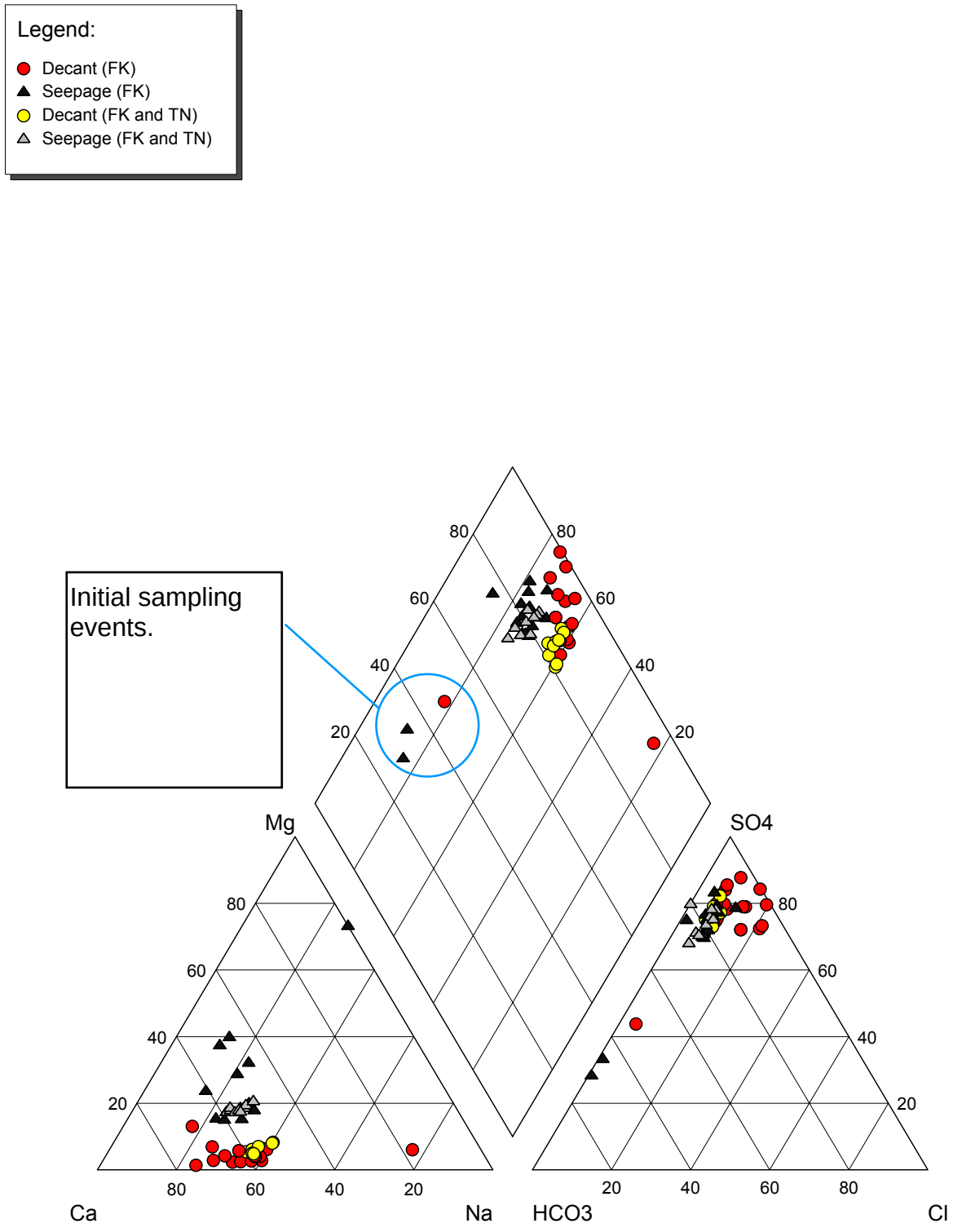
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

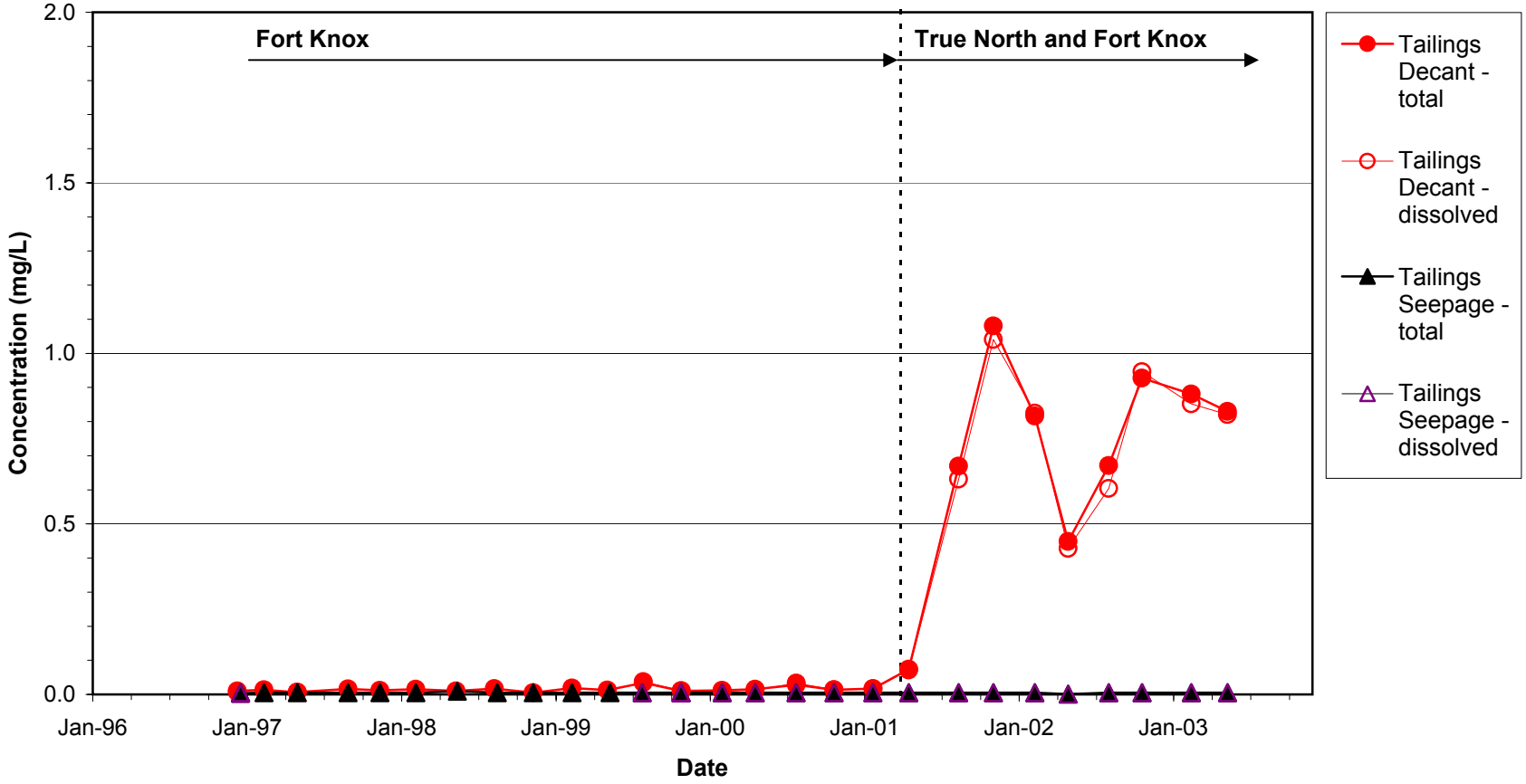
Tailings Water Quality - pH (field)

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	3



Golder Associates	FIGURE 4 Tailings Pond Piper Plot	
	PROJECT: Fort Knox Environmental Audit	
	PROJ. #: 033-5601	DATE: March 2004



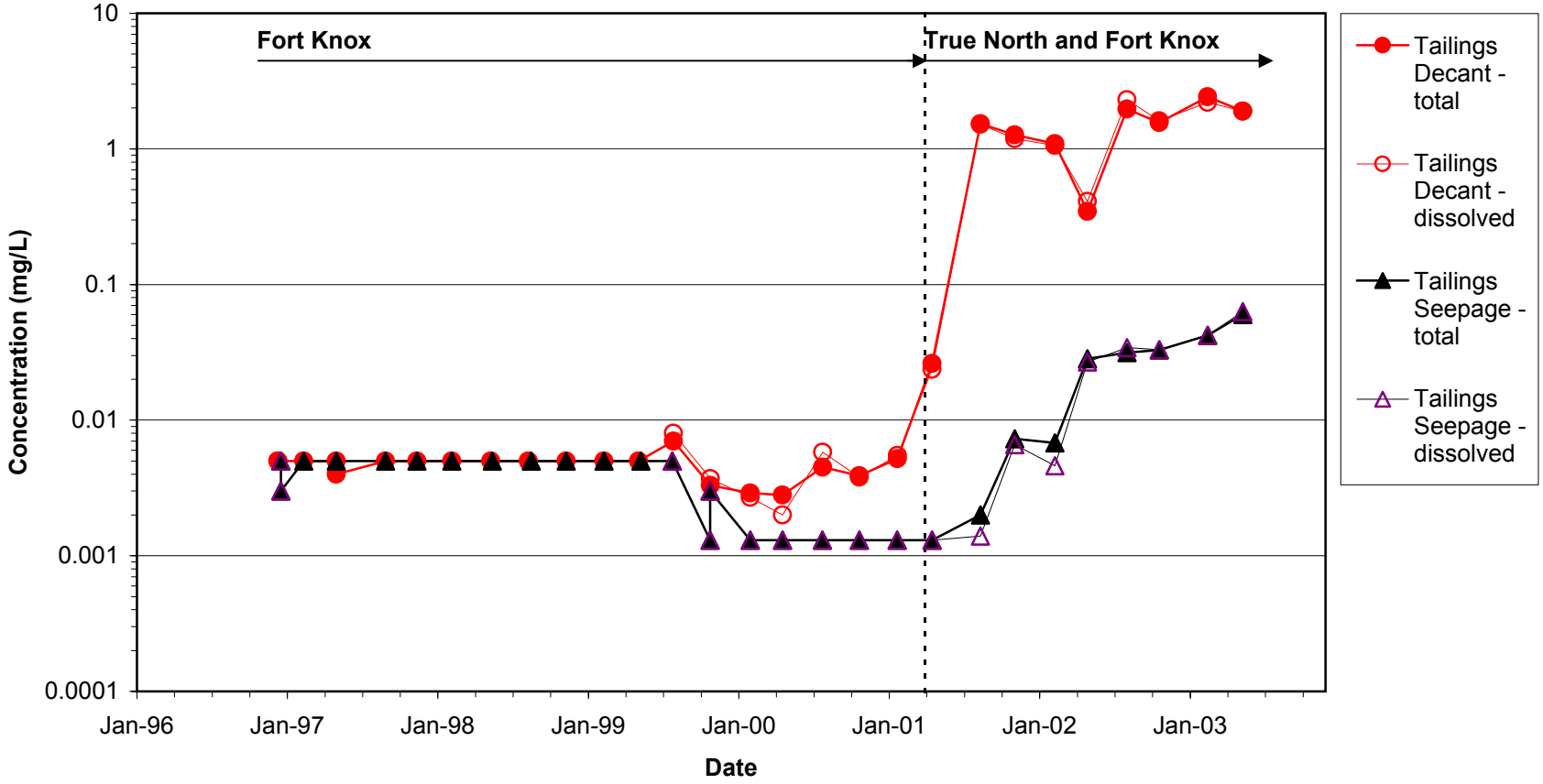
Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.001 to 0.005 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Arsenic**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	5



Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) equal to 0.0013 to 0.005 mg/L.

Golder Associates

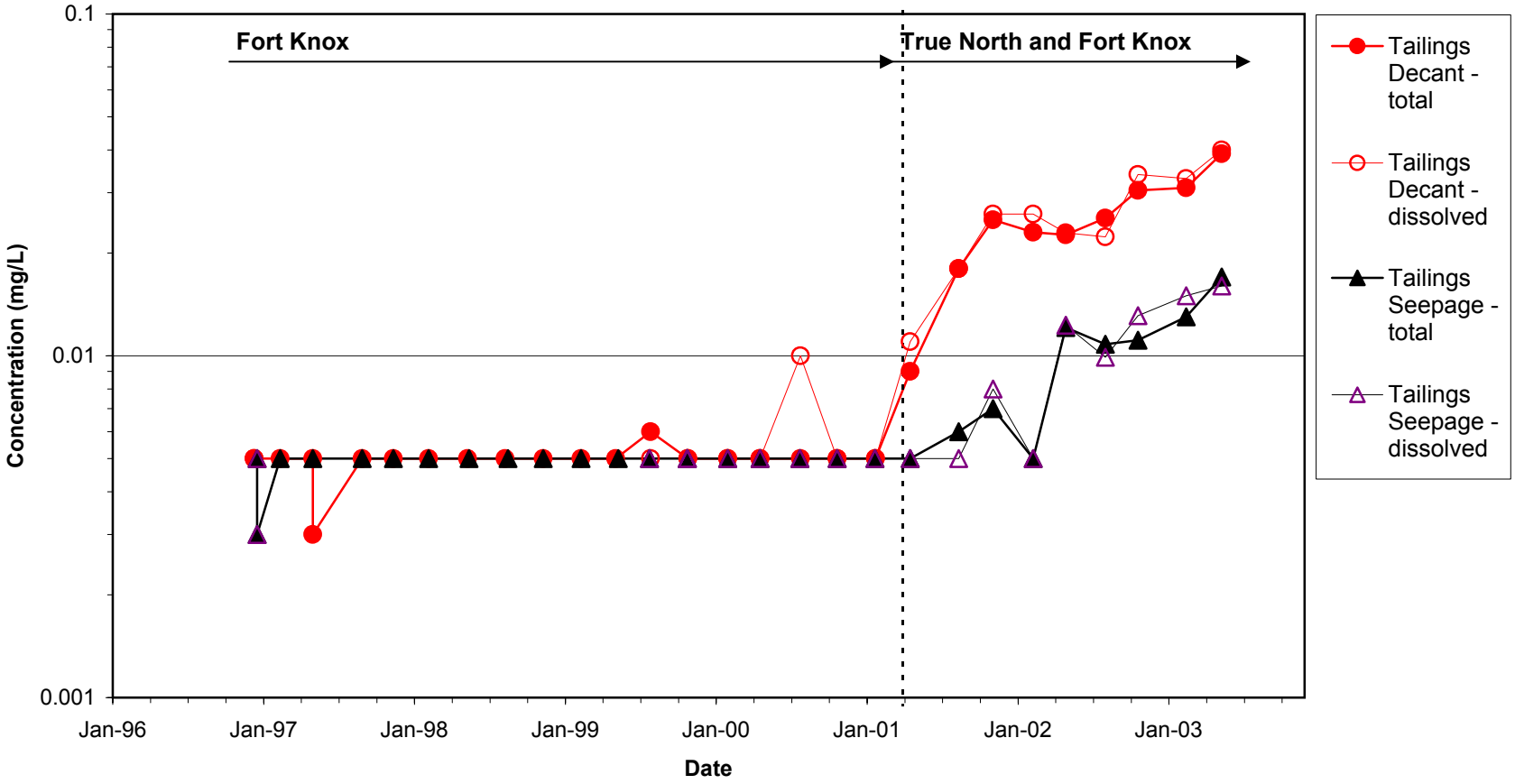
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Antimony

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	6



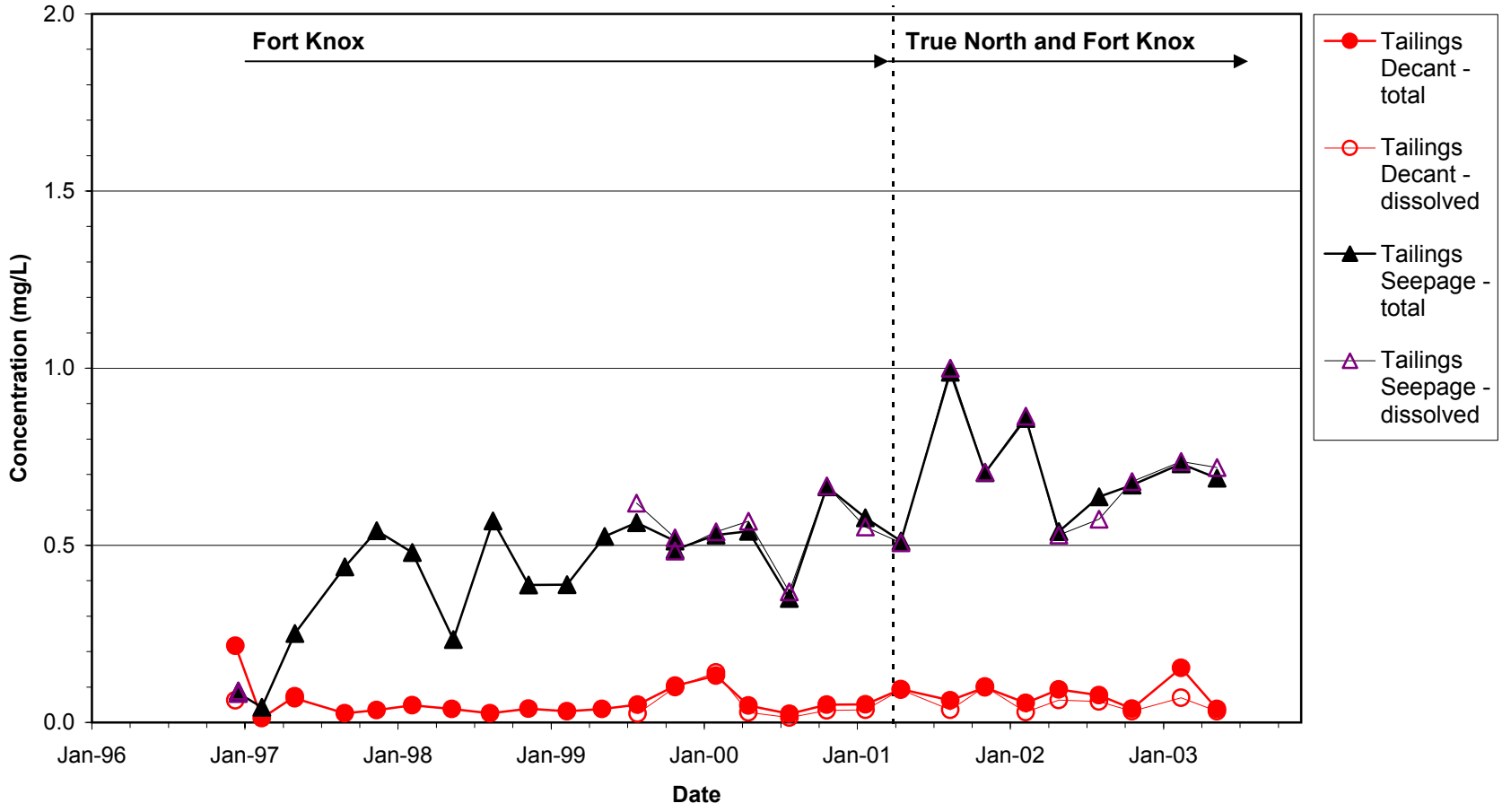
Note: Non-detect concentrations plotted at the detection limit. Mmethod detection limit (MDL) ranges from 0.003 to 0.005 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Selenium**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	7



Golder Associates

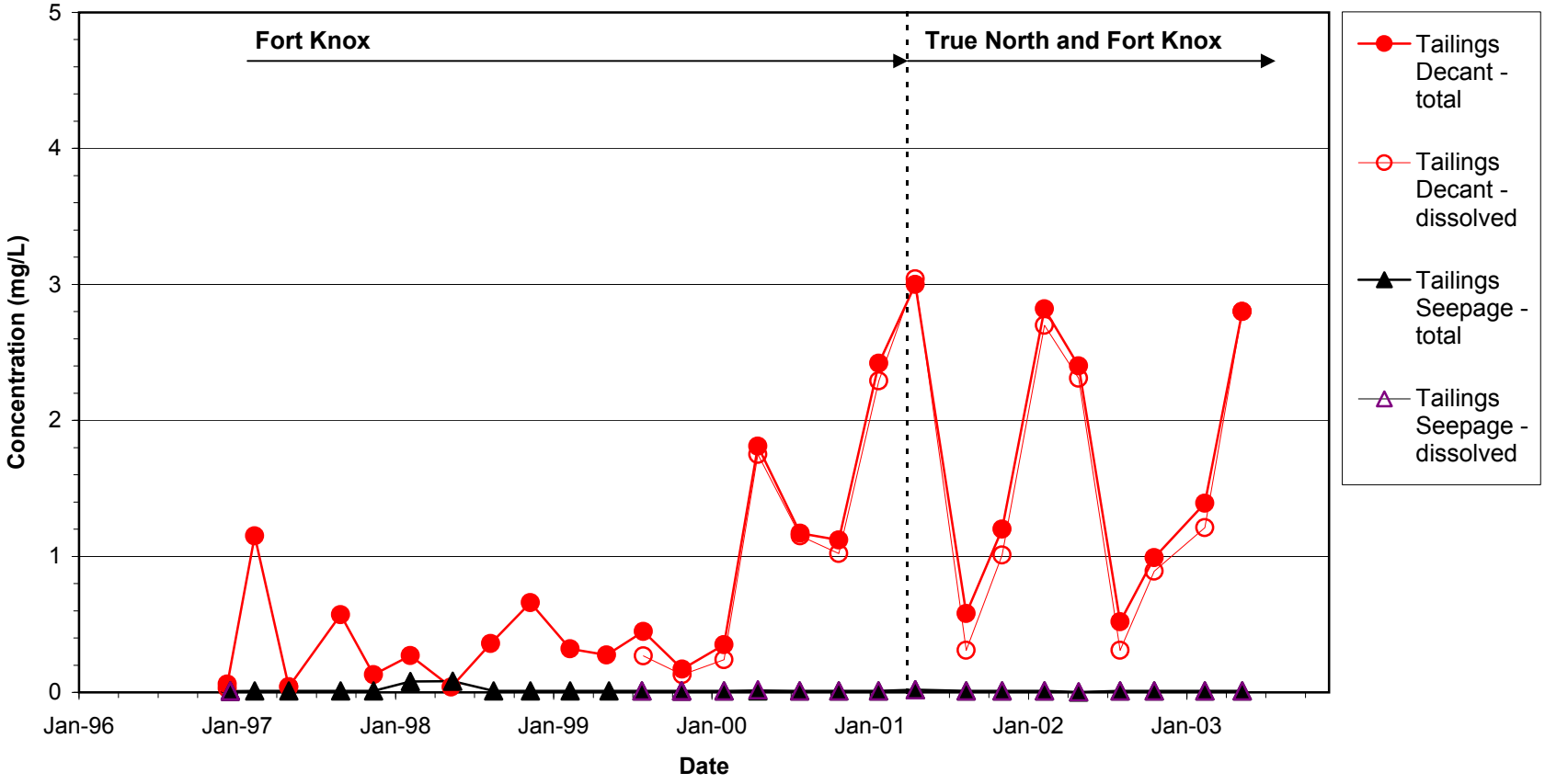
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Manganese

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	8



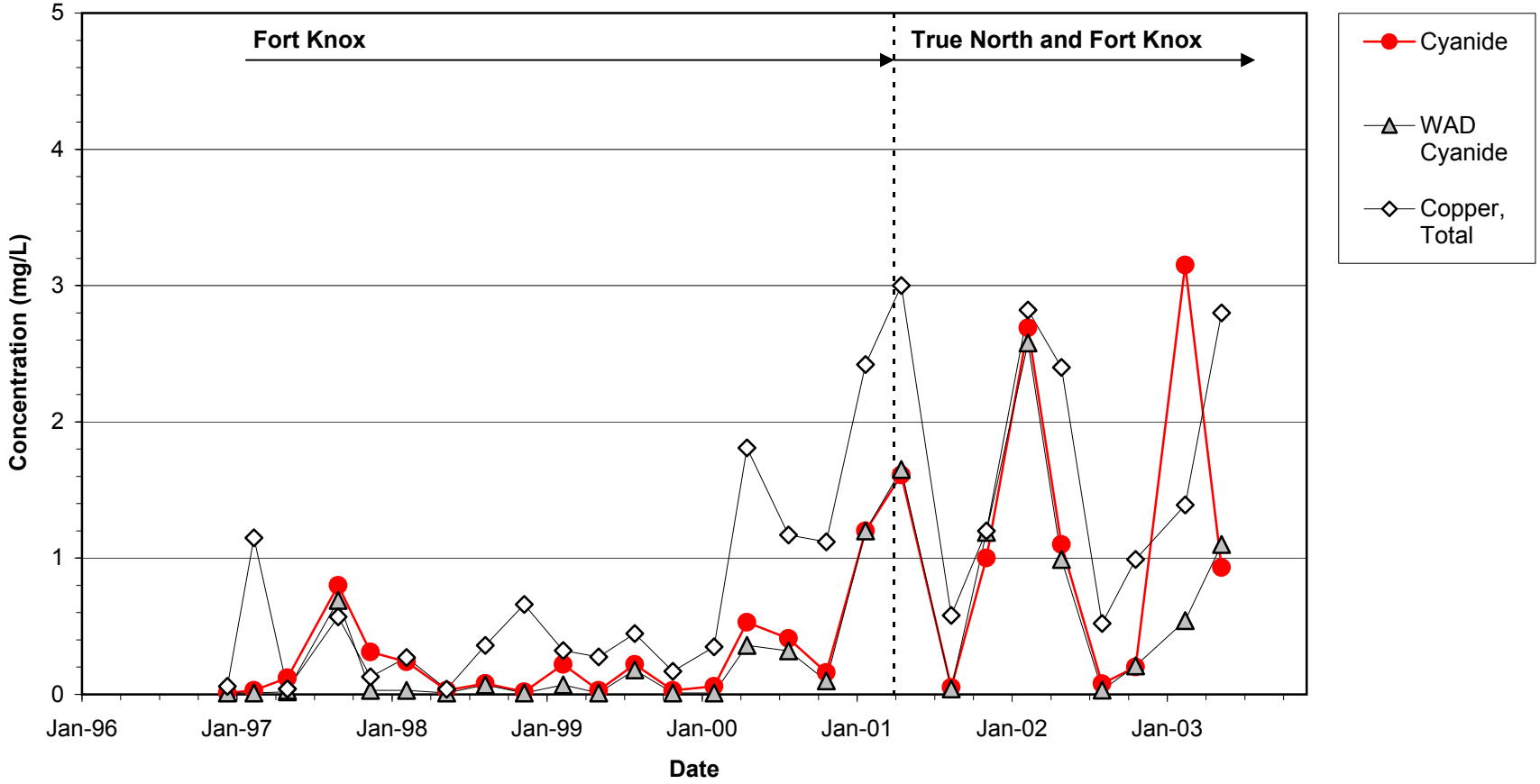
Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.009 to 0.01 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Copper**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	9



Note: Non-detect concentrations plotted at the detection limit.

Golder Associates

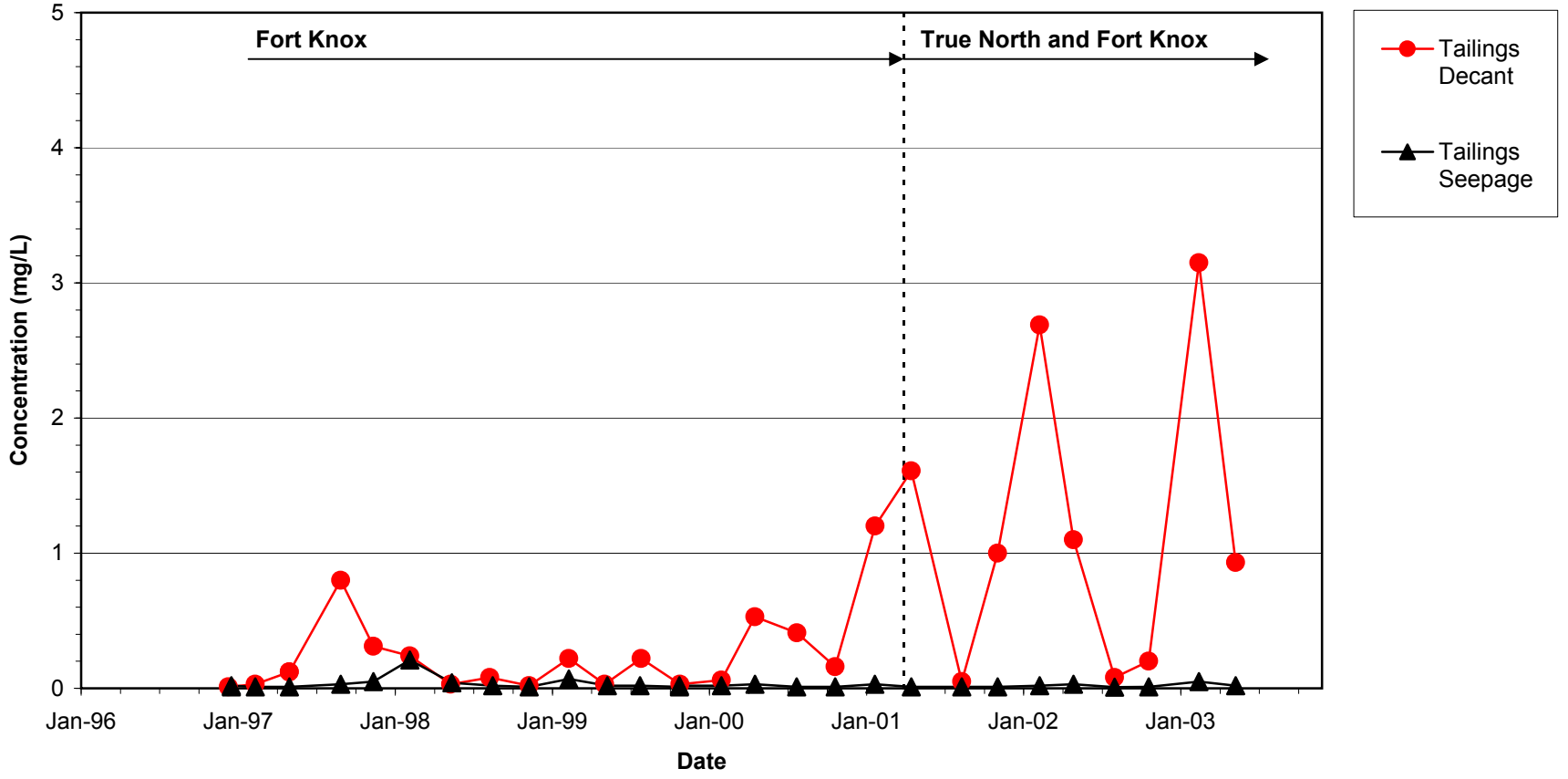
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Decant Water Quality - Cyanide and Copper

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**10**



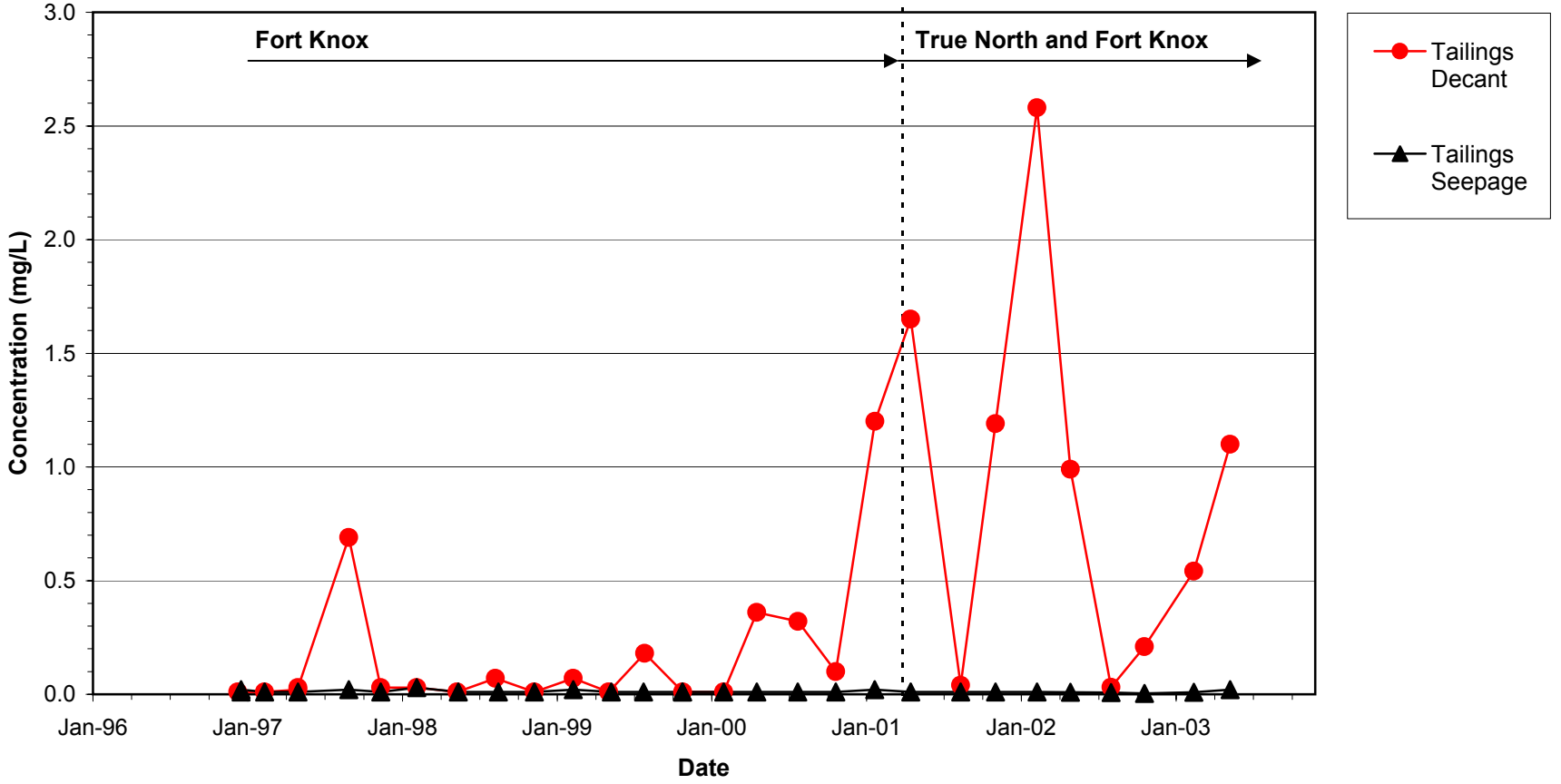
Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.008 to 0.02 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Cyanide**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	11



Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.004 to 0.01 mg/L.

Golder Associates

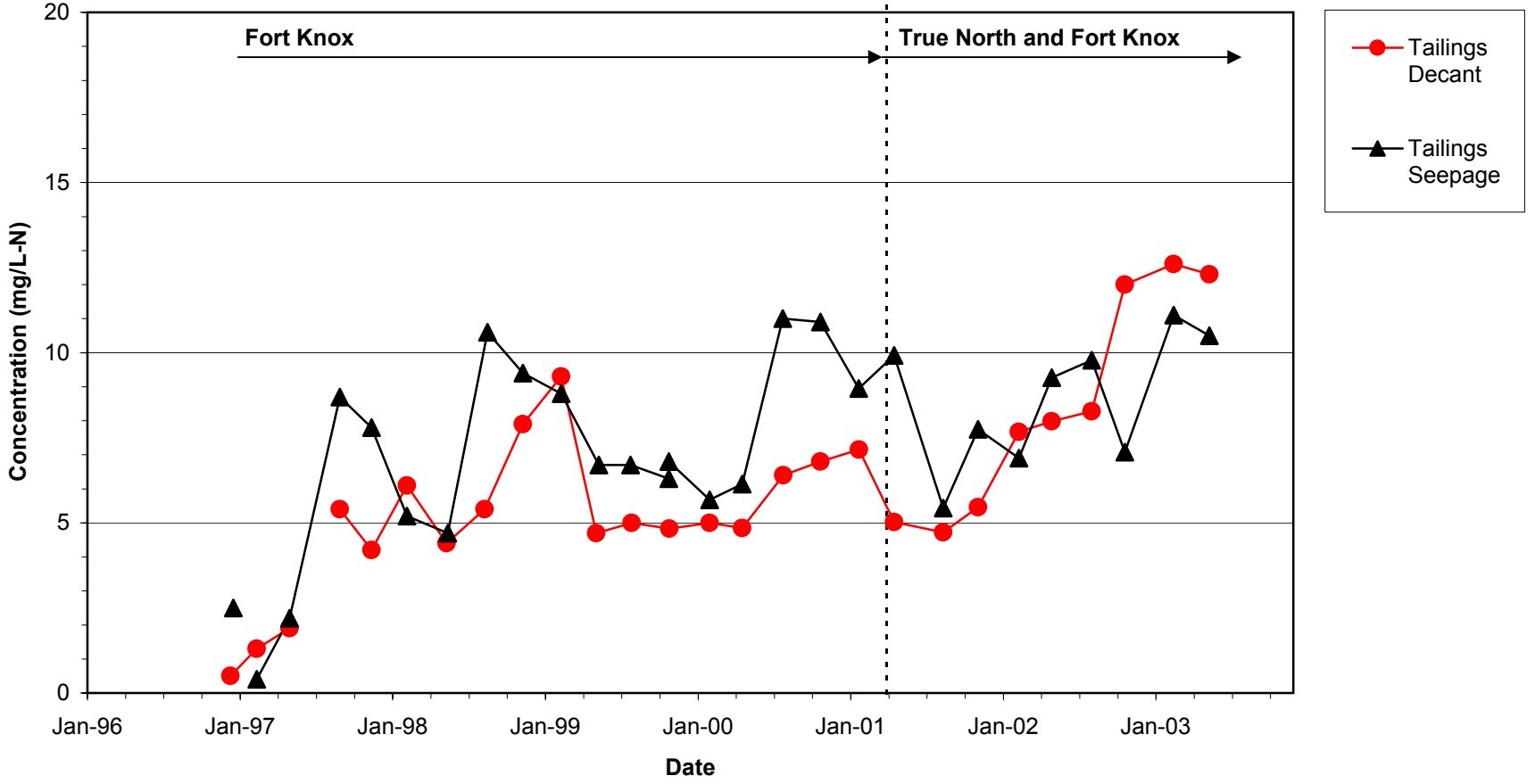
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - WAD Cyanide

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	12



Golder Associates

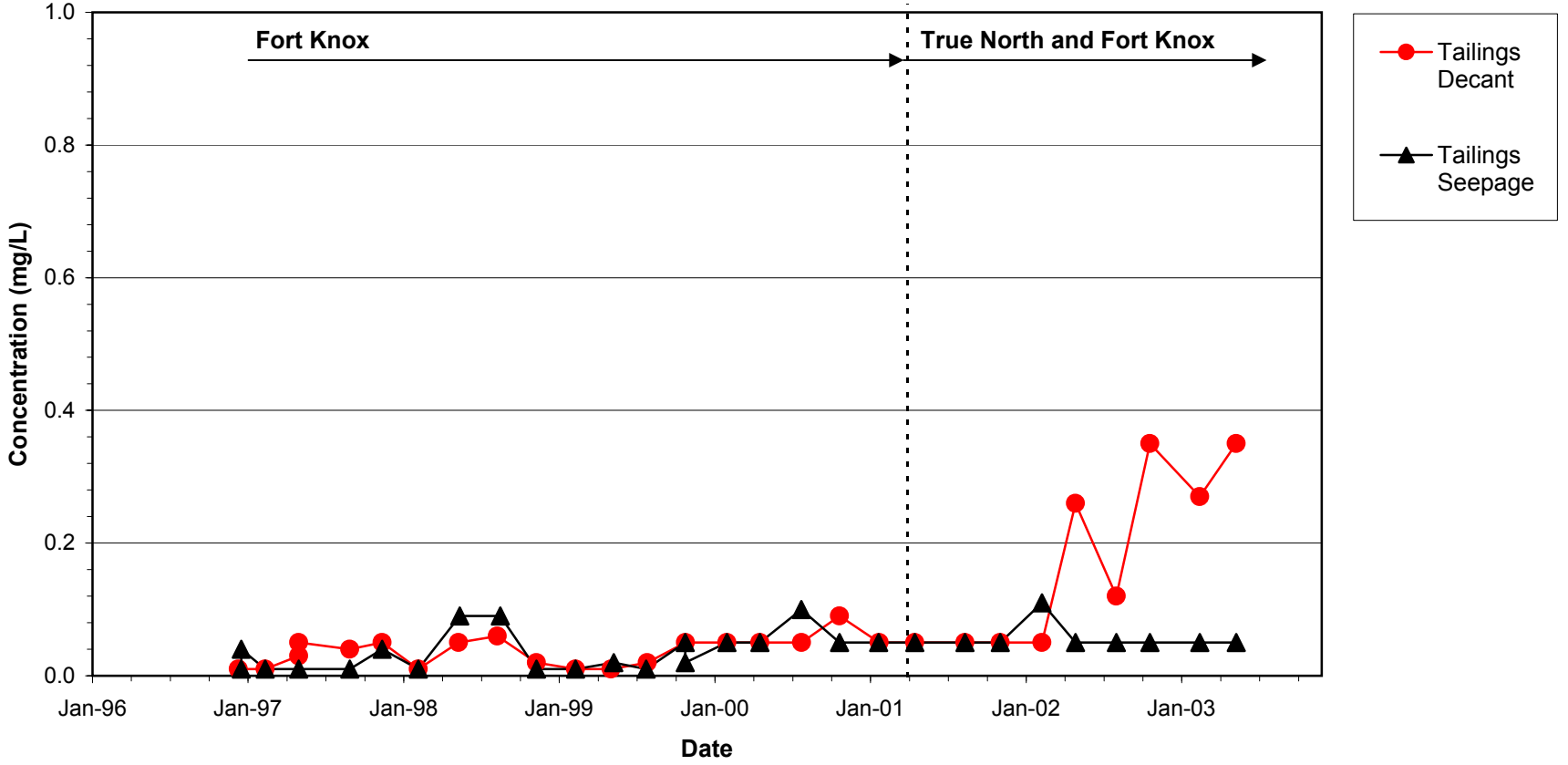
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Nitrate

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	13



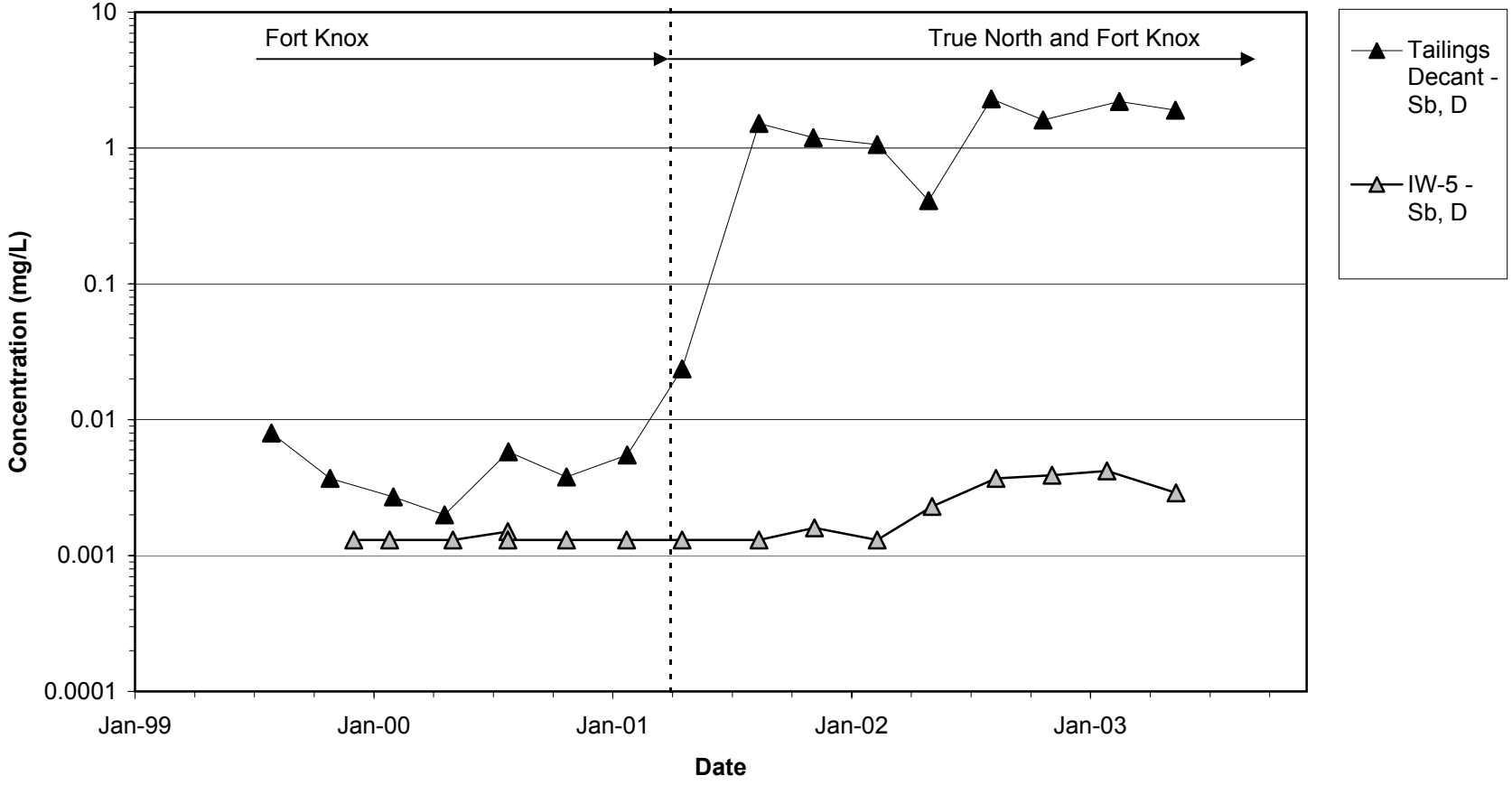
Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.01 to 0.05 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

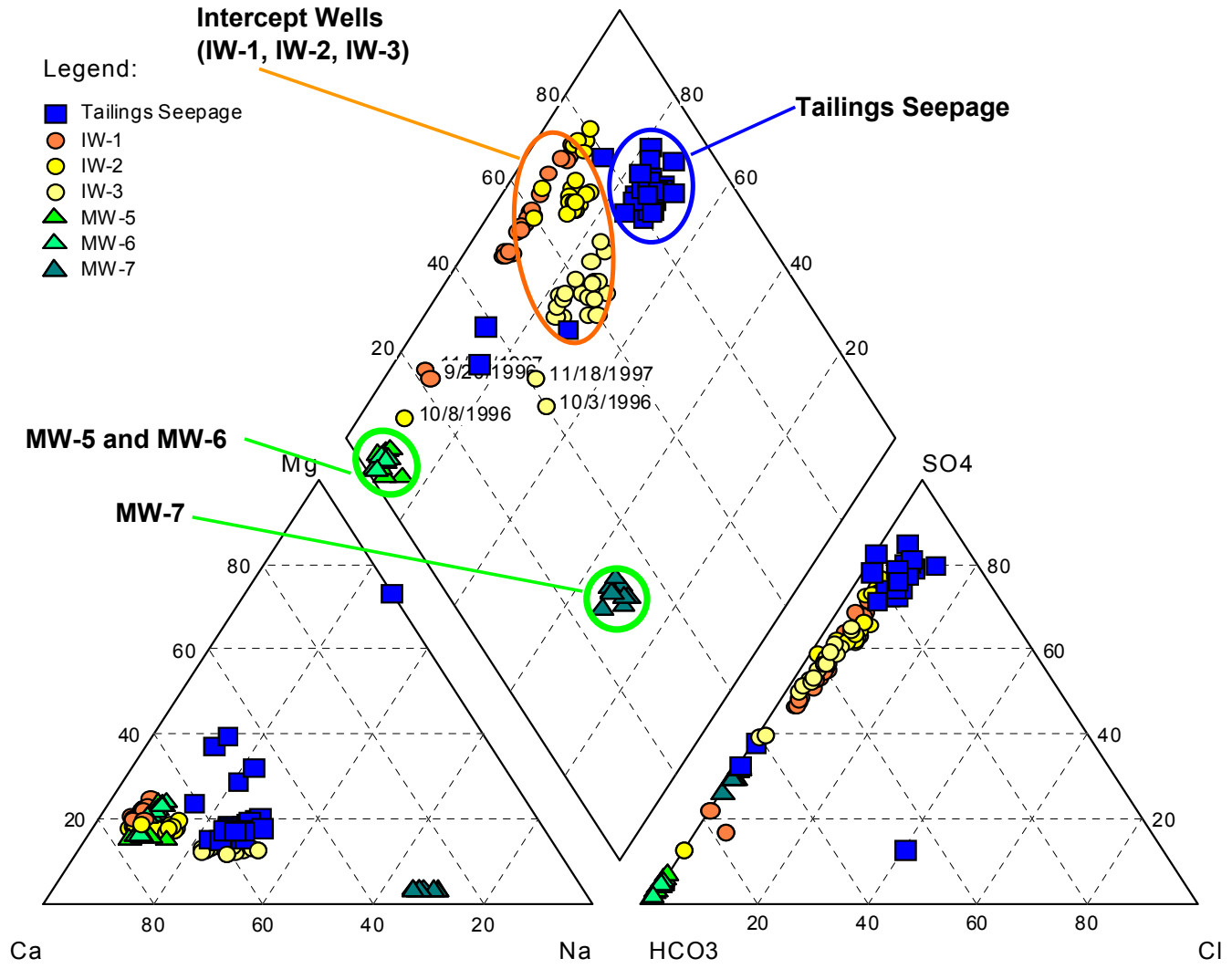
TITLE: **Tailings Water Quality - Phosphate**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	14



Note: Non-detect concentrations plotted at the detection limit.

Golder Associates	TITLE	**Tailings Water and Groundwater Quality - Sb** **Quarterly Monitoring Results**		
Fairbanks Gold Mining Inc. **Fort Knox Environmental Audit**	DRAWN CR	DATE March 2004	JOB NO. 033-5601	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED RV	FILE NO. Fort Knox Water Quality.xls	FIGURE NO. **15**	



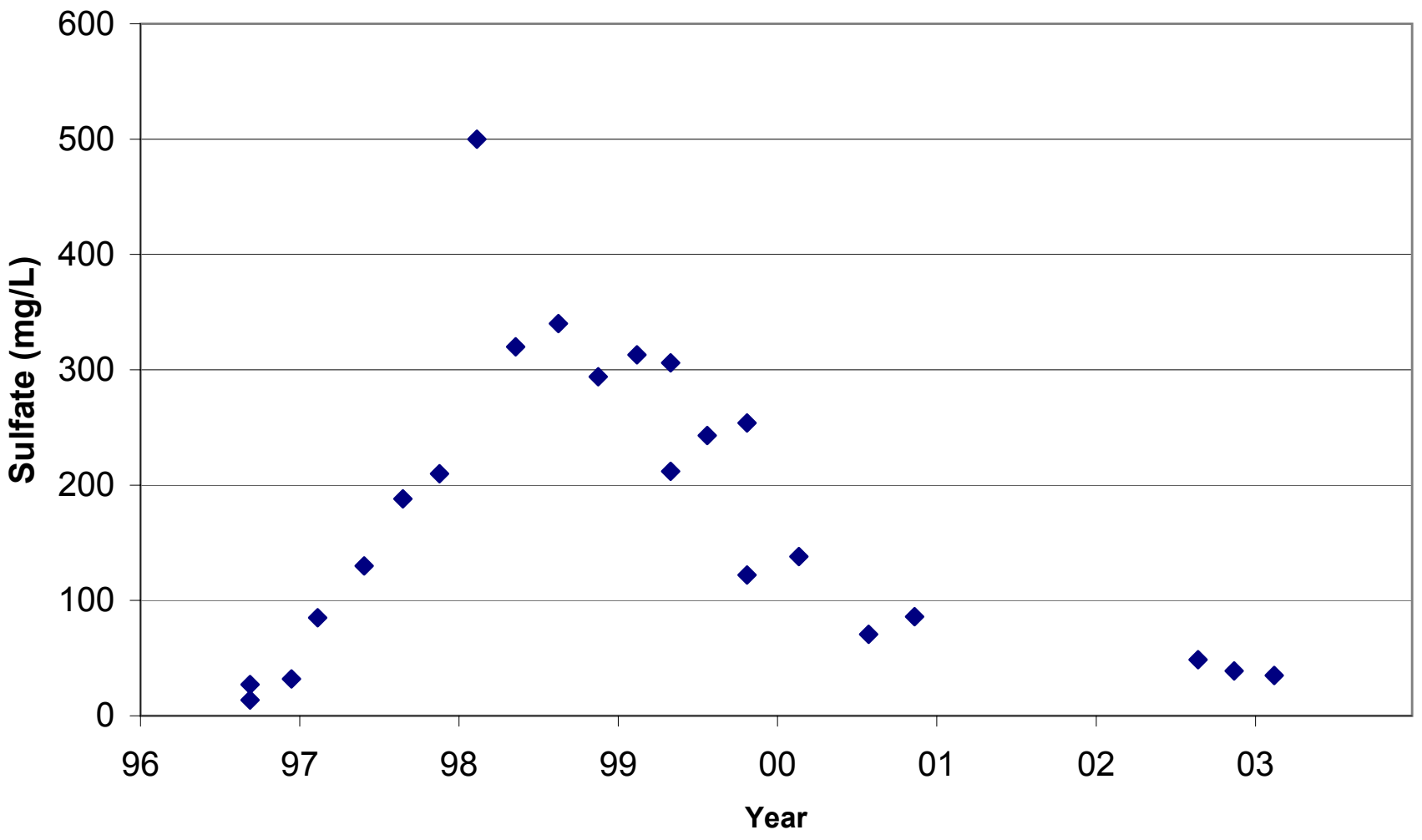
Golder Associates

DENVER, COLORADO USA

PIPER DIAGRAM FOR TAILINGS SEEPAGE AND SELECTED WELLS

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	JSW	DATE	March 2004	JOB NO.	033-5601
CHECKED	PSM	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	SHM	FILE NO.		FIGURE NO.	Figure 16



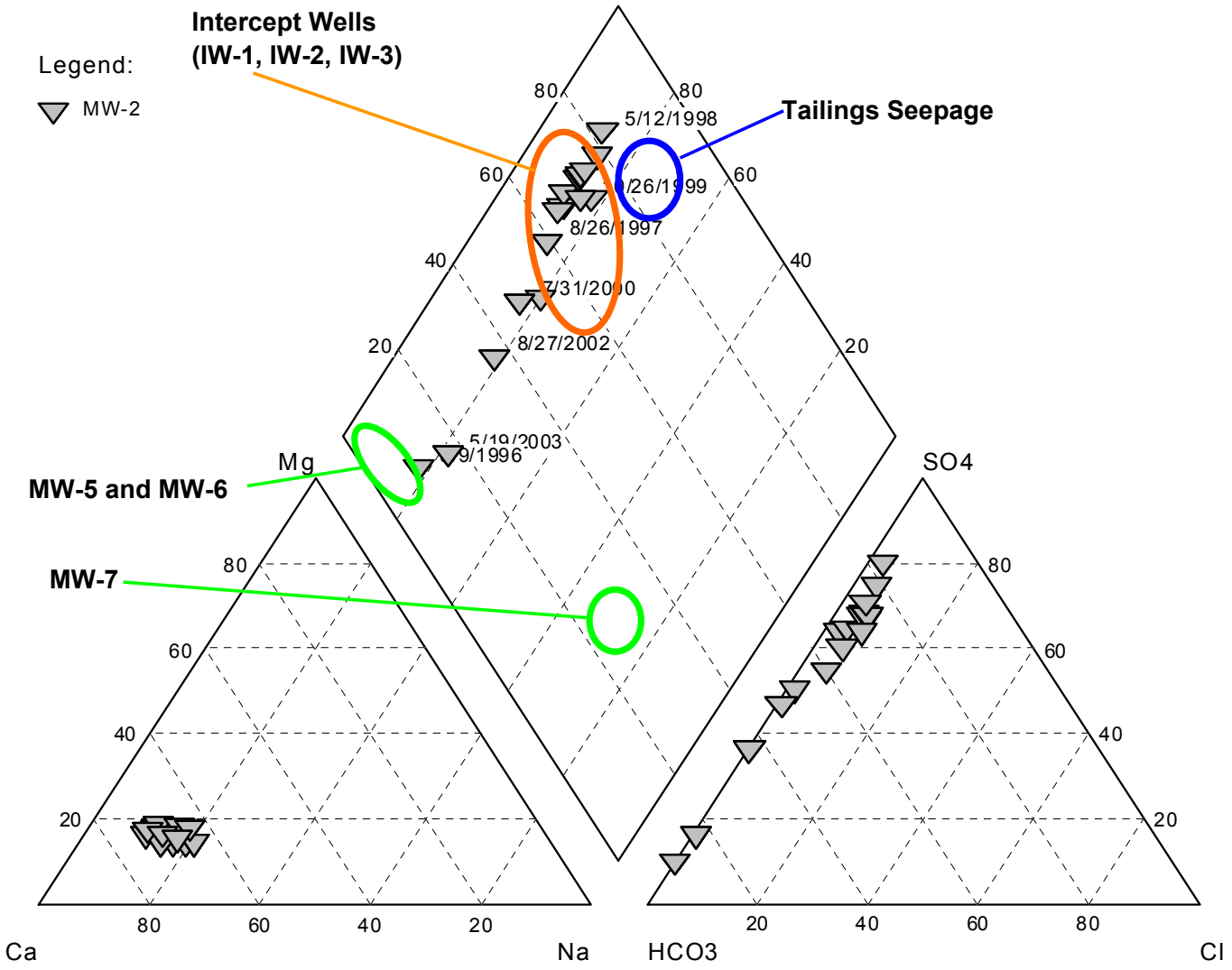
Golder Associates

DENVER, COLORADO USA

SULFATE CONCENTRATIONS AT MW-2 OVER TIME

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	JSW	DATE	March 2004	JOB NO.	033-5601
CHECKED	PSM	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	SHM	FILE NO.		FIGURE NO.	Figure 17



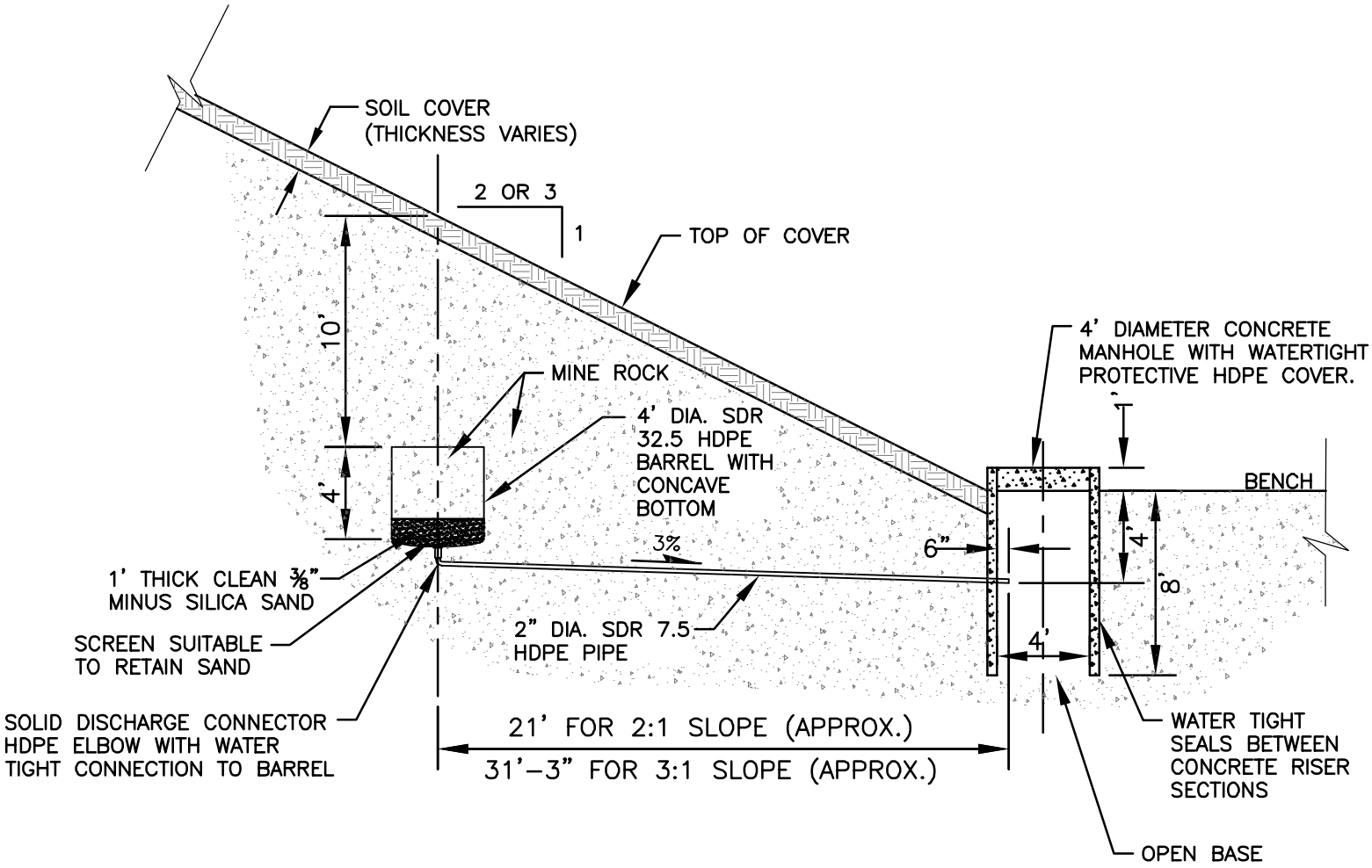
PIPER DIAGRAM SHOWING MW-2

Golder Associates

DENVER, COLORADO USA

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	JSW	DATE	March 2004	JOB NO.	033-5601
CHECKED	PSM	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	SHM	FILE NO.		FIGURE NO.	Figure 18



PROJECT

FORT KNOX MINE
ENVIRONMENTAL AUDIT
FAIRBANKS, ALASKA

TITLE

TYPICAL BARREL LYSIMETER DETAIL

Golder Associates
Denver, Colorado

PROJECT No.	033-5601		FILE No.	0335601A003	
DESIGN	BRB	1/15/04	SCALE	N.T.S.	REV.
CADD	MRJ	1/15/04	FIGURE 20		
CHECK	SHM	1/15/04			
REVIEW	SHM	1/15/04			

APPENDIX A

AGENCY INTERVIEW SUMMARIES

APPENDIX A

AGENCY INTERVIEW SUMMARY

Golder telephone interviewed Victor Ross of the Corps of Engineers. Mr. Ross made the following points:

- FGMI is in compliance with the Corps 404 permit for both Fort Knox and True North mines
- He makes one or two site inspections per year
- He has good communications with FGMI
- FGMI corrects issues as they are brought up
- At True North, the operations "were not as good as they could have been but they were corrected when potential deficiencies were pointed out (stripped organics were within permit boundaries but the boundaries were not staked so that the dozer operators would know where the limits were – this was corrected)"
- Fort Knox 404 Permit originally permitted for 35% wetlands, 35% ponds, and 30% uplands. "Now, State Dam Safety sees a hazard in leaving a big pond on the Tailings and wants it greatly reduced or eliminated to reduce the hazard. Therefore, what the state wants is in conflict with the reclamation plan and with the Corps permit. The Corps will go along with the reduced ponds and wetlands provided it can be justified by the creation of enough high value aquatic habitat below the TD. He wants to know what the balance of acreage will be, although he is already aware that the fresh water reservoir (FWR) has created an extraordinary nursery for grayling that is worth more per acre than a regular wetland. He wants to know what the wetland or aquatic acreages (by type) will be there at a the time of closure of the mine so a change in the 404 permit can be justified and presented to the public as required under the 404 permit process. He expects the audit to confirm/quantify the acreage types. He thinks there is more aquatic acreage below the TD than originally planned and it is of higher value. He likes what he sees."
- Acreage numbers are important and there have been several enhancements over time on Last Chance Creek, Ott Plan, reservoir, and spawning channels. Corps must know how much wetland is being created.

Golder interviewed Mr. Ed Fogels (DNR, Anchorage), Mr. Charles Cobb (State Dam Safety Engineer), and Michael Franger (Alaska Mental Health Trust Lands Office) in Anchorage. All three of them stated that the communication/responsiveness with FGMI and their office is very good.

Mr. Fogels had the following main points:

- He makes several visits a year.
- The big issue is the True North road to Fort Knox – there have been efforts to abate noise, dust, and lights from the haul trucks although only noise is monitored and FGMI is meeting it.
- Water quality is a DEC concern but everything is apparently fine although they had a short term spike of arsenic and maybe a few other elements.
- DNR prefers a closure of the tailings impoundment that is dry although the closure plan currently calls for a partial wet one to satisfy Corps desire for wetlands. Apparently the Corps is willing to have a dry one now as well although the issue is not resolved and the agencies need guidance and hope to get it from the audit we are doing. If is not to be dry, then how much and where can the water be ponded (DNR wants it further back from the dam).
- The Reclamation plan has been administratively extended.
- Tailings placement – FGMI may need toe adjust deposition process and address settling (for closure purposes).

Mr. Cobb's main points were:

- He conducts site visits
    - FGMI does exceptional job of cooperating with Dam Safety
    - Dams are in compliance
    - Big question as to who will take responsibility of dams after reclamation and closure (bond is likely inadequate)
    - Tailings dam – location of post-closure residual pond is an issue as it is a threat to the water supply dam below it.

Mr. Franger's main points were:

- Conducts site visits and has regular meeting with FGMI
    - No problems with FGMI

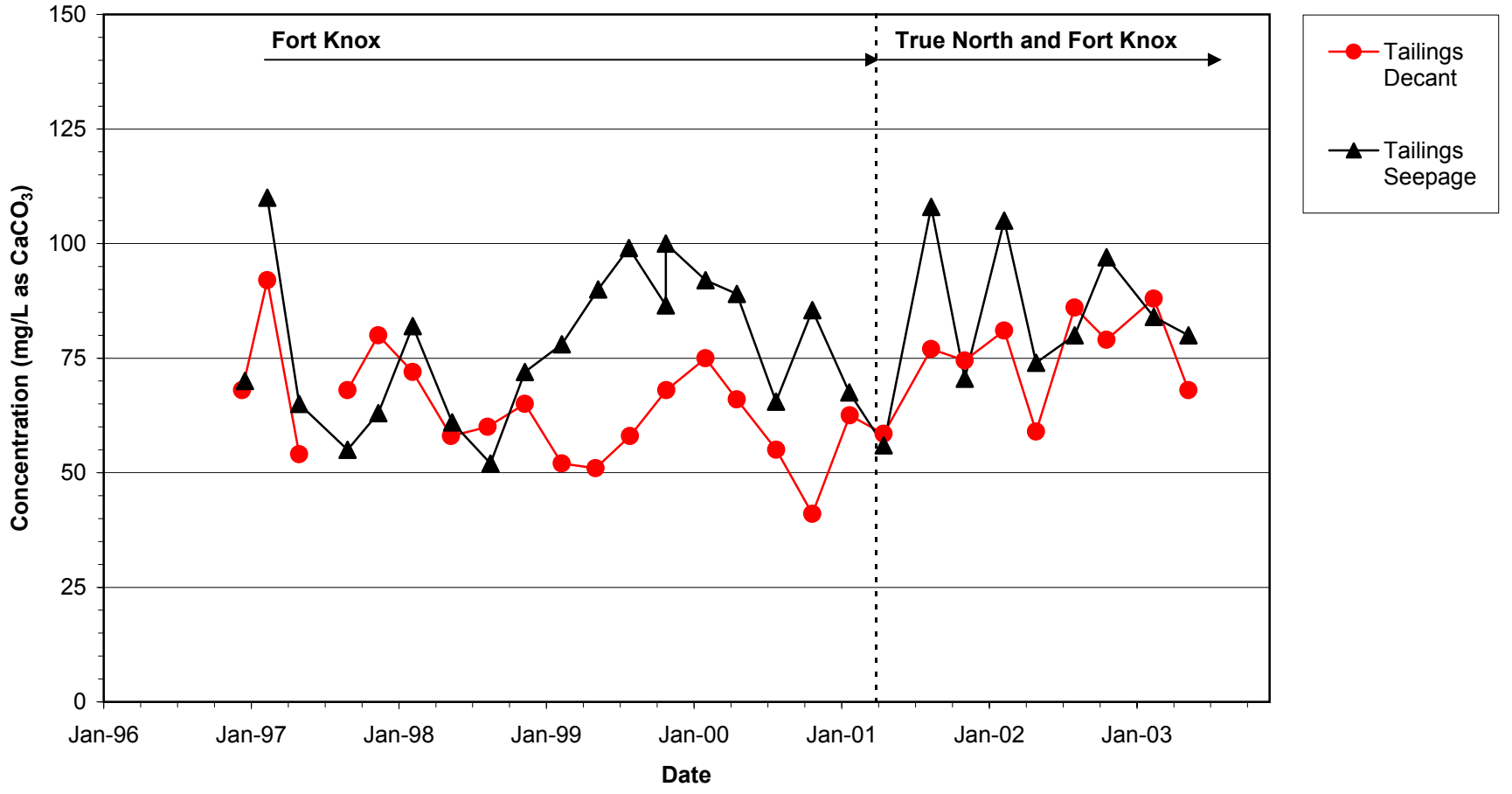
- Good communications
- Very interested in audit results

Golder met in Fairbanks with DNR and DEC personnel. The main issues raised at that meeting were:

- Agencies felt comfortable with the communications and responsiveness of FGMI
- FGMI is proactive (sited an oil spill response as an example)
- Wetlands are a "feather" in FGMI's cap
- Both agencies preferred a dry tailings closure with channels instead of the Corps' proposed 35% wetland. Concerned about the geochemistry of the tailings at closure and the adequacy of bonding, especially with regard to long-term water management.
- DNR concerned about closure of the True North waste dumps and backfilling of the pits with regard to potential metal leaching to ground and surface waters. Recommend that lysimeters that are properly designed be placed in the waste dumps for monitoring.
- Concern of inadequate topsoil salvage at True North and whether FGMI is stockpiling enough soil for reclamation and closure.
- Concern about adequate funds for the long-term management of the fresh water reservoir.
- DEC receives complaints from mine neighbors about noise, dust and light associated with the haul road. DEC has responded several times to neighbors complaints and have monitored noise and dust from the neighbors' property. DEC stated that dust control is particularly difficult in the winter. An inspection on 9/5/02 identified that one too many trucks were hauling on the night shift. This was corrected.

APPENDIX B

TAILING DECANT AND SEEPAGE PLOTS



Golder Associates

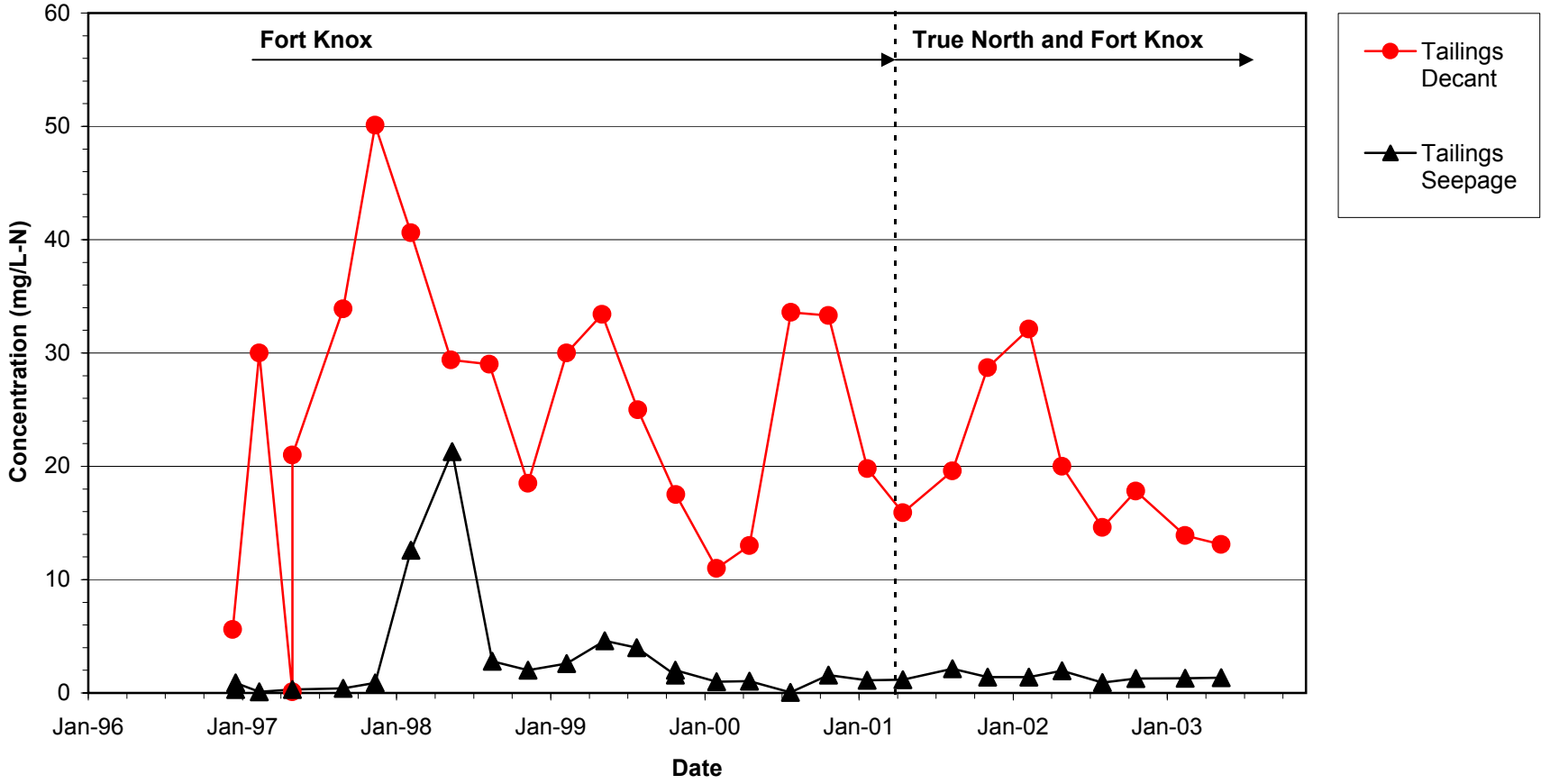
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Total Alkalinity

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-1



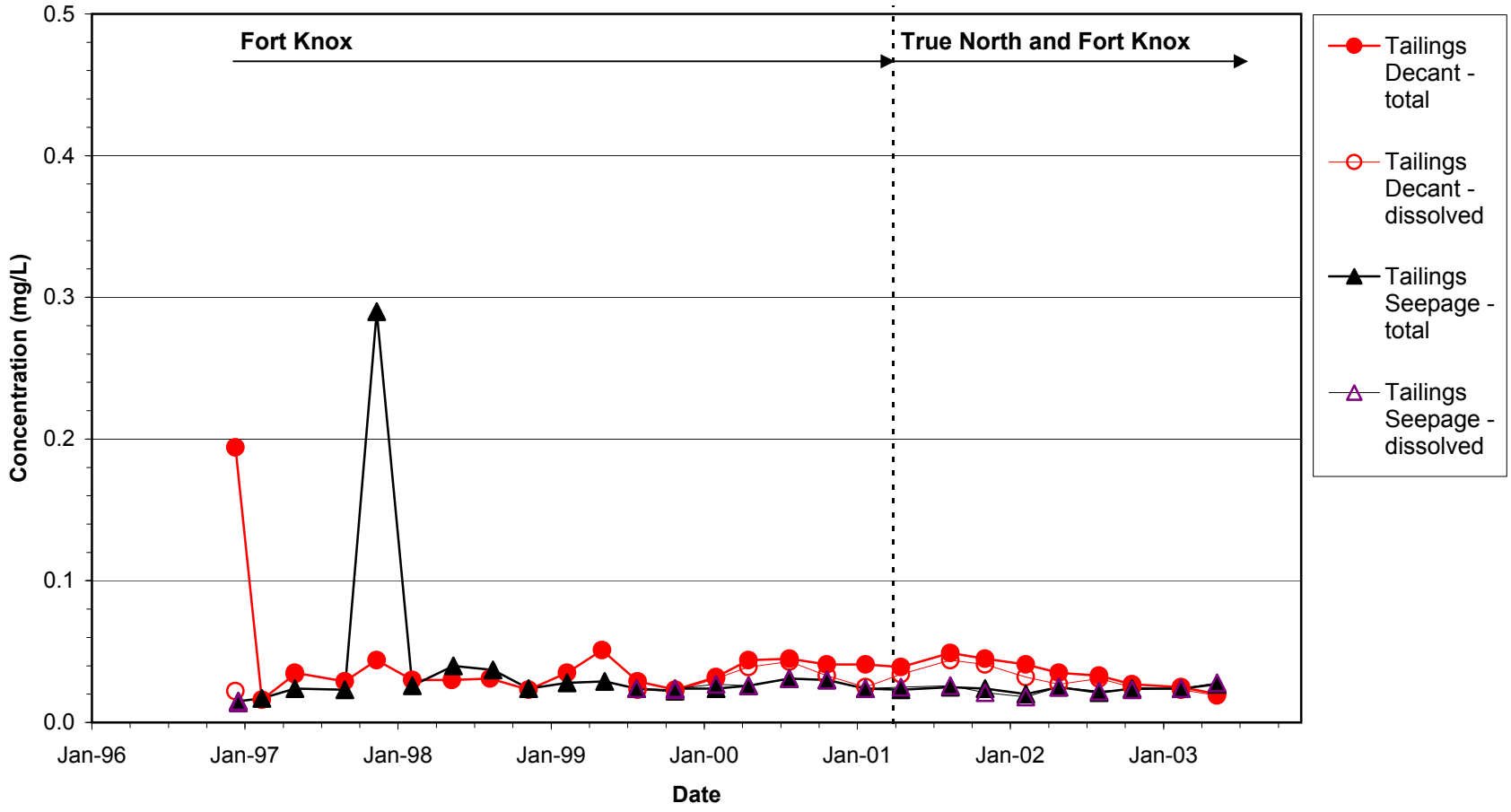
Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.05 to 0.1 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Ammonia**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-2



Golder Associates

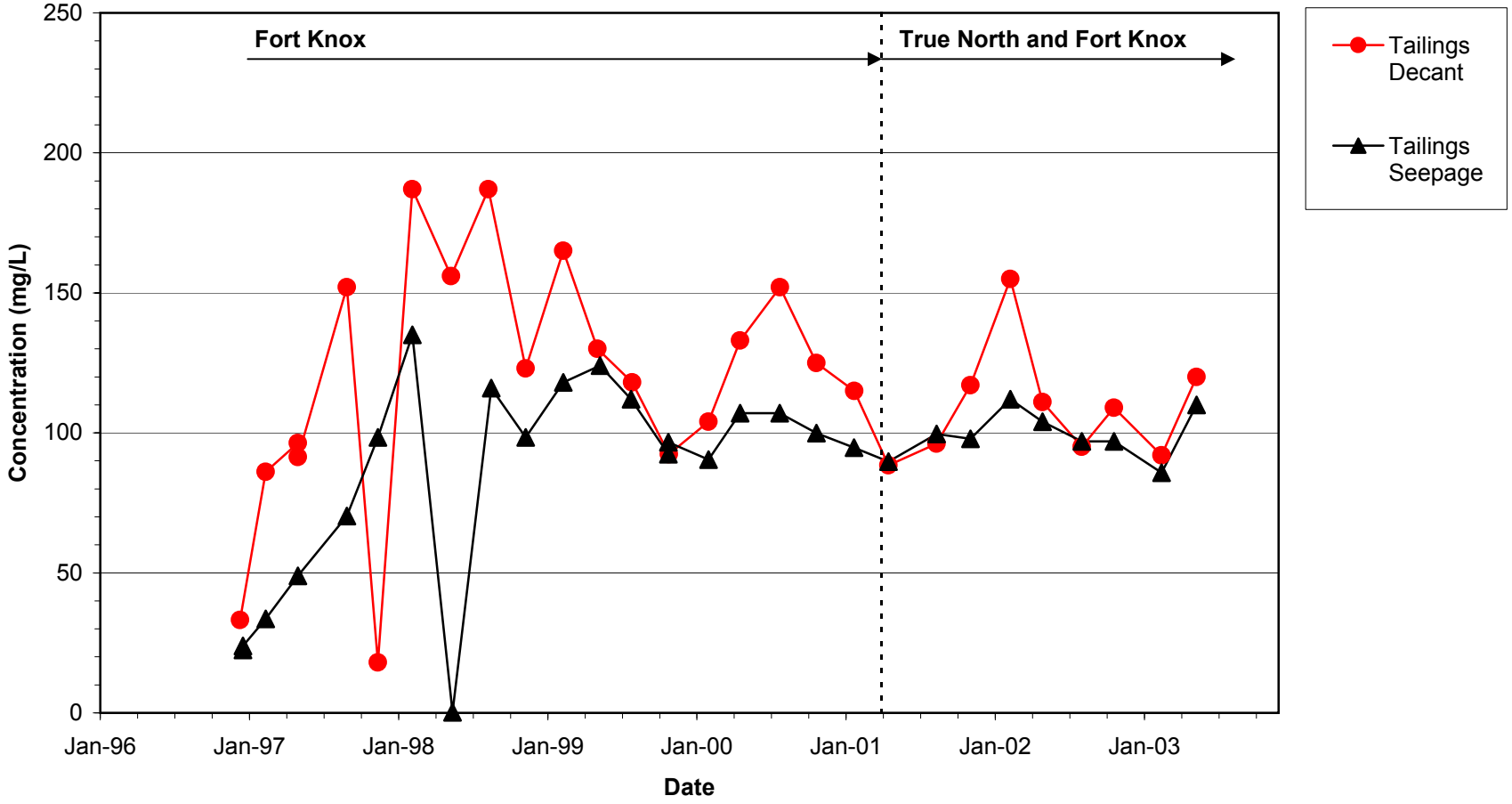
TITLE

Tailings Water Quality - Barium

Quarterly Monitoring Results

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-3



Golder Associates

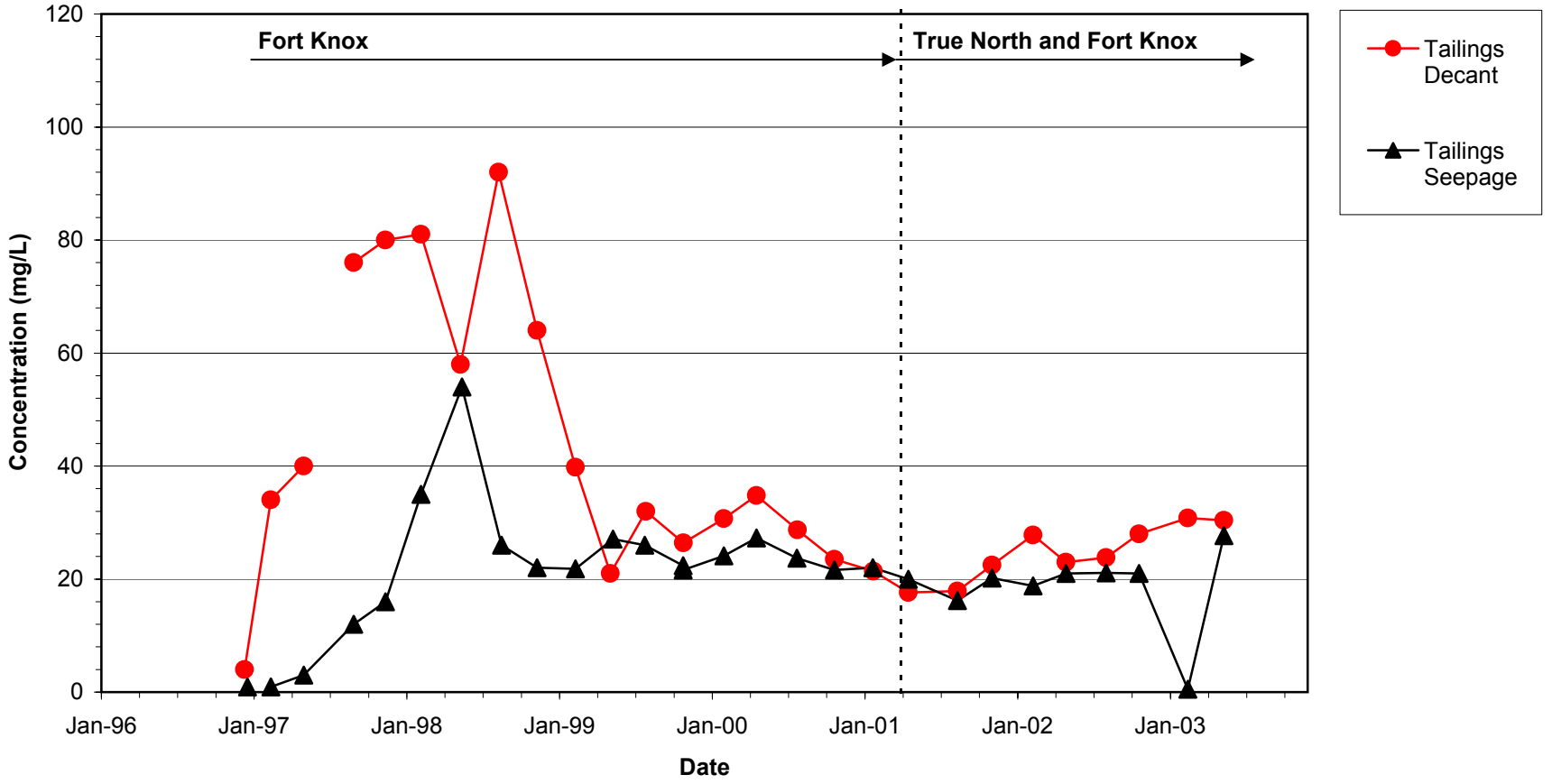
TITLE

Tailings Water Quality - Calcium

Quarterly Monitoring Results

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**B-4**



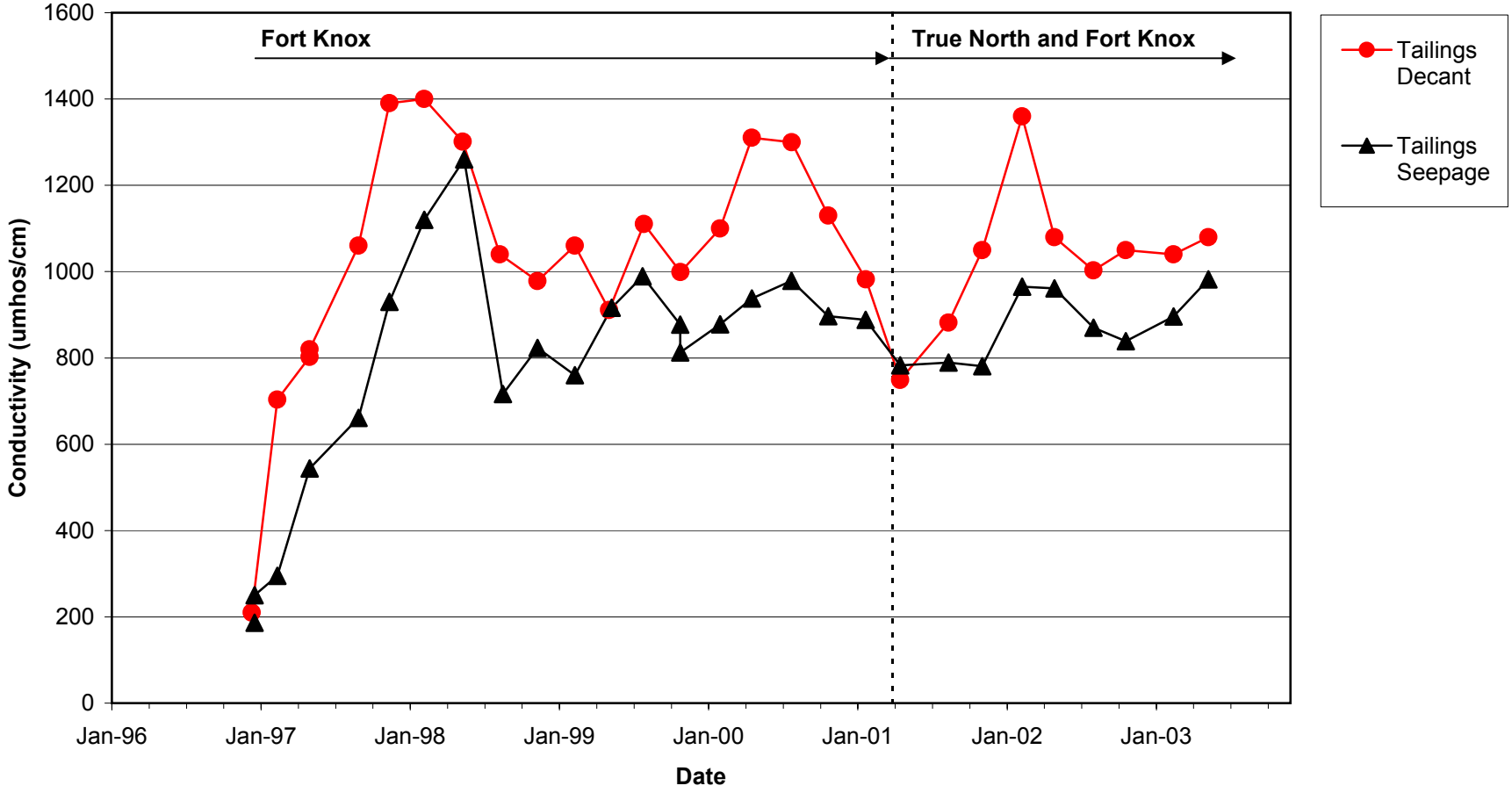
Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.5 to 0.9 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Chloride**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-5

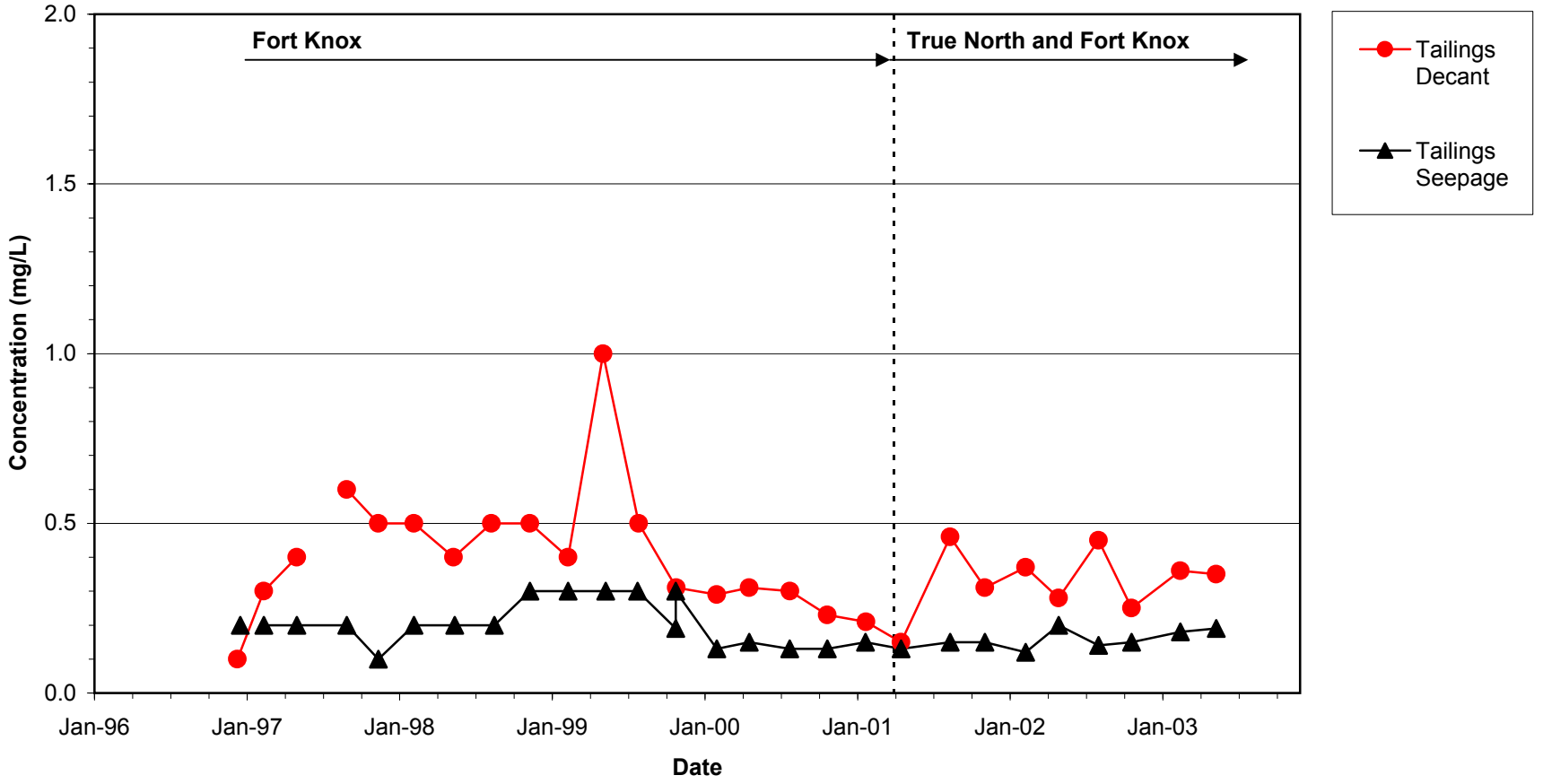


Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Conductivity**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-6



Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) equal to 0.2 mg/L.

Golder Associates

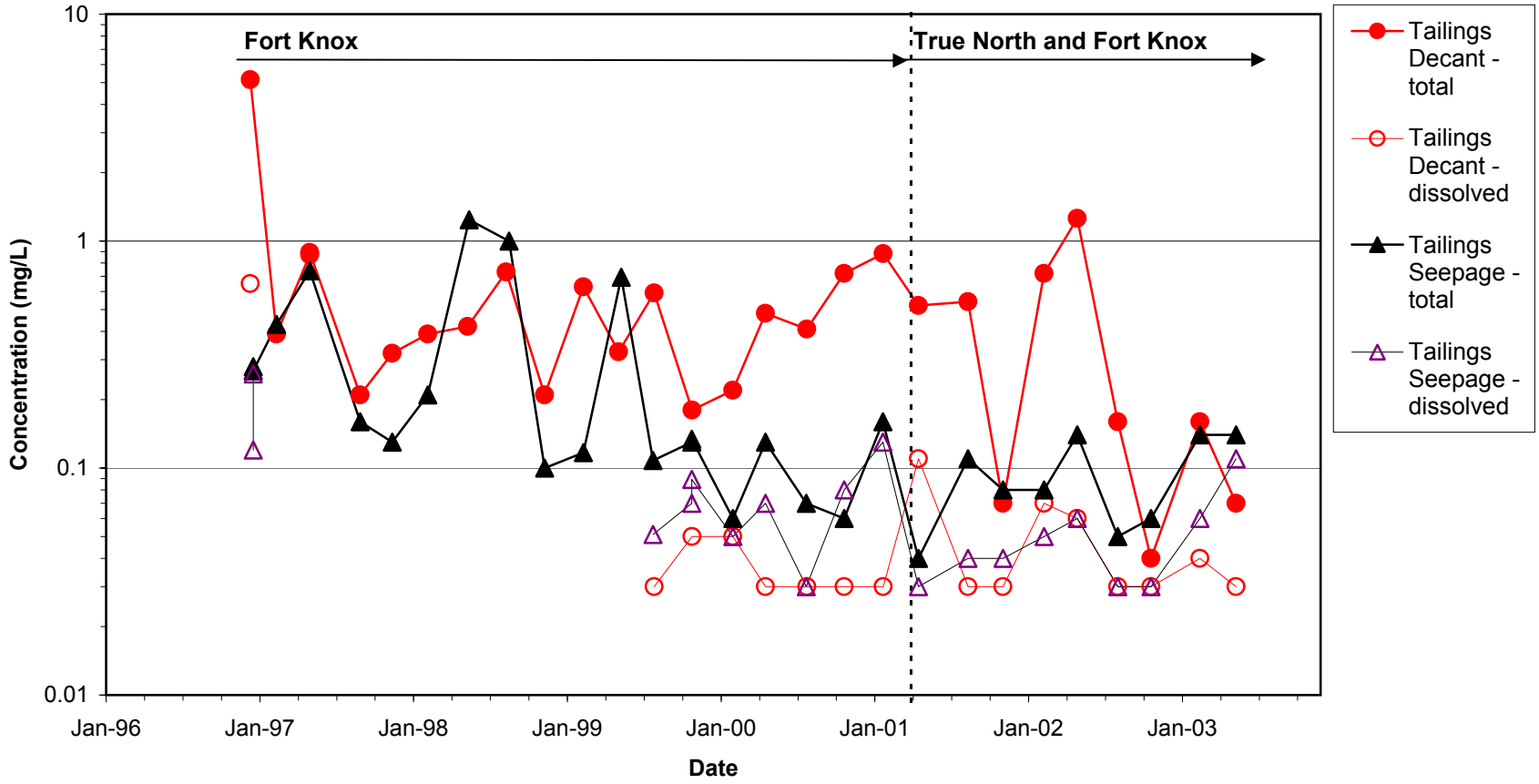
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Fluoride

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-7



Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) equal to 0.03 mg/L.

Golder Associates

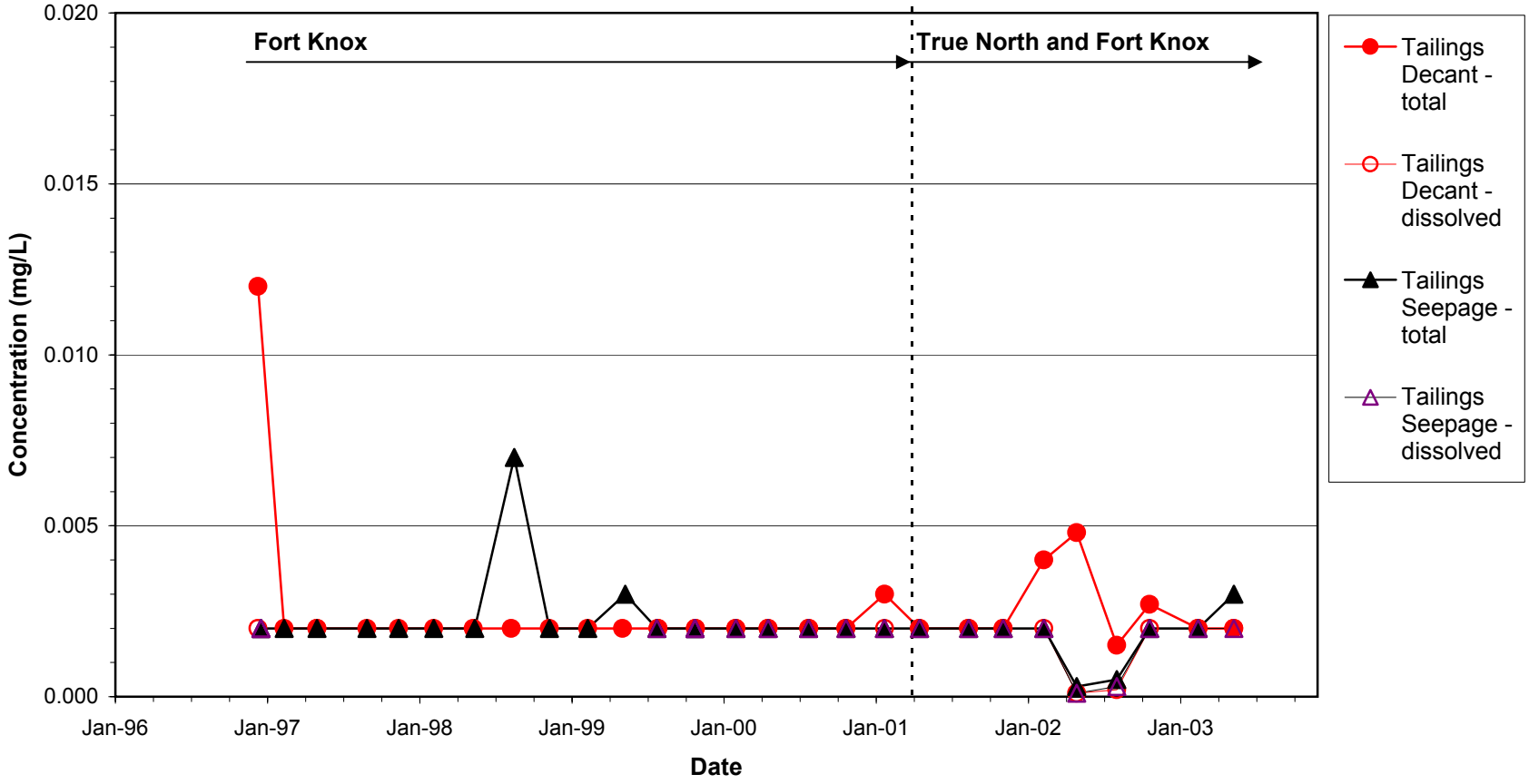
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Iron

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-8



Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) generally equal to 0.002 mg/L.

Golder Associates

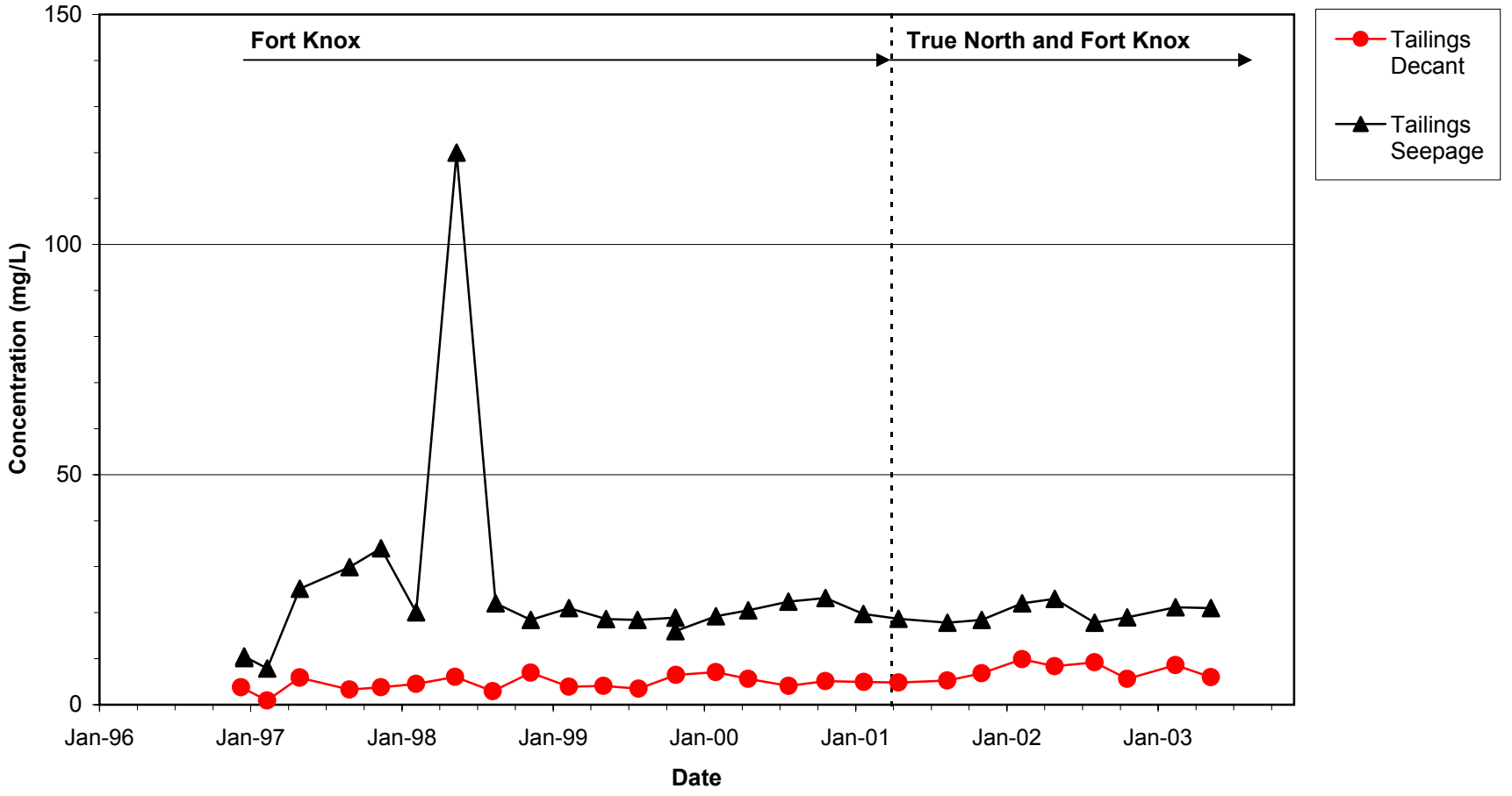
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Lead

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-9



Golder Associates

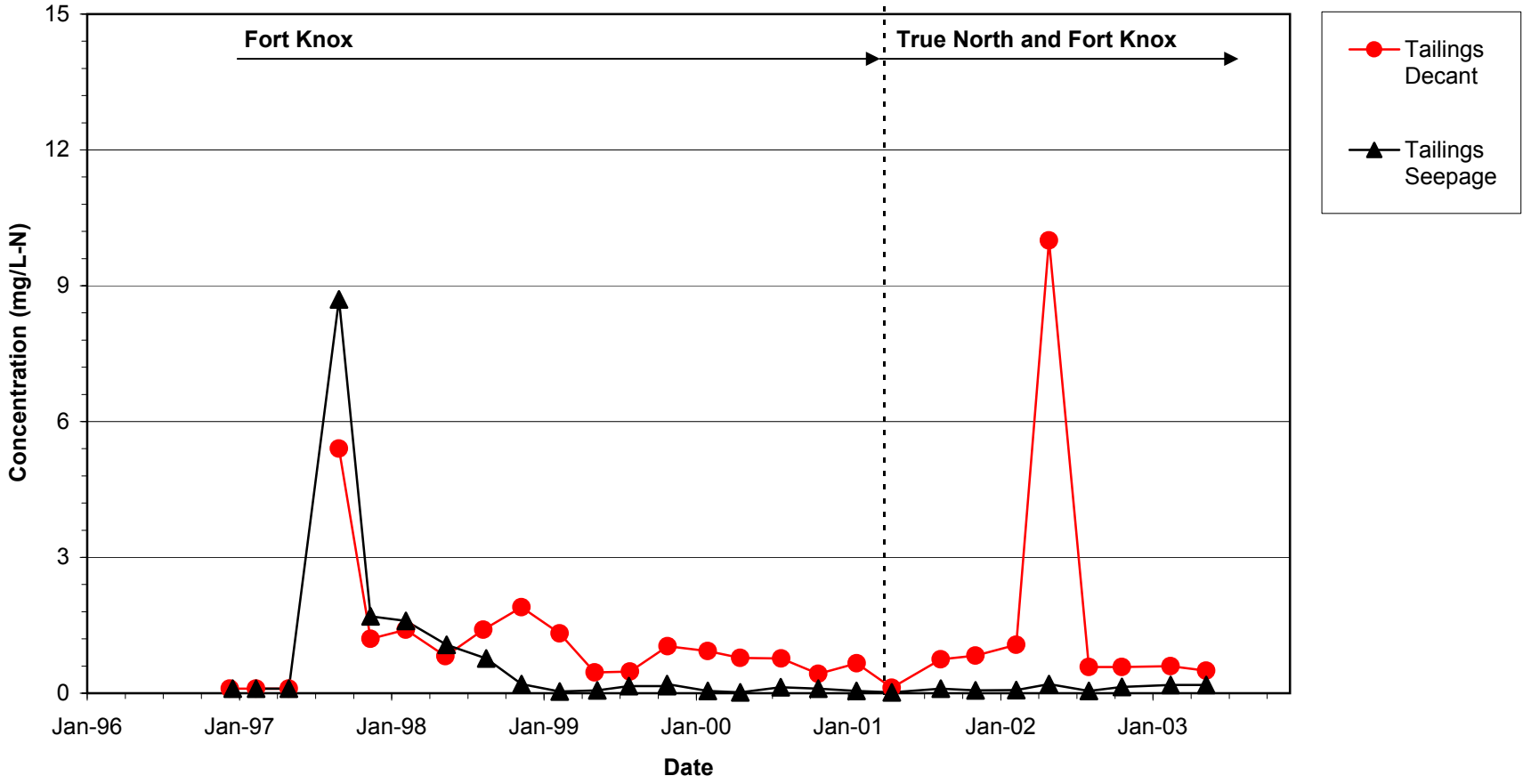
TITLE

Tailings Water Quality - Magnesium

Quarterly Monitoring Results

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**B-10**



Golder Associates

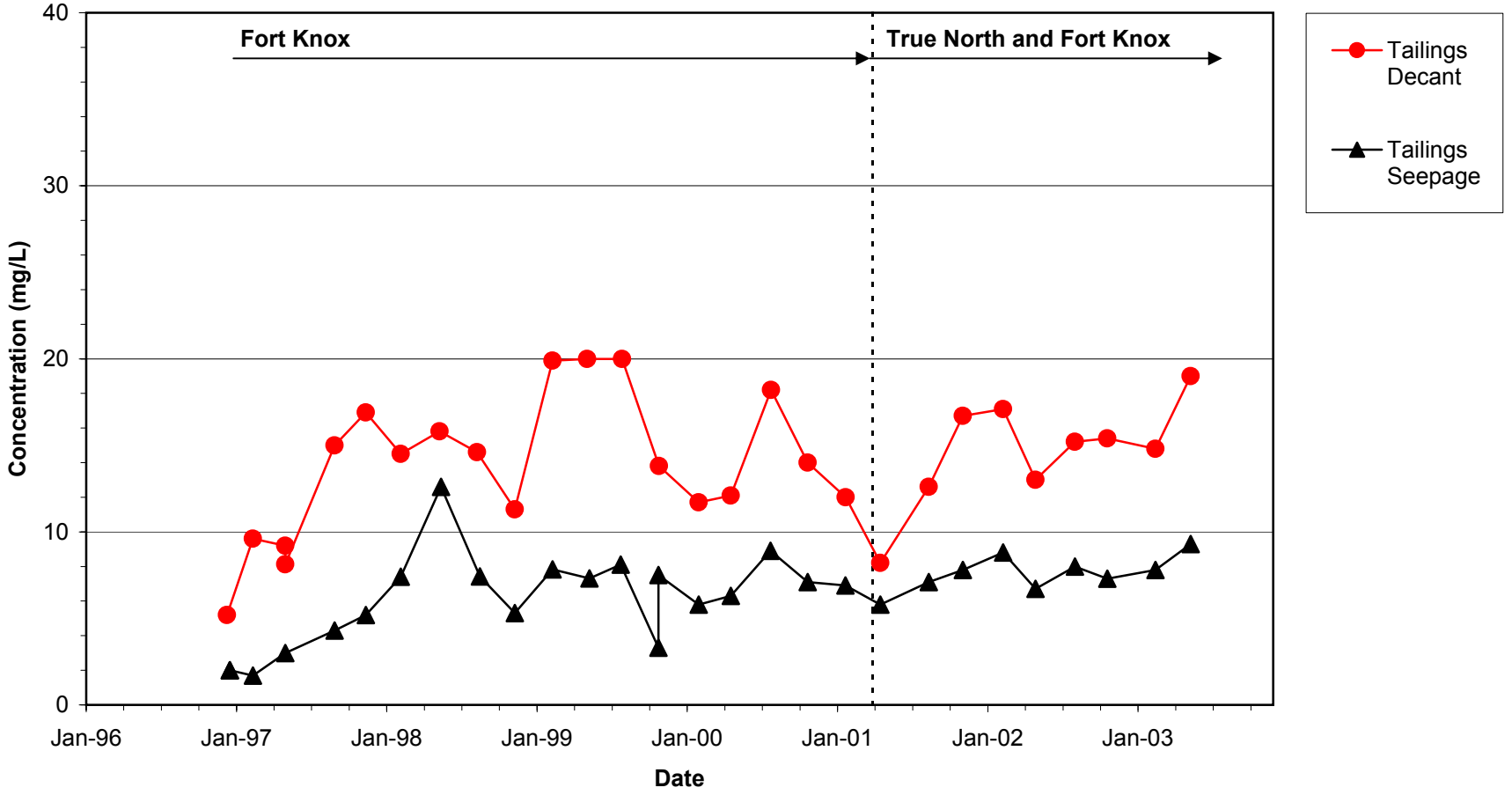
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Nitrite

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**B-11**



Golder Associates

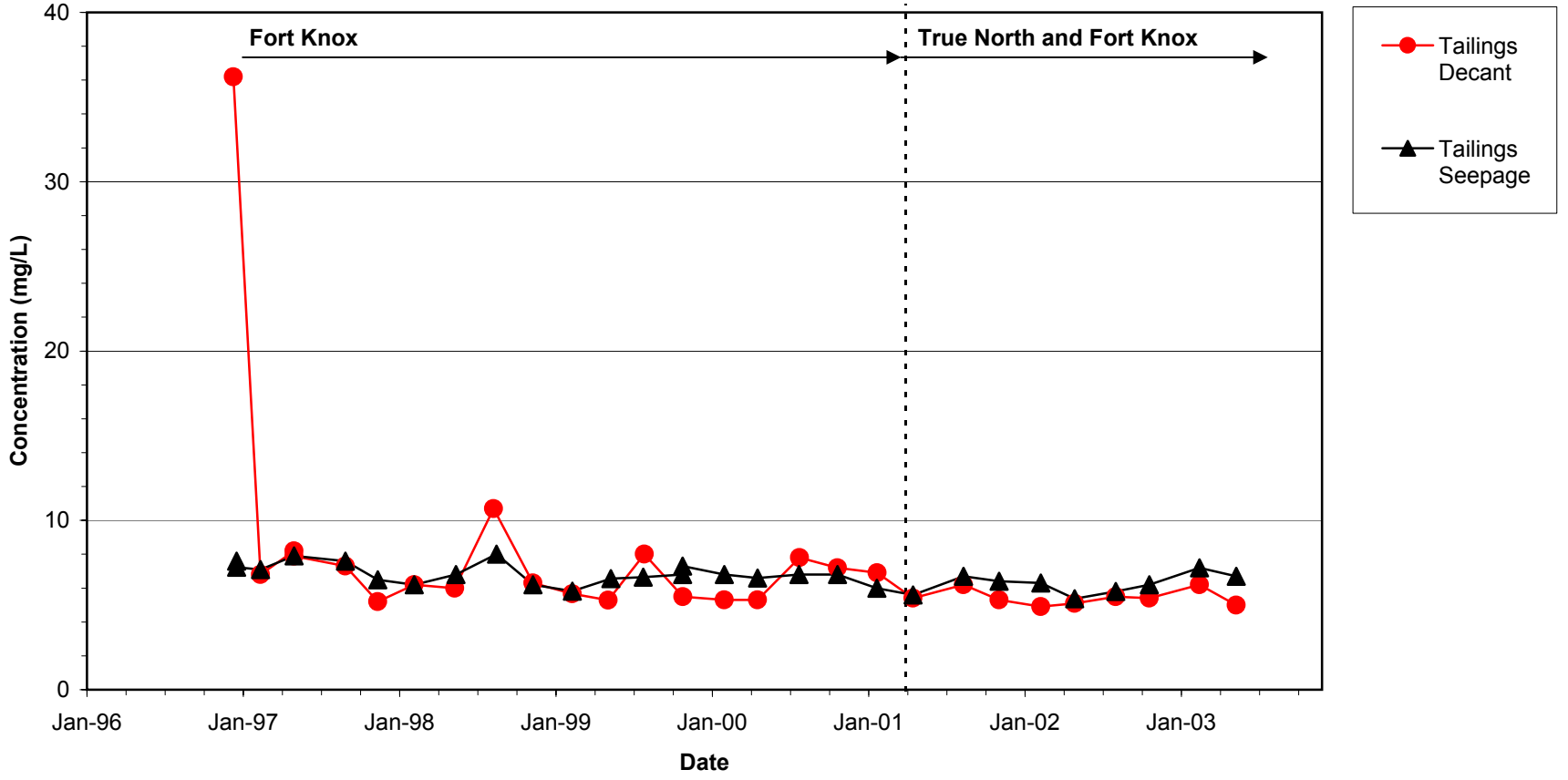
TITLE

Tailings Water Quality - Potassium

Quarterly Monitoring Results

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**B-12**



Golder Associates

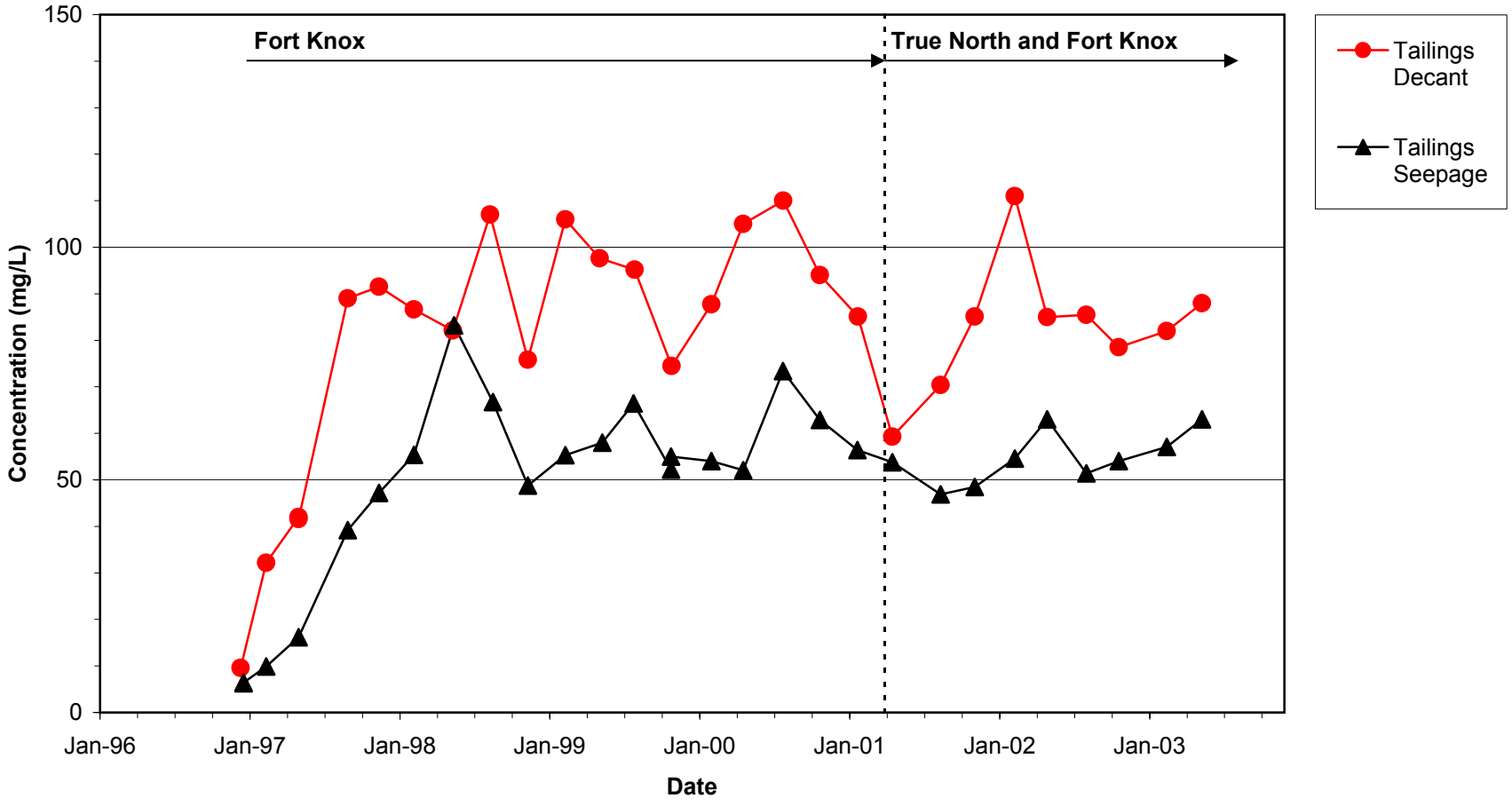
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Silicon

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-13



Golder Associates

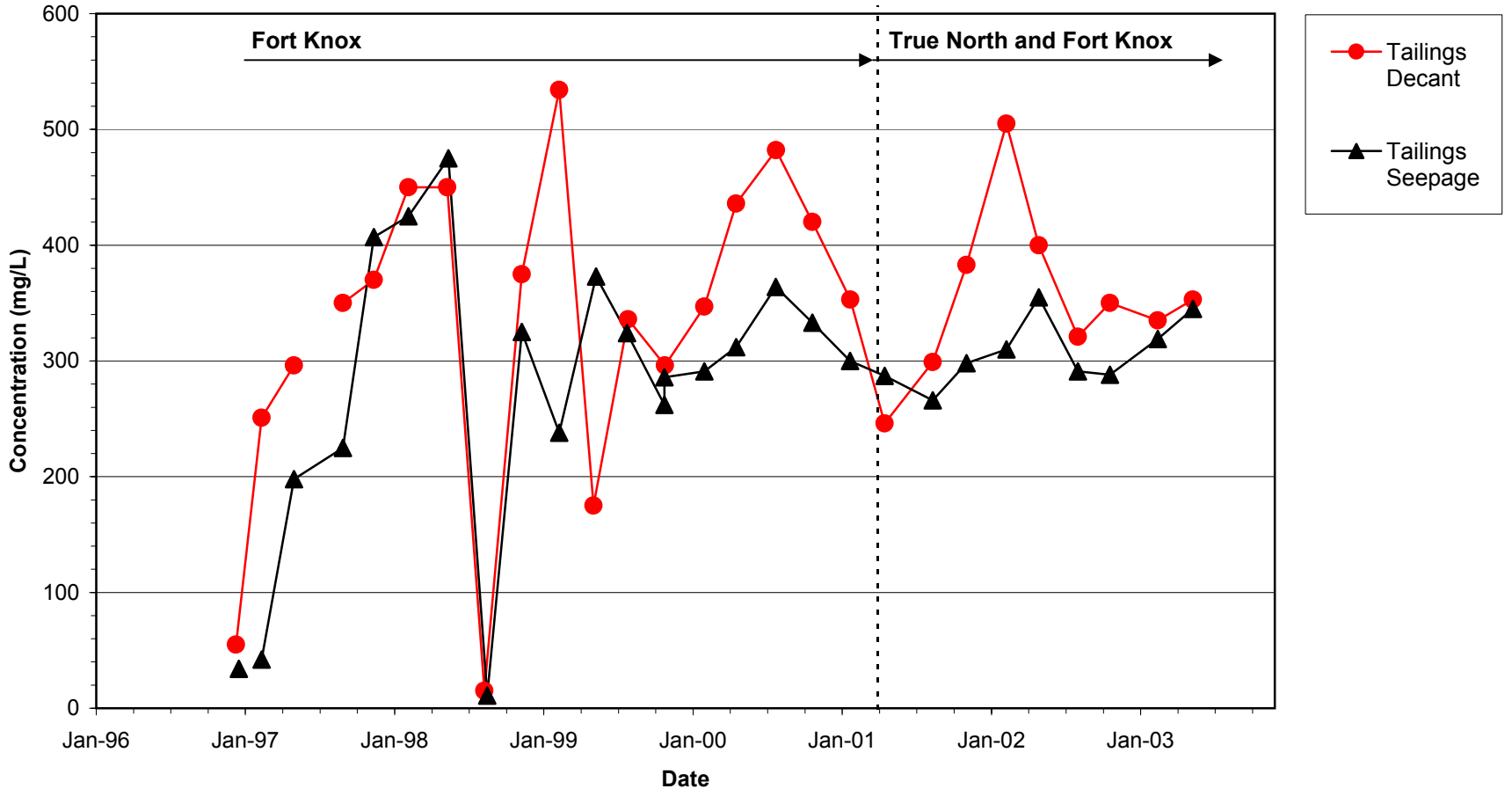
Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE

Tailings Water Quality - Sodium

Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**B-14**



Golder Associates

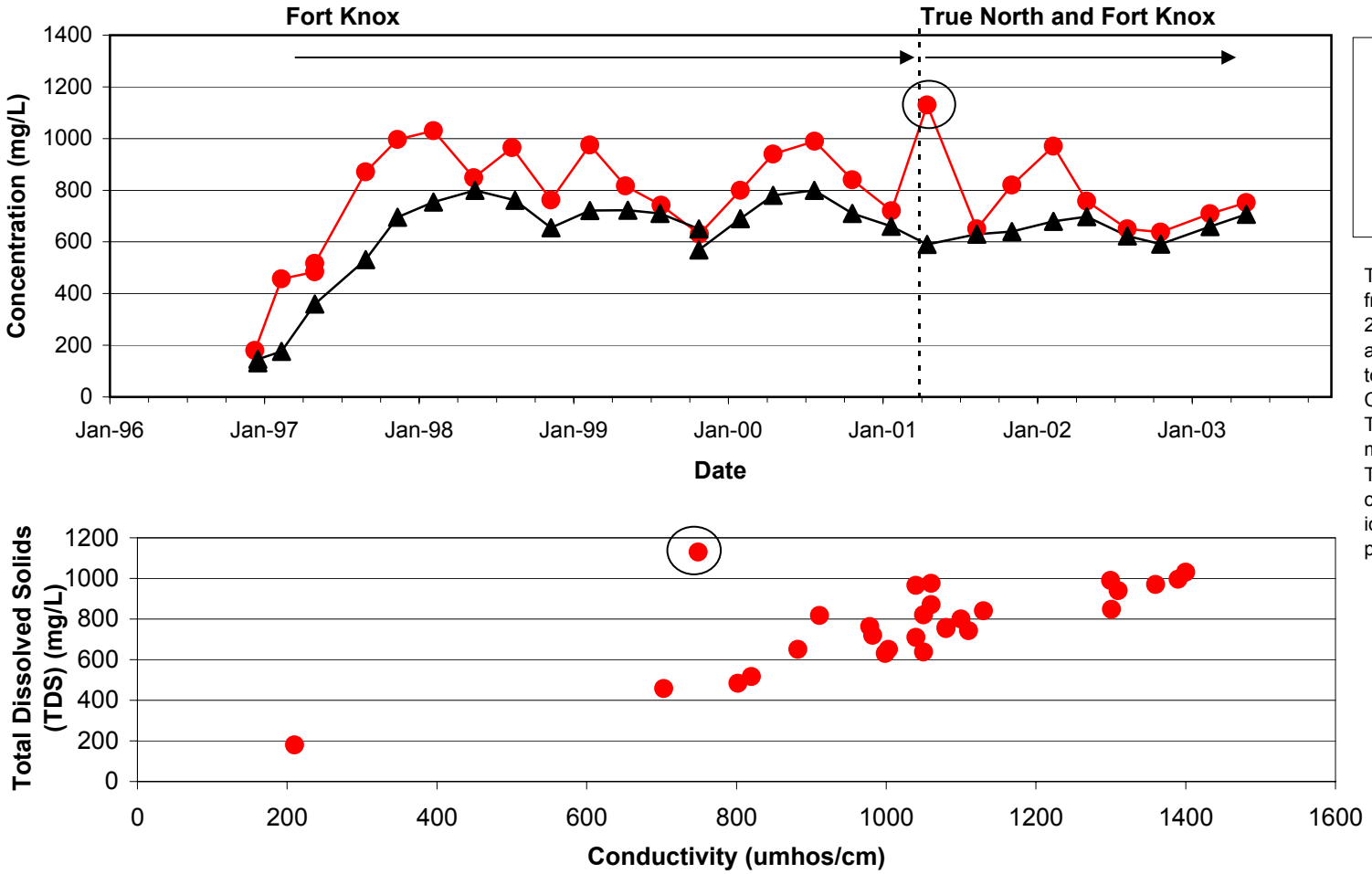
TITLE

Tailings Water Quality - Sulfate

Quarterly Monitoring Results

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**B-15**



TDS measurement from April 2001 (circled) assumed to be erroneous. Calculated TDS less than measured TDS. TDS versus conductivity plot identifies this data point as an outlier.

Golder Associates

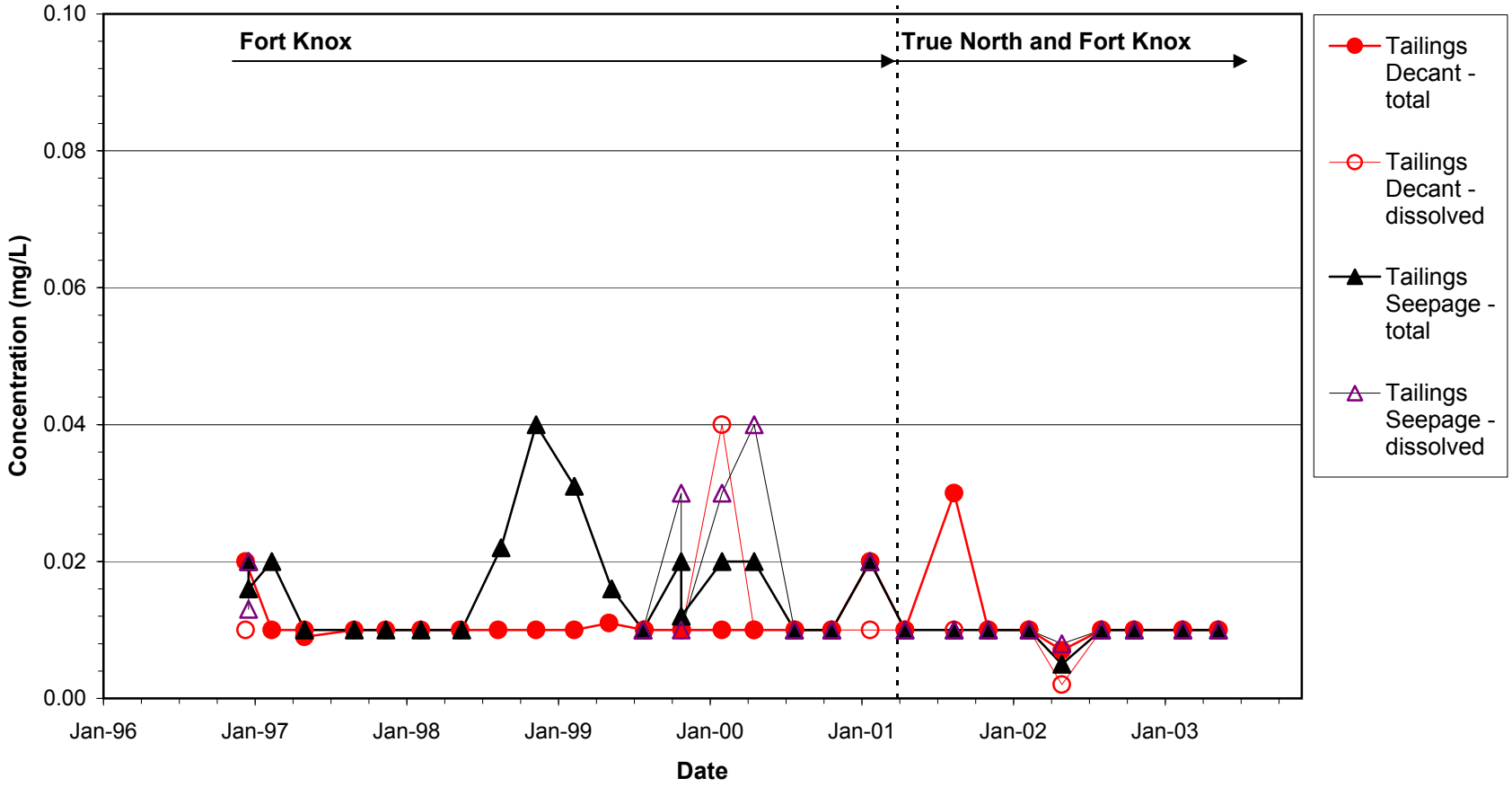
TITLE

Tailings Water Quality - Total Dissolved Solids (TDS)

Quarterly Monitoring Results

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	**B-16**



Note: Non-detect concentrations plotted at the detection limit. Method detection limit (MDL) ranges from 0.009 to 0.01 mg/L.

Golder Associates

Fairbanks Gold Mining Inc.
Fort Knox Environmental Audit

TITLE: **Tailings Water Quality - Zinc**
Quarterly Monitoring Results

DRAWN	CR	DATE	March 2004	JOB NO.	033-5601
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	RV	FILE NO.	Fort Knox Water Quality.xls	FIGURE NO.	B-17

APPENDIX C

TAILING SEEPAGE COLLECTION HYDROLOGY ANALYSIS

Data Filter Report

Source Data File Name:	N:\Interceptor Wells\Surfer\June_03_H2O_levels.dat
X Column:	B
Y Column:	C
Z Column:	D

Data Counts

Number of Active Data:	29
Number of Original Data:	29
Number of Excluded Data:	0
Number of Deleted Duplicates:	0
Number of Retained Duplicates:	0
Number of Artificial Data:	0

Filter Rules

Duplicate Points to Keep:	First
X Duplicate Tolerance:	0
Y Duplicate Tolerance:	0
Exclusion Filter String:	Not In Use

Data Statistics Report

Data Counts

Number of Active Data:	29
Number of Original Data:	29
Number of Excluded Data:	0
Number of Deleted Duplicates:	0
Number of Retained Duplicates:	0
Number of Artificial Data:	0

X Variable Statistics

X Range:	1191.42
X Midrange:	20432.5
X Minimum:	19836.8
X 25%-tile:	20037.2
X Median:	20113.8
X 75%-tile:	20221.2
X Maximum:	21028.3
X Average:	20192.2
X Standard Deviation:	295.147
X Variance:	87111.8

Y Variable Statistics

Y Range:	1351.92
Y Midrange:	13616.5
Y Minimum:	12940.6
Y 25%-tile:	13472
Y Median:	13767.7
Y 75%-tile:	14059.1
Y Maximum:	14292.5
Y Average:	13717.2
Y Standard Deviation:	387.1
Y Variance:	149847

Z Variable Statistics

Z Range:	229.29
Z Midrange:	1022.72
Z Minimum:	908.08
Z 25%-tile:	957.8
Z Median:	1049.92
Z 75%-tile:	1124.9
Z Maximum:	1137.37
Z Average:	1041.58
Z Standard Deviation:	82.5744
Z Variance:	6818.53
Z Coef. of Variation:	0.0792781
Z Coef. of Skewness:	-0.292836

Inter-Variable Correlation

	X	Y	Z
X:	1	0.0365608	0.325112
Y:		1	0.0728472
Z:			1

Inter-Variable Covariance

	X	Y	Z
X:	87111.8	4177.13	7923.49
Y:		149847	2328.53
Z:			6818.53

Gridding Report

Search Rules

Use All Data: true

Gridding Rules

Gridding Method: Kriging
Kriging Type: Point

Semi-Variogram Model

Component Type: Linear
Variogram Slope: 1
Anisotropy Angle: 0
Anisotropy Ratio: 1

Polynomial Drift Order: 0
Kriging standard deviation grid: no

Grid Summary

Grid File Name:	N:\Interceptor Wells\Surfer\June_03_H2O_levels.grd
Minimum X:	19836.8
Maximum X:	21028.3
Minimum Y:	12940.6
Maximum Y:	14292.5
Minimum Z:	913.762
Maximum Z:	1169.39
Number of Rows:	100
Number of Columns:	88
Number of Filled Nodes:	8800
Number of Blanked Nodes:	0
Total Number of Nodes:	8800

Appendix C

June 30, 2003 Surfer Input Data

	X	Y	Z
IW-1	19972.55	14129.34	931.67
IW-2	20037.18	13787.43	950.55
IW-3	20113.78	13471.99	918.87
IW-4	20184.69	13140.12	921.29
IW-5	20005.03	13871.53	908.08
IW-6	20060.7	13698.6	926.1
MW-1	20117.6	13900.74	943.58
MW-2	20164.75	13649.73	970.11
MW-3	20221.16	13413.77	968.34
MW-4	20131.03	14067.88	1040.71
MW-5	21001.45	14059.1	1124.38
MW-6	20940.36	14193.46	1115.68
MW-7	21028.25	13857.55	1133.38
PZ-1	20045.07	13950.78	1049.05
PZ-2	19995.91	13767.67	1036.99
PZ-3	20075.8	13522.45	985.54
PZ-4	20014.27	14118.86	1049.92
PZ-5	20099.59	13587.06	957.8
PZ-6			
PZ-7	20181.71	13280.27	1073.8
Sump	19887.53	13590.6	1135
MW-1DD	20246.5	13923.46	1094.05
MW-2DD	20299.5	13673.49	1093.05
MW-3DD	20261.84	13420.94	1095.05
IW-1DD	19943.78	14292.5	1137.37
IW-1DD	19836.83	14224.37	1129.37
IW-1DD	20067.58	14265.06	1133.37
IW-4DD	20219.88	12940.58	1129.9
IW-4DD	20068.47	12974.14	1127.9
IW-4DD	20350.67	13023.9	1124.9

Appendix C

Well Number	Northing	Easting	Casing Elevation	Completed Depth	Ground Elevation	Pump Horsepower	Pump Manuafcturer	Pump	Volts	Pump Depth	Drop Pipe	Target Depth	Pump Serial #	Depth to Water *	Water Elevation	Depth to Water **	Water Elevation	Depth to Water ***	Water Elevation
IW-1	14,129.34	19,972.55	1,197.97	320.00	1,193.97	15.00	Grundfos	85S150-10	460/380	283.00	3" Sc. 40 Galv.	260.00		272.35	925.6	203.25	994.72	270.18	927.79
IW-2	13,787.43	20,037.18	1,174.05	329.00	1,170.05	10.00	Grundfos	75S150-16	460/380	232.00	1" Sc. 40 Galv.	220.00		257.85	916.2	267.90	906.15	289.2	884.85
IW-3	13,471.99	20,113.78	1,173.77	310.00	1,169.77	10.00	Goulds	100H105	460/380	283.00	3" Sc. 40 Galv.	260.00		256.10	917.7	247.24	926.53	263.45	910.32
IW-4	13,140.12	20,184.69	1,191.99	330.00	1,187.99	5.00	Goulds	60GS50-11	460/380	295.00	2" Sc. 40 Galv.	275.00		237.32	954.7	282.00	909.99	284.1	907.89
MW-1	13,900.74	20,117.60	1,177.78	305.00	1,173.78	15.00	Grundfos	85S150-10	460/380	285.00	3" Sc. 40 Galv.	260.00		39.00	1,138.8	166.65	1,011.13	247	930.78
MW-4	14,067.88	20,131.03	1,192.86	288.00	1,188.86	10.00	Goulds	25GS10	460/380	210.00	1" Sc. 40 Galv.	N/A		130.00	1,062.9	141.80	1,051.06	142.83	1,050.03
MW-2	13,649.73	20,164.75	1,173.61	279.00	1,169.61	10.00	Goulds	25GS10	460/380	240.00	3" Sc. 40 Galv.	N/A		136.75	1,036.9	130.64	1,042.97	132.15	1,041.46
MW-3	13,413.77	20,221.16	1,173.34	296.00	1,169.34	10.00	Goulds	25GS10	460/380	231.00	1" Sc. 40 Galv.	210.00		109.25	1,064.1	104.53	1,068.81	100.71	1,072.63
A-1	13,632.83	20,135.03	1,173.16	73.00	1,169.16	N/A	N/A	N/A	N/A	N/A	N/A	N/A				Dry		Dry	
PH99-1/PZ-1	14,028.57	20,026.18	1,187.70	420.00	1,183.87	N/A	N/A	N/A	N/A	N/A	N/A	N/A							
PH99-2/PZ-2	13,846.68	20,004.70	1,174.69	450.00	1,171.69	N/A	N/A	N/A	N/A	N/A	N/A	N/A							
PH99-3/PZ-3	13,422.00	20,102.00	1,172.60	445.00	1,169.60	N/A	N/A	N/A	N/A	N/A	N/A	N/A							
PH99-4/ABDN	14,455.48	19,899.20		450.00	1,235.50	N/A	N/A	N/A	N/A	N/A	N/A	N/A							
PH99-5/PZ-4	14,208.55	19,992.49	1,210.83	550.00	1,207.83	N/A	N/A	N/A	N/A	N/A	N/A	N/A							
IW-5	13,871.53	20,005.03	1,176.88	380.00	1,173.88	30.00	Grundfos	150S300-17	460/380	294.00	3" Sc. 40 Galv.	260.00							
IW-6	13,698.60	20,060.70	1,175.60	380.00	1,173.10	15.00	Grundfos	85S150-10	460/380	280.00	2" Sc. 40 Galv.	260.00							
PZ-5	14,059.10	21,001.45	1,160.18	120.00	1,158.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A							
							Spare Pump in Connex	Grundfos	85S150-10	460/380									

* Depth to water measurements were taken on 4/23/99.
** Depth to water measurements were taken on 5/28/99.
*** Depth to water measurements were taken on 6/27/99
**** Depht to water measurements were taken on 7/31/99

Appendix C

Depth to Water ****	Water Elevation	Initial Depth to Water	Angle	Vertical Depth to Water	Depth to Water 8/23/99	Vertical Depth to Water		Depth to Water 12/24	Vertical D. to Water	Horiz. D. to Water	Water Elevation	Depth to Water 1/31	Vertical D. to Water	Horiz. D. to Water	Water Elevation		Depth to Water 2/28	Vertical D. To Water	Horiz. D. to Water
					289			237.28	237.28	N/A	960.69	223.00	223.00	N/A	974.97	IW-1	275.55	275.55	N/A
258.00	916.05				230.5			232.00	232.00	N/A	942.05	232.00	232.00	N/A	942.05	IW-2	232.00	232.00	N/A
					268.46			276.98	276.98	N/A	896.79	278.60	278.60	N/A	895.17	IW-3	277.70	277.70	N/A
					289.46			287.95	287.95	N/A	904.04	286.42	286.42	N/A	905.57	IW-4	282.27	282.27	N/A
					180.38			214.50	214.50	N/A	963.28	208.65	208.65	N/A	969.13	MW-1	224.80	224.80	N/A
					136.56			144.95	144.95	N/A	1,047.91	149.30	149.30	N/A	1,043.56	MW-4	152.82	152.82	N/A
134.28	1,039.33				193.74			248.60	248.60	N/A	925.01	230.20	230.20	N/A	943.41	MW-2	259.00	259.00	N/A
					103.2			82.36	82.36	N/A	1,090.98	94.00	94.00	N/A	1,079.34	MW-3	95.90	95.90	N/A
					Dry			Dry	Dry	N/A	Dry	Dry	Dry	N/A	Dry	A-1	Dry	Dry	N/A
		90.00	1.05	77.94	97.47	84.41	1,103.29	137.12	118.75	68.56	1,068.95	171.20	148.26	85.60	1,039.44	PH99-1/PZ-	171.54	148.56	85.77
		69.00	1.05	59.76	93.2	80.71	1,106.99	172.20	149.13	86.10	1,025.56	180.50	156.32	90.25	1,018.37	PH99-2/PZ-	184.50	159.78	92.25
		480.00	1.05	415.69	153.66	133.07	1,054.63	213.92	185.26	106.96	987.34	205.00	177.54	102.50	995.06	PH99-3/PZ-	211.45	183.12	105.73
		400.00	1.05	199.03						0.00	0.00			0.00	0.00	PH99-4/ABDN			0.00
		550.00	1.05	273.66	143	124.04	1,063.66	182.08	157.94	90.60	1,052.89	187.40	162.56	93.24	1,048.27	PH99-5/PZ-	191.10	165.76	95.09
								117.75	117.75	N/A	1,059.13	175.85	175.85	N/A	1,001.03	IW-5	177.30	177.30	N/A
								273.26	273.26	N/A	902.34	247.00	247.00	N/A	928.60	IW-6	274.50	274.50	N/A
																PZ-5	50.2	50.20	N/A
		153	1.05	132.50															
		450	1.05	225.00															
		150	0.52	129.90															
		150	0.52	75.00															

Appendix C

Water Elevation	Depth to Water 4/2	Vertical D. to water	Horirz. D. to Water	Water Elevation	Depth to Water 4/29	Vertical D. to water	Horirz. D. to Water	Water Elevation	Depth to Water 5/30	Vertical D. to water	Horirz. D. to Water	Water Elevation	Depth to Water 6/30	Vertical D. to water	Horirz. D. to Water	Water Elevation	Depth to Water 7/31	Vertical D. to water	Horirz. D. to Water	Water Elevation
922.42	283.03	283.03	N/A	914.94	262.6	262.60	N/A	935.37	281.28	281.28	N/A	916.69	268	268.00	N/A	929.97	273.15	273.15	N/A	924.82
942.05	203.78	203.78	N/A	970.27	169	169.00	N/A	1,005.05	232	232.00	N/A	942.05	231	231.00	N/A	943.05	228	228.00	N/A	946.05
896.07	279.08	279.08	N/A	894.69	254.97	254.97	N/A	918.80	264.28	264.28	N/A	909.49	240	240.00	N/A	933.77	262	262.00	N/A	911.77
909.72	289.9	289.90	N/A	902.09	286.18	286.18	N/A	905.81	284.95	284.95	N/A	907.04	273	273.00	N/A	918.99	266.2	266.20	N/A	925.79
952.98	236.58	236.58	N/A	941.20	231.18	231.18	N/A	946.60	219.75	219.75	N/A	958.03	220.36	220.36	N/A	957.42	221.18	221.18	N/A	956.60
1,040.04	154.36	154.36	N/A	1,038.50	152.67	152.67	N/A	1,040.19	154.85	154.85	N/A	1,038.01	152.45	152.45	N/A	1,040.41	151.95	151.95	N/A	1,040.91
914.61	257.5	257.50	N/A	916.11	257.5	257.50	N/A	916.11	257.5	257.50	N/A	916.11	243.8	243.80	N/A	929.81	220.5	220.50	N/A	953.11
1,077.44	99.23	99.23	N/A	1,074.11	91.57	91.57	N/A	1,081.77	65.06	65.06	N/A	1,108.28	150	150.00	N/A	1,023.34	152.5	152.50	N/A	1,020.84
Dry	Dry	Dry	N/A	Dry	Dry	Dry	N/A	Dry	Dry	Dry	N/A	Dry	Dry	Dry	N/A	Dry	Dry	Dry	N/A	Dry
1,039.14	172.35	149.26	86.18	1,038.44	176.77	153.09	88.39	1,034.61	182.75	158.27	91.38	1,029.43	184.7	159.95	92.35	1,027.75	182.62	158.15	91.31	1,029.55
1,014.91	185.05	160.26	92.53	1,014.43	174.97	151.53	87.49	1,023.16	176.6	152.94	88.30	1,021.75	173.86	150.57	86.93	1,024.12	160.1	138.65	80.05	1,036.04
989.48	217.75	188.58	108.88	984.02	202.96	175.77	101.48	996.83	185.52	160.67	92.76	1,011.93	172.3	149.22	86.15	1,023.38	222.3	192.52	111.15	980.08
0.00	0		0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
1,045.07	191.65	166.24	95.36	1,044.59	190.05	164.85	94.56	1,045.98	192.16	166.68	95.61	1,044.15	189.6	164.46	94.34	1,046.37	187.54	162.68	93.31	1,048.15
999.58	181.7	181.70	N/A	995.18	190.58	190.58	N/A	986.30	210.52	210.52	N/A	966.36	223.15	223.15	N/A	953.73	221.47	221.47	N/A	955.41
901.10	281.88	281.88	N/A	893.72	266.07	266.07	N/A	909.53	270	270.00	N/A	905.60	256	256.00	N/A	919.60	243.7	243.70	N/A	931.90
1,109.98	51.57	51.57	N/A	1,108.61	52.18	52.18	N/A	1,108.00	44.15	44.15	N/A	1,116.03	34.65	34.65	N/A	1,125.53	31.7	31.70	N/A	1,128.48

APPENDIX D

SITE PHOTOGRAPHS

July 2003 – Test Plot Overview

July 2003 – Test Plot Overview

July 2003 – Test Plot Overview

Plot #4 on 9/10/03

Plot #8 0n 9/10/03

Plot #12 on 9/10/03

Plot #16 on 9/10/03

(Provided by FGMI)