BacTech Manitoba Corporation

Environmental Assessment Report

Remediation Project – Snow Lake, Manitoba

Submitted to: Environmental Approvals Branch
Manitoba Conservation and Water Stewardship

December 2012 **12-1380-0037**

ACKNOWLEDGEMENTS

BacTech Environmental Corporation and BacTech Manitoba Corporation acknowledge the contributions of Golder Associates Ltd. (Golder) and Aurora Surveys (Aurora) in the completion of this document. Golder was responsible for completing sections on the regional and local Study Area, and existing environment (climate and meteorology, surface water, groundwater, soils and geology, heritage resources). They also contributed to the monitoring and reporting and provided map products. Aurora provided information on vegetation and wildlife, including species of conservation concern. The assessment of effects was completed by Golder, and was partially based on information provided by BacTech and Aurora.

EXECUTIVE SUMMARY

BacTech Manitoba Corporation (**BacTech**), a subsidiary of BacTech Environmental Corporation, is proposing to treat and stabilize material from an arsenopyrite residue stockpile (**ARS**) in Snow Lake, Manitoba utilizing the REBgold patented bioleach process (**BACOX**). The ARS has been identified as a designated site in the Province of Manitoba's Orphaned/Abandoned Mine Site Rehabilitation Program. The Province accepted a proposal from BacTech to remediate the site using the BACOX process. This project is considered a Class II development under Manitoba's *Classes of Development Regulation.* This report provides the Environmental Assessment Report (**EAR**) to fulfill part of the licensing requirements of *The Manitoba Environment Act*.

The proposed development is situated within the industrial zone of the Town of Snow Lake, approximately 685 kilometers (km) north of Winnipeg, Manitoba. A Study Area of approximately 5.1 square km was defined based on the predicted potential environmental effects from the BacTech Remediation Project (Project) on the surrounding environment.

The Project is composed of five major components:

- the Arsenopyrite Residue Stockpile (ARS);
- hauling of Arsenopyrite Residue (AR) along a haul road to the Bioleach Plant Site;
- a Bioleach Plant Facility where the AR will be remediated;
- pipelines to transport stabilized waste to, and recover water from a Storage Impoundment Facility; and
- the Storage Impoundment Facility.

Once the route for the pipelines for the ARS to the Bioleach Plant Site, and from the Plant Site to the Storage Impoundment Site have been finalized, the need for additional environmental field surveys will be based on the season, land type crossed (e.g. wetlands), and proposed construction techniques.

Construction on the Bioleach Plant Site is slated to begin in early 2013, with a commissioning date of late 2013. Based on the volume of AR to be remediated, the plant operation is estimated to continue until mid-2020. Decommissioning of the Project is slated to be complete in 2022.

The patented BACOX process developed by REBgold involves a biological reactor leaching process that can be applied to the remediation of the ARS in an economically beneficial manner. The bioleach process is a commercially proven technology with over 20 applications world-wide. This process employs naturally-occurring bacteria, harmless to humans and the environment, to liberate precious and base metals from sulphide ore residues. The process also results in the production of a stable iron-arsenic precipitate which is an environmentally benign product.

The Existing Environment

Biophysical Environment

Baseline conditions within the Study Area were evaluated by reviewing literature and existing data sources, and through a site visit. The Project is located in an area that has been extensively disturbed and contaminated by previous mining activity, tailings storage and industrial activity.

Groundwater, soil and surface water is contaminated with high levels of heavy metals over much of the Study Area. In particular, drainage from the ARS has resulted in high levels of Arsenic (As), zinc (Zn) and iron (Fe) in groundwater, soils and surface water in the area west of the ARS, often exceeding Canadian Council of Ministers of the Environment (CCME) guidelines by up to several thousand times. However, this effect appears localized, as levels of As (and other metals) are much lower in Canada Creek approximately 1 km west, and are within CCME guidelines in Snow Lake.

Sediments at the Plant Site have high As levels, several times CCME guidelines. Some areas of the Plant Site were also slightly to moderately contaminated by hydrocarbons.

In addition to disturbed areas, the Study Area also includes extensive wetlands, as well as several small ponds, and a drainage channel. The drainage channel passes from east to west through the Study Area to the south of the Storage Impoundment Area. The channel drains towards a small waterbody located between the ARS and the Storage Impoundment area, which passes under the roads via culverts towards the northwest and connects to Canada Creek and Snow Lake.

Although Snow Lake supports several species of large-bodied fish, only small-bodied fish were captured in the Study Area. The dominant species was brook stickleback (*Culaea inconstans*) with fewer specimens of lake chub (*Couesius plumbeus*) and fathead minnow (*Pimephales promelas)*. Dead brook stickleback were observed in various locations throughout the drainage channel. Much of the fish habitat within the Study Area was considered poor for fish.

Most of the areas identified for Project development have been cleared and/or are devoid of vegetation. The Plant Site consists of sediment and gravel, with approximately 0.8 hectares (ha) of wetland consisting of commonly occurring aquatic plants such as common cattails (*Typha latifolia*), bulrushes (*Scirpus* spp.), bur-reeds (*Sparganium* spp.), and sedges (*Carex* spp.). None of the 12 vegetation species of conservation concern identified in the Churchill River Upland Ecoregion were found in the proposed development area.

The Churchill River Upland Ecoregion provides habitat for moose (*Alces alces*), woodland caribou (*Rangifer tarandus caribou*), black bear (*Ursus americanus*), lynx (*Lynx canadensis*), wolf (*Canis lupus*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), snow-shoe hare (*Lepus americanus*) and many other species. Wildlife is plentiful in the Snow Lake area, with major species including wolves, bear and moose. Moose, bear and various bird species are hunted as part of recreation and tourism in the area. Some commercial trapping of fur-bearing animals still continues in the Snow Lake region. However, most of the area identified for development is heavily disturbed, and does not provide good or high quality natural habitat for wildlife. Although there is potential for woodland caribou to inhabit the Ecoregion, there were no traces of key habitat types or migration routes or rutting areas at the proposed BacTech Snow Lake project site.

Socioeconomic Environment

The Town of Snow Lake has been experiencing a steady decrease in population for the past ten years. The population in 2011 was 723, a 13.6% drop from the population in 2006. The median age of the population in 2011 was 48.4, ten years above the provincial average. There were a total of 526 private residences in the Town of Snow Lake in 2011, with an average household size of 2.2 people.

The labour force participation rate in Snow Lake was 59.4% in 2011, slightly below the provincial average. The largest employer in the Town of Snow Lake is HudBay Minerals Inc., which operates the Chisel North Mine and employs 74 people. Other employers include the Town of Snow Lake, and several small businesses. The average pre-tax income in Snow Lake was $75,515, compared to $47,875 in Manitoba.

Public Engagement

BacTech has undertaken a number of activities to engage stakeholders in the Project. They have held a public meeting or met with the Snow Lake town council on three occasions to outline the project. Aboriginal engagement activities have been ongoing with the First Nations of Mathias Colomb Cree Nation, Sapotaweyak Cree Nation and Opaskwayak Cree Nation.

Potential Environmental Effects

The potential for environmental effects of the project was undertaken in the Study Area. Remediation of the ARS, and implementation of a water management system (WMS) is expected to decrease the loading and concentration of metals, particularly As, to groundwater, soil, surface water and biota west of the ARS. Infilling at the Plant Site and north of the Plant Site for construction of a 0.17 km haul road and pipeline right-of-way is estimated to result in a permanent loss of 0.85 ha of wetland. The likelihood of spills from transporting the AR to the Plant Site, from the Plant facility, a breach of the pipeline, and from the Storage Impoundment Facility were estimated to be very low, and the potential effects on the receiving environment minimal.

During the construction phase, there will be 10 to 20 tradespeople at any given point on site to construct the Bioleach Facility, pipeline, and Storage Impoundment Site. The operational phase of the project is expected to last seven to eight years, providing an additional feed source is not located during that time. The facility will treat the ARS on a 24 hour, seven day per week (24/7) basis. The required labor force is estimated at 31 employees' to manage, operate, and maintain the facility throughout the life expectancy of the Project. A positive indirect impact is also expected from the increase in economic activity from the production of the primary and intermediate goods and services purchased by suppliers of direct goods and services provided to the Bioleach Facility. This would include royalties paid to the Provincial government for gold recovered from the ARS.

Mitigation Measures

Throughout the construction phase, an Environmental Management System (EMS) will be implemented to control and mitigate environmental effects such as dust and noise control, spills, emissions from construction equipment, traffic control, water and waste water management, maintenance of roadways, and excavation.

Once operational, an Operator Interfacing System (OIS) will be installed at the Plant Site to provide centralized plant monitoring and control functionality for the operators. Instrumentation such as level, pressure and flow transmitters and control valves will be engineered into the design to allow the plant to operate as automatically as possible. To mitigate the possibility of a spill to the environment while transferring the stabilized ferric arsenate to the Storage Impoundment Site, BacTech will use state of the art control technology as well as regular pipeline inspections performed by trained personnel. The process, including the pipeline, will be monitored continuously utilizing the Programmable Logic Controller (PLC) capable of detecting the slightest change in the process including a pressure drop in the pipeline.

All dry reagents required for daily operations will be stored in a separate area of the facility. Mixed/liquefied reagents will be stored in appropriately designed tanks. Each of the containment areas will have an individual sump pump to transfer all spills. Petroleum products will be stored within federal and provincial regulations. All waste generated at the facility outside of the neutralized precipitate will be suitable for recycling or disposal in the local landfill.

Noise abatement in the form of a bermed landscaped area or wall will be installed between the facility and Highway 392 to reduce the level of noise to the surrounding area that may be generated at the facility during operation.

Upon decommissioning of the facility, the neutralized precipitate Storage Impoundment area will be covered with a clay cap and suitable growth material to promote re-vegetation with a regulatory approved seed mix that is compatible or comparable to the local endemic vegetation. At the Plant Site the process equipment will be removed and the building will be relocated to another project, handed over to the Town of Snow Lake, or sold. The pipeline utilized to transfer the neutralized precipitate will be sold or recycled and any ground disturbance will be returned to a natural or stable grade.

Residual Effects

Residual effects, or those effects that exist after applying mitigation, are predicted to occur to terrain (wetlands and slope profiles), soils, vegetation, wildlife habitat and wildlife, land use, and socioeconomic environments. Two residual effects identified for the Project are expected to have a positive effect on the Study Area. The purpose of the Project is to remediate one of the many tailings piles that exist in the area. This will effectively remove a source of contamination and contribute to the improvement of the surrounding soil, surface and groundwater quality in the long term. The second positive effect is socioeconomic, as a result of the estimated 41 to 51 jobs that will be created during the construction and operation phases of the Project.

While the Project will result in minor loss of wetland vegetation and habitat for wildlife and fish, the Project is located in an area that has been extensively disturbed and contaminated by previous mining activity, tailings storage, and industrial activity and is currently zoned for industrial activities.

Monitoring and Reporting

During all phases of the Project, standardized monitoring, reporting, and auditing will be incorporated into the EMS to confirm that all Federal and Provincial legislation, regulations and laws are adhered to. Once the final routings for the pipelines from the ARS to the Bioleach Facility and from the Bioleach Facility to the Storage Impoundment Site have been determined, the need for additional environmental field surveys will be evaluated based on the season, land type crossed (e.g., wetlands), and proposed construction techniques.

Following approval of the Project, environmental monitoring programs will be developed to track conditions or issues during the development lifespan, and implement appropriate and necessary adaptive management. It will also be used to test and verify effects predictions and determine the effectiveness of mitigation and environmental design features.

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1 INTRODUCTION AND BACKGROUND

BacTech Environmental Corporation (BacTech) was granted the rights to remediate a gold-bearing arsenical stockpile on April 25th, 2011, by Manitoba Innovation, Energy and Mines. BacTech will use their licensed bioleaching technology to stabilize the arsenic contained therein to prevent further leaching of heavy metals and arsenic into the surrounding environment. The arsenopyrite residue stockpile (ARS) is composed of approximately 300,000 tonnes (t) of cyanide-treated concentrate residue from mining activities in the 1950s placed over a native clay impoundment. An estimated 83 percent (%) of the available gold was extracted from the host rock and a BacTech drilling program resulted in an estimated measured resource of 9.7 grams per tonne (g/t) of gold (Newson 2011).

The ARS has been identified as a source of contaminant loading at the site in Snow Lake based on metal concentrations measured in the pore water of the ARS and in groundwater adjacent to the ARS. Elevated concentrations of metals in the soil proximate to and north of the pile, lie within a natural drainage channel draining into a wetland that discharges into Snow Lake (BacTech 2011). Concentrations of metals in groundwater at the site are sufficiently elevated that they pose an unacceptable risk to human health, aquatic life and terrestrial life should they come into contact with this water.

On December 22, 2010, The Government of Manitoba, issued a Request for Proposal (**RFP)** for the implementation of an appropriate technology to remediate the ARS and would allow for the recovery of residual gold from the ARS. BacTech presented the Government of Manitoba with a proposal entailing the application of proprietary bioleaching technology to the ARS dated February 9, 2011 (the **Proposal**), which was accepted by the Government of Manitoba. BacTech proposes to construct a Bioleach Plant in Snow Lake. BacTech will remove the material from the ARS, apply the bioleaching technology (which will remove and neutralize harmful elements such as sulphides and arsenic), safely dispose of unmarketable by-products and recover the gold and other marketable products. BacTech will receive the proceeds from the sale of the gold and other marketable products as compensation for its activities. At the conclusion of the Project, the source of arsenic and metals which leach into the groundwater and environment will be permanently removed, and the ARS site will be remediated to applicable environmental regulatory standards. The site of the ARS will be leveled with locally available material.

The patented BACOX process involves a biological reactor leaching process that can be applied to the remediation of the ARS in an economically beneficial manner. This bioleach process is a commercially proven technology with over 20 applications world-wide. This process employs naturally-occurring bacteria, harmless to humans and the environment, to liberate precious and base metals from ore residues. The process also results in the production of a stable iron-arsenic precipitate which is an environmentally benign product, thereby remediating the residuals.

The Project is considered a Class II development under Manitoba's *Classes of Development Regulation,* and as such requires an Environmental Assessment Report (**EAR**) as part of the licensing requirements (Class II License) of *The Manitoba Environment Act*. This EAR is organized as follows:

- Chapter 1.0 provides an introduction and background on the Project, including a rationale, purpose and alternatives to development;
- Chapter 2.0 provides a Project description, including activities and timelines, and a description of the bioleaching process and waste products;
- Chapter 3.0 summarizes the regional setting and project Study Area;
- Chapter 4.0 summarizes the existing environment for the biophysical and socioeconomic elements;
- Chapter 5.0 describes the public engagement process;
- Chapter 6.0 summarizes the potential environmental effects of the Project;
- Chapter 7.0 summarizes the planned mitigation measures and residual effects;
- Chapter 8.0 summarizes the residual effects; and
- Chapter 9.0 provides a monitoring and reporting plan for the Project.

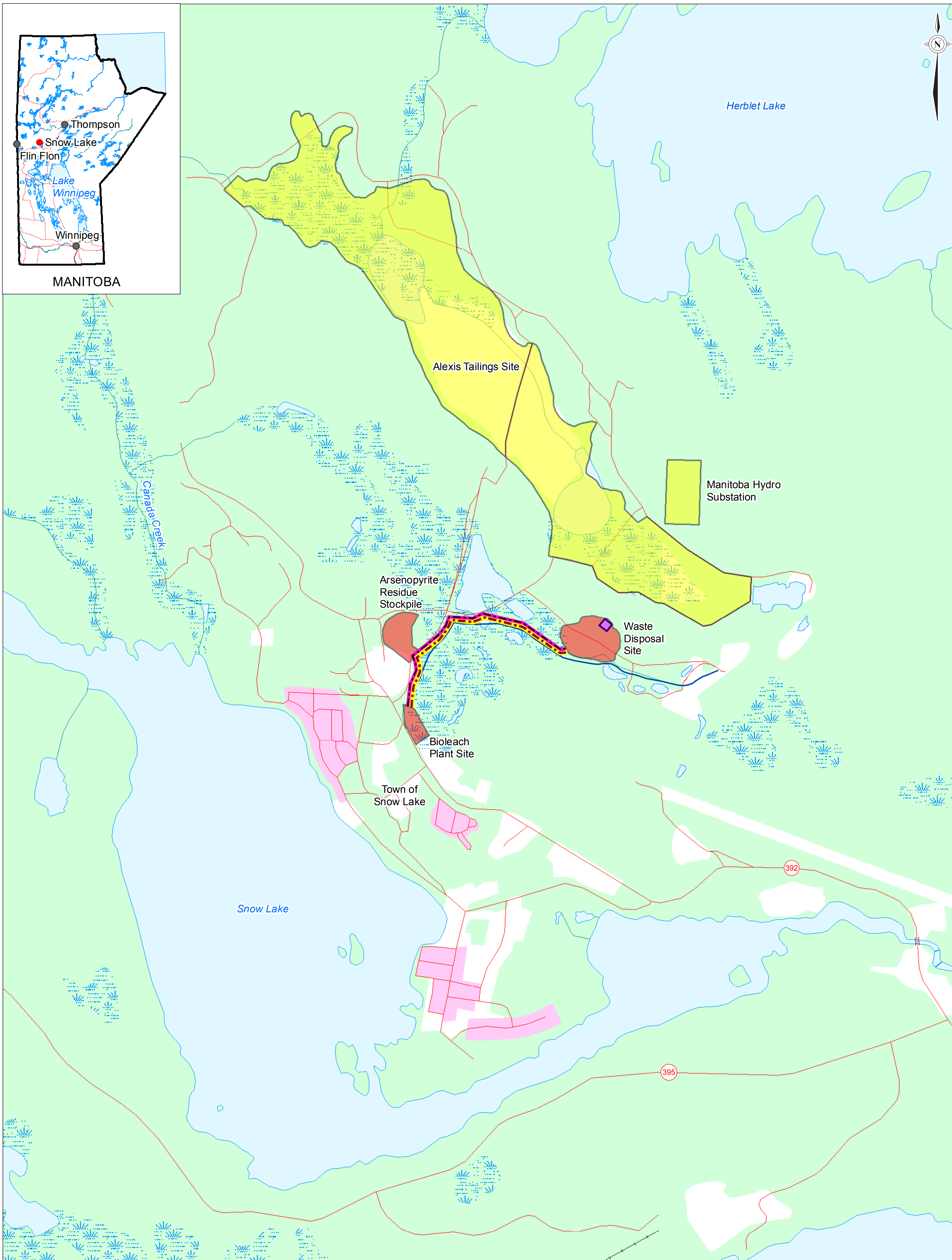
1.1 Background on Snow Lake Arsenopyrite Residues

Nor-Acme operated a gold mine in Snow Lake, Manitoba and extracted ore from 1950 to 1959. The ore zones consisted of quartz-carbonate veins containing free gold overgrowing sulphide minerals, and refractory gold inside the grains of sulphide. The ore assemblage was dominated by arsenopyrite (FeAsS) with minor pyrrhotite (FeS), pyrite (FeS_2) and chalcopyrite ($CuFeS_2$). Throughout the duration of mining, approximately 300,000 t of cyanide treated, refractory arsenopyrite ore concentrate, measuring upwards of 55% arsenopyrite was deposited in the ARS. The ARS measures 185 metre (m) long and 85 m wide (Figure 1). Remaining gold concentrations remain in the ARS at an estimated grade of 9.7 g/t of gold (Newson 2011).

From 1959 to 2000, the ARS was not covered resulting in the unrestricted oxidation of the sulphides. In 2000 the ARS was capped with layers of waste rock and clay (Figure 2), limiting further oxidation and produced a reducing environment (i.e., an environment that lacks oxygen, reducing the generation of acid mine drainage). In 2004, the ownership of the ARS pile was transferred to the Province of Manitoba.

Through its Orphaned/Abandoned Mine Site Rehabilitation Program, Manitoba assumed ownership of and responsibility for environmental and mine site rehabilitation at designated sites. This included portions of the New Britannia Mine Site, at Snow Lake, Manitoba known as the Lined Leach Basin (**LLB**), the former Nor Acme emergency tailings deposit (the "**Nor Acme tailings**") and the ARS. The ARS is located on land that is subject to a mineral lease and a surface lease, both held by QMX Gold Corp. (**QMX**), formerly the Alexis Minerals Corporation (**Alexis Minerals**). QMX has renamed the mine the Snow Lake Mine.

G:\2012\1380\12-1380-0037 BacTech Bioleach Facility EIS\Figures\Phase 4000 - Surface Water\12-1380-0037 - Proposed Site Location.mxd Date: 10/25/2012 12:53:38 PM



LEGEND

- WATERBODY
- WETLAND
- WATERCOURSE
- ROAD
- PROJECT COMPONENTS
- OTHER SITE OF INTEREST
- DRAINAGE CHANNEL
- PROPOSED HAUL ROAD
- PROPOSED PIPELINE ROUTE

0.5 0 0.5

SCALE 1:20,000 KILOMETRES

REFERENCE

CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT

BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

TITLE

PROPOSED SITE LOCATION FOR BACTECH BIOLEACH FACILITY IN SNOW LAKE, MANITOBA

Golder Associates
Saskatoon, Saskatchewan

PROJECT	12-1380-0037		FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
GIS	JRC	23/10/12	**FIGURE: 1**	
CHECK	GS	23/10/12		
REVIEW	MS	25/10/12		

Figure 2: Arsenopyrite Residue Stockpile with Rock Cap in July, 2001

Source: BacTech 2012.

The ARS is composed of approximately 300,000 t of concentrate residue placed over bedrock and native clay, from 1949 to 1958 by the Nor-Acme Mine mining activities. The ARS has been identified as the largest source of contaminant loading at the site in Snow Lake based on metal concentrations in the waste material. Elevated concentrations of metals in the pore water at the base of the waste pile have resulted in high soil concentrations proximate and to the north of the pile. These lie within a natural drainage channel that flows into a wetland that discharges into Snow Lake. Concentrations of metals at the site are sufficiently elevated that they pose an unacceptable risk to human health, aquatic life, and terrestrial life (Salzsauler 2005).

1.2 Rationale for Development

Most tailings in the world contain sulphides, as well as other toxic elements, and due to historic mineral extraction technology limitations, economically recoverable quantities of precious or base metals. In addition, conventional waste disposal practices, including those at the Snow Lake Mine, complied with standards that existed at the time, but that today would be classified as unsuitable for environmental compliance. Sulphides in tailings readily react with the atmosphere to create an acidic solution known as acid mine drainage (**AMD**). This typically has elevated sulphate and metal concentrations and acidic pH. At Snow Lake, residues in the ARS contain high levels of arsenic that have been leaching into local lakes and streams as a result of AMD. Concentrations of metals at the site are sufficiently elevated that they pose an unacceptable risk to human health, aquatic life and terrestrial life. The Province of Manitoba has identified that additional measures must be undertaken to minimize the environmental and human health risks associated with the site.

The drill program BacTech conducted on the ARS indicated:

- an estimated Measured Mineral Resource of 265,000 t grading 9.7 g/t of gold and 2.17 g/t of silver;
- an estimated Indicated Mineral Resource of 9,300 t grading 9.2 g/t of gold and 2.15 g/t of silver; and
- an estimated Mineral Resource of 28,000 t grading 7.0 of gold and 2.4 g/t of silver.

In addition to the need to undertake remediation activities at the site, the ARS contains an estimated mass of residual gold in the stockpile of 9.7 g/t, which is recoverable with BacTech's bioleach process. In summary, BacTech's proposed Bioleach Facility will eliminate environmental risks associated with the ARS, while generating significant revenues and employment opportunities in Snow Lake (BacTech 2011).

1.3 Purpose of the Development

The purpose of this development is to eliminate further leaching of arsenic generated within the ARS into the surrounding watershed utilizing BacTech's Proprietary Bioleaching Technology.

1.4 Alternatives to Development

Several alternatives to leaving the ARS stockpile in its existing state have been investigated. BacTech explored two options which would have involved pretreatment of the material and blending with an existing ore feed. The remaining alternatives include:

1) leaving the ARS stockpile where it is, and develop and implement mitigation measures to prevent water and air ingress to inhibit arsenic and iron leaching;
2) using alternative technology providers, e.g. Albion Process or Pressure Oxidation (POX) to conduct oxidation before blending with conventional cyanidation process;
3) reclamation of material and trucking off site for treatment; and
4) reclamation of material and trucking off site for disposal.

Potential benefits and disadvantages of each of these alternatives are summarized in Table 1.

Table 1: Summary of Potential Benefits and Disadvantages of Alternatives to Proposed Development

Option	Description	Potential Benefits	Potential Disadvantages
1	Leave stockpile in place; Prevention of water and air ingress to inhibit arsenic/iron leaching	• Accepted practice • Ease of undertaking	• Risk of arsenic mobilization through reductive dissolution of arsenic sulphides • Future land use of area restricted • No revenue to pay for remediation costs • No jobs created or taxes generated
2	Alternative technology to conduct oxidation before blending with conventional cyanidation process	• Provides a method of treating future refractory material from underground • Permanent removal or arsenic from site	• Albion has a poor commercial track record • POX is a more expensive technology than the proposed bioleach process
3	Reclamation and trucking of material off site for treatment and blending with conventional cyanidation process	• Permanent removal of arsenic from site	• Trucking of arsenopyrite concentrate required • Solution outside Manitoba • Option is expensive • Low gold recovery
4	Reclamation and trucking of material off site for disposal	• Permanent removal or arsenic from site	• Trucking of AS concentrate required • Solution outside Manitoba • Option is expensive • No gold recovery

2 PROJECT DESCRIPTION

2.1 Description of Proposed Development

The proposed development is situated in the industrial zone of the Town of Snow Lake, approximately 685 km north of Winnipeg, Manitoba (Figure 1). The development is composed of five major components which are described in the subsections below. The location of these components is shown in Figure 3. Appendix A contains letters indicating agreement and support for the project from the Province of Manitoba (Mines Branch), the Town of Snow Lake, and a draft letter forwarded to QMX Corporation.

2.1.1 Arsenopyrite Residue Stockpile

The ARS is located on the Snow Lake Mine site (formerly the New Britannia Mine and the Nor-Acme Mine) now owned by QMX. The stockpile occupies an area of approximately 180 m by 105 m, centred at 54°53'16” north latitude and 100°01'20” west longitude (Figure 4). In order to process the ARS material the first major component will be the removal the existing course angular mine waste cap. Conventional earth moving equipment will be utilized for the removal of the cap as well as loading and hauling of the material to the Plant Site for processing (Figure 5). The second major component associated with the ARS will be a water management system (**WMS**) to control any ground or surface water that may accumulate during the excavation of the ARS material as well as dust suppression. The WMS will consist of two or three pumps, a sedimentation tank, a storage tank, and a pipeline or tanker truck to transfer the collected water from the ARS excavation site to the BacTech facility for consumption into the process.

Dust suppression for the private roadway that will be used to haul the ARS to the Bioleach Plant Site will be constructed of an adequate dirt/rock material will most likely be in the form of a water truck.

Dust suppression for the excavation site will consist of a storage tank, gas driven pump, and adequate hoses fitted with fire nozzles to be utilized in the prevention of air born dust created during the dry and windy periods of excavation. The dust suppression system will also be available as part of the emergency response plan in the event of a fire.

Figure 3: Location of Project Elements near Snow Lake, Manitoba

Figure 4: Schematic Plan View of the Arsenopyrite Residue Site

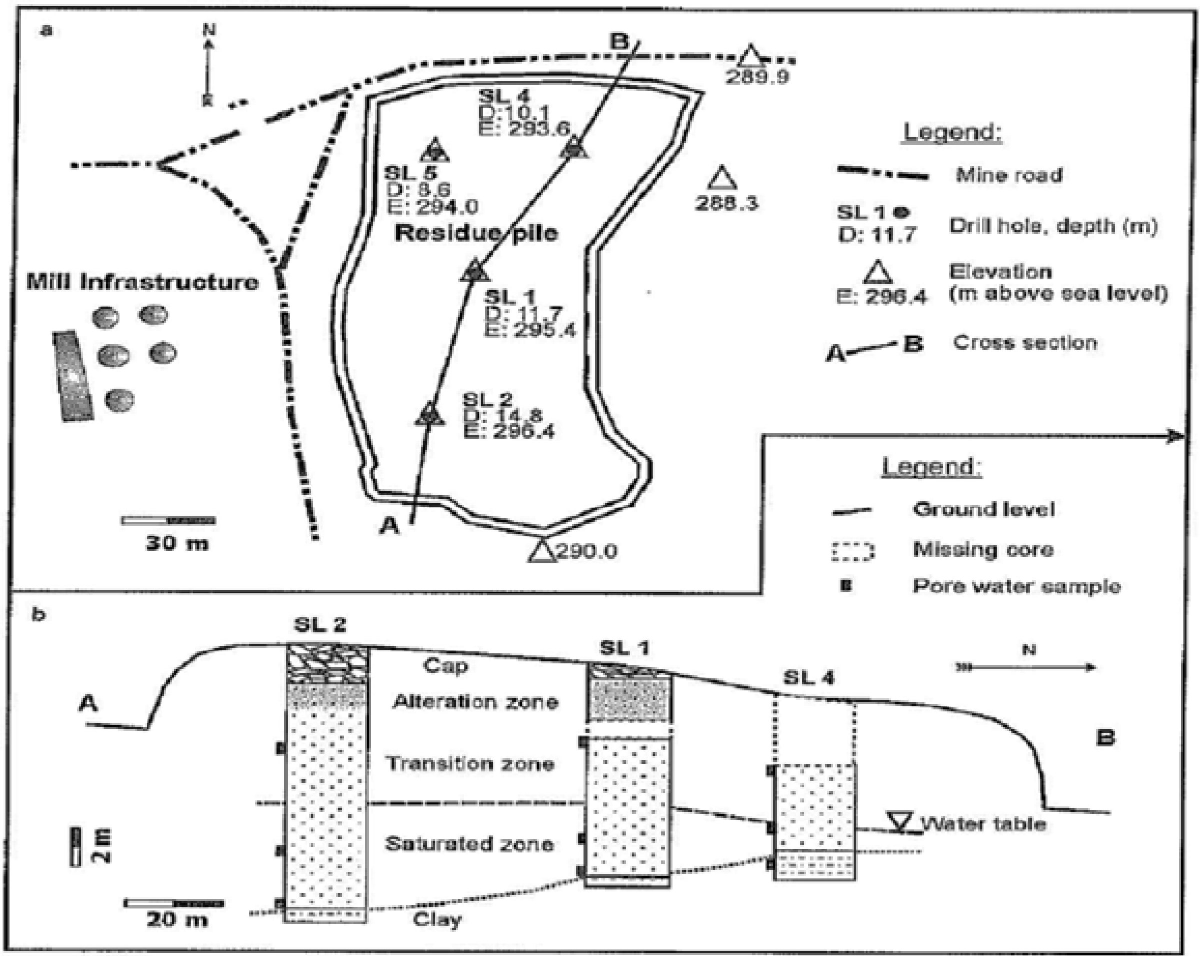
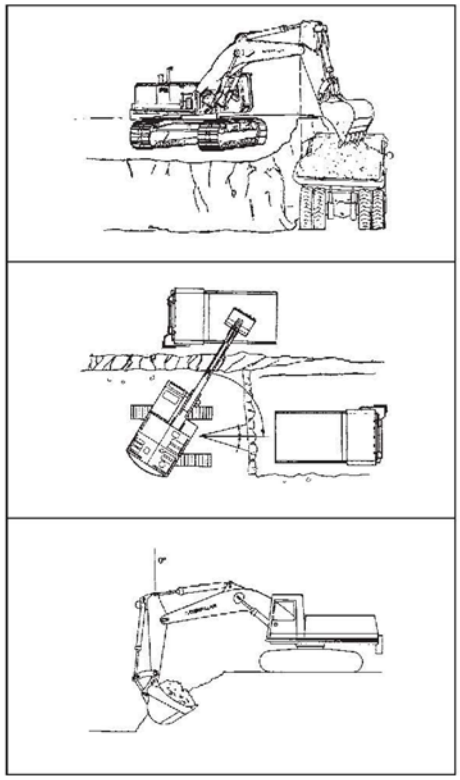


Figure 5: Schematic View of the Hydraulic Excavator Loading a Truck



2.1.2 Hauling of Arsenopyrite Residue

The ARS material will be trucked an approximate, distance of 0.37 km by road. This road is partially existing (0.2 km); construction of the remaining 0.17 km will be required on the route shown in Figure 1.

The removal and hauling process of the ARS material will be completed by a third party contractor. The reclamation process will commence from the closest location in the ARS to access road or processing facilities working towards the remaining in-situ material. The Project does not require intensive selectivity or grade control because grade variability of the deposit material is reported to be low. The relative insensitivity of the grade change in the deposited material permits the material to be excavated from any locations, either by layer or trenching or with variable faces if an increase capacity is required. The equipment fleet will consist of one 2.3 to 3.0 cubic metres (m^3) bucket capacity excavating equipment (hydraulic excavator or FEL) with one 28 t payload truck. This equipment will be able to transport approximately 450 t of material in an eight hour shift based on a preliminary estimate of the production cycle time.

Based on this estimate, there will be excess capacity so that the excavation operation can be concentrated during the day shift. An operation of 243 days has the capacity of producing 109,350 t of material compared to the proposed annual production rate of 46,650 wet t.

The reclamation will only be operating eight months per year and will be shut down during the winter months. Any forecasted operation into the winter months will require the working area to be covered with an insulating material or thick geotextile to prevent freezing. It is recommended to cover the stockpiled material exposed to the weather and heat if necessary to avoid freezing or excess exposure to moisture during spring or rainy days.

2.1.3 Bioleach Plant Site

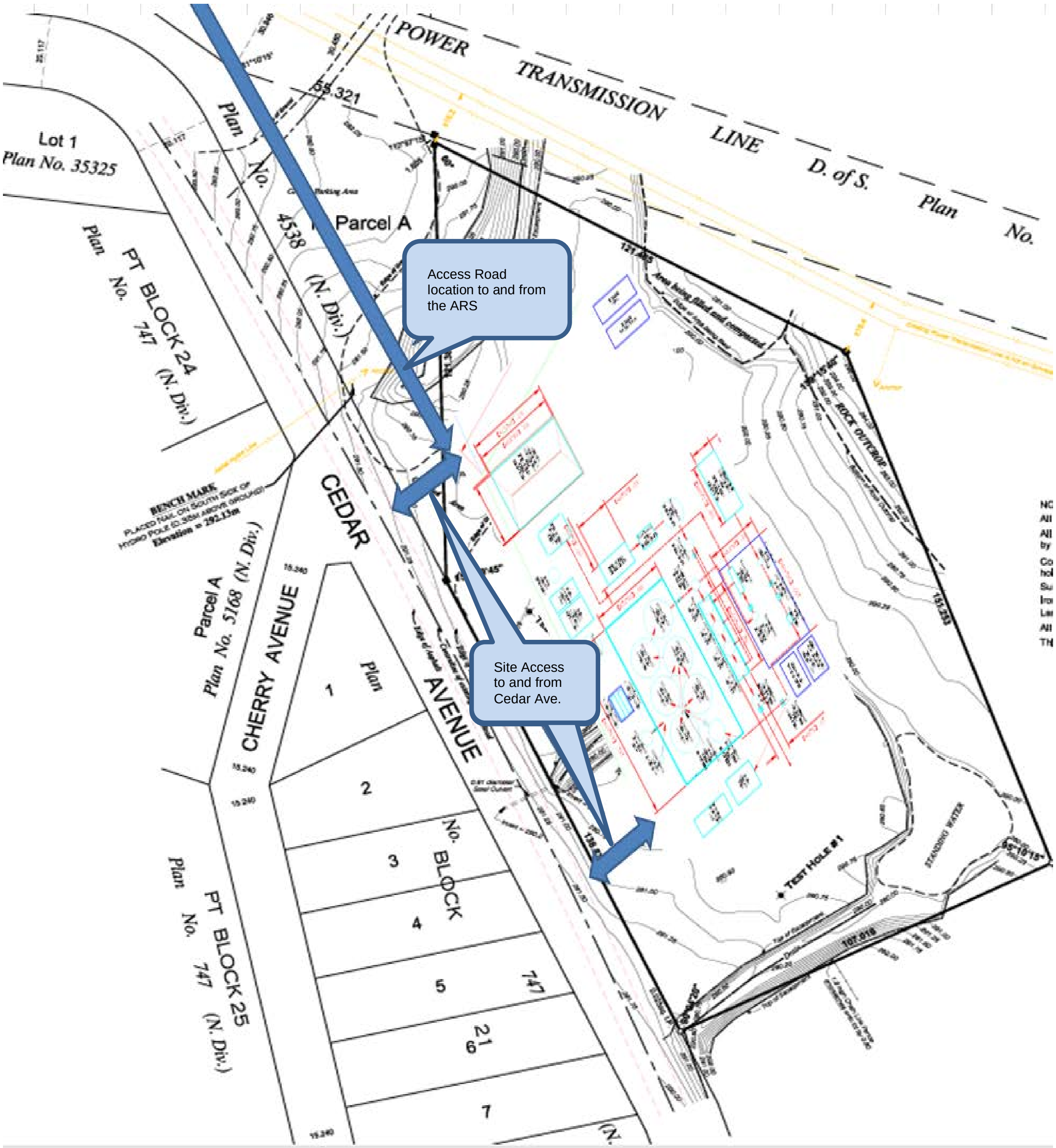
The proposed Plant Site is a brownfield site on the outer edge of the Town of Snow Lake (Figure 1). The property is located at SW 17-68-17 WPM on the east side of Cedar Avenue, includes Parcels A & B of certificate of title 1709674/3. The development site is shown in Figure 6. The lot is 2.29 hectares (ha) (5.67 acres) in size.

Prior to the construction of the process facility the site will require civil work to obtain the required grade and foot print to accommodate the facility. Access to the facility is directly off of Highway 392. The Town of Snow Lake has assumed the responsibility of obtaining the access requirements.

The process facility will consist of the following;

- a building approximately 18.3 m by 30.5 m (60 feet [ft] by 100 ft) which will house the Bioleach Facility;
- possible outlying auxiliary buildings to house technical support, laboratory, maintenance shop, warehouse and concentrate storage;
- tankage consisting of reactors, mix tanks, and storage tanks;
- mechanical equipment consisting of but not limited to pumps, piping, a grinding mill, air compressor and blowers, and cooling tower; and
- electrical components consisting but not limited to a Motor Control Center, automated Human Machine Interface (**HMI**) and controls system, auxiliary power supply.

Figure 6: Proposed Site Location for BacTech Bioleach Facility in Snow Lake, Manitoba



The Bioleach Facility will consist of the following circuits:

- material preparation;
- bioleach;
- separation;
- neutralization; and
- reagent.

Further information on the processes within these circuits is provided in the following section on the bioleach process (Section 2.4). The facility will operate 24 hours per day, seven days a week (24/7) with four crews consisting of, but not limited to, four individuals per 12 hour roster.

A series of confidential process and instrumentation diagrams for the plant are provided in Appendix B.

2.1.4 Pipeline

Three 50 mm (2”) HDPE pipelines approximately 1.4 km long running in parallel will be required between the plant facility and the Storage Impoundment area. One (1) of the three (3) pipelines will be designated to return reclaimed water from the Storage Impoundment area back to a holding tank at the bioleach facility to be reused in the process. The two (2) remaining pipelines will be designated to transfer the stable ferric arsenate to the Storage Impoundment area. One (1) of the two (2) pipelines designated to transfer the ferric arsenate will be in constant operation as a primary and the second pipeline will be a stand-by only to will mitigate the risk of a plant shutdown in the event of a blockage in the primary line. Detailed engineering will determine the exact size HDPE pipe to be utilized to transfer the reclaimed water and neutralized ferric arsenate.

Pipeline Material:

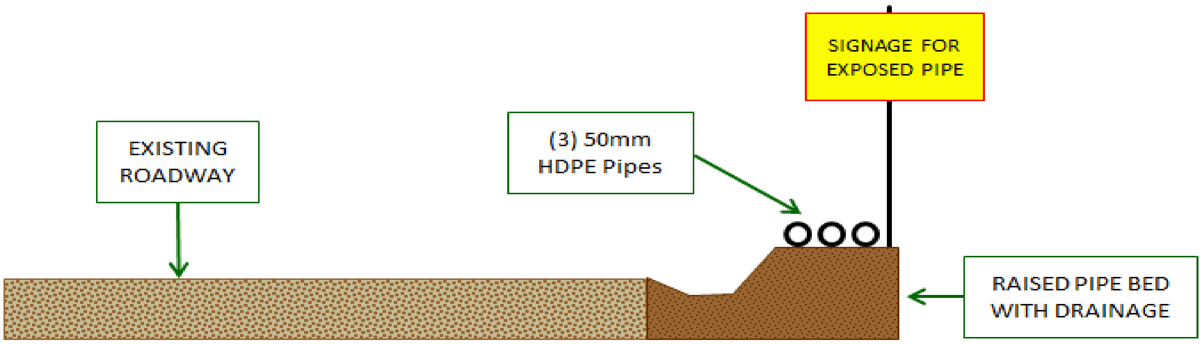
The three (3) pipelines between the bioleach facility and the Storage Impoundment will be constructed of HDPE (high density polyethylene) material that offers a life span of more than 50 years. The products strength and flexibility makes it resistant to impact and best suited for lying on uneven terrain. HDPE piping is available in longer lengths than conventional piping which will reduce the number of joints in the pipeline. HDPE pipe is joined using an electro fusion technique that is leak resistant. HDPE piping is re-usable and can be easily dismantled from one particular location/application and re-used. This product is environmental friendly because it will not corrode into the existing environment.

Pipeline Location:

Dependent on approval and detailed engineering it is anticipated the pipelines will run parallel to the existing private access road between the bioleach facility and the Storage Impoundment area as outlined in Figure 3. The pipelines will be exposed on a gravel bench that will run parallel to the roadway. Following approval; detailed engineering will determine the required size of the bed, material of construction and optimum location in conjunction to the existing roadway.

Signage will be posted between the roadway and pipeline warning of the exposed piping. Figure 7 illustrates an end-view of the existing roadway, and anticipated location of the benching and pipelines.

Figure 7: Cross Section of the Pipeline Location and Benching

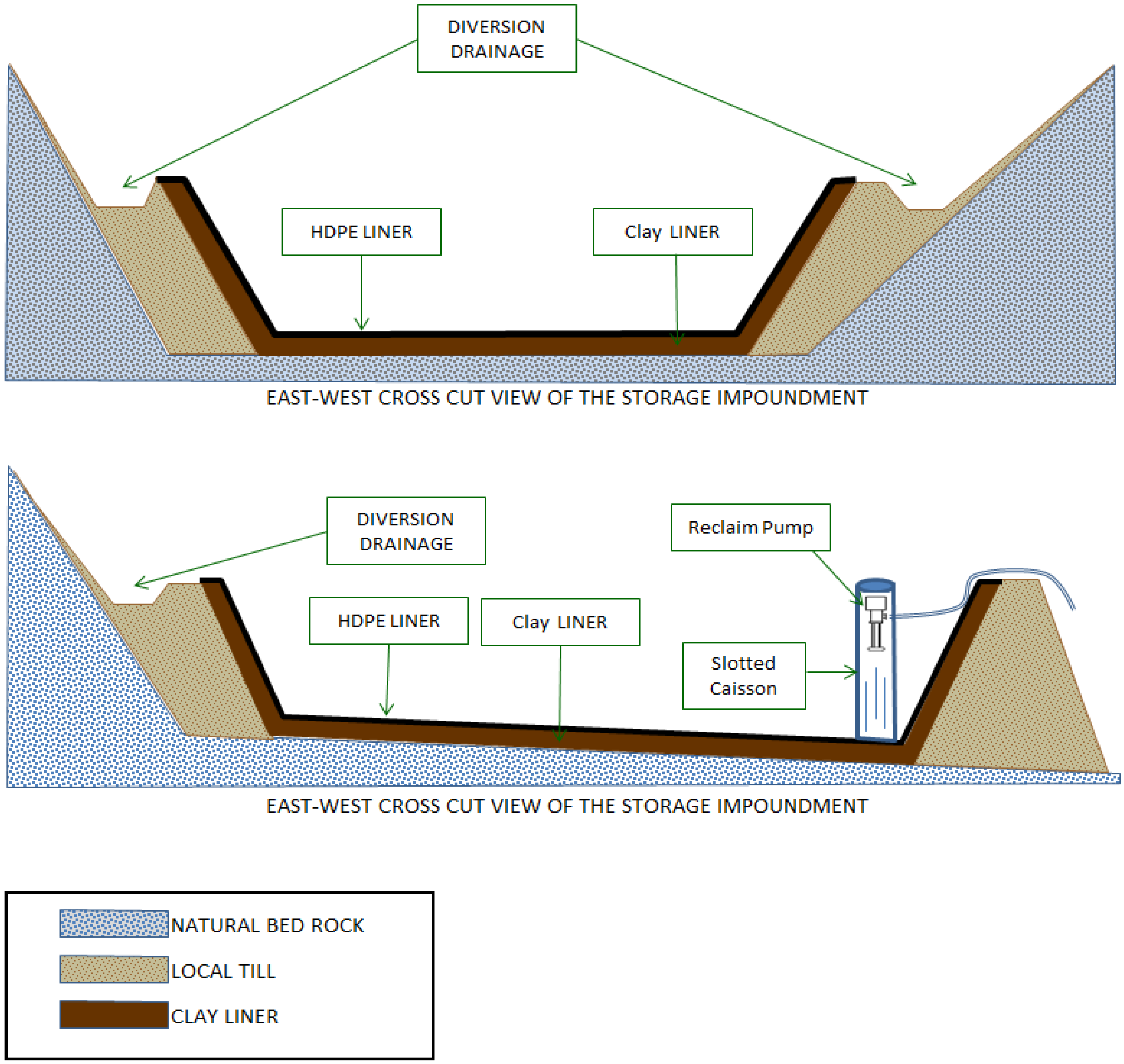


2.1.5 Storage Impoundment Area

Once the arsenic has been stabilized the neutralized precipitate will be pumped to a Storage Impoundment area approximately 1.4 km northeast of the Bioleach Facility. It is expected the detailed engineering of the Storage Impoundment will be clay and HDPE lined to prevent any seepage into or out of the impoundment cello. The impoundment area will be designed to divert surface runoff water from impeding the storage volume of the neutralized precipitate. Figure 8 shows the expected detailed design of the storage area.

Detailed engineering will provide the best option to reclaim the water from the storage cell; one option as depicted in the lower half of Figure 8 would be to install a vertical slotted caisson in the Storage Impoundment area that would house the reclaim water pump to return the water back for re-use in the process. The slots in the caisson would allow for the pore and captured run-off water to enter the caisson while holding back the solids of the precipitate.

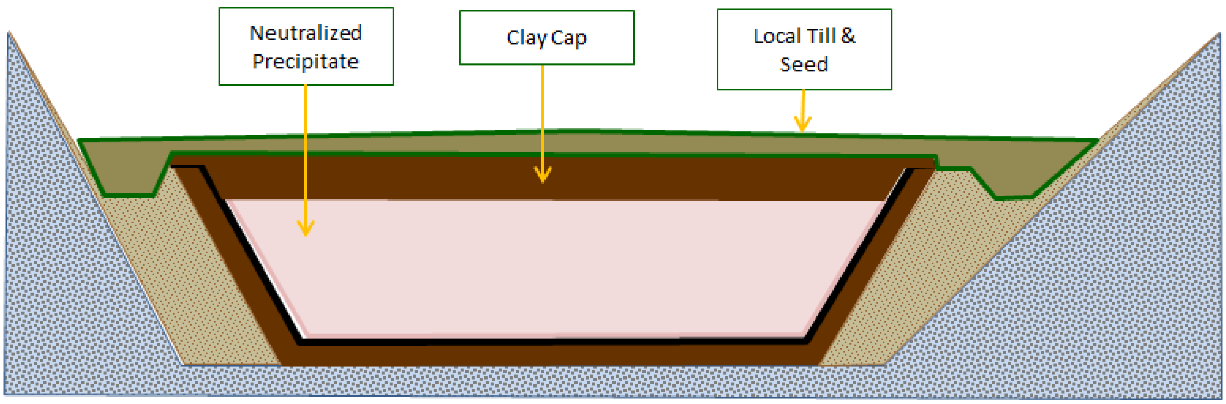
Figure 8: Expected Design of the Impoundment Area



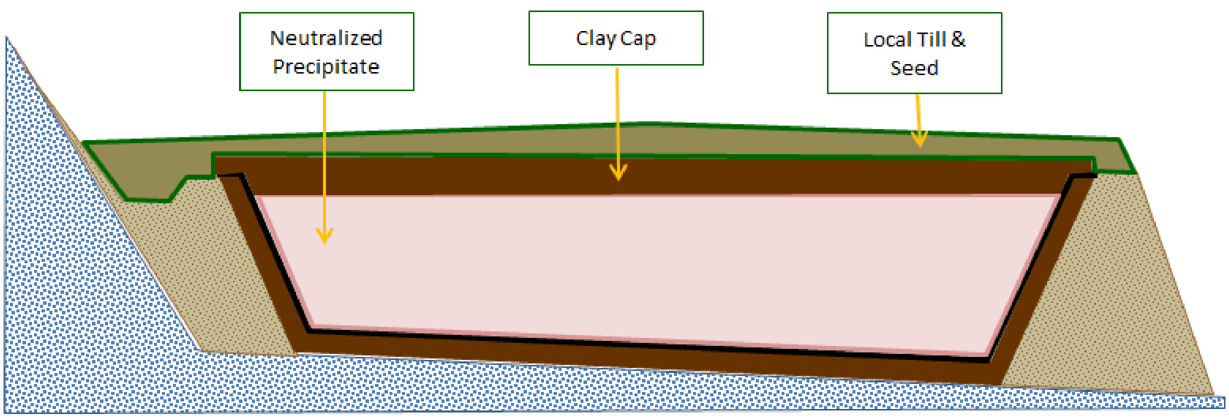
Monitoring wells will be strategically drilled around the Storage Impoundment area to monitor the ground water quality before and after the neutralized precipitate is capped to assure there is no effect to the surrounding water quality from the precipitate.

The closure plan will outline the decommissioning requirements of the Storage Impoundment area. We expect the closure plan may require a clay cap to be installed over the neutralized precipitate, topped with a layer of local till and possibly planting of local wild grasses. Water sample analysis from the monitoring wells will continue to be recorded following the closure of the Storage Impoundment area. Figure 9 shows the expected capping of the Storage Impoundment following the closure of the project.

Figure 9: Expected Capping Requirements Following the Closer of the Impoundment Area



EAST-WEST CROSS CUT VIEW OF THE STORAGE IMPOUNDMENT



EAST-WEST CROSS CUT VIEW OF THE STORAGE IMPOUNDMENT

2.2 Rights, Land Use and Title

Mineral and Surface Rights

The location of the proposed Bioleach Facility, Storage Impoundment Area, and the pipelines are fully contained within the QMX Mineral Leases. The Mineral Leases that encompass the Project site are P6561B (BUD5) (Appendix C, Manitoba Mineral Lease Map). Mineral leases issued through the Mines Branch of Innovation, Energy and Mines, provide the owner the access to the surface rights. A cooperation agreement between QMX and BacTech is being negotiated. The holder of the quarry lease QL-52 which will host the Storage Impoundment Site, is the Town of Snow Lake. An agreement is being negotiated with the Town of Snow Lake for access to the borrow pit, and is expected to be completed by November 30, 2012.

Existing and Adjacent Land Use and Zoning

The existing land use for the site of the proposed Bioleach Facility is a recycling property hosting the Town's recycling trailer. The land to the north and south are zoned industrial and the Plant Site is zoned industrial through a by-law amendment 913/12 and was given final reading on July 3, 2012. The surrounding land is zoned industrial.

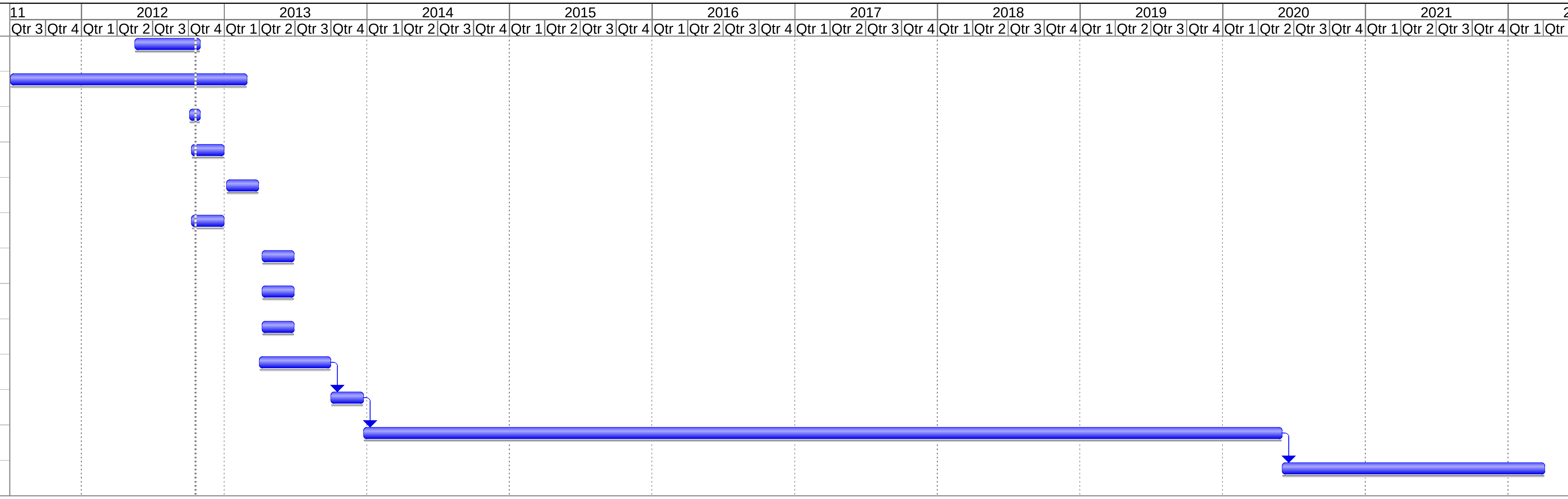
Certificate of Title

The proposed plant facility will be constructed in Parcels A & B of surveyed Pt. SW ¼ 17-68-17. An agreement for purchase of the land for the establishment of the Bioleach Facility with the Town of Snow Lake has been negotiated. The Town is awaiting title from Manitoba Conservation and Water Stewardship, at which time they will transfer ownership of the parcel of land to BacTech.

2.3 Project Development Activities and Timelines

The timelines for project activities are summarized in Figure 10. Details for each of these stages are provided in the subsections following.

ID	Task Name
1	Pre-construction Site Assessment
2	Complete environmental and engineering studies
3	Submit Environmental Assessment Report
4	Complete Geotechnical Report
5	Receive Environmental Act Licence
6	Process Optimization Test Work
7	Process Optimization Test Work - Phase 2
8	Closure Plan
9	Front End Engineering Design (FEED)
10	Construction
11	Plant Commissioning
12	Operations
13	Decommissioning (tentative)



2.3.1 Site Activities (Pre-operations)

Drilling and Sampling: The drilling and sampling process within the ARS was concluded in two stages. Stage I sampling consisted of half-cut core samples obtained from Dr. Barbara Sherriff of the University of Manitoba in April 2010. The samples were drawn from inventory of frozen drill core samples obtained from four sampling drill holes on the ARS site in March 2002. Stage II samples were obtained in May 2011. A total of 33 vertical holes, from 1.0 to >10 m deep were drilled by BacTech to obtain samples for a resource calculation to NI 43-101 standards for metallurgical testing (Newson 2011).

Sediment samples were collected from backhoe excavations at the plant and waste Storage Impoundment site.

Tailings Reclamation Plan: An RFP has been submitted to Golder and Associates Ltd. (Golder) to complete The Tailings Reclamation Plan.

Closure Plan: The Closure Plan will be provided upon completion.

2.3.2 Metallurgical Test Work

Snow Lake Project test work was conducted during Stage I (April to September, 2010) and Stage II (June 2011 to March 2012) metallurgical testing programs using BACOX technology to treat the ARS material, which is a highly refractory sulphide material with a high arsenic content.

The key findings of the metallurgical testing programs were very positive in providing BacTech with an evaluation into the refractory nature of the ARS material and its suitability to bio-oxidation processing. Diagnostic leaching confirmed that the majority of the gold present in the ARS material was refractory and high oxidation levels will be required to maximize extraction by cyanidation. A maximum gold recovery of 96.5% was obtained after hot nitric acid digestion followed by cyanidation. This extraction compares to a gold extraction of only 9.4% for direct carbon-in leach (CIL) cyanidation.

In conclusion, the key findings of the metallurgical testing programs support the applicability of BACOX technology to the BacTech Snow Lake Remediation Project. Optimization Test Work is currently underway at an SGS Australia facility, expected to be completed in Q4, 2012.

2.3.3 Studies

A process model was established to generate anticipated operating and capital cost for such a process. A metallurgical test work report summarized the results from Stage I and II metallurgical test programs using BACOX technology to treat the ARS.

A water balance study was undertaken to determine the volume of process water required, and the amount to be recirculated from the Storage Impoundment Facility, and re-used in the process, and is included in Appendix D.

CAPEX/OPEX studies were completed Q2, 2012 confirming the estimated cost to construct and operate the BacTech Bioleach facility for the life of the remediation project.

Micon International Ltd. (Micon) completed the NI 43-101 Preliminary Economic Assessment (PEA) study in August 2012 (Micon 2012). The report was made public on October 12, 2012 and is available at: http://www.bactechgreen.com/s/NI43101.asp.

Optimization Test Work is underway at an SGS facility and is expected to be completed in Q4, 2012.

2.3.4 Engineering/Procurement

The preliminary design criteria and subsequent flow sheet design of the facility were completed by BacTech in Q1 2012 and the front end engineering and design (FEED) has commenced. Equipment procurement will occur in sequence with the detailed design as each circuit is completed and drawings are approved. The procurement process is scheduled to commence in Q4 2012.

2.3.5 Site Preparation

Requirements for the site preparation will be outlined in the completion of the Geotechnical report and detailed civil engineering. BacTech will work in conjunction with the Town of Snow Lake to ensure all drainage and service requirements are addressed accordingly.

2.3.6 Construction

Following the approval of the construction application and any other remaining approval requirements, construction will commence in Q2 2013 and extend through to the expected completion in Q4, 2013.

2.3.7 Commissioning/Operation

Commissioning will begin during the final stages of the construction phase during Q4 of 2013 and is scheduled to take 44 days to complete. Commissioning will be determined when the facility can operate for 14 days at 75% capacity.

Operations will begin immediately following commissioning on a 24 hr seven d/wk basis.

2.3.8 Potable Water and Waste Water

Potable water and waste water treatment will require tie-ins to the Town’s service lines expected to be available in Q3 2013. During operation the estimated consumption of potable water is 1,200 liters (L) per day with an estimated 500 L per day of wastewater. Detailed engineering and further discussions with the Town will determine the requirements for both services. At this stage of the project it is anticipated that the services will require to be tied in from the last serviced lot on the east side of highway 392 near the corner of Poplar Avenue. Sewerage services may require a lift station to be installed at the plant facility to compensate for the facility location being in a low lying area.

2.3.9 Decommissioning

Decommissioning of the BacTech facility will be outlined in the closure plan in the event an alternative feed source is not established.

2.4 Description of the Bioleaching Process

Preparation of ARS Material

Material will be fed from the Bioleach Facility stockpile into the feed hopper at the Material Preparation Circuit at a nominal rate of 100 tonnes per day (t/d) by a front end loader. A grizzly screen will remove debris before entering the repulp tank where wash water will be added to give a 40 percent weight (% wt.) pulp. The pulped material will feed a polishing regrind process which will operate in closed circuit with two cyclones and a polishing mill, with the cyclone overflow being fed to a hi-rate thickener. The cyclone underflow will be returned to the regrind circuit after further grinding in the polishing mill Figure 11.

Figure 11 Bioleach Facility

Source: BacTech 2012.

The purpose of the regrind polishing is to freshen the surfaces of the particles and reduce the size of the coarse fraction present to achieve a particle size of P80 75 micrometres (µm). This process will also result in the removal of any residual cyanide species present from the previous operation which could otherwise interfere with the bacterial oxidation process. The thickener overflow will feed the mill process water pond for re-use in the circuits. Thickened underflow from the regrind circuit will be pumped to an agitated feed storage tank at the head of the Bioleach Circuit. The storage tank is designed for a 30 hour (hr) buffer storage capacity to allow for downtime maintenance of the regrind circuit.

The thickened pulp from the storage tank will be pumped to the primary bacterial oxidation reactors with in-line water dilution being added using automatic control to give a feed operating density of 10% solids. The diluted pulp will be fed to a splitter header box where the pulp will be divided equally between three primary reactors operating in parallel.

The bacterial oxidation circuit consists of six reactors of identical size with three reactors operating in parallel as primary reactors with the combined product from these reactors feeding a train of three reactors operated in series. Pulp will flow between the different reactor stages by gravity, using a system of open launders. The total residence time for the process will be five to six days with a minimum oxidation level of 95% pyrite being achieved and total oxidation of arsenopyrite. Acid addition will be made to the primary reactors to satisfy the acid balance requirements for arsenopyrite oxidation. A nutrient mix consisting of milligram levels of nitrogen phosphorous and potassium will be fed to the primary bacterial oxidation reactors.

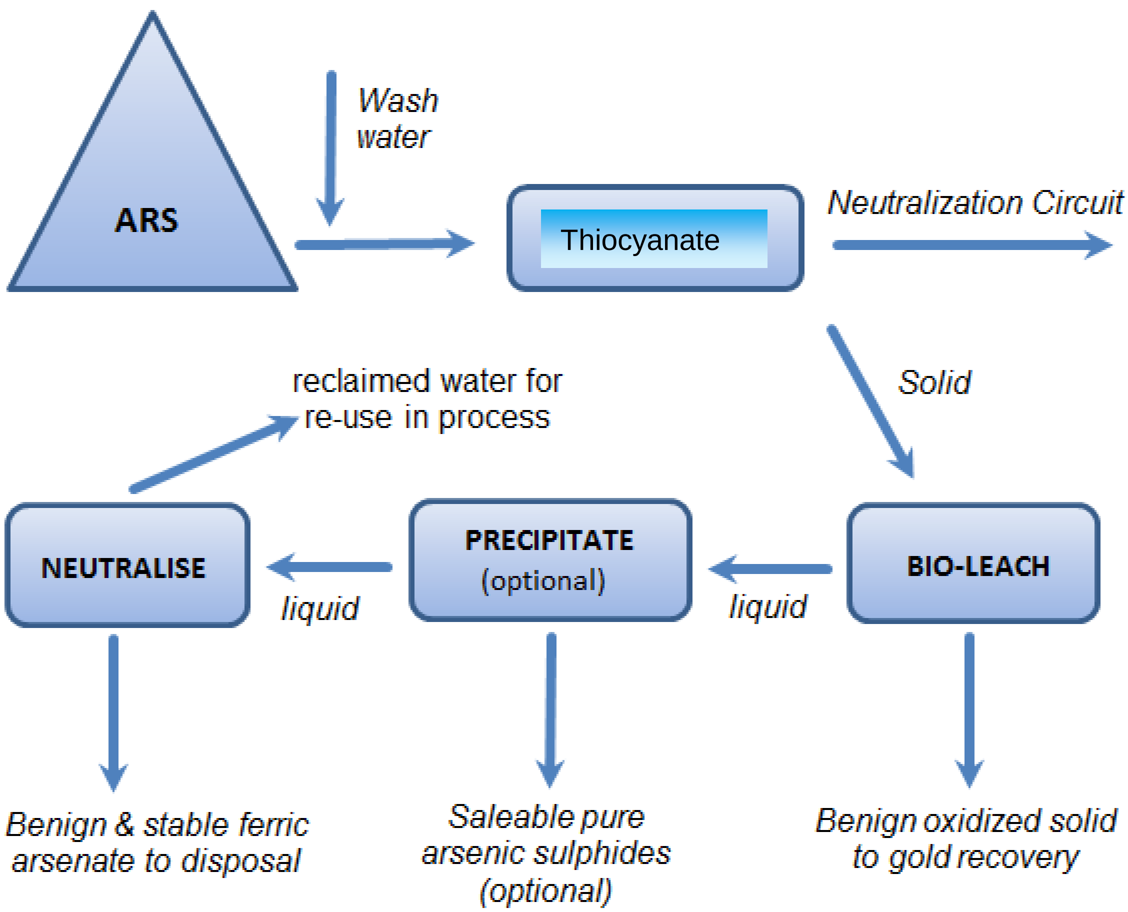
The reactors will be agitated with fixed speed drives and hydrofoil type impellors for three phase mixing, and sparged with air through a ring main delivered from two low pressure blowers. The process is exothermic and heat is removed by cooling tube bundles located in the reactors which also act as baffles to ensure good mixing and solids suspension. The temperature of the reactors will be maintained at 40°C by regulating the flow of cooling water to each of the reactors.

The oxidized pulp will be pumped from the last bioleach reactor to the residue thickener at the head of the Residue Liquor Separation Circuit. The overflow from the thickener reports to the Neutralization Circuit and the oxidized underflow solids will be washed and filtered using a belt filter. The filter cake consisting of the oxidized residue containing gold and silver values will be shipped off-site for precious metals extraction.

In the Neutralization Circuit the bioleach liquor from the residue thickener overflow containing soluble iron, arsenic and acid, together with the filtrate from residue filtration operation will be neutralized with limestone to produce a stable ferric arsenate precipitate for disposal. The neutralization section consists of four agitated leach tanks reactors, 75 m^3 in volume each, that operate in series. The design residence time for liquor neutralization is six hours and the pH of the liquor will be increased to pH 6.5 using limestone slurry delivered through a ring main.

The neutralization process results in the formation of ferric arsenate in a matrix of gypsum and ferric hydroxide. The neutralized pulp feeds the neutralized precipitate thickener where a thickened underflow of precipitate will be produced, which will be pumped to the Storage Impoundment Site as a slurry or sludge. Water will be reclaimed from the Storage Impoundment area after settlement of the precipitate. The return water together with the clean neutral overflow water from the neutralization thickener will report to the process water pond where it will be re-used as dilution water for bacterial oxidation process. A schematic diagram of the bioleach process is shown in Figure 12.

Figure 12: Bioleaching Process



Source: BacTech 2012.

2.5 Process Consumptions

2.5.1 Feed Material (ARS)

Feed material from the ARS will be fed into the process at a nominal rate of 100 t/d. Approximately half of the feed material will be trucked off site as gold residue concentrate for further processing with the amount remaining reporting to the ferric arsenate Storage Impoundment Site.

2.5.2 Reagents

The reagents utilized in the BIOX process consist of a polymer, 93% sulphuric acid, antiscalents, nutrients, and limestone.

Polymer is utilized in the dewatering process to bind particles together to assist solid liquid separation. Polymer will be added to the polishing mill thickener, the neutralized participate thickener, and the residue thickener at a combined rate of approximately 100 grams per second per tonne (g/s/t) of feed. Fifty percent of the flocculent added to the polishing mill thickener will report in the concentrate and the remaining 50% will be captured in the overflow water that reports to the mill process water pond for consumption through the plant. Simple inorganic nutrients will be added in the following amounts (Table 2) to the bio-oxidation reactors to support bacterial growth and division:

Table 2: Summary of Nutrient Requirements

Nutrient Requirements	Kilograms/Tonne	Kilograms/Day
Di-Ammonium Phosphate (DAP) $(NH_4)_2PO_4$	1.86	210
Ammonium Sulphate $(NH_4)_2SO_4$	1.55	175
Potassium Sulphate K_2SO_4	0.89	101

The majority of the nutrients will be incorporated into new biological cell structure, while trace amounts of nutrient will report with the liquor to the neutralization section reporting to clear water for re-use back to the plant.

Concentrated sulphuric acid at 93% strength will be added to the first bioreactors at approximately 140 kilograms per tonne (kg/t) of feed or 16 t/d to offset the acid consumption by solubilization of the arsenic. The overall oxidation will be one of acid production which will occur by solubilization of iron sulphides such as pyrite in secondary reactors. Limestone will be added to neutralize the soluble iron arsenic and acid values present in the liquor in the separate downstream liquor treatment process at a rate of 630 kg/t of feed (71 t/d) to achieve a final pH of 6.5 to 6.8. The acidity is converted to solid calcium sulphate (i.e. gypsum) for disposal in the iron arsenic waste product as discussed below

Antiscalents will be used in the cooling water circuit at a rate of less than 100 g/t of feed and present at a few parts per million (ppm) in the cooling water. Under normal operational conditions, this functions as a closed circuit. Cleaning would be required and the resulting waste water from this operation equivalent to 0.3 tonnes per hour (t/hr) will be discharged to waste; this cleaning will take place during the regular scheduled preventative maintenance shutdown.

2.5.3 Process Water

An application to Divert and Use Water was submitted to the Manitoba Water Stewardship, Water Licensing Branch the first week of November (Appendix E). While taking into consideration the estimated average volume of Snow Lake is 82,000 dam^3 BacTech would like to draw water directly from Snow Lake. The Mass Water Balance has determined the process will require 34 m^3 per hour of water for the first six (6) months of operation. The process design has incorporated reclaiming water from the Storage Impoundment Area at a rate of 8 m^3/hr. within 6 months of operation, this will reduce the total water consumption from Snow Lake from 34 to 25.1 m^3/hr. for the remainder of the project; The water drawn from Snow Lake for the first six (6) months of operation is estimated to be approximately 0.182% of the total estimated annual volume of the Lake. The annual estimated draw from the lake for the remainder of the project is estimated to be 0.257% of the estimated annual volume. A process water balance for the operation is provided in Appendix D. Table 3 presents an estimate of the expected water consumption for the project that includes the first fill of all tankage in the process.

Table 3: Estimated Process Water Consumption

First Fills of Tankage

m^3	dam^3
6772.87	6.77287

First 6 months of Operations

m^3/second	m^3/minute	m^3/hour	dam^3/day	dam^3/year
0.0094	0.5666	34	0.816	285.926

Duration of the Project (reclaiming 8 m^3/hour from Impoundment

m^3/second	m^3/minute	m^3/hour	dam^3/day	dam^3/year
0.006	0.418	25.1	0.602	211.08

2.5.3.1 Water Transportation System

The water transportation system will consist of the following:

- an electric submersible stacked impellor pump capable of delivering between 25.1 to 34 m^3 of water per hour. This style of pump is the most suitable for this application to accommodate for head pressure and friction losses in the pipeline; and
- approximately 1,000 m of SDR 11 (2") HDPE that will be coupled by fusion joints and mechanical couplers at strategic locations. HDPE piping is best suited for this purpose because of its long lasting durability, and is corrosion free.

2.5.3.2 Pipeline Location

BacTech Manitoba Corporation is currently working in conjunction with the Town of Snow Lake to determine the best route to accommodate the pipeline between the pumping station and the facility. Approximately 50% of the pipeline will be exposed with the remainder of the pipeline running on surface; Figure 13 outlines the initial proposal for the pipeline location.

Figure 13: Proposed Pipeline Locations

2.6 Waste Products

To understand the stability of the ferric arsenate it is important to understand conditions under which the neutralization precipitate is formed. The neutralization process is undertaken in a step wise sequence of specific pH adjustments made over a six hour period in a series of four separate stages to reach the final pH of 6.5 to 6.8 from the starting pH of 1.0 to 1.8.

The chemistry involved in the neutralization of the Snow Lake ARS bacterial oxidation liquors by limestone can be described by the following equations:

(1) $H_2SO_4 + CaCO_3 + H_2O \rightarrow CaSO_4{\bullet}H2O\downarrow + CO_2$

(2) $Fe_2(SO_4)_3 + 6H_2O \rightarrow 2Fe(OH)_3 \downarrow + 3H_2SO_4$

(3) $(Y+1)/2\ Fe_2(SO_4)_3 + H_3AsO_4 + 3(Y+1)/2\ CaCO_3 + 3(3Y+1)/2\ H_2O$
$\rightarrow FeAsO_4{\bullet}YFe(OH)_3 \downarrow + 3(Y+1)/2\ CaSO_4{\bullet}2H_2O \downarrow + 3(Y+1)/2\ CO_2$

As the neutralization reaches the final pH of 6.5 to 6.8, all the sulphuric acid (H_2SO_4) in the liquor has been neutralized. The precipitate formed is chemically stable at pH 6.5 to 6.8. Sulphides in the AR will be fully oxidized, and no sulphuric acid will be generated by sulphide oxidation when the neutralization precipitate is exposed to natural weathering. The neutralization precipitate will not be blended with other acid generating substances (e.g. flotation tailings or sanitary sewage). It will be transported by pipeline to a Storage Impoundment area lined with clay and an HDPE liner to reduce the possibility of seepage into the environment.

2.6.1 Composition of the Neutralized Ferric Arsenate Precipitate

The chemical composition of the neutralized ferric arsenate precipitate from neutralization circuit on a dry equivalent basis is estimated in Table 4 as follows:

Table 4: Ferric Arsenate Gypsum Product Composition (Dry Equivalent)

Compound	Percent (%) Composition
Unreacted $CaCO_2$	4
$CaSO_4.H_2O$	5
$CaSO_4.2H_2O$	56
Total Calcium Product Compounds	***65***
$FeAsO_2$.Y $Fe(OH)_2$	35
Total	***100***

As mentioned in section 2.1.4, the neutralized precipitate will be fed into the Storage Impoundment facility via HDPE pipeline. After settlement, the product will be expected to consist of 50% clean neutral water bound into the chemical matrix; however, this water is non-recoverable. It is estimated that the amount of solid in this waste product will be equivalent to 50% of the feedstock weight to the plant.

3 REGIONAL SETTING AND STUDY AREA

3.1 Regional Setting

The Project is located within the limits of the Town of Snow Lake, approximately 685 km north of Winnipeg, Manitoba (Figure 1). More specifically, the Project is situated on land that is subject to a mineral lease and a surface lease, both currently held by QMX. A number of existing and former tailings areas exist within the region resulting from the gold and other mining activities. Within the region, an existing network of municipal roads, grid access roads, and provincial highways provide access within the region. Access to the facility is directly off of Highway 392.

The area is located within the Churchill River Upland ecoregion of Manitoba (Smith et al. 1998). The topography of the region is typical of the Canadian Shield, with low rounded outcrops surrounded by wetlands, and boreal forest, and generally has low topographic relief. The property sits on fairly flat, level, previously disturbed ground within a brownfield mine site. Snow Lake, located south of town site, and Canada Creek, a tributary draining into the north shore of Snow Lake approximately 1 km west of the ARS, are the only natural water bodies found within the immediate Project area. Surface runoff within the region generally flows north and west into Canada Creek through interconnected wetlands and small stream channels.

3.2 Study Area

To quantify baseline conditions and evaluate potential environmental effects of the Project, the Study Area was defined. The Study Area is based on the predicted potential environmental effects from the Project on the surrounding environment. For example, direct effects include disturbance to wetlands, and changes to surface water drainage. Potential indirect environmental effects may include temporary changes to the environment from dust deposition, increased noise, and air emissions during construction. The Study Area is expected to be large enough to capture the spatial extent of environmental effects from the Project. The project Study area shown in Figure 14 consists of an area approximately 5.1 square kilometers (km^2) and includes the following project elements:

- the existing ARS;
- a road from the ARS to the Bioleach Plant Site;
- the bioleach Plant Site; (0.02 km^2)
- the proposed pipeline route from the Plant Site to the Storage Impoundment area northeast of the Plant Site; and
- the Storage Impoundment area. (0.05 km^2)

Considering this is a brownfield development in an area that has been extensively modified and altered from its natural state, the Study Area was deemed to be adequate. The Study Area includes part of the Town of Snow Lake, and a portion of QMX mine property, and represents a buffer of approximately 500 m away from the Project elements. To the north of the Study Area lies the QMX tailings facility which drains into Herblet Lake to the north. There are extensive wetlands to the north, west and east of the Plant Site. A non-natural surface drainage channel contributing runoff to Snow Lake passes to the south of the Storage Impoundment area. The channel drains west towards a small waterbody located between the ARS and the Storage Impoundment area, which passes under the roads via culverts towards the northwest and connects to Canada Creek. Another surface water drainage channel flows into this same small waterbody from the area near the Plant Site. A drainage channel and extensive wetlands drain west into Canada Creek which is located at the west end of the Study Area. Canada Creek drains into Snow Lake to the South.

Figure 15 shows surface runoff from the northeast corner of the ARS. Figure 16 shows the Plant Site looking north. Figure 17 shows the proposed Storage Impoundment Site.

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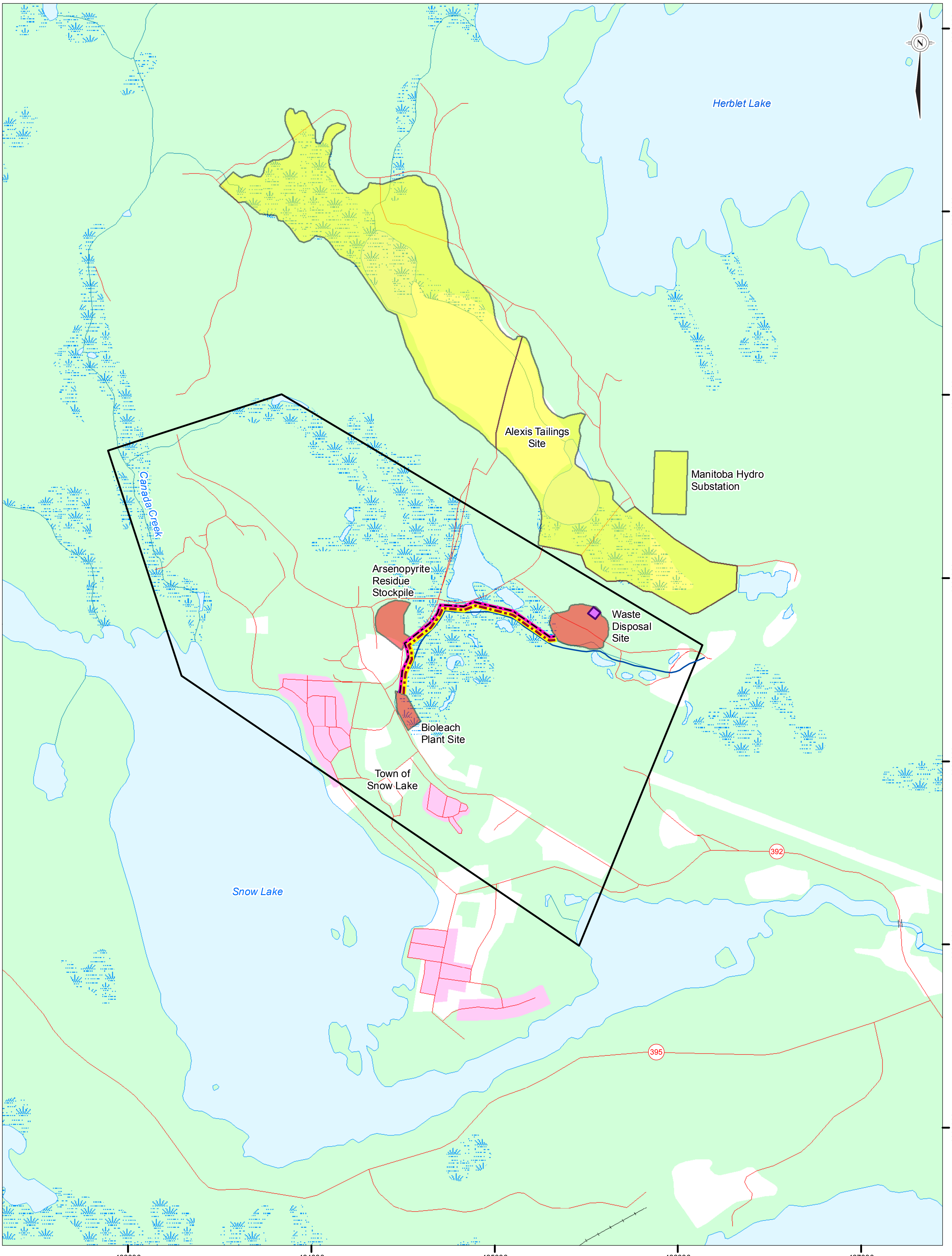


LEGEND

- WATERBODY
- WETLAND
- WATERCOURSE
- ROAD
- STUDY AREA
- PROJECT COMPONENTS
- OTHER SITE OF INTEREST
- DRAINAGE CHANNEL
- PROPOSED HAUL ROAD
- PROPOSED PIPELINE ROUTE

0.5 0 0.5
SCALE 1:20,000 KILOMETRES

REFERENCE

CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT

BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

TITLE

STUDY AREA FOR BACTECH BIOLEACH FACILITY IN SNOW LAKE, MANITOBA

Golder Associates
Saskatoon, Saskatchewan

PROJECT	12-1380-0037	FILE No.
DESIGN		SCALE AS SHOWN REV. 0
GIS	JRC 23/10/12	
CHECK	GS 23/10/12	
REVIEW	MS 25/10/12	

FIGURE: 14

Figure 15: Surface Runoff from the Northeast Side of the Arsenopyrite Residue Stockpile

Figure 16: View of the Proposed Plant Site Looking North

Figure 17: Proposed Site for the Storage Impoundment Facility

4 THE EXISTING ENVIRONMENT

This section provides a summary of the biophysical and socioeconomic environment for the Study Area, The biophysical elements include climate and meteorological conditions, surface water environment (hydrology, water quality, fish and fish habitat), groundwater resources, and terrestrial environment (soils, vegetation, wildlife, including species of conservation concern), Socioeconomic elements include land and resource use, and societal elements/value and economics.

4.1 Biophysical Environment

4.1.1 Climate and Meteorological Conditions

Based on the Köppen climate classification (Kottek 2006) the climate in Snow Lake is classified as "continental subarctic or Boreal Taiga" with short, warm summers, and long severe winters. Two Environment Canada climate stations have historically operated at Snow Lake, but there currently are no active stations now. The Snow Lake station (5062706) has daily data records from 1983 to 1998, and the Snow Lake Anderson Bay station (5062707) has daily precipitation data from 1999 to 2000. Neither station was in operation long enough to provide climate normals for the area. Therefore, the long-term climate records for the Flin Flon A climate station (5050960) which is approximately 120 km west of Snow Lake were used to represent climate normals for Snow Lake.

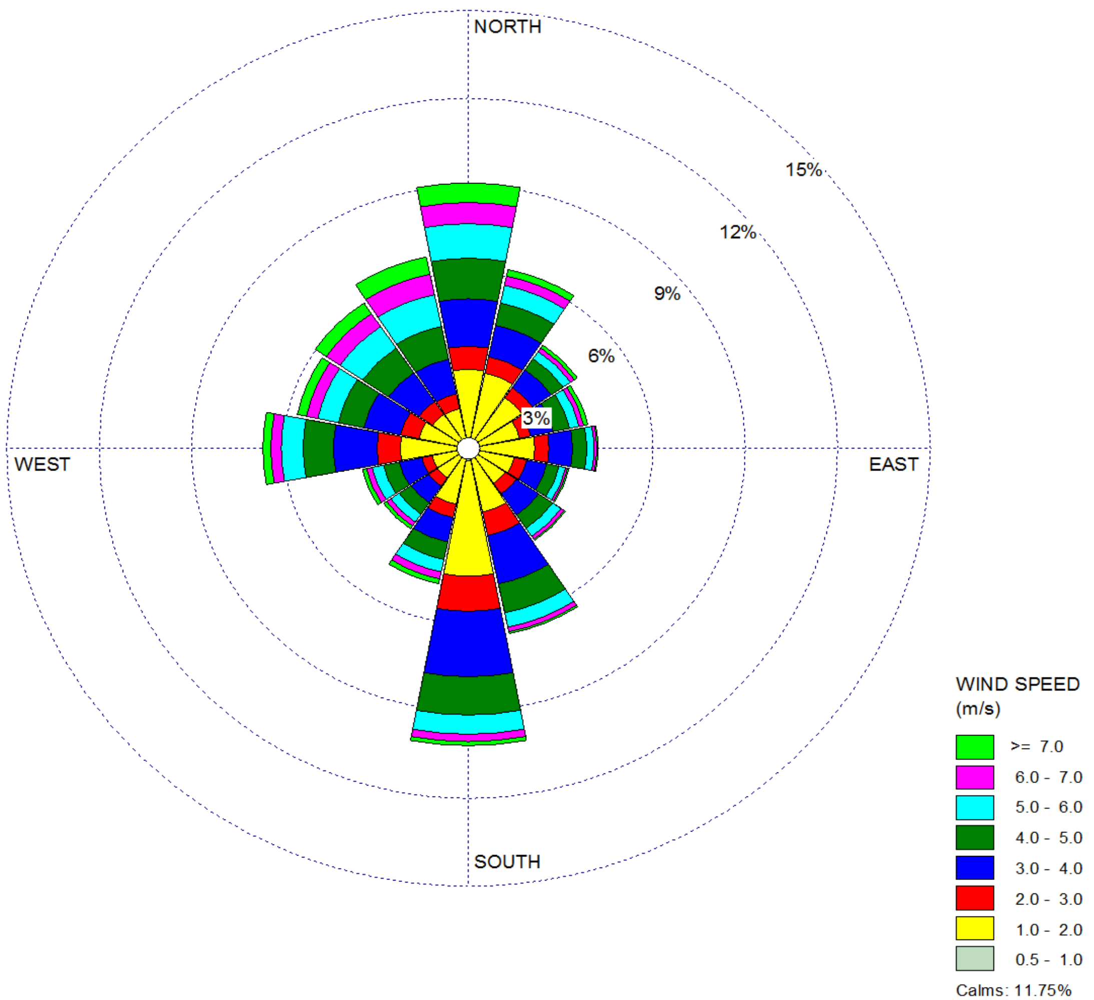
Monthly climate normals for temperature and precipitation for the region containing Snow Lake are provided in Table 5. Average monthly air temperatures range from a low of -21.4°C in January to 17.8°C in July. Extreme daily minimum and maximum temperatures recorded at Flin Flon A were -46°C and 35°C, respectively. Mean annual precipitation was 470.8 mm for the years 1971 to 2000, with 72% being made up of rainfall (Environment Canada 2012).

Table 5: Summary of Monthly Normals between 1971-2000 for the Environment Canada Flin Flon A Climate Station (5050960)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Daily Average Temp (°C)	-21.4	-16.7	-9.3	0.7	8.8	14.9	17.8	16.6	9.8	2.7	-8.4	-18.4	--
Daily Min Temp (°C)	-26.2	-22.3	-15.8	-5.5	2.6	9.3	12.6	11.4	5.4	-0.8	-11.7	-22.6	--
Max Temp (°C)	-16.6	-11	-2.9	6.9	15	20.4	23.1	21.8	14.2	6.2	-5.1	-14	--
Precipitation (mm)	17.6	13.4	19	28.3	40.6	66.6	76.5	66.6	57.3	38.3	24.8	21.8	470.8
Rainfall (mm)	0.1	0.3	0.9	8.6	36.9	66.6	76.5	66.6	55.3	25.6	1.4	0.4	339.2
Snowfall (cm)	19.6	14.6	19.1	20	3.7	0	0	0	2	13	25.4	23.9	141.3
Wind Speed (km/h)	9.4	9.7	10	10.9	11.1	11.2	10.9	10.7	12.1	12.2	11.1	9.3	10.7

A wind rose summarizing wind records between 1980 and 2009 at two Flin Flon Environment Canada Stations is shown in Figure 18. The records used for this wind rose omitted 6 years of data within the period of 1980 to 2009 due to incomplete data sets. The combined data from the Flin Flon A (5050960) and Flin Flon (5050919) Environment Canada meteorological stations was used to develop the wind rose. Based on these records, Flin Flon's prevailing winds come from the south with the strongest winds coming from the north, north-northwest and northwest directions. Based on 1971 to 2000 Monthly Normals from the Flin Flon A Station, average wind speeds are relatively consistent throughout the year, with September and October experiencing the highest mean wind speeds, and December and January experiencing the lowest mean wind speeds.

Figure 18: Wind Rose Developed from Wind Data at the Flin Flon (5050919) and Flin Flon A (5050960) Climate Stations, 1980 to 2009



4.1.2 Surface Water Environment

This section describes the major surface water features, including hydrology, water quality and fish and fish habitat within the Study Area. Data was summarized from relevant reports and databases. A site visit was conducted from July 30 to August 4, 2012 to collect additional information on drainage patterns, water quality, and fish communities and to assess fish habitat within the Study Area. The results of this site visit are provided in Appendix F. Figure 19 shows the surface water features and sampling sites within the Study Area.

4.1.2.1 Hydrology

The Project is located within the Canada Creek watershed, which flows into Snow Lake. The Snow Lake outflow is Snow Creek, which flows into Wekusko Lake, a large lake southeast of Snow Lake. Snow and Wekusko lakes are part of the Upper Grass River watershed, which drains to the Nelson River and eventually to Hudson Bay. There are extensive wetlands, but no major waterbodies within the boundaries of the Study Area. Surface runoff from the Project generally flows north and west into Canada Creek through interconnected wetlands and small stream channels. Canada Creek is a major tributary draining into the north shore of Snow Lake, approximately 1 km west of the ARS.

A site visit was conducted to document culvert size and locations and to confirm flow directions in the vicinity of the Project site. Observations of surface runoff pathways on and adjacent to the Project site were documented and are summarized in Figure 20. A surface drainage channel contributing runoff to Snow Lake passes from east to west through the Study Area to the south of the Storage Impoundment area. The channel drains towards a small waterbody located between the ARS and the Storage Impoundment area, which passes under the roads via culverts towards the northwest and connects to Canada Creek. Another surface water drainage channel flows into this same small waterbody from the area near the Plant Site. These drainage paths are shown on Figure 20. Other waterbodies within the Study Area consist of small ponds and wetlands.

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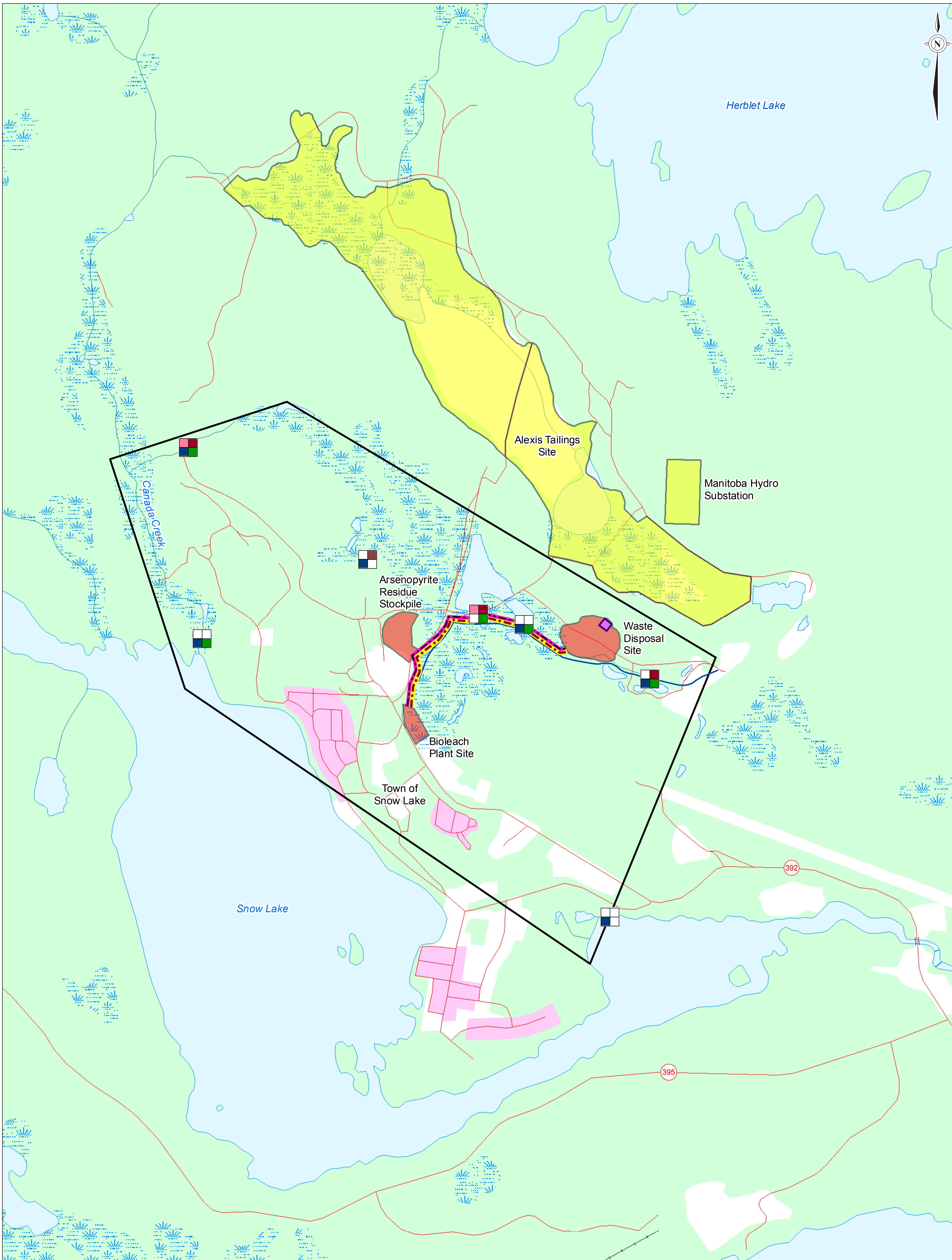


LEGEND

- WATERBODY
- WETLAND
- WATERCOURSE
- ROAD
- STUDY AREA
- PROJECT COMPONENTS
- OTHER SITE OF INTEREST
- DRAINAGE CHANNEL
- PROPOSED HAUL ROAD
- PROPOSED PIPELINE ROUTE
- WATER QUALITY SAMPLING LOCATION
- MINNOW TRAP SAMPLING LOCATION
- BACKPACK ELECTROFISHING SAMPLING LOCATION
- FISH HABITAT MAPPING

0.5 0 0.5

SCALE 1:20,000 KILOMETRES

REFERENCE

CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT

BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

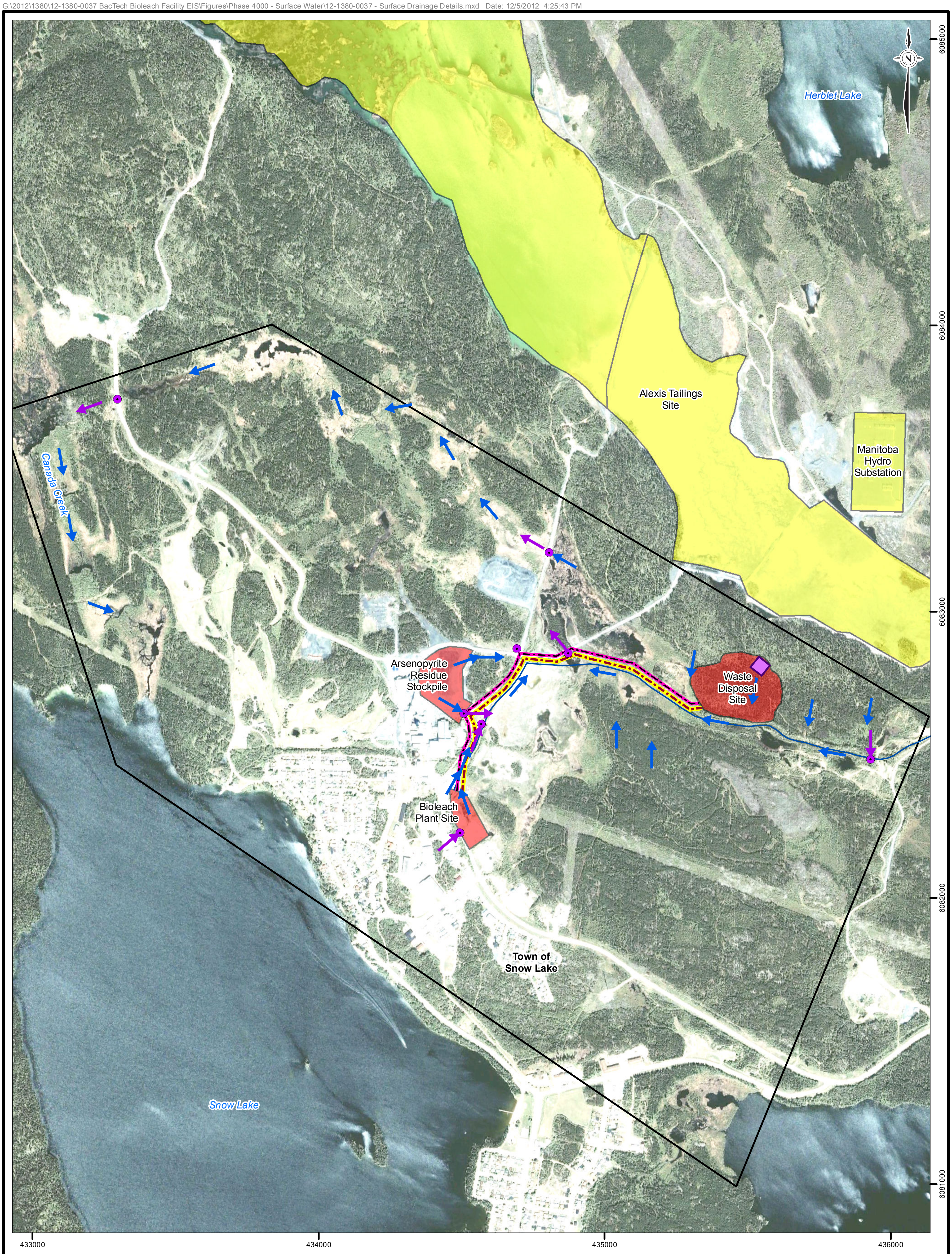
TITLE

SURFACE WATER FEATURES, WATER QUALITY AND FISH SAMPLING LOCATIONS WITHIN THE STUDY AREA

Golder Associates
Saskatoon, Saskatchewan

PROJECT		12-1380-0037	FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
GIS	JRC	23/10/12	**FIGURE: 19**	
CHECK	GS	23/10/12		
REVIEW	MS	25/10/12		

G:\2012\1380\12-1380-0037 BacTech Bioleach Facility EIS\Figures\Phase 4000 - Surface Water\12-1380-0037 - Surface Drainage Details.mxd Date: 12/5/2012 4:25:43 PM



LEGEND

- STUDY AREA
- PROJECT COMPONENTS
- OTHER SITE OF INTEREST
- DRAINAGE CHANNEL
- PROPOSED HAUL ROAD
- PROPOSED PIPELINE ROUTE
- CULVERT
- FLOW DIRECTION THROUGH CULVERT
- FLOW DIRECTION OVER LAND

250 0 250

SCALE 1:12,500 METRES

REFERENCE

GOOGLE EARTH IMAGERY, GEOEYE 2012
CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT

BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

TITLE

SURFACE DRAINAGE DETAILS WITHIN THE STUDY AREA

Golder Associates
Saskatoon, Saskatchewan

PROJECT		12-1380-0037	FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
GIS	JRC	27/11/12		
CHECK	GS	27/11/12	**FIGURE: 20**	
REVIEW	MS	27/11/12		

4.1.2.2 Surface Water Quality

Information on surface water quality was summarized from existing reports and databases. A site visit was conducted to measure water quality parameters in situ (pH, dissolved oxygen, temperature and conductivity) and collect surface water quality samples for more extensive analyses from surface water features within the Study Area.

Site Visit

Limnology data was collected following Golder's Technical Procedures 8.23-0: *Basic Limnology and Bathymetry Procedures* (unpublished file information). Measurements were recorded at water quality sampling locations and fish sampling locations with an Oakton water quality field meter. The following parameters were recorded:

- dissolved oxygen;
- water temperature;
- pH; and
- specific conductivity.

Wetlands and Drainage Channels

Dissolved oxygen levels in the drainage channel ranged from 3.29 mg/L to 4.95 mg/L (Appendix G Table G1.1) and were below the CCME guidelines (acute-5.0 mg/L, chronic-6.5 mg/L). Similar to many wetlands and drainage channels, dissolved oxygen was relatively low (3 to 6 mg/L) within the Study Area, likely due to low flows and biochemical oxygen demand. Conductivity of surface water was moderate for most sites collected (150 to 500 microSiemens per centimetre [μS/cm]), with the exception of SL-02, just north of the ARS, which has relatively high conductivity (1,130 μS/cm), likely deriving from effluent from the tailings pile. General water quality data are in Appendix G Table G1.1.

There is a wetland just north of the ARS that receives surface runoff from this site. This wetland drains into Canada Creek, which in turn empties into Snow Lake near the north-western-most section of the town. There is also a drainage channel to the east of the ARS that drains into the wetland area (Salzsauler 2005). A second drainage channel exists to the east of the ARS, which flows into the wetland.

Canada Creek

Canada Creek pH values ranged from 6.0 to 7.4 with an average value of 6.3 which is slightly below the CCME guideline of 6.5 to 8.5. The pH values in the connecting drainage channel ranged from 6.4 to 6.8 with an average of 6.63 which is within the CCME guidelines. During the site visit, dissolved oxygen levels in Canada Creek, ranged from 6.0 to 6.1 mg/L (Appendix G Table G1.1) which was slightly below CCME guidelines of 6.5 mg/L (CCME 2011).

Snow Lake

Snow Lake is a well-oxygenated lake (dissolved oxygen approximately 8 mg/L) with near neutral pH and sufficient buffering capacity for acidic inputs, as measured by alkalinity (50 to 60 mg/L $CaCO_3$ (Manitoba Conservation, 2001). Although the region is relatively nutrient poor (for both nitrogen (N), and phosphorus (P)), Snow Lake is borderline between oligotrophic and mesotrophic, on the basis of chlorophyll α and P concentrations (Manitoba Conservation 2001).

Patterns of Arsenic, Zinc and Iron Concentrations

Data on metal concentrations obtained from reports (Manitoba Conservation 2001, DNE Knight-Piésold 1995, Salzsauler 2005) and surface water samples collected during the site visit were used to create maps of surface water concentrations for three metals which consistently exceeded CCME water quality guidelines for the protection of aquatic life (CCME 2011): arsenic (As), zinc (Zn) and iron (Fe). Data are found in (Appendix G Table G2).

As concentrations in surface water samples near the ARS, in creeks and wetlands within the Study Area were high, with some sites exceeding guidelines of 0.005 mg/L by four to 2,000 times (0.02 to 18.8 mg/L; Figure 21). The highest concentrations were found closest to the ARS. Concentrations of As in Canada Creek, approximately 2 km upstream and just upstream from where the creek drains into Snow Lake were lower but still exceeded CCME guidelines. However, As concentrations from five sites within Snow Lake were below CCME guidelines (0.0017 to 0.0026 mg/L; Manitoba Conservation 2001). Similar patterns were observed for Zn (range 0.02 to 1.89 mg/L), where levels were below CCME guidelines to 60 times greater than guidelines. Concentrations of Zn in Snow Lake were below CCME guidelines of 0.03 mg/L (Figure 22). Surface water concentrations also exceeded CCME guidelines of 0.3 mg/L for Fe at several sites (range 0.02 to 55.6 mg/L) (Figure 23). Concentrations ranged from below CCME guidelines to approximately 200 times greater than guidelines. Levels fell below CCME guidelines at distances farther from the ARS. Concentrations of Fe in Snow Lake surface water were all within CCME guidelines (0.10 to 0.18 mg/L).

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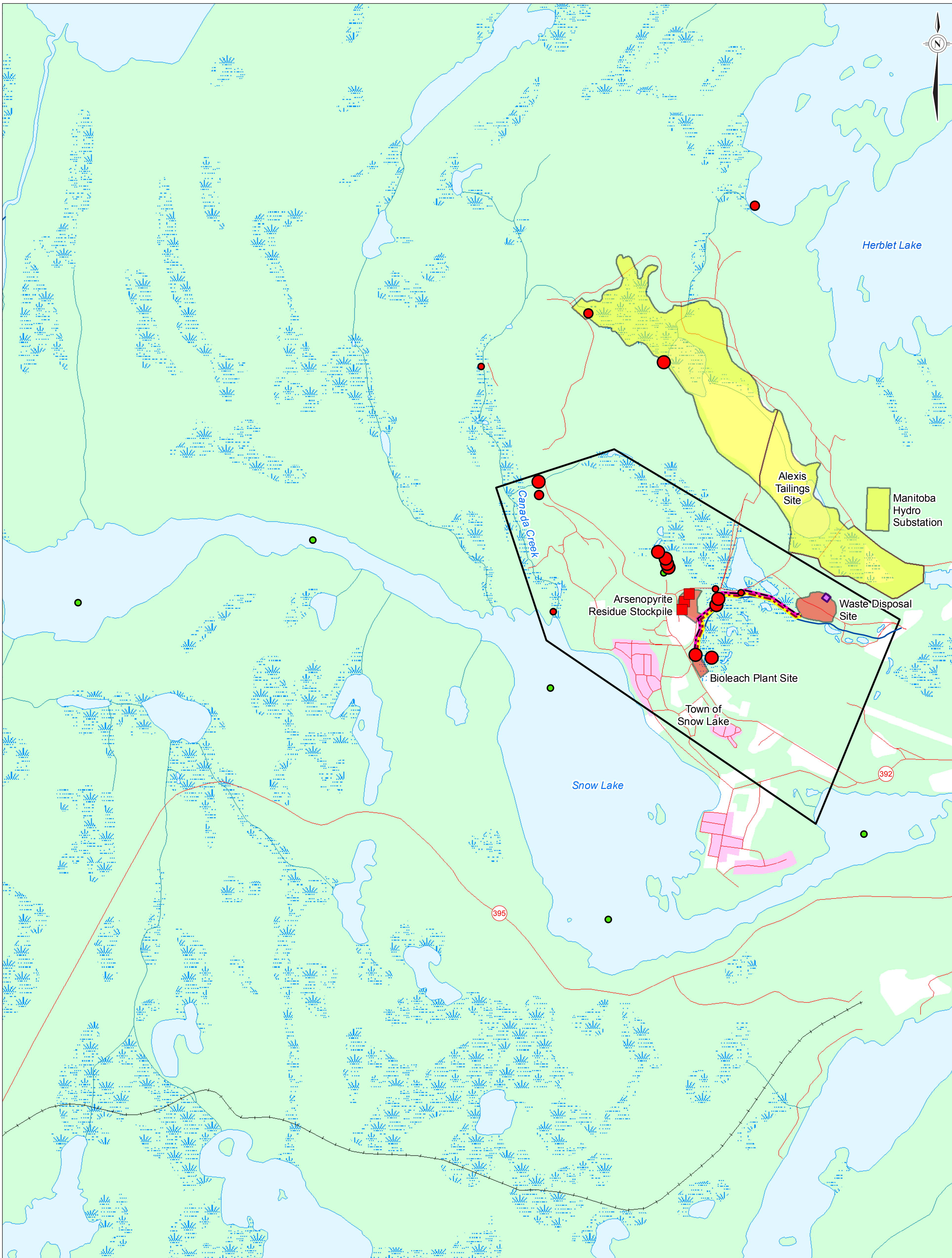


LEGEND

WATERBODY	STUDY AREA	SURFACE WATER CONCENTRATIONS	GROUNDWATER CONCENTRATIONS	
WETLAND	PROJECT COMPONENTS	< CCME	<CCME	
WATERCOURSE	OTHER SITE OF INTEREST	1-10x CCME	1-10x CCME	
ROAD	DRAINAGE CHANNEL	10-100x CCME	10-100x CCME	
RAILWAY	PROPOSED HAUL ROAD	>100x CCME	>100x CCME	
	PROPOSED PIPELINE ROUTE			

1 0 1

SCALE 1:30,000 KILOMETRES

REFERENCE

CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT
BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

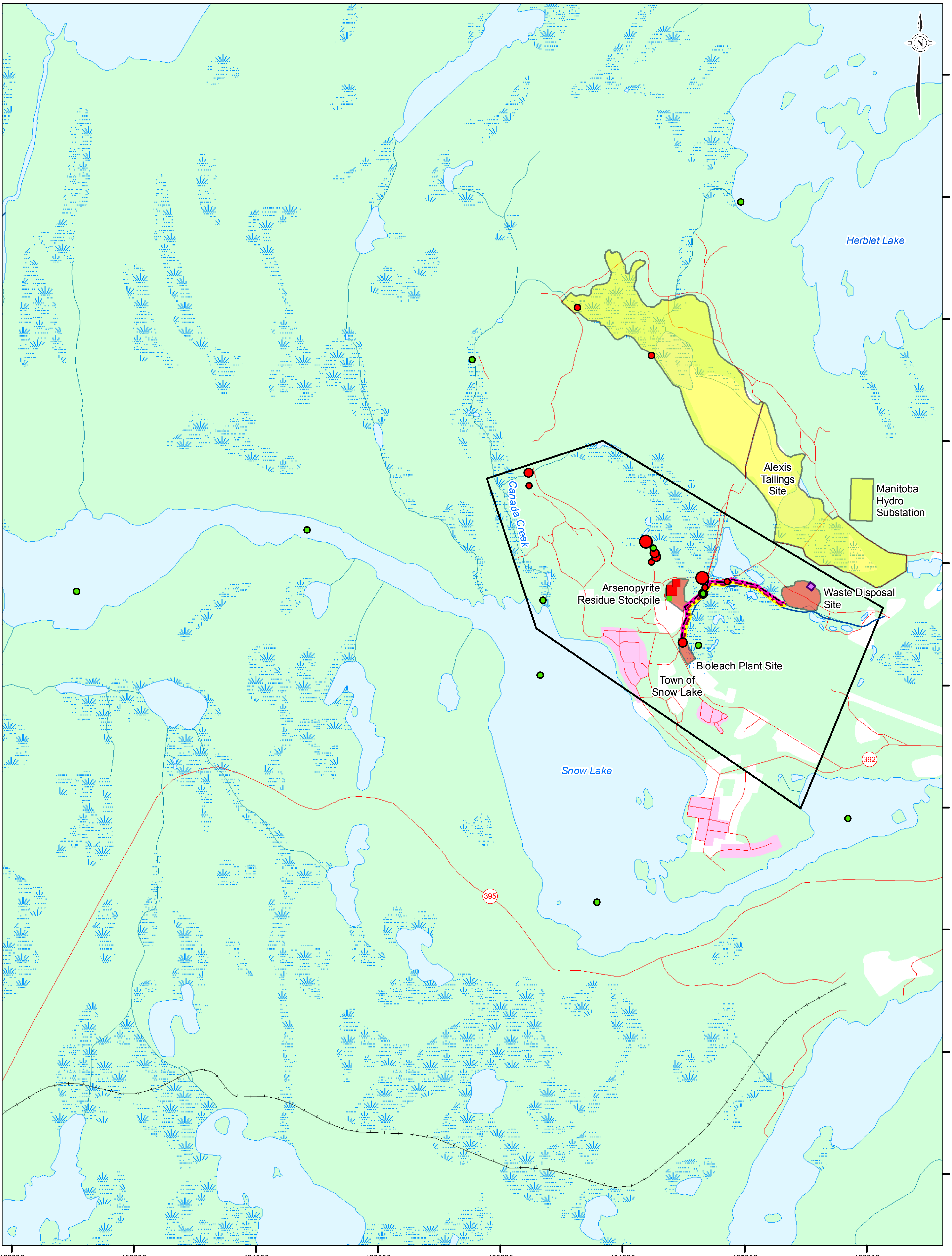
TITLE
SURFACE WATER AND GROUNDWATER ARSENIC CONCENTRATIONS

Golder Associates
Saskatoon, Saskatchewan

PROJECT		12-1380-0037	FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
GIS	JRC	23/10/12		
CHECK	GS	23/10/12		
REVIEW	MS	25/10/12		

FIGURE: 21

G:\2012\1380\12-1380-0037 BacTech Bioleach Facility EIS\Figures\Phase 4000 - Surface Water\12-1380-0037 - Zinc Concentrations.mxd Date: 12/5/2012 4:42:21 PM



LEGEND

WATERBODY
WETLAND
WATERCOURSE
ROAD
RAILWAY
STUDY AREA
PROJECT COMPONENTS
OTHER SITE OF INTEREST
DRAINAGE CHANNEL
PROPOSED HAUL ROAD
PROPOSED PIPELINE ROUTE

SURFACE WATER CONCENTRATIONS
< CCME
1-10x CCME
10-30x CCME
>30x CCME

GROUNDWATER CONCENTRATIONS
< CCME
1-10x CCME
10-30x CCME
>30x CCME

1 0 1
SCALE 1:30,000 KILOMETRES

REFERENCE

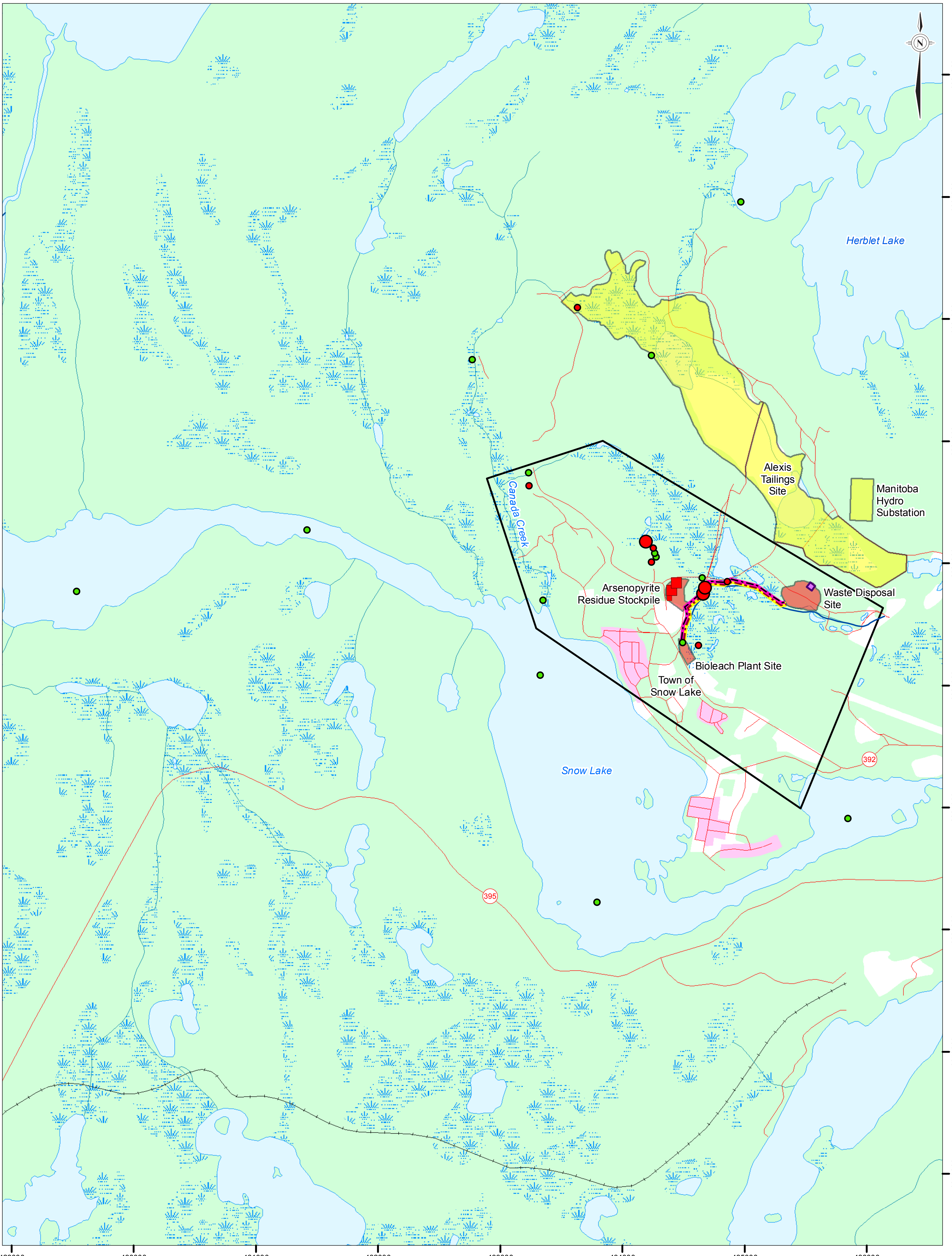
CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT
BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

TITLE
SURFACE WATER AND GROUNDWATER ZINC CONCENTRATIONS

Golder Associates
Saskatoon, Saskatchewan

PROJECT	12-1380-0037		FILE No.	
DESIGN			SCALE AS SHOWN	REV. 0
GIS	JRC	23/10/12		
CHECK	GS	23/10/12	**FIGURE: 22**	
REVIEW	MS	25/10/12		



LEGEND

WATERBODY	STUDY AREA	SURFACE WATER CONCENTRATIONS	GROUNDWATER CONCENTRATIONS
WETLAND	PROJECT COMPONENTS	< CCME	1-5x CCME
WATERCOURSE	OTHER SITE OF INTEREST	1-5x CCME	5-10x CCME
ROAD	DRAINAGE CHANNEL	5-10x CCME	>10x CCME
RAILWAY	PROPOSED HAUL ROAD	>10x CCME	
	PROPOSED PIPELINE ROUTE		

1 0 1

SCALE 1:30,000 KILOMETRES

REFERENCE

CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT
BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

TITLE
SURFACE WATER AND GROUNDWATER IRON CONCENTRATIONS

Golder Associates
Saskatoon, Saskatchewan

PROJECT	12-1380-0037	FILE No.	
DESIGN		SCALE AS SHOWN	REV. 0
GIS	JRC	23/10/12	
CHECK	GS	23/10/12	
REVIEW	MS	25/10/12	

FIGURE: 23

4.1.2.3 Fish and Fish Habitat

Data was summarized from relevant reports and databases. A site visit was conducted from July 30 to August 4, 2012 to collect additional information on fish communities and map fish habitat within the Study Area. The results and analysis from this site visit are included in Appendix F and summarized here. Supporting information for water quality and fish is summarized in Appendix G Tables G1.1 and G1.2.

Fish

Existing data on fish species was summarized from the Manitoba Conservation and Water Stewardship Fish Inventory and Habitat Classification (FIHCS) database (Manitoba Conservation and Water Stewardship 2012) and available reports (DNE Knight-Piésold 1995, Stewart-Hay 1963).

Snow Lake is rated a Type 1 waterbody with a high capability for the production of fish; recreational angling is a popular activity in the lake (Manitoba Conservation and Water Stewardship 2012). Table 6 summarizes the fish species found within Snow Lake.

Table 6: Summary of Fish Species Presence from the Fish Inventory and Habitat Classification Database

Common Name	Scientific Name	FIHCS[(a)]	DNE Knight Piésold (1995)	Stewart-Hay (1963)
Cisco	*Coregonus artedii*	X	X	X
Lake Whitefish	*Coregonus clupeaformis*	X	X	X
Northern Pike	*Esox lucius*	X	X	X
Spottail Shiner	*Notropis hudsonius*	X		
Brook Stickleback	*Culaea inconstans*		X	
Walleye	*Sander vitreus*	X	X	X
White Sucker	*Catostomus commersonii*	X	X	X

(a) Manitoba Conservation and Water Stewardship, 2012.

A fish presence/absence survey was undertaken in the Study Area to determine if any of the water bodies supported fish communities. Fish were captured with a backpack electro fishing unit and Gee minnow traps. The fish surveys were conducted according to Golder Associates Technical Procedure (TP) 8.1-3*, Fish Inventory Methods* (unpublished information). Fish were sampled in Canada Creek, the drainage channel, and wetlands within the Study Area.

Three species of small-bodied fish were found in the Study Area (Table 7). The most common species was brook stickleback (*Culaea inconstans*); a total of 50 specimens were captured in Canada Creek and 42 specimens within the drainage channel. Dead brook stickleback were observed in various locations throughout the drainage channel. Seven specimens of lake chub (*Couesius plumbeus*) and one fathead minnow (*Pimephales promelas*) were captured in

Canada Creek. No large-bodied fish species were captured in the Study Area. However, the habitat in Canada Creek represents ideal for spawning and rearing habitat for large-bodied species such as northern pike (*Esox lucius*).

Table 7: Summary of Species and Size for Fish Captured, August 2012

Waterbody	Sampling Methods	Fish Species	Total Fish Captured
Canada Creek	Electrofishing (a)	NA	0
	Minnow trap	Brook Stickleback	50
		Lake Chub	7
		Fathead Minnow	1
Drainage Channel	Electrofishing	Brook Stickleback	41
	Minnow trap	Brook Stickleback	1

NA= not applicable.
(a) Fish were observed while electrofishing, unable to capture/identify due to difficulty accessing stream.

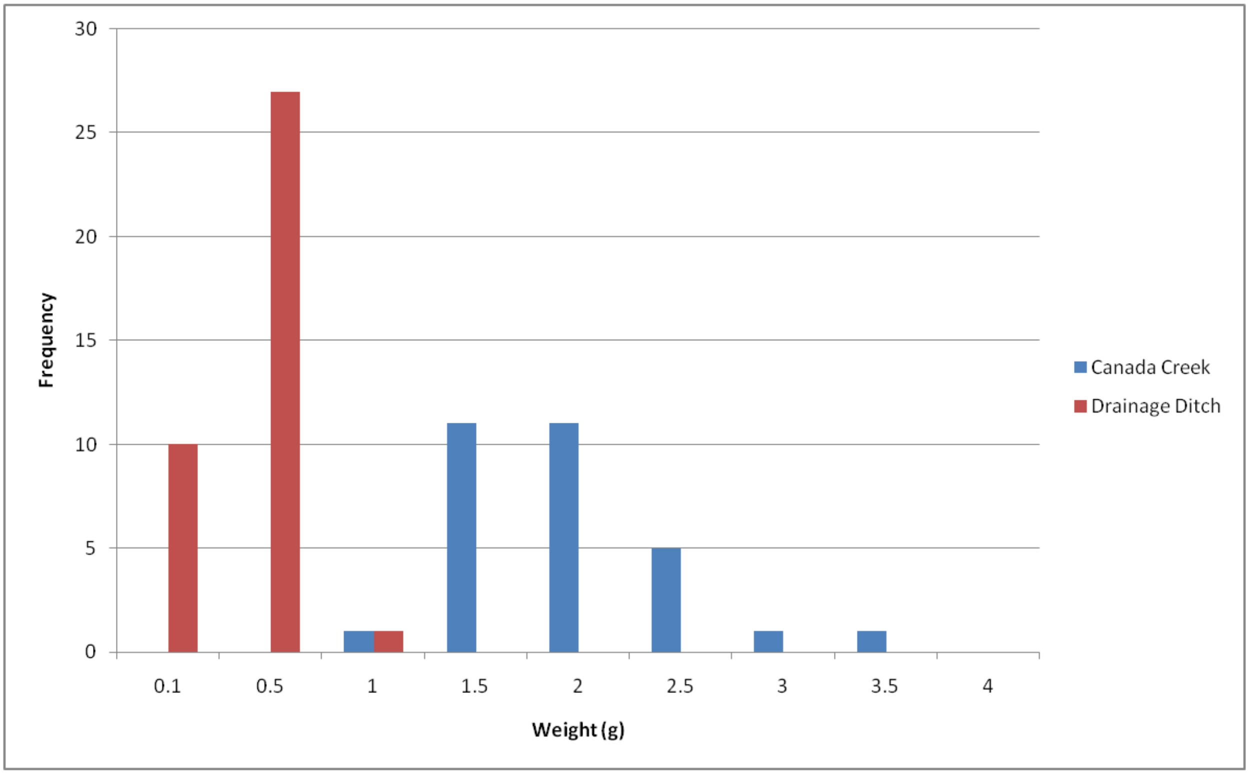
During the fish survey, external fish health assessments were conducted on 38 specimens in Canada Creek (30 brook stickleback, a fathead minnow and 7 lake chub) and on 42 specimens in the drainage channel (all brook stickleback). All but one of the fish exhibited no external abnormalities. Fish length, weight and condition factor were summarized for brook stickleback and lake chub (Appendix F, Table F4). A fish length weight regression for brook stickleback is found in Appendix F Figure F3.

Figure 24 shows the length distribution of brook stickleback from Canada Creek (represented in blue) and the drainage channel (represented in red). At least two distinct distributions were present indicating likely two age classes. The specimens in the drainage channel were shorter and weighed less (median length = 29 millimetres (mm); median weight = 0.2 g) than specimens in Canada Creek (median length = 60 mm; median weight = 1.8 g). These data suggest that fish may use the drainage channel and surrounding wetlands as nursery and rearing habitat, and may migrate downstream to Canada Creek once mature.

Fish Habitat

Fish habitat was assessed to provide an ecological inventory of the type and diversity of habitats found within the Study Area. Fish Habitat was assessed according to Golder's Technical Procedure 8-5-1 *Watercourse Habitat Mapping System* (unpublished file information). Wetlands were classified according to Stewart and Kantrud (1971). Approximately 1,860 m of stream type habitat and 13 ha of wetlands were assessed at the Plant Site, near the ARS, along the drainage channel and pipeline route, and Canada Creek. Much of the habitat within the drainage channel was considered poor for fish. Extensive disturbance in areas north of the Plant Site between the ARS and the proposed Storage Impoundment Facility has been, and is being cleared for development. Data on fish habitat is summarized in Appendix F Table F5 (Drainage Channel) and Appendix F Table F6 (Canada Creek).

Figure 24: Weight Frequency of Brook Stickleback Captured in Canada Creek and the Drainage Channel



Plant Site

Between the north and south end on the proposed Plant Site was a portion of the drainage channel that was infilled with cattails (*Typha* spp.*)* and graminoids. To the north of the Plant Site was a large disturbed area with some wetlands and a drainage channel. Minimal water was observed in the area.

ARS and Surrounding Area

The ARS stockpile was approximately 0.4 km northwest of the Plant Site. North of the ARS stockpile was a bog which was classified as a Class III wetland. (Figure 25). Surface drainage from the ARS Site flows northwest into Canada Creek.

Figure 25: Class III Bog North of the ARS

Proposed Pipeline Route and Drainage Channel

Approximately 1,500 m of man-made drainage channel was assessed for fish habitat. In areas of flowing water the bankfull width ranged from 3.0 to 20.0 m and the wetted width ranged from 0.7 to 8.0 m (Appendix F Table F5). The channel depth ranged from 0.1 to 1.5 m, however depth may be greater as there were access limitations. Organic material was the dominant substrate type followed by silt and sand. Many areas of the drainage channel were inundated with emergent vegetation, including cattails, sedges (*Carex* spp.) and rushes (*Juncus* spp.). The fish habitat in the channel stream consisted primarily of run and flat habitat, Beaver (*Castor canadensis*) impoundments were also present within the area. Most of the channel provided poor fish habitat due to unstable banks, encroachment of roads and cleared areas extending into the channel, and a sulphur-like odour that was detected at a number of locations.

The road adjacent to the drainage channel contained gravel and boulders which were pushed into some areas of the drainage channel (Figure 26).

Figure 26: Road Adjacent to Drainage Channel

Class IV and Class V wetlands were observed within the drainage channel area covering approximately 12 ha, with black spruce (*Picea mariana*) surrounding the area. The Class IV wetland was dominated by cattails with sand and organic materials being the dominant substrates. The Class V wetland consisted primarily of cattail marsh with areas of open water, other aquatic vegetations such as sedges, pondweed (*Potamogeton* spp.), and water arum (*Calla palustris*). The marsh covered approximately 12 ha of land with black spruce forest surrounding the area. An active beaver dam was observed upstream of the Class V wetland.

A Class IV pond was identified near the inflow from the western sections of the drainage channel (Figure 27). The pond had a strong sulphur-like odour and decomposing organic material along the perimeter and the middle of the pond. Inundated vegetation, emergent and submergent vegetation was present throughout the pond. Dead brook stickleback were observed in the area.

The proposed pipeline route follows the existing road through an area previously deforested for industrial purposes. The road runs adjacent north of the Class V wetland and east section of the drainage channel. The area has been cleared and active clearing was occurring during the time of the site investigation.

Figure 27: Cleared Roadway Adjacent to the Drainage Channel

Canada Creek

Approximately 360 m of stream was assessed in Canada Creek. The bankfull width ranged from 1.1 to 70.0 m and the wetted width ranged from 0.4 to 6.0 m (Appendix F Table F6). Stream depth ranged from 0.1 to 1.5 m, although the maximum depth may exceed this as there were access limitations. Silt was the dominant substrate type followed by organic material and boulder. The fish habitat in the stream consisted primarily of run and flat habitat with one section of rapid. Moderate to abundant submergent and emergent vegetation grew within the stream channel, which was often ill defined.

4.1.2.4 Groundwater Resources

The community of Snow Lake uses surface water from Snow Lake for their water needs. As a result, there is limited data available describing groundwater in this region. The only groundwater data readily available were taken near the tailings site (Salzsauler 2004) after the capping of the ARS in 2000. A greater area was covered by the DNE Knight-Piésold report of 1995 prior to the capping of the ARS. These data are in Appendix G Table G3 and were used to create Figures 21 to 23, along with data from Salzsauler (2005). These data show that the groundwater concentrations often exceeded CCME guidelines for aluminum (Al) (0.1 mg/L) by two to 38 times (0.2 to 3.8 mg/L). In regards to As, concentrations ranged from 6.2 to 98.3 mg/L), exceeding the CCME guideline of 0.005 mg/L by approximately 10^4 to 10^5 times (Figure 21). Fe concentrations ranged from 1.2 to 879 mg/L, exceeding the CCME guideline of 0.3 mg/L by 4 to 300 times (Figure 23). Zn concentrations ranged from 0.15 to 1.37 mg/L, exceeding the CCME guideline of 0.03 mg/L by 5 to 45 times Figure 22).

In general, the highest values were found near the surface of the drilled areas. Other elements may exceed CCME guidelines, as the detection limits for the laboratories used for analysis were above the guidelines, but no definitive statements can be made at this time in regards to these elements. These elements include silver (Ag), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), lead (Pb) and selenium (Se). Of note, one sample for Cu and two for Cd were above detection limits (and CCME guidelines), while the detection limits were one and two orders of magnitude higher, respectively, than the CCME guidelines. This suggests that some of the samples taken would also exceed guidelines for these elements.

While the groundwater near the ARS exceeded CCME guidelines, particularly for As, Fe, Zn and Al, the effects appear to be highly localized. Surface water samples taken from four locations in Snow Lake by Manitoba Conservation (2001) showed that most of these elements (As, Fe, and Zn) fell below CCME guidelines, while Al was greatly reduced and approached the CCME guidelines. This indicates that these elements are precipitating out of solution prior to entering Snow Lake, likely within 10 to 100's m from the ARS. In addition, surface water samples collected from Canada Creek near the highway crossing (Salzsauler 2004) showed significant decreases in the concentrations of several elements, although some still exceeded CCME guidelines. In particular, As concentrations were approximately 10,000 times lower in Canada Creek, than at the ARS. However, levels in Canada Creek still exceeded CCME guidelines by approximately 10 times.

4.2 Terrestrial Environment

This section provides a description of the existing terrestrial environment, including soils and geology, vegetation, and wildlife, including species of conservation concern.

4.2.1 Soils and Geology

Geology in the Snow Lake region consists of Precambrian rocks (Canadian Shield/Churchill-Superior Boundary Zone) overlain by Phanerozoic carbonates (McMartin et al. 1996). The carbonates contribute to the alkalinity of the region, as observed in the surface water. The Snow Lake region is a known volcanogenic massive sulphide (VMS) deposit, with numerous copper (Cu), and Zn rich deposits in the vicinity (McMartin et al. 1996). These can lead to naturally-occurring “hotspots” or localized regions of high metal content.

Relief is generally low throughout the region, leading to low drainage flows and many wetlands. The region between the proposed Storage Impoundment Site and the ARS is relatively flat and dominated by a wetland feature. Wetlands are known to be efficient filters, and this is confirmed by the good water quality of Snow Lake, despite the poor water quality surrounding the ARS.

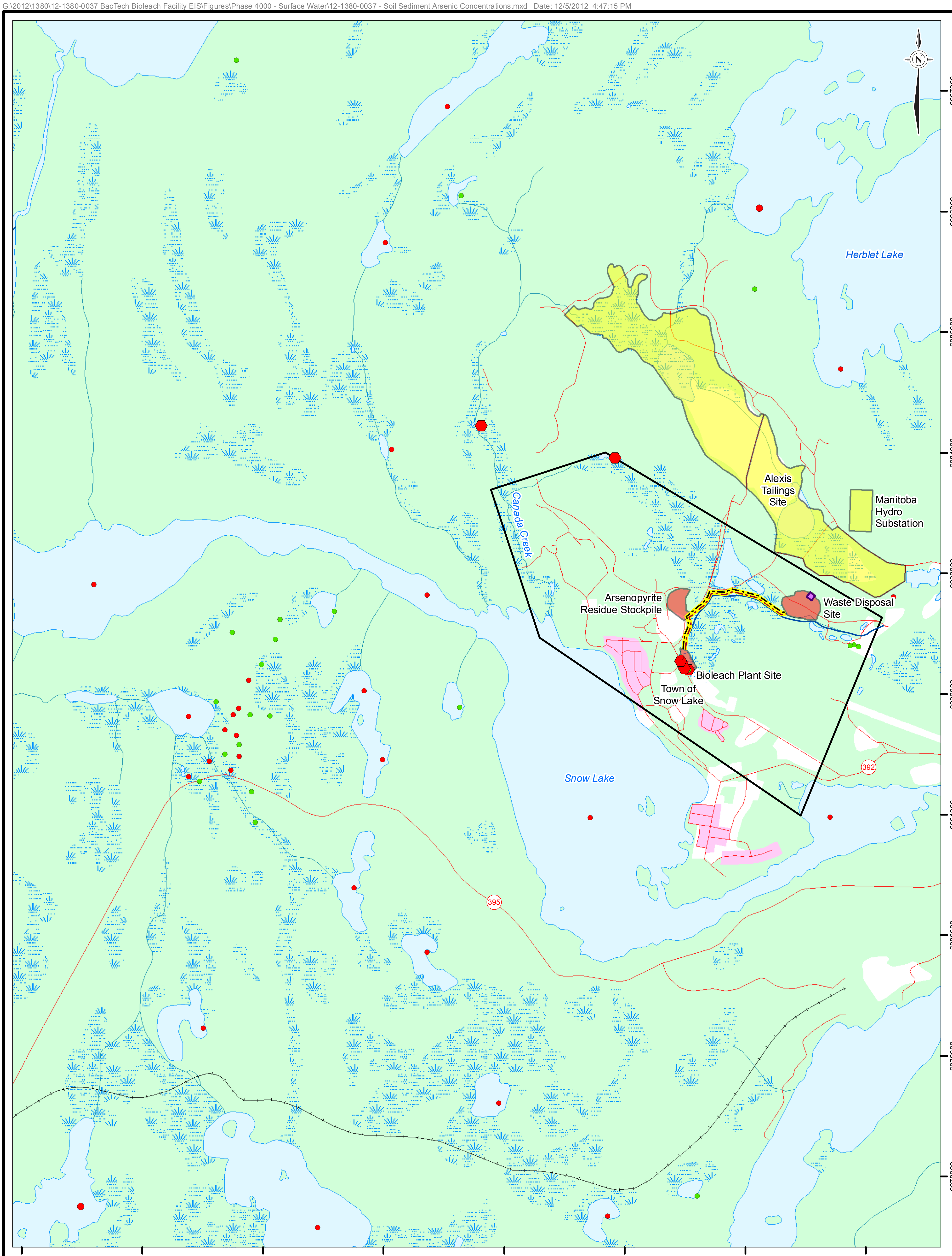
4.2.2 Patterns of Metal Concentrations in Soils and Sediment

Surface samples were collected at the proposed Plant Site, and at a site approximately 1.4 km east of the Plant Site on June 7, 2012; Samples were submitted to ALS Laboratories for analysis of metals, oils and greases. These results were combined with data from previous reports to produce maps of metals exceeding CCME guidelines.

Soils within a few hundred meters of the ARS and other tailings piles were highly contaminated with As, often exceeding CCME guidelines (CCME 1999) by 10 times. Sediment samples collected at five sites at the proposed Plant Site indicated high arsenic concentrations (approximately 4 to 17 times CCME guidelines of 12 milligrams per kilogram [mg/kg] for soils). Land adjacent to the a larger tailings pile northeast of the ARS, had As concentrations ranging from one to 35 mg/kg also exceeding CCME guidelines (Figure 28). Data used to create Figure 28 are found in Appendix G Table G4 and Table G5. Other elements did not exceed CCME guidelines. A few sites at the proposed Plant Site exceeded the guidelines of 360 mg/kg for Fe for commercial/industrial soils.

4.2.3 Hydrocarbon Levels in Sediment at the Proposed Plant Site

Sediment at the proposed Plant Site were either not contaminated with hydrocarbons (total hydrocarbons below detection at site BAC-4 and BAC-5), slightly contaminated (276 mg/kg total hydrocarbons at BAC-1; 186 mg/kg at BAC-2) or moderately contaminated (759 mg/kg at BAC-3). Hydrocarbon fractions detected were all heavier compounds, such as greases and heavier oils (C16-C60) (Appendix G Table G6) Sites near the proposed Storage Impoundment Site were not contaminated with hydrocarbons; all samples were below detection limits.



LEGEND

WATERBODY	STUDY AREA	CONCENTRATION LEVEL
WETLAND	PROJECT COMPONENTS	< CCME
WATERCOURSE	OTHER SITE OF INTEREST	1-5x CCME
ROAD	DRAINAGE CHANNEL	5-10x CCME
RAILWAY	PROPOSED HAUL ROAD	>10x CCME
	PROPOSED PIPELINE ROUTE	

1 0 1

SCALE 1:30,000 KILOMETRES

REFERENCE

CANVEC © 2012, NATURAL RESOURCES CANADA
ROADS AND HIGHWAYS © DMTI, 2011
NTS MAPSHEET: [NTS#]
DATUM: NAD83 PROJECTION: UTM ZONE [Z#]

PROJECT

BAC TECH ENVIRONMENTAL CORP.
SNOW LAKE, MB

TITLE

SOIL/SEDIMENT ARSENIC CONCENTRATIONS

Golder Associates
Saskatoon, Saskatchewan

PROJECT	12-1380-0037	
DESIGN		
GIS	JRC	23/10/12
CHECK	GS	23/10/12
REVIEW	MS	25/10/12

FILE No.

SCALE AS SHOWN REV. 0

FIGURE: 28

4.2.4 Vegetation

Approximately 0.8 ha of the proposed Plant Site is wetland consisting of various commonly occurring aquatic plants such as common cattails (*Typha latifolia*), bulrushes, bur-reeds, and sedges.

There is no endemic vegetation on the ARS, the proposed pipeline route or at the Storage Impoundment Site, as these are in an active industrial zone.

4.2.5 Wildlife

The Churchill River Upland Ecoregion provides habitat for moose (*Alces alces*), woodland caribou (*Rangifer tarandus caribou*), black bear (*Ursus americanus*), lynx (*Lynx canadensis*), wolf (*Canis lupus*), muskrat (*Ondatra zibethicus*), snow-shoe hare (*Lepus americanus*), and beaver, as well as many other species. Wildlife is plentiful in the Snow Lake area, with major species including moose, bear and wolves. Moose, bear and various bird species are hunted as part of recreation and tourism in the area. Some commercial trapping of fur-bearing animals still continues in the Snow Lake area.

4.2.6 Species of Conservation Concern

Woodland caribou may be found in the Churchill River Upland Ecoregion and are considered to be a threatened species under the *Species at Risk Act (*SARA) as well as the Manitoba *Endangered Species Act*. Although there is potential for woodland caribou to inhabit the ecoregion, there were no signs of key, high potential habitat, areas of important migration routes or rutting areas at or near the proposed BacTech Snow Lake Site.

Although there are 12 different plants and fungi listed by Manitoba Conservation as species of concern in the Churchill River Upland Ecoregion, none of these vegetative species occur in the the proposed development area. Further, the habitat in the immediate area has been extensively modified or disturbed by anthropogenic activities, and natural habitat suitability for these species is low to moderate.

4.3 Socioeconomic Environment

This section describes the existing environment in terms of land and resource use, population demographics, employment, and heritage resources of the Study Area.

4.3.1 Existing Land and Resource Use

The Town of Snow Lake has a rich history in mining which continues to be the mainstay of the community. In addition to mining, land use activities that typically take place in the region include recreational and commercial fishing, hunting, trapping, and tourism. Snow Lake is home to a vibrant business community catering to the many needs of mineral related projects. HudBay Minerals is in the construction stages of developing a new zinc gold mine near Lalor Lake, Manitoba, located approximately 9 km west of the Project. QMX is in the process of reopening the Snow Lake Mine. The ARS is located on the Snow Lake Mine site, formerly the New Britannia Mine site, which is now owned by QMX. The property consists of refractory mill tailings with a high residual gold content, which were impounded in a special enclosure separate from other tailings. The proposed Plant Site is an in-fill dumping area that hosts the town's recycling trailer. The land to the north and south is zoned industrial and the Plant Site is zoned industrial through a by-law amendment September 13, 2012 and given final reading on July 3, 2012.

4.3.2 Population Demographics and Employment

The Town of Snow Lake had a total population of 723 in 2011, a 13.6% drop from the population in 2006 (837) (Table 8). Snow Lake has been experiencing a steady decrease in population for the past ten years. Between 2001 and 2006, the population of Snow Lake fell from 1,207 to 837, a decrease of 30.7% (Statistics Canada 2007). In contrast, the Province of Manitoba saw an increase in population of 5.2% between 2006 and 2011. The median age of the population in 2011 was 48.4, 10 years above the provincial average. There were 526 private residences in the Town of Snow Lake in 2011, with an average household size of 2.2 people.

Table 8: Population Demographics in Snow Lake, Manitoba

Community	2011 Population	2006 Population	2006 to 2011 Population Change (%)	2011 Median Age of Population	2011 Number Private Residences	2011 Average Household Size
Town of Snow Lake	723	837	-13.6	48.4	526	2.2
Province of Manitoba	1,208,268	1,148,401	5.2	38.4	512,689	2.5

% - percent
Source: Statistics Canada 2012.

Education levels in Snow Lake are quite similar to education levels across Manitoba. Approximately 24.8% of the population 15 years and over does not have a certificate, diploma, or degree. A further 34.6% of the population has a high school certificate or equivalent as highest attained education, and the remaining 40.6% has some form of post-secondary education.

The labour force participation rate in Snow Lake is 59.4%, slightly below the provincial average. The unemployment rate is also slightly below the provincial average, at 5.1%. Income in Snow Lake is well above provincial averages. The average pre-tax income in Snow Lake is $75,515, compared to $47,875 in Manitoba.

The largest employer in the Town of Snow Lake is HudBay Minerals Inc. who operates the Chisel North Mine, and employs 74 people (HudBay 2012). Other employers include the Town of Snow Lake, and several small businesses. QMX is not currently operating the Snow Lake Mine. Operations at the Snow Lake Mine were halted in early 2005 (QMX 2012).

A look at the occupation classifications in Snow Lake shows that the majority of the population works in business, finance and administration, and occupations in primary industry (Table 9). Other common occupations are in health occupations, trades, transport, equipment operators and related occupations.

Table 9: Occupation Classifications in Snow Lake, Manitoba

Community	Management (%)	Business, Finance, and Administration (%)	Natural and Applied Sciences (%)	Health (%)	Social Science, Education, Government Service, Religion (%)	Art, Culture, Recreation, Sport (%)	Sales, Service (%)	Trades, Transport, Equipment Operators, Related	Primary Industry (%)	Processing, Manufacturing, and Utilities (%)
Town of Snow Lake	7.7	34.6	6.4	10.3	5.1	0.0	16.7	10.3	28.2	0.0
Province of Manitoba	8.5	17.3	4.9	6.7	8.8	2.3	24.6	15.0	6.5	5.3

4.3.3 Heritage Resources

A letter was received from the Historic Resources Branch of Manitoba Culture, Heritage, and Tourism in response to information provided regarding the Project. The letter indicated that the potential to impact significant heritage resources was low and there were no concerns with the Project (Appendix H).

5 PUBLIC ENGAGEMENT

BacTech has undertaken a number of activities to engage stakeholders in the Project. They held a public meeting on January 17, 2012 and met with the Snow Lake town council on three occasions to outline the Project. BacTech is working to maximize the long-lasting social, educational and capacity-building benefits for the Province of Manitoba, with particular emphasis on nearby and/or affected communities.

The company plans to establish an advisory committee for the purpose of improving public participation and receiving public comments regarding the Project, environmental matters, and other community opportunities and concerns. The advisory committee would include residents and business representatives.

Whenever practicable, BacTech will seek to maximize local benefits, including employment opportunities and related training of selected personnel. BacTech plans to undertake applicable Project-related technical and research work in Manitoba, preferably onsite or near the Project's facilities, and to establish co-op, scholarship or similar programs with local educational institutions. BacTech will seek to formally establish a Bioleaching Center of Excellence in Manitoba, perhaps co-sponsoring the facility with an existing Manitoba educational institution, which is envisaged by BacTech as a world-class center of excellence in this field.

Aboriginal engagement activities have been ongoing with the First Nations of Mathias Colomb Cree Nation, Sapotaweyak Cree Nation and Opaskwayak Cree Nation.

Table 10 summarizes meetings, open houses and outreach activities to engage stakeholders and solicit input on the proposed development. Supporting documentation for the public engagement activities is provided in Appendix I.

Table 10: Summary of Engagement Activities

Date	Purpose	Participants
Nov 19, 2010	Manitoba Minerals and Mining Conference talk on the proposed Snow Lake bioleach project	VP Technology and Engineering, industry and government officials
Oct 27, 2011	Underground Press article on release of NI 43-101 report on ARS stockpile	Citizens of Snow Lake and general public
Jan 17, 2012	Presentation and Q&A with Town of Snow at Town Office	Mayor, council and Chief Administrative Officer
Jan 17, 2012	Town of Snow Lake Community Meeting, Snow Lake Community Hall	Approximately 60 Snow Lake citizens, Ross Orr, Paul Miller, Dave Salari, MaryAnn Mihychuk, Bogdan, Damjanovic, Pat Carswell
Feb 2, 2012	Underground Press article on January 17 public presentation	Citizens of Snow Lake and general public
March 29, 2012	Underground Press update article on bioleach test results	Citizens of Snow Lake and general public
July 3, 2012	Presentation re zoning by-law delegation at Town Council meeting	Mayor C. Fisher, Deputy Mayor R. Klyne, Councillors B. Forsyth-Flamand, D. Mayer, C. Samborski, A. Kowalchuk, CAO, general public
July 19, 2012	Letter to the Editor, Underground Press	Citizens of Snow Lake and general public Underground Press readers (Ross Orr)
Aug 20, 2012	Posted BacTech Snow Lake project video on Facebook	General public

5.1 Summary of Input from Public Engagement Activities

The input from the public engagement has been and continues to be very positive regarding the remediation of the ARS. The two main factors contributing to the positive engagement include the removal of the threat of arsenic contaminating the local watershed that would affect everyone in the immediate area concerning to their drinking water, fish habitat, recreation, and livelihoods. The socioeconomic benefits the project will bring to the area are also one of the main contributing factors for the projects support.

Issues raised during public engagement activities regarding the project ranged from concerns as to why an environmental permit has not been submitted, and stability of the arsenic following the treatment process. Both these issues were addressed in the public forum as well as a written response that was printed in the local new paper.

6 DESCRIPTION OF POTENTIAL ENVIRONMENTAL EFFECTS

Despite careful planning and conscientious implementation of the Project, several associated Project activities were evaluated for potential effects on the environment during the construction, and operation phases of the Project. During construction, the potential effects from the following activities were considered:

- infilling and grading of Plant Site;
- infilling of wetlands to build the 0.17 km road from existing private road to Plant Site;
- instillation of three pipelines to transport water and residues to and from the Plant Site;
- building of the Storage Impoundment Facility northeast of the Plant Site; and
- dust and noise.

During operations, the following activities were considered:

- remediation of existing ARS;
- potential for spills from transport of residue from the ARS to the Plant Site; through leakage from trucks, or trucks overturning;
- potential for leakage of water transported from the ARS to the Plant Site for treatment;
- potential for spills at Plant Site;
- potential for fire at Plant Site;
- potential leakage of waste from pipeline to Storage Impoundment facility; and
- potential leakage of water from pipeline to plant from the Storage Impoundment facility for re-use.

Potential effects of the project activities listed above on the biophysical and socioeconomic environment within the Study Area are described in the sections below.

Emissions

There are no noxious emissions from the bioleaching process. The bacterial-oxidation reactor is designed to ensure that all the requirements of the process are met. The sulphide-leaching reactions are oxidation reactions, and so an adequate supply of oxygen is critical to the process. The bacteria also require a supply of carbon, as this is their basic catalyst for growth.

Oxygen is supplied by means of air injection into the reactor. An agitator is used to disperse the air and to promote the transfer of oxygen from the air bubbles into the leach liquor.

Carbon dioxide is obtained from the carbonates (CO_3^{2-}) associated with the concentrate and the small amount of carbon dioxide in the air. The CO_3^{2-} is dissolved in the acid environment in the bacterial-oxidation process, and carbon dioxide (CO_2) gas is produced in the reactors.

The bacterial-oxidation reactor is an open agitation tank, thus any unused air stream will leave the reactor from the top of the tank.

Although no discharges to air or water will be part of the process, waste products will be produced and transported to a Storage Impoundment facility northeast of the Plant Site. The section below provides more detail on the nature of these waste products.

Solid Wastes

Currently, the main solid waste to be disposed of is the neutralization precipitate containing gypsum, ferric hydroxide, and ferric arsenate. The neutralization process is undertaken in a step wise sequence of specific pH adjustments made over a six hour period in a series of four separate stages to reach the final pH of 6.5 to 6.8 from the starting pH of 1.0 to 1.8.

As the neutralization reaches the final pH of 6.5 to 6.8, all the sulphuric acid (H_2SO_4) in the liquor has been neutralized. The precipitate thus formed is chemically stable under pH 6.5 to 6.8. The neutralization precipitate would be thickened and pumped the disposal site to the disposal site. No effluent will be discharged from the Storage Impoundment Site.

Arsenic Toxicity

In order to evaluate the potential for impacts to the environment related to the forms of arsenic involved in the Project, including the arsenic leaching from the ARS, and the ferric arsenate in the waste product produced at Bioleach Facility, a brief review of arsenic toxicity was undertaken.

Arsenic (As) in its elemental form is a silver-grey crystalline metallic material and has an atomic number of 33. Arsenic is a moderately toxic naturally abundant element with no known nutritional or metabolic roles (McIntyre and Linton 2012). Arsenic undergoes chemical and microbiological oxidation, reduction, and methylation (CCME 2001). Levels of total As in uncontaminated surface waters are generally less than 2 micrograms per litre (µg/L) (CCME 2001).

Three chemical forms of As are of interest to the Project: arsenite (As(III)), arsenate (As(V)) and ferric arsenate ($FeAsO_4$). Both As(III) and As(V) compounds are highly soluble in water, where ferric arsenate is generally insoluble (under certain conditions).

In water As(III) converts readily into As(V) under anaerobic conditions (but some may persist depending on conditions) (Clement and Faust 1973). Arsenic accumulates readily in living tissues because of its strong affinity for proteins and lipids (Ferguson and Gavis 1972). The degree to which As accumulates in an aquatic organism varies with the form of As, the trophic level, species and diet (McIntyre et al. 2012). There is no indication that As biomagnifies up the food chain (CCME 2001).

Data summarized by CCME (2001) indicates that As is most toxic to plants; and less toxic to invertebrates and fish. The CCME water quality guideline for the protection of aquatic life (5.0 µg/L) was derived from multiplying the 14-d EC_{50} for the most sensitive organism, the alga *Scenedesmus obliquus* by a safety factor of 0.1 (CCME 2001). As noted in section 4.1.2.2, the level of As in surface water in the study area ranged from 0.02 to 18.8 mg/L; up to several thousand times the CCME guideline. The highest concentrations were found just downstream of the ARS.

By comparison, ferric arsenate, the form produced in the waste from the BACOX process, is a relatively stable compound that is insoluble in water under the pH conditions of the waste (pH 6.5 to 6.8) (Nyombolo et al. 2000). No data on toxicity to aquatic organisms was found.

6.1 Effects on the Biophysical Environment

6.1.1 Potential Effects on Wildlife

The Churchill River Upland Ecoregion provides habitat for a variety of wildlife species, and some hunting and commercial trapping of fur-bearing animals still continues in the Snow Lake area. However, the proposed Project is located largely on a brownfield site that has been extensively modified and altered which has reduced local habitat suitability for several of these species.

During construction of the plant, access road and pipelines, there is increased potential for dust emissions, noise pollution, and wildlife/vehicle collision. Increased dust and noise in the area during construction may be a stressor that temporarily displaces wildlife that currently utilizes habitats in the area. Dust control systems will be used, and construction equipment will be regularly inspected and maintained to reduce noise. Speed limits will be enforced to minimize these effects.

Since the proposed development is located in a previously disturbed area in close proximity to an existing mining operation and industrial area of Snow Lake, once in operation, resident wildlife may have already adapted to industrial, residential, and commercial activities. However, there could still be localized displacement, avoidance or stress as a result of noise pollution from heavy duty machinery and regular vehicle travel.

There is a small wetland (0.8 ha) within the Plant Site that could act as a potential habitat for waterfowl, beavers and muskrats, all of which are common species in the Boreal Forest Region, are widely distributed and alternate habitat is readily available nearby. Nonetheless, all possible steps will be taken to minimize disturbance in the area.

It is expected that fill will be required to accommodate the construction of the Plant Facility which will result in the loss of this wetland, which represents <1% of wetland habitat within the Study Area. Effects on wildlife due to loss of the wetland are anticipated to be negligible. Construction of the additional 0.17 km haul road and pipeline right of way is not anticipated to result in loss of additional wildlife habitat.

The potential for damage to wildlife from spills from the transportation of ARS to the Plant Site, spills at the Plant Site, and transportation of the waste by pipeline to the Storage Impoundment facility are considered to be minimal.

6.1.2 Potential Effects on Soil and Vegetation

The effects on the soil are considered to be minor; the Plant Site is located in the area that has been previously affected by mining activities, with abandoned waste still located on the site including various types of construction debris such as broken concrete, wood, cut trees, and piles of waste fill material. Approximately 0.8 ha of the proposed Plant Site is wetland consisting of various commonly occurring aquatic plants such as common cattails, bulrushes bur-reeds, and sedges. It is expected that fill will be required to accommodate the construction of the Plant Facility which will discontinue the growth of these plants. This area represents less than 1% of the wetlands within the Study Area. This process of infilling at the plant site has been ongoing for several years by the Town of Snow Lake. Soil will be disturbed or compacted during the construction phase of this Project including but not limited to the Plant Site.

Although there are 12 different plants and fungi listed by Manitoba Conservation as species of concern in the Churchill River Upland Ecoregion, none of these species have been documented to occur in the Project area. The habitat suitability to support these species is assessed to be low to marginal as a result of past site use.

The construction of a 0.17 km road north of the Plant Site to accommodate transport of the AR to the facility will require infilling of an approximately 0.8 ha of wetland. To accommodate construction of the Storage Impoundment Facility, an area of approximately 0.05 ha will have to be cleared. Most of the pipeline route is barren of vegetation and/or is located along an existing roadway. The proposed Storage Impoundment Site has been previously cleared of vegetation.

The potential for damage to vegetation, particularly wetlands, from spills from the transportation of AR to the Plant Site, spills at the Plant Site, and transportation of the waste by pipeline to the Storage Impoundment Facility are considered to be minimal. Spills of fuel from vehicles may alter the environment, as soils sampled were at or below detection limits for organic compounds. However, these effects are likely to be highly localized due to the generally small quantities from a given vehicle.

6.1.3 Potential Effects on the Surface Water Environment

The remediation of the ARS, and implementation of a WMS within the ARS is expected to decrease the loading and concentrations of metals, particularly As to surface water (and groundwater) downstream of the site. Currently, surface water concentrations exceed CCME guidelines by up to 2,000 times for As, 60 times for Zn, and 200 times for Fe. The remediation is expected to result in declines of these metals in the surface water environment, including Canada Creek. This will result in improved fish habitat downstream of the ARS and within Canada Creek by decreasing toxic metal levels, potentially resulting in lower body burdens in fish. Although only small-bodied fish species were captured in the Study Area, the habitat of Canada Creek would represent an excellent spawning and rearing habitat for large-bodied fish species in Snow Lake, such as northern pike. Therefore, remediation of the ARS could have benefits for large-bodied fish species from Snow Lake that may use Canada Creek at some point in their life cycle. As a result, the potential effect on surface water from the remediation of the ARS is anticipated to be positive over the long term.

Excavation and removal of the material currently in the ARS will change the hydrology at this site, as the topography of the ground will change. A WMS will control any ground or surface water which accumulates in the excavation. Collected runoff water will be used to provide some process water for the Bioleach Plant. The remaining volume process water required will be accessed from Snow Lake. A significant portion of the process water will be recovered and reused, which will minimize the Projects demands on fresh process water from the lake.

Approximately 0.8 ha of the proposed Plant Site is wetland, which will be infilled to accommodate the construction of the Plant Facility. Minimal water and no fish were observed during the site visit, and it is unlikely that this represents fish habitat. Therefore minimal impact to fish and fish habitat is expedited due to the infilling of the wetland.

The possibility of a leak or spill into the receiving environment is a potential effect of the Project. During construction, all equipment will be regularly inspected and maintained to minimize the potential for fuel or hydraulic oil leaks. In the event of a spill during construction, the emergency response plan for spills developed for the Project would be followed.

There is a very low risk of potential effects to the surface water environment occurring during transportation by truck from the ARS pile to the Bioleach Plant Site. The existing haul road crosses an area that has been previously disturbed and contaminated by mining activity and tailings deposition. Potential for spills of ARS from a truck are reduced by safe loading and unloading practices and the use of a transport truck with a sealed box to prevent spillage during transport. Locating the Bioleach Plant Site close to the ARS Pile results in a short (0.37 km) haul distance between the two locations, which further limits the risk of a spill during transport. The haul route would be along an existing private road from the ARS to the Plant Site. If a truck were to accidentally overturn on the haul route, an emergency response plan for spills would be followed immediately and the area cleaned up. It is anticipated that the effect of an AR spill along the haul road would be negligible.

Potential spills from a pipeline leak would be mitigated with the use of engineering and operational controls. Constant pressure monitoring of pipeline the pipeline will occur; with an automated pump shutdown in the event of a pressure drop. Regular pipeline inspections by trained personnel will supplement the automated monitoring. There are two mitigation strategies being considered to reduce the effect of a ruptured pipeline. One is to surround the pipeline in a bermed channel or bed with land grading designed to contain any released material in the event of a leak. The second is to run the pipeline carrying the sludge inside a larger pipeline, which would contain any released material in the event of a leak in the sludge carrying inner pipeline. An Emergency Response Plan for spills would be in place; and spill reporting as per Manitoba Conservation's Emergency Response Program requirements would be completed in the case of a leak in the pipeline. A spill or break of the two inch pipeline would be captured by the sand bed enclosing the pipeline. With these engineering and operational controls in place, it is anticipated that the effect to the surface water environment would be minimal to negligible.

The sludge being transported in the pipeline is stable with respect to arsenic and would not contain sulphides that oxidize and generate acidity or leach metals. Therefore, the risk to the environment is less than that posed by the current state of the material stored in the ARS. The sludge at the Storage Impoundment Site will be stored in an appropriately engineered facility lined with clay and HDPE to prevent seepage into the groundwater, surrounding soil, and surface water. Once the ARS remediation is complete, the Storage Impoundment Site will be covered to limit infiltration. Given that fish habitat near the Storage Impoundment Site is poor, any effects on fish and fish habitat would be expected to be negligible.

Much of the surface water within 1 km of either the ARS shows very high concentrations of As, far exceeding CCME guidelines (DNE Knight-Piésold 1995, Salzsauler 2005). Beyond this, however, concentrations drop off markedly, with As falling below CCME guidelines. Similar trends are observed for Fe and Zn. Given the pipeline route and the existing levels of contamination found in the area, negligible environment effects are anticipated, should a pipeline leak or spill occur. Groundwater concentrations of As, Zn and Fe are higher than the surface water values and extend to larger areas due to the less oxidizing environment, which allow As, Fe and Zn to remain soluble for longer periods.

Another potential effect to the surface water environment is that construction and operation of the Bioleach Plant Site, Storage Impoundment Site, and haul road would result in changes to the local topography of these sites which may alter surface water flow patterns in the immediate area. The construction of a roadway and pipeline route from the Plant site to the Waste Impoundment site will require crossing a drainage channel north of the Plant site, and clearing a minimal amount of wetlands (estimated to be 0.05 ha). A properly sized culvert will be installed to allow for unimpeded flow within the drainage channel under expected flow conditions. Based on these conditions, changes to the existing hydrology (water quantity) would be negligible and localized. Given that fish habitat near the Plant Site, and north of the Plant Site is poor, any effects on fish and fish habitat would be expected to be negligible.

6.1.4 Potential Effects on Groundwater

The remediation of the ARS, and implementation of a WMS within the ARS is expected to decrease the loading and concentrations of metals, particularly As to groundwater downstream of the site. Currently, groundwater concentrations exceed CCME guidelines by up to 10^5 times for As, 300 times for Zn, and 45 times for Fe. The remediation is expected to result in declines of these metals in groundwater, and the surface water environment, including Canada Creek. As a result, the potential effect on groundwater from the remediation of the ARS is anticipated to be positive over the long term.

6.1.5 Climate Change

As no air emissions are to be produced at the Plant Site, it is expected that the implications will be minor.

6.2 Effects on Socioeconomic Environment

During the construction phase, there will be 10 to 20 tradespeople at any given point on site to construct the Bioleach Facility, pipeline, and Storage Impoundment Site. A local general contractor will be selected to complete the construction of the facility and will be responsible for providing the required tradespeople and labor. This will produce moderate benefits to the local economy from the salaries paid to local staff. The operational phase of the Project is expected to last seven to eight years, providing an additional material feed source is not located during that time. The facility will treat the ARS on a 24/7 basis. The required labor force is estimated at 31 employees' to manage, operate, and maintain the facility throughout the life expectancy of the project. BacTech is investigating the potential to extend the life of the plant by identifying additional tailings for remediation at the plant. If additional feedstock is secured, this would extend the life of the plant. These jobs are expected to benefit the local economy.

The direct impact from the facility include spending on goods and services, employment of the required staff, income they earn, and the taxes they provide to governments. The indirect impact captures the increase in economic activity occurring elsewhere in the economy in the production of the primary and intermediate goods and services purchased by suppliers of direct goods and services provided to the Bioleach Facility. This would include royalties paid to the provincial government for gold recovered from the ARS.

BacTech is committed to community building activities. As a result of the Project, Manitoba and BacTech wish to maximize long lasting social, educational, and capacity building benefits for Manitoba and particularly for those residents living in and near Snow Lake. BacTech proposes, among other activities, to:

- establish an advisory committee (whose members will include residents, representatives of local businesses and other local stakeholders) for the purpose of improving public engagement and receiving public comment regarding the Project;
- maximize local benefits, whenever practicable to do so. This includes training and employment opportunities, undertaking Project-related technical and research activities in Manitoba and establishing co-op, scholarship or similar programs with local educational institutions; and
- seek to establish a bioleaching research facility in Manitoba. This proposed center of excellence will be established in partnership with an existing educational institution.

7 MITIGATION MEASURES

This section summarizes the mitigation measures, including environmental management practices and control technologies what will be employed construction, operation and decommissioning of the facility to minimize potential environmental effects.

BacTech Environmental understands the utmost importance of the health and safety of all employees' and the effects our projects will have on the environment. Manitoba Certificate of Recognition (COR) certification, safety performance, and an environmental policy will be prerequisites in the selection process of all contractors and sub-contractors hired to construct the facility. The Project Manager (PM) will be responsible to assure BacTech's Health, Safety, and Environmental Policy is met or surpassed. The PM will also confirm the appropriate safety programs are adhered to and encompass the applicable Health, Safety, and Environmental acts, regulations, and codes.

Throughout the construction phase mitigation measure to control environmental effects will be implemented to assure concerns such as dust and noise control, spills, emissions from construction equipment, traffic control, water and waste water management, maintenance of roadways, excavation, etc. will be mitigated by the implementation of an EMS. The EMS is a systematic approach which allows for environmental considerations to be incorporated into routine decisions. It defines the management framework of an environmental program and provides for the monitoring, evaluation and communication of the environmental programs performance. The system will ensure that those employees whose job can have a significant impact on the environment are appropriately trained. These employees will be informed of the potential environmental consequences of their actions and will be competent to do their jobs. The core elements of the EMS will include the Environmental policy, operating procedures, work instructions, preventive maintenance procedures, an effective emergency preparedness and response plan, a clear and concise monitoring and reporting structure for both internal and external organizations

During operation and the decommissioning of the facility the Plant Manager will be responsible to assure the safety, health, and Environmental Policy is adhered to by utilizing an EMS that will provide a framework for a holistic, strategic approach to the environmental policy, plans and actions which will mitigate any possible environmental effects.

During operation in order to mitigate the possibility of a spill to the environment while transferring the stabilized ferric arsenate to the storage area, BacTech will depend heavily on a state of the art control technology as well as regular pipeline inspections performed by trained personal. The process including the pipeline will be monitored 24/7 utilizing the PLC capable of detecting the slightest change in the process including a pressure drop in the pipeline. The PLC will be programmed to notify the operations team with an alarm system throughout the facility, for example if a pressure drop is detected in the pipeline transferring the neutralized precipitate below a given set point, the PLC program will shut down the pump transferring the material and alert the plant operators with a screen display, audio alarm and flashing lights throughout the facility. Also, the pipeline itself will be routed in a current brown field site placed on or in a bermed channel or bed with strategically placed catchment areas to contain any stabilized material in the event of a leak until clean-up occurs. The berms and catchment areas will be designed to address rain fall events and seasonal runoff. An alternative solution in mitigating the risk of a ruptured pipeline under consideration is to run the pipeline transferring the ferric arsenate within a larger pipeline.

Noise abatement in the form of a bermed landscaped area or wall will be installed between the facility and Highway 392 to reduce the level of noise to the surrounding area that may be generated at the facility during operation.

7.1 Proposed Environmental Management Practices

This section summarizes environmental management practices that will be employed to prevent or mitigate adverse effects from the impacts described in Section 6.0.

7.1.1 Mitigation incorporated at the planning and design stages

The process in its entirety will be subject to a hazard and operability (HAZOP) study throughout the design process. A HAZOP study is a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation.

7.1.2 Containment Handling, Monitoring, Storage, Treatment and Final Disposal of Pollutants

All dry reagents required for daily operations will be stored in a separate area of the facility. Mixed/liquefied reagents will be stored in appropriately designed tanks that will be housed within a bounded area that will contain the total volume of the particular tank or tanks within that particular containment. Each of the containment areas will have an individual sump pump to transfer all spills. Petroleum products will be stored within federal/provincial regulations. All waste generated at the facility outside of the neutralized precipitate will be suitable for recycling or the local landfill.

7.1.3 Environmental Restoration and Rehabilitation of the Site upon Decommissioning

Upon decommissioning of the facility the Storage Impoundment area will be covered with a clay cap and suitable material to re-vegetate with plant approved grass mix of the local vegetation. At the Plant Site the process equipment will be removed and the building can be relocated to another project, handed over the Town of Snow Lake, or sold to the highest bidder. The pipeline utilized to transfer the neutralized precipitate will be sold or recycled and any ground disturbance will be returned to the natural grade.

7.1.4 Protection of Environmental Health

Protection of the environment health is one of the main objectives of the EMS. The EMS is a systematic approach which allows for environmental considerations to be incorporated into routine decisions. It defines the management framework of an environmental program and provides for the monitoring, evaluation and communication of the environmental programs performance.

A key part of the EMS will be an Emergency Response Plan (ERP). Each phase of the project will require a separate ERP because of the difference in tasks being carried out. Each of the ERPs will consist of but are not limited to the following;

- Introduction,
- Purpose and Scope,
- Definitions,
- Risk Analysis,
- Communications Protocol,
- Who implements the ERP,
- When should the ERP be put into action,
- Response Action/Containment/Cleanup
- Evacuation,
- Disposal of Spilled Contaminants and Debris,
- Site Restoration/Remediation,
- Post-Incident Evaluation,
- Training and practice drills,
- Plan Evaluation,
- Plan Updates.

7.2 Control Technology

The control requirements for bioleach processing are relatively simple but have been demonstrated as being robust and reliable over time incorporating easy to understand interlock and fail safe systems. Much of the equipment and systems used in bioleach processing are common to those found in other areas of new plant operating successfully in the mining industry and only control loops and sequences providing a real benefit in operability and safety are engineered into the plant. Instrumentation such as level, pressure and flow transmitters and control valves will be provided to a degree which will allow the plant to operate as automatically as possible. One example would be the pipeline transferring the waste material to the Storage Impoundment area will be consistently monitored for pressure by the PLC program.

The overall control system for the plant is likely to centre on a PC-based control system interfacing to PLCs. The plant PLC based control system will control all drives and instrumentation. PLCs will be installed in the Process control cubicles located in the Motor Control Center room with field instruments wired back to input/output (I/O) cards in the PLC rack. PLCs and instruments will be supplied from an uninterruptable power supply (UPS) which will provide temporary backup in the event of a complete power failure. This will permit an orderly shutdown of the control system. Drives of 30 kiloWatts (kW) and above will incorporate electronic overloads with networking / communications capability to the PLC while drives smaller than 30 kW will include I/O modules with similar networking / communications ability.

An operator interfacing system (OIS) will be installed to provide centralized plant monitoring and control functionality for the operators. The main control room will have the overall control function for the entire process plant with computers to serve as operator interface terminals. Video links would be provided to certain areas of the plant to provide monitor feed back to the control room. Graphic displays, trend displays and sequence control systems will be configured to allow automatic plant operation with minimum operator requirements. Alarms will be logged and the facility to produce operating reports provided.

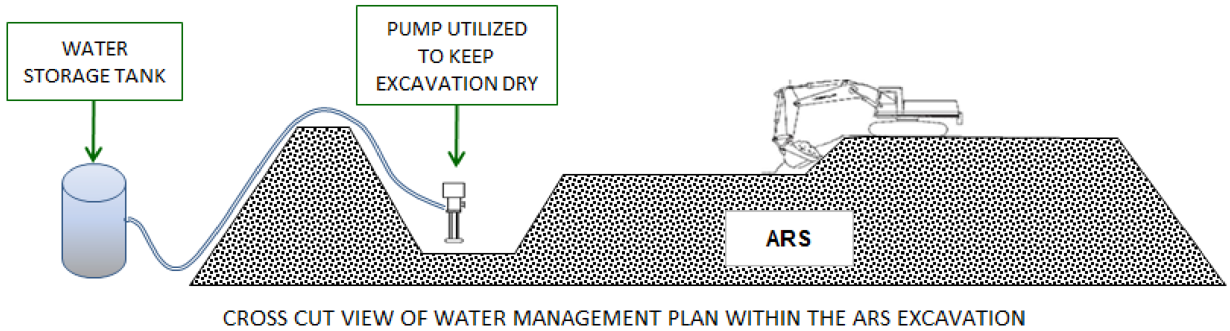
For the Bioleach process PLC control is the best available control technology because of its ability to be controlled by an industry-specific software that can be tailored to the individual process. The next suitable option would be a DCS (distributed control system) which is not OEM (original equipment manufacturer) friendly. OEMs are control systems provided by manufactures required to control their specific piece of equipment (i.e. filter press, air compressor, air blowers, and back-up genset).

7.3 Surface Water Control Measures for the ARS, Plant, and Storage Impoundment

ARS Site:

Surface water control measures for the ARS site will consist of a collection point within the excavation, submersible pump, piping, storage tank, and transfer piping. During the excavation of the ARS a collection point will be maintained within the excavation that will be lower than the area being excavated allowing for any surface water to pool. A submersible pump will remain at the collection point at all times. A float switch connected to the pump will turn the pump on and off as the water level increases and decreases within the collection point. The submersible pump will transfer the water from the ARS excavation to an HDPE (high density polyethylene) storage tank outside the excavation. The water collected in the storage tank will either be pumped or trucked to the bioleach facility to be consumed in the process. Figure 29 is a cross view of the sump area that will be maintained within the ARS excavation to manage ground and surface water runoff.

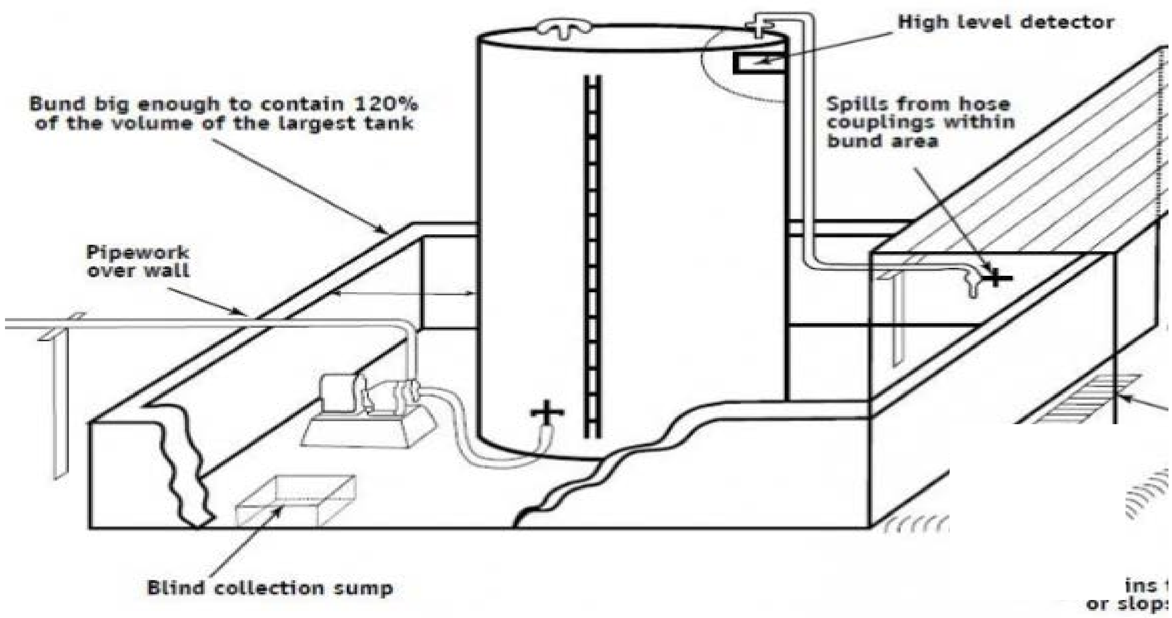
Figure 29: Cross View of the Sump Area that will be Maintained Within the ARS Excavation to Manage Ground and Surface Water Runoff



Plant Site:

Surface water control measures at the plant site will be managed with appropriate civil design that includes site grading, collection points, and submersible pumps. The site grading of the property which will be determined during the civil engineering will allow for the surface water to drain away from and around the facility. Inside the process facility each of the process circuits will have individual sump pumps that will contain any spills within each individual circuit. The tankage and or process circuits that are required to be outside the process building will be contained within a bunded area designed to hold 120% of the largest tank volume contained within the bund. Each bunded area/circuit will be constructed out of concrete and include a blind collection sump box and pump to control any spill or surface water within each particular bunded circuit (Figure 30).

Figure 30: Diagram of a Bunded Tank Area with Collection Sump



Storage Impoundment Area:

Once the arsenic has been stabilized in the Neutralization Circuit the precipitate will be pumped to a Storage Impoundment area approximately 1.4 km northeast of the Bioleach Facility. It is anticipated detailed engineering of the Storage Impoundment will include a clay and HDPE liner which will prevent any seepage into and out of the Storage Impoundment area. The Storage Impoundment area will be designed to divert surface runoff water from impeding the storage volume of the neutralized precipitate. The impoundment area will be designed to adequately house approximately 350,000 cubic meters of precipitate. The proposed design of the Storage Impoundment facility is shown in an east-west, and north-south cross cut view is shown in Figure 8 in Section 2.1.5.

A reclaim pumping system will be utilized at the Storage Impoundment area to reclaim all released pore water from the precipitate and captured run-off water back to the process facility to be utilized in the process. Detailed engineering will provide the best option to reclaim the water, however one option as depicted in Figure 8 would be to install a vertical slotted caisson in the Storage Impoundment area that would house the reclaim water pump to return the water back for re-use in the process. The slots in the caisson would allow for the pore and captured run-off water to enter the caisson while holding back the solids in the precipitate.

8 RESIDUAL EFFECTS

Residual effects, or those effects that exist after applying mitigation, are predicted to occur to terrain (wetlands and slope profiles), soils, vegetation, wildlife habitat and wildlife, land use, and socioeconomic environments. Based on the mitigation measures summarized in Section 7.0, the residual effects from the project are summarized in Table 11. The nature of the effect was determined to be either positive or negative with respect to the benefit or detriment of the environment predicted to result from the Project.

Table 11: Summary of Residual Effects of the Project

Environment	Residual Effect	Direction	Magnitude	Summary
Biophysical Environment	Wetland Infilling	Negative	Negligible to Low	An area of approximately 0.80 ha will be infilled within the Plant Site to grade the property for construction and ensure proper site drainage. An additional area of approximately 0.05 ha will bed infilled to accommodate construction of a haul road and pipeline right of way 0.17 km from the Plant Site to an existing road. This will represent a permanent loss of 0.85 ha of wetland, representing <1% of the wetland within the Study Area.
	Reduction in As and other metal loading to groundwater, surface water	Positive	High	The acid mine drainage from the ARS will be remediated, reducing heavy metal contamination downstream of the ARS. This will result in a reduction in heavy metal levels (particularly As) in the groundwater, and surface water to the west of the ARS, and into Canada Creek.
Socioeconomic Environment	Job Creation	Positive	Moderate	An estimated 41 to 51 jobs will be created during the construction and operation phases of the Project. Ten to 20 of these jobs will be to construct the Project in its entirety. To operate the plant, approximately 31 jobs will be created over the seven to eight years required to remediate the ARS. BacTech is in negotiation with other mining companies to investigate the potential for additional gold tailings to be processed at the BacTech Snow Lake Site. This would result in potential longer term job opportunities for the Town of Snow Lake.

Two of the three residual effects identified for the Project were identified as having a positive effect on the Study Area. The purpose of the Project is to remediate one of the many tailings piles that exist in the area. This will effectively remove a source of contamination in the area and contribute to the improvement of the surrounding soil, surface and groundwater quality in the long term. An estimated 41 to 51 jobs will be created during the construction and operation phases of the Project.

While the Project will result in minor loss of wetland vegetation, and habitat for wildlife and fish, the Project is located in an area that has been highly disturbed and contaminated by previous mining activity, tailings storage and industrial activity, and is currently zoned for industrial activities.

9 MONITORING AND REPORTING

This section will describe follow-up activities that will be required at all stages of development of the Project.

During all phases of the project monitoring, reporting, and auditing will be incorporated under the EMS to assure all Federal and Provincial legislations, regulations and laws are adhered to. As outlined in the agreement with the Manitoba government, BacTech is providing the office of the Manitoba Minister of Innovation, Energy and Mines with a quarterly progress report.

Monitoring will be used to test and verify effects predictions and determine the effectiveness of mitigation and environmental design features. It is expected that monitoring will identify unanticipated effects and that appropriate adaptive management will be implemented. Monitoring and follow-up programs are planned and designed including one or more of the following categories, which may be applied during the development of the Project:

- Compliance Inspection: monitoring the activities, procedures, and programs undertaken to confirm the implementation of approved design standards, mitigation, and conditions of approval and company commitments.
- Environmental Monitoring: monitoring to track conditions or issues during the development lifespan, and subsequent implementation of adaptive management.
- Follow-up: programs designed to test the accuracy of effects predictions, reduce uncertainty, determine the effectiveness of environmental design features, and provide appropriate feedback to operations for modifying or adopting new mitigation designs, policies, and practices. Results from these programs can be used to increase the certainty of effects predictions in future environmental assessments.

Following approval of the Project, environmental monitoring programs may be developed and reviewed during the permitting phase to track conditions or issues during the development lifespan, and implement appropriate and necessary adaptive management. For example, if significant heritage resources are discovered during the construction phase, BacTech will notify the Historic Resources Branch of Manitoba Culture, Heritage and Tourism and a heritage resource management strategy will be developed and implemented. BacTech plans to obtain records from past monitoring programs within the Study Area to provide background groundwater quality data. A number of water quality monitoring wells currently exist within the Study Area in proximity to the ARS site, and the proposed Plant Site. BacTech will continue to obtain the water quality data collected from the existing monitoring wells during the construction and operation phases of the Project. Records from this program will be useful for monitoring any potential water quality changes within the Study Area.

The Storage Impoundment Site is located in an area with fewer existing monitoring wells. The waste material disposed of is benign material and is anticipated to have negligible effect to the surrounding environment; however, the groundwater monitoring program will be extended to include the waste disposal site to contribute to the water quality monitoring within the Study Area.

Once the final routings for the pipelines from the ARS to the Bioleach Facility and from the Bioleach Facility to the waste disposal site have been determined, the need for additional environmental field surveys will be evaluated based on the season, land type crossed (e.g., wetlands), and proposed construction techniques. The Project is located within a brownfield site that has been previously disturbed; however, wildlife habitat does still exist within the area, including the Class IV and V wetlands located within the drainage channel adjacent to the existing road. Industry best practices for pipeline construction will be followed, and to the extent practical, disturbance caused by pipeline construction will be minimized in areas identified as having potential environmental sensitivities.

During operations, a WMS will be developed to manage the anticipated runoff into the ARS as the stockpile is excavated. This water will be pumped to the Bioleach Facility and used as process water. No process water will be released or otherwise disposed of from the Bioleach Facility as it is re-circulated continually into the process. Water re-circulation will be monitored for leaks so that water is properly contained and managed.

Above and below group pipelines transporting water or sludge will be continually monitored and regularly inspected for integrity concerns. Constant pressure monitoring of the pipelines will occur; with an automated pump shutdown in the event of a pressure drop. An Emergency Response Plan for spills will be developed, and spill reporting as per Manitoba Conservation’s Emergency Response Program requirements would be completed in the case of a leak in the pipeline.

Hazardous substance storage and fuel containment areas and will meet federal/provincial regulations and will be regularly inspected by qualified employees. The appropriate secondary containment will be used for each substance, and storage areas will have individual sump pumps to transfer all spills. In the event of a hazardous substance spill, an emergency response plan for hazardous substance spills will be developed. Spilled material will be collected and stored at the facility until it can be properly transported to an approved disposal facility.

Compliance inspections and environmental monitoring reporting will be undertaken as part of the site EMS. The EMS will provide guidance that will include a clear and concise monitoring and reporting structure for both internal and external organizations. The plan will provide flexibility for BacTech and Manitoba Conservation and Water Stewardship to effectively identify and respond to unanticipated changes to the environment (e.g., wildlife, vegetation or water quality), and to adapt to new regulatory frameworks.

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Appendix A Letters of Support from the Province Of Manitoba, the Town of Snow Lake and QMX Gold Corp.

From: "Armitt, Ernest (IEM)" <Ernest.Armitt@gov.mb.ca>
To: "'MaryAnn Mihychuk'" <maryann@corporate-relations-services.com>
Cc: "Boswick, Robert (CON)" <Robert.Boswick@gov.mb.ca>, "Armitt, Ernest (IEM)"<Ernest.Armitt@gov.mb.ca>, "Liske, Cal (IEM)" <Cal.Liske@gov.mb.ca>
Subject: RE: Timely: request for letter re BacTech project
Date: Mon 12-03-2012 02:23 PM

Bactech have submitted an EAL application to construct a Bio Leach facility in Snow Lake Manitoba

The plant is to be located on Crown Land which will be Transferred to the Town of Snow Lake and then by agreement to BacTech either as a purchase agreement or Leased from the Town. The waste from the plant will be located on Crown Land.

It should be noted that the Bio Leach Plant is be Built to initial reprocess an Arsenophyrite pile [the "Pile"] of Concentrate left by previous Mining Operations for which the Province has the responsibility to remediate

The Province has entered into an agreement with BacTech whereby they will reprocess the "Pile' which will neutralize all environmental concerns

Ernest Armitt P.Eng

Director of Mines

Robert

If you have any other concerns please give me a call 945 6505 or e-mail

From: MaryAnn Mihychuk [mailto:maryann@corporate-relations-services.com]
Sent: November-29-12 4:15 PM
To: Armitt, Ernest (IEM)
Subject: Timely: request for letter re BacTech project

Hi Ernie,

Robert Boswick, Conservation is looking for some type of document indicating that you are aware of the sites and that the land is crown. We would like to reprint the EA and submit early next week.

Warm Regards,

MaryAnn

MaryAnn Mihychuk M Sc., P Geo.
President, CR Services
c: 204.299.4036

(maryann@corporate-relations-services.com) - Tue, 12-04-2012 15:24:02 -0500

BacTech

BY EMAIL AND FAX

November 23, 2012

Town of Snow Lake
Box 40
Snow Lake Manitoba R0B 1M0

Attention: Mr. Jeff Precourt, Chief Administrative Officer

Dear Mr. Precourt:

This letter is intended to notify the Licensing Branch of Manitoba Conservation of your knowledge that BacTech Environmental Corporation is in development to complete the following:

- ✓ Remediate the existing Arsenopyrite Residue Stockpile (ARS) from its current location over a period of 7-8 years;
- ✓ Construct a neutralized precipitate storage impoundment area located approximately 1 km northeast of the plant site (Figure 1);
- ✓ Run three (3) separate 50 mm HDPE (high density polyethylene) pipelines in parallel on a .5 m bed beside the private access road between the BacTech Facility and the Storage Impoundment area (Figure 1).

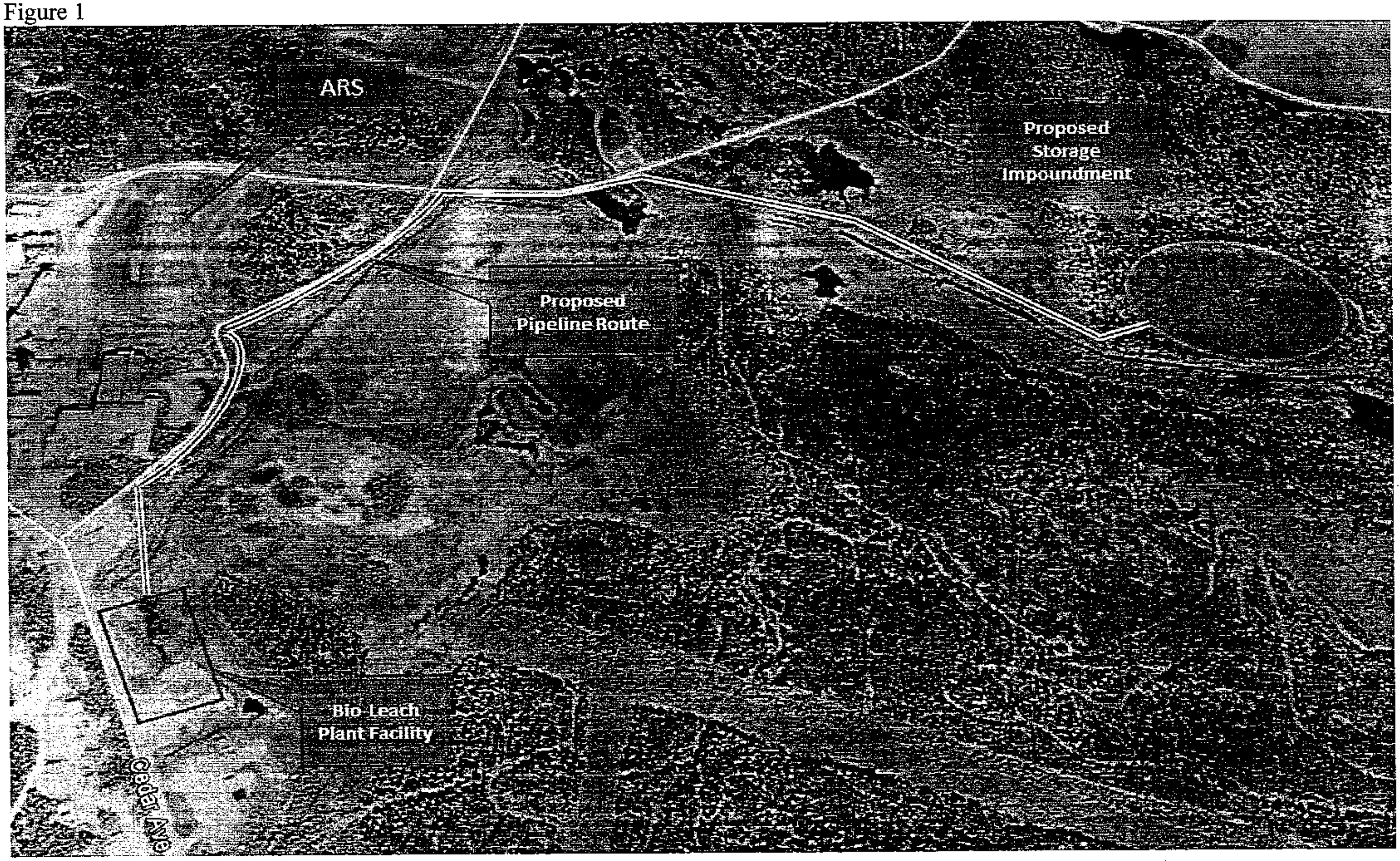
The construction of the storage impoundment area and installation of the three (3) pipelines is scheduled to commence in Q2 of 2013 in conjunction with the construction of the plant facility, all of which is expected to be completed in Q4 of 2013. The storage impoundment area will be engineered and sufficient in size to contain an estimated 150,000 cubic meters of neutralized precipitate. It is BacTech's understanding that the ARS, Impoundment Storage Area, and the pipeline route as outlined in Figure 1 are Crown land currently leased to QMX Gold Corporation.

If you have any questions or concerns with the above, please do not hesitate to contact me. Please sign and return a copy of this letter to us at your earliest convenience.

BACTECH ENVIRONMENTAL CORP	TOWN OF SNOW LAKE
Per: David J. Salari	Per: Jeff Precourt
Title: Chief Operating Officer	Title: Chief Administrative Officer

BacTech Environmental Corporation
50 Richmond Street East, Suite 300, Toronto, Ontario M5C 1N7 Canada, Tel: 416.813.0303 Fax: 416.596.9840
www.bactechgreen.com

Figure 1



BacTech Environmental Corporation
50 Richmond Street East, Suite 300, Toronto, Ontario M5C 1N7 Canada, Tel: 416.813.0303 Fax: 416.596.9840
www.bactechgreen.com

November 22, 2012

QMX Gold Corporation
65 Queen Street West Suite 815
Toronto Ontario Canada, M5H 2M5

VIA EMAIL

Attention: Mr. Thornton, Jr. Vice President

Dear Mr. Thornton,

This letter is intended to notify Manitoba Conservation and Water Stewardship of your knowledge that Bactech Environmental Corporation is in development to complete the following;

- ✓ Remediate the existing Arsenopyrite Residue Stockpile (ARS) from its current location over a period of 7-8 years,
- ✓ Construct a neutralized precipitate storage impoundment area located approximately 1 km northeast of the plant site. (Figure 1)
- ✓ Run three (3) separate 50mm HDPE (high density polyethylene) pipelines in parallel on a .5m bed beside the private access road between the BacTech Facility and the Storage Impoundment area. (Figure 1)

The construction of the storage impoundment area and installation of the three (3) pipelines is scheduled to commence in Q2 of 2013 in conjunction with the construction of the plant facility; all of which is expected to be completed in Q4 of 2013. The storage impoundment area will be engineered and sufficient in size to contain an estimated 150,000 cubic meters of neutralized precipitate. It is BacTech's understand that the ARS, Impoundment Storage Area, and the pipeline route as outlined in figure 1 is crown land currently leased to QMX Gold Corporation.

Please do not hesitate to contact me with any questions or concerns to the above mentioned.

BACTECH ENVIRONMENTAL CORP

QMX Gold Corporation

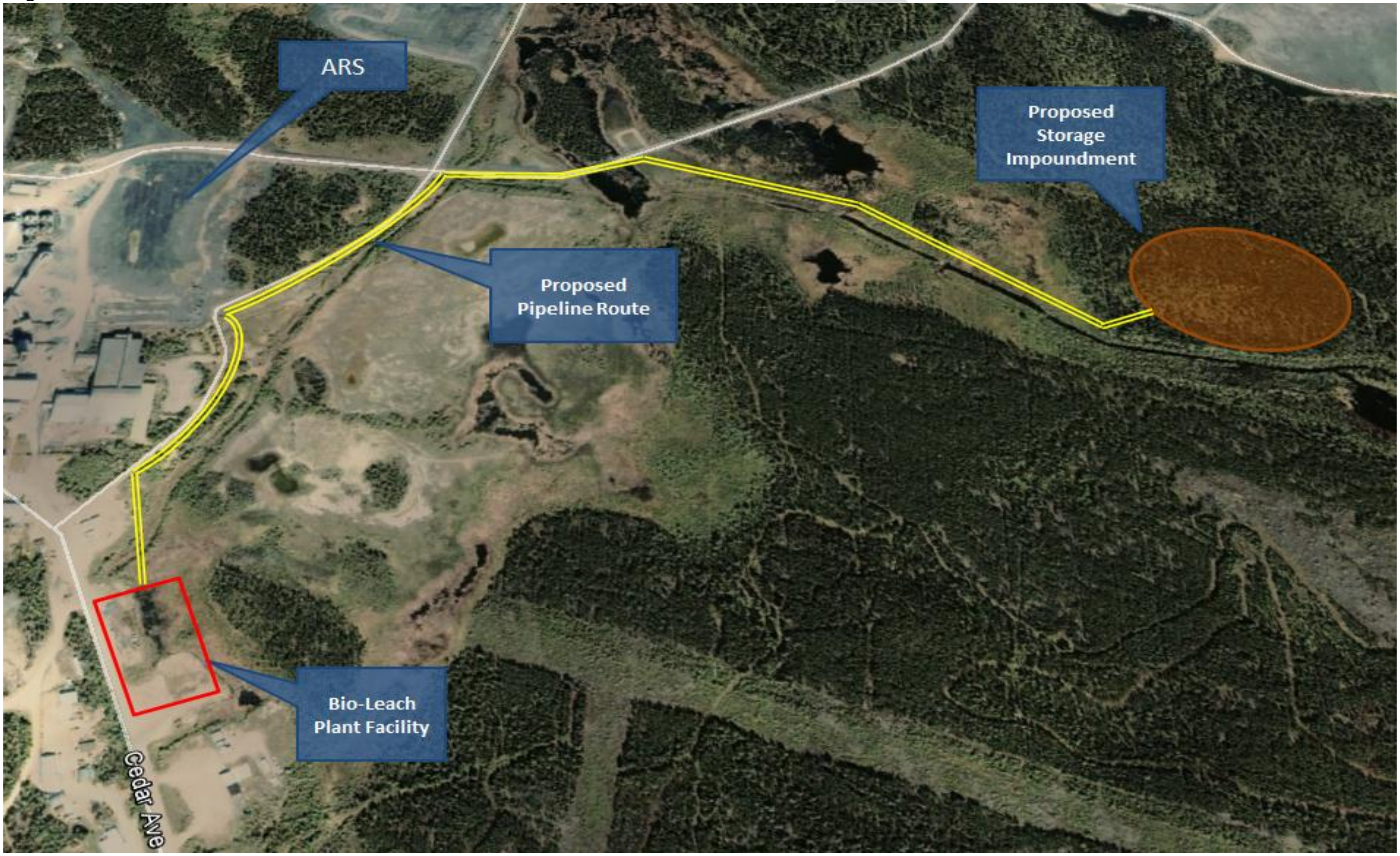
per: David J. Salari

title: Chief Operating Officer

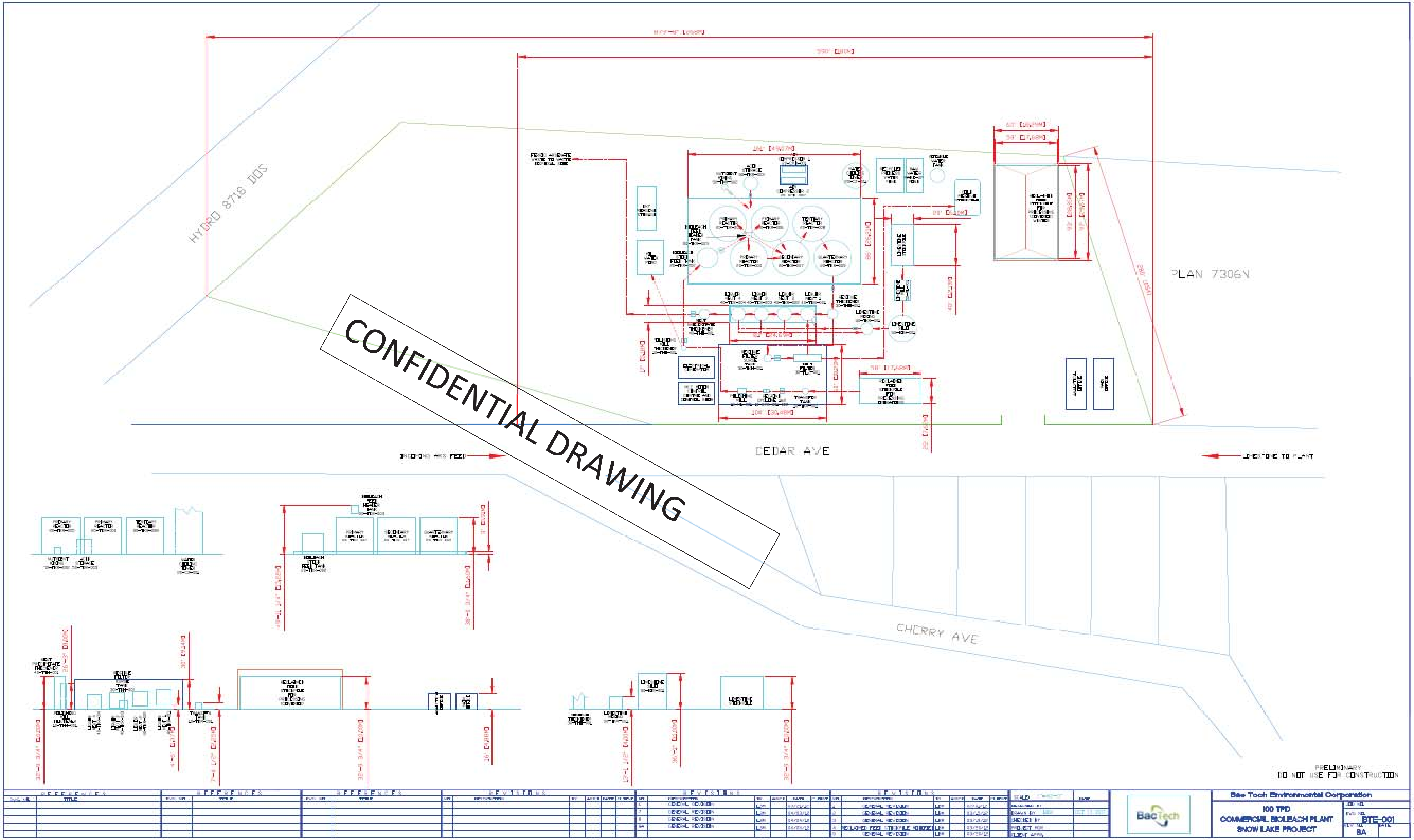
per: Gerald J. Thornton, Jr.

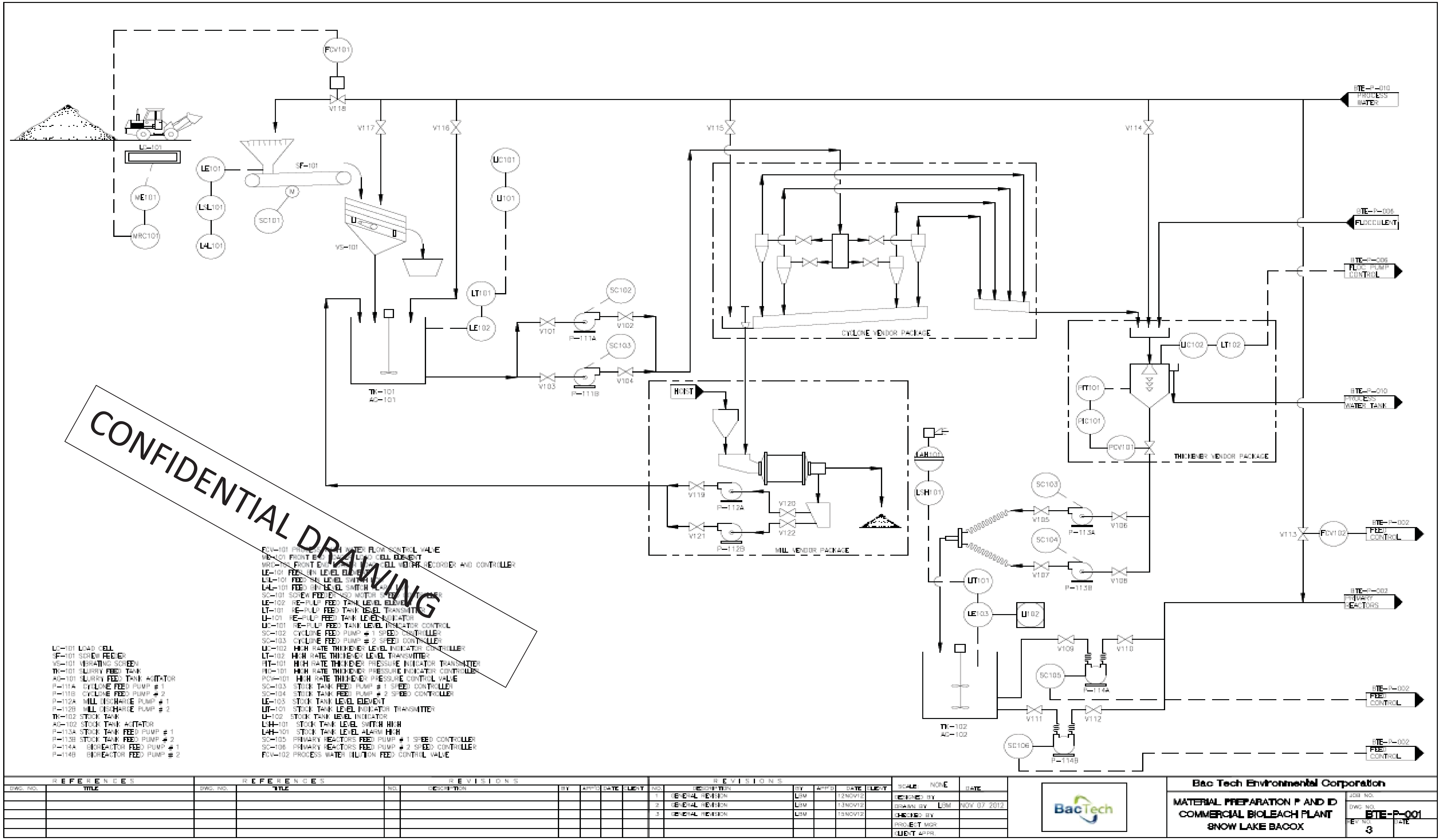
title: Vice President

Figure 1


ARS
Proposed Storage Impoundment
Proposed Pipeline Route
Bio-Leach Plant Facility
Cedar Ave

Appendix B Confidential – Process Piping and Instrumentation Diagrams


HYDRO 8718 DOS
PLAN 7306N
CEDAR AVE
CHERRY AVE
LIMESTONE TO PLANT
CONFIDENTIAL DRAWING
PRELIMINARY
DO NOT USE FOR CONSTRUCTION
Bac Tech Environmental Corporation
100 TPD
COMMERCIAL BIOLEACH PLANT
SNOW LAKE PROJECT
BTE-001
8A


CONFIDENTIAL DRAWING
FCV101
V118
V117
V116
V115
V114
BTE-P-010 PROCESS WATER
BTE-P-006 FLOCCULENT
BTE-P-006 FLOC PUMP CONTROL
BTE-P-010 PROCESS WATER TANK
BTE-P-002 FEED CONTROL
BTE-P-002 PRIMARY REACTORS
LC-101
SF-101
VS-101
ME101
MRC101
LE101
LSL101
LAL101
SC101
LIC101
LI101
LT101
LE102
TK-101
AG-101
SC102
SC103
V101
V102
V103
V104
P-111A
P-111B
CYCLONE VENDOR PACKAGE
HOIST
MILL VENDOR PACKAGE
V119
V120
V121
V122
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LIC102
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THICKENER VENDOR PACKAGE
LAH101
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LI102
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V111
V112
SC106
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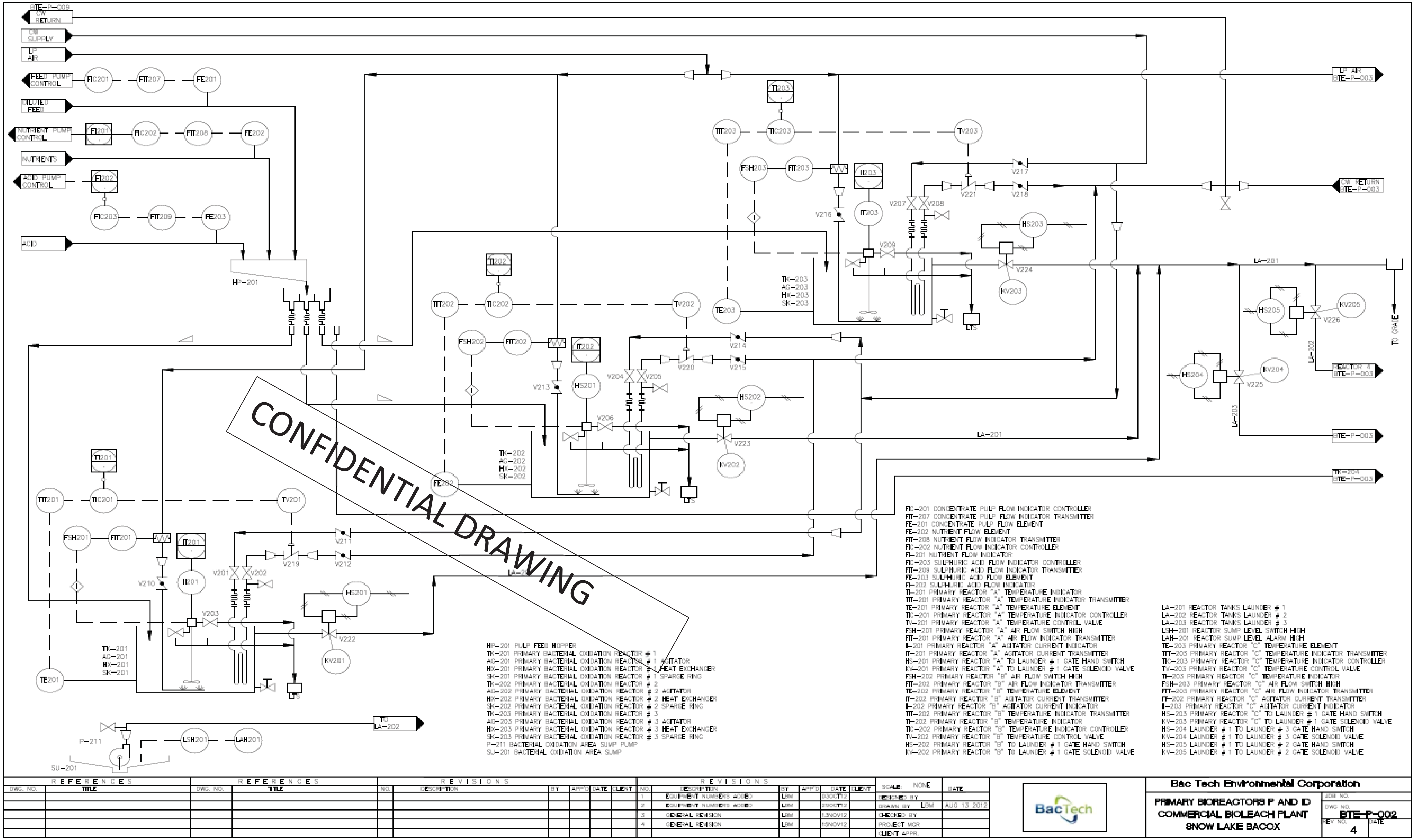
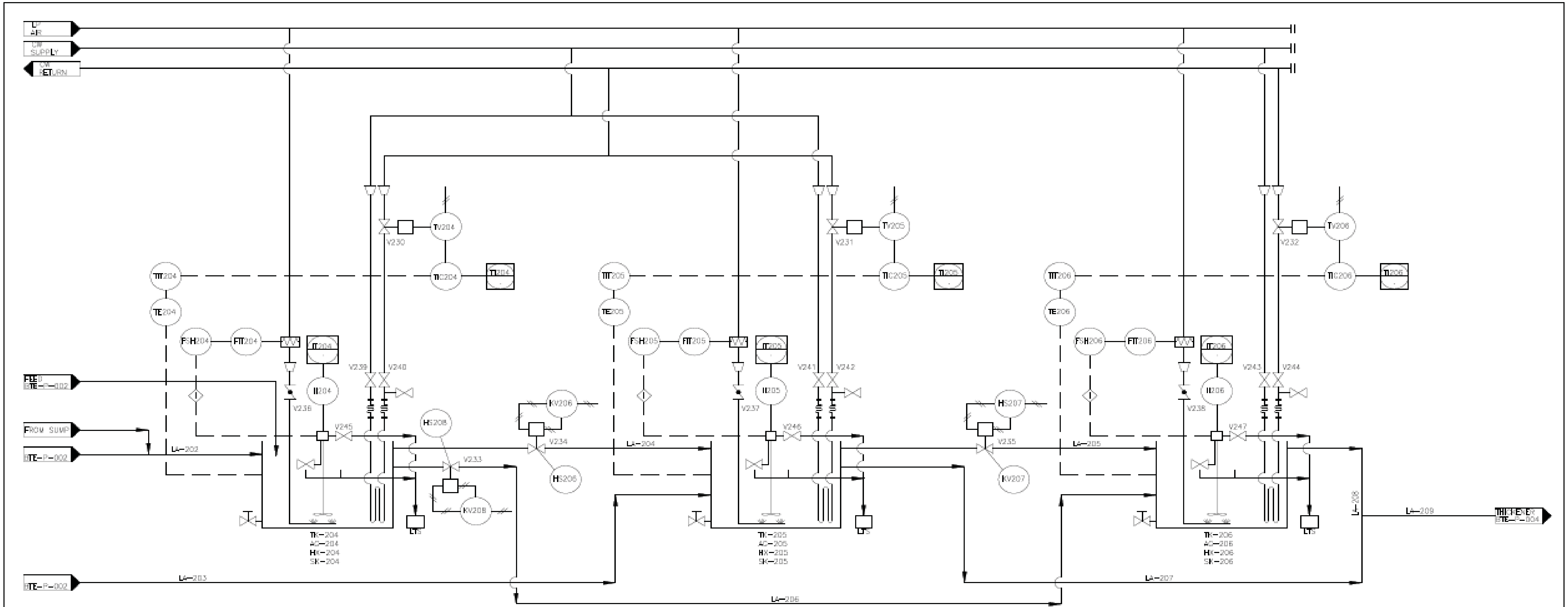
TK-102
AG-102
V113
FCV102
LC-101 LOAD CELL
SF-101 SCREW FEEDER
VS-101 VIBRATING SCREEN
TK-101 SLURRY FEED TANK
AG-101 SLURRY FEED TANK AGITATOR
P-111A CYCLONE FEED PUMP # 1
P-111B CYCLONE FEED PUMP # 2
P-112A MILL DISCHARGE PUMP # 1
P-112B MILL DISCHARGE PUMP # 2
TK-102 STOCK TANK
AG-102 STOCK TANK AGITATOR
P-113A STOCK TANK FEED PUMP # 1
P-113B STOCK TANK FEED PUMP # 2
P-114A BIOREACTOR FEED PUMP # 1
P-114B BIOREACTOR FEED PUMP # 2
FCV-101 PROCESS WASH WATER FLOW CONTROL VALVE
ME-101 FRONT END LOADER LOAD CELL ELEMENT
MRC-101 FRONT END LOADER LOAD CELL WEIGHT RECORDER AND CONTROLLER
LE-101 FEED BIN LEVEL ELEMENT
LSL-101 FEED BIN LEVEL SWITCH LOW
LAL-101 FEED BIN LEVEL SWITCH ALARM LOW
SC-101 SCREW FEEDER VSD MOTOR SPEED CONTROLLER
LE-102 RE-PULP FEED TANK LEVEL ELEMENT
LT-101 RE-PULP FEED TANK LEVEL TRANSMITTER
LI-101 RE-PULP FEED TANK LEVEL INDICATOR
LIC-101 RE-PULP FEED TANK LEVEL INDICATOR CONTROL
SC-102 CYCLONE FEED PUMP # 1 SPEED CONTROLLER
SC-103 CYCLONE FEED PUMP # 2 SPEED CONTROLLER
LIC-102 HIGH RATE THICKENER LEVEL INDICATOR CONTROLLER
LT-102 HIGH RATE THICKENER LEVEL TRANSMITTER
PIT-101 HIGH RATE THICKENER PRESSURE INDICATOR TRANSMITTER
PIC-101 HIGH RATE THICKENER PRESSURE INDICATOR CONTROLLER
PCV-101 HIGH RATE THICKENER PRESSURE CONTROL VALVE
SC-103 STOCK TANK FEED PUMP # 1 SPEED CONTROLLER
SC-104 STOCK TANK FEED PUMP # 2 SPEED CONTROLLER
LE-103 STOCK TANK LEVEL ELEMENT
LIT-101 STOCK TANK LEVEL INDICATOR TRANSMITTER
LI-102 STOCK TANK LEVEL INDICATOR
LSH-101 STOCK TANK LEVEL SWITCH HIGH
LAH-101 STOCK TANK LEVEL ALARM HIGH
SC-105 PRIMARY REACTORS FEED PUMP # 1 SPEED CONTROLLER
SC-106 PRIMARY REACTORS FEED PUMP # 2 SPEED CONTROLLER
FCV-102 PROCESS WATER DILUTION FEED CONTROL VALVE
REFERENCES
DWG. NO.
TITLE
REVISIONS
NO.
DESCRIPTION
BY
APP'D
DATE
CLIENT
1 GENERAL REVISION LBM 12NOV12
2 GENERAL REVISION LBM 13NOV12
3 GENERAL REVISION LBM 13NOV12
SCALE: NONE
DATE
DESIGNED BY
DRAWN BY LBM NOV 07 2012
CHECKED BY
PROJECT MGR
CLIENT APPR.
BacTech
Bac Tech Environmental Corporation
MATERIAL PREPARATION P AND ID
COMMERCIAL BIOLEACH PLANT
SNOW LAKE BACOX
JOB NO.
DWG NO.
BTE-P-001
REV NO.
3
DATE


CONFIDENTIAL DRAWING
HP-201 PULP FEED HOPPER
TK-201 PRIMARY BACTERIAL OXIDATION REACTOR # 1
AG-201 PRIMARY BACTERIAL OXIDATION REACTOR # 1 AGITATOR
HX-201 PRIMARY BACTERIAL OXIDATION REACTOR # 1 HEAT EXCHANGER
SK-201 PRIMARY BACTERIAL OXIDATION REACTOR # 1 SPARGE RING
TK-202 PRIMARY BACTERIAL OXIDATION REACTOR # 2
AG-202 PRIMARY BACTERIAL OXIDATION REACTOR # 2 AGITATOR
HX-202 PRIMARY BACTERIAL OXIDATION REACTOR # 2 HEAT EXCHANGER
SK-202 PRIMARY BACTERIAL OXIDATION REACTOR # 2 SPARGE RING
TK-203 PRIMARY BACTERIAL OXIDATION REACTOR # 3
AG-203 PRIMARY BACTERIAL OXIDATION REACTOR # 3 AGITATOR
HX-203 PRIMARY BACTERIAL OXIDATION REACTOR # 3 HEAT EXCHANGER
SK-203 PRIMARY BACTERIAL OXIDATION REACTOR # 3 SPARGE RING
P-211 BACTERIAL OXIDATION AREA SUMP PUMP
SU-201 BACTERIAL OXIDATION AREA SUMP
FIC-201 CONCENTRATE PULP FLOW INDICATOR CONTROLLER
FIT-207 CONCENTRATE PULP FLOW INDICATOR TRANSMITTER
FE-201 CONCENTRATE PULP FLOW ELEMENT
FE-202 NUTRIENT FLOW ELEMENT
FIT-208 NUTRIENT FLOW INDICATOR TRANSMITTER
FIC-202 NUTRIENT FLOW INDICATOR CONTROLLER
FI-201 NUTRIENT FLOW INDICATOR
FIC-203 SULPHURIC ACID FLOW INDICATOR CONTROLLER
FIT-209 SULPHURIC ACID FLOW INDICATOR TRANSMITTER
FE-203 SULPHURIC ACID FLOW ELEMENT
FI-202 SULPHURIC ACID FLOW INDICATOR
TI-201 PRIMARY REACTOR "A" TEMPERATURE INDICATOR
TIT-201 PRIMARY REACTOR "A" TEMPERATURE INDICATOR TRANSMITTER
TE-201 PRIMARY REACTOR "A" TEMPERATURE ELEMENT
TIC-201 PRIMARY REACTOR "A" TEMPERATURE INDICATOR CONTROLLER
TV-201 PRIMARY REACTOR "A" TEMPERATURE CONTROL VALVE
FSH-201 PRIMARY REACTOR "A" AIR FLOW SWITCH HIGH
FIT-201 PRIMARY REACTOR "A" AIR FLOW INDICATOR TRANSMITTER
II-201 PRIMARY REACTOR "A" AGITATOR CURRENT INDICATOR
IT-201 PRIMARY REACTOR "A" AGITATOR CURRENT TRANSMITTER
HS-201 PRIMARY REACTOR "A" TO LAUNDER # 1 GATE HAND SWITCH
KV-201 PRIMARY REACTOR "A" TO LAUNDER # 1 GATE SOLENOID VALVE
FSH-202 PRIMARY REACTOR "B" AIR FLOW SWITCH HIGH
FIT-202 PRIMARY REACTOR "B" AIR FLOW INDICATOR TRANSMITTER
TE-202 PRIMARY REACTOR "B" TEMPERATURE ELEMENT
IT-202 PRIMARY REACTOR "B" AGITATOR CURRENT TRANSMITTER
II-202 PRIMARY REACTOR "B" AGITATOR CURRENT INDICATOR
TIT-202 PRIMARY REACTOR "B" TEMPERATURE INDICATOR TRANSMITTER
TI-202 PRIMARY REACTOR "B" TEMPERATURE INDICATOR
TIC-202 PRIMARY REACTOR "B" TEMPERATURE INDICATOR CONTROLLER
TV-202 PRIMARY REACTOR "B" TEMPERATURE CONTROL VALVE
HS-202 PRIMARY REACTOR "B" TO LAUNDER # 1 GATE HAND SWITCH
KV-202 PRIMARY REACTOR "B" TO LAUNDER # 1 GATE SOLENOID VALVE
LA-201 REACTOR TANKS LAUNDER # 1
LA-202 REACTOR TANKS LAUNDER # 2
LA-203 REACTOR TANKS LAUNDER # 3
LSH-201 REACTOR SUMP LEVEL SWITCH HIGH
LAH-201 REACTOR SUMP LEVEL ALARM HIGH
TE-203 PRIMARY REACTOR "C" TEMPERATURE ELEMENT
TIT-203 PRIMARY REACTOR "C" TEMPERATURE INDICATOR TRANSMITTER
TIC-203 PRIMARY REACTOR "C" TEMPERATURE INDICATOR CONTROLLER
TV-203 PRIMARY REACTOR "C" TEMPERATURE CONTROL VALVE
TI-203 PRIMARY REACTOR "C" TEMPERATURE INDICATOR
FSH-203 PRIMARY REACTOR "C" AIR FLOW SWITCH HIGH
FIT-203 PRIMARY REACTOR "C" AIR FLOW INDICATOR TRANSMITTER
IT-202 PRIMARY REACTOR "C" AGITATOR CURRENT TRANSMITTER
II-203 PRIMARY REACTOR "C" AGITATOR CURRENT INDICATOR
HS-203 PRIMARY REACTOR "C" TO LAUNDER # 1 GATE HAND SWITCH
KV-203 PRIMARY REACTOR "C" TO LAUNDER # 1 GATE SOLENOID VALVE
HS-204 LAUNDER # 1 TO LAUNDER # 3 GATE HAND SWITCH
KV-204 LAUNDER # 1 TO LAUNDER # 3 GATE SOLENOID VALVE
HS-205 LAUNDER # 1 TO LAUNDER # 2 GATE HAND SWITCH
KV-205 LAUNDER # 1 TO LAUNDER # 2 GATE SOLENOID VALVE
REVISIONS
1 EQUIPMENT NUMBERS ADDED LBM 03OCT12
2 EQUIPMENT NUMBERS ADDED LBM 25OCT12
3 GENERAL REVISION LBM 13NOV12
4 GENERAL REVISION LBM 15NOV12
SCALE: NONE
DRAWN BY LBM AUG 13 2012
Bac Tech Environmental Corporation
PRIMARY BIOREACTORS P AND ID
COMMERCIAL BIOLEACH PLANT
SNOW LAKE BACOX
DWG NO. BTE-P-002
REV NO. 4



CONFIDENTIAL DRAWING

LA-202 REACTOR TANKS LAUNDER #2
LA-203 REACTOR TANKS LAUNDER #3
LA-204 REACTOR TANKS LAUNDER #4
LA-205 REACTOR TANKS LAUNDER #5
LA-206 REACTOR TANKS LAUNDER #6
LA-207 REACTOR DISCHARGE LAUNDER #1
LA-208 REACTOR DISCHARGE LAUNDER #2
LA-209 REACTOR DISCHARGE LAUNDER #3

TK-204 SECONDARY REACTOR TANK
AG-204 SECONDARY REACTOR TANK AGITATOR
HX-204 SECONDARY REACTOR TANK HEAT EXCHANGER
SK-204 SECONDARY BACTERIAL OXIDATION SPARGE RING
TK-205 TERTIARY REACTOR TANK
AG-205 TERTIARY REACTOR TANK AGITATOR
HX-205 TERTIARY REACTOR TANK HEAT EXCHANGER
SK-205 TERTIARY BACTERIAL OXIDATION SPARGE RING
TK-206 QUATERNARY REACTOR TANK
AG-206 QUATERNARY REACTOR TANK AGITATOR
HX-206 QUATERNARY REACTOR TANK HEAT EXCHANGER
SK-206 QUATERNARY BACTERIAL OXIDATION SPARGE RING

TIT-204 SECONDARY REACTOR TEMPERATURE INDICATOR TRANSMITTER
TE-204 SECONDARY REACTOR TEMPERATURE ELEMENT
FSH-204 SECONDARY REACTOR AIR FLOW SWITCH HIGH
FIT-204 SECONDARY REACTOR AIR FLOW INDICATOR TRANSMITTER
IT-204 SECONDARY REACTOR AGITATOR CURRENT TRANSMITTER
II-204 SECONDARY REACTOR AGITATOR CURRENT INDICATOR
TV-204 SECONDARY REACTOR TEMPERATURE CONTROL VALVE
TIC-204 SECONDARY REACTOR TEMPERATURE INDICATOR CONTROLLER
TI-204 SECONDARY REACTOR TEMPERATURE INDICATOR
HS-206 SECONDARY REACTOR TO LAUNDER #4 GATE HAND SWITCH
KV-206 SECONDARY REACTOR TO LAUNDER #4 GATE SOLENOID VALVE
HS-208 SECONDARY REACTOR TO LAUNDER #6 GATE HAND SWITCH
KV-208 SECONDARY REACTOR TO LAUNDER #6 GATE SOLENOID VALVE

TIT-205 TERTIARY REACTOR TEMPERATURE INDICATOR TRANSMITTER
TE-205 TERTIARY REACTOR TEMPERATURE ELEMENT
FSH-205 TERTIARY REACTOR AIR FLOW SWITCH HIGH
FIT-205 TERTIARY REACTOR AIR FLOW INDICATOR TRANSMITTER
IT-205 TERTIARY REACTOR AGITATOR CURRENT TRANSMITTER
II-205 TERTIARY REACTOR AGITATOR CURRENT INDICATOR
TV-205 TERTIARY REACTOR TEMPERATURE CONTROL VALVE
TIC-205 TERTIARY REACTOR TEMPERATURE INDICATOR CONTROLLER
TI-205 TERTIARY REACTOR TEMPERATURE INDICATOR
HS-207 TERTIARY REACTOR TO LAUNDER #5 GATE HAND SWITCH
KV-207 TERTIARY REACTOR TO LAUNDER #5 GATE SOLENOID VALVE

TIT-206 QUATERNARY REACTOR TEMPERATURE INDICATOR TRANSMITTER
TE-206 QUATERNARY REACTOR TEMPERATURE ELEMENT
FSH-206 QUATERNARY REACTOR AIR FLOW SWITCH HIGH
FIT-206 QUATERNARY REACTOR AIR FLOW INDICATOR TRANSMITTER
IT-206 QUATERNARY REACTOR AGITATOR CURRENT TRANSMITTER
II-206 QUATERNARY REACTOR AGITATOR CURRENT INDICATOR
TV-206 QUATERNARY REACTOR TEMPERATURE CONTROL VALVE
TIC-206 QUATERNARY REACTOR TEMPERATURE INDICATOR CONTROLLER
TI-206 QUATERNARY REACTOR TEMPERATURE INDICATOR

REFERENCES		REFERENCES		REVISIONS						REVISIONS						
DWG. NO.	TITLE	DWG. NO.	TITLE	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT
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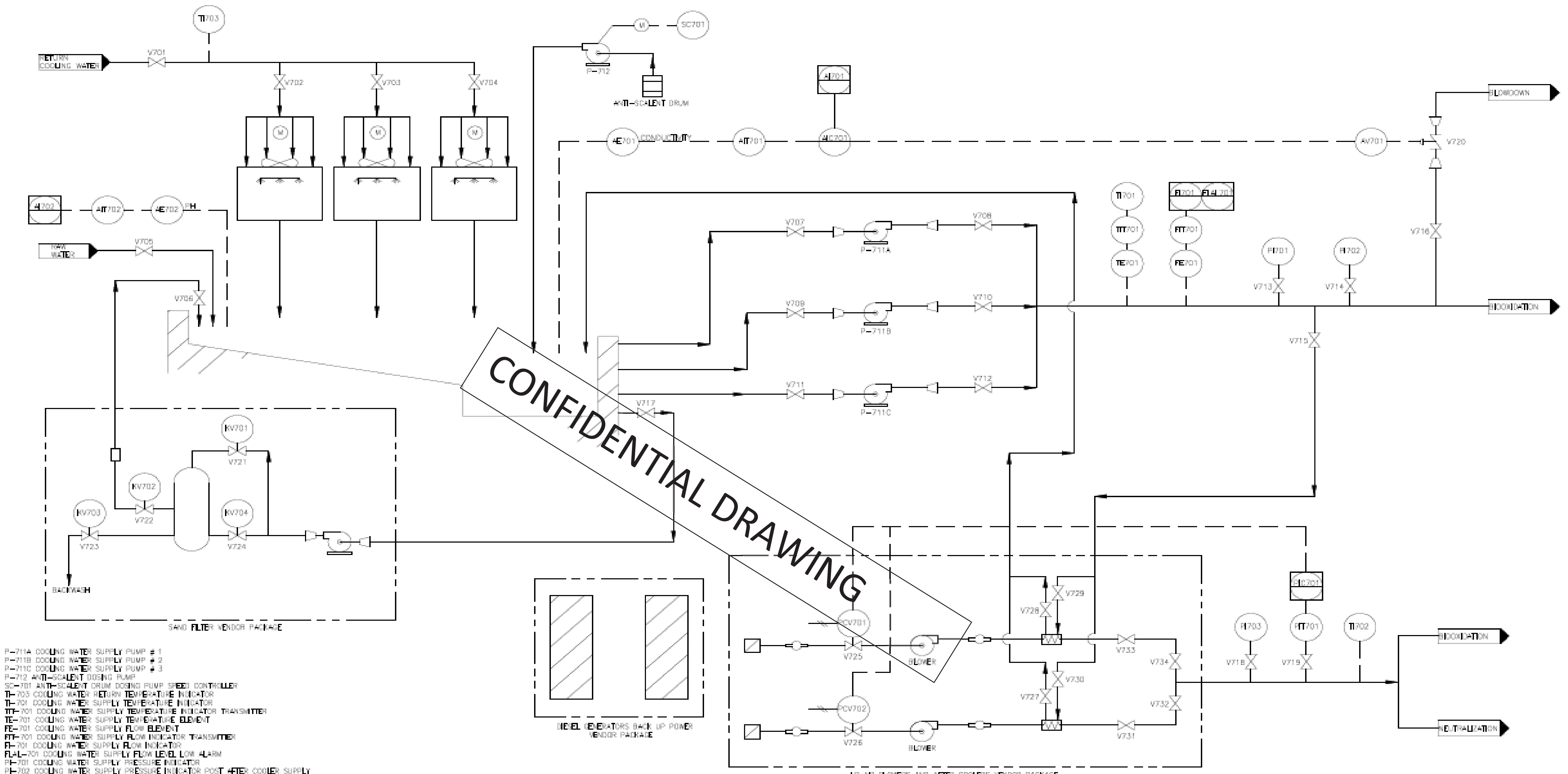
SCALE: NONE	DATE
DESIGNED BY	
DRAWN BY LBM	OCT 27 2012
CHECKED BY	
PROJECT MGR	
CLIENT APPR.	

Bac Tech Environmental Corporation

SECONDARY BIOOXIDATION REACTORS
P AND ID
COMMERCIAL BIOLEACH PLANT
SNOW LAKE BACOX

JOB NO.
DWG. NO. BTE-P-003
REV NO. 1
DATE



P–711A COOLING WATER SUPPLY PUMP # 1
P–711B COOLING WATER SUPPLY PUMP # 2
P–711C COOLING WATER SUPPLY PUMP # 3
P–712 ANTI–SCALENT DOSING PUMP
SC–701 ANTI–SCALENT DRUM DOSING PUMP SPEED CONTROLLER
TI–703 COOLING WATER RETURN TEMPERATURE INDICATOR
TI–701 COOLING WATER SUPPLY TEMPERATURE INDICATOR
TIT–701 COOLING WATER SUPPLY TEMPERATURE INDICATOR TRANSMITTER
TE–701 COOLING WATER SUPPLY TEMPERATURE ELEMENT
FE–701 COOLING WATER SUPPLY FLOW ELEMENT
FIT–701 COOLING WATER SUPPLY FLOW INDICATOR TRANSMITTER
FI–701 COOLING WATER SUPPLY FLOW INDICATOR
FLAL–701 COOLING WATER SUPPLY FLOW LEVEL LOW ALARM
PI–701 COOLING WATER SUPPLY PRESSURE INDICATOR
PI–702 COOLING WATER SUPPLY PRESSURE INDICATOR POST AFTER COOLER SUPPLY
PCV–701 LP BLOWER # 1 PRESSURE CONTROL VALVE
PCV–702 LP BLOWER # 2 PRESSURE CONTROL VALVE
PI–703 LP BLOWER SUPPLY PRESSURE INDICATOR
PIC–701 LP BLOWER SUPPLY PRESSURE INDICATOR CONTROL
PIT–701 LP BLOWER SUPPLY PRESSURE INDICATOR TRANSMITTER
TI–702 LP BLOWER SUPPLY TEMPERATURE INDICATOR
KV–701 SIDE STREAM SAND FILTER INLET SOLENOID VALVE
KV–702 SAND FILTER INLET SOLENOID VALVE
KV–703 SAND FILTER BACK WASH SOLENOID VALVE
KV–704 SAND FILTER EXIT SOLENOID VALVE

AV–701 COOLING WATER COLLECTION SUMP CONDUCTIVITY FLOW CONTROL VALVE
AE–701 COOLING WATER COLLECTION SUMP CONDUCTIVITY ANALYZER ELEMENT
AIT–701 COOLING WATER COLLECTION SUMP CONDUCTIVITY INDICATOR TRANSMITTER
AIC–701 COOLING WATER COLLECTION SUMP CONDUCTIVITY INDICATOR CONTROL
AI–701 COOLING WATER COLLECTION SUMP CONDUCTIVITY INDICATOR
AE–702 COOLING WATER COLLECTION SUMP PH ANALYZER ELEMENT
AIT–702 COOLING WATER COLLECTION SUMP PH INDICATOR TRANSMITTER
AI–702 COOLING WATER COLLECTION SUMP PH INDICATOR

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DWG. NO.	TITLE	DWG. NO.	TITLE	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT
1	GENERAL REVISION	LBM		13NOV12	
2	GENERAL REVISION	LBM		15NOV12	

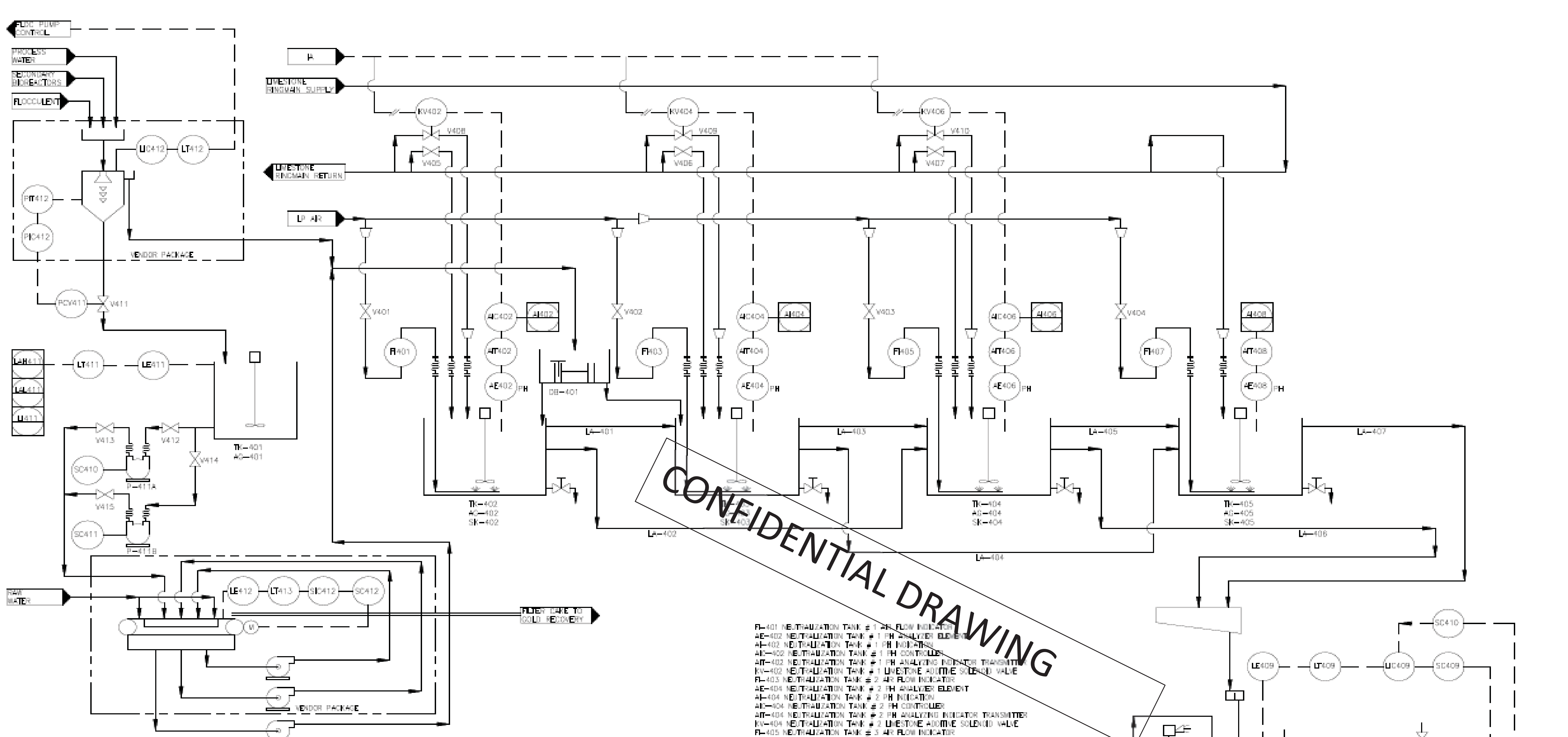
SCALE: NONE	DATE
DESIGNED BY	
DRAWN BY LBM	NOV 01 2012
CHECKED BY	
PROJECT MGR	
CLIENT APPR.	

BacTech

Bac Tech Environmental Corporation

COOLING WATER , LP AIR SERVICES AND EMERGENCY POWER P AND ID COMMERCIAL BIOLEACH PLANT SNOW LAKE BACOX

JOB NO.
DWG NO. BTE–P–009
REV NO. 2
DATE



PCV-411 THICKENER UNDERFLOW PRESSURE CONTROL VALVE
LE-411 FILTER SURGE TANK LEVEL ELEMENT
LT-411 FILTER SURGE TANK LEVEL TRANSMITTER
LAH-411 FILTER SURGE TANK LEVEL ALARM HIGH
LAL-411 FILTER SURGE TANK LEVEL ALARM LOW
LI-411 FILTER SURGE TANK LEVEL INDICATOR
SC-410 FILTER FEED PUMP # 1 SPEED CONTROLLER
SC-411 FILTER FEED PUMP # 2 SPEED CONTROLLER
LT-412 HIGH RATE THICKENER LEVEL TRANSMITTER
LIC-412 HIGH RATE THICKENER LEVEL INDICATOR CONTROLLER
PIT-412 HIGH RATE THICKENER PRESSURE INDICATOR TRANSMITTER
PIC-412 HIGH RATE THICKENER PRESSURE INDICATOR CONTROL
SC-412 BELT FILTER MOTOR SPEED CONTROLLER
SIC-412 BELT FILTER MOTOR SPEED INDICATOR CONTROLLER
LE-412 BELT FILTER CAKE LEVEL ELEMENT
LT-413 BELT FILTER CAKE LEVEL TRANSMITTER

TK-401 FILTER SURGE TANK
AG-401 FILTER SURGE TANK AGITATOR
TK-402 NEUTRALIZATION TANK # 1
AG-402 NEUTRALIZATION TANK # 1 AGITATOR
SK-402 NEUTRALIZATION TANK # 1 SPARGE RING
TK-403 NEUTRALIZATION TANK # 2
AG-403 NEUTRALIZATION TANK # 2 AGITATOR
SK-403 NEUTRALIZATION TANK # 2 SPARGE RING
TK-404 NEUTRALIZATION TANK # 3
AG-404 NEUTRALIZATION TANK # 3 AGITATOR
SK-404 NEUTRALIZATION TANK # 3 SPARGE RING
TK-405 NEUTRALIZATION TANK # 4
AG-405 NEUTRALIZATION TANK # 4 AGITATOR
SK-405 NEUTRALIZATION TANK # 4 SPARGE RING

P-411A FILTER FEED PUMP # 1
P-411B FILTER FEED PUMP # 2
P-412 FILTRATE FEED PUMP
SU-401 NEUTRALIZATION AREA SUMP
P-414 NEUTRALIZATION AREA SUMP PUMP
HP-401 NEUTRALIZED SOLUTION HOPPER
P-413A NEUTRALIZATION SOLUTION TRANSFER PUMP # 1
P-413B NEUTRALIZATION SOLUTION TRANSFER PUMP # 2
DB-401 NEUTRALIZATION FEED BOX
LA-401 SOLUTION NEUTRALIZATION LAUNDER # 1
LA-402 SOLUTION NEUTRALIZATION LAUNDER # 2
LA-403 SOLUTION NEUTRALIZATION LAUNDER # 3
LA-404 SOLUTION NEUTRALIZATION LAUNDER # 4
LA-405 SOLUTION NEUTRALIZATION LAUNDER # 5
LA-406 SOLUTION NEUTRALIZATION LAUNDER # 6
LA-407 SOLUTION NEUTRALIZATION LAUNDER # 7

FI-401 NEUTRALIZATION TANK # 1 AIR FLOW INDICATOR
AE-402 NEUTRALIZATION TANK # 1 PH ANALYZER ELEMENT
AI-402 NEUTRALIZATION TANK # 1 PH INDICATION
AIC-402 NEUTRALIZATION TANK # 1 PH CONTROLLER
AIT-402 NEUTRALIZATION TANK # 1 PH ANALYZING INDICATOR TRANSMITTER
KV-402 NEUTRALIZATION TANK # 1 LIMESTONE ADDITIVE SOLENOID VALVE
FI-403 NEUTRALIZATION TANK # 2 AIR FLOW INDICATOR
AE-404 NEUTRALIZATION TANK # 2 PH ANALYZER ELEMENT
AI-404 NEUTRALIZATION TANK # 2 PH INDICATION
AIC-404 NEUTRALIZATION TANK # 2 PH CONTROLLER
AIT-404 NEUTRALIZATION TANK # 2 PH ANALYZING INDICATOR TRANSMITTER
KV-404 NEUTRALIZATION TANK # 2 LIMESTONE ADDITIVE SOLENOID VALVE
FI-405 NEUTRALIZATION TANK # 3 AIR FLOW INDICATOR
AE-406 NEUTRALIZATION TANK # 3 PH ANALYZER ELEMENT
AI-406 NEUTRALIZATION TANK # 3 PH INDICATION
AIC-406 NEUTRALIZATION TANK # 3 PH CONTROLLER
AIT-406 NEUTRALIZATION TANK # 3 PH ANALYZING INDICATOR TRANSMITTER
KV-406 NEUTRALIZATION TANK # 3 LIMESTONE ADDITIVE SOLENOID VALVE
FI-407 NEUTRALIZATION TANK # 4 AIR FLOW INDICATOR
AE-408 NEUTRALIZATION TANK # 4 PH ANALYZER ELEMENT
AI-408 NEUTRALIZATION TANK # 4 PH INDICATION
AIT-408 NEUTRALIZATION TANK # 4 PH ANALYZING INDICATOR TRANSMITTER
LE-409 NEUTRALIZED SOLUTION HOPPER LEVEL ELEMENT
LT-409 NEUTRALIZED SOLUTION HOPPER LEVEL INDICATOR
LIC-409 NEUTRALIZED SOLUTION HOPPER LEVEL CONTROLLER
LIT-409 NEUTRALIZED SOLUTION HOPPER LEVEL INDICATING TRANSMITTER
SC-409A HOPPER TRANSFER PUMP # 1 SPEED CONTROLLER
SC-410 HOPPER TRANSFER PUMP # 2 SPEED CONTROLLER
LAH-410 NEUTRALIZATION AREA SUMP LEVEL HIGH ALARM
LSH-410 NEUTRALIZATION AREA SUMP LEVEL SWITCH HIGH

REFERENCES	
DWG. NO.	TITLE

REFERENCES	
DWG. NO.	TITLE

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT
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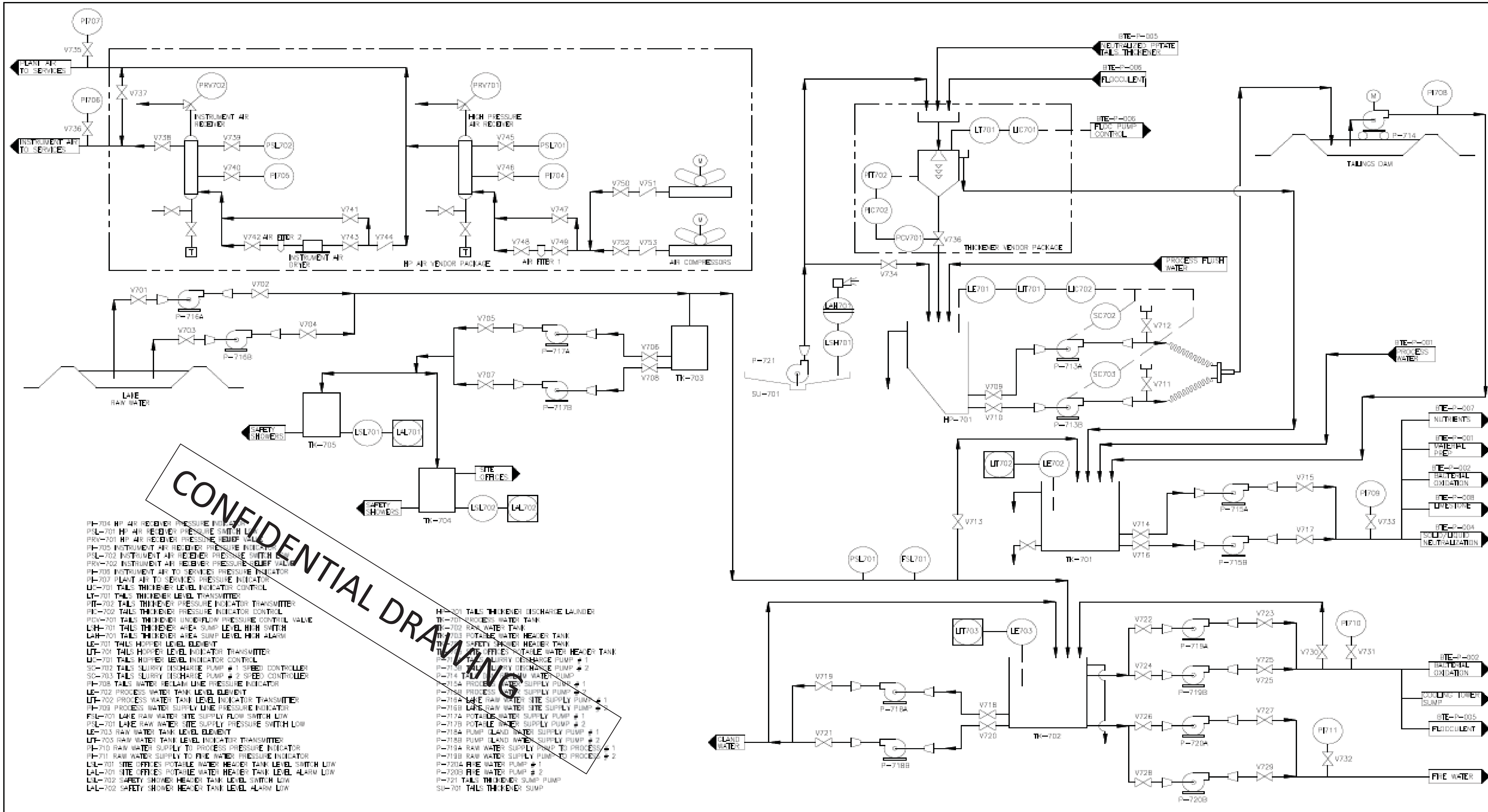
3	GENERAL REVISION	LBM		05NOV12	
4	GENERAL REVISION	LBM		13NOV12	
5	GENERAL REVISION	LBM		15NOV12	
6	GENERAL REVISION	LBM		19NOV12	

SCALE: NONE	DATE
DESIGNED BY	
DRAWN BY LBM	SEPT 05 2012
CHECKED BY	
PROJECT MGR	
CLIENT APPR.	

Bac Tech Environmental Corporation

SOLID / LIQUID SEPARATION AND NEUTRALIZATION P AND ID COMMERCIAL BIOLEACH PLANT SNOW LAKE BACOX

JOB NO.
DWG. NO. **BTE-P-004**
REV NO. 6
DATE



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SCALE: NONE | DATE
DESIGNED BY
DRAWN BY: LBM — NOV 15 2012
CHECKED BY
PROJECT MGR
CLIENT APPR.

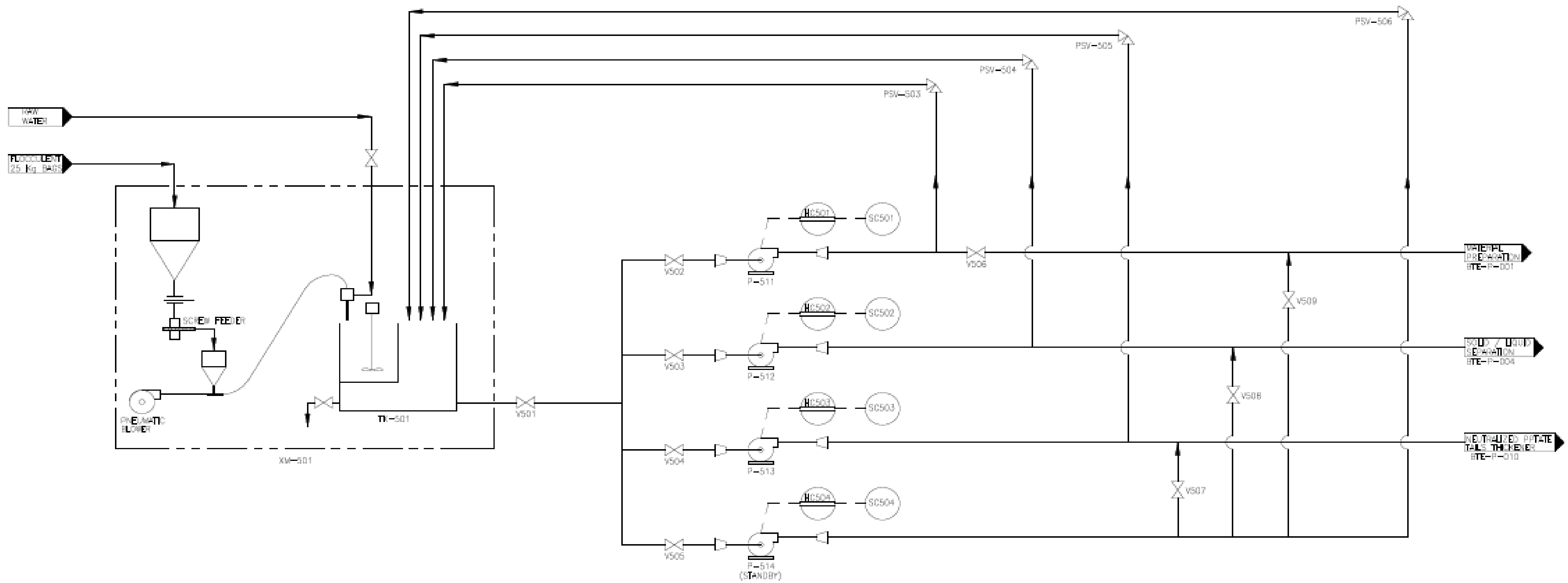
BacTech

Bac Tech Environmental Corporation

WATER SUPPLY, TAILS DISCHARGE, AND HP AIR SERVICES P AND ID COMMERCIAL BIOLEACH PLANT SNOW LAKE BACOX

JOB NO.
DWG. NO. **BTE-P-010**
REV NO. | DATE

CONFIDENTIAL DRAWING



TK-501 FLOCCULENT MIX / STORAGE TANK
XM-501 FLOCCULENT MIXING PACKAGE
P-511 DOSING PUMP TO MATERIAL PREPARATION
P-512 DOSING PUMP TO SOLID / LIQUID SEPARATION
P-513 DOSING PUMP TO NEUTRALIZED TAILS THICKENER
P-514 DOSING PUMP STANDBY

HC-501 FLOCCULENT DOSING PUMP # 1 SPEED HAND CONTROLLER
SC-501 FLOCCULENT DOSING PUMP # 1 (VSD) SPEED CONTROLLER
PSV-503 FLOCCULENT DOSING PUMP # 1 DISCHARGE PRESSURE VALVE
HC-502 FLOCCULENT DOSING PUMP # 2 SPEED HAND CONTROLLER
SC-502 FLOCCULENT DOSING PUMP # 2 (VSD) SPEED CONTROLLER
PSV-504 FLOCCULENT DOSING PUMP # 2 DISCHARGE PRESSURE VALVE
HC-503 FLOCCULENT DOSING PUMP # 3 SPEED HAND CONTROLLER
SC-503 FLOCCULENT DOSING PUMP # 3 (VSD) SPEED CONTROLLER
PSV-505 FLOCCULENT DOSING PUMP # 3 DISCHARGE PRESSURE VALVE
HC-504 FLOCCULENT DOSING PUMP # 4 SPEED HAND CONTROLLER
SC-504 FLOCCULENT DOSING PUMP # 4 (VSD) SPEED CONTROLLER
PSV-506 FLOCCULENT DOSING PUMP # 4 DISCHARGE PRESSURE VALVE

REFERENCES		REFERENCES	
DWG. NO.	TITLE	DWG. NO.	TITLE

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT
1	GENERAL REVISION	LBM		13NOV12	
2	GENERAL REVISION	LBM		15NOV12	

SCALE:	NONE	DATE
DESIGNED BY		
DRAWN BY	LBM	OCT 25 2012
CHECKED BY		
PROJECT MGR		
CLIENT APPR.		

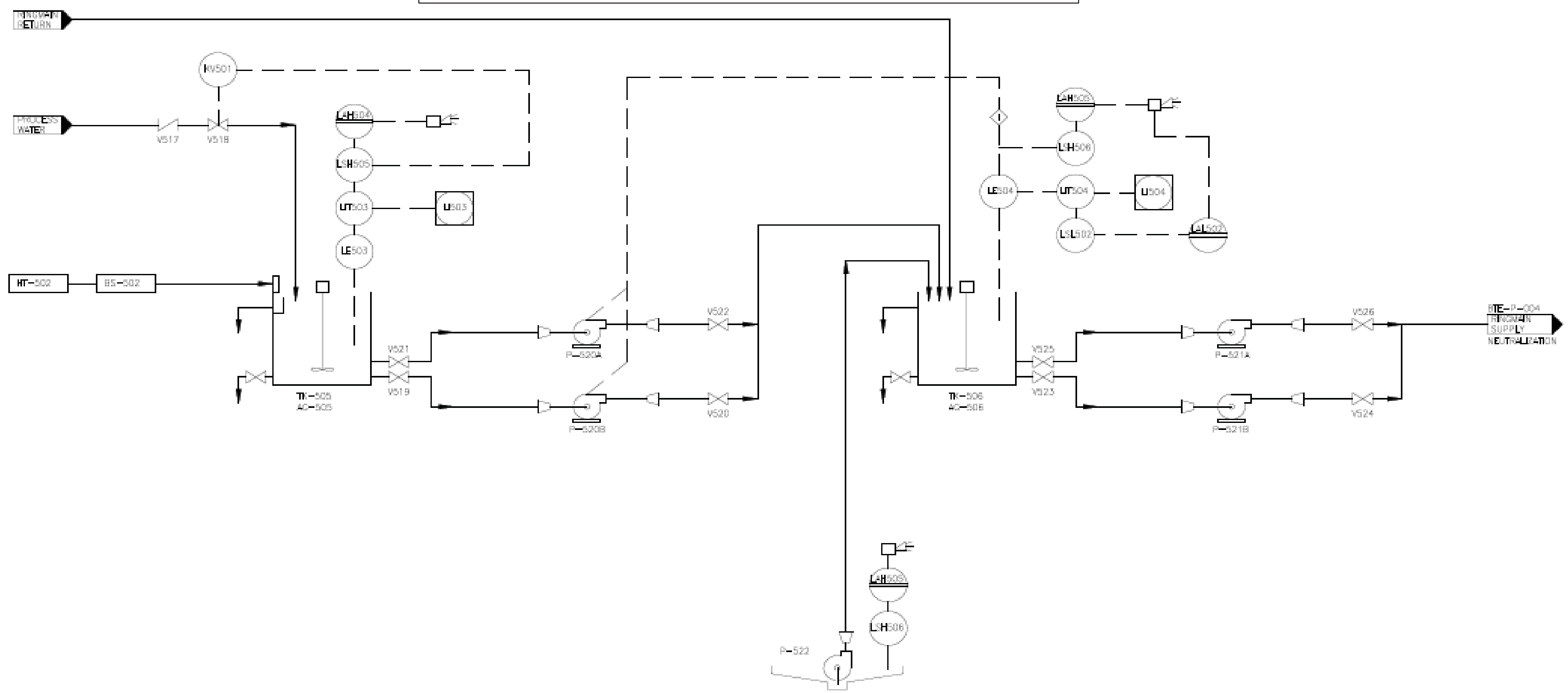
BacTech

Bac Tech Environmental Corporation

FLOCCULENT MAKE-UP ,DISTRIBUTION
P AND ID
COMMERCIAL BIOLEACH PLANT
SNOW LAKE BACOX

JOB NO.
DWG NO. BTE-P-005
REV NO. 2
DATE

CONFIDENTIAL DRAWING



HT-502 LIMESTONE BAG LIFT HOIST
BS-502 LIMESTONE BAG SPLITTER
TK-507 LIMESTONE MIXING TANK
AG-507 LIMESTONE MIXING TANK AGITATOR
TK-508 LIMESTONE STORAGE TANK
AG-508 LIMESTONE STORAGE TANK AGITATOR

P-520A LIMESTONE TRANSFER PUMP # 1
P-520B LIMESTONE TRANSFER PUMP # 2
P-521A LIMESTONE SLURRY CIRCULATION PUMP # 1
P-521B LIMESTONE SLURRY CIRCULATION PUMP # 2
P-522 LIMESTONE SUMP PUMP

KV-501 LIMESTONE MIXING TANK RAW WATER SOLENOID VALVE
LAH-504 LIMESTONE MIXING TANK LEVEL ALARM HIGH
LSH-505 LIMESTONE MIXING TANK LEVEL SWITCH HIGH
LIT-503 LIMESTONE MIXING TANK LEVEL INDICATOR TRANSMITTER
LI-503 LIMESTONE MIXING TANK LEVEL INDICATOR
LE-503 LIMESTONE MIXING TANK LEVEL ELEMENT
LE-504 LIMESTONE SLURRY STORAGE TANK LEVEL ELEMENT
LIT-504 LIMESTONE SLURRY STORAGE TANK LEVEL INDICATOR TRANSMITTER
LI-504 LIMESTONE SLURRY STORAGE TANK LEVEL INDICATOR
LSL-502 LIMESTONE SLURRY STORAGE TANK LEVEL SWITCH LOW
LAL-502 LIMESTONE SLURRY STORAGE TANK LEVEL ALARM LOW
LSH-506 LIMESTONE SLURRY STORAGE TANK LEVEL SWITCH HIGH
LAH-505 LIMESTONE SLURRY STORAGE TANK LEVEL ALARM HIGH
LSH-506 LIMESTONE SUMP LEVEL SWITCH HIGH
LAH-505 LIMESTONE SUMP LEVEL ALARM HIGH

REFERENCES		REFERENCES		REVISIONS						REVISIONS					
DWG. NO.	TITLE	DWG. NO.	TITLE	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT
										1	GENERAL REVISION	LBM		13NOV12	
										1	GENERAL REVISION	LBM		13NOV12	

SCALE: NONE	DATE	
DESIGNED BY		
DRAWN BY	LBM	OCT 25 2012
CHECKED BY		
PROJECT MGR		
CLIENT APPR.		

BacTech

Bac Tech Environmental Corporation

LIMESTONE SLURRY PREPARATION
P AND ID
COMMERCIAL BIOLEACH PLANT
SNOW LAKE BACOX

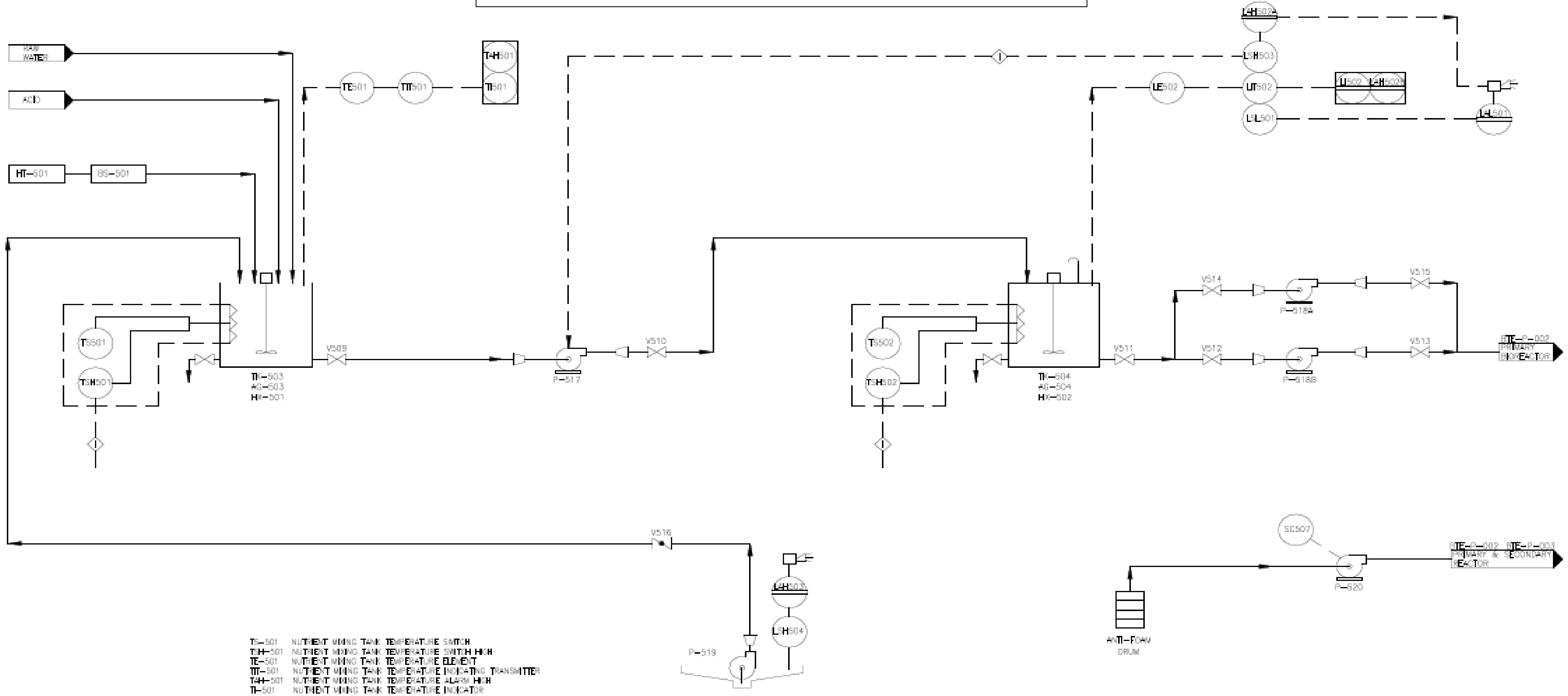
JOB NO.

DWG. NO. **BTE-P-008**

REV. NO. **2**

DATE

CONFIDENTIAL DRAWING



HT–501 NUTRIENT PALLET LIFT HOIST
BS–501 NUTRIENT BAG SPLITTER
TK–503 NUTRIENT MIXING TANK
HX–501 NUTRIENT MIXING TANK HEATER
AG–503 NUTRIENT MIXING TANK AGITATOR
TK–504 NUTRIENT STORAGE TANK
HX–502 NUTRIENT STORAGE TANK HEATER
AG–504 NUTRIENT STORAGE TANK AGITATOR
P–517 NUTRIENT TRANSFER PUMP
P–518A NUTRIENT DELIVERY PUMP # 1
P–518B NUTRIENT DELIVERY PUMP # 2
P–519 NUTRIENT SUMP PUMP
P–520 ANTI–FOAM DOSING PUMP

TS–501 NUTRIENT MIXING TANK TEMPERATURE SWITCH
TSH–501 NUTRIENT MIXING TANK TEMPERATURE SWITCH HIGH
TE–501 NUTRIENT MIXING TANK TEMPERATURE ELEMENT
TIT–501 NUTRIENT MIXING TANK TEMPERATURE INDICATING TRANSMITTER
TAH–501 NUTRIENT MIXING TANK TEMPERATURE ALARM HIGH
TI–501 NUTRIENT MIXING TANK TEMPERATURE INDICATOR
TS–502 NUTRIENT STORAGE TANK TEMPERATURE SWITCH
TSH–502 NUTRIENT STORAGE TANK TEMPERATURE SWITCH HIGH
LE–502 NUTRIENT STORAGE TANK LEVEL ELEMENT
LSL–501 NUTRIENT STORAGE TANK LEVEL SWITCH LOW
LIT–502 NUTRIENT STORAGE TANK LEVEL INDICATING TRANSMITTER
LSH–503 NUTRIENT STORAGE TANK LEVEL SWITCH HIGH
LAH–502A NUTRIENT STORAGE TANK LEVEL ALARM HIGH (AUXILIARY CONTROL PANEL)
LAH–502B NUTRIENT STORAGE TANK LEVEL ALARM HIGH (MAIN CONTROL PANEL)
LI–502 NUTRIENT STORAGE TANK LEVEL INDICATOR
LAH–502B NUTRIENT STORAGE TANK LEVEL ALARM HIGH
LAL–501 NUTRIENT STORAGE TANK LEVEL ALARM LOW
LSH–504 NUTRIENT AREA SUMP LEVEL SWITCH HIGH
LAH–503 NUTRIENT AREA SUMP LEVEL ALARM HIGH
SC–507 ANTI–FOAM DOSING PUMP SPEED CONTROLLER

REFERENCES		REFERENCES		REVISIONS						REVISIONS					
DWG. NO.	TITLE	DWG. NO.	TITLE	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT
										1	GENERAL REVISION	LBM		13NOV12	
										2	GENERAL REVISION	LBM		15NOV12	

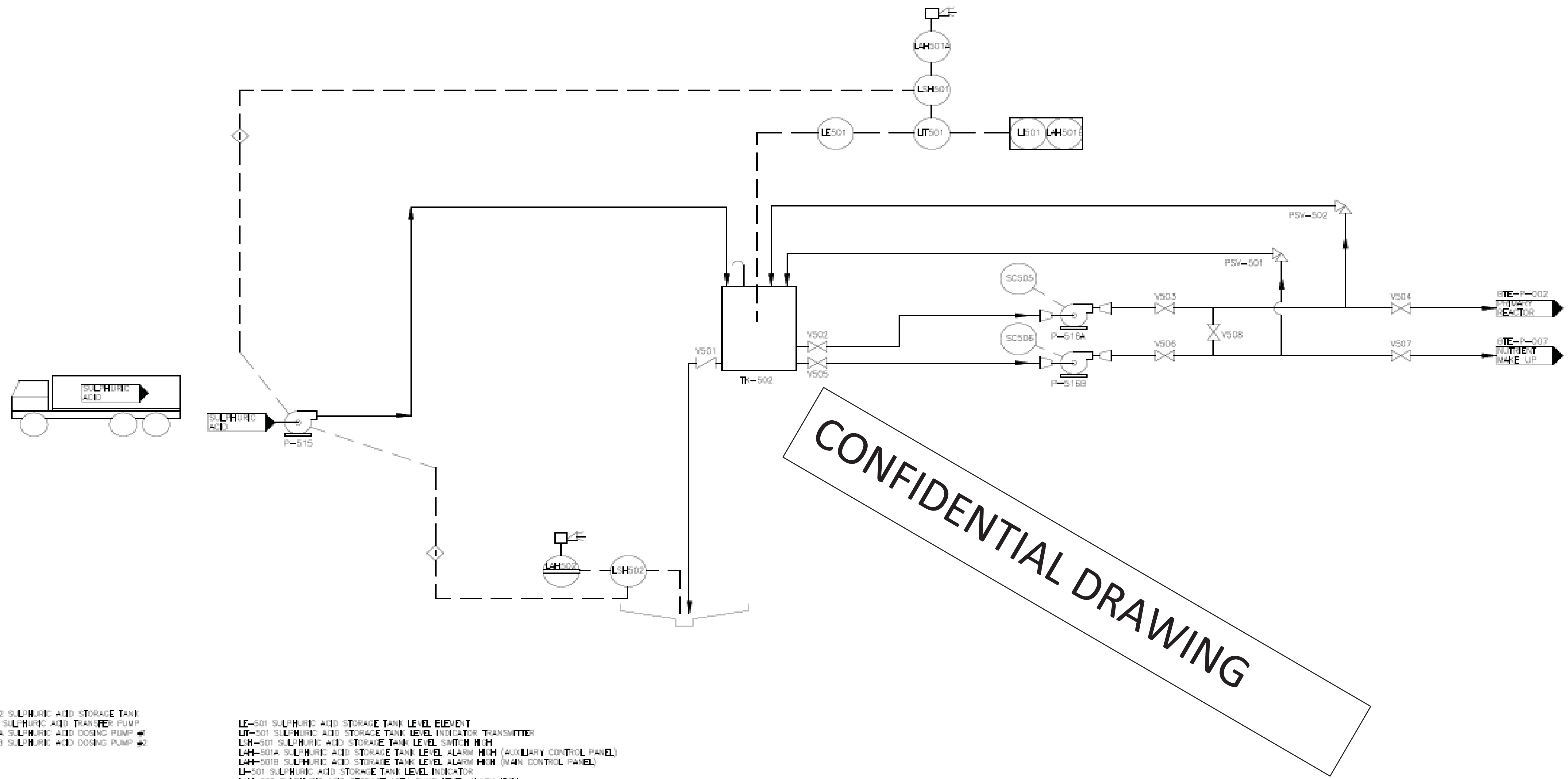
SCALE: NONE		DATE
DESIGNED BY		
DRAWN BY	LBM	OCT 23 2012
CHECKED BY		
PROJECT MGR.		
CLIENT APPR.		

BacTech

Bac Tech Environmental Corporation

NUTRIENT MAKE–UP, STORAGE, DELIVERY AND ANTI–FOAM P AND ID
COMMERCIAL BIOLEACH PLANT
SNOW LAKE BACOX

JOB NO.
DWG. NO. BTE–P–007
REV NO. 2
DATE



TK-502 SULPHURIC ACID STORAGE TANK
P-515 SULPHURIC ACID TRANSFER PUMP
P-516A SULPHURIC ACID DOSING PUMP #1
P-516B SULPHURIC ACID DOSING PUMP #2

LE-501 SULPHURIC ACID STORAGE TANK LEVEL ELEMENT
LIT-501 SULPHURIC ACID STORAGE TANK LEVEL INDICATOR TRANSMITTER
LSH-501 SULPHURIC ACID STORAGE TANK LEVEL SWITCH HIGH
LAH-501A SULPHURIC ACID STORAGE TANK LEVEL ALARM HIGH (AUXILIARY CONTROL PANEL)
LAH-501B SULPHURIC ACID STORAGE TANK LEVEL ALARM HIGH (MAIN CONTROL PANEL)
LI-501 SULPHURIC ACID STORAGE TANK LEVEL INDICATOR
LAH-502 SULPHURIC ACID STORAGE AREA SUMP LEVEL ALARM HIGH
LSH-502 SULPHURIC ACID STORAGE AREA SUMP LEVEL SWITCH HIGH
SC-505 SULPHURIC ACID PUMP # 1 SPEED CONTROLLER
SC-506 SULPHURIC ACID PUMP # 2 SPEED CONTROLLER
PSV-501 PRESSURE SWITCH VALVE FOR ACID DOSING PUMP TO NUTRIENT
PSV-502 PRESSURE SWITCH VALVE FOR ACID DOSING PUMP TO PRIMARY REACTORS

REFERENCES		REFERENCES	
DWG. NO.	TITLE	DWG. NO.	TITLE

REVISIONS						
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT
1	GENERAL REVISION	LBM		13NOV12	
2	GENERAL REVISION	LBM		15NOV12	

SCALE: NONE	DATE
DESIGNED BY	
DRAWN BY LBM	OCT 22 2012
CHECKED BY	
PROJECT MGR	
CLIENT APPR.	

BacTech

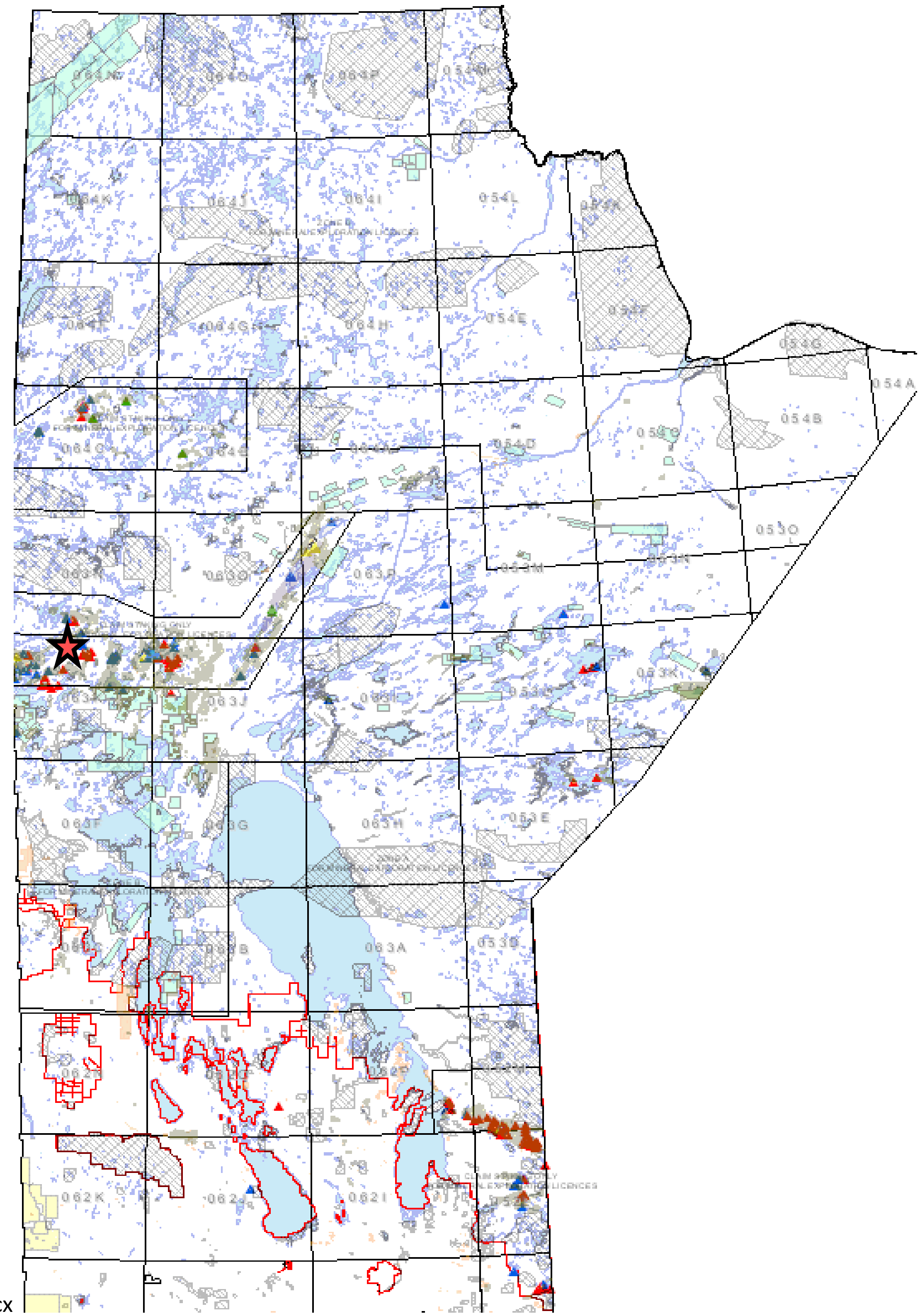
Bac Tech Environmental Corporation

SULPHURIC ACID DISTRIBUTION
P AND ID
COMMERCIAL BIOLEACH PLANT
SNOW LAKE BACOX

JOB NO.
DWG NO. **BTE-P-006**
REV NO. **2** DATE

Appendix C Mineral Lease Map

MANITOBA'S MINERAL LEASE MAP



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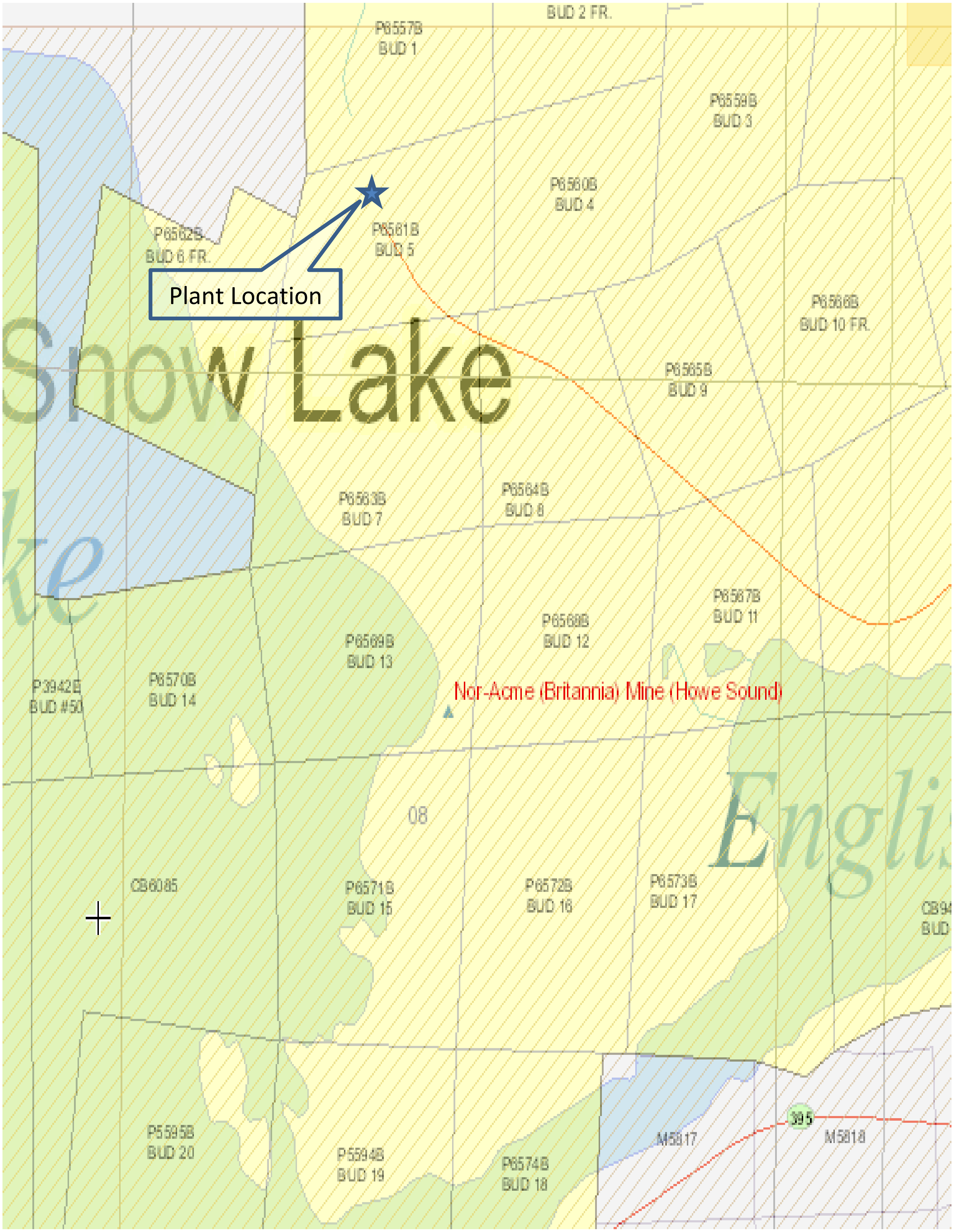
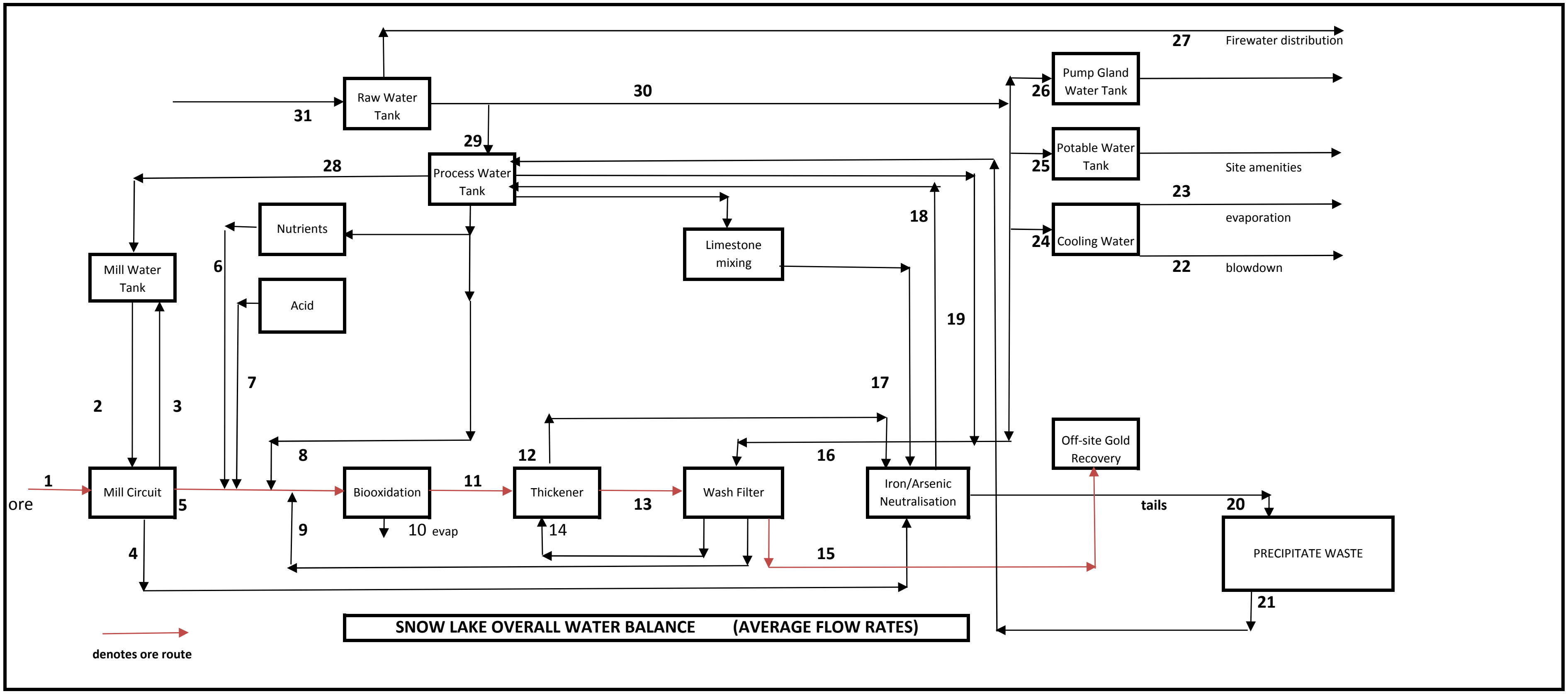
MANITOBA'S MINERAL LEASE MAP



Appendix D Water Balance



Stream	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
tph	0.9	6.18	1.36	1.36	4.36	0.04	0.65	22.41	15.00	2.33	40.13	41.29	4.38	5.54	1.57

Stream	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
tph	17.73	5.49	30.24	6.43	17.9	8.95	0.3	11	11.3	0.5	2	-	4.82	0	25.1

Stream	31
tph	25.1

Services and Water Circuit (see separate water balance sheet)

SNOW LAKE PROJECT

Stream No	Raw water inventory						Process water inventory						
Stream Description	Raw water to raw water tank	Fire water distribution	Raw water tk to Bacox residue wash filter	Raw water tk to cooling water Make-up	Raw water tk to Pump gland seals allowance	Raw water tk to Potable Water site usage	Raw water tk to process water tank	Tailings Return water to process water tank	Neutralised Return water to process water tank	Process water to Bacox Make-up	Process water to Mill water tank	Process water to Limestone Mixing	Process water to wash filter	Process water to Nutrient Mixing
Water Mass Flow t/h*	25.1	-	11.3	11.3	2	0.5	0	8.95	30.24	22.41	4.82	5.49	6.43	0.04

* (all units metric)

Mass Balance

SNOW LAKE PROJECT

	Milling Circuit										
Stream No											
Stream Description	Feed Repulp	Mill Repulp Water	Mill Pulp Feed	Cyclone U/F	Total Mill Feed	Cyclone O/F	Thick Floc Dil	Thickener O/F	Thickener O/F rtn Mill Water tk	Thickener O/F SCN bleed to Neutralisation	Thickener U/F
Stream Mass Flow t/h	5.62	6.18	11.80	22.03	33.84	11.80	0.00	2.72	1.36	1.36	9.08
Stream Volume Flow m^3/h	2.08	6.18	8.26	9.64	17.90	8.26	0.00	2.72	1.36	1.36	5.54
Stream SG	2.70	1.00	1.43	2.29	1.89	1.43	0.00	1.00	1.00	1.00	1.64
Solids Mass Flow t/h	4.72	0.00	4.72	16.53	21.25	4.72	0.00	0.00	0.00	0.00	4.72
Solids Volume Flow m^3/h	1.18	0.00	1.18	4.13	5.31	1.18	0.00	0.00	0.00	0.00	1.18
Solids SG	4.00	0.00	4.00	4.00	4.00	4.00	0.00	0.00	0.00	0.00	4.00
Solution Mass Flow t/h	0.90	6.18	7.08	5.51	12.59	7.08	0.00	2.72	1.36	1.36	4.36
Solution Volume Flow m^3/h	0.90	6.18	7.08	5.51	12.59	7.08	0.00	2.72	1.36	1.36	4.36
Solution SG	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Stream Density % solids w/w	84	0	40	75	63	40	0	0	0	0	52
Operating Time h/d	24	24	24	24	24	24	0	24	24	24	24
Solids kg/h Iron	1189	0	1189	4161	5350	1189	0	0	0	0	1189
Solids kg/h Arsenic	1032	0	1032	3613	4645	1032	0	0	0	0	1032
Solids Assay ppm Au	9.68	0.00	9.68	9.68	9.68	9.68	0.00	0.00	0.00	0.00	9.68
Solids Assay ppm Ag	2.17	0.00	2.17	2.17	2.17	2.17	0.00	0.00	0.00	0.00	2.17
Solution kg/h Iron	0	0	0	0	0	0	0	0	0	0	0
Solution kg/h Arsenic	0	0	0	0	0	0	0	0	0	0	0
Solution Assay ppm Au	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solution Assay ppm Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAu/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAg/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Bioleach											Cooling v			
Stream No															
Stream Description	Bioleach Stock Tk Feed	Process water	Dirty Filter Spray Water to bacox feed	Sulphuric acid	Nutrients	Total Bioleach Feed	Cool water	Air	Bacox Product	Hot water to C/tower	Evap loss Vent	Cooling water Make -up	Sidestream Filter Prod	Blowers a/Cooler Return	Total Cooling Water
Stream Mass Flow t/h	9.08	22.41	15.00	0.65	0.04	47.19	346.00	27.00	42.49	346.00	31.69	11.30	40.00	42.00	388.00
Stream Volume Flow m^3/h	5.54	22.41	15.00	0.35	0.04	37.81	346.00	25,156	39.10	346.00	23,309	11.30	40.00	42.00	388.00
Stream SG	1.64	1.00	1.00	1.86	1.00	1.25	1.00	0.00	1.09	1.00	0.00	1.00	1.00	1.00	1.00
Solids Mass Flow t/h	4.72	0.00	0.00	0.00	0.00	4.72	0.00	0.00	2.36	0.00	0.00	0.00	0.00	0.00	0.00
Solids Volume Flow m^3/h	1.18	0.00	0.00	0.00	0.00	1.18	0.00	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00
Solids SG	4.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	2.70	0.00	0.00	0.00	0.00	0.00	0.00
Solution Mass Flow t/h	4.36	22.41	15.00	0.65	0.04	42.46	346.00	0.00	40.13	346.00	2.33	11.30	40.00	42.00	388.00
Solution Volume Flow m^3/h	4.36	22.41	15.00	0.35	0.04	42.46	346.00	0.00	38.22	346.00	2.33	11.30	40.00	42.00	388.00
Solution SG	1.00	1.00	1.00	1.84	1.00	1.00	1.00	0.00	1.05	1.00	1.00	1.00	1.00	1.00	1.00
Stream Density % solids w/w	52	0	0	0	0	10	0	0	6	0	0	0	0	0	0
Operating Time h/d	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Solids kg/h Iron	1189	0	0	0	0	1189	0	0	156	0	0	0	0	0	0
Solids kg/h Arsenic	1032	0	0	0	0	1032	0	0	204	0	0	0	0	0	0
Solids Assay ppm Au	9.68	0.00	0.00	0.00	0.00	9.68	0.00	0.00	16.20	0.00	0.00	0.00	0.00	0.00	0.00
Solids Assay ppm Ag	2.17	0.00	0.00	0.00	0.00	2.17	0.00	0.00	3.62	0.00	0.00	0.00	0.00	0.00	0.00
Solution kg/h Iron	0	0	0	0	0	0	0	0	1032	0	0	0	0	0	0
Solution kg/h Arsenic	0	0	0	0	0	0	0	0	828	0	0	0	0	0	0
Solution Assay ppm Au	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solution Assay ppm Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAu/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAg/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tails Streams Summary

SNOW LAKE PROJECT

	PRECPITATE TAIL		
Stream No			
Stream Description	Stream after neutralisation to precipitate tails	Return Water from Tails to Plant	Settled slurry remaining in tails
Stream Mass Flow t/h	25.40	8.95	16.45
Stream Volume Flow m^3/h	20.90	8.95	11.95
Stream SG	1.22	1.00	1.38
Solids Mass Flow t/h	7.50	0.00	7.50
Solids Volume Flow m^3/h	3.00	0.00	3.00
Solids SG	2.50	0.00	2.50
Solution Mass Flow t/h	17.90	8.95	8.95
Solution Volume Flow m^3/h	17.90	8.95	8.95
Solution SG	1.00	1.00	1.00
Stream Density % solids w/w	30	0	46
Operating Time h/d	24	24	24
Solids kg/h Iron	1026	0	1026
Solids kg/h Arsenic	824	0	824
Solids Assay ppm Au	0.00	0.00	0.00
Solids Assay ppm Ag	0.00	0.00	0.00
Solution Assay kg/h Iron	0.00	0.00	0.00
Solution Assay kg/h Iron	0.00	0.00	0.00
Solution Assay ppm Au	0.00	0.00	0.00
Solution Assay ppm Ag	0.00	0.00	0.00
Carbon Assay gAu/t	0.00	0.00	0.00
Carbon Assay gAg/t	0.00	0.00	0.00

Services and Water Circuit (see

Mass Balance

SNOW LAKE PROJECT

vater services				
Stream No				
Stream Description	Cooling Evaporation	Blowdown	Sidestream Filter feed	Blowers a/Cooler water Feed
Stream Mass Flow t/h	11.00	0.30	40.00	42.00
Stream Volume Flow m^3/h	11.00	0.30	40.00	42.00
Stream SG	1.00	1.00	1.00	1.00
Solids Mass Flow t/h	0.00	0.00	0.00	0.00
Solids Volume Flow m^3/h	0.00	0.00	0.00	0.00
Solids SG	0.00	0.00	0.00	0.00
Solution Mass Flow t/h	11.00	0.30	40.00	42.00
Solution Volume Flow m^3/h	11.00	0.30	40.00	42.00
Solution SG	1.00	1.00	1.00	1.00
Stream Density % solids w/w	0	0	0	0
Operating Time h/d	24	24	24	24
Solids kg/h Iron	0	0	0	0
Solids kg/h Arsenic	0	0	0	0
Solids Assay ppm Au	0.00	0.00	0.00	0.00
Solids Assay ppm Ag	0.00	0.00	0.00	0.00
Solution kg/h Iron	0	0	0	0
Solution kg/h Arsenic	0	0	0	0
Solution Assay ppm Au	0.00	0.00	0.00	0.00
Solution Assay ppm Ag	0.00	0.00	0.00	0.00
Carbon Assay gAu/t	0.00	0.00	0.00	0.00
Carbon Assay gAg/t	0.00	0.00	0.00	0.00

Solid Liquid Separation and washing												
Stream No												
Stream Description	Thickener Feed from Bacox	Total Thickener feed	Thick Floc Dil	Thickener U/F	Thickener O/F	Raw water Filter First Wash	Raw water Filter Final Wash	Raw water Filter Belt Spray	Process water Filter Belt Spray	Dirty Spray water to Sump	Belt Filter discharge	Belt Filter Filtrate to Thickener
Stream Mass Flow t/h	42.49	48.03	0.00	6.74	41.29	5.00	1.73	4.57	6.43	15.00	3.93	5.54
Stream Volume Flow m^3/h	39.10	44.64	0.00	5.04	39.32	5.00	1.73	4.57	6.43	15.00	2.37	5.28
Stream SG	1.09	1.08	0.00	1.34	1.05	1.00	1.00	1.00	1.00	1.00	1.66	1.05
Solids Mass Flow t/h	2.36	2.36	0.00	2.36	0.00	0.00	0.00	0.00	0.00	0.00	2.36	0.00
Solids Volume Flow m^3/h	0.87	0.87	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.00
Solids SG	2.70	2.70	0.00	2.70	0.00	0.00	0.00	0.00	0.00	0.00	2.70	0.00
Solution Mass Flow t/h	40.13	45.67	0.00	4.38	41.29	5.00	1.73	4.57	6.43	15.00	1.57	5.54
Solution Volume Flow m^3/h	38.22	43.76	0.00	4.17	39.32	5.00	1.73	4.57	6.43	15.00	1.50	5.28
Solution SG	1.05	1.05	0.00	1.05	1.05	1.00	1.00	1.00	1.00	1.00	1.05	1.05
Stream Density % solids w/w	6	5	0	35	0	0	0	0	0	0	60	0
Operating Time h/d	24	24	24	24	24	24	24	24	24	24	24	24
Solids kg/h Iron	156	156	0	156	0	0	0	0	0	0	156	0
Solids kg/h Arsenic	204	204	0	204	0	0	0	0	0	0	204	0
Solids Assay ppm Au	16.20	16.20	0.00	16.20	0.00	0.00	0.00	0.00	0.00	0.00	16.20	0.00
Solids Assay ppm Ag	3.62	3.62	0.00	3.62	0.00	0.00	0.00	0.00	0.00	0.00	3.62	0.00
Solution kg/h Iron	1032	1139	0	113	1026	0	0	0	0	0	6	107
Solution kg/h Arsenic	828	914	0	90	824	0	0	0	0	0	4	86
Solution Assay ppm Au	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solution Assay ppm Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAu/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAg/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Liquor Neutralisation							
Stream No							
Stream Description	Total Feed Neut	Neut Limestone	Neut Air	Neut Product	Thick Floc Dil	Thickener U/F	O/F to process water tank
Stream Mass Flow t/h	42.65	8.46	0.17	55.64	0.00	25.40	30.24
Stream Volume Flow m^3/h	40.62	6.59	140.00	46.61	0.00	20.90	30.24
Stream SG	1.05	1.28	0.00	1.19	0.00	1.22	1.00
Solids Mass Flow t/h	0.00	2.97	0.00	7.50	0.00	7.50	0.00
Solids Volume Flow m^3/h	0.00	1.10	0.00	3.00	0.00	3.00	0.00
Solids SG	0.00	2.69	0.00	2.50	0.00	2.50	0.00
Solution Mass Flow t/h	42.65	5.49	0.00	48.14	0.00	17.90	30.24
Solution Volume Flow m^3/h	40.62	5.49	0.00	43.61	0.00	17.90	30.24
Solution SG	1.05	1.00	0.00	1.00	0.00	1.00	1.00
Stream Density % solids w/w	0	35	0	13	0	30	0
Operating Time h/d	24	24	24	24	24	24	24
Solids kg/h Iron	0	0	0	1026	0	1026	0
Solids kg/h Arsenic	0	0	0	824	0	824	0
Solids Assay ppm Au	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids Assay ppm Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solution kg/h Iron	1026	0	0	0	0	0	0
Solution kg/h Arsenic	824	0	0	0	0	0	0
Solution Assay ppm Au	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solution Assay ppm Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAu/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Assay gAg/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix E Application for Water Diversion and Use License

Print Form

FORM C

Application for Licence to Divert and Use Water

Manitoba Water Stewardship
Water Licensing Branch
Box 16, 200 Saulteaux Crescent
Winnipeg MB R3J 3W3

Pursuant *to The Water Rights Act*

APPLICANT'S NAME: BacTech Manitoba Corporation — TELEPHONE: 204 272 2412

POST OFFICE ADDRESS: 445 Ellice Avenue, suite 311, Winnipeg Manitoba, Canada, R3B 3P5

Hereby applies for authority to divert water from /

Snow Lake
(name of river, creek, etc)

by means of a pump located on the following described land:

LEGAL SUBDIVISION	OR QUARTER	SECTION	TOWNSHIP	RANGE	E OR W
8		18	68	17	W

or otherwise described as ______

for industrial purposes,
(domestic, municipal, agricultural, industrial, irrigation, other)

on the following described land:

LEGAL SUBDIVISION	OR QUARTER	SECTION	TOWNSHIP	RANGE	E OR W
		17	68	17	W

or otherwise described as: ______

at the following rates:
.0094 cubic metres per second
.816 cubic decametres per day
285.926 cubic decametres per year

Number of hectares to be irrigated: 0 (if applicable)

The above described lands are held as follows: (check applicable box)

- ☐ as registered owner
- ☐ lessee
- ☒ purchased under agreement for sale
- ☐ to be negotiated

Copy(s) of the certificate(s) of title or title number(s) must be included.

Is this application for renewal or transfer of an existing licence? ☐ yes ☒ no Previous licence no. N/A

Date: ______ 20 ____

______
(Signature of applicant)

FOR OFFICE USE ONLY

Application filed with the Executive Director, Infrastructure and Operations, at Winnipeg, Manitoba on

______, 20 _____.

______
(Signature of Executive Director)

** IMPORTANT **

FEE OF $50.00 MUST ACCOMPANY THIS APPLICATION, CHEQUE AND APPLICATION TO BE MAILED TO:

MANITOBA CONSERVATION
CASHIER'S OFFICE
BOX 42, 200 SAULTEAUX CRESCENT
WINNIPEG MB R3J 3W3

CHEQUES TO BE MADE PAYABLE TO MINISTER OF FINANCE

MG-14841

Appendix F Site Visit – Results and Analysis

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2012 SITE INVESTIGATION

A site visit was conducted from July 30 to August 4, 2012, to collect additional information on drainage patterns, water quality, fish communities and map fish habitat within the Study Area.

1 METHODS

1.1 Fish Presence/Absence Survey

Fish surveys were conducted according to Golder Associates Technical Procedure (TP) 8.1-3*, Fish Inventory Methods* (unpublished information). Backpack electro fishing was completed in Canada Creek, the drainage channel and wetlands within study area. Gee minnow traps were set overnight in Canada Creek and the drainage channel. Water samples were collected at six sites within the study area. Sampling locations are shown on Figure 19 of the BacTech Environmental Assessment Report. For each sampling effort, the following data were recorded:

- sampling location (i.e., waterbody name, Universal Transverse Mercator [UTM] coordinates);
- sample date and time;
- start and end times for sampling;
- site code;
- supporting environmental data;
- general habitat description for site sampled; and
- number of individuals for each species captured.

All captured fish were held in an aerated holding tank and were enumerated by species. Fork length and total weight was recorded for all specimens. The sampling effort and catch information was used to calculate a standardized catch-per-unit-effort (CPUE) for each method.

An external fish health examination was completed following the procedures outlined in Golder's Technical Procedure 8.15-0: *Fish Health Assessment* (unpublished file information).

1.2 Fish Habitat Assessment

Available fish habitat in Canada Creek, the drainage channel and wetlands was mapped to provide an ecologically relevant inventory of the type and diversity of habitats found with the Study Area. Features mapped included availability of refuge or cover habitat, over wintering or deeper water habitat, spawning habitat, and foraging habitat.

1.2.1 Stream Assessment

The assessment of fish habitat within the Study Area was completed in accordance with the habitat mapping protocols outlined in Golder's Technical Procedure 8-5-1 *Watercourse Habitat Mapping System* (unpublished file information). Stream length was separated into channel units (i.e., impoundment, run, or snye) depending on the channel characteristics (i.e., flow velocity, water depth, and substrate). For each channel unit, habitat features including wetted and bankfull width, shoreline substrate type, presence/absence of fish cover, shoreline slope, and bank stability were recorded in a field notebook. Potential fish passage barriers, tributaries confluences, and areas of habitat disturbance or alteration were noted as applicable. Representative photographs were taken to document the various habitat features observed.

1.2.2 Wetland Assessment

The assessment of ponds and wetlands within the study area was completed in accordance with the habitat mapping protocols outlined in Golder's Technical Procedure 8.19-0: *Lake Habitat Mapping* (unpublished file information). Wetlands were classified according to Steward and Kantrud (1971).

1.3 Data Entry and Analysis

All fish and fish health data were entered into Excel for data analysis and presentation. Fishing effort was calculated for each fishing method by waterbody or watercourse. CPUE was calculated for successful fishing efforts and summarized by sampling area and method of capture. CPUE data provided a measure of relative abundance by standardizing the catch data.

Summary statistics for each variable were calculated for all fish and summarized by species and waterbody or watercourse. External fish health data is provided in Appendix G Table G1.2. Condition factor (K), a comparison of body weight to length and is a measure of the energy stores in a fish and was calculated as follows:

$$K = [\text{weight (g)} \times 10^5] / [\text{fork length}^3 \text{ (mm)}]$$

For species with sufficient numbers of specimens (>30), a length frequency histogram was plotted to assess the size range captured, and to make inferences about the variety of age classes in the population. A weight length regression was calculated on $\log_{10}$ transformed data. The regression was compared to published information about the species to assess the health of the population. Microsoft Office Excel was used to plot the data, and perform linear regression analysis.

Field habitat information was recorded on field maps and in the field notebook. Fish habitat data and waypoints from the GPS were transferred to a Geographic Information System to create habitat maps. Waypoints were described in the field notebook and a table of Universal Transverse Mercator (UTM) coordinates was prepared upon completion of the field program. Descriptions and photograph numbers were recorded in the field notebook for each photograph taken.

1.4 Quality Assurance/Quality Control

Field personnel reviewed the detailed sampling plan (Golder 2012) prior to the field program to ensure project objectives and sampling protocols were followed. Fish capture, processing and habitat mapping were conducted according to Golder Technical Procedures (unpublished file information).

Detailed field notes were recorded in a waterproof field notebook and on pre-printed waterproof field data sheets. Field data sheets were verified at the end of each day for completeness and accuracy. Following data entry into Excel, all data sets underwent a transcriptional Quality Assurance / Quality Control (QA/QC) check by a person not involved in the initial data entry process. All summary tables generated from the database underwent an additional QA/QC screening.

2 RESULTS

2.1 Fish Communities

The Canada Creek drainage system was found to support three small bodied fish species: brook stickleback (*Culaea inconstans*), lake chub (*Couesius plumbeus*) and fathead minnow (*Pimephales promelas*). No large bodied fish species were captured during the site visit. Fifty brook stickleback, seven lake chub and one fathead minnow were captured in Canada Creek and 42 brook stickleback were captured in the drainage channel (Table F1). All fish data are summarized in Appendix G Table G1.2. Dead brook stickleback were observed in various locations throughout the drainage channel.

Table F1: Summary of Species and Size for Fish Captured, August 2012

<table>
<tr><th>Waterbody</th><th>Sampling Method</th><th>Fish Species</th><th>Total Fish Captured</th></tr>
<tr><td rowspan="4">Canada Creek</td><td>Electrofishing [(a)]</td><td>NA</td><td>0</td></tr>
<tr><td rowspan="3">Minnow trap</td><td>Brook Stickleback</td><td>50</td></tr>
<tr><td>Lake Chub</td><td>7</td></tr>
<tr><td>Fathead Minnow</td><td>1</td></tr>
<tr><td rowspan="2">Drainage Channel</td><td>Electrofishing</td><td>Brook Stickleback</td><td>41</td></tr>
<tr><td>Minnow trap</td><td>Brook Stickleback</td><td>1</td></tr>
</table>

Notes: mm= millimetre; g=grams; NA= not applicable.
(a)=Fish were observed while electrofishing, unable to capture/identify due to difficulty accessing stream.

The catch-per-unit effort (CPUE) for backpack electrofishing was standardized to number of fish of each species captured per 100 seconds (Table F2). Canada Creek had a total backpack electrofishing effort of 298 seconds yielding no fish, however fish were observed. Backpack electrofishing in Canada Creek was difficult due to accessibility restrictions, limited water depth and abundant emergent vegetation. The drainage channel yielded 41 brook stickleback during a total fishing effort of 800 seconds for a CPUE of 5.13 fish per 100 seconds. The wetland designated as site SL-02 was electrofished for a total of 83 seconds, and no fish were captured or observed.

The CPUE for minnow traps was standardized fish species captured per hour (Table F3). Two minnow traps were set in Canada Creek for 24.3 hours and 24.4 hours yielding a total of 50 brook stickleback, seven lake chub and one fathead minnow. Canada Creek minnow trap one (CA-MT01) had a CPUE of 1.15 fish per hour for brook stickleback and 0.12 fish per hour for lake chub. Canada Creek minnow trap two (CA-MT02) had CPUE values of 0.90 fish per hour for brook stickleback, 0.16 fish per hour for lake chub and 0.04 fish per hour for fathead minnow. Two minnow traps were deployed in the drainage channel yielding one brook stickleback in 23.0 hours, for a CPUE of 0.04 fish per hour.

Table F2: Catch-Per-Unit Effort of Fish Species Captured by Backpack Electrofisher, August 2012

Waterbody	Station Code	UTM Coordinates Start		UTM Coordinates End		Date	Fish Species Captured	No. of Fish Captured	Total Effort (seconds)	CPUE (Fish/100 seconds)
		Easting	Northing	Easting	Northing					
Canada Creek	CA-BP01	433302	6083776	433249	6083731	Aug. 2, 2012	NA	0	298	0.00
Drainage Channel	DD-BP01	435936	6082498	435704	6082552		BRST	41	800	5.13
	DD-BP02	434888	6082882	434870	6082882		NA	0	179	0.00
SL-02 Wetland	SL02-BP01	434266	6083149	434266	6083149		NA	0	83	0.00

Notes: UTM=Universe Transverse Mercator; CA=Canada Creek; DD=Drainage Channel; No. = number; MT=Gee minnow trap; BRST=brook stickleback; LKCH=lake chub; FTMN=fathead minnow; NA=not applicable. UTM Coordinates collected in NAD 84, Zone 14U.

Table F3: Catch-Per Unit Effort of Fish Species Captured in Minnow Traps, August 2012

Waterbody	Station Code	UTM Coordinates		Start Date	End Date	Check No.	Fish Species Captured	No. of Fish Captured	Total Effort (hours)	CPUE (Fish/ hour)
		Easting	Northing							
Canada Creek	CA-MT01	433297	6083756	Aug.. 1, 2012	Aug. 2, 2012	1	BRST	28	24.33	1.15
							LKCH	3	24.33	0.12
	CA-MT02	433297	6083756			1	BRST	22	24.42	0.90
							LKCH	4	24.42	0.16
							FTMN	1	24.42	0.04
Drainage Channel	DD-MT01	434872	6082865			1	BRST	1	22.97	0.04
	DD-MT02	434872	6082865			1	NA	0	22.97	0.00

Notes: UTM=Universe Transverse Mercator; CA=Canada Creek; DD=Drainage Channel; BP=Backpack electrofishing; BRST=brook stickleback; No.=number; NA=not applicable. UTM Coordinates collected in NAD 84, Zone 14U.

2.2 External Fish Health

During the fish survey, external fish health assessments were conducted on 38 specimens in Canada Creek (30 brook stickleback, one fathead minnow and seven lake chub) and on 42 specimens in the drainage channel (all brook stickleback). The detailed health results are presented in Appendix G Table G1.2. All but one of the fish had no external abnormalities. Fish length, weight and condition factor are summarized for brook stickleback and lake chub (Table F4).

The total lengths of brook stickleback in Canada Creek ranged from 52 mm to 78 mm with a mean of 60 mm. The mean total length of brook stickleback in Canada Creek was almost twice that of those in the drainage channel where total lengths ranged from 20 mm to 45 mm with a mean of 29 mm. Brook stickleback in Canada Creek had weights ranging from 0.7 g to 3.5 g with a mean of 1.8 g. Brook stickleback in the drainage channel had weights ranging from 0.1 g to 0.9 g with a mean weight of 0.2 g. Condition factor (K) of brook stickleback in Canada Creek ranged from 0.42 to 1.54, with a mean of 0.85. Condition factor of brook stickleback in the drainage channel ranged from 0.41 to 1.14 with a mean of 0.83.

Figure F1 shows the weight distribution of brook stickleback from Canada Creek (represented in blue) and the drainage channel (represented in red). At least two distinct distributions are represented, indicating likely two age classes were present. The specimens in the drainage channel were shorter and weighed less than specimens in Canada Creek. These data suggest that fish may use the drainage channel (and surrounding wetlands) as nursery and rearing habitat, and may migrate downstream to Canada Creek once mature.

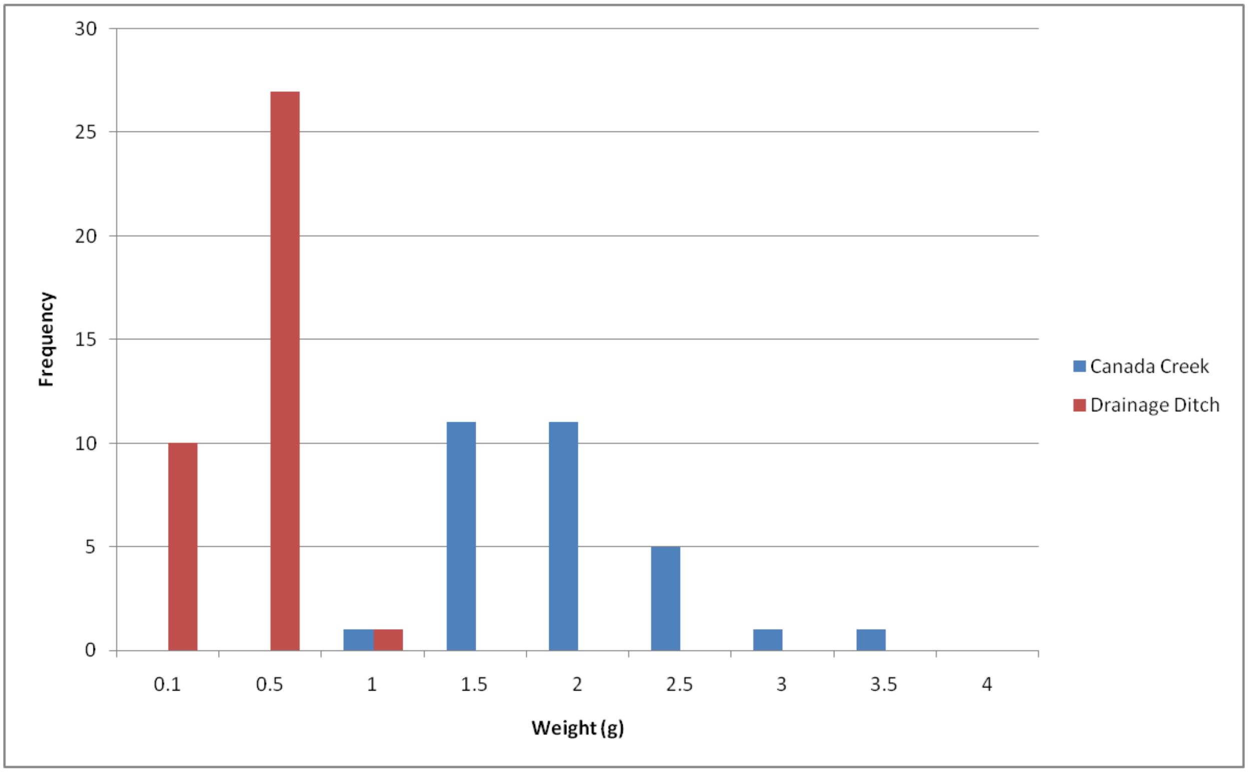
The fork lengths of lake chub captured and processed in Canada Creek ranged from 52 mm to 110 mm with a mean of 105 mm. Total body weights ranged from 0.7 g to 10.4 g with a mean of 10.3 g. Condition factor ranged from 0.42 to 1.54 with a mean of 1.3. No lake chub were observed or captured in the drainage channel.

Table F4: Length, Weight and Condition Factor of Brook Stickleback and Lake Chub in the Canada Creek Drainage, August 2012

Species[a]	Parameter	Unit	Canada Creek							Drainage Channel						
			n	Mean	Median	SD	SE	Min	Max	n	Mean	Median	SD	SE	Min	Max
Brook Stickleback	Length	mm	30	60	58	6.65	1.21	52	78	42	29	29	5.12	0.79	20	45
	Total Body Weight	g	30	1.8	1.7	0.56	0.10	0.7	3.5	38	0.2	0.2	0.15	0.02	0.10	0.90
	Condition Factor	K	30	0.85	0.80	0.21	0.04	0.42	1.54	38	0.83	0.82	0.18	0.03	0.41	1.14
Lake Chub	Length	mm	7	105	105	6.28	2.37	52	110	-	-	-	-	-	-	-
	Total Body Weight	g	7	10.3	10.4	0.29	0.11	0.7	10.4	-	-	-	-	-	-	-
	Condition Factor	K	7	1.3	0.90	0.29	0.11	0.42	1.54	-	0.9	0.9	0.14	0.05	0.42	1.54

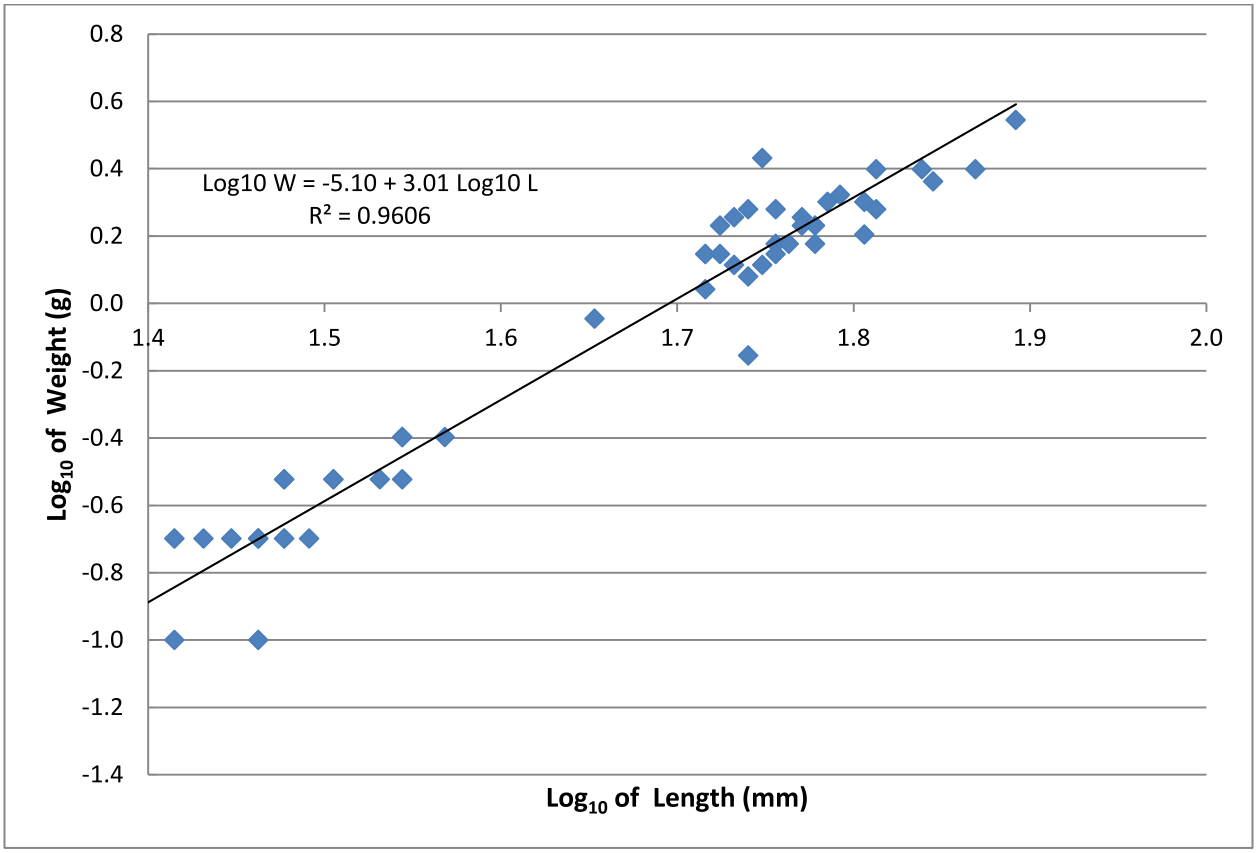
Notes:; mm=millimetres; g=grams, K = condition factor, n = number of specimens, SD = standard deviation, SE = standard error, Min = minimum, Max = maximum
(a) One fathead minnow was captured in Canada Creek: fork length (mm) = 59, total body weight (g) = 2.7, condition factor= 1.31.

Figure F1: Weight Frequencies of Brook Stickleback Captured in Canada Creek and the Drainage Channel, August 2012.



The log_{10} weight of brook stickleback was plotted against the log_{10} length for 68 specimens from the Study Area (Figure F2). There was an excellent fit as indicated by the high coefficient of determination (R^2) of 0.9606.

Figure F2: Length-Weight Relationship for Brook Stickleback in the Canada Creek Drainage, August 2012



2.3 Fish Habitat Assessment

Fish habitat was mapped to provide an ecological inventory of the type and diversity of habitats found within the Study Area. Important features in evaluating aquatic habitat to the diversity of include the amount and type of habitat available, e.g. refuge or cover habitat, overwintering or deeper water habitat, spawning habitat, and foraging habitat.

2.3.1 Habitat Near the Plant Site

The proposed Plant Site is located north of Cedar Avenue, Snow Lake, Manitoba. The north and south ends of the Site consists of cleared land with packed gravel. There is a road adjacent to the drainage channel on the north end of the Project Site. Between the north and south end on the proposed plant site is part of the drainage channel that contains a wetted area consisting primarily of cattails and grasses (Figure F3). Minimal water was observed in the area, and no fishing was possible.

Figure F3: Wetlands within the Proposed Plant Site

2.3.2 ARS Stockpile and Surrounding Area

The ARS stockpile is approximately 0.4 km northwest of the plant site. Runoff from the stockpile was observed flowing from the northeast corner of the stockpile east into a mixed wood treed area which drains into the drainage channel (Figure F4). The south east corner of the ARS stockpile appeared to have an existing runoff flow down into a drainage area that drains into the drainage channel near the QMX Corporation camp

Figure F4: Runoff on Northeast side of Arsenopyrite Residue Stockpile

North of the ARS is SL-02 bog; further north the Canada Creek drainage continues from the Project site). SL-02 bog was classified as a Class III wetland and had mosses, sedges and grass surrounding an open water area (Figure F5). The open water contained inundated vegetation (black spruce) on the northeast corner and black spruce forest surrounding the area. There was evidence of vehicle travel adjacent to the bog with signs of runoff down the travelled path.

Figure F5: Class III SL-02 Bog North of the Arsenopyrite Residue Stockpile

2.3.3 Proposed Pipeline Route and Drainage Channel

During the site investigation the entire drainage channel, (approximately 1,500 m) and 13 ha of wetlands were assessed. In areas of flowing water the bankfull width ranged from 3.0 m to 20.0 m and the wetted width ranged from 0.7 m to 8.0 m (Table F5). The maximum depth recorded in the channel was 1.5 m however depth may be greater as there were access limitations. The dominant substrate type was organic material, with some silt and sand. The road adjacent to the drainage channel contained gravel and boulders which were pushed into some areas of the drainage channel (Figure F6). The fish habitat in the channel consisted primarily of run and flat habitat, and beaver impoundments were also present within the area. Shoreline slope ranged from shallow to steep and in stream slope was predominantly steep on north to east sections of the drainage channel and shallow in the south to west portions. In stream cover ranged from low to abundant, submergent and emergent vegetation and water depths deeper than a metre. Overhead cover, inundated vegetation and woody debris ranged from low to abundant.

Figure F6: Road Adjacent to Drainage Channel

Table F5: Aquatic Habitat Summary for Drainage Channel, August 2012

Habitat Classification	Total Habitat Unit Length (m)	Surface Area (ha)	Maximum Depth (m) [(a)]	Wetted Width (m)	Bankfull Width (m)	Substrate (dominant/ subdominant	Habitat Assessment
Run Class 3	15	-	0.2	1.3	3.0	Organic material/sand	Man-made stream bed, downstream of rusted culvert, drainage area, sedges and grass along shoreline; no canopy cover; minimal water; poor fish habitat.
Class IV Wetland	150	1.0	0.2	-	-	Organic material/sand	Cattail dominated wetland; sedges, grasses mixed into area; limited water however ground wetted; amongst cattails gravel bar exposed; poor fish habitat.
Run Class 3	500	-	0.2	0.9	5.0	Sand/organic material	Man-made stream bed; drainage area; road on west side of channel and cleared area on east side (active construction site); sedges and grasses along shoreline; 0-25% canopy cover; unstable banks; poor fish habitat.
Run Class 3	230	-	0.1	2.0	10.0	Sand/silt	Man-made stream bed; drainage area; road on north side of channel and cleared area on south side (active construction site); sedges and grasses along shoreline; unstable banks; no canopy cover; poor fish habitat.
Class V Pond	60	0.5	1.0	-	-	Organic material/silt	Ponded area near culvert; boulder/gravel around culvert; submergent and emergent vegetation (cattails); decomposing organic material visible, sulphur-like odour; inundated vegetation (black spruce); 0-25% canopy cover; brook stickle back captured and observed. dead brook stickleback observed.
Class V Wetland	420	12	1.5	-	-	Organic material/silt	Cattail marsh; dominated by cattails, sedges, rushes and shrubs closer to shore; submergent and emergent vegetation; inundated vegetation (black spruce); large woody debris; 0-25% canopy cover; decomposing organic material visible, sulphur-like odour; channel not clearly defined, open water in areas observed.

Table F5: Aquatic Habitat Summary for Drainage Channel, August 2012 (continued)

Habitat Classification	Total Habitat Unit Length (m)	Surface Area (ha)	Maximum Depth (m) [(a)]	Wetted Width (m)	Bankfull Width (m)	Substrate (dominant/ subdominant	Habitat Assessment
Flat	90	-	1.5	6.0	8.0	Silt/organic material	Downstream of active beaver dam; moderate in stream cover; submergent and emergent vegetation; 0-25% canopy cover; sulphur-like odour; steep undercut banks; poor fish habitat.
Flat	130	-	1.5	8.0	20.0	Silt/organic material	Upstream of active beaver dam; abundant in stream cover; submergent and emergent vegetation; inundated vegetation; overhanging vegetation; overhead cover; 25-50% canopy cover; sulphur-like odour; steep undercut banks; poor fish habitat.
Flat	105	-	1.5	8.0	18.0	Silt/sand	Active beaver house and evidence of beaver activity within area; abundant in stream cover, submergent and emergent vegetation, inundated vegetation, overhanging vegetation and overhead cover; 25-50% canopy cover; sulphur-like odour; steep undercut banks; poor fish habitat.
Flat	200	-	0.7	8.0	9.0	Silt/sand	Moderate in stream cover; submergent and emergent vegetation along shoreline; large and small woody debris; 0-25% canopy cover; moderate to steep banks; undercut banks; brook stickleback captured; poor fish habitat.
Run Class 3	30	-	0.1	0.7	8.0	Sand/silt	Poor in stream cover; no vegetation along shoreline; evidence of older beaver dam on right downstream bank; 0-25% canopy cover; drainage from cleared area south of drainage channel; poor fish habitat.
Flat	60	-	0.5	1.0	5.0	Organic material/sand	large and small woody debris; visible decomposing organic material; sulphur-like odour; grasses along shoreline; submergent vegetation; 0-25% canopy cover; poor fish habitat.
Run Class 3	225	-	0.1	1.0	6.0	Sand/organic material	Man-made stream bed; drainage area; sedges and grasses along shoreline; large and small woody debris; overhanging vegetation; overhead cover; 25-75% canopy cover; unstable banks; poor fish habitat.

Notes: m=meters; Ha=hectares; Wetland classification according to The Stewart and Kantrud (1971) Classification System.

(a) 1.5 metres was the maximum depth safely measurable, deeper sections present.

Class IV and Class V wetlands were observed within the drainage channel area. Near the proposed Plant Site, the drainage channel had limited ponded water however the ground was wetted. Areas of Class IV wetland were dominated by cattails; the dominant substrate was sand and organic material. Areas of Class V wetland consisted primarily of cattail marsh with areas of open water, other aquatic vegetation such as sedges, pondweed and water arum. The marsh covered approximately 12 ha of land with black spruce forest surrounding the area. An active beaver dam was observed upstream of the Class V wetland.

A Class IV pond was identified near the inflow from the western sections of the drainage channel (Figure F7). The pond had a strong sulphur-like odour and decomposing organic material along the perimeter and the middle of the pond. Inundated vegetation, emergent and submergent vegetation was present throughout the pond. Dead brook stickleback were observed in the area.

Figure F7: Class IV Pond

The proposed pipeline route follows an existing road through an area previously deforested for industrial purposes. The road runs adjacent north of the Class V wetland and east section of the drainage channel (Figure F8). The area has been cleared and active clearing was occurring during the time of the site investigation. The lay of the land slopes down towards the drainage channel

Figure F8: Road north of Drainage Channel, Proposed Pipeline Route

2.3.4 Canada Creek

Approximately 360 m of stream was assessed. The bankfull width ranged from 1.1 m to 70.0 m and the wetted width ranged from 0.4 m to 6.0 m (Table F6). The maximum depth recorded in the stream was 1.5 m however depth may be greater as there were access limitations. Silt was the dominant substrate type followed by organic material and boulder. The fish habitat in the stream consisted primarily of run and flat habitat with one section of rapid (Figure 9). Shoreline slope ranged from shallow to steep and in stream slope was predominantly steep. In stream cover ranged from moderate to abundant submergent and emergent vegetation. Overhead cover, inundated vegetation and woody debris ranged from moderate to abundant. Overgrown vegetation and water depth limited access to the stream (Figure F10).

Table F6: Aquatic Habitat Summary for Canada Creek, Summer 2012

Habitat Classification	Total Habitat Unit Length (m)	Surface Area (Ha)	Maximum Depth (m) [(a)]	Wetted Width (m)	Bankfull Width (m)	Substrate (dominant/ subdominant	Habitat Assessment
Run Class 3	13	-	0.3	1.5	25.0	Silt/organic material	Downstream of cattail dominated wetland; abundant in stream vegetation and in stream cover; 0-25% canopy cover; shallow slope; sedges and grasses along shoreline.
Flat	35	-	0.3	1.5	25.0	Silt/organic material	Abundant in stream vegetation and in stream cover; shallow slope; large and small woody debris; inundated vegetation; 0-25% canopy cover; sedges and grasses along shoreline.
Run Class 3	25	-	0.2	1.1	1.1	Boulder/organic material	Moderate in stream cover; undercut banks; abundant over hanging vegetation; 75-100% canopy cover; large and small woody debris.
Falls	6	-	0.1	0.4	1.1	Boulder/organic material	Moderate in stream cover; undercut banks; abundant over hanging vegetation; 75-100% canopy cover; large and small woody debris.
Run Class 3	55	-	0.2	0.5	2.0	Boulder/organic material	Downstream of culvert; moderate in stream cover; shallow slope; inundated vegetation; large and small woody debris; 75-100% canopy cover; in stream vegetation.
Flat	25	-	0.3	0.8	10.0	Silt/sand	Abundant in stream vegetation and in stream cover; shallow slope; sedges and grasses along shoreline; 25-50% canopy cover; overgrown difficult to find channel.
Class IV Wetland	-	0.1	0.3	-	-	Silt/sand	Cattail marsh; channel not well defined; shallow slope; inundated vegetation; 25-50% canopy cover; slight sulphur-like odour; poor fish habitat due to limited water.
Class V Wetland	200	0.7	1.5	6.0	70.0	Organic material/silt	Cattail swamp; channel flows down middle of cattails and shrubs; shallow slope; inundated vegetation; slight sulphur-like odour; submergent and emergent vegetation; 0-25% canopy cover; open to Snow Lake therefore potentially utilized by large-bodied and small-bodied fish species found in Snow Lake.

Notes: m=meters; Ha=hectares; Wetland classification according to The Stewart and Kantrud (1971) Classification System.
(a)=1.5 metres was the maximum depth safely measurable, deeper sections present.

Figure F9: Section of Rapids within Canada Creek.

Figure F10: Overgrown Vegetation within Canada Creek

Appendix G Supporting Documentation – Water and Soil Chemistry

Table G1.1: Supporting Environmental Variables and Water Quality Sampling Locations, August 2012

Waterbody	Field Number	Date	Time	Waypoint	Easting	Northing	Air Temperature (°C)	Cloud Cover (%)	Precip Rate	Precip Type	Wind Direction	Wind Rate	Depth (m)	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	pH
Canada Creek	CA-BP01	August 2, 2012	9:32	19	433302	6083776	14	50-75	NA	NA	Calm	NA	0.20	14.1	7.08	435.6	7.43
	CA-MT01	August 1, 2012	8:20	1	433297	6083756	15	75-100	NA	NA	Calm	NA	0.25	17.3	6.04	427.6	6.04
	CA-MT02		8:25	1	433297	6083756	15	75-100	NA	NA	Calm	NA	0.25	17.3	6.04	427.6	6.04
Drainage Channel	DD-BP01	August 2, 2012	12:48	34	435936	6082498	16	50-75	NA	NA	Southeast	Light	0.30	16.2	4.77	281.8	6.77
	DD-BP02		14:46	36	434888	6082882	18	50-75	NA	NA	Southeast	Light	0.30	18.0	4.95	1370	6.64
	DD-MT01	August 1, 2012	16:18	9	434872	6082865	18	50-75	NA	NA	Southeast	Light	0.30	18.0	4.95	1370	6.64
	DD-MT02		16:18	9	434872	6082865	18	50-75	NA	NA	Southeast	Light	0.30	18.0	4.95	1370	6.64
SL-02 Wetland	SL02-BP01	August 2, 2012	11:41	SL-02	434266	6083149	16	50-75	NA	NA	Southeast	Light	0.30	18.1	5.47	1101	6.91

Notes: UTM=Universal Transverse Mercator; CA=Canada Creek; DD=Drainage Channel; MT=Gee-minnow trap; BRST=Brook Stickelback; LKCH=Lake Chub; FTMN=Fathead Minnow; NA=not applicable. UTM Coordinates collected in NAD 84, Zone 14U.

Table G1.2: Fish Health Data, August 2012

Fishing Effort	Fish Species	Fish ID	Weight (g)	Length (mm)	Condition Factor (K)	Sex	Life Stage	Maturity	External Health Assessment									
									Body Deformity	Skin	Fins	Eyes	Thymus (haemorrhage)	Opercula (shortening)	Gills	Pseudobranchs	Hindgut	External Parasites
Canada Creek																		
CA-MT01	BRST	001	1.5	57	0.81	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	002	2.0	61	0.88	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	003	1.2	55	0.72	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	004	2.0	64	0.76	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	005	2.7	56	1.54	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	006	1.9	65	0.69	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	007	2.5	69	0.76	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	008	1.4	52	1.00	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	009	2.3	70	0.67	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	010	2.5	65	0.91	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	011	2.1	62	0.88	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	012	2.5	74	0.62	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	013	1.5	58	0.77	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	014	1.8	59	0.88	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	015	1.7	60	0.79	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	016	1.3	56	0.74	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	017	1.1	52	0.78	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	018	1.7	53	1.14	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	019	1.6	64	0.61	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	020	1.9	55	1.14	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	021	1.4	57	0.76	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	022	0.7	55	0.42	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	023	1.8	54	1.14	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	024	1.5	60	0.69	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	025	1.7	59	0.83	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	026	1.3	54	0.83	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	027	1.4	52	1.00	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	LKCH	001	9.8	97	1.07	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	LKCH	002	10.4	110	0.78	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	LKCH	003	10.1	97	1.11	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	028	3.5	78	0.74	Unknown	Adult	Unknown	Yes	Normal	Left pectoral forward	Normal	None	None	Normal	Normal	Normal	None

Table G1.2: Fish Health Data, August 2012 (continued)

Fishing Effort	Fish Species	Fish ID	Weight (g)	Length (mm)	Condition Factor (K)	Sex	Life Stage	Maturity	External Health Assessment									
									Body Deformity	Skin	Fins	Eyes	Thymus (haemorrhage)	Opercula (shortening)	Gills	Pseudobranchs	Hindgut	External Parasites
CA-MT02	BRST	029	1.4	53	0.94	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	030	1.9	57	1.03	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	LKCH	004	10.1	103	0.92	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	LKCH	005	10.4	109	0.80	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	LKCH	006	10.7	113	0.74	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	LKCH	007	10.4	105	0.90	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	FTMN	001	2.7	59	1.31	Unknown	Adult	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
Drainage Creek																		
DD-BP01	BRST	001	0.2	29	0.82	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	002	0.2	28	0.91	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	003	0.2	29	0.82	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	004	0.2	29	0.82	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	005	0.4	35	0.93	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	006	0.4	35	0.93	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	007	0.3	35	0.70	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	008	0.1	29	0.41	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	009	0.4	35	0.93	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	010	0.1	25	0.64	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	011	0.3	30	1.11	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	012	0.1	25	0.64	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	013	0.1	25	0.64	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	014	0.2	29	0.82	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	015	0.3	30	1.11	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	016	0.0	21	0.00	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	017	0.3	34	0.76	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	018	0.2	29	0.82	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	019	0.3	30	1.11	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	020	0.4	37	0.79	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	021	0.3	32	0.92	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	022	0.1	21	1.08	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	023	0.2	30	0.74	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	024	0.2	27	1.02	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	025	0.2	28	0.91	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	026	0.2	29	0.82	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	027	0.1	24	0.72	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None

Table G1.2: Fish Health Data, August 2012 (continued)

Fishing Effort	Fish Species	Fish ID	Weight (g)	Length (mm)	Condition Factor (K)	Sex	Life Stage	Maturity	External Health Assessment									
									Body Deformity	Skin	Fins	Eyes	Thymus (haemorrhage)	Opercula (shortening)	Gills	Pseudobranchs	Hindgut	External Parasites
	BRST	028	0.2	26	1.14	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	029	0.2	31	0.67	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	030	0.1	24	0.72	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	031	0.3	32	0.92	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	032	0.1	25	0.64	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	033	0.2	30	0.74	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	034	0.2	26	1.14	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	035	0.0	20	0.00	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	036	0.1	26	0.57	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	037	0.0	21	0.00	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	038	0.3	35	0.70	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	039	0.0	20	0.00	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	040	0.1	25	0.64	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
	BRST	041	0.3	32	0.92	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None
DD-MT01	BRST	042	0.9	45	0.99	Unknown	Unknown	Unknown	None	Normal	Normal	Normal	None	None	Normal	Normal	Normal	None

Notes: CA=Canada Creek; DD=Drainage Channel; MT= Gee-minnow trap; BRST=brook stickleback; LKCH=lake chub; FTMN=fathead minnow; g=grams; mm=millimetres. K = [weight (g) x 105] / [fork length3 (mm)].

Table G2: Surface Water Arsenic, Iron and Zinc Concentrations

Sample ID	Type	Latitude (°)	Longitude (°)	As (mg/L)	Fe (mg/L)	Zn (mg/L)
Source: Salzsauler (2004)						
SLW16	Surface water	54.88837	-100.01516	**0.02**	**0.55**	**0.256**
SLW17	Surface water	54.88744	-100.01822	**18.8**	**36.1**	**0.431**
SLW17-2	Surface water	54.88744	-100.01822	**17.7**	**55.6**	0.0257
SLW19	Surface water	54.88862	-100.01842	**0.02**	0.02	**0.958**
SLW20	Surface water	54.88971	-100.02491	0	**0.72**	**0.237**
SLLP1	Surface water	54.89009	-100.02430	**0.23**	0.05	**0.572**
SLLP2	Surface water	54.89038	-100.02450	**0.29**	<0.01	**0.458**
SLLP3	Surface water	54.89076	-100.02471	**10.6**	**0.48**	0.0187
SLCC	Surface water	54.89615	-100.04074	**0.07**	0.16	**0.501**
SLTP	Surface water	54.88383	-100.02077	**2.3**	0.03	**0.544**
SLTP-2	Surface water	54.88363	-100.01873	**0.19**	**0.38**	0.00103
SLTS	Surface water	54.88789	-100.01801	**4.3**	**18.4**	**0.182**
Source: SENES (2008)						
SENES-REF	Surface water	54.89170	-100.06893	0.0014	0.09	0.02
SENES-EXP	Surface water	54.91631	-100.01418	**0.0358**	0.1	0.02
Source: Manitoba Conservation (2001)						
WQ2282	Surface water	54.87106	-99.99934	0.0026	0.1	<0.02
WQ2283	Surface water	54.86462	-100.03119	0.0023	0.16	<0.02
WQ2284	Surface water	54.88129	-100.03886	0.0022	0.18	<0.02
WQ2285	Surface water	54.88693	-100.09821	0.0017	0.13	<0.02
Source: DNE Knight Piesold (1995)						
SWQ03	Surface water	54.90492	-100.02530	**0.693**	0.143	**0.0354**
SWQ06	Surface water	54.90835	-100.03484	**0.027**	**0.41**	**0.055**
SWQ07	Surface water	54.90443	-100.04815	**0.017**	0.259	<0.0005
SWQ08	Surface water	54.89521	-100.04065	**0.047**	**0.435**	**0.055**
SWQ09	Surface water	54.89122	-100.02564	**4.57**	**55**	**1.89**
SWQ10	Surface water	54.88678	-100.03865	**0.018**	0.257	0.0157
Source: Golder Site Visit (2012)						
SL-01	Surface water	54.88613	-100.03859	**0.0844**	**0.92**	<0.020
SL-02	Surface water	54.89005	-100.02324	**1.25**	**0.92**	<0.020
SL-03	Surface water	54.88572	-100.00420	**0.0299**	**2.44**	<0.020
SL-04	Surface water	54.88786	-100.01152	**0.0196**	**1.02**	<0.020
SL-05	Surface water	54.89667	-100.03912	**0.11**	0.28	<0.020
SL-06	Surface water	54.87410	-100.00417	0.0027	<0.10	<0.020
CCME guidelines				*0.005*	*0.3*	*0.03*

** Numbers in bold indicate concentrations exceed CCME guidelines*

Table G3: Groundwater Arsenic, Iron and Zinc Concentrations

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/L)	Fe (mg/L)	Zn (mg/L)
Source: Salsaular (2004)						
SL1-4M	Groundwater	54.88768	-100.02229	**4.38**	**879**	**1.37**
SL2-5M	Groundwater	54.88711	-100.02258	**6.2**	**1.17**	**0.24**
SL4-4M	Groundwater	54.88825	-100.02172	**23.6**	**19.2**	**0.39**
Source: DNE Knigth Source Piesold (1995)						
GW16	Groundwater	54.88851	-100.01599	**0.058**	**2.9**	0.007
GW17	Groundwater	54.88625	-100.02035	**15**	**40**	0.006
GW1B	Groundwater	54.88925	-99.99054	<0.0005	**1.4**	0.008
GW18	Groundwater	54.88221	-100.01827	**0.013**	**2.6**	<0.005
GW25	Groundwater	54.89800	-100.04065	**0.012**	**11**	0.03
GW26	Groundwater	54.88614	-100.02832	**0.19**	**3.5**	<0.005
CCME guidelines				*0.005*	*0.3*	*0.03*

** Numbers in bold indicate concentrations exceed CCME guidelines*

Table G4: Soil and Sediment Arsenic, Iron and Zinc Concentrations

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
Source: BacTech Site Visit (2012)						
BAC1-1	Soil	54.88250	-100.02019	**200**		**426**
BAC1-2	Soil	54.88250	-100.02019	4.32		101
BAC2-1	Soil	54.88307	-100.02064	**53.3**		181
BAC3	Soil	54.88260	-100.02076	**127**		216
BAC4	Soil	54.88313	-100.02123	**180**		**644**
BAC5	Soil	54.88343	-100.02120	**28.4**		111
BAC6	Soil	54.88456	-99.99886	11.2		66
BAC7	Soil	54.88442	-99.99829	3.69		104
BAC8	Soil	54.88449	-99.99933	2.54		17
Source: McMartin et al. (1996)						
92MOB1239	Soil	54.87367	-100.08319	8	3700	196
92MOB0281	Soil	54.87519	-100.08195	**14**	4500	14
92MOB0289	Soil	54.87960	-100.08119	8	2500	66
92MOB1220	Soil	54.87753	-100.07999	**18**	15700	70
92MOB1218	Soil	54.87573	-100.07994	2	17500	34
91SL130H	Soil	54.92743	-100.07986	2.5	3900	93
92MOB1237	Soil	54.88479	-100.07924	1	8900	14
92MOB0283	Soil	54.87451	-100.07914	**16**	10700	54
91SL145H	Soil	54.87868	-100.07894	**16**	6000	119
91SL144H	Soil	54.87712	-100.07851	**33**	11100	92
92MOB1222	Soil	54.87916	-100.07824	**34**	9100	16
91SL139H	Soil	54.87645	-100.07810	2.5	3300	100
91SL140H	Soil	54.87555	-100.07808	**23**	7700	60
92MOB1224	Soil	54.88125	-100.07698	**30**	9000	24
92MOB0285	Soil	54.87870	-100.07679	6	2000	58
92MOB1235	Soil	54.87295	-100.07640	12	3400	114
92MOB1233	Soil	54.87069	-100.07589	8	4600	50
92MOB1251	Soil	54.88244	-100.07535	8	3100	48
92MOB0287	Soil	54.87862	-100.07422	4	2600	54
92MOB1226	Soil	54.88434	-100.07365	6	4600	112
92MOB1228	Soil	54.88582	-100.07308	4	10700	60
91SL034H	Soil	54.91094	-100.01234	8	21700	118
91SL035H	Soil	54.88817	-99.99384	**35**	9800	117
91SL010H	Soil	54.92602	-99.86291	2.5	6100	88
92MOB0340	Soil	54.86789	-99.59093	2	5300	46
92MOB0343	Soil	54.92401	-99.49977	1	4500	102
92MOB1178	Soil	54.92566	-99.42198	1	3500	50
92MOB0191	Soil	54.89561	-99.31032	1	9500	26
CCME Guidelines				*12*	*n/a*	*360**

**Value for commercial/industrial guidelines given*
*** Numbers in bold indicate concentrations exceed CCME guidelines*

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
Source: McMartin et al. (1996).						
911002	Sediment	54.83236	-99.97210	4.7	9000	118
911003	Sediment	54.82467	-99.94930	**16**	58000	**151**
911004	Sediment	54.80008	-99.95650	4.7	20000	35
911005	Sediment	54.77648	-99.93390	**6.7**	8000	**144**
911006	Sediment	54.76179	-99.97471	**12**	5000	**140**
911007	Sediment	54.75209	-99.95220	**16**	10000	**176**
911008	Sediment	54.75729	-99.94730	**7.2**	6000	**140**
911009	Sediment	54.75099	-99.76931	**11**	54000	**131**
911010	Sediment	54.80457	-99.73750	**8.5**	20000	**127**
911011	Sediment	54.80977	-99.75491	**13**	41000	**147**
911016	Sediment	54.84636	-99.82310	**21**	9000	**125**
911017	Sediment	54.82827	-99.80290	**11**	6000	109
911018	Sediment	54.82827	-99.78921	**13**	10000	**126**
911020	Sediment	54.83256	-99.75420	**12**	15000	**154**
911022	Sediment	54.86590	-99.76281	**6.9**	41000	104
911023	Sediment	54.85525	-99.77941	3.6	21000	87
911024	Sediment	54.85345	-99.79610	3.5	9000	**141**
911025	Sediment	54.85345	-99.79610	3.2	8000	73
911027	Sediment	54.86520	-99.87750	**13**	45000	95
911028	Sediment	54.88060	-99.96971	**17**	15000	89
911029	Sediment	54.87470	-99.93160	5.9	17000	111
911030	Sediment	54.87230	-99.88101	5.4	49000	**133**
911031	Sediment	54.86960	-99.83961	**10**	52000	**149**
911032	Sediment	54.88099	-99.80671	**12**	45000	**150**
911033	Sediment	54.89109	-99.77230	**18**	54000	**125**
911034	Sediment	54.88199	-99.71740	**11**	53000	**141**
911035	Sediment	54.87060	-99.70801	**8.2**	35000	73
911036	Sediment	54.84456	-99.71750	**8.4**	45000	85
911037	Sediment	54.79778	-99.71790	**11**	3000	**195**
911038	Sediment	54.78728	-99.72090	**7**	7000	**142**
911039	Sediment	54.78158	-99.73660	5.3	6000	94
911040	Sediment	54.76199	-99.72780	**15**	45000	**146**
911043	Sediment	54.77298	-99.70120	**18**	39000	**146**
911044	Sediment	54.77888	-99.68271	**16**	37000	**135**
911045	Sediment	54.79138	-99.69211	**8.4**	8000	**193**
911046	Sediment	54.79138	-99.69211	**7.5**	7000	**200**
911047	Sediment	54.79957	-99.67441	**24**	11000	**124**
911048	Sediment	54.80557	-99.67151	**60.6**	9000	**250**
911049	Sediment	54.80907	-99.69511	5.6	7000	**143**
911050	Sediment	54.82466	-99.68751	4.6	9000	**126**
911051	Sediment	54.88650	-99.66950	**14**	52000	111
911052	Sediment	54.89809	-99.67011	**12**	40000	87
911053	Sediment	54.90279	-99.68981	**10**	44000	**140**
911054	Sediment	54.92389	-99.69240	5.3	46000	**124**
911055	Sediment	54.91709	-99.70531	3.6	13000	122
911056	Sediment	54.90869	-99.74361	3.8	49000	**129**

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations (continued)

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
911057	Sediment	54.91100	-99.79840	1.7	8000	72
911058	Sediment	54.88860	-99.85231	4.2	47000	**150**
911059	Sediment	54.88839	-99.93240	5.4	8000	**126**
911060	Sediment	54.88500	-99.95081	**19**	12000	109
911062	Sediment	54.91059	-99.95670	**28**	41000	**132**
911063	Sediment	54.91059	-99.95670	**25**	36000	**133**
911064	Sediment	54.90180	-99.89960	**12**	40000	**131**
911065	Sediment	54.89739	-99.87530	**15**	44000	**156**
911066	Sediment	54.91439	-99.87981	**15**	38000	**147**
911067	Sediment	54.92139	-99.82741	**10**	35000	83
911068	Sediment	54.93669	-99.75340	3.4	15000	85
911069	Sediment	54.94219	-99.73861	5.7	65000	**196**
911070	Sediment	54.93488	-99.71530	3.2	29000	114
911071	Sediment	54.94109	-99.69460	5.9	29000	**132**
911072	Sediment	54.95749	-99.66731	4.7	18000	**155**
911073	Sediment	54.97089	-99.67840	4.7	43000	**153**
911074	Sediment	54.98979	-99.67470	4.6	32000	**187**
911075	Sediment	54.99930	-99.68171	2.7	36000	**145**
911076	Sediment	54.97638	-99.73611	4.7	58000	**127**
911078	Sediment	54.96159	-99.71991	5	38000	**235**
911079	Sediment	54.95389	-99.70931	2.2	5000	**136**
911080	Sediment	54.95099	-99.72241	4.7	53000	**131**
911082	Sediment	54.93899	-99.79131	3.5	7000	**158**
911083	Sediment	54.93899	-99.79131	3.4	7000	**160**
911085	Sediment	54.93109	-99.90191	**9.3**	36000	**141**
911086	Sediment	54.92409	-99.94661	**13**	33000	**136**
911087	Sediment	54.93559	-99.98341	**18**	29000	**124**
911088	Sediment	54.93609	-99.93620	**8**	40000	**138**
911089	Sediment	54.94389	-99.85800	**21**	52000	**132**
911090	Sediment	54.95648	-99.84981	4.9	35000	**165**
911091	Sediment	54.95439	-99.83460	3.5	7000	123
911092	Sediment	54.94319	-99.83801	3	17000	**145**
911093	Sediment	54.94759	-99.81601	2	4000	**126**
911094	Sediment	54.95209	-99.78991	2.3	5000	**125**
911095	Sediment	54.96179	-99.76950	3.8	10000	**143**
911096	Sediment	54.96689	-99.78861	3.1	11000	**180**
911097	Sediment	54.97849	-99.79281	3.4	8000	**210**
911098	Sediment	54.99098	-99.76861	3.3	6000	**127**
911099	Sediment	54.99528	-99.78510	3.6	14000	**158**
911100	Sediment	54.99528	-99.81830	5.5	36000	**170**
911102	Sediment	54.99870	-99.83680	4.2	7000	**168**
911103	Sediment	54.97189	-99.87731	4.9	48000	**199**
911104	Sediment	54.98808	-99.87071	4.2	44000	**195**
911105	Sediment	54.98808	-99.87071	3.9	41000	**200**
911106	Sediment	54.96978	-99.90571	2.2	9000	103
911107	Sediment	54.99558	-99.89790	1.8	3000	110
911108	Sediment	54.98738	-99.91000	1.9	6000	**124**
911109	Sediment	54.99119	-99.93320	2.6	25000	**156**
911110	Sediment	54.99238	-99.95261	2.2	5000	100

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations (continued)

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
911111	Sediment	54.98908	-99.96211	2.7	39000	**212**
911112	Sediment	54.96629	-99.94131	3.3	41000	**210**
911114	Sediment	54.95799	-99.93240	3.9	40000	**192**
911115	Sediment	54.96198	-99.96971	**10**	36000	**141**
911116	Sediment	54.98098	-99.98370	2.6	4000	**135**
911117	Sediment	54.99299	-99.99070	2.3	41000	116
911118	Sediment	54.94909	-99.99660	3.7	9000	114
911002	Sediment	54.87140	-100.03261	**19**	85000	**137**
911003	Sediment	54.85005	-100.04390	**17**	20000	**158**
911004	Sediment	54.84335	-100.01810	4.7	12000	**138**
911007	Sediment	54.81557	-100.02851	1.8	6000	**140**
911008	Sediment	54.81557	-100.02851	2.2	6000	**150**
911009	Sediment	54.79008	-100.02780	**14**	18000	102
911010	Sediment	54.77348	-100.01120	**6.4**	53000	**138**
911011	Sediment	54.76209	-100.02330	**7**	45000	**129**
911012	Sediment	54.75129	-100.03240	**7.2**	43000	119
911013	Sediment	54.77798	-100.09890	2.7	7000	**186**
911014	Sediment	54.75179	-100.16821	**8.8**	27000	**185**
911015	Sediment	54.76768	-100.17420	**6.3**	13000	**162**
911016	Sediment	54.75649	-100.18511	**6.4**	8000	**137**
911017	Sediment	54.76039	-100.21161	5.3	37000	**201**
911018	Sediment	54.77388	-100.22941	5.7	45000	**173**
911019	Sediment	54.76508	-100.26881	**6**	57000	**153**
911020	Sediment	54.76028	-100.29480	1.7	7000	**150**
911022	Sediment	54.75679	-100.33610	4.6	26000	**147**
911023	Sediment	54.75359	-100.38270	5.6	52000	**139**
911024	Sediment	54.75959	-100.36491	4.6	57000	104
911025	Sediment	54.77438	-100.32110	2.9	18000	**124**
911026	Sediment	54.77578	-100.27600	4.9	58000	103
911027	Sediment	54.79957	-100.14810	**11**	41000	**6500**
911028	Sediment	54.80067	-100.11290	5.3	12000	**144**
911029	Sediment	54.80067	-100.11290	5.5	12000	**145**
911030	Sediment	54.79077	-100.11000	**10**	23000	114
911031	Sediment	54.78447	-100.04861	**6.2**	53000	112
911032	Sediment	54.84175	-100.02960	**6.4**	6000	**143**
911033	Sediment	54.83666	-100.03581	**7.6**	7000	**136**
911034	Sediment	54.83896	-100.04810	**12**	7000	**151**
911035	Sediment	54.82706	-100.04641	**7.9**	11000	**143**
911036	Sediment	54.82117	-100.06580	**29**	10000	**293**
911038	Sediment	54.79247	-100.07681	**7.7**	25000	**148**
911039	Sediment	54.80687	-100.08950	**8.3**	14000	**151**
911040	Sediment	54.81477	-100.09660	**6.8**	8000	**127**
911042	Sediment	54.81186	-100.10250	4.1	5000	**140**
911043	Sediment	54.81186	-100.10250	4.2	6000	**128**
911044	Sediment	54.80467	-100.17471	3.9	18000	111
911045	Sediment	54.79558	-100.18801	3.1	11000	**127**
911046	Sediment	54.79107	-100.20141	2.3	15000	**157**
911047	Sediment	54.80437	-100.22660	5.8	55000	95
911048	Sediment	54.79717	-100.27971	**6.2**	62000	**126**

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations (continued)

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
911049	Sediment	54.80347	-100.31871	**6**	59000	**146**
911050	Sediment	54.80387	-100.33031	4.2	8000	**128**
911052	Sediment	54.79217	-100.35520	5.9	9000	**129**
911053	Sediment	54.77968	-100.39600	**9.1**	17000	**150**
911054	Sediment	54.80837	-100.38160	5.4	7000	**126**
911055	Sediment	54.81526	-100.36321	5.4	18000	119
911056	Sediment	54.82816	-100.30640	**6.1**	21000	**192**
911057	Sediment	54.82746	-100.28761	4.5	15000	**282**
911058	Sediment	54.82306	-100.26530	**6**	58000	**174**
911059	Sediment	54.81836	-100.21411	2	6000	105
911060	Sediment	54.81927	-100.17890	4.3	40000	**150**
911062	Sediment	54.82087	-100.15361	3.5	6000	**154**
911063	Sediment	54.82087	-100.15361	2.2	5000	**142**
911064	Sediment	54.82386	-100.08001	**14**	9000	**152**
911065	Sediment	54.83246	-100.06321	**21**	15000	**127**
911066	Sediment	54.84056	-100.06700	**23**	14000	**155**
911067	Sediment	54.86119	-100.05342	**13**	12000	94
911069	Sediment	54.85529	-100.08220	**12**	6000	116
911070	Sediment	54.84186	-100.09770	**36**	10000	**129**
911071	Sediment	54.83736	-100.10520	**35**	9000	**138**
911073	Sediment	54.80907	-100.14081	**69.5**	110000	**142**
911074	Sediment	54.77578	-100.19671	5.1	14000	**1050**
911075	Sediment	54.80087	-100.19971	3.4	10000	**157**
911076	Sediment	54.83306	-100.20200	3.1	30000	**154**
911077	Sediment	54.84755	-100.29240	4.3	9000	**143**
911078	Sediment	54.84026	-100.33221	5.6	60000	**159**
911079	Sediment	54.79807	-100.41221	**7.2**	9000	**126**
911080	Sediment	54.76088	-100.42090	**9**	11000	**133**
911082	Sediment	54.76869	-100.43280	**16**	12000	**160**
911083	Sediment	54.78988	-100.47200	3.2	24000	28
911084	Sediment	54.83735	-100.38530	**13**	12000	118
911085	Sediment	54.83735	-100.38530	**15**	13000	94
911086	Sediment	54.83706	-100.37240	5	9000	**152**
911087	Sediment	54.83636	-100.35981	2.6	5000	**124**
911088	Sediment	54.85590	-100.26851	2.9	6000	**380**
911089	Sediment	54.85280	-100.25471	1.3	3000	99
911090	Sediment	54.85066	-100.20810	2.8	34000	**150**
911091	Sediment	54.84296	-100.20541	2	5000	**156**
911092	Sediment	54.83976	-100.18811	1.6	10000	**129**
911093	Sediment	54.83665	-100.18310	2.8	18000	78
911094	Sediment	54.83946	-100.17021	2.5	6000	**154**
911095	Sediment	54.83246	-100.15181	3.6	8000	**202**
911097	Sediment	54.86590	-100.06301	**10**	8000	118
911098	Sediment	54.84695	-100.11961	**11**	30000	**171**
911099	Sediment	54.84135	-100.11751	**13**	36000	**245**
911100	Sediment	54.83836	-100.14411	4.6	12000	**181**
911102	Sediment	54.84256	-100.15490	1.6	4000	117
911103	Sediment	54.84256	-100.15490	1.7	5000	115
911104	Sediment	54.85500	-100.13751	5.5	12000	**137**

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations (continued)

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
911105	Sediment	54.85860	-100.17660	5	39000	**146**
911106	Sediment	54.86669	-100.22201	2.7	8000	**148**
911107	Sediment	54.86349	-100.25131	2.9	19000	**150**
911108	Sediment	54.85969	-100.30811	2.5	12000	**165**
911109	Sediment	54.84965	-100.34490	2.3	3000	100
911110	Sediment	54.84636	-100.35990	2	6000	**127**
911111	Sediment	54.82056	-100.44241	**10**	46000	97
911112	Sediment	54.81606	-100.47901	2.3	3000	115
911114	Sediment	54.82156	-100.47620	3.2	6000	107
911115	Sediment	54.82286	-100.49870	3	13000	**178**
911116	Sediment	54.83026	-100.47569	3.9	9000	**126**
911117	Sediment	54.84686	-100.49691	4.2	27000	**345**
911118	Sediment	54.85009	-100.47251	2.5	26000	**126**
911119	Sediment	54.83986	-100.45551	5	21000	38
911120	Sediment	54.85810	-100.41120	5.2	35000	55
911122	Sediment	54.85419	-100.37021	**15**	12000	66
911123	Sediment	54.86579	-100.34710	3.4	23000	27
911124	Sediment	54.86789	-100.27741	2.7	6000	**168**
911126	Sediment	54.86789	-100.27741	2.6	6000	**180**
911127	Sediment	54.87819	-100.23681	4.9	27000	**185**
911128	Sediment	54.87889	-100.19811	3.6	22000	**138**
911129	Sediment	54.86580	-100.16041	2.2	13000	**128**
911130	Sediment	54.85939	-100.13511	4.3	3000	**135**
911131	Sediment	54.87550	-100.05960	**13**	9000	120
911132	Sediment	54.87949	-100.04970	4.3	6000	77
911133	Sediment	54.88060	-100.06210	**13**	6000	105
911134	Sediment	54.87399	-100.08461	**20**	4000	**124**
911135	Sediment	54.87849	-100.08471	**19**	15000	104
911136	Sediment	54.88279	-100.13831	2.8	41000	86
911137	Sediment	54.88610	-100.15770	3.6	11000	118
911138	Sediment	54.87500	-100.15590	**6.3**	16000	113
911139	Sediment	54.87770	-100.17411	5.5	44000	**127**
911140	Sediment	54.88799	-100.20041	4.7	33000	**253**
911142	Sediment	54.88519	-100.25250	2.8	7000	101
911143	Sediment	54.88519	-100.25250	2.9	6000	78
911144	Sediment	54.88279	-100.30600	5.6	45000	74
911145	Sediment	54.87820	-100.43541	**7.1**	43000	**146**
911146	Sediment	54.86529	-100.44520	**12**	40000	123
911147	Sediment	54.86990	-100.47571	**6.7**	19000	**163**
911148	Sediment	54.87840	-100.49571	4.8	27000	**134**
911149	Sediment	54.88660	-100.48652	5.6	31000	**144**
911150	Sediment	54.89149	-100.45041	3.5	6000	**235**
911151	Sediment	54.88739	-100.44501	5.9	28000	**125**
911152	Sediment	54.90349	-100.40981	5.7	41000	75
911153	Sediment	54.90509	-100.33890	5.1	53000	106
911155	Sediment	54.89030	-100.26800	3.3	8000	**194**
911156	Sediment	54.90179	-100.26191	2.8	11000	**173**
911157	Sediment	54.89459	-100.21522	2.1	6000	105
911158	Sediment	54.89639	-100.18790	4	23000	**138**

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations (continued)

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
911159	Sediment	54.90069	-100.17521	4.3	5000	**145**
911160	Sediment	54.89509	-100.15291	**7.7**	9000	**130**
911162	Sediment	54.90269	-100.14631	5.9	7000	94
911163	Sediment	54.90269	-100.14631	5	9000	103
911164	Sediment	54.89899	-100.13301	2.6	5000	**126**
911165	Sediment	54.88819	-100.09721	**13**	38000	120
911166	Sediment	54.88779	-100.05411	**16**	47000	114
911168	Sediment	54.88649	-100.06611	5.8	5000	94
911169	Sediment	54.89429	-100.10930	4	26000	71
911170	Sediment	54.89849	-100.11960	3.3	6000	71
911171	Sediment	54.90379	-100.15340	5.1	10000	114
911172	Sediment	54.90599	-100.19191	3.6	11000	**197**
911173	Sediment	54.91279	-100.23801	2.3	5000	**152**
911174	Sediment	54.91419	-100.29480	**8.6**	53000	**127**
911175	Sediment	54.91649	-100.31591	**7.5**	10000	**144**
911176	Sediment	54.92109	-100.33740	**7.5**	55000	**137**
911177	Sediment	54.92279	-100.35840	4.7	43000	82
911178	Sediment	54.92859	-100.38491	3.2	31000	68
911179	Sediment	54.89939	-100.43161	**6.9**	27000	65
911180	Sediment	54.89479	-100.44291	**8.7**	37000	114
911182	Sediment	54.89899	-100.46731	**8.4**	46000	**132**
911183	Sediment	54.90549	-100.45951	**8.2**	38000	**137**
911184	Sediment	54.90669	-100.47370	5.8	11000	98
911185	Sediment	54.90899	-100.49200	**6.8**	30000	113
911186	Sediment	54.91399	-100.46791	**14**	12000	107
911187	Sediment	54.91399	-100.46791	**13**	11000	97
911188	Sediment	54.91729	-100.42550	4.5	10000	122
911189	Sediment	54.92419	-100.44920	4.3	14000	83
911191	Sediment	54.92319	-100.46600	**20**	13000	119
911192	Sediment	54.92819	-100.48800	4.5	12000	68
911193	Sediment	54.93449	-100.49710	**7.6**	18000	102
911194	Sediment	54.93308	-100.44331	2.1	6000	**190**
911195	Sediment	54.93719	-100.41600	**6.8**	46000	**135**
911196	Sediment	54.92849	-100.25670	4	28000	111
911197	Sediment	54.92539	-100.23821	4.3	55000	**142**
911198	Sediment	54.91859	-100.21921	3.4	29000	**167**
911199	Sediment	54.91729	-100.19861	3.2	8000	**163**
911200	Sediment	54.91357	-100.17460	2.9	5000	122
911202	Sediment	54.89859	-100.05901	**18**	20000	84
911203	Sediment	54.91169	-100.12001	1.9	11000	84
911204	Sediment	54.92009	-100.16141	3.6	24000	106
911205	Sediment	54.92669	-100.16601	2.6	13000	**177**
911206	Sediment	54.92669	-100.16601	2.8	15000	**185**
911207	Sediment	54.93379	-100.17571	3.1	9000	**190**
911208	Sediment	54.93529	-100.18791	3.3	13000	122
911209	Sediment	54.93968	-100.21711	2.8	22000	73
911210	Sediment	54.94009	-100.26730	**8**	63000	**126**
911211	Sediment	54.93929	-100.30381	4.6	8000	90
911212	Sediment	54.94189	-100.34410	4.5	16000	69

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations (continued)

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
911213	Sediment	54.94879	-100.40161	5.1	11000	84
911214	Sediment	54.93959	-100.43591	4.5	31000	105
911215	Sediment	54.95099	-100.43411	4.2	9000	93
911216	Sediment	54.95479	-100.44860	**6.4**	56000	**152**
911218	Sediment	54.94529	-100.45450	**7.7**	52000	**126**
911219	Sediment	54.94359	-100.48880	5.6	57000	**144**
911220	Sediment	54.96119	-100.47821	**7.4**	69000	**160**
911222	Sediment	54.97278	-100.49701	4.5	31000	73
911223	Sediment	54.99430	-100.47421	5.7	45000	116
911224	Sediment	54.99631	-100.45200	3.3	24000	87
911225	Sediment	54.98939	-100.43331	1.9	11000	71
911226	Sediment	54.98939	-100.43331	1.9	13000	74
911227	Sediment	54.99841	-100.42070	2.9	20000	96
911228	Sediment	54.98008	-100.40960	4.8	6000	**129**
911230	Sediment	54.96128	-100.40431	2.5	11000	49
911231	Sediment	54.96609	-100.37290	2.4	31000	84
911232	Sediment	54.95729	-100.32361	**14**	24000	**126**
911233	Sediment	54.95348	-100.30411	4.2	6000	115
911234	Sediment	54.94509	-100.29561	5.7	12000	**166**
911235	Sediment	54.94509	-100.23041	3.6	45000	**155**
911236	Sediment	54.94809	-100.19150	5.4	3000	79
911237	Sediment	54.93169	-100.15391	5.1	23000	108
911238	Sediment	54.90044	-100.04744	**112**	20000	100
911239	Sediment	54.91399	-100.06021	**15**	10000	102
911240	Sediment	54.94538	-100.15431	4	13000	93
911242	Sediment	54.94729	-100.16481	3.9	7000	**178**
911243	Sediment	54.95988	-100.21191	3.9	13000	**140**
911244	Sediment	54.95988	-100.21191	3.5	13000	**130**
911245	Sediment	54.96149	-100.24891	**6.6**	51000	99
911246	Sediment	54.98178	-100.39580	2.2	6000	108
911247	Sediment	54.99911	-100.39290	2.1	14000	97
911248	Sediment	54.99961	-100.35521	2.7	13000	**140**
911249	Sediment	54.97889	-100.30081	**10**	12000	**136**
911250	Sediment	54.98130	-100.27471	2.5	5000	108
911251	Sediment	54.97338	-100.25490	3.7	22000	94
911252	Sediment	54.99128	-100.25751	2.9	29000	114
911253	Sediment	54.99328	-100.22621	2.2	8000	100
911254	Sediment	54.97349	-100.22441	2.3	4000	92
911255	Sediment	54.89819	-100.03010	**467**	26000	97
911256	Sediment	54.91759	-100.05050	5.1	5000	110
911258	Sediment	54.92419	-100.05250	**13**	8000	**134**
911259	Sediment	54.93109	-100.09171	**7.8**	56000	120
911260	Sediment	54.94129	-100.08760	**9.2**	63000	**144**
911262	Sediment	54.95408	-100.10481	**6.3**	48000	99
911263	Sediment	54.95638	-100.13901	**8.1**	31000	75
911264	Sediment	54.95799	-100.16291	2.3	6000	**196**
911265	Sediment	54.95799	-100.16291	2.5	6000	**168**
911266	Sediment	54.97009	-100.16271	3.6	6000	**125**
911267	Sediment	54.97078	-100.18730	2.9	8000	86

Table G5: Lake Sediment Arsenic, Iron and Zinc Concentrations (continued)

Sample ID	Matrix	Latitude (°)	Longitude (°)	As (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
911268	Sediment	54.98548	-100.20230	2.2	19000	**210**
911269	Sediment	54.99108	-100.19290	4	10000	**138**
911270	Sediment	54.97509	-100.12901	**7**	47000	105
911272	Sediment	54.98308	-100.10091	**12**	27000	112
911273	Sediment	54.98488	-100.07861	**6.7**	11000	88
911274	Sediment	54.97158	-100.08920	5	8000	92
911275	Sediment	54.97189	-100.02241	**7**	35000	**146**
911276	Sediment	54.97198	-100.00531	**46**	48000	**128**
911277	Sediment	54.96469	-100.02571	**18**	54000	89
911278	Sediment	54.95448	-100.05251	**8.8**	53000	90
911279	Sediment	54.95318	-100.00991	**28**	7000	105
911280	Sediment	54.95038	-100.03931	**37**	50000	**133**
911282	Sediment	54.94509	-100.03411	5.3	26000	**134**
911283	Sediment	54.94509	-100.03411	4.6	29000	**137**
911284	Sediment	54.93439	-100.02380	**6.2**	13000	82
911285	Sediment	54.91699	-100.01191	**39**	28000	120
911286	Sediment	54.90509	-100.00111	**13**	34000	108
911291	Sediment	54.87171	-100.00166	**23**	34000	94
CCME Guidelines				*5.9*	*n/a*	*123*

** Data from GSC Open File 3015

Table G6: Soil and Sediment Hydrocarbon Concentrations

Sample ID	Matrix	BTEX C6-C10	BTEX F1	BTEX F2	BTEX F3	BTEX F4	Total Hydrocarbons
Source: BacTech Site Visit (2012)							
BAC 1-1	Soil	<10	<10	<10	188	88	276
BAC 1-2	Soil	<10	<10	<10	<50	<50	<50
BAC 2-1	Soil	<10	<10	<10	100	86	186
BAC 3	Soil	<10	<10	<10	277	482	759
BAC 4	Soil	<10	<10	<20	<100	<100	<100
BAC 5	Soil	<10	<10	<10	<50	<50	<50
BAC 6	Soil	<10	<10	<10	52	<50	52
BAC 7	Soil	<10	<10	<10	<50	<50	<50
BAC 8	Soil	<10	<10	<10	<50	<50	<50

Appendix H Letter from Historic Resources Branch Regarding Heritage Resources

Manitoba Memorandum

DATE: October 30, 2012

TO: Patrick Young
Archaeologist
Golder Associates
1721 8th Street East
Saskatoon SK

FROM: Gordon Hill
Impact Assessment
Archaeologist
Historic Resources
Branch
Main Floor 213 Notre
Dame Avenue
Winnipeg MB
R3B 1N3

PHONE NO: (204) 945-7730

SUBJECT: HERITAGE RESOURCES

YOUR FILE:

HRB FILE: AAS-12-5063

BIOLEACH FACILITY
SNOW LAKE

In response to your memo regarding the above-noted proposed project, I have examined Branch records for areas of potential concern. The potential to impact significant heritage resources is low, and, therefore, the Historic Resources Branch has no concerns with the project.

If at any time however, significant heritage resources are recorded in association with these lands during development, the Historic Resources Branch may require that an acceptable heritage resource management strategy be implemented by the developer to mitigate the affects of development on the heritage resources.

If you have any questions or comments, please contact me at 945-7730.

C. Gordon Hill

Appendix I Supporting Documentation – Public Engagement

NEWS

The Reminder July 20, 2012 Page 9

My Take on Snow Lake

Marc Jackson
Snow Lake Writer

Officials from BacTech Environmental were in Snow Lake recently to look over property for their proposed plant and attend a public hearing that would see their desired property rezoned to industrial.

Arriving in town in early July were Ross Orr, company president and CEO, and Lou Nagy, chief financial officer.

Orr advised in an interview prior to the rezoning that the piece of land, which sits between the Snow Lake Mine and Stittco Energy's site, is exactly what BacTech was looking for.

Orr said the property is preferable to another potential site across from the Osborne Lake road turnoff. Every time BacTech has to pick something up and handle it, it only adds to the cost of the project. So the closer to their concentrate, the better.

BacTech is set to build a new-to-North America plant in Snow Lake. It will neutralize a mound of old mine tailings, known locally as Toke Mountain, extracting the valuable gold still trapped within. Going forward, it is hoped the plant will also be used to neutralize tailings from other mine sites.

Both Orr and Nagy said the reality of the Snow Lake plant is that it is a fairly high-cost project. Orr said this is because the grade is lower than what one would normally be treating in most gold situations.

"I mean, 9.7 grams (per ton), if that was the head grade of the ore, you'd be laughing because your concentrate would probably be 60 or 70 grams (per ton)," he explained. "You get the sort of one for 10 rollup. But a 9.7 grams grade of concentrate, it caps your revenue, so you really have to make sure that your expenses are pretty tight."

Nagy said fact that there isn't any compatible limestone (to be used as a precipitant in the process) close to Snow Lake also increases costs. BacTech will, however, bring it in through a joint venture with a First Nation over 300 km from Snow Lake.

"Again, every time you have to pick up something and move it... instead of paying $5 a ton for limestone, we're paying probably $75 to $80 per ton," said Nagy. "And that is probably our biggest single expense."

When will BacTech begin building its Snow Lake plant? Orr said both the company and its potential partner in the project, Newalta, are waiting for the numbers from an economic study presently underway.

The study currently sits in the hands of the consulting firm Micon. It should be back to BacTech by the end of July. Newalta has 90 days from the publishing of that report to determine if it wants to be involved in the project.

Orr said a perfect deal for BacTech would be 50/50, with Newalta operating the plant.

"They operate 85 plants in North America, so they know what they are doing," he said. "And let's face it, we aren't dealing with anything toxic here, but at the same time, you want it done professionally, with the least disruption to the surrounding community as possible, and I think that they're pretty good at that.

"If that is the case, later this year we could get in and start to do some preparation work on the site."

Nagy agreed and said depending on how fast things move with Newalta, it's possible concrete could be poured in late fall.

"We will be putting up one of those (tensioned membrane buildings), because we have to move concentrate indoors for the winter months," Orr said. "So it's possible that could go up over the winter. Building the actual tanks, I think that would begin in April."

Once workers put the six tanks together, technically BacTech could be processing on Snow Lake's 3.8-acre site by late summer 2013.

Some recent good news for the company is a patent that has resulted from studies it has gone through over the past while.

Because BacTech wanted to add iron to its process, company officials talked to a company that produces a liquid ferric sulphate (iron). Orr said the cost was $2,000 per ton, far beyond what the company could afford.

See 'BacTe...' on pg. 10

PHOTO BY MARC JACKSON

BacTech Environmental president and CEO Ross Orr (left) and chief financial officer Lou Nagy during their recent visit.

BacTech went back to drawing board

Continued from pg. 9

However, BacTech went back to the drawing board, noting that with bioleaching, when raw pyrite is put into a tank it produces ferric sulphate. From there the company began to wonder how many other mines in the Canadian north have the same requirement.

Orr said ferric sulphate is used to remove substances like arsenic and phosphorus and is a great way to clean water. It is used in remote mines, pulp and paper operations and waste water treatment plants.

So as a secondary mission of cleaning up tailings, the company can use those tailings to produce the ferric sulphate it will need in its operation, as well as make tanks to turn out more that can be used to do environmental good elsewhere.

"It was a bit overpowering at the beginning, because it was just like being a kid in a candy store," said Orr. "We realized we had a new way of making something that has been used for a long time and we're going to be able to do it a lot cheaper than anyone else out there. The idea would be to build a single bioleach tank at a mine, or (wastewater treatment plant), and put pyrite in it. Imagine going into all these old tailings and plucking out the pyrite, which is the thing that is causing the problems in the first place?"

Orr and Nagy said the proposed Snow Lake operation has a six- to seven-year life and it will employ close to 40 people.

"There will be 40 people directly employed… that is technician millwright, electrician, plant manager, administrative staff," said Nagy. "That isn't including the trucking outside the plant."

When asked where the employees will live, Orr doesn't wait for the question to finish, before replying "home" in his matter-of-fact style.

"We are looking at hiring all locally, absolutely," he said. "We will look for people who don't want to work underground anymore. Running the plant can be taught. There are very few moving parts… it's more the ability to read ph levels, through a computer-generated monitor. If the acid gets too low, you add acid. If it gets too high, you add limestone."

Quite simple

Both men say the actual operation of the plant is quite simple. Although they will still have millwrights and electricians, in order to install, maintain and repair equipment, for other positions there will be training.

"We will have our people there for the first six months to make sure it is running properly," Orr said. "But we don't want to get into setting up camps… we want people to live at home."

Finally, where will plant tailings go? Orr said the hope is to be able to use the pits that are being dug by Strilkewski about a kilometre away from the proposed property.

"What we want to do is pipeline it and deposit it in there," he said. "They are clay-lined and we will line them as well… eventually we would just cap it. You see what we've done is oxidize all the sulphides, so there is nothing in it that will mobilize it again. It needs acid for that to happen. We are taking over 95 per cent of the sulphides out of the concentrate through the oxidation process. So there are 300,000 tons.

"You lose about half your mass through bioleaching, you reclaim the mass when you put the limestone in to precipitate. But it is not going to be a problem for anybody. It is ferric arsenate, a benign form of arsenic. The only way that it could become re-liberated is if you ripped a hole in the cover with a backhoe and poured sulphuric acid into it."

Orr feels there will be a fair number of people coming to look at the Snow Lake plant, as it will be the only one of its kind in North America.

"This will be a prototype for other plants, so people who are trained here, maybe there is opportunity for them to assist in other locations if they choose to," added Nagy. "I'm excited, I think we'll have monthly plane trips up here just to show the wares."

In closing the interview, Orr said he can't say enough about the reception that BacTech has enjoyed in Snow Lake.

"It's been fantastic," he said. "Obviously people want this cleaned up and I understand that some have concerns over what they see as a new technology, even though there are 20 plants in the world using it. Everyone of them produces a ferric arsenate and none of them have ever had a problem, dating back to 1986."

My Take on Snow Lake runs Fridays.

Six calls for firefighters

A half-dozen calls kept Flin Flon firefighters busy throughout June, city council learned Tuesday.

Council reviewed the monthly fire chief's Shopping Centre. Upon arrival, firefighters determined the cause stemmed from a power outage. The fire chief and 16 firefighters responded.

June 8, 12:40 PM: A attendants. The fire chief and five firefighters responded.

June 10, 4:27 AM: A call from 911 stated there was a fire on Second Avenue. Upon arrival, on-call officer and 19 firefighters responded.

June 29, 8:20 AM: A call from the RCMP requested one person from the fire department attend a motor vehicle

Letter to the Editor

Dear Editor:

I would like to take this opportunity to address several issues that were raised at the July 4th Town Council meeting at the Snow Lake town hall with respect to the proposed BacTech Environmental bioleach plant. It is important that both sides of any story be heard. It is our belief that the information that was presented by a local citizen was false and in many cases blatantly inaccurate. Please find below some of the issues raised for which we have concerns.

- "They (BacTech) have not applied to the Environmental Approvals Branch, Conservation and Water Stewardship Mb. for an Environmental License"

Rebuttal: We are fully aware that an environmental license needs to be issued by the government and we are actively engaged in the preparation of the Environmental Assessment Proposal and we have engaged Golder Associates to prepare the application. A requirement of the application is that we must have title to properties for the bioleach facility and waste disposal site. We have been totally transparent and have worked with the government to date and will continue to do so. Our agreement with the Government of Manitoba outlines a series of "gates" or milestones which includes the environmental license process. If the results of the environmental assessment are acceptable, we will move to the next phase. The waste site will be lined and the neutralized material capped when complete.

- "The Department of Mines agreement with BacTech does not give them the go-ahead, the agreement is only an opportunity for BacTech to present a process for our environmental arsenic problem; and it must be a long term solution. BacTech must get an Environmental License to operate"

Rebuttal: On December 22, 2010, Manitoba, issued a Request for Proposal ("**RFP**") for the implementation of an appropriate technology to remediate the arsenopyrite stockpile ("ARS") at Snow Lake and recover the residual gold from the ARS.

BacTech presented Manitoba Innovation Energy and Mines with a proposal entailing the application of proprietary bioleaching technology to the ARS dated February 9, 2011 (the "Proposal"), and BacTech's Proposal came closest to meeting the requirements of the RFP. If testing confirms that the project is environmentally and economically viable, BacTech proposes to construct a bioleaching plant.

Bioleaching will treat the environmental hazard of Toke Mountain. The bacteria oxidize all the sulphides, thereby eliminating acid mine drainage which, in turn, eliminates the leaching of arsenic from the stockpile into the water table. The stockpile is made up of high levels of sulphides and arsenic. Sulphides oxidize when exposed to natural elements such as rain, wind, sun and temperature and release sulphuric acid. The sulphuric acid, in turn, takes soluble metals (i.e., arsenic) with it when it leaves the stockpile and enters the local environment. **If you remove the sulphides, you eliminate all the problems associated with acid rock drainage.** Protection measures will be implemented to control water discharge as we are treating the stockpile.

- "Have you looked at BacTech's website? Find the Snow Lake Project and be sure to read the "Arsenic Stabilization" short section. I have included it here in my letter, with Red Text added to list a few questions"

Rebuttal: The writer obviously is misinformed about the ARS material to be processed at Snow Lake. The verbiage cited refers to a project investigated by BacTech 5 years ago in Cobalt, Ontario. The Cobalt project involved tailings, whereby the tailings floatation process would be used to separate the sulphide minerals from the waste rock. The sulphides contain the recoverable metals AND the arsenic. This flotation process produces a sulphide concentrate, which is then treated by bioleaching. Historically, the sulphides make up 5-7% of the tailings. The other 95-93%

is waste rock with no value or hazardous material.

In contrast, the ARS material at Snow Lake is ***already a concentrate,*** meaning 100% of the material will be processed in the bioleach plant. If you process 100% of the stockpile, you process 100% of the arsenic. There will be nothing left at the site once the last ton of ARS has been fed into the plant. The site will be reclaimed and rehabilitated, most likely to the specifications of the government, town and QMX Mining. As a result of the bioleach process, 95% of the sulphides will be oxidized, meaning there is no more acid mine drainage. No more acid mine drainage means no more mobilization of arsenic.

- "Are we to believe that they will concentrate the original volume to 7% of the original volume and bioleach the 7% for the recovery of the gold and silver?"

Rebuttal: Again, the writer does not understand the fundamental makeup of the ARS stockpile in Snow Lake. There is no 7% solution here. It's a 100% solution and it deals with the removal of 100% of the pile.

Rebuttal: The writer cited work done by Mintek of South Africa. Mintek and BacTech were partners many years ago. BacTech's business plan was to install commercial applications of the technology, but Mintek, **which is owned by the South African government,** was more interested in R&D.

The over 20 bioleach plants that have operated or are currently operating all treat arsenopyrite. The end product is usually a form of ferric arsenate, which is safely deposited into the tailings areas. The stability of the ferric arsenate has been documented for over 25 years and by these plants.

- "Arsenic can change its valence state and chemical form in the environment"

Rebuttal: This is, in fact, accurate. As stated earlier, if you remove the acid generating sulphides, you will remove any chance of arsenic changing its steady state.

- "The Contaminants and Remediation Directorate of the Dep't. of Aboriginal Affairs and Northern Development Canada will not be accepting BacTech's proposal (Feb 2008) for treatment of the surface

- "With reference to the paper written by the University of Manitoba entitled "Arsenic mobility in alteration products of sulphide-rich, arsenopyrite-bearing wastes, Snow Lake, Manitoba, Canada…"

Rebuttal: We could not agree more with this paper. The key word above is "sulphides." Bioleaching destroys sulphides, thereby eliminating mobility of the arsenic. Bioleaching deals with the problem of acid mine drainage by eliminating the sulphides. Conventional capping process is only a band-aid solution.

- "The plant and the final deposit site should be side by side to prevent further contamination. There is only one logical location for both the plant and the final disposal."

Rebuttal: Again, we could not agree more. That plant site is very close to the ARS stockpile which eliminates the use of heavy trucks, and it is also very close to the proposed clay-lined disposal pits which will receive the final neutral ferric arsenate waste product via a small 2 inch pipe. Once in the pit, it will be dewatered, with the water returning by pipe to be reused in the process.

- "Let's talk about stability of arsenic compounds" tailings at the Giant Mine in the North West Territories."

Rebuttal: Some years ago, we may have sent a general letter enquiring about the prospects of bioleaching but it wasn't in a formal proposal. In 2012, however, the Company is actively pursuing this project and in May, we met in Ottawa with senior representatives of Aboriginal Affairs and Northern Development Canada. We have been allowed access to the many studies completed on the Giant Mine over the last 20 years and the Company is currently evaluating the project to determine if it is a candidate for using our bioleaching.

- "I am no chemist but it sounds like the final disposal site is of high importance."

Rebuttal: Again, I can't argue with either of these claims.

In closing, we have tried to be good corporate citizens to date. We have presented our project to all citizens last January and are willing to discuss the project with anyone.

Regards,
Ross Orr - President and CEO, BacTech Environmental Corporation, 50 Richmond Street East, Suite 300, Toronto, Ontario M5C 1N7, Telephone: 416-813-0303 ext 222

June 7, 2012

Property proposed for Bactech plant

In their recently discussed and since implemented 2012 Financial Plan, the Town of Snow Lake listed the amount of $300,000 under the heading Land Sales. Asked what that figure encompassed Mayor Fisher and CAO Precourt advised that it includes money they would receive from the sale of land to both Bactech Environmental and Multicrete Systems.

"Finally some pieces of land are becoming available," said the mayor. "It actually just came through last week. The land that is proposed for them (Bactech) is between Stittco and the Snow Lake Mine. That land has just come into the town's possession, so they are now trying to make a deal with Bactech with them buying it."

CAO Precourt said the news was so fresh, it hadn't even gone to a council meeting yet. "It will be on the June 5th agenda to purchase that land from the government," he said. Asked about the people using the land right now, the CAO said that Gardwine had a permit for their land, but that the town will own the area from that property up to Stittco.

The land sales figure of $300000 covers this area as well as an area adjacent to the dump for Multicrete in addition to the eight industrial lots. "That 300 K is probably conservative for what we're looking at," said the mayor. ***MJ***

(Photo of lots proposed for Bactech - by Marc Jackson)

Columnists

BacTech to take a toke of Snow Lake Gold!

Marc Jackson

My Take on Snow Lake

mjaxon@gillamnet.com

WITH FILES FROM BACTECH NEWS RELEASES

Directly behind the Snow Lake Mine headframe sits what is known locally as Toke Mountain, a landmark that has been with the community since the 1950s. This local beacon is an arsenopyrite stockpile left over from the glory days of the Nor-Acme Gold Mine.

Although dubious in nature (in more ways than one), the stockpile's name comes from area young folks of the 1970/80's. They drove their vehicles to the spot on weekend nights and partied there unhindered for years. It's rumoured that the name was derived from some of the resultant activities.

Nickel Belt photo courtesy of Jim Parres

Snow Lake's Toke Mountain (arsenopyrite stockpile), which sits behind the Snow Lake Mine.

Nevertheless ... it has sat and leached for more than 50 years now. A minute amount of its residue has no doubt mixed with runoff and made its way into the Wekusko and Snow Lake watersheds. However, by the time it reaches Snow Lake's environment, nature has done its job and arsenic levels are down below the objectives required of drinking water. According to information published on the Town of Snow Lake's website, levels of arsenic in Snow Lake are considerably lower than the Manitoba Surface Water Quality Objectives allowable limit. A sample of the lake's water taken in 2010 shows arsenic at a level of 0.00075mg/l, well below the 0.01mg/l maximum acceptable concentration.

The tailings stockpile resulted from the progression of the original Nor-Acme Mine, which operated from 1949 to 1958. The technology of the day allowed them to recover only 83 per cent of the available gold from the ore they milled. As a result, arsenic laden tailings were stockpiled in an open containment area constructed from waste rock placed directly on clay. This stockpile remained uncovered for 50 years, eventually becoming an orphaned site under the responsibility of the Province of Manitoba.

In 1999, TVX Gold, operator of a reincarnation of the Nor-Acme, the New Britannia Mine, capped the pile to reduce oxidation of the tailings and further contamination via surface runoff.

Even though it had been capped, in 2008 Andrea Hachkowski, an engineer with AECOM Environment reported that during sampling done at that time, arsenic concentrations in the stockpile's pore water increased with depth and were highest just below the water table. The highest concentration of solid phase arsenic, 120,000 ppm, was observed in October 2008. "Clay beneath (the) stockpile may have settled under its weight, allowing for arsenic to pass more rapidly into the underlying sandy till," Hachkowski noted at the time. "Hydraulic gradient and local topography indicate a flow path from the stockpile to the low-lying wetlands that feed Snow Lake."

The pathway mentioned was 300 metres long and 20 to 40 metres wide and concentrations of up to 39,000 ppm were detected in the top half-metre of soil beneath it.

Apparently, the 50 years that the pile was left uncovered resulted in the elevated arsenic concentrations.

It seemed imperative that something be done with this possible peril for the community. In the 1980's Sikaman Resources tried and failed. Now comes news – and lots of it – that BacTech Environmental has a process that will do what others have attempted in the past, which is negate the threat of the stockpile, while extracting the gold from it in order to pay for the effort.

In April the Manitoba government awarded BacTech with a contract to remediate the Nor-Acme arsenopyrite stockpile. After negotiation of an agreement with the government, BacTech proposes a solely funded approach to the the tailings."

The company says that they have engaged the services of Barbara Sherriff, a recently retired professor from the University of Manitoba, who has a 15-year history evaluating the stockpile. She will oversee a drill program, which was slated to begin May 9. The program will obtain representative samples from some 30 holes to be drilled on the stockpile. These samples will then be subjected to diagnostic and bioleach testing to determine the appropriate approach for treating the concentrate.

It is anticipated that the holes will be drilled on three fences with 10 metres spacing between holes. In addition, all holes will be drilled into the base sediments below the stockpile to determine the extent of the arsenic penetration. The drill core will be split, with one half being retained for purposes clean up. They will recover, as their own, all payable metals from the stockpile, while treating the contained arsenic.

BacTech says that their bio-oxidation technology has been used successfully in the gold industry for many years to aid the extraction of gold from arsenical concentrates, while stabilizing arsenic values into a benign form. The company's website notes, "BacTech's patented BACOX technology (licensed from REBgold Corporation) uses naturally occurring bacteria, harmless to both humans and the environment, to oxidize the contained sulphides and separate metal from the difficult-to-process tailings. In the process, toxic elements such as arsenic are stabilized. The tailings created by bioleaching are benign, and zero environmental damage occurs as a result of the process. An added bonus is its ability to recover valuable metals such as gold, silver, cobalt and nickel that remain in of calculating the 43-101 report. The other half will be shipped to Inspectorate Exploration and Mining Services Ltd. in Vancouver where they will assay for gold and do bioleach test work. It is estimated that the bioleach work will be completed in the third quarter of 2011. Alexis Minerals has granted BacTech access to their site so that samples can be obtained for test work.

The anticipated life of the project, beginning with the onset of processing concentrates, will be about six to seven years. Engineering design for the plant and operations will be carried out concurrently with the work program. The anticipated start date for the construction of the plant will be the summer of 2012. Theoretically, the plant could also have value in being capable of treating other refractory type gold values and waste in the region, and efforts to incorporate this concept might be made at the design stage.

Thompson Citizen Articles Regarding BacTech Environmental Corporation

Snow Lake bioleach plan 'economic', assessment finds

Comments Tweet 1

AUGUST 31, 2012

BacTech Environmental Corp. says a new preliminary economic assessment finds its planned bioleach plant in Snow Lake is "economic" in current market conditions.

The company plans to build a new-to-North America plant in Snow Lake that will neutralize and extract valuable gold from a decades-old pile of toxic mine waste.

The Toronto-based BacTech commissioned Micon International Ltd. to conduct the economic assessment.

BacTech plans to soon release a summary of the study on its website after it has been reviewed and approved by Micon, which is also based in Toronto.

BacTech is now negotiating with the Town of Snow Lake to acquire a property for the bioleach plant that will be near the mine waste, known as tailings.

This will provide for relatively easy access to and from the plant and keep noise and dust at a minimum, the company said.

Concurrent with the economic assessment, BacTech has engaged Golder and Assoc. to provide baseline environmental studies for the proposed plant site, as well as submission of environmental operating permits and closure plan to the Manitoba government.

The planned bioleach plant is designed to treat 109 tonnes of concentrate per day from the tailings pile.

This provides for a project life of about seven years to remediate the tailings safely and benefit from an annual gold production of 10,400 oz.

Meanwhile, BacTech continues to identify and evaluate additional feeds that potentially can add to the life of the plant.

The release of the assessment triggers the onset of a 90-day period of exclusivity for Newalta Corp. to review the project's economics and negotiate its participation in the project with BacTech.

Newalta provided $300,000 toward the cost of the assessment in exchange for the exclusivity period. BacTech also announced that it plans to raise up to $1.65 million by way of a private placement of common share units.

The proceeds will be used for the Snow Lake project, general working capital and ongoing test work.

The economic assessment is, of course, preliminary and includes inferred mineral resources that are considered too speculative to have the economic considerations applied to them that would enable them to be categorized as mineral reserves; and there is no certainty the economic assessment will be realized.

The assessment is an analysis of mineral resources that are not mineral reserves and do not have demonstrated economic viability.

Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

My Take on Snow Lake

Comments Tweet 0

APRIL 10, 2012

MARC JACKSON
MJAXON@GILLAMNET.COM

BacTech Environmental Corporation has been in the news several times in the last couple of weeks. Most notably in the release of results from their bioleach testing on concentrates from the Snow Lake arsenic/gold residue stockpile or Toke Mountain as it is more commonly known.

The company noted that their BACOX bio-oxidation process did very well in the testing. The process oxidizes over 95 per cent of the sulphides, thereby eliminating future acid mine drainage environmental problems associated with the stockpile. Additionally, the bio-oxidation process renders 88.6 per cent of gold contained in the sulphides available for extraction, compared to only 9.4 per cent using conventional gold extraction without oxidation.

It was stated that a high weight loss of 45.7 per cent was obtained during oxidation, resulting in the gold grade almost doubling to 17.8 g/t from the original 9.80g/t, but still maintaining the same amount of gold in the plant feed.

"This mass reduction reduces considerably the size and cost of equipment required in final gold extraction processing," the release read. "The reagent consumptions noted in the test work for gold extraction were also modest and comparable to those associated with current bio-oxidation plants used in the gold mining industry."

Ross Orr, president and CEO of BacTech, was pleased with the numbers the testing brought back.

Photo courtesy of Marc Jacks

MARY ANN MIHYCHUK AND PAT CARSWELL

Mary Ann Mihychuk, left, listens as Pat Carswell senior operations manager of technical development for Newalta Corporation addresses Bach Tech's Jan. 17 information meeting in Sno Lake.

Related Links:

- My Take on Snow Lake
- My Take on Snow Lake
- My Take on Snow Lake
- My Take on Snow Lake
- BacTech gets green light to bioleach
- My Take on Snow Lake
- BacTech wins contract to clean up Snow Lake metals stockpile

* Bioleaching may clean up Snow Lake

"Historically, we have found that we should be able to obtain higher recoveries in a commercial operation compared to the laboratory where optimization of parameters is easier on a continuous basis and the bacteria used in the process adapt over time to the type of feedstock," he said. "This result clearly demonstrates the effectiveness of BacTech technology for these types of environmental remediation."

Another news release earlier in the month announced a change to BacTech's board of directors and the appointment of a vice-president for its wholly-owned subsidiary that holds the Snow Lake project.

BacTech announced that Mary Ann Mihychuk, requested that she step down from the board to assume the role of vice-president of operations for BacTech Manitoba Corporation. BMC has 100 per cent ownership of the Snow Lake project on behalf of BacTech. BacTech Manitoba has established an office in the National Research Council Business Commercialization Centre (BCC) in Winnipeg, Manitoba.

"We are pleased to have Mary Ann carry a more hands-on role with respect to Snow Lake," said Orr. "Much of what we have accomplished, in a relatively short period of time, can be traced back to her participation to date."

Along with an extensive background in business and public service, Mihychuk is currently employed as the community development officer with the Town of Snow Lake. Asked if he saw any conflict with Mihychuk, who is also a former NDP mines minister in the Doer government, performing both jobs, Snow Lake's Mayor Clarence Fisher advised that he didn't anticipate any conflicts or troubles emerging.

"First of all, Ms. Mihychuk is a professional, who I have confidence in and who I know will do all that she can to make sure conflicts do not arise," said Fisher in an e-mail reply to the question. "But more than that, it is really very similar to many other people associated with the town. For example, I also work at the school, Mr. (Dave) Mayer owns Home Hardware, Mr. (Chris) Samborski owns Cornerview. When any issues come up that directly concern our other 'hats', we need to be aware of them and step away from the table; which people have been willing to do."

Mihychuk, Manitoba's former NDP minister of industry and mines, was hired by Snow Lake Town council Feb. 21 as its community development officer. She holds a MSc. in geology from Brock University in St. Catharines, Ont. and is a registered geoscientist in Manitoba and Ontario.

She has a background of 30 years as a geologist, has served as the director of corporate relations for HudBay Minerals Inc., as well as director of regulatory affairs at PDAC, and while NDP MLA for Winnipeg's Minto constituency, she served as minister of industry, trade and mines, and as minister of intergovernmental affairs and trade.

Fisher says that he believes there may have been more of a concern if the council were still in the process of attracting BacTech to set up in Snow Lake. "When you are in the early stages of these types of negotiations, people need to be very careful if they wear multiple hats," said the mayor. "But we are past that stage. BacTech has decided to set up shop in Snow Lake. They are finalizing all of their chemical and economic assessments, but beyond having to settle on and sell them a piece of property, we currently have no ongoing negotiations with BacTech. They will need more time with us as a council and with Mr. (Jeff) Precourt and Mr. (Viktar) Lazar as the town's project manager, but in regards to the town, they should have little to do with Ms. Mihychuk's office."

The company also announced the appointment of Don Whalen to the board of BacTech. Whalen is no stranger to the people of Snow Lake. He is the former executive chairman of High River Gold Corporation , which owned and operated the New Britannia Mine in the late 1990s.

JANUARY 27, 2012

MARC JACKSON

Officials from BacTech Environmental Corporation and Newalta Corporation were in Snow Lake for a public presentation Jan. 17. The event took place in the Lawrie Marsh Community Hall and close to 60 people were on hand to hear what the companies had to say about a recently proposed development that will extract gold from Toke Mountain and in the process safely do away with this longstanding environmental liability.

Related Links:

- Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

The meeting began with BacTech chief executive officer Ross Orr welcoming attendees and introduced the folks who sat with him at the front of the hall; Paul Miller, BacTech's vice-president of technology, "or the head bug guy, as we call him," joked Orr, as well as David Salari, chief operating officer; Pat Carswell, senior operations manager of technical development for Newalta Corporation; and Mary Ann Mihychuk, a company director, geologist and former Manitoba NDP mines minister.

After introductions, Orr gave an overview of BacTech as a company, his own background and that of others within BacTech as well as the process that they intend to incorporate in the plant proposed for Snow Lake.

Orr stated that BacTech has taken a technology that has been around the industry for 25 years and in addition to its mining applications, has been used to retrieve metals from, then render inert, arsenic and sulphide laden mine tailings with the stable end product being ferric arsenate.

He noted that a common thread with tailings disposal sites is that governments tend to own a lot of the nastier ones. "They are left behind through bankruptcies or whatever," said Orr. "We decided to challenge the conventional approach, which was to clay cap it and treat the water for the next 50 years at the taxpayer's expense. So our initial proposal to Innovation, Energy and Mines Minister Dave Chomiak was let us build a plant at for zero dollars to them, but we wanted to take the proceeds recovered from the actual pile."

Continuing, Orr spoke about the drill program they carried out in the spring of 2011. Noting that their 43-101 for the pile confirms that it contains a measured resource of 82,000 ounces of gold and 10,000 ounces in the inferred category. The grade of the 300,000-ton pile is 9.7 per cent. He also said that even though they aren't sure exactly where the plant will sit, they hope to begin construction later in 2012, after completing their environmental and bioleach work.

Prior to handing the floor over to Miller, Orr summarized BacTech's affiliation with Newalta, a company that is an established leader in minimizing waste and maximizing the recovery of valuable products and resources.

In respect to the people she will be working with in order to bring local and area development strategies to fruition, Mihychuk says, "I am pleased to work with a group of committed hard working leaders with a positive attitude. With a good plan and a great team, we have the recipe of success."

MARCH 11, 2011

BY RYAN FLANAGAN
NEWS@THOMPSONCITIZEN.NET

Related Links:

- Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

BacTech Environmental Corporation has responded to a provincial request for proposals, tendering a proposal to clean up a stockpile of arsenopyrite at Snow Lake.

Arsenopyrite is an iron arsenic sulfide mineral, which in Snow Lake's case has been stockpiled since the 1950s when gold was harvested from the Nor Acme Mine. This was done due to the high levels of arsenic as well as the refractory nature of the gold associated with the arsenopyrite.

In the 1950s, the stockpile was treated with cyanide, but the gold was not extracted at the time. According to a 1996 government study, the 250,000-tonne stockpile contains 8.7 grams per tonne of gold, or about 2,175 kilograms of gold in all. BacTech says that they have not verified those numbers, but that they "believe this historic estimate is relevant and reliable."

"We are pleased to tender a proposal for the clean up of the Snow Lake stockpile and look forward to working with all levels of government and local partners to solve this long-standing problem should our proposal be accepted," said BacTech president and chief executive officer Ross Orr. "More importantly, we look forward to establishing North America's first bioleach plant in Manitoba and establishing a home base for our environmental remediation technology."

BacTech's proposal includes the construction of a bioleach plant in Snow Lake, which would be able to treat 150 tonnes of the arsenopyrite per day, getting through the entire stockpile in approximately five years. This would be the first bioleach plant of its kind in North America, and BacTech says it could possibly be adapted to treat additional tailing issues in the future.

Bioleaching involves using naturally-occurring bacteria, harmless to both humans and the environment, to extract precious and base metals – such as gold – from ores and concentrates which are more difficult to treat, such as arsenic. By putting the bacteria in a reactor which simulates its ideal living conditions, the bacteria is able to work its way into extracting the metals in a much quicker time span than it could in open air.

BacTech, which is working on a similar proposal for the town of Cobalt, in northern Ontario, says that their bioleaching will be able to stabilize the arsenic contained in the arsenopyrite, which will reduce future monitoring and treatment costs.

According to BacTech's proposal, there will be no direct cost to the government for the bioleaching plan – they will fund their efforts through recovery of the gold.

My Take on Snow Lake

Town hits home run with new hire

Comments Tweet 0

MARCH 30, 2012

MARC JACKSON

The mayor has called it a coup. Our MLA has stated the move couldn't have been more positive, and Snow Lake citizens are scratching their heads and wondering how the council did it! If you are still wondering what has caused all this excitement, it is council's Feb. 21 hiring of MaryAnn Mihychuk , Manitoba's former NDP minister of industry and mines into the position of community development officer.

Related Links:

- Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

Asked why she wanted to relocate to Snow Lake and take on the position of community development officer, Mihychuk says that the community has always held a special place in her heart. While employed with the Manitoba Geological Survey, she helped map the area in the 1980s and her son attended J.H. Kerr School for several months during that field season. "It was the year of the big forest fire," she said. "I came to understand what a special place Snow Lake was."

Mihychuk says she has always kept track of the community, watching it go through a variety of ups and downs in the ensuing decades. She also acknowledged the pain which was undoubtedly felt during the depths of the downturns. "Needless to say when BacTech approached me to assist in the bioleach project, I was keen to bring a new opportunity to one of my favourite places," said Mihychuk. "Finally, when I was approached to consider assisting the town, I was honoured to participate in the next chapter."

A chapter that she says will see the town capitalize on the Lalor development, BacTech's $25-million plant, the re-starting of Alexis Snow Lake Mine, and the massive amounts of exploration going on in the Snow Lake camp. She says there are over 30 companies and prospectors working in the area and that this has made Snow Lake a hot exploration play.

Mihychuk is extremely well qualified for the position, and she will undoubtedly bring a wealth of knowledge and understanding to the table. As well as a formidable education (she holds a MSc. geology from Brock University and is a registered geoscientist in Manitoba and Ontario), Mihychuk has an abundance of experience.

She has a background of 30 years as a geologist, has served as the director of corporate relations for Hudbay, as well as director of regulatory affairs at PDAC, and while NDP MLA for Manitoba's Minto constituency, she served as minister of industry, trade and mines, and as minister of intergovernmental affairs and trade.

In terms of how she will tackle the job, Mihychuk feels Snow Lake is in a great position. She has confidence in the Snow Lake Community Development Plan and says that it is a great platform for future development. "The mineral supply and service sector and the development of a centre of excellence building on BacTech's commitment to conduct R&D on tailings from many parts of Canada and the Americas, are clearly opportunities for Snow Lake," said the new CDO. "The challenge is undoubtedly infrastructure of transportation, retail, housing, and the need to work with our provincial partners to cut red tape and make things happen in a timely manner."

MAY 13, 2011

MARC JACKSON
WITH FILES FROM BACTECH NEWS RELEASES

Photo courtesy of Jim Parres

Snow Lake's Toke Mountain (arsenopyrite stockpile), which sits behind the Snow Lake Mine.

Related Links:

- Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

Directly behind the Snow Lake Mine headframe sits what is known locally as Toke Mountain, a landmark that has been with the community since the 1950s. This local beacon is an arsenopyrite stockpile left over from the glory days of the Nor-Acme Gold Mine.

Although dubious in nature (in more ways than one), the stockpile's name comes from area young folks of the 1970/80's. They drove their vehicles to the spot on weekend nights and partied there unhindered for years. It's rumoured that the name was derived from some of the resultant activities.

Nevertheless ... it has sat and leached for more than 50 years now. A minute amount of its residue has no doubt mixed with runoff and made its way into the Wekusko and Snow Lake watersheds. However, by the time it reaches Snow Lake's environment, nature has done its job and arsenic levels are down below the objectives required of drinking water. According to information published on the Town of Snow Lake's website, levels of arsenic in Snow Lake are considerably lower than the Manitoba Surface Water Quality Objectives allowable limit. A sample of the lake's water taken in 2010 shows arsenic at a level of 0.00075mg/l, well below the 0.01mg/l maximum acceptable concentration.

The tailings stockpile resulted from the progression of the original Nor-Acme Mine, which operated from 1949 to 1958. The technology of the day allowed them to recover only 83 per cent of the available gold from the ore they milled. As a result, arsenic laden tailings were stockpiled in an open containment area constructed from waste rock placed directly on clay. This stockpile remained uncovered for 50 years, eventually becoming an orphaned site under the responsibility of the Province of Manitoba.

In 1999, TVX Gold, operator of a reincarnation of the Nor-Acme, the New Britannia Mine, capped the pile to reduce oxidation of the tailings and further contamination via surface runoff.

Even though it had been capped, in 2008 Andrea Hachkowski, an engineer with AECOM Environment reported that during sampling done at that time, arsenic concentrations in the stockpile's pore water increased with depth and were highest just below the water table. The highest concentration of solid phase arsenic, 120,000 ppm, was observed in October 2008. "Clay beneath (the) stockpile may have settled under its weight, allowing for arsenic to pass more rapidly into the underlying sandy till," Hachkowski noted at the time. "Hydraulic gradient and local topography indicate a flow path from the stockpile to the low-lying wetlands that feed Snow Lake."

The pathway mentioned was 300 metres long and 20 to 40 metres wide and concentrations of up to 39,000 ppm were detected in the top half-meter of soil beneath it.

Apparently, the 50 years that the pile was left uncovered resulted in the elevated arsenic concentrations.

It seemed imperative that something be done with this possible peril for the community. In the 1980's Sikaman Resources tried and failed. Now comes news – and lots of it – that BacTech Environmental has a process that will do what others have attempted in the past, which is negate the threat of the stockpile, while extracting the gold from it in order to pay for the effort.

In April the Manitoba government awarded BacTech with a contract to remediate the Nor-Acme arsenopyrite stockpile. After negotiation of an agreement with the government, BacTech proposes a solely funded approach to the clean up. They will recover, as their own, all payable metals from the stockpile, while treating the contained arsenic.

BacTech says that their bio-oxidation technology has been used successfully in the gold industry for many years to aid the extraction of gold from arsenical concentrates, while stabilizing arsenic values into a benign form. The company's website notes, "BacTech's patented BACOX technology (licensed from REBgold Corporation) uses naturally occurring bacteria, harmless to both humans and the environment, to oxidize the contained sulphides and separate metal from the difficult-to-process tailings. In the process, toxic elements such as arsenic are stabilized. The tailings created by bioleaching are benign, and zero environmental damage occurs as a result of the process. An added bonus is its ability to recover valuable metals such as gold, silver, cobalt and nickel that remain in the tailings."

The company says that they have engaged the services of Barbara Sherriff, a recently retired professor from the University of Manitoba, who has a 15-year history evaluating the stockpile. She will oversee a drill program, which was slated to begin May 9. The program will obtain representative samples from some 30 holes to be drilled on the stockpile. These samples will then be subjected to diagnostic and bioleach testing to determine the appropriate approach for treating the concentrate.

It is anticipated that the holes will be drilled on three fences with 10 metres spacing between holes. In addition, all holes will be drilled into the base sediments below the stockpile to determine the extent of the arsenic penetration. The drill core will be split, with one half being retained for purposes of calculating the 43-101 report. The other half will be shipped to Inspectorate Exploration and Mining Services Ltd. in Vancouver where they will assay for gold and do bioleach test work. It is estimated that the bioleach work will be completed in the third quarter of 2011. Alexis Minerals has granted BacTech access to their site so that samples can be obtained for test work.

The anticipated life of the project, beginning with the onset of processing concentrates, will be about six to seven years. Engineering design for the plant and operations will be carried out concurrently with the work program. The anticipated start date for the construction of the plant will be the summer of 2012. Theoretically, the plant could also have value in being capable of treating other refractory type gold values and waste in the region, and efforts to incorporate this concept might be made at the design stage.

BacTech gets green light to bioleach

Comments Tweet 0

MAY 13, 2011

BY JONATHON NAYLOR
FLIN FLON REMINDER

A cutting-edge processing plant will open in Snow Lake next year to remediate – and extract valuable gold from – a mound of toxic mine waste.

Nickel Belt photo courtesy BacTech Environmental C

This pile of mine waste known locally in Snow Lake as Toke Mountain will be the site of BacTech's first bioleaching project, which will extract gold from the arsenic-laced tailings.

Related Links:

- Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

BacTech Environmental Corp. expects the new-to-North America facility will open in late 2012 to process decades-old tailings left behind at the Nor Acme gold mine.

"This is a major step forward for BacTech as we position ourselves as a leader in the field of tailings reclamation," said Ross Orr, president and CEO of the Toronto-based company. "It is a highly visible project whose success could lead to bioleaching playing a prominent role in future clean-ups in North and South America."

The plant will utilize chemical-based bio-oxidation technology to neutralize and cull gold from roughly 250,000 tonnes of tailings. The pile covers nearly 20,000 square metres and stands as high as 10 metres in some places.

Historic data suggests the tailings may contain as much as US$122 million worth of gold, though BacTech stresses that estimate is conceptual in nature.

The plant will not be a major employer, requiring only 15 employees for its around-the-clock operating schedule.

But MaryAnn Mihychuk, a director with BacTech, said the company is committed to research and development that could one day expand its presence in the region.

While the plant will initially process tailings, Mihychuk said the technology can also extract gold from a type of ore known as refractory ore.

Beyond gold, she said BacTech has conducted test work involving base metal extraction and has been approached to study uranium extraction.

"I think the potential will be much broader than one project in Snow Lake," Mihychuk said, adding that BacTech has had "very positive" discussions with HudBay Minerals about the technology.

BacTech projects it will take six to seven years to process the arsenic-laced Snow Lake mound, referred to by locals as "Toke Mountain."

After that, Mihychuk said, the plant will hopefully remediate other tailings stockpiles or be sold to a mining company for outright ore processing.

Snow Lake resident and Nickel Belt News columnist Marc Jackson greeted BacTech's announcement with cautious optimism.

"This isn't the first time we have heard noise about a company doing something with Toke Mountain," he told the Flin Flon Reminder. "Although, there have been companies attempt what BacTech is suggesting in the past, Snow Lakers will no doubt be happy to see something done with this threat on the edge of town. The possibility of some jobs and additional money coming into the community is gravy."

Not only will the Snow Lake plant be the first of its kind in North America, it will also be one of few in the world. Mihychuk said there are only 20 bioleach plants in existence today, three of which – located in China and Australia – are owned by BacTech.

BacTech officially committed to the Snow Lake plant last week after being awarded a provincial contract to remediate the tailings stockpile, created in the 1950s.

The company said the contract remains subject to negotiating a "suitable agreement" between itself and the Manitoba government.

BacTech is not asking for government support, as it plans to cover its costs by pulling the gold trapped within the tailings.

The company said its interest in the project stems from test work completed last year whereby bioleaching technology was determined to be well suited for the stabilization of the high levels of arsenic in the stockpile.

Alexis Minerals Corp., which owns and hopes to restart the defunct Nor Acme mine, has granted BacTech access to the site so that samples can be obtained for test work.

The test work is to be completed later this year, with an environmental baseline study to begin shortly.

To aide the test work, BacTech has hired Dr. Barbara Sherriff, a recently retired University of Manitoba professor who spent 15 years evaluating the Snow Lake stockpile.

Dr. Sherriff will oversee a drill program slated to begin in a week. The program will obtain representative samples from about 30 holes to be drilled on the stockpile.

These samples will then be subjected to diagnostic and bioleach testing to determine the appropriate approach for treating the concentrate.

BacTech said an engineering design for the plant and operations will be carried out concurrently with the test work program.

BacTech hopes to begin construction in July or August of 2012. The plant would be commissioned about four months later.

My Take on Snow Lake

Nothing finalized yet between Bactech Environmental and Town of Snow Lake

Comments Tweet 0

OCTOBER 14, 2011

MARC JACKSON

Photos courtesy of Jim Parres

Toke Mountain (foreground to right) is the area in Snow Lake Bactech proposes to cleanup (Alexis Minerals' Snow Lake Mine in background).

Related Links:

- Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

On Sept. 16 at the Cambridge Toronto convention, Sheldon Kraft, CEO of SNN Inc. (Stock News Now) did a video press release interview with Ross Orr, president and CEO of Bactech Environmental.

During the interview, Kraft noted that Bactech was an interesting case being a green company situated at a resource conference. To explain why, he asked Orr to give an overview of what the company does. "Basically we use naturally occurring bacteria to do in six days what they would normally do in 20 to 25 years," said Orr. "We give them the Garden of Eden to oxidize sulphides, to release metal that we recover for our own account." Chuckling at this, Kraft suggested that everyone from governments to mining companies must love Bactech. "Well they should love us," Orr responded. "The one negative thing about mining is the problems and the legacies that are left behind." Orr said that the company had found that the older the problem is, the better it becomes for Bactech. He says that there is more metal to recover. There is also acid mine drainage problems and that's what his company is in the business of cleaning up.

Asked what a typical situation for the company was, Orr replied that a representative property would be a government owned site, where the mining company that operated it has long disappeared and left behind acid mine drainage problems and or arsenic issues and they want it cleaned up. He said that the first project that the company would be doing was with the province of Manitoba. "Effectively we said to them, 'we'll clean up the mess - we're keeping the gold,'" said Orr.

Kraft then observed that process as Orr explained it had to be worthwhile. "Right," Orr agreed. "We're going to spend $20 million to build a bioleach plant and depending on the price of gold, we are going to extract anywhere from $130 - $150 million worth of gold."

"Plus you will return the property back to an environmentally sound situation," Kraft queried? "That's correct, because we'll have taken out all of the arsenic," answered Orr. "One of the nice by-products of bioleaching is that we actually stabilize arsenic into what is called a ferric arsenate, which is a benign USEPA (United States Environmental Protection Agency) land fillable end product. So that's huge … there are a lot of arsenic issues around the world."

Asked what his background was, Orr replied that he was in the securities industry up until about 1991, then moved to venture capital. "I found these guys (Bactech) down in Australia in 1997, brought them up here - took them public," he said. "And Like Victor Kiam says, I liked it so much, well I didn't buy the company, but I'm running the company now."

Kraft also asked what was next for Bactech? "He explained that the current company was called Bactech Mining Corporation up until last December when it split in half. One half uses the technology to produce the gold, like a mining company - it is called RebGold, and Orr sits as a director on its board. The other side of the spilt, which is Bactech Green, works with the environmental part. Of their work, Orr said, "Your product is already on surface… it's already been crushed and ground, so the capital (outlay) is a lot less and you're dealing with a known commodity at the end of the day as well, which is nice."

Orr also noted that he was thinking about bringing the technology to the United States and actually had a meeting in a couple weeks time in the mother lode district (Sierra Nevada gold region in California). "It's arsenopyrite in a refractory ore," he said of the area. "One of our plants can start bringing in concentrates from all over the state and clean up a lot of these 150-year old problems."

As for Bactech's potential set-up in Snow Lake, nothing has been finalized. Snow Lake chief administrative officer Jeff Precourt advises that the company and the town continue to discuss establishing a site in Snow Lake. "Several parcels of town land have been discussed, including the old Stittco property (corner of #392 and #393)," said Precourt. "A final decision and agreement have yet to be finalized, although the town remains optimistic an announcement will be made regarding Bactech's operation within the next several weeks."

My Take on Snow Lake

Report from mining convention

Comments Tweet 0

DECEMBER 9, 2011

MARC JACKSON

The 43rd annual Manitoba Mining and Minerals Convention ran from Nov. 17-19 at the Winnipeg Convention Centre. The convention's primary purpose is to present new geoscientific findings, define mineral potential and provide critical data to attract exploration companies to Manitoba, but it also features a trade show, a property showcase, the annual aboriginal mining workshop and a free open house for the last day of the gathering.

Related Links:

- Wearing two hats: Former NDP mines minister Mary Ann Mihychuk working for BacTech Manitoba and Town of Snow Lake

Speaking on the event during the first day of the conference, Energy and Mines Minister Dave Chomiak stated, "Manitoba's rich mineral resources and competitive business environment have made this province one of the best places worldwide for mining investment," he said. "This convention brings together industry experts and provides them an opportunity to explore potential investments and seek new partnerships."

Representing the Town of Snow Lake at the conference was the group of councillors Rupert Klyne, Aldon Kowalchuk, Angela Enright, Brenda Forsyth-Flamand, as well as project manager Viktar Lazar, and chief administrative officer Jeff Precourt.

Forsyth-Flamand states that Snow Lake was once again a hot topic of conversation at the three-day gathering of the industry. "One morning session was dedicated to updates within the Snow Lake area," she said. "Kim Proctor, (HudBay's Lalor project manager) gave an update on Lalor, including a slide show on what has been happening, as well as the time lines for future development, production, and for the new concentrator."

She also noted that Gerald Thornton, Alexis' vice- president of Manitoba Operations, gave a presentation about where Alexis is and what is needed for them to get up and running. "Which is basically money," said Forsyth-Flamand. "Their feasibility study is done and they are hopeful for production in 2013." Also taking to the podium on something Snow Lake-related was Dr. Alan Bailes (chief geologist in charge of the Precambrian section of Manitoba Geological Survey from 2001 to 2008) who spoke on the large synvolcanic alteration zones associated with Snow Lake VMS deposits.

In addition to being the topic of discussion within many of the conference's sessions, Forsyth-Flamand stated that the Snow Lake delegation was extremely busy on the convention floor and at the Team Manitoba booth. "There were a lot of people there who were really interested in Snow Lake," she said. "One of us was always there (at the booth), never leaving it with just someone from one of the other communities. We really pushed how excited we are about the future of Snow Lake and all the mining activity around us." Forsyth-Flamand adds that they also explained the growth-related issues of the town and what is going on to get ready for it.

She said that in order to get to get to Winnipeg and the convention for 1 p.m., the Snow Lake attendees left for the conference at 5 a.m. on Thursday morning. "As soon as we arrived, we got the booth rolling and started to answer questions," she said. At 6 p.m., along with the mayor of Bissett, Thompson Mayor Tim Johnston and the minister of mines, Forsyth-Flamand (who is the town's deputy mayor), gave a speech at the welcoming reception.

There were a number of companies with a Snow Lake connection who had a presence at the convention, including HudBay, VMS, Alexis, Rockcliff, BacTech, and Jiminex. Forsyth-Flamand says that she talked to Ross Orr from BacTech and he advised that they are still waiting on the government to get things rolling, but he expected a decision any day. They plan to hold a presentation in Snow Lake after they get their go-ahead.

In addition to the conference and all that resulted from it, council members also held meetings and touched base with people on other Snow Lake issues. Northern mayors met and spoke of acting regionally on issues they all face, such as roads and infrastructure. "We also talked about re-defining the Northern Development Strategy," said Forsyth-Flamand. "It was just an informal meeting to see where everyone was and we basically found out that we all face similar issues. Another issue communities are worried about is the wheat board closure and the Bay rail line. I offered that anytime the mayors want to meet, they can do so in Snow Lake, as it is central for most."

Additionally, Forsyth-Flamand says that Enright and Lazar met with several people on development issues. Precourt, Lazar, Kowalchuk and Klyne met with wastewater plant engineers Stantec, and all of the councillors who were down for the event met over Saturday morning breakfast with Brad Lance, HudBay's vice-president of the Manitoba business unit, and Tom Goodman, senior vice-president and chief operating officer. "It was very informal, just an update of what council is up to and what is going on in the community," said Forsyth-Flamand. "They knew most of what was going on already, for example the airport power issues, curling rink roof concerns, Highway 395 (mine road) concerns. It was really just a talk, to touch base because we were all in the same place. We haven't set a date to talk about payment in lieu yet."

As a matter of note and in relation to the industry as a whole, in 2010, the value of production of base and precious metals, industrial minerals and petroleum totalled $2.5 billion, a 29 per cent increase from 2009. Mineral production accounted for approximately 5.8 per cent of the provincial GDP and about 12 per cent of Manitoba's total exports. Last year alone, Manitoba's mining and petroleum industries invested $706.8 million in capital expenditures, up 24 per cent from 2009. The industry employed 6,100 people, an increase of 5.2 per cent, as well as many more jobs indirectly through the service sector and spin-off businesses.

When asked for her overall view of the convention and whether it was worthwhile attending, Forsyth-Flamand said, "It is a fantastic, very busy two days! It is a great experience for anyone who lives or works in a mining town, not just for council members."

Prior to handing the floor over to Miller, Orr summarized BacTech's affiliation with Newalta, a company that is an established leader in minimizing waste and maximizing the recovery of valuable products and resources.

Miller, a chemical and biochemical engineer, has been involved with the technology for over 30 years. He began by stating that the first question anyone asks is, 'Are these bugs harmful to us, or what are these bugs?' "As I'm sure you are all aware, there are good bugs and bad bugs, and you can rest assured that we only employ good bugs," said Miller. "But that assurance is probably not enough for you, so let me just explain what these bugs are. These bugs eat rocks! And they enjoy arsenic and sulphides. So unless you yourself have a diet of arsenic, sulphides, and rock, I really don't think that you have much to be concerned about. To be more scientific, the physiology of these bacteria is actually quite unique. They are one of the oldest life forms on this planet, and we are able to harness their energy and basically use them in an environment, a reactor, to actually speed up the process they undertake in nature. These bacteria are ubiquities, they are everywhere in the environment. And clearly, we have scientific programs where we go out and we identify these bacteria, bring them back into the laboratory and just culture them. The process is more akin to wastewater treatment than a type of mineral processing activity. And as you know, wastewater treatment plants are a good thing. They take our rubbish and create clean water. Effectively, that's what these bacteria are able to do in the mining environment." Miller went on to explain, in-depth, how BacTech's bugs will break down arsenic and sulphides and leave the gold and ferric arsenate behind, which they say can be disposed of safely. As well, he covered the standards of design for the plant being proposed for Snow Lake and explained by way of a flow sheet, exactly how it would operate.

Following his portion of the presentation, officials took questions from the floor. The questions were abundant, thoughtful in nature, and came in an orderly fashion. Their content proved that community members are as concerned about the disturbance of this long dormant, but leaching legacy, as they are interested in the jobs and spin-off development BacTech could possibly create. All the questions that were asked were answered and it appeared that people left the presentation generally pleased with what the project could mean for Snow Lake, both by way of development and in dealing with the legacy left behind by the community's initial employer.

Nickel Belt News • www.thompsoncitizen.net Friday, January 27, 2012

Photo courtesy of BacTech Environmental

A 250,000 tonne arsenopyrite stockpile at Snow Lake, known locally as Toke Mountain.

BacTech: Bring on the rock-eating bugs

Marc Jackson

My Take on Snow Lake

mjaxon@gillamnet.com

Officials from BacTech Environmental Corporation and Newalta Corporation were in Snow Lake for a public presentation Jan. 17. The event took place in the Lawrie Marsh Community Hall and close to 60 people were on hand to hear what the companies had to say about a recently proposed development that will extract gold from Toke Mountain and in the process safely do away with this longstanding en- ferric arsenate.

He noted that a common thread with tailings disposal sites is that governments tend to own a lot of the nastier ones. "They are left behind ing waste and maximizing the recovery of valuable products and resources.

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The meeting began with BacTech chief executive officer Ross Orr welcoming attendees and introduced the folks who sat with him at the front of the hall; Paul Miller, BacTech's vice-president of technology, "or the head bug guy, as we call him," joked Orr, as well as David Salari, chief operating officer; Pat Carswell, senior operations manager of technical development for Newalta Corporation; and Mary Ann Mihychuk, a company director, geologist and former Manitoba NDP mines minister.

After introductions, Orr gave an overview of BacTech as a company, his own background and that of others within BacTech as well as the process that they intend to incorporate in the plant proposed for Snow Lake.

Orr stated that BacTech has taken a technology that has been around the industry for 25 years and in addition to its mining applications, has been used to retrieve metals from, then render inert, arsenic and sulphide laden mine tailings with the stable end product being through bankruptcies or whatever," said Orr. "We decided to challenge the conventional approach, which was to clay cap it and treat the water for the next 50 years at the taxpayer's expense. So our initial proposal to Innovation, Energy and Mines Minister Dave Chomiak was let us build a plant at for zero dollars to them, but we wanted to take the proceeds recovered from the actual pile."

Continuing, Orr spoke about the drill program they carried out in the spring of 2011. Noting that their 43-101 for the pile confirms that it contains a measured resource of 82,000 ounces of gold and 10,000 ounces in the inferred category. The grade of the 300,000-ton pile is 9.7 per cent. He also said that even though they aren't sure exactly where the plant will sit, they hope to begin construction later in 2012, after completing their environmental and bioleach work.

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Gewinne aus grünem Gold, Zink und mehr!

von Jan Kneist

Von mehreren Seiten wird die Goldindustrie heutzutage in die Zange genommen:

- Große Hochgradlagerstätten werden selten
- Man muss daher immer öfter auf niedriggradige Lagerstätten mit schwierig zu verarbeitendem Erz zurückgreifen
- Die Sensibilität der Menschen für umweltverschmutzenden Abbau nimmt stark zu, d.h. umweltschonende Verfahren sind im Vormarsch.

Das im Folgenden vorzustellende kleine, innovative Unternehmen sitzt genau in dieser Nische. BacTech Environmental wendet nachgewiesenermaßen erfolgreiche Technologien an, die nicht nur aus dem schwierig zu verarbeitenden Erz ein Maximum an Edel- und Basismetallen gewinnen, sondern die alte Halden mit arsenhaltigem Material verarbeiten, sanieren und die Metalle zurückgewinnen und damit eine ideale Kombination von Umweltschutz UND Gewinnen aus dem Bergbau installieren! Ein ähnliches Verfahren wurde von Gold-Fields nur für den Goldabbau entwickelt. 2010 gegründet und das Arrangement zur Neuorganisation schloss man am 2. Dezember 2010 ab. Altaktionäre von BacTech Mining erhielten damals je Altaktie eine neue Aktie von REBgold und eine Fünftel-Aktie von BacTech Environmental. BacTech Env. erhielt die exklusive und unbefristete Royalty-freie Lizenz der Nutzung der Bio-Auslaugungs-Technologie von REBgold. REBgold behielt die Minenprojekte von BacTech Mining. Am 2. Dezember 2010 stimmten die Aktionäre dieser Neustrukturierung zu. Zur Zeit führt Bactech eine Kapitalerhöhung zu 0,20 CAD durch, um die Weiterentwicklung seines ersten Projekts „Snow Lake" voranzutreiben. Bevor das Snow Lake Projekt und das mexikanische Tailings-Projekt besprochen werden, muss auf die eigentliche Technologie eingegangen werden.

BACOX Technologie

Die bakterielle Oxidation, auch Bioauslaugung genannt, wurde ursprünglich von BacTech Mining entwickelt. Das Verfahren nutzt ungefährliche Bakterien, um den und die Edelmetalle zur Gewinnung übrig bleiben. Die Menge des verbrennbaren Sulfids im Röster ist aber begrenzt und Schmelzereien können nur Konzentrate mit ca. höchstens 1,5% Arsen verarbeiten. Ganz zu schweigen von den giftigen Abgasen (Arsentrioxid) beim Rösten, dem hohen Energieaufwand und der letztendlich hohen Kosten! Erz mit sehr hohem Sulfidgehalt bzw. stark belastete Konzentrate wurden also früher einfach „verklappt", liegengelassen. Weltweit gibt es zahllose solche Minen bzw. Absetzbecken (Tailings) und diese beinhalten oft noch hochgradige Metalle, wenn man sie denn effizient gewinnen könnte!

Ein großes Problem stellen diese Tailings dar, aus denen arsenhaltiges Wasser aussickert und so permanent das Grundwasser vergiftet. Auch hierfür bietet BacTech die Lösung, denn es wird nicht nur die Quelle dieses Sickerwassers durch die Biolaugung des Materials beseitigt, es werden sogar noch Gewinne aus dem Metallverkauf erzielt. Eine perfekte Win-Win-Situation.

Hintergrund

Bactech Environmental Corp. und REBgold Corp. gingen zusammen aus BacTech Mining Corp. hervor. Bactech Environmental wurde am 5. Oktober Edel- und Basismetalle aus schwer zu verarbeitendem Erz, Konzentrat und Tailingsmaterial freizusetzen. Ein hergebrachtes Verfahren zur Verarbeitung stark arsenhaltiger Erze ist das Schmelzen bzw. „Rösten", bei dem die Sulfide verbrannt wer- Beim BACOX Verfahren wird das sulfidhaltige Material (Erz oder Tailings) in Bioreaktoren in eine Lösung mit Bakterien gegeben. Unter für die Bakterien optimalen Lebensbedingungen können diese die Sulfide innerhalb von 5-6 Tagen oxidieren. In die

Tanks wird noch eine Eisenquelle eingebracht (z.B. Pyrit). Das Eisen verbindet sich mit dem Arsen zu Eisenarsenat (AsFeO4), was wiederum chemisch stabil ist und ohne Ausgasung bzw. -schwemmung gelagert werden kann. Damit ist das Arsen unschädlich gemacht. Die Edel- und Basismetalle werden auf verschiedene Weise separiert. Der edelmetallhaltige Schlamm in einem Tank wird z.B. mit Carbon-in-Pulp Technologie behandelt, die Edelmetalle getrennt und anschließend Dore-Barren gegossen. Bei Basismetallen läuft der Prozess anders ab. Die Bakterien schaffen eine saure Umgebung, wenn sie die Sulfide oxidieren. Basismetalle lösen sich in Säuren, sie gehe in die Lösung über. Man kann dann Kalkstein zur Ausfällung nehmen oder sich der Elektrolyse (besonders gut bei Kupfer) bedienen.

stallierte das chinesische Unternehmen Shandong Tarzan Biogold Co. eine Anlage zur Behandlung von 100 t Konzentrat pro Tag. Die Anlage wurde später auf 200 t pro Tag erweitert und das Unternehmen von Sino Gold (heute Eldorado Gold) übernommen.

Somit ergeben sich für BacTech zwei prinzipielle Möglichkeiten – Minen des kanadischen Bundesstaats Manitoba einen Vertrag zur Sanierung der Snow Lake Halde.

Es handelt sich hierbei um Konzentrat-Haldenmaterial von früherem Abbau der Nor Acme Mine in den 1950er Jahren, das viel Arsenopyrit enthält und somit über Sickerwasser das Grundwasser belastet. Die Halde

Erfolgreiche Umsetzung

Bioauslaugung war seit 1986 bei weltweit 20 erfolgreichen Projekten im Einsatz. Die erste kommerzielle Anwendung von BACOX begann 1994 bei Gold Mines of Australia, deren Bio-Laugungsanlage das Minenleben um 3 Jahre verlängern konnte.

Im Jahre 1998 errichtete Allstate Mining die zweite Anlage, um arsenhaltiges Erz aus der australischen Beaconsfield Mine zu verarbeiten. Die BACOX Anlage ist noch heute beim Nachfolgerunternehmen BCD Resources im Einsatz.

Im Jahre 2000 lizensierte und in-

die Technologie an andere Produzenten zu lizensieren und sie selbst bei eigenen Projekten umzusetzen. Zur Zeit liegt das Hauptaugenmerk auf der zweiten Variante.

Projekte

Im April 2011 erhielt Bactech vom Ministerium für Innovationsentwicklung, Energie und

wird auf 250.000 t mit einem durchschnittlichen Goldgehalt von 9 g/t geschätzt. Das Material liegt 6-10 m hoch und bedeckt eine Fläche von ca. 2 ha.

Der Vertrag von BacTech und dem Ministerium sieht vor, dass BacTech die Halde beseitigt und dafür das gewonnene Metall behalten kann.

BacTech hat Frau Dr. Barbara Sheriff, eine pensionierte Professorin der Uni von Manitoba, engagiert. Sie kennt die Halde

und gemahlen werden. Über die 7 Betriebsjahre würden ca. 72.300 oz Gold und 14.500 oz Silber produziert. Der hieraus re-

Anfang Juni damit, tiefere Gräben im Absetzbecken auszuheben, um frisches, nicht oxidiertes Material zu erhalten.

Dieses Material wird im Labor des Mexican Geological Service in Chihuahua konzentriert und dann zu BacTech nach Kanada gesandt, wo man Diagnose-Tests und Biolaugungs-Studien durchführen wird. Nach Abschluss, 4-5 Monate später, wird sich genau und soll BacTech beraten und die Arbeiten an der Halde überwachen.

Ein Bohrprogramm begann am 9. Mai, bei dem aus 30 Löchern repräsentative Proben gewonnen werden sollen, die dann Laugetests unterzogen werden, um die Optimallösung für die Verarbeitung des Konzentrats zu finden. Verläuft alles zufriedenstellend, so will man im Sommer 2012 mit dem Bau der Anlage beginnen.

Die gesamten Investitionen werden auf 21,5 Mio. CAD geschätzt, der NPV liegt bei 21,62 Mio. CAD. BacTech hat hierbei einen Goldpreis von 1.300 USD und einen Silberpreis von 22 USD/oz angenommen. Im ersten Teil-Betriebsjahr sollen 9.458 t, dann 5 Jahre lang 37.833 und im letzten Jahr 28.377 t (zusammen also 227.000 t) verarbeitet werden. In der Umgebung befinden sich noch andere ähnliche Halden.

Der große Vorteil bei diesem Projekt liegt in den relativ niedrigen Investitionen, denn das Haldenmaterial muss nicht gefördert sultierende Cashflow soll für die Entwicklung weiterer Projekte genutzt werden.

Das zweite Projekt von BacTech liegt in der Nähe von Chihuahua, Mexiko. Am 6. Juni schloss man mit TW SEOP, S.C. („Teamwork") eine Absichtserklärung zur Verarbeitung der Tailings der stillgelegten Avalos Schmelzerei. Das Tailings-Material enthält bis zu 250 g/t Silber, 10% Zink und 3,5% Blei. Während Silber und Blei meist in niedrigeren Gehalten vorkommen, ist der Zinkgehalt im Allgemeinen sehr hoch. Als diese Schmelzerei vor über 80 Jahren produzierte, wurden nur Silber und Blei mittels Flotation gewonnen, für Zink hatte man damals kaum Verwendung (eine bedeutende Autoindustrie gab es noch nicht) und so landete es in den Absetzbecken. Die Tonnage dieses Absetzbeckens, auch wenn noch keine genauen Daten vorhanden sind, ist gewaltig.

Bis zwischen beiden Parteien eine definitive Jointventure-Vereinbarung geschlossen wird, sind noch einige Vorleistungen zu erbringen. Teamwork begann erwiesen haben, ob die Biolaugung erfolgreich angewendet werden kann. In diesem Falle wird ein 50/50 Jointventure geschlossen, bei dem BacTech als Betreiber auftritt.

Das Avalos Projekt ist auch deshalb von großem Interesse, weil es nicht im unerschlossenen Nirgendwo liegt, sondern in Chihuahua. Ein Gleisanschluss ist vorhanden, so dass das Material leicht abgebaut und zu einer neu zu errichtenden Verarbeitungsanlage geschafft werden kann.

Da es sich hier um Tailingsmaterial handelt, muss wie bei Snow Lake keine teure Vermahlung stattfinden, sondern es bedarf nur eines Konzentrators und der Biolaugetanks. Die Gewinnaussichten bei diesem Projekt stellen Snow Lake weit in den Schatten und das könnte erst der Anfang sein, denn ähnliche Absetzbecken gibt es dort reichlich.

Bewertung

BacTech hat zur Zeit 34,9 Mio. Aktien ausstehend, bald kommen noch 15 Mio. aus der lau-

fenden Kapitalerhöhung zu 0,20 CAD hinzu, dann also 49,9 Mio. Wie weiter oben beschrieben, hat das Snow Lake Projekt bei 1.300 US/oz Gold und 22 USD/oz Silber einen NPV (Kapitalwert) von 21,62 Mio. CAD. Beim aktuellen Goldpreis dürfte der Wert um die 25 Mio. CAD liegen. Vor Kapitalerhöhung stellt das einen Wert je Aktie von 0,62 CAD dar, nach KE 0,43 CAD. Legt man die 25 Mio. CAD zugrunde, dann erhöhen sich beide Werte auf 0,72 bzw. 0,50 CAD. Nach der Kapitalerhöhung hat BacTech die Mittel, um Snow Lake UND Avalos zügig voranzubringen. Alleine Snow Lake rechtfertigt also einen Kurs von ca. 0,50 CAD je Aktie, Avalos könnte das vervielfachen. Und weitere ähnliche Projekte sind in der Prüfung.

Fazit: Mit BacTech Environmental kann der Rohstoffanleger sehr vielversprechendes Neuland betreten. Dieses Unternehmen löst den mitunter auftretenden Konflikt von Umweltbewusstsein und Rohstoffanlagen auf. Die Biolaugungs-Technologie ist dabei kein "Venture", sondern sie ist schon erfolgreich im Einsatz. Und sie ist für Edel- und Basismetalle anwendbar. Es ist 100 oder mehr Jahren einfach verklappt wurde, ist heute begehrter Rohstoff! Ganz zu schweigen davon, dass das Arsen mittels Eisenarsenat gebunden und unschädlich gemacht werden kann. Zu diesen "harten" Faktoren kommen noch einige "weiche", z.B. das gute Management um Ross Orr, der auf 25 Jahre Erfahrung in der Minenindustrie zurückblickt. John C. Gingerich ist Chairman von BacTech und CEO von Advanced Exploration. MaryAnn Mihychuk, Direktorin von BacTech, war früher Bergbauministerin in Manitoba. Jay L. Naster ist Rechtsanwalt und war früher Sonderberater der Wertpapierbehörde von Ontario, Walter Cimowsky ist Mitbegründer von Ocean Partners, einem weltweit aktiven Konzentrat-Händler.

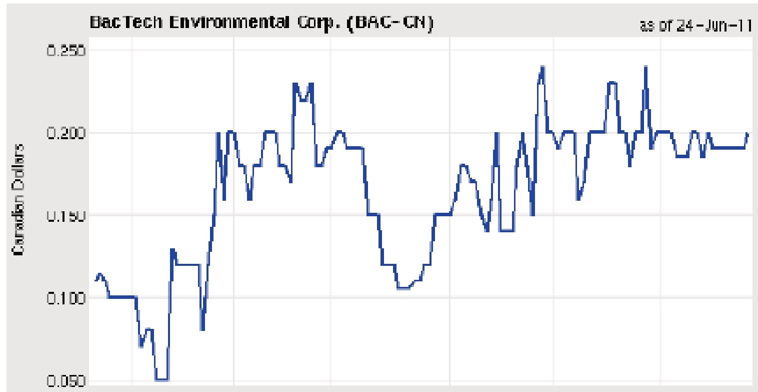
Und die Tatsache, dass Yamana Gold mit 11%, Baker Steel mit 15% und Pinetree Capital mit 11,3% beteiligt sind, spricht sicherlich nicht gegen das Unternehmen!

BacTech Environmental Corp.		
Akt. Kurs	0,19 CAD	CNSX
Akt. Kurs	0,135 EUR	Frankfurt
Marktkap.	6,63	Mio. CAD
WKN	A1H4TY	
ISIN	CA0704901077	
Kürzel	BAC	CNSX
Kürzel	0BT	Frankfurt
Website	www.bactechgreen.com	

Performance - 12 Monate (CSNX) - Kurs in CAD

sie ist schon erfolgreich im Einsatz. Und sie ist für Edel- und Basismetalle anwendbar. Es ist eine Tatsache, dass die Gehalte der Metalle im Boden im Durchschnitt abnehmen, da nur selten noch Hochgrad-Lagerstätten gefunden werden. Die Unternehmen sind also gezwungen, auf problematischeres Erz zurückzugreifen und hier kommt BacTech zum Zuge. Das Recyceln von Halden und Tailings wird auch deutlich zunehmen, man muss hier kein Prophet sein. Was vor

Performance - 12 Monate (CSNX) - Kurs in CAD



BacTech Pursuing Historic Mine Tailings for Reclamation

Where Cleantech Meets Profits...

If your investment strategy is focused on improving the environment through green technologies, you might consider BacTech Environmental Corporation (CNSX: BAC), a company that has spent $20 million to develop a commercially-proven, patented, environmentally-friendly process that reclaims historic mine tailings and recovers both precious and base metals, often from arsenic-laden tailings left over from primary mining and processing operations.

Yamana Gold (TSX: YRI) expressed an interest to invest in BacTech and management was more than willing to allow them on to the company ledger. They presently hold 13% of the company with warrants to double their position if seen fit. Baker Steel, a large resource trust in London, England, and Pinetree Capital of Toronto (TSX- PNP) have bought significant stakes, as well, providing solid backing going forward.

$20 Million in R&D Produces Environmentally-Friendly Bioleaching Process

BacTech's rights to use a commercially-proven bioleaching technology owned by REBgold, formerly part of BacTech, allows for the liberation of metal from rock that otherwise would be sent to a smelter or roaster for burning. These pyrometallurgical processes create noxious gases as a by-product of burning off the sulphides. The bioleaching process oxidizes sulfides containing gold, silver and base metals using bacteria. The process takes approximately six days to oxidize the sulphides and takes place in large stainless vats. Effectively, you are speeding up nature by giving the bacteria the ideal conditions for them to thrive. In addition, the process does not produce any noxious gases.

A base metals application of the technology has been successfully tested at a demonstration plant in Monterrey, Mexico in partnership with Industrias Penoles, the world's largest silver producer. The bioleaching process is environmentally significant for the project because of its ability to stabilize and remove hazardous metals, such as arsenic.

BacTech also has its eye on building a processing plant in Mexico where it will investigate the use of its technology to clean up tailings left behind at a closed smelter in Chihuahua, Mexico. The tailings are to be removed from the site as part of the closing and reclamation of the land that hosts the smelter. Very high levels of zinc and silver have been reported from previous studies. Also in Mexico, the company agreed to test some arsenic copper concentrates with the idea of treating the material in country instead of shipping it to China or elsewhere for processing. At present, smelters can't process more than 1.5% arsenic in concentrates, which opens the door of opportunity for BacTech (bioleaching has treated in excess of 10% arsenic previously).

BacTech also tested an arsenopyrite stockpile of gold-bearing concentrate from a 1950s era gold mine in Manitoba now owned by the provincial government. It is believed to contain C$140 million in gold (100,000 oz). The study determined that the material is

REBgold's patented bioleaching technology's ability to extract gold and stabilize arsenic from refractory sulfide gold deposits and tailings has been operating at China's Laizhou demonstration plant (pictured above) since 2001. A similar process was successfully tested for extraction of base metals at the Penoles demonstration plant in Mexico (pictured at right).

The Technology: Bioleaching

BacTech's patented BACOX bioleaching technology uses naturally occurring bacteria, harmless to both humans and the environment, to oxidize the contained sulphides and separate metal from the difficult-to-process tailings. In the process, toxic elements such as arsenic are stabilized. The tailings created by bioleaching are benign, and zero environmental damage occurs as a result of the process. An added bonus is its ability to recover valuable metals such as silver, cobalt and nickel that remain in the tailings. Bioleaching is an environmental clean-up solution that also creates a profit.

Why NOW is the Time for a Permanent Solution

The worldwide contamination caused by abandoned mines is so widespread that it is neither quantified nor fully evaluated. It is generally accepted, however, that in countries with a long history of mining, the magnitude of the problem is considerable; these areas are generally laden with toxic chemicals that leach into the surrounding areas. There are tens of thousands of sites around the world that contain mining-related arsenic and other substances. The public is increasingly demanding that the governments and companies responsible address the contamination due to the negative consequences of such sites. These effects include polluted water, contaminated land, air pollution, loss of useful groundwater and land, and significant negative health consequences to humans and animals living in the area.

amenable to bioleaching and can recover the gold and stabilize the contained arsenic. The company has now submitted a formal bid to the Manitoba government to clean up this long running problem. A decision will be rendered in April. The proposal includes a "no cost to the government" approach, with the Company being compensated recovering the gold for its own account. It is anticipated that a bioleach plant would cost in the neighborhood of $20M.

"We have noticed that in many cases where tailings are a problem the government, i.e. the taxpayer, has been left holding the bag for the clean up," says BacTech President and CEO Ross Orr. "Manitoba is a classic example of this. The problem is governments don't have a lot of money to spend on these problems so our 'no cost to the taxpayer' offer is being well received by the various governments we have spoken to."

The company's business strategy is to offer free testing of its processing technology while negotiating for a significant equity position in the project. "Bioleaching is a game-changer," says Orr. "It is akin to the start of heap leaching in gold which completely changed the gold industry."

"With the recent prices of gold, silver and base metals the economics for these projects, are very strong," Orr says. "It is also a double-edged sword, with holders of tailings demanding higher prices for ounces that used to be valued at under $15 per ounce."

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Investment Considerations

Yamana Gold (TSX: YRI $11) owns 13% of BacTech while Baker Steel of London holds just under 20% and Pinetree Capital 10%. BacTech Environmental Corporation, a cleantech company, is now listed on the Canadian National Stock Exchange (CNSX: BAC). The Company is also investigating listing its shares in the US to offer an easier way of buying its shares. Investors should visit www.bactechgreen.com or www.stockwatch.com if they are having difficulty finding a quote for the stock.

BacTech Environmental recently completed a small $300,000 financing which closed on December 22nd. The proceeds will fund the company until a solid project can be acquired.

"This is a rare opportunity that offers not only a cleantech solution to an old problem but the ability to generate substantial earnings from the clean up" says Orr.