Environmental Assessment of the Proposed Expansion of the Lalor Mine to add the Lalor Paste Plant

Hudson Bay Mining and Smelting Co., Limited

Project Number: 60519517

December 19, 2016

Quality Information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1					

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Executive Summary

Project Overview

Hudson Bay Mining and Smelting Co., Limited (HBMS) proposes to construct a paste backfill plant ("Lalor Paste Plant" or "Paste Plant") within the site currently occupied by the Lalor Mine and previously the Lalor Advanced Exploration Project (the "Lalor site"), on which HBMS has been exploring and then operating since 2007. The Lalor Mine is located in the Snow Lake mining district in northern Manitoba.

The purpose of a paste backfill plant is to produce an alternative source of backfill which can both stabilize underground workings and produce environmental advantages. Because of these advantages, the use of a paste backfill plant is regarded as a best practice in the mining industry. HBMS has been successfully operating a paste backfill plant at the 777 Mine in Flin Flon since 2003. HBMS intended to implement this technology in the construction of the Lalor Concentrator, which did not proceed (*Environment Act* application is now withdrawn), but now proposes to apply the paste backfill technology to the operation of the Lalor Mine.

This proposed alteration is essentially a mitigation measure to be applied to the operation of Lalor Mine and related facilities. It will reduce the waste stream generated by Lalor Mine by diverting tailings produced in Stall Concentrator from the Anderson TIA, mixing them into paste backfill, and depositing the paste backfill underground. It is expected that approximately 85% of the tailings produced by Stall Concentrator during the life of Lalor Mine will be diverted away from the Anderson TIA for use in the paste backfill plant, thus greatly reducing the need for storage of tailings in the Anderson TIA.

Diverting a significant portion of tailings from the Anderson TIA will also simplify the TIA deposition plan. Currently, the location of the tailings pipeline terminus is adjusted on a daily basis by HBMS employees. The location of the terminus is adjusted based on tailings discharge rates, settling of deposited tailings, and environmental conditions. With a significant portion of tailings diverted to the paste backfill plant, the frequency of pipeline adjustments will be reduced. This will result in a reduction of traffic into and within the operating site of the Anderson TIA, with resultant reduction in greenhouse gas emissions.

The paste backfill process will replace the use of waste rock as backfill, reducing the traffic volumes of large rock trucks which currently transport waste rock into (and within) the Lalor Mine, also reducing GHG emissions.

In 2012, HBMS contracted Outotec Consultants (formerly Kovit Engineering Ltd.) to evaluate design options for a Paste Plant at the Lalor Mine. Subsequently in 2015, Outotec conducted a Paste Backfill Study for the Lalor site, investigating three different options for processing and transporting tailings for use in the Lalor Paste Plant. These options were evaluated based on a number of criteria, including safety, risk to the environment, life of mine, effects of the environment on the project, cost, and others.

HBMS now proposes to alter the development operating under the Lalor Mine *Environment Act* License No.3096 ("Lalor Mine EAL No. 3096") to add the Lalor Paste Plant. The alteration includes the construction and operation of two components: the plant building and associated infrastructure ("Paste Facility") and a Pipeline System. The Paste Facility will be located on the site of the Lalor Mine. The Pipeline System will be laid in rights of way that have been owned in fee simple or controlled by HBMS for mining purposes or alongside a right of way used by the Province of Manitoba for public purposes for more than 30 years.

This environmental assessment report contains the information described in the Department of Sustainable Development's Information Bulletin, "Alterations to Developments with *Environment Act* Licences." It is intended for consideration of the Notice of Alteration submitted by HBMS in relation to *Environment Act* License No.3096 ("Lalor Mine EAL No. 3096").

Summary of Results of the Assessment

In 2007, baseline terrestrial and aquatic investigations were commenced in anticipation that discoveries in the region of the newly discovered Lalor deposit could lead to future development. The investigations dealt broadly with aquatic and terrestrial resources that could be affected by future development, including local geology, soil, vegetation, and wildlife.

The baseline investigations carried out in 2007, 2008, 2010, 2011, 2012, 2013, 2014, and 2015 are reported on in the Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a), which was filed with the Lalor Mine *Environment Act* Proposal (EAP) (AECOM, 2012b), the Proposed Lalor Concentrator Environmental Baseline Assessment, which was filed with the Lalor Concentrator EAP (now withdrawn), and the information filed with the Anderson Tailings Impoundment Area, Notice of Alteration (AECOM, 2016). The baseline reports are the primary source for the information summarized in this report. The descriptions of the physical, aquatic, and terrestrial environments within the Project Area and Region are based on the results of the investigations conducted in the area since 2007.

The assessment takes into account mitigation measures that have been incorporated into the proponent's proposed plan, as well as environmental protection practices and procedures included in the proponent's standard of operation (such as compliance with International Organization for Standardization (ISO) certified safety and environmental management systems and the drafting of the tender documents to include requirements for mitigation measures outlined below). In addition, AECOM has taken into account that this Project consists not of a new development, but rather planning and implementation of a mitigation measure applied to existing operations, which is designed to reduce the environmental impact of Lalor Mine and related existing operations.

Lalor Mine and the related operations have been and continue to be operated in compliance with regulatory criteria and well-established HBMS operating practices. These regulatory criteria include the full range of monitoring and reporting requirements contained in the MMER and applicable Manitoba environmental licenses.

AECOM's assessment includes our opinion of the sufficiency of the mitigation measures built into the design and intended construction of the proposed alteration. The results of the assessment are as follows:

Topography

Sources of changes to site topography include activities such as clearing, levelling, trenching, and stockpiling of materials during construction of the Paste Facility and Pipeline System. Wherever practicable, existing access roads and laydown areas will be used in order to minimize changes to topography. The Project Site consists of previously levelled and disturbed areas such as the Lalor site, former rail bed, and the operating site of the Anderson TIA and therefore minimal clearing and levelling will be required. Any additional levelling activities for the Paste Facility will be minimal and are within the scope of operations of Lalor Mine. All changes to topography will occur inside the boundary of HBMS operations on land to which only HBMS has access. The closure phase will include restoration of any changes to topography of the site to match the pre-construction condition of the surrounding area to the extent practical. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

Overall, the residual impact on topography caused by the Project is assessed to be Negligible. The change in topography, while permanent, will impact only features which are limited to the Project Site, and not unique in the Project Region.

Soils

High wind and precipitation events can lead to soil erosion, which can consequentially affect other components of the environment (e.g. air quality, water quality, or vegetation). Activities that can result in elevated erosion potential include clearing, grubbing, and excavation.

The site for the Paste Facility has already been cleared, levelled, and covered with crushed non-acid generating rock as a part of the construction of the Lalor Mine.

Construction of the Pipeline System component could result in increased potential for soil erosion, through clearing, grubbing, excavating, and placing fill. This could consequentially affect surface water quality along the Pipeline System route.

However, the Project Site consists of previously levelled and disturbed areas such as the Lalor site, former rail bed, and operating site of the Anderson TIA, and therefore minimum clearing and levelling will be required. Any activities that occur near culverts or other watercourses along the route will be carried out in accordance with Fisheries and Oceans Canada's applicable "Measures to Avoid Causing Harm to Fish and Fish Habitat" or other applicable standards. Erosion and sediment control measures will be in place to prevent the generation and movement of sediment-laden water.

Excavated materials will be stockpiled, compacted and reused, where appropriate. Excavation activities will not occur during high rain or wind events, to minimize the erosion potential of exposed soils. All rock used to widen the former rail bed will be non-acid generating and will be clean and free of silt and other materials.

At the time of closure, HBMS will contour disturbed areas to match the surrounding topography to the extent possible, apply soil to disturbed areas, and allow all disturbed areas to naturally re-vegetate. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

Wastes such as used oils, rags, drums, and miscellaneous garbage can potentially affect soil quality, which can in turn affect other environmental components (e.g. vegetation, groundwater, and surface water). Wastes generated during construction will be collected in garbage bins maintained at specific locations throughout the Project Site. The bins will be emptied on a regular basis for recycling and/or disposal at a licensed waste disposal facility. Waste oils and other hazardous materials generated (chemicals, reagents, waste oil, lubricants, or petroleum products) will be removed by a licensed hazardous materials handler for appropriate disposal or recycling.

The mitigation measures to minimize the impact on soil (due to erosion and materials and wastes) are deemed sufficient. Therefore, the overall residual impact on soil as a result of the Project is assessed to be Negligible.

Air

Dust and particulate matter have the potential to adversely affect air quality with consequent effects on human health (e.g. respiratory concerns and safety concerns related to impaired visibility on roads) and vegetation (decrease growth due to deposition). Dust occurs primarily during the summer and fall, with greater likelihood for an increase in dust during dry and windy conditions. Sources of dust include activities such as clearing, levelling, crushing, movement of traffic on roads, stockpiling materials, and operation of the Paste Facility.

The dense nature of the vegetation immediately surrounding the Project Site is expected to mitigate wind effects and overall potential dust migration, limiting its effects to the Project Site and the immediate Project Area. Areas to be cleared will be minimized where practical; project components lie mainly on previously disturbed areas. Stockpiles materials will be compacted and re-used, where practicable. Material stockpile heights will be limited. Clearing and levelling at the Lalor site has been completed as part of the development of the approved Lalor Mine. Trucks hauling materials will be covered to minimize dust coming off loads. If required, dust suppression activities, such as the use of approved dust control agents will be undertaken on unpaved roads. The increase in traffic during construction and closure phases (when traffic volumes are highest) is temporary. The speed limits on all roads will be adhered to. Vegetated buffers will be maintained to minimize the transport of dust generated on site. Re-vegetation of disturbed areas will occur as part of site closure activities and will provide long term mitigation of dust effects upon completion of closure activities. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

During operation, dust will be generated during the offloading of cement and mixing paste backfill. Delivery of cement will occur on a daily basis. The cement silos will be equipped with a dust collection system which will be used during cement offloading. The paste batch mixer will be equipped with a wet scrubber. During operation, all activities will be carried out in accordance with *The Workplace Safety and Health Act* and the HBMS Occupational Health and Safety Standard 18000 certified management system, which will avoid potential effects on health and safety. These systems include measures to protect worker safety with respect to air quality (i.e. dust). If needed, appropriate personal protective devices (e.g. respirators) will be provided to employees.

Sources of emissions associated with the proposed alteration include: vehicles and exhausts from diesel construction equipment (general vehicle movement on site, using equipment for grading, placing materials etc.). Approximately 25 pieces of equipment will be required during both the construction and closure phases. Emissions from these are anticipated to be limited to the Project Site and the Project Area. Construction is anticipated to take eight months beginning in spring 2017. Closure will take place mainly in the summer months, over a three year period. It is expected that during construction, on average, a maximum of four vehicles and, during operation, a maximum of three vehicles will access public roads in vicinity of the Lalor Mine. The increase in traffic during construction along public and private roads (e.g. Lalor Access Road, PR 395 and PR 392) is temporary. Vehicles and equipment will be well maintained. Vehicle idling will be kept to a minimum. All vehicles used for the Project will comply with Environment Canada’s On-Road Vehicle and Engine Emission Regulations as required.

An increase in noise levels at the Project Site and within the Project Area could potentially affect people, wildlife, and infrastructure (from vibration) in the surrounding area. Sources of noise during construction would be typical of heavy equipment such as dump trucks, front end loaders, and excavators. During the operation phase, sources of noise outside of the Paste Facility include vehicle movement and trucks loading/unloading (cement or other materials for operation), dust suppression system for the cement silos, and other general equipment used on site. Inside the Paste Facility, noise will be generated by compressors, generators, pumps, and the paste batch mixer. At the Anderson BPS and the Makeup Water Pumphouse, noise will be generated by the pumps.

The Paste Facility will be located within an active mine site that has noise associated with its operation. There have been no known noise complaints in recent history associated with the operations in the Snow Lake area. The compressors, generators, pumps, and paste batch mixer will be enclosed in the Paste Facility. The pumps for the Anderson BPS and Makeup Water Pumphouse will be enclosed in the pump house buildings. HBMS provides hearing protection as required to ensure employees working on site are protected from noise during construction, operation, and closure activities. All closure activities will be carried out in accordance with *The Workplace Safety and Health Act* and HBMS’ Occupational Health and Safety Standard (OHSAS) 18000 certified management system, which will avoid potential effects on health and safety.

The mitigation measures proposed are sufficient to mitigate any adverse effects due to dust, emissions, and noise and vibration during the construction, operation, and closure phases. Residual effects on air quality are therefore assessed to be Negligible.

Climate

Sources of greenhouse gas (GHG) emissions associated with the proposed alteration include: vehicle exhausts and exhausts from diesel construction equipment (e.g. general vehicle movement on site, using equipment for grading, and placing materials). During construction and closure, GHG emissions are expected to be typical of construction activities that, in any case, will be required during closure of the Lalor Mine site, and will be limited in duration. During operation, GHG emissions will be limited to vehicle use. GHG emissions associated with the operation of the Lalor Mine will be reduced because the paste backfill process will replace the distribution of waste rock fill underground, which is carried out by large rock trucks which are consuming fossil fuel.

The mitigation measures proposed are sufficient to mitigate any adverse effects due to GHG emissions. Residual effects on climate are therefore assessed to be Negligible.

Groundwater

Activities such as handling fuels, lubricants, and waste can potentially affect groundwater quality. The paste backfill will discharge into two boreholes which will connect to an underground piping distribution network in Lalor Mine. The casing will be grouted in place to provide support and prevent groundwater from entering the boreholes. The mitigation measures identified for accidents and malfunctions and materials and waste management are deemed sufficient to prevent potential effects on groundwater quality.

There are no withdrawals of groundwater proposed for the Project. The direct footprint of project components can change surface-to-groundwater recharge pathways which has the potential to affect groundwater quantity. In this case, however, the impact of this change in footprint is negligible, as there are numerous other pathways for groundwater recharge, the project components will lie primarily on previously disturbed areas.

With the implementation of the mitigation measures, there will be a Negligible effect on groundwater.

Surface Water

Surface water quality may be affected by erosion, materials and waste management, and wastewater management. Changes in surface water quality can affect aquatic resources in downstream waterbodies, which can have consequential effects on recreational, subsistence or commercial fishing.

The proposed alteration does not require undertaking any activities in or near Lalor Lake and therefore there will be no effect on surface water quality at Lalor Lake.

Surface water quality along the route of the Pipeline System could potentially be affected by various construction activities such as clearing or excavating. The measures planned to mitigate soil erosion and spills and leaks are deemed sufficient to mitigate adverse effects on surface water quality. As well, to prevent potential effects on surface water quality in culverts during construction, all physical activities near culvert locations will be carried out in accordance with DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat."

Wastewater generated during the operation of the Paste Facility will be managed using existing licensed treatment facilities. The existing facilities will continue to operate in accordance with the applicable *Environment Act* licenses/Clean Environment Commission Orders. HBMS will continue regular monitoring as prescribed by the MMER of the effluent discharged from Anderson TIA into Anderson Creek to ensure that it meets MMER criteria (and therefore the limits laid out under the CEC Order No. 766). Water quality at the final discharge point of the TIA is and at all times has been in compliance with applicable regulatory requirements. No treatment, other than retention in the TIA, has ever been required. During operation, return water from the Paste Plant will be deposited into the Anderson TIA. This water will not contain tailings; therefore, it will not affect the surface water quality of the Anderson TIA.

The residual effects on surface water quality are assessed to be Negligible.

Surface water quantity may be affected by water withdrawal, with consequential effects on surface water quality and groundwater. HBMS is presently permitted to withdraw water from Snow Lake under Licence No. 2011-110 issued under *The Water Rights Act*. The freshwater requirements are reduced, where practicable, through the use of water from other sources (e.g. treated water from Chisel North WTP). As the need for freshwater is accommodated within existing approved limits, any effect on quantity of surface waterbodies is expected to be Negligible. In addition, water recycled from the Anderson TIA (makeup water) will be used to reduce the fresh water requirements of the proposed alteration. The residual impact on surface water quality in waterbodies in the Project Area is deemed to be Negligible.

The overall residual impact on surface water quantity in the Project Area is deemed to be Negligible.

Aquatic Resources

Effects on aquatic resources occur primarily through changes in habitat quality or quantity. Reduced quantity and quality of habitat can reduce the abundance, diversity, or community composition of aquatic resources, with secondary effects on organisms higher in the food chain. Habitat quality may be affected through changes in surface water quality, through surface runoff (elevated concentration of metals or other contaminants), through air dispersion (dust), or any accidental leaks or spills during the construction phase of the Project. Habitat quantity can be reduced through direct changes in habitat caused by construction activities.

Effects on fish and fish habitat occur primarily through changes in habitat quality and quantity. Changes to surface water quality through deposition of dust, soil erosion, spills or leaks, or effects on surface water quality can impact the quality of fish habitat. Dust, erosion and spill mitigation measures have all been incorporated into the project design and considered in the assessment. The route of the Pipeline System traverses a total of 20 locations which contain existing culverts. None of these culverts will be replaced during construction of the Pipeline System. The watercourses along the Pipeline System ROW do not contain unique or rare fish habitat. Any activities that occur near these culverts will be carried out in accordance with applicable DFO “Measures to Avoid Causing Harm to Fish and Fish Habitat” or other applicable standards.

During operation, the proposed alteration will not have any effect on fish and fish habitat downstream of the Anderson TIA as the only material that will be discharged into the Anderson TIA will be return water from the tailings dewatering process. The mitigation measures designed to prevent potential accidents or malfunctions and manage the impacts of any that may occur during operation are deemed sufficient.

Lower trophic level biota can be affected by a change in surface water quality and habitat disruption. The nearest waterbody to the Paste Facility is Lalor Lake. The proposed alteration does not require undertaking any activities in or near Lalor Lake and therefore there will be no effect on surface water quality. There is also a potential for surface runoff to adversely affect surface water quality along the Pipeline System ROW. Taking into account the mitigation measures proposed to minimize the potential adverse effects on surface water, the effect on lower trophic biota along the Pipeline System is assessed to be Negligible.

Protected aquatic species can be impacted by changes in habitat quality and quantity. The mitigation measures designed to protect the environmental components related to fish habitat are also sufficient with respect to any protected species. It is unlikely that protected species occur in any area which could be potentially affected by the Project. No protected species were collected in the aquatic surveys undertaken as part of the baseline investigations and it is assessed that there are not likely present in any area which could be affected by the Project.

Therefore, the residual effects on aquatic resources are assessed to be Negligible.

Terrestrial Flora Species

Pathways for effects on protected and other terrestrial flora include clearing and dust deposition. The Lalor site has been previously cleared for the Lalor Mine and no additional clearing will be required for the components located at the Lalor site. A maximum of 11.9 ha will be cleared during the construction of the Pipeline System. The cover classes impacted by the clearing associated with the Pipeline System are common to the area surrounding the Project Region. In addition to that, where possible during closure activities associated with the route of the Pipeline System, native conditions will be restored to the maximum extent possible. Once the infrastructure on the site has been removed and the site has been re-graded, disturbed areas will be re-vegetated with appropriate vegetation species as applicable. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration. Based on HBMS mine closure experience in the Snow Lake region, the growth of grasses and mosses is apparent within the first few years following closure, whereas trees and shrubs take longer to establish through natural succession and may be evident within a five to ten year period following closure. However, to ensure the success of re-vegetation efforts at the Project Site, monitoring will occur regularly with subsequent re-vegetation occurring, if required. Once re-vegetation efforts are determine to be successful, monitoring will be scaled back or suspended.

Dust generated during the construction and closure phases of the proposed alteration can potentially affect vegetation in the area by interfering with the photosynthetic ability of the vegetation. However, with implementation of the designed mitigation measures, effects on terrestrial flora due to dust are assessed to be Negligible.

The pathway of effect on protected species is primarily through indirect effects on other environmental components and the mitigation measures applied to those components will sufficiently mitigate the potential effect on protected species. The nearest recorded occurrence of any federally protected species is 93 km west-south-west of the Lalor site. This species was not observed during the biophysical surveys in the Project Area.

The overall residual impact on terrestrial flora species (including protected flora species) due to clearing and dust deposition is assessed to be Negligible.

Terrestrial Fauna Species

Clearing (loss of habitat), noise (disturbance), vehicle collisions (mortality), and light pollution are potential sources of effects on protected and other terrestrial fauna species.

Loss of vegetation through clearing can affect fauna by reducing the amount of habitat available. No critical wildlife habitat was observed on the Project Site (such as calving or over-winter areas) and, based on site conditions and field observations, it is assessed that there is no critical wildlife in the Project Area. The site of the Lalor Mine has been previously cleared and the balance of the Project Site is characterized by little variety in plant habitats. The cover classes affected by the construction of the Pipeline System are not unique to the Project Area and there are similar habitats in the area which wildlife disturbed by the clearing activities can occupy.

Nesting birds that may make use of the edge habitat available along the route of the Pipeline System will be able to continue to use this habitat following the development of the Project. Any clearing will be done outside of nesting season (April 15 to July 31). There will be no net loss of edge habitat due to clearing. As observed during field investigations, two water crossings along the Pipeline System offer potential brooding areas for waterfowl. The proximity of these brooding areas to potential nesting areas (edge habitat) makes these suitable waterfowl habitats. However, no brooding areas will be affected by Project activities, and as described above, there will be no net loss of edge habitat so the amount of suitable waterfowl habitat will remain. At closure, the Project Site will be returned to the native conditions to the extent possible. The restoration of vegetation during closure will provide for restoration of available habitat. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

Noise generated during the construction, operation, and closure phases of the proposed alteration has the potential to deter wildlife from the area. During construction, noise will be generated to varying degrees. It is anticipated that local fauna are likely already accustomed to some level of noise based on the existing activity in the area (e.g. Lalor Mine, Chisel North mine site, PR 395, PR 392, and Stall Concentrator). Since the habitat in the Project Site is common and no specific or critical value to wildlife was identified, if local fauna are deterred from the Project Site, it is not anticipated that this will substantially affect wildlife as similar habitats are available in the Project Area and Region.

With the anticipated increase in traffic on local public and private roads, there is potential for increased wildlife collisions. As local wildlife populations are considered low, the potential for increased wildlife collisions is also considered low. HBMS experience in the local area indicates that wildlife collisions are rare. Speed limits on access roads, local roads, and Provincial highways will continue to be implemented.

The Paste Plant will operate 24 hours per day and 362 days a year, resulting in the need for lighting on the site at all times to allow for a safe working environment. Light pollution has the potential to adversely affect animal behaviour by interfering with their biological cycles. The Lalor Mine already operates 24 hours per day, 365 days a year, utilizing lighting during all hours of darkness. With the addition of the Paste Plant, some additional lighting will be required, consistent with the type of lighting already present on the site. To minimize the light disturbance, HBMS has selected lighting that directs light down to the mine site only. With selection of this lighting, residual disturbance from light would be limited to the Project Site and the area immediately surrounding the site. Since the area is already developed, the effect of additional light pollution is assessed to be Negligible.

Protected terrestrial species can be impacted by project activities and components through changes in habitat quality and quantity. The pathway of effect is primarily through indirect effects on other environmental components. The mitigation measures applied to those components will sufficiently mitigate any potential effect on protected species. There are 27 terrestrial wildlife species of special concern, none of which were observed in the areas examined during the extensive biophysical surveys of the Project Area. Of the species of special concern that could potentially be in the Project Region, eight terrestrial fauna species are protected either federally or provincially. None of the protected species were observed within the Project Site and Area during the biophysical surveys conducted in the area.

For the reasons outlined above, the residual impact (loss of habitat, noise, light pollution, and risk of vehicle collisions) on terrestrial fauna species (including protected fauna species) is assessed to be Negligible.

Socio-Economic Effects

Land and resource uses in the Project Region include harvesting and trapping opportunities, fishing (recreational, subsistence, and commercial), and recreational use of existing trails. The Project Site has been developed for mining purposes for nearly 40 years. The Project will not change the land and/or resource use at the Project Site. All of the components of the proposed alteration are contained within land that is held by HBMS under lease or in fee simple and which is already occupied and used by HBMS for mining purposes. As presented in this report, residual environmental effects on environmental components have been assessed to be Negligible in magnitude.

No activity, component or impact of the proposed alteration will impede access to downstream resources or affect any current user’s ability to continue to exercise any recreational, commercial or subsistence use of these resources. All trappers with rights in the area to be affected have been identified and HBMS maintains communication with them and works with them to ensure that access to their traplines is not impacted as a result of HBMS projects. With respect to snowmobile trails, HBMS has discussed the proposed alteration with members of the Sno-Drifters snowmobiling club. The club has no concerns with the proposed alteration. Prior to commencement of construction, HBMS will notify the club, to ensure that snowmobilers do not interfere with the construction or operation of the proposed alteration.

The proposed Project will not cause any impact on either Park or Park users as residual environment effects that extend into the Project Region (Wekusko Falls Provincial Park is the only park within the Project Region) have been assessed as Negligible.

Project activities such as clearing or excavating can potentially affect heritage resources. However, there are no known heritage resources at the Project Site and the potential for any to be found is minimal. There will be no disturbance beyond the Project Site. If artifacts or historical features of skeletal remains were to be encountered during construction activities, work activities would stop immediately around the affected area with the find reported to the site supervisor. A qualified archaeologist would investigate and assess the find prior to continuation of work. If skeletal remains were encountered, the find would be immediately reported to the site supervisor and the RCMP.

Project activities during construction and operation could potentially impact the aesthetics of the Project Site. However, all project components are located in areas that have been previously disturbed as part of the Lalor Mine, Anderson TIA, or other HBMS activity in the area. The site will be inspected on a regular basis for loose waste and debris in order to maintain a clean site. Waste and debris will be stored in bins and removed from the site on a regular basis. During the closure phase, the Project Site will be re-vegetated and returned to native conditions to the extent possible. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

HBMS has operated in the Snow Lake district for over 50 years. The Lalor Mine site has been in continuous occupation since 2007. The route of the proposed Pipeline System lies within land that has been under use, occupation, and control by HBMS for decades. The route of the Chisel Access Road (formerly PR 395) itself is owned by the Town of Snow Lake and leased to HBMS. All of the components of the proposed alteration are contained within land that is held by HBMS under lease or in fee simple and which is already occupied and used by HBMS for mining purposes. Based on Government of Manitoba and Federal sources, there is no Indian Reserve or Registered Trap Line zone within the Project Region. The Project does not require access to, use or occupation of, or the exploration, development, and production of lands and resources currently used for traditional purposes by indigenous peoples.

The overall residual effect on the socio-economic environment is assessed to be Negligible.

Summary

In summary, the potential environmental effects of the proposed alteration are considered Negligible with the implementation of the design features and standard operating and mitigation measures described in the report. The measures described to mitigate the risk of occurrence of accidents and malfunctions are deemed to be appropriate in mitigating such risks. The proposed alteration itself is a mitigation project, which will reduce the waste stream (tailings) and improve the environmental management of Lalor Mine.

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1. Introduction

1.1 Project Overview

Hudson Bay Mining and Smelting Co., Limited (HBMS) proposes to construct a paste backfill plant ("Lalor Paste Plant" or "Paste Plant") within the site currently occupied by the Lalor Mine and previously the Lalor Advanced Exploration Project (the "Lalor site"), on which HBMS has been exploring and then operating since 2007. As shown in **Figure 01**, the Lalor Mine is located in the Snow Lake mining district in Northern Manitoba.

The Lalor Mine, like many underground mining operations, utilizes "backfill", often comprised of waste rock, to fill voids that are created by extraction of rock during underground mining. Backfill requirements for the Lalor Mine are 6.4 million tonnes of rock fill assuming 100% of the voids are filled.

The purpose of a paste backfill plant is to produce an alternative source of backfill which can both stabilize underground workings and produce environmental advantages. Because of these advantages, the use of a paste backfill plant is regarded as a best practice in the mining industry. HBMS has been successfully operating a paste backfill plant at the 777 Mine in Flin Flon since 2003 and now proposes to apply the paste backfill technology to the operation of Lalor Mine. HBMS intended to implement this technology in the construction of the Lalor Concentrator, which did not proceed (*Environment Act* application is now withdrawn), but now proposes to apply the paste backfill technology to the operation of the Lalor Mine.

Paste backfill is created by mixing tailings generated by a mining operation with water and cement or a similar binding agent. Paste backfill is distributed into the voids in the mine and then gains compressive strength over time. Using paste backfill is a sustainable way to manage tailings and it increases operational safety within a mine. Using paste backfill as opposed to waste rock will extend the life of a mine by creating greater underground efficiency. It also recycles tailings in a way that prevents the formation of acid rock drainage and reduces the need for storage of tailings in a tailings impoundment area.

Currently, ore from Lalor Mine is processed in the Stall Concentrator, which discharges into the Anderson Tailings Impoundment Area ("Anderson TIA"). Tailings from the Stall Concentrator will be used to create paste backfill at the Lalor Paste Plant, reducing the amount of tailings that will need to be stored in the Anderson TIA. The process will mix tailings from the Stall Concentrator with a binding agent largely comprised of cement ("binder" or "cement"). The Paste Plant will receive tailings from the Stall Concentrator via a pipeline to be constructed at the surface and along existing rights-of-way ("ROW"). Water for this Paste Plant will come from the Lalor Mine Water Treatment Plant ("Lalor WTP") and the existing Anderson Water Tank. Any water that is not used will be pumped into the Anderson TIA via a return surface pipeline. Tailings will be pumped to the Paste Plant continuously, thickened, and stored in tanks until required for paste backfill mixing.

This proposed alteration is essentially a mitigation measure to be applied to the operation of Lalor Mine and related facilities. It will reduce the waste stream generated by Lalor Mine by diverting tailings produced in Stall Concentrator from the Anderson TIA, mixing them into paste backfill, and depositing the paste backfill underground. It is expected that approximately 85% of the tailings produced by Stall Concentrator during the life of Lalor Mine will be diverted away from the Anderson TIA for use in the Paste Plant, thus greatly reducing the need for storage of tailings in the Anderson TIA.

In addition, diverting a substantial amount of the tailings away from Anderson TIA simplifies the operation of the Anderson TIA, through reducing the amount of effort required to implement the TIA deposition plan. Currently, the location of the tailings pipeline terminus is adjusted on a daily basis by HBMS employees. The location of the terminus is adjusted based on tailings discharge rates, settling of deposited tailings, and environmental conditions. With a significant portion of tailings diverted to the paste backfill plant, the frequency of pipeline adjustments will be reduced. This will result in a reduction of traffic into and within the operating site of the Anderson TIA, with resultant reduction in greenhouse gas emissions. The paste backfill process will replace the use of waste rock as backfill, reducing the traffic volumes of large rock trucks which currently transport waste rock into (and within) the Lalor Mine.

In addition to the environmental and health and safety benefits discussed above, the proposed alteration provides economic benefit for the area and the province. Stabilizing the underground workings with paste backfill, as opposed to crushed waste rock, will permit more efficient extraction of the mineral resource and thus may be expected to extend the life of the mine.

Figure 01 displays the general location of the Lalor Mine in Manitoba. **Figure 02** displays the location of the Project site of the proposed alteration in context with existing and former HBMS facilities in the Snow Lake region. **Figure 03** displays the municipal boundary of the Town of Snow Lake, in which the Lalor Mine is located.

This environmental assessment report contains the information described in the Department of Sustainable Development's Information Bulletin, "Alterations to Developments with *Environment Act* Licences." It is intended for consideration of the Notice of Alteration submitted by HBMS in relation to *Environment Act* License No.3096 ("Lalor Mine EAL No. 3096").

A copy of the *Notice of Alteration* Form is attached in **Appendix A**.

1.2 Proponent Contact Information

Table 1-1. Proponent Contact Information

Name of Project	Lalor Paste Backfill Plant
Name of Proponent	Hudson Bay Mining and Smelting Co., Limited (HBMS), a wholly subsidiary of Hudbay Minerals Inc. (HudBay)
Address of Proponent	PB Box 1500, #1 Company Road, Flin Flon, Manitoba, R8A 1N9
Principal Contact Person for the NOA	**Jay Cooper** Superintendent Environment, HBMS PO Box 1500, #1 Company Road, Flin Flon, Manitoba, R8A 1N9 Ph: 204-687-2667 Email: jay.cooper@hudsonbayminerals.com

1.3 Company Profile

The proponent of the proposed alteration is HBMS, a wholly owned subsidiary of HudBay Minerals Inc. (HudBay). HBMS has three active mines in Manitoba: the 777 Mine in Flin Flon, the Lalor Mine near Snow Lake, and the Reed Mine in the Grass River Provincial Park.

Copper and zinc ore from the 777 Mine and copper ore from the Reed Mine is concentrated in the Flin Flon Metallurgical Complex (FFMC). Zinc and copper ore produced at the Lalor Mine is processed in the Stall Concentrator. Tailings from the Stall Concentrator are deposited via a pipeline into the Anderson Tailings Impoundment Area ("Anderson TIA").

Zinc concentrate from both the FFMC and the Stall Concentrator is processed to produce refined zinc in the FFMC (which includes the zinc pressure leach, cellhouse, and zinc casting plant). Since closure of the Flin Flon copper smelter in June of 2010, copper concentrate has been shipped out of Manitoba for further processing.

In 2015, HBMS directly employed 1,399 people, with an annual payroll of $141.5 million (USD) in wages and benefits. HBMS paid approximately $15.8 million in municipal taxes and grants as well as making community investments and charitable donations of approximately $307,000.

1.4 History of Mining in the Snow Lake Region

The Snow Lake region of northern Manitoba has had an active mining history for more than 50 years. HBMS played an integral part in this history since the late 1950's by operating mines in the area, including the Photo Lake, Rod, Chisel Open Pit, Stall Lake, Osborne Lake, Spruce Point, Ghost Lake, Anderson Lake, Chisel North Mines, and Lalor Mine.

Located at the heart of the Snow Lake mining district, the Anderson TIA has been in operation since 1979, when an earthen control dam (Anderson Dam) was built across Anderson Creek to raise the water level in Anderson Lake by approximately 2.75 m and to provide discharge control. The Stall Concentrator was commissioned at the same time and has been in continuous operation since then, with the exception of brief periods during 1993-94, 1999, and 2009.

1.5 Project Planning Process

In 2012, HBMS contracted Outotec Consultants (formerly Kovit Engineering Ltd.) to evaluate design options for a Paste Plant at the Lalor Mine. In designing the options, HBMS and Outotec took into consideration the existing paste plant that has been in operation since 2003 at the 777 Mine. However, Outotec determined that the 777 Mine Paste Plant design would not be feasible for the Lalor Mine site. The Lalor Paste Plant will incorporate lessons learned from the 777 Mine Paste Plant, including switching from a pumping system to a gravity flow system for distribution of the paste, both within the plant and underground. The use of a gravity flow system will minimize the energy requirements and operational risks associated with the proposed alteration.

Subsequently in 2015, Outotec conducted a Paste Backfill Study for the Lalor site, investigating three different options for processing and transporting tailings for use in the Lalor Paste Plant. The study identified the following options:

Option 1: Thickening and filtering of tailings at the Stall Concentrator and transporting thickened tailings by truck to the Lalor site;

Option 2: Transporting tailings as is from the Stall Concentrator via pipeline to the Lalor site and thickening tailings at the Lalor site; and

Option 3: Extracting tailings at the Birch Tailings Area, located at the former New Britannia Mine in Snow Lake (**Figure 02**), thickening tailings at New Britannia, and transporting thickened tailings by truck to the Lalor site.

These options were evaluated based on criteria which include the following:

- Safety;
- Environmental impact to Anderson TIA;
- Environmental impact – risks;
- Spillage and carry over of tailings material on loader tires;
- Material suitability for paste fill – quality, strengths, contaminants;
- Material quantity for life of mine;
- Material balance;
- Process water;
- Winter – road conditions;
- Winter – frozen material during transport;
- Winter – frozen material during storage;
- Winter – frozen material during handling on site;
- Bulk handling of tailings – contamination;
- Spillage handling in paste backfill plant;
- Annual Operating Cost ($CDN);
- Work force required;
- Mobile equipment; and
- Annual Energy Costs ($CDN).

Based on the results of this study, Outotec recommended **Option 2** for the following reasons:

- Does not require trucking of tailings, thus minimizing potential for spillage during transport and minimizing greenhouse gas emissions;
- Eliminates risk of tailings freezing during transport, thus increasing energy efficiency by not having to defrost tailings;
- Tailings from the Stall Concentrator are more suitable for paste backfill as they have a consistent chemical composition and particle size distribution;
- Reduces long term storage requirements for tailings; and
- Lower operating costs compared to other options.

2. Project Description

2.1 Components and Activities

The proposed Paste Plant has two components:

1. The plant building and associated infrastructure (“Paste Facility”), which is comprised of the following:

- A tailings thickening system;
- A tailings filtration system;
- A binder addition system constructed adjacent to the plant building;
- A paste batch mixer;
- Two boreholes into which paste backfill will discharge and an underground piping distribution network that connects the boreholes to the stopes in the Lalor Mine; and
- An emergency spill protection system.

2. A Pipeline System comprised of:

- Existing tailings pipes from the Stall Concentrator to the Anderson TIA;
- Anderson Booster Pump Station, Makeup Water Pumphouse, and smaller ancillary pipes to be constructed on the site of the Anderson TIA (“Anderson Site Ancillary Pipes”);
- Two pipes to be laid on surface for approximately 14 km between the Anderson TIA and the Lalor site; and
- Ancillary pipes to be added within the Lalor Mine site (“Lalor Site Ancillary Pipes”).

The Pipeline System will be laid in rights of way that have been owned in fee simple or controlled by HBMS for mining purposes or alongside a right of way which was used by the Province of Manitoba for public purposes for more than 30 years and which is now owned by the Town of Snow Lake and leased to HBMS.

The following spatial boundaries are used in describing the Project Components and Activities:

- **Project Site** – is comprised of the proposed Paste Facility site and the proposed Right-of-Way (ROW) for the Pipeline System.
- **Project Area** – is comprised of an area 2 km beyond the Project Site, which is intended to take into account the effects of the Project (such as noise, vehicle emissions, and traffic).
- **Project Region** – is comprised of an area up to 10 km beyond the Project Site, which is intended to take into account the maximum spatial extent of any potential impacts of the Project.

Figure 04 shows the Project Site, Project Area, and Project Region.

2.1.1 The Paste Facility

This section discusses the sub-components of the Paste Facility, describing them in the order in which tailings will flow through the various processes. **Figure 05** displays the location of the Paste Facility and its sub-components within the Lalor site. **Figures 06** and **07** display the profile and plan view of the general arrangement of the Paste Facility, respectively.

Figure 08 displays an overview of the Paste Plant processes which will be described in the following sections.

2.1.1.1 Thickener

The first step in processing the tailings to create paste backfill will be thickening, which will occur in a "thickener". A thickener is a circular building 14 m in diameter and will be located just outside of the Paste Plant building (**Figure 07**). Tailings from the Stall Concentrator will be pumped to the thickener via the Pipeline System. Tailings that come from the Stall Concentrator will be approximately 35 wt% (percent by mass) solids. A polyacrylamide flocculant (substance that promotes the clumping of particles) will be added to the tailings (at a rate of 30 g flocculant per tonne of tailings) to promote settling of the tailings to the desired consistency of 68 wt% solids. The flocculant will be delivered to the Paste Facility twice a month via truck in 20 kg bags. The bags will be stored in the Paste Plant building until they are used in the thickening process. The Paste Plant will use approximately 23.4 tonnes of flocculant per year.

Underflow (thickened tailings at 68 wt% solids) from the thickener will feed into two filter feed tanks (discussed below in **Section 2.1.1.2**). Overflow (water remaining from the thickening process) from the thickener will be pumped into a thickener overflow tank inside the Paste Plant building and eventually be pumped back to the Anderson TIA.

2.1.1.2 Filter Feed

Once tailings have been thickened to 68 wt% solids in the thickener, they will be pumped (as underflow) into one of the two filter feed tanks. The feed tanks will be approximately 12.2 m in diameter, 15.75 m tall, and constructed of carbon steel. The filter feed tanks will be located outside of the Paste Plant building adjacent to the thickener.

The feed tanks will store tailings for up to 48 hours. Thickened tailings will be pumped from the tanks to the disc filter inside the Paste Plant building as required.

2.1.1.3 The Paste Plant Building

The Paste Plant building will be constructed within the footprint of the Lalor site and will consist of a wood frame with insulated painted metal siding. The building will be approximately 10 m x 25 m in area and approximately 30 m high. The height of the Paste Plant building will allow for gravity-flow of materials in the paste backfill-mixing process. This eliminates the need for backfill pumps to be included in the design, thus minimizing energy requirements for the operation of the plant, as well as for ongoing maintenance.

2.1.1.3.1 Disc Filter

The disc filter will be approximately 3.8 m in diameter and utilize 15 discs. The disc filter will receive tailings at 68 wt% solids from the filter feed tanks. The disc filter is designed to further dewater the tailings to produce a filter cake that is approximately 82 wt% to 85 wt% solids. Filtrate (water removed from the tailings in the filter) will be pumped back to the thickener (**Section 2.1.1.1**) and eventually overflow into the thickener overflow tank. From the disc filter, the filter cake will fall on to a flat conveyor (approximately 762 mm x 10 m), which will convey the filter cake to a tailings weigh hopper (discussed below in **Section 2.1.1.3.2**).

2.1.1.3.2 Tailings Weigh Hopper

The tailings weigh hopper will measure the mass of the filter cake required for each batch of paste backfill. The volume of the tailings weigh hopper will be approximately 6 m^3. Once the desired weight required for the paste backfill recipe is achieved, the filter cake will be discharged from the tailings weigh hopper by three screw conveyors located at the bottom of the hopper into the paste batch mixer.

2.1.1.3.3 Binder Addition System

The binder will be comprised largely of Portland cement but may also include other binding materials to increase the compressive strength of the paste backfill. The binder and other binding materials required will be delivered to the site via truck on a daily basis (approximately 2 truckloads per day).

The binder addition system includes binder storage silos, a binder weigh hopper, and a screw conveyor.

Two 250 tonne storage silos, located outside of the Paste Plant building, will be used to store the binder. The storage silos will be approximately 4.27 m in diameter, 12.4 m tall, and be constructed using carbon steel. The silos will be equipped with a dust collection system to collect dust during binder offloading.

Binder will be transferred from the silos into the Paste Plant building via a screw conveyor. The screw conveyor will discharge into the binder weigh hopper. Once the desired weight (i.e. amount needed for the paste backfill recipe) is achieved, a knife gate valve will open and discharge the binder into the paste batch mixer. Vibrators will be used in the binder weigh hopper to ensure the hopper fully empties into the paste batch mixer.

Pouring the binder into the paste batch mixer will generate dust. This dust will be collected by a wet scrubber. Dust particles will be mixed with water in the scrubber to create slurry which will discharge from the bottom of the scrubber into the cleanup sump.

The binder will be added to the tailings at a ratio of 4.0% to create paste backfill. The Paste Plant will use approximately 31,169 tonnes of binder per year.

2.1.1.3.4 Paste Batch Mixer

The paste batch mixer will mix the filter cake, binder, and water from the thickener overflow tank to create paste backfill. As discussed in **Section 2.1.1.3.3**, binder is added at a ratio of 4.0% of the mass of filter cake. The amount of water added will be adjusted per batch, depending on consistency, as described below.

Mixing will occur until the desired consistency is achieved and binder has been distributed evenly. Consistency will be measured based on how much power the mixing motor is drawing. If the energy consumption of the motor is greater than the target level, it would suggest that the motor is working too hard, and that therefore the paste backfill is too thick. If this is the case, more water will be added to the mixer, and the mixer will be run for an additional period of time before checking the energy consumption. This process will continue until the paste backfill achieves the target consistency.

When the target consistency is achieved, the paste batch mixer will discharge paste backfill into the paste hopper using a hydraulically-operated dump door. The level of paste backfill in the hopper will be measured with an ultrasonic level sensor. A control valve on the bottom of the hopper will open and close as needed to maintain the level of paste backfill in the hopper which will prevent air from entering the boreholes. This valve will allow paste backfill to discharge into the boreholes as required.

2.1.1.4 Underground Distribution System

The underground distribution system will consist of two boreholes located at the surface, a sump, a pressure gauge and camera, and distribution pipes.

Two boreholes will connect the ground floor of the Paste Plant building to the underground distribution system which will commence at approximately the 790 m level underground inside the Lalor Mine. The boreholes will have been drilled at an angle of approximately 60 degrees from the surface, and will be approximately 890 m in length. The boreholes are cased with a 200 mm diameter casing with a wall thickness of 13 mm. The casing is grouted in place to provide support, and to prevent any groundwater from entering the boreholes. Drill rig access to the top of the borehole will be provided so that the casing can be cleaned.

HBMS intends to use only one borehole at any given time, with the second borehole held as a spare.

A pressure gauge will be installed at the base of the active borehole casing to monitor the pressure of paste backfill as it moves through the underground distribution system. If the pressure exceeds normal operating levels, it may be an indicator of a plugged pipe. If this occurs, the contents of the borehole will be dumped into the borehole sump. This sump will be located at the base of the boreholes, and will allow for collection of paste backfill and any water used to flush the system in the event of a malfunction.

The underground piping distribution network will be a combination of piping along the drifts, ramps, and lined boreholes between the various levels and drifts of the Lalor Mine. The piping along the lateral portions at each mine level will be primarily carbon steel 8" Schedule 80 (200 mm diameter, with a wall thickness of 13 mm) coupled with Victaulic clamps. Support brackets mounted on the roof of the drifts will support the pipe in place. High-density polyethylene (HDPE) pipe will be used in the stope access drifts.

Ancillary boreholes will be drilled between drifts where required to facilitate the transfer of paste backfill between drifts. This will help to optimize the piping distribution network. The boreholes will be drilled and lined with HDPE pipe grouted in place.

Pressure gauges and cameras will be used to monitor paste backfill as it flows through the underground distribution system. A paste backfill operator will be able to view this flow from a monitor in the Paste Plant control room.

The underground mine crew will redirect the HDPE pipes into the voids where paste backfill is required.

2.1.1.5 Ancillary Components

2.1.1.5.1 Emergency Spill System

The emergency containment system will consist of a spill swale and a lined temporary containment pond located at surface (illustrated on **Figure 05**). The containment pond will be constructed downhill from the swale to contain the tailings in case of a spill. The temporary containment pond will have the capacity to contain approximately 2,000 m^3 (110% of the largest tank's volume) and have 0.5 m freeboard. In the event of a spill, tailings will drain via the swale into the temporary containment pond which will be lined with a geo-synthetic liner to prevent leaching. A sump pump will be used to pump the tailings from the temporary holding pond back into the thickener to be used for paste backfill production.

Thus, this emergency spill system will effectively prevent any potential risk that may arise from accidental spills.

2.1.1.5.2 Control Room

The Paste Plant building will include a control room that will be operated 24 hours a day. The control room will be located within line of sight to the disc filter. This will allow the operator to see if there is an upset condition in the system and turn the plant off if needed.

There will also be a small lab and curing chamber for QA/QC tests located next to the control room.

2.1.1.5.3 Washrooms

The Paste Plant building will include two washrooms, consisting of toilet and sink facilities only. The washrooms will include an insulated holding tank for sewage and grey water operated pursuant to the Onsite Wastewater Management Systems Regulation. Sewage and grey water will be hauled from the Paste Plant Building to the Town of Snow Lake Waste Water Treatment Facility.

2.1.1.5.4 Water Tanks

The Paste Plant building will include four water tanks. They are as follows:

- A thickener overflow tank, which will contain overflow water from the tailings dewatering processes described above in **Section 2.1.1.1**.

- A reserve water tank, which will also contain overflow water from the tailings dewatering processes. The reserve water tank will be trickle charged with thickener overflow water during normal operation and will be used to top up the thickener overflow tank. The reserve water tank will be kept full for emergency use.
- A borehole wash tank, which will also contain overflow water from the tailings dewatering processes. The borehole wash tank will be trickle charged with thickener overflow water during normal operation and will be used for flushing of the boreholes. This tank will also be kept full and only be used for flushing.
- A fresh water tank, which will contain fresh water to be used as gland seal water for the tailings pumps and vacuum pump within the Paste Facility. This fresh water will be received from the existing Lalor Mine Water Treatment Plant ("Lalor WTP") via a pipeline, which is to be constructed within the Lalor Mine Site (described below in **Section 2.1.4.6**). (The fresh water supply used in the existing Lalor Mine WTP originates in Chisel Lake.)

2.1.1.5.5 Pumps

The following pumps will be used at the Paste Facility:

- Thickener underflow pumps – 3" x 2"; one operating, one stand-by;
- Thickener overflow pumps – 4" x 3"; one operating, one stand-by;
- Return water pump box – 4 m diameter x 5 m high;
- Return water/slime pumps – 6" x 4"; two pumps;
- Filter feed pumps – 3" x 2"; one operating, one stand-by; and
- Miscellaneous pumps – 2 gland water pumps (1.5 x 3-6), 2 clean water pumps (2 x 3-6), 2 sump pumps.

2.1.1.5.6 Diesel Generator

The Paste Facility will be equipped with a diesel generator for backup emergency power. The diesel generator will have a capacity of approximately 1000 kW. Secondary containment for the fuel will be provided by a dual wall sub-base tank purchased with the generator.

2.1.1.5.7 Emergency Warning System

The emergency warning system that will be used in the event of a fire will be tied into the emergency system at the Lalor Mine.

2.1.2 The Pipeline System Component

The primary purpose of the Pipeline System will be to transport tailings from the Stall Concentrator to the Paste Facility and transport return water from the Paste Facility to the Anderson TIA via the proposed Anderson Booster Pump Station which will be located at the Anderson TIA. The Pipeline System also will continue to deliver tailings directly to the Anderson TIA when tailings are not required by the Paste Plant.

The Pipeline System (as shown on **Figure 09**) will be comprised of: a new Anderson Booster Pump Station ("Anderson BPS"), a new Makeup Water Pumphouse, ancillary pipes to be constructed at the operating site of the Anderson TIA, two 14 km pipes to be laid on the surface between the Anderson BPS and the Paste Facility, and ancillary water pipes to be constructed at the Lalor site. In addition to these components, the Pipeline System will include the existing Anderson Water Tank, the existing Snow Lake pumphouse and fresh water pipe, the existing Lalor WTP, and the existing pipes which lie within the site of the Stall Concentrator or the site of the Anderson TIA or which connect these two sites.

The seven pipes to be constructed as part of the Paste Plant project are as follows:

2.1.2.1 Main Pipes

- **Pipe 1:** To transport tailings from the Stall Concentrator to the Paste Facility via the Anderson Booster Pump Station (addition to an existing line) ("tailings pipe").
- **Pipe 2:** To transport thickener overflow water (**Section 2.1.1.1**) from the Paste Facility back to the Anderson Booster Pump Station ("return water pipe").

2.1.2.2 Anderson Site Ancillary Pipes:

- **Pipe 3:** To transport tailings and return water from the Anderson Booster Pump Station to the Anderson TIA (an existing line which will be slightly modified and continue in use) ("Anderson tailings pipe").
- **Pipe 4:** To transport fresh water from the Anderson Water Tank to the Anderson Booster Pump Station ("Anderson fresh water pipe").
- **Pipe 5:** To transport make-up water from the Anderson TIA to the Anderson Booster Pump Station ("makeup water pipe").

2.1.2.3 Lalor Mine Site Ancillary Pipes:

- **Pipe 6:** To transport raw fresh water from the storage cells located under the Lalor WTP to the Paste Facility ("Lalor raw fresh water pipe").
- **Pipe 7:** To transport treated water from the Lalor WTP to the Paste Facility ("treated water pipe").

The following section describes the route for the Pipeline System, including the route both of existing pipelines and the proposed route for the pipelines to be added. The following general routing criteria were used:

- Following existing linear features to allow for gradual bends.
- Avoiding and/or minimizing water crossings, to the extent possible.
- Avoiding rock outcrops to minimize the need for leveling and the use of explosives.
- Using available cleared ROW, where available, to minimize clearing requirements.

An additional consideration was that the ROW containing the Pipeline System must be wide enough to accommodate vehicle access. This is needed because the pipes will be subject to daily inspection. Some clearing (or re-clearing) may be required.

Figure 09 illustrates the entire Pipeline System route. It also shows the route in relation to the Anderson Booster Pump Station, the Makeup Water Pumphouse, the Anderson TIA, the Stall Concentrator, and the proposed Paste Facility to be constructed within the Lalor Mine site.

2.1.3 Detailed Characteristics of Pipeline System and Its Route

Figure 09 shows the route in five portions, with illustrations of their current use.

2.1.3.1 Anderson Booster Pump Station

The purpose of the Anderson Booster Pump Station ("Anderson BPS") will be to increase the pressure along the tailings pipeline to allow tailings to flow the length of the pipeline to the Paste Facility. The Anderson BPS will be located near the existing tailings discharge point at the Anderson TIA (**Figure 09**).

The Anderson BPS will receive tailings from the Stall Concentrator via Pipe 1, described below **Section 2.1.3.4**. The tailings will then be pumped to the thickener at the Paste Facility.

2.1.3.2 Makeup Water Pumphouse

The purpose of the Makeup Water Pumphouse will be to pump makeup water (reclaim water from the Anderson TIA) to the water tank in the Anderson BPS via Pipe 5 (described below in **Section 2.1.3.3**). Makeup water will be used as gland seal water in the Anderson BPS, reducing the need to withdraw fresh water from the Anderson Water Tank (from Snow Lake). The Makeup Water Pumphouse will be located on the shoreline of the Anderson TIA.

2.1.3.3 Anderson Site Ancillary Pipes

The following ancillary pipelines will provide process water for the Anderson BPS:

- Pipe 4 will run from the Anderson Water Tank to the proposed Anderson BPS. This line will supply water to the gland seals on the booster pumps, and makeup water as needed to the water tank within the Anderson BPS. The existing Anderson Water Tank receives fresh water from the existing Snow Lake Pumphouse via the existing fresh water pipe shown on **Figure 09**.
- Pipe 5 will run from the new Makeup Water Pumphouse (to be located on the shoreline of the Anderson TIA) to the proposed Anderson BPS. This line will also supply water to the gland seals on the booster pumps, and makeup water as needed to the water tank within the Anderson BPS.

This area is already occupied by HBMS infrastructure associated with the operation of the Anderson TIA and lies behind gates that restrict access to HBMS and HBMS authorized persons.

2.1.3.4 Portion 1 (Pipe 1 – Origin of Tailings Pipe)

Portion 1 covers the distance between the Stall Concentrator and the Anderson BPS. The area in which Portion 1 is located is already occupied by HBMS infrastructure associated with the operation of the Anderson TIA and lies behind gates that restrict access to HBMS and HBMS authorized persons.

At present, Portion 1 is occupied by an existing pipe which is used to transport tailings from the Stall Concentrator to the Anderson TIA. A “tee” with control valves will be installed in this line at the east side of the Anderson BPS. These fittings will allow the flow of tailings to be directed either to the Anderson BPS or to Pipe 3 for distribution in the TIA depending upon the needs of the operation. Thus, the existing pipe lying in Portion 1 will become the start of Pipe 1, which will run from the Stall Concentrator to the Paste Facility within the Lalor site.

2.1.3.5 Portion 2 (Pipe 3)

Portion 2 will contain an existing pipe (Pipe 3) modified to permit the new connection at the “tee” and run from the proposed Anderson BPS to the Anderson TIA.

This area is already occupied by HBMS infrastructure associated with the operation of the Anderson TIA and lies behind gates that restrict access to HBMS and HBMS authorized persons.

2.1.3.6 Portion 3 (Pipe 1 and Pipe 2 – Terminus of Return Water Pipe)

Portion 3 will run from the Anderson BPS to the ROW of the Chisel Access Road (formerly PR 395). Portion 3 lies almost entirely within the ROW for a former rail bed. Portion 3 will be occupied by the tailings pipe (Pipe 1) and the return water pipe (Pipe 2). This ROW is owned by HBMS pursuant to Certificate of Title No. 1701932 (Plan No. 784). Currently, HBMS maintains the rail bed as an access road. It is accessible to car and truck traffic for most of its length and to off-road vehicles for its full length. **Figure 02** contains a photo which displays the current condition of the rail bed. Access to the rail bed is and will continue to be restricted to HBMS and HBMS authorized persons.

Portion 3 will be linked to Portion 4 by crossing a distance of about 150 m of land held by HBMS pursuant to Mineral Lease No. M5776. A Manitoba Hydro transmission line runs beside the Chisel Access Road, within a cleared ROW. The link between Portions 3 and 4 transects the Manitoba Hydro ROW. Please see **Figure 09**, which illustrates the link.

Those portions of the rail bed which have become somewhat overgrown will have to be re-cleared to accommodate the Pipes and the inspection vehicle. As well, there will have to be turnaround bays (described below in **Section 2.1.4.8**) to safely accommodate vehicles travelling in opposite directions. These turnarounds will also be within the rail bed ROW owned by HBMS.

2.1.3.7 Portion 4 (Pipe 1 and Pipe 2)

Portion 4 will lie within the ROW for the Chisel Access Road, which is leased to HBMS by the Town of Snow Lake and which is in daily use for industrial traffic. Portion 4 will be occupied by the tailings pipe (Pipe 1) and the return water pipe (Pipe 2). Portion 4 already contains the existing water lines which service the Lalor Mine.

2.1.3.8 Portion 5 (Pipe 1 – Terminus of Tailings Pipe, Pipe 2 – Origin of Return Water Line)

Portion 5 will lie behind the gates of the Lalor Mine site, running between Chisel Access Road and the Paste Facility (alongside the Lalor Access Road). Portion 5 will be inside the ROW which already contains the Lalor Access Road and the water lines which service the Lalor Mine. Portion 5 contains the tailings pipe and the return water pipe. Please see **Figure 02** which displays a photograph of Portion 5 as it exists today. Access is restricted to HBMS and HBMS authorized persons.

2.1.3.9 Lalor Site Ancillary Pipelines (Pipe 6 and Pipe 7)

The Lalor Site Ancillary Pipelines will lie entirely within the existing site of Lalor Mine. These pipelines will connect the Lalor Mine Water Treatment Plant and the proposed Paste Facility.

The Lalor raw fresh water pipe (Pipe 6) will supply the gland seal water for the tailings pumps and vacuum pump within the Paste Facility. The treated water pipe (Pipe 7) will supply domestic and emergency shower water for the Paste Facility.

2.1.4 Pipeline System Construction and Materials

2.1.4.1 Anderson Booster Pump Station

The location of the proposed Anderson BPS is shown on **Figure 09**. The Anderson BPS will measure approximately 10 m x 13 m, and an electrical house measuring approximately 4.25 m x 9.2 m will be adjacent to it. **Figure 10** displays the general arrangement of the Anderson BPS.

Power will be supplied by overhead wires from the nearby pole line to a dry-type transformer beside the electrical house. A diesel generator with a capacity of 500 kvA will be installed to maintain pump operation and prevent freezing in the event of a power failure. Secondary containment for the fuel will be provided by a dual wall sub-base tank purchased with the generator. The Anderson BPS will be heated using electrical space heaters.

The tailings pumping system will be comprised of a pumpbox with a volume of approximately 9 m^3 to receive tailings from the Stall Concentrator. Pipe 1 and four x 100 Hp tailings pumps will be connected in series to deliver tailings to the Paste Facility. A water tank with a volume of approximately 65 m^3 will receive fresh water from the Anderson Water Tank through Pipe 4 and makeup water from the Anderson TIA through Pipe 5. A gland seal water pump on this tank provides gland water to the booster pumps, and a cleaning water pump provides water to the hose station for clean-up.

2.1.4.2 Anderson Booster Pump Station Ancillary Components

2.1.4.2.1 Makeup Water Pumphouse

The location of the proposed Makeup Water Pumphouse is shown on **Figure 09**. The Makeup Water Pumphouse will measure approximately 3 m x 3 m.

Power will be supplied by overhead wires from the nearby pole line to a dry-type transformer beside the electrical house. A diesel generator with a capacity of 500 kvA will be installed to maintain pump operation and prevent freezing in the event of a power failure. Secondary containment for the fuel will be provided by a dual wall sub-base tank purchased with the generator.

The water pumping system will be comprised of a pump with a capacity of approximately 500 US Gal/min, to pump makeup water from the Anderson TIA to the Anderson BPS.

2.1.4.2.2 Pipe 4: Makeup Water Pipe

This pipeline will supply approximately 5,200 m^3 of makeup water annually to the proposed Anderson BPS from the Anderson TIA.

HDPE piping with a nominal diameter of 50 mm will be used. This pipeline will be insulated and heat traced to minimize risk of freezing.

2.1.4.2.3 Pipe 5: Anderson Fresh Water Pipe

This pipeline will supply approximately 29,700 m^3 of fresh water annually to the proposed Anderson BPS from the Anderson Water Tank. The Anderson Water Tank receives fresh water from Snow Lake via the Snow Lake Pumphouse.

HDPE piping with a nominal diameter of 50 mm will be used. This pipeline will be insulated and heat traced to minimize risk of freezing.

2.1.4.3 Pipe 1: Tailings Pipe

This tailings pipe will deliver tailings from the Stall Concentrator to the thickener at the Paste Facility via the proposed Anderson BPS. It will transport approximately 2,252,700 m^3 of water and 779,000 tonnes of solids annually. Pipe 1 is composed of approximately 3 km of existing pipe which runs from the Stall Concentrator to the proposed Anderson BPS along with 14 km of new pipe which will run from the proposed Anderson BPS to the proposed Paste Facility.

HDPE piping with nominal diameters of 300 mm to 355 mm will be used. The diameter and wall thickness of the pipe will vary along the route according to the pressure profile within the pipeline. The pipe will be pre-insulated with 50 mm of rigid foam. The pipeline will be covered with sand to a depth of approximately 500 mm to minimize seasonal pipe expansion and contraction.

Leak detection will be provided by flow and pressure monitoring stations along the pipe to detect anomalies. Communication to the paste plant process control system will be provided by fibre optic cable running the length of the pipeline. In the event of an alarm, site personnel will be dispatched to visually inspect the length of the pipeline to determine if there is a problem. The pipeline will be inspected daily by HBMS personnel.

2.1.4.4 Pipe 2: Return Water Pipe

The thickening and filtration process in the Paste Plant will extract water from the tailings (overflow water). Approximately 2,081,900 m^3 of water annually will be extracted and pumped to the Anderson TIA via the Anderson BPS through the existing Anderson Tailings Pipe (Pipe 3, described below in **Section 2.1.4.5**).

HDPE piping with a nominal diameter of 200 mm will be used. The pipe will be pre-insulated with 50 mm of rigid foam. This line will run beside the tailings pipeline (Pipe 1), and will be sheltered under the same berm. This pipeline will also be inspected daily.

2.1.4.5 Pipe 3: Anderson Tailings Pipe

When not required by the Paste Plant, tailings from the Stall Concentrator will continue to discharge into the Anderson TIA via the Anderson Tailings Pipe. Return water from the tailings filtration process will also discharge into the Anderson TIA via Pipe 3. This is an existing pipe.

The Anderson Tailings Pipe will discharge 2,081,900 m^3 of return water annually via the Anderson Booster Pump Station.

2.1.4.6 Pipe 6: Lalor Raw Fresh Water Pipe

This pipeline will supply approximately 47,600 m^3 of raw fresh water annually to the Paste Plant from the storage cells located under the Lalor WTP.

HDPE piping with a nominal diameter of 75 mm will be used. The pipeline will be insulated and shallow-buried along with other utilities to prevent freezing.

2.1.4.7 Pipe 7: Treated Water Pipe

This pipeline will supply approximately 1,000 m^3 of treated water annually to the Paste Plant from the Lalor WTP.

HDPE piping with a nominal diameter of 37 mm will be used. The pipeline will be insulated and shallow-buried along with other utilities to prevent freezing.

2.1.4.8 Fill Requirements

Within Portion 2 of the route, design provides for intermittent 10 m wide points to allow for construction of the turnaround bays. These bays will occur at an average of approximately 250 m intervals. The exact location of the turnaround bays will be determined in the detailed design phase of the Project, avoiding such features as bedrock, outcrops, marsh/bogs, and water crossings.

Fill requirements will be met from non-acid generating (NAG) sources (limestone or quarry) available in the region. Once constructed, the pipes will be covered with a loosely placed cover material (i.e. sand) along the entire route. Approximately 11,560 m^3 of cover material will be required, which will come from a locally accessed quarry.

2.1.4.9 Culvert Locations

In total, the route of the Pipeline System traverses 20 locations which contain existing culverts. The locations of these culverts are shown in **Figure 15** and their type, length, and diameter are displayed below on **Table 2-1**. There is no plan to replace any of these culverts and no new culverts will be required as part of the construction of the Pipeline System. The culvert locations fall into two categories, as follows:

2.1.4.9.1 Culverts in Drainage Features (17)

These culverts were installed at the time the Provincial road or railway was constructed. They were placed in drainage features, either natural or engineered, that traversed that linear feature. Their purpose was and is to prevent surface runoff from ponding along the linear feature. These culverts are merely water control features of the particular linear feature. They are not connected to any potentially fish bearing habitat.

These culverts will not be altered during construction of the Pipeline System. However, any activities that occur near these culverts will be carried out in accordance with applicable DFO Operational Statement(s) or other applicable standards.

2.1.4.9.2 Culverts in Streams and Off-take Ditches (3)

These culverts were also installed at the time the road or railway was constructed. They were installed for the purpose of directing the flow of a stream or off-take ditch through the road or rail bed so that flow could continue, unimpeded by construction of that linear feature. These three locations consist of streams or off-take ditches which are or may lead to potentially fish bearing waterbodies.

These culverts will not be altered during construction of the Pipeline System. However, any activities that occur near these culverts will be carried out in accordance with applicable DFO Operational Statement(s) or other applicable standards.

Table 2-1. Culvert Features

ID	Number	Type	Diameter (m)	Length (m) (2)	Description	Comment
LR01	2	HDPE	0.9	15	Stream or Off-Take Ditch	
LR02	1	HDPE	0.6	15	Drainage Feature	
RB01	1	CSP	0.77	10	Drainage Feature	
RB02	1	CSP	1.63	25	Stream or Off-Take Ditch	
RB03	2	CSP	1.95	25	Stream or Off-Take Ditch	
RB04	2	CSP	-	10	Drainage Feature	Buried
RB05	1	CSP	0.8	10	Drainage Feature	
RB06	1	CSP	0.7	10	Drainage Feature	
RB07	1	CSP	0.86	10	Drainage Feature	
RB08	1	CSP	0.75	10	Drainage Feature	
RB09	1	CSP	0.56	10	Drainage Feature	
RB10	1	CSP	0.6	10	Drainage Feature	
RB11	1	CSP	0.62	10	Drainage Feature	
RB12	1	CSP	0.8	10	Drainage Feature	
RB13	1	CSP	0.6	10	Drainage Feature	
RB14	1	CSP	0.55	10	Drainage Feature	
RB15	-	-	-	10	Drainage Feature	Buried
RB16	1	CSP	0.95	10	Drainage Feature	
RB17	1	CSP	0.7	10	Drainage Feature	
AD03	1	CSP	0.9	10	Drainage Feature	

Notes: Length is approximate. Diameter was not measured for buried features. Locations shown on ***Figure 15****.*
CSP = Corrugated Steel Pipe
HDPE = High Density Polyethylene

2.2 Continued Use of Existing Approved Facilities

2.2.1 Pipelines

As introduced in **Section 2.1.2**, Pipe 1 will be comprised of approximately 3 kilometers of existing pipe leading from Stall Lake Concentrator to the Anderson TIA, to which will be added 14 kilometers of new pipe leading from the Anderson BPS (to be constructed) to the Paste Facility. Pipe 3 is an existing pipe which will continue to carry the tailings that are not being diverted to the paste process into the Anderson TIA. Pipe 3 will also link to Pipe 2 at the Anderson BPS and divert return water from Pipe 2 into the Anderson TIA.

2.2.2 Snow Lake Waste Water Treatment Facility

The Paste Plant building will have two washrooms consisting only of toilets and sinks. The washrooms will include an insulated holding tank for sewage. Sewage will be trucked from the Lalor Site to the Snow Lake Waste Water Treatment Facility.

2.2.3 Snow Lake Pumphouse

The Anderson Booster Pump Station will obtain fresh water from Snow Lake via the Snow Lake Pumphouse, which is the source of the water used in the existing Anderson Water Tank.

The existing Snow Lake Pumphouse is operated under *Water Rights Act* Licence No. 2011-110. Under this licence, HBMS is permitted to withdraw 1,150 dam^3/year of water from Snow Lake, not exceeding a withdrawal rate of 36.8 L/s.

2.2.4 Anderson Water Tank

The existing Anderson Water Tank will be the source of fresh water used in the Anderson BPS.

2.2.5 Anderson TIA

The Anderson TIA has been used for sub-aqueous disposal of tailings since commissioning of the Stall Concentrator in 1979. It is operated in accordance with the Metal Mining Effluents Regulation (MMER) and Manitoba Clean Environment Commission (CEC) Order No. 766, which will remain in effect until it is replaced in accordance with the application for alteration currently in progress. The MMER-regulated final discharge point is a decant pipe passing through Anderson Dam into Anderson Creek. The return water line from the Paste Plant will discharge into the Anderson TIA via the existing Anderson Tailings Pipe, which will continue to operate in accordance with these approvals and any alteration thereof.

2.2.6 Lalor Water Treatment Plant

The Lalor Mine WTP will be the source of fresh water that will be used as gland seal water within the Paste Facility. The treated water from the Lalor Mine WTP will be used for domestic use in the Paste Facility.

The Lalor Mine WTP, operated in accordance with *Environment Act* License No.3096 for the Lalor Mine, has ample capacity to accommodate the minor amount required for this purpose.

2.2.7 Use of Other Existing Facilities

- The existing access road from PR 395 to the Lalor site (Lalor Access Road) and Chisel Open Pit (Chisel Access Road) will be used for construction and operation of the proposed Paste Plant.
- Equipment used in construction and operation of the Paste Plant will be fuelled at the existing Lalor Mine's fuel facilities.
- The Lalor Mine parking lot will also be used by employees working at the proposed Paste Plant.
- The communication tower on the Lalor site currently provides wireless phone services and internet access. No separate communications facility will be required for the Paste Plant.
- An underground electrical line from the electrical room in the Paste Plant building will tie into the electrical grid at the Lalor Mine.

2.3 Production Capacity

The Paste Plant will produce paste backfill at a rate of approximately 165 tph for three days at a time. The Paste Plant will produce approximately 810,385 tonnes of paste backfill per year.

2.3.1 System Cleaning

The batch mixer, paste hopper, and other hoppers and tanks will be cleaned by using a high pressure washing system.

The thickener overflow water from the Paste Plant, followed by compressed air will be used for flushing the underground paste backfill line upon completion of the pour. A sump pump will pump to the tailings thickener or the return pump box directly for pumping back to Anderson TIA.

2.4 Water Requirements

The water requirements for the Paste Plant are set out in in the mass balance diagram contained in **Figure 11**.

2.4.1 Thickener Overflow Water

Thickener overflow water will be used for mixing paste backfill, flushing of boreholes, and system cleaning. Re-using thickener overflow water for processes within the Paste Facility will minimize the amount of fresh water required.

2.4.2 Fresh Water

A small amount of fresh water will be required by the Paste Plant for certain applications such as tank cleaning and gland seal for pumps. The freshwater will be supplied from the Snow Lake via the Anderson Water Tank and from Chisel Lake via the Lalor WTP (described above in **Sections 2.1.3.3 and 2.1.3.9**).

2.4.3 Treated Water

Domestic water for sanitary usage in the Paste Plant building will be pumped from the Lalor WTP (via Pipe 7, **Section 2.1.4.7**) to a water distribution system in the facility.

2.4.4 Potable Water

Potable water, sourced from the water treatment system in the Town of Snow Lake, is hauled to Lalor Mine in portable jugs.

2.4.5 Makeup Water

Makeup water, sourced from the Anderson TIA, will be used as gland seal water for the pumps in the Anderson Booster Pump Station (see **Section 2.1.3.2**).

2.5 Air

Pouring the binder into the paste batch mixer will generate dust. This dust will be collected by a wet scrubber. Dust particles will be mixed with water in the scrubber to create slurry which discharges from the bottom of the scrubber into the cleanup sump.

Back-up generators, should they need to be operated, will generate some exhaust emissions.

2.6 Noise

Sources of noise associated with typical construction activities will occur during the construction phase of the Paste Plant.

Sources of noise generated inside the Paste Plant building during the operation phase include:

- Vacuum pump from the disc filter.
- Blowing air from disc filter discharge.
- Compressor.

- Fans on the tank scrubbers.

These sources of noise will be contained within the Paste Plant building and will not add to the overall noise level of the Lalor site. Employees on Lalor Mine site are equipped with noise protection as per the Provincial and HBMS specific Health and Safety Requirements.

Sources of noise generated outside of the Paste Plant building during the operation phase include the self-unloading cement trucks, general traffic, the Anderson BPS, and Makeup Water Pumphouse.

2.7 Employees

The proposed Paste Plant will engage approximately five operators in total and two tradespeople during operation. The workers will either take up accommodations in the Town of Snow Lake, or stay at the Lalor Mine Camp.

There will be one person at the control station at a time and the control station will be operated 24 hours a day, seven days a week.

2.8 Materials

The Lalor Paste Plant will utilize reagents that are commonly used in similar paste backfill applications throughout the mining industry. Areas where reagents are handled will be equipped with containment berms and clean-up sump pumps to minimize the risk of spills and prevent the escape of fugitive dusts into the Paste Plant or the environment.

Table 2-2 provides a summary of consumption requirements, while specific functions of these materials, addition rates, and dispositions are provided in the sections that follow.

Table 2-2. Summary of Reagents and Additives Required for the Proposed Lalor Paste Plant

Reagent Material	Quantity Required (tonnes per year)
Flocculant	23.4
Cement	31,169

2.8.1 Flocculant

Flocculant is used in the thickening process to promote the settling of solid particles and produce a clear overflow suitable for recycling via the process water system. The polyacrylamide flocculant that will be used for the Paste Plant is Magnafloc 10™ flocculant.

Flocculant will be received in 20 kg bags, mixed to a 0.2% solution with fresh water from the Lalor WTP and added to the thickener as required. Flocculant will report preferentially with the solids in the thickener underflow stream. Sump pumps in the flocculant preparation area will collect any clean-up and send back into the system.

2.8.2 Cement

Portland cement will be used in the production of the paste backfill. Cement will be trucked separately to the Plant Facility by trailer from Flin Flon or Winnipeg and offloaded pneumatically into the binder silos located adjacent to the plant (described above in **Section 2.1.1.3.3**). Each 250 tonne silo will be equipped with a dust collector to minimize particulate emissions to the environment.

The annual estimated total cement consumption will be 31,169 tonnes.

2.8.3 Lubricant and Fuel

Diesel fuel for the emergency power generator and the backup diesel fire water pump will be stored in double-walled tanks. The diesel fuel tank has approximately 4,000 L capacity and will be located near the Paste Facility. Secondary containment for the fuel will be provided by a dual wall sub-base tank purchased with the generator.

Lubricating oils will generally be received in 20 L plastic containers. These will be placed in the dedicated storage area for the Lalor Mine, which is equipped with spill containment berms and fire suppression. Used oil will be temporarily stored in a double-walled tank and then removed from the site by a licensed contractor.

2.9 Equipment Use

Table 2-3 presents the equipment use expected during construction of the proposed Paste Plant.

Table 2-3. Equipment Use during Construction of the Proposed Paste Plant

Equipment	Units	Duration of Use
Forklift	1	8 months
Zoom Boom	1	8 months
50t Crane	1	4 months
100t Crane	1	2 months
JLG® Manlift	2	5 months
Welders	2	3 months
Light Stands	3	3 months
Construction Crew/Supervisor Trucks	3	8 months
Front End Loader	1	6 months
Bobcat	1	8 months
Caterpillar Dozer	1	3 months
Generator	1	6 months
Construction Heaters	3	2 months
Excavator	1	4 months
Dump Trucks	3	4 months

2.10 Traffic

Table 2-4 presents the estimated daily traffic volumes expected during construction and operation of the proposed Lalor Paste Plant.

Table 2-4. Estimated Average Daily Traffic Volumes [1]

Vehicle	Construction			Operation							
	2017			2018				2019			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Trucks-concrete	1										
Trucks- equipment	1	1									
Trucks – steel	1										
Trucks – delivery warehouse [2]	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trucks - cement			1	1	1	1	1	1	1	1	1
Cars – pick-ups			1	1	1	1	1	1	1	1	1
Total Paste Plant Traffic	3.5	1.5	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25

Notes:
[1] Numbers are averages per day, in each quarter.
[2] Trucks- delivery warehouse: includes material deliveries to warehouse and sewage pump-out truck.

2.11 Land Ownership and Property Rights

All surface and sub-surface rights required for the development of the proposed project are held by HBMS as follows:

2.11.1 The Paste Facility Component

The Paste Facility component will be constructed within the boundaries of Mineral Lease ML-334 obtained on March 29, 2012 from the Mines Branch, Government of Manitoba. This lease was converted from mineral claims which have been held since 1960. **Figure 12** displays all of the HBMS property rights that support the Lalor projects.

2.11.2 The Pipeline System Component

The greater extent of the Pipeline System will be laid in land that is held by the proponent in fee simple. **Figure 12** displays the Project Site, a portion (Portion 3 of the Pipeline System) of which is owned by HBMS pursuant to Certificate of Title No. 1701932 (Plan No. 784).

The proponent holds the rights to the remainder of the land required for the Project Site by means of mineral and/or surface leases shown in **Table 2-5** and **Figure 12**. These leases were converted from claims which have been held since 1960. These leases permit use and occupation of the land for the purpose of prospecting, exploring for, developing, mining or production of minerals on, in, or under the land. Certain portions of the Pipeline System lie within areas for which HBMS has surface leases as well as mineral leases.

Table 2-5. Mineral and/or Surface Leases Associated with the Lalor Paste Plant

M5726	M7276	M5721
M5730	M5724	M7491
M5731	M7242	M7240
M5789	M7359	M7241
M5806	M5810	M7286
M7243	M7366	M7360
M5812	ML334	M5776
M7309	M5732	M7285
M5725	M7239	M7333
M7307	M5784	M5809
M7238	M5803	M5721

2.12 Land and Water Use

There is no water user in or near the Project Site other than HBMS. The Project Site crosses three registered trap lines (RTLs) owned by Martin McLaughlin, Jim Schollie and Russell Bartlett. None of these trap lines is associated with an Indigenous community.

The Project does not require access to, use or occupation of, or the exploration, development and production of lands and resources currently used for traditional purposes by Indigenous peoples. All elements of the proposed Lalor Paste Plant will be on land which HBMS holds under lease or in fee simple, and is already occupied and used by HBMS for mining purposes as follows:

- The Paste Facility and Lalor Ancillary Pipes will lie within the Lalor Mine site, on land that has been under continuous use for mining purposes (including exploration) since at least 2007.
- Portions 1 and 2 of the Pipeline System are located on land which the proponent has used for mining purposes since the late 1970's. These portions lie behind the gates of existing HBMS projects, which excludes users other than the proponent, on land that has been taken up for mining purposes for over 30 years.
- Portion 3 of the Pipeline System will fall within the ROW for a former rail bed, which is owned by HBMS pursuant to Certificate of Title No. 1701932 (Plan No. 784). This is private land to which Indigenous peoples do not have a right of access.
- Portion 4 of the Pipeline System will lie within the ROW for the Chisel Access Road, which is leased to HBMS by the Town of Snow Lake and which is in daily use for industrial traffic. In addition, Provincial regulations prohibit hunting within 300 m of roadways.
- Portion 5 of the Pipeline System, which will follow the Lalor Access Road, lies on land which is controlled by gated access, and which has been under continuous use by HBMS for mining purposes (including exploration) since at least 2007.

The Anderson BPS, Makeup Water Pumphouse, and Anderson Ancillary Pipes will lie within the operating site of the Anderson TIA, near the existing tailings discharge point, on land which the proponent has used for mining purposes since the late 1970's.

2.13 Environmental and Water Rights Licenses

In order to proceed with the construction, operation and maintenance, and eventual closure of the proposed Lalor Paste Plant, HBMS will require approval of an alteration with respect to Lalor Mine *Environment Act* Licence No. 3096, notice of which is given herewith. The proposed alteration will also be supported by existing approvals related to the current operation of the Stall Concentrator, Anderson TIA, and other HBMS facilities in the Snow Lake area, as follows:

- The Stall Concentrator is operated in accordance with Clean Environment Commission (CEC) Order No. 765.
- The Anderson TIA is operated in accordance with CEC Order No. 766, and an application for a major alteration is currently in progress.
- Water withdrawal from Snow Lake is authorized under License No. 2011-110, issued under *The Water Rights Act* (Manitoba).
- Electrical supply from Chisel Substation is authorized under Licence No. 3005, issued under *The Environment Act* (Manitoba) on May 10, 2012.

Copies of these licences are included in **Appendix B**.

2.14 Crown Land General Permits and Other Rights

The Lalor Access Road between the Chisel North Mine site and the Lalor Mine site was constructed in accordance with General Permit GP59093.

The Lalor Mine and Chisel Mine sites are covered under Crown Land General Permits.

HBMS holds a Quarry Lease (QL-1928) for a quarry which will be used as the source of material needed for construction of the pipeline system described in **Section 2.1.4.8** above. The quarry is located adjacent to the Lalor Access Road.

The existing General Permits are as follows in **Table 2-6**.

Table 2-6. Applicable General Permits

Permit Number	Permit Name	Work
GP59093	General Permit for Lalor Access Road	All clearing, leveling and construction
QL-1928	Quarry Lease	Extraction of material
GP63483	Lalor site	General mining purposes
GP3625	Chisel Mine	General mining purposes

All clearing, leveling, and construction activities will be carried out in accordance with these general permits and any specific work permits issued from time to time.

Copies of these general permits are included in **Appendix B**.

2.15 Waste and Waste Disposal

2.15.1 Solid Waste

All domestic and non-hazardous waste generated at the Lalor Paste Plant will be disposed of at HBMS present and future licensed facilities. HBMS will continue to use a licensed hazardous waste handler with respect to any hazardous wastes produced (for example used oil, oily rags, chemical delivery containers, etc.).

2.15.2 Sewage and Grey Water

Sewage and grey water generated in the two washrooms contained within the Paste Facility will be managed in a holding tank and pumped out approximately once a week by a licensed sewage hauler, all in accordance with the Onsite Wastewater Management System Regulation.

2.16 Other Approvals

As shown in **Figure 09**, a small portion of the Pipeline System will cross an existing transmission line ROW owned by Manitoba Hydro. In a letter dated March 8, 2013, Manitoba Hydro approved HBMS use of their ROW for the Pipeline System. A copy of the letter is enclosed in **Appendix C**.

All physical activities conducted near culverts will be carried out in accordance with applicable DFO Operational Statement(s) or other applicable standards. No DFO *Fisheries Act* permits will be sought.

2.17 Project Phases and Proposed Scheduling

Table 2-7. Project Phases and Proposed Scheduling

Project Phases and Activity	Proposed Schedule (subject to the results of Regulatory review)
CONSTRUCTION	
Bringing Materials and Equipment to Site (excavating, hauling, stockpiling, storing fuels)	Q2 2017 through to Q3 2017
Preparing Construction Site (clearing vegetation, installing utilities)	Q2 2017
Constructing Paste Plant Building and Associated Facilities (erecting buildings, installing equipment, grading, backfilling)	Q2 2017 through to Q3 2017
Preparing Pipeline System ROW (clearing vegetation, stripping topsoil, excavating)	Q2 2017 balance of work
Installing Pipeline (laying pipes, grading, compacting, installing)	Q2 2017 through to Q3 2017

Project Phases and Activity	Proposed Schedule (subject to the results of Regulatory review)
OPERATION	
Stockpiling, Chemical/mechanical Processing, Mixing Paste Backfill	Q4 2017 to 2027
Transporting, Storing, and Handling Materials	Q4 2017 to 2027
Handling Process Wastes (treating sewage, recycling process water, removing sludge)	Q4 2017 to 2027
Maintaining Paste Plant	Q4 2017 to 2027
CLOSURE	
Removing All Buildings, Foundations, Storage Tanks, Site Refuse	2027-2030
Scarifying Pipeline System ROW.	2027-2030
Testing, removing, and remediating any contaminated soils.	2027-2030
Re-grading and contouring	2027-2030
Re-vegetating disturbed areas	2027-2030

2.18 Alteration to Lalor Mine Closure Plan

Once the proposed alteration has been constructed, the Lalor Mine Closure Plan, submitted to the Director of Mines in accordance with Manitoba Mine Closure Regulation 67/99 on September 30, 2014, will be updated to include the proposed alteration and it will be submitted to the Director of Mines for approval, along with any additional financial assurance that may be required.

The alteration to the Lalor Mine Closure Plan, including the information required to calculate the financial assurance to be held by Manitoba, can be prepared as soon as construction has been completed. In accordance with the Manitoba Mine Closure Regulation 67/99, the proposed alteration will not be commissioned until the closure plan has been accepted.

The additions to the Lalor Mine Closure Plan will contemplate all of the following in relation to the new facilities to be constructed in accordance with the proposed alteration:

- Removing all buildings and foundations.
- Removing and appropriately disposing of any miscellaneous infrastructure such as power lines, generators, transformers, pipelines pumps, water storage tanks etc.
- Removing and appropriately disposing of site refuse.
- Scarifying Pipeline System ROW.
- Removing all fuel storage tanks.
- Testing, removing and/or remediating any contaminated soils.
- Re-grading and contouring stockpile pads, concentrator haul road and parking area.
- Re-vegetating disturbed areas in order to restore landscape to the extent possible to their native appearance.

It continues to be anticipated that the end-use of the Lalor site will consist of a natural space with no planned residential, commercial, or industrial development. Based on HBMS closure experience in the Snow Lake region, the growth of grasses and mosses is apparent within the first few years following closure, whereas trees and shrubs take longer to establish.

3. Scope of the Assessment

To assess the potential environmental effects of the proposed Lalor Paste Plant, spatial and temporal boundaries were defined as follows:

3.1 Temporal Boundaries

The temporal boundaries of the assessment are divided as follows:

- **Construction Phase**: Construction from the second quarter of 2017 through to third quarter of 2017 (approximately eight months).
- **Operation Phase**: Fourth quarter of 2017 to 2027
- **Closure Phase**: 2027-2030, depending on the time it takes for re-vegetation.

3.2 Spatial Boundaries

Spatial boundaries used for the assessment are described below.

- **Project Site** – is comprised of the proposed Paste Facility, the Pipeline System, and associated components.
- **Project Area** – is comprised of an area 2 km beyond the Project Site, which is intended to take into account the effects of the Project (such as noise, vehicle emissions, and traffic).
- **Project Region** – is comprised of an area up to 10 km beyond the Project Site, which is intended to take into account the maximum spatial extent of any potential impacts of the Project.

Figure 04 shows the Project Site, Project Area, and Project Region.

4. Environmental Setting

This Project Site is already occupied by HBMS infrastructure and has been used for mining purposes for the past 50 years. This section provides an overview of the physical, aquatic, and terrestrial environment in the Project Area and Region. The information presented herein was obtained either through literature searches of publicly available datasets or through environmental baseline studies conducted on behalf of HBMS since 2007.

In 2007, baseline terrestrial and aquatic investigations were commenced in anticipation that discoveries in the region of the newly discovered Lalor deposit could lead to future development. The investigations dealt broadly with aquatic and terrestrial resources that could be affected by future development, including local geology, soil, vegetation, and wildlife.

The baseline investigations carried out in 2007, 2008, 2010, 2011, 2012, 2013, 2014, and 2015 are reported on in the Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a), which was filed with the Lalor Mine *Environment Act* Proposal (EAP) (AECOM, 2012b), the Proposed Lalor Concentrator Environmental Baseline Assessment, which was filed with the Lalor Concentrator EAP (now withdrawn), and the information filed with the Anderson Tailings Impoundment Area, Notice of Alteration (AECOM, 2016). The baseline reports are the primary source for the information summarized in the subsequent sections. The descriptions of the physical, aquatic, and terrestrial environments within the Project Area and Region are based on the results of the investigations conducted in the area since 2007.

4.1 Environmental and Social Components

This environmental assessment considers changes to the environment caused by the proposed alteration, as well as any consequential socio-economic implications. The ECs and SCs were selected following the guidance provided in Manitoba Conservation's Information Bulletin, "*Environment Act* Proposal Report Guidelines." SCs include components of the socio-economic environment that may be affected by a change in the environment as a result of the proposed alteration.

The potential interactions between Project components and ECs and SCs are identified in **Table 4-1**. Potential interactions were identified based on the professional judgement of the assessor combined with assumed implementation of standard environmentally responsible construction techniques and operating procedures in the course of construction, operation, and closure of the proposed alteration. The potential interactions identified in **Table 4-1** are assessed in **Section 5**. Mitigation measures and residual effects are also described in **Section 5**.

Table 4-1. Potential Interactions Between Project Components and the Environmental and Social Components.

PROJECT PHASES, COMPONENTS & ACTIVITIES	ENVIRONMENTAL COMPONENTS									SOCIO-ECONOMIC COMPONENTS			
	Physical					Aquatic		Terrestrial					
	Topography	Soil	Air	Climate	Groundwater	Surface Water	Aquatic Resources	Flora	Fauna	Land and Resource Use	Heritage Resources	Aesthetics	Effects on Indigenous Peoples
CONSTRUCTION													
Bringing Materials and Equipment to Site (excavating, hauling, stockpiling, storing fuels)	X		X	X		X	X	X	X	X		X	
Preparing Construction Site (clearing vegetation, installing utilities)	X	X	X	X		X	X	X	X	X		X	
Constructing Paste Plant Building and Associated Facilities (erecting buildings, installing equipment, grading, backfilling)	X	X	X	X		X	X	X	X			X	
Preparing Pipeline ROW (clearing vegetation, stripping topsoil, excavating)	X	X	X	X		X	X	X	X	X		X	
Installing Pipeline (laying pipes, grading, compacting, installing)	X	X	X	X		X	X	X	X	X		X	
OPERATION													
Stockpiling, chemical/mechanical processing, mixing paste			X	X		X	X	X	X				
Transporting, Storing and Handling Materials			X	X		X	X	X	X	X		X	
Handling Process Wastes (sewage, recycling process water, removing sludge)			X	X	X	X	X	X	X			X	
Maintaining Paste Plant			X	X					X				
CLOSURE													
Removing all buildings, foundations, storage tanks, site refuse		X	X	X				X	X	X		X	
Scarifying Pipeline System ROW.	X	X	X	X		X	X	X	X	X			
Testing, removing, and remediating any contaminated soils.		X	X	X	X	X	X	X	X	X			
Re-grading and contouring	X	X	X	X		X	X	X	X			X	
Re-vegetating disturbed areas		X	X	X		X	X	X	X	X		X	

4.2 Physical Environment

The physiographic setting of the Project Region is defined using the ecological land classification system. This hierarchical system of ecozones, ecoregions, and ecodistricts represents subdivisions of increasing ecological detail. The Project Site is located within the:

- Boreal Shield Ecozone, which contains the
- Churchill River Upland Ecoregion, which contains the
- Reed Lake Ecodistrict.

The Boreal Shield Ecozone, the largest ecozone in Canada, extends from northern Saskatchewan east to Newfoundland, north and east of Lake Winnipeg and finally north of the Great Lakes and St. Lawrence River. The Churchill River Upland Ecoregion extends from the sparsely forested regions to the north, the southern edge of the Precambrian Shield to the south, and extends westward from the Grass River to the Saskatchewan border. The Reed Lake Ecodistrict extends west from Wekusko Lake to just over the Saskatchewan border as shown in **Figure 13**.

4.2.1 Topography

The elevations in the Reed Lake Ecodistrict range from approximately 255 metres above sea level (masl) to 335 masl. Slope lengths in the Ecodistrict range from approximately less than 50 m to more than 150 m in length. Rocky cliffs can rise from 35 m to 40 m above the lakes and peat-filled depressions (Smith, *et al.*, 1998).

The Project Region is characterized by broken, hilly to rolling bedrock, which controls relief of the area. The bedrock is partially covered by unconsolidated mineral and organic materials. Areas to the east of Lalor Lake contain extensive lacustrine deposits, while the remainder contains a mixture of lacustrine sediments, till deposits and peatlands. Elevations within the Project Region vary from more than 312 masl for the highest bedrock outcrops to the west to approximately 256 masl near Wekusko Lake, located to the east (Department of Energy, Mines and Resources, 1985 and 1995).

4.2.2 Geology

The Project Region is part of the Flin Flon Belt (FFB), which according to the Manitoba Geological Survey, is in the juvenile internal zone of the Trans-Hudson Orogen and consists of Paleoproterozoic volcanic, plutonic and minor sedimentary rocks. According to Manitoba's Mineral Resources Geological Survey, *"the Flin Flon greenstone belt extends hundreds of kilometres to the south-southwest beneath a thin, geophysically transparent Phanerozoic cover. To the north the FFB is tectonically overthrust by younger metasedimentary rocks of the Kisseynew domain and by nappes of metavolcanic rocks that are the same age as those in the FFB."* (Government of Manitoba, 2016).

The tectonostratigraphic architecture of the FFB is of vital economic significance. The FFB is one of the largest Proterozoic volcanic-hosted massive sulphide (VMS) districts in the world, containing 27 copper – zinc (gold) deposits. Of these deposits, more than 162 million tonnes of sulphide have already been mined (Bailes and Galley, 1999).

The Snow Lake arc assemblage that hosts the Lalor ore deposit is a 20 km wide by 6 km thick section that records the transition from primitive to mature arc. The mature arc Chisel Sequence that hosts the Lalor deposit typically contains thin and discontinuous volcanoclastic deposits and intermediate to felsic flow-dome complexes. Rock units in the hanging walls of the deposit typically include mafic and felsic volcanic and volcanoclastic units, mafic wacke, fragmental and crystal tuff units. The footwall rocks have extensive hydrothermal alteration and metamorphic recrystalization which has produced exotic aluminous mineral assemblages including; chloritic and seracitic schist; and cordierite-anthophylite gneisses (Bailes and Galley, 1999).

4.2.3 Soil

As noted above, the Reed Lake Ecodistrict extends west from Wekusko Lake to just over the Saskatchewan border. Acidic granitoid bedrock in the form of sloping uplands and lowlands can be found in this ecodistrict. Bedrock areas are subdominant and widely distributed areas of permafrost can occur in peatlands.

Dystric Brunisols are the dominant soils in the ecodistrict. These soils have developed over glacial till overlying bedrock and consist of shallow, sandy and stoney veneers. Peat-filled depressions with very poorly drained Typic and Terric Fibrisolic and Mesisolic Organic soils can be found throughout the ecodistrict. These soils are overly loamy to clayey glaciolacustrine sediments. Eutric Brunisols and Gray Luvisols can be found on sandy bars, beaches, and exposed clayey deposits (Smith, *et al.*, 1998).

4.2.4 Air

Specific measurements of air quality in the Project Region are not available. However, air quality in this area is considered very good compared with larger cities and commercial and industrial areas in Manitoba. There are no industrial operations that release to the atmosphere within the Project Region. The closest significant industrial activity is in the City of Flin Flon and the Town of The Pas, located approximately 109 km and 135 km west of the Lalor site, respectively. Occasional regional impediments to air quality, although uncommon, may occur in the Project Region. This could include smoke from forest fires and wood-burning stoves, emissions from fuel storage tanks and vehicle emissions.

4.2.5 Noise and Vibration

A baseline noise assessment was undertaken by AECOM in July, 2011 (AECOM, 2012c). Noise baseline data was collected at two Points of Reception (POR) within the Town of Snow Lake. The measured background levels were determined to be typical of a suburban area where the dominant sources of ambient noise and vibration are vehicular traffic. The equivalent day/night sound levels were calculated to be 53 dBA at POR 1and 49 dBA at POR 2. Average root mean square velocities ranged from 0.045 to 0.426 mm/s at POR 1 and POR 2 over a 24 hour period.

4.2.6 Climate

The closest weather station to the site is near Baker's Narrows at the Flin Flon airport, approximately 99 km west of the Project Site. The Flin Flon airport is located at an elevation of 304 masl and in our opinion is climatically representative of the Project Site. The mean annual air temperature at the Flin Flon airport is -0.2°C. The daily mean temperature ranges between 18°C in July and -21°C in January. Total annual precipitation at the Flin Flon airport is composed of 339 mm of rain and 141 cm of snow. July has the highest average rainfall (77 mm), whereas November has the highest average snowfall (25 cm) (Environment Canada, 2016).

The average temperature, precipitation and wind conditions measured at the Flin Flon airport each month are provided in **Table 4-2**.

4.2.7 Hydrology

The Reed Lake Ecodistrict lies within the glacial Lake Agassiz basin and is part of the Nelson River drainage system. The area drains generally eastward through Wekusko Lake, other medium sized lakes in the general region, and an irregular bedrock-controlled network of streams that are all part of the Grass River watershed (Smith, *et al.*, 1998). **Figure 14** illustrates Manitoba basins and watershed boundaries. **Figure 15** shows waterbodies in the Project Area. Within the Project Area and Project Region, there are numerous small to large lakes, creeks, and fens.

The closest waterbody to the Lalor site is Lalor Lake. Lalor Lake is a small (0.4 km^2) headwater lake located 250 m to the west of the Lalor site (where the concentrator and associated infrastructure will be located). Lalor Lake drains northward for approximately 300 m through a creek and marsh into Maw Lake (0.16 km^2). Maw Lake then continues to drain north into Varnson Lake (via Unnamed Creek 1 (2007)), and continues to flow east into Squall Lake, a relatively large and deep lake. Squall Lake then drains south via Snow Creek and eventually into Snow Lake Narrows, which makes up the west arm of Snow Lake. Snow Lake also receives water from the south via Tern Creek, Tern Ditch, and Tern Lake, a small lake (0.15 m^2).

Along Portion 3 of the Pipeline System route (shown in **Figure 09**), there are 20 culverts, including small channels, several small ephemeral and intermittent creeks, and drainage features. Ghost Lake, Arm Lake, and Threehouse Lake drain northward through a number of small creeks. Ghost Creek and Threehouse Creek waterbodies join to form Tern Creek, which eventually drains into Snow Lake. A number of smaller waterbodies (Nutt Lake, Gaspard Lake, and Unnamed Lake 1 (2011)) are low-lying areas with no obvious surface water drainage features. Unnamed Creek 1 (2011) crosses under the former rail bed and drains towards the Anderson TIA.

As a result of varying topography created by hummocky bedrock surfaces, the drainage conditions in the region vary considerably over short distances. Terrain falls at about 0.6 m to 1.0 m per km. Regionally, runoff from bedrock and upland areas collects in peat filled lows (bogs), which slowly release excess water to surrounding lakes and creeks. Groundwater tables are high in most bogs and in low areas bordering the bogs. Similar to much of the Boreal Shield Ecozone, contiguous and isolated bogs cover between 20% and 40% of the Project Region. Bogs are widespread and stagnant in the Project Region. Prior to clearing and leveling (for the Lalor site), the area was a large rocky outcrop in a large stand of dense Black Spruce surrounded by wet bog. The rock outcrop has been leveled and a bog/wet area exists to the north of the existing footprint of the Lalor site, within an area that had been previously cleared of vegetation.

Table 4-2. Climate Data for the Flin Flon Airport, Manitoba (1981-2010)

Parameter		Month													
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**	**Code**
Temperature (°C)	**Daily Average**	-19.8	-16.2	-8.9	0.8	8.4	14.9	18.2	17	10.4	2.6	-8.4	-17.1	0.2	A
	Daily Maximum	-15.1	-10.8	-2.7	6.9	14.4	20.4	23.4	22	14.7	6	-5.1	-12.9	5.1	A
	Daily Minimum	-24.5	-21.5	-15	-5.3	2.3	9.5	13	12	6.1	-0.9	-11.6	-21.3	-4.8	A
Precipitation	**Rainfall (mm)**	0.2	0.3	1.4	10.3	37.3	67.2	83.1	67.2	62.5	23.6	1.4	0.5	354.9	A
	Snowfall (cm)	21.7	18.2	19.7	18.7	3.6	0	0	0	1.7	14.6	27.5	24.6	150.2	A
Wind Conditions (km/h)	**Speed**	9.1	9.9	9.9	10.8	10.8	11.2	10.6	10.6	12	12	10.9	9.3	10.6	D
	Most Frequent Direction	NW	N	S	S	S	S	S	S	S	N	N	N	S	D

Notes: Data obtained from Flin Flon A meteorological station, latitude 54 ^{o} 41' N longitude 101 ^{o} 41' W Elevation 303.90 m (Environment Canada, 2016).

"A": World Meteorological Organization "3 and 5 rule" (i.e., no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation) between 1971 and 2000, "D":

4.3 Aquatic Environment

4.3.1 Previous Aquatic Environment Studies in the Area

The biophysical environment, in the area around Snow Lake, has been the subject of numerous studies since 1965. The baseline information collected during the most recent surveys performed by AECOM (2007-2015) were compared, where appropriate, to the historical information available:

- A Survey of Anderson Lake, 1965 (Allard, 1965).
- A Survey of Wekusko Lake in 1967 (Schlick, 1968).
- A 1974 Limnological Survey of Five Lakes in the Snow Lake Area (Crowe, 1975).
- A Limnological Survey of Wekusko Lake, 1975 (Blunt, 1976).
- Stall Lake Ore Concentrator, Snow Lake Manitoba; Revised Environmental Impact Statement (Labarre, 1977).
- Anderson Bay - Wekusko Lake Limnological Survey. (Bridges, 1977).
- Baseline Biological Survey of Anderson Bay (Booy, 1980).
- A Limnological Survey of Anderson and Wekusko Lakes, 1977 (Brown et al., 1980a).
- Data Supplement To A Limnological Survey of Anderson and Wekusko Lakes, 1977 (Brown et al., 1980b).
- Anderson Bay Limnology Survey (July 1980 - June 1981) Prior to Discharging from Anderson Lake into Anderson Bay (Booy, 1983).
- Anderson & Berry Bays Reduced Limnology survey (July, 1986) (West, 1986).
- A Preliminary Assessment of Subaqueous Tailings Disposal in Anderson Lake, Manitoba (Rescan Environmental Services, Ltd., 1990).
- Wekusko Lake (Anderson & Berry Bays) Limnology Survey (Rideout, 1997; McNeill, 2000; and West, 2004).
- Water Quality Assessment of Wekusko Lake, Manitoba Canada (Hughes, 2005).
- Metal Mining EEM Snow Lake Mill/Anderson Tailings Initial Monitoring Program Final Report & Appendices (Stantec Consulting Ltd., 2005).
- Metal Mining EEM Anderson Tailings Periodic Monitoring Program Final Report & Appendices (Stantec Consulting Ltd., 2008).
- Metal Mining EEM Anderson Tailings Focused Monitoring Program Final Report & Appendices (Stantec Consulting Ltd., 2010).
- Assessment of Walleye Population in Wekusko Lake – 2011 (Campbell, 2011).
- Metal Mining EEM Anderson Tailings Impoundment Area Discharge, Investigation of Cause Program Final Report (Stantec Consulting Ltd., 2012).
- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Lalor Mine *Environment Act* Proposal Report (AECOM, 2012b).
- Lalor Mine - Noise Baseline and Impact Assessment (AECOM, 2012c).
- Lalor Vegetation Regional Analysis (AECOM, 2012d).
- Environmental Assessment of the Proposed Expansion of the Anderson Tailings Impoundment Area (AECOM, 2016).

4.3.2 Summary of Recent Aquatic Environment Studies in the Area

Aquatic baseline investigations included bathymetry, water and sediment chemistry, aquatic macroinvertebrates communities, fish habitat, health, and community and metal residues in fish tissues (**Table 4-3**). There were three main field investigations as follows:

1. 2007 Baseline Study (North/South Consultants Inc., 2008)
2. 2010 Baseline Study (AECOM, 2012a).
3. 2011-2015 Baseline Studies (AECOM, 2016).

The aquatic investigations focused on waterbodies that were potentially affected by HBMS developments (Lalor Mine and proposed expansion of the Anderson TIA). The investigations summarized herein are focused on the waterbodies within the Project Area.

Table 4-3. Summary of Aquatic Baseline Investigations (2007-2015)

Waterbody	Bathymetry				Water & Sediment Chemistry							Lower Trophic Level Biota				Fish Community & Habitat			
	2007	2008	2010	2011	2007	2010	2011	2012	2013	2014	2015	2007	2010	2011	2012	2007	2010	2011	2012
Anderson Bay (of Wekusko Lake)	-	-	-	X	-	-	X	-	WQ	WQ	WQ	-	-	X	-	-	-	X	X
Anderson Creek	-	-	-	-	-	-	X	X	WQ	WQ	WQ	-	-	X	-	-	-	X	-
Unnamed Creek 1 (2011)	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-
Unnamed Lake 1 (2011)	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-
Nutt Lake	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-
Gaspard Lake	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-
Threehouse Lake	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-
Threehouse Creek	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	X	X
Ghost Lake	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	-	-	X	X
Ghost Creek	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-
Arm Lake	-	-	-	X	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-
Tern Creek	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Tern Lake	X	-	-	-	X	X	-	-	-	-	-	X	X	-	X	X	-	-	-
Tern Ditch Pond	-	-	X	-	-	X	-	-	-	-	-	-	X	-	X	-	X	-	-
Tern Ditch	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Lalor Lake	X	-	-	-	X	X	-	-	-	-	-	X	X	-	X	X	-	-	-
Maw Lake	X	-	-	-	X	X	-	-	-	-	-	X	X	-	X	X	-	-	-
Unnamed Creek 1 (2007)	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Snow Lake	-	-	-	-	X	-	WQ	-	-	-	-	-	-	-	-	-	-	-	-

*Notes: Unnamed Creek 1 assessed in 2007 is NOT the same as the Unnamed Creek 1 assessed in 2011. Waterbodies located within the Project Area are illustrated on **Figure 15**.*
WQ = Only samples for water chemistry were collected.

4.3.3 Lake Bathymetry

The assessment of lake bathymetry, carried out as part of the baseline aquatic work, summarized below, will function as a baseline reference for the depth of lakes and other waterbodies within the potential area of influence of the existing Lalor Mine.

4.3.3.1 Sampling Effort

Table 4-4 summarizes the bathymetric sampling effort that was collected for years 2007 to 2011 for each waterbody by sampling event.

Table 4-4. Bathymetric Sampling Effort in Project Region (2007-2011)

Waterbody	September 2007	June 2010	May 2011
Anderson Bay (of Wekusko Lake)	-	-	X
Unnamed Lake 1 (2011)	-	-	X
Nutt Lake	-	-	X
Gaspard Lake	-	-	X
Threehouse Lake	-	-	X
Ghost Lake	-	-	X
Arm Lake	-	-	X
Tern Lake	X	-	-
Tern Ditch Pond	-	X	-
Lalor Lake	X	-	-
Maw Lake	X	-	-

*Notes: Locations of waterbodies illustrated on **Figure 15**.*

4.3.3.2 Sampling Methodology

In 2007, North/South Consultants assessed lake bathymetry of Lalor Lake, Maw Lake, and Tern Lake (**Table 4-4**), using either a boat-mounted sonar unit (Lalor Lake and Tern Lake) or manual measurements (Maw Lake). In subsequent years, AECOM assessed lake bathymetry using a boat-mounted sonar unit.

Detailed methodology, results, and discussion of bathymetry can be found in:

- Aquatic Baseline Study in the Lalor Lake Area: Fall 2007 (North/South Consultants Inc, 2008).
- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Lalor Mine *Environment Act* Proposal Report (AECOM, 2012b).

4.3.3.3 Results

4.3.3.3.1 Anderson Bay (of Wekusko Lake)

Anderson Bay of Wekusko Lake, has numerous islands and reef structures, a steep rocky eastern shore, a gentle shallow western shore, and estuary like features at the northern end where the combined Anderson Creek and Stall Creek discharge into Wekusko Lake. Anderson Bay had an average depth of 2.3 m and a maximum depth of 5.3 m. Anderson Bay was the largest waterbody examined during the baseline assessments, with a total surface area of 1,106,100 m^2 and a total calculated volume of 2,583,400 m^3.

4.3.3.3.2 Unnamed Lake 1 (2011)

Unnamed Lake 1 was the smallest lake assessed during the bathymetric survey, with a mean depth of 0.8 m and a maximum depth of 1.2 m. The total surface area of Unnamed Lake 1 was 22,800 m² and the total calculated volume was 19,200 m³. Unnamed Lake 1 had a featureless bottom; essentially a low depression that has filled with sediments.

4.3.3.3.3 Nutt Lake

The total surface area of Nutt Lake was 63,000 m² and the total calculated volume was 59,600 m³. Nutt Lake had a mean depth of 0.9 m and a maximum depth of 1.4 m. Nutt Lake had a homogenous bottom topography with a shoreline that was composed of bedrock and fen or emergent vegetation.

4.3.3.3.4 Gaspard Lake

Gaspard Lake was one of the smallest waterbodies examined during the baseline assessments, with a total surface area of 88,000 m² and the total calculated volume was 93,700 m³. A small creek, Gaspard Creek, drains toward Gaspard Lake from the former rail bed located to the south. The shoreline of Gaspard Lake was dominated by emergent vegetation, such as wild rice, and/or fen areas.

4.3.3.3.5 Threehouse Lake

Threehouse Lake had a mean depth of 1.3 m and a maximum depth of 2.8 m. The total surface area of Threehouse Lake was 1,065,400 m² and the total calculated volume was 1,401,200 m³. The bottom topography was relatively complex with several reef structures and islands. A small creek, Threehouse Creek, drains Threehouse Lake towards the former rail bed located to the north.

4.3.3.3.6 Ghost Lake

Ghost Lake had a mean depth of 1.6 m and a maximum depth of 4.4 m, making it the deepest lake along the former rail bed. The total surface area of Ghost Lake was 607,100 m² and the total calculated volume was 967,700 m³. Ghost Creek drains from the northern bay in Ghost Lake, towards the former rail bed located to the north. Ghost Lake had a relatively complex bottom topography with several deep holes, reefs and islands. The shoreline was composed of steep bedrock and some areas of fen or emergent vegetation.

4.3.3.3.7 Arm Lake

Arm Lake is a shallow lake with a mean depth of 0.8 m and a maximum depth of 1.3 m. The total surface area of Arm Lake was 127,800 m² and the total calculated volume was 107,100 m³. The average grade was similar to other lakes along the former rail bed (*e.g.,* Gaspard Lake). There were large areas of emergent and submergent vegetation along the margins of the lake. Arm Lake is accessible via Threehouse Creek.

4.3.3.3.8 Tern Lake

Tern Lake is a small lake with a total surface area of 153,150 m². Tern Lake had a mean depth of 1.6 m and a maximum depth of 2.2 m. The total calculated volume of Tern Lake was 246,701 m³.

4.3.3.3.9 Tern Ditch Pond

Tern Ditch Pond had a modeled area of 75,125 m², a volume of 39,750 m³, and the mean depth was 0.5 m at the time of the bathymetric assessment in 2010. Depth was homogenous over the majority of the pond except for one northeast-southwest trending trench of up to 1.0 m in depth. The average grade of the lake bottom was 1.9% which is characteristic of a shallow gently sloping headwater lake. The shallow bottom allows for significant vegetation to grow within the pond itself. Only one small rock island with associated small rocky ridges was observed in the east end of the pond. Sediment was highly organic with limited distribution of cobble or mineral soils. Leaf matter was also present in near-shore areas, particularly on the south-eastern shore of Tern Ditch Pond.

4.3.3.3.10 Lalor Lake

Lalor Lake was found to be a relatively shallow lake with a mean depth of 1.2 m and a maximum depth of 2.1 m. The total surface area of Lalor Lake was 413,650 m² and the total calculated volume was 477,823 m³.

4.3.3.3.11 Maw Lake

Similar to Lalor Lake, Maw Lake is a relatively shallow lake. Maw Lake was determined to have a mean depth of 0.7 m and a maximum depth of 1.4 m. The total surface area of Maw Lake was 163,675 m² and the total calculated volume was 120,918 m³.

4.3.3.4 Bathymetry Summary

Results of the bathymetric assessment are presented in **Table 4-5**.

Table 4-5. Summary of Bathymetric Surveys (2007-2011)

Waterbody	Year Assessed	Maximum Depth (m)	Average Depth (m)	Area (m²)	Volume (m³)
Anderson Bay (of Wekusko Lake)	2011	5.3	2.3	1,106,100	2,583,400
Unnamed Lake 1 (2011)	2011	1.2	0.8	22,800	19,200
Nutt Lake	2011	1.4	0.9	63,000	59,600
Gaspard Lake	2011	1.6	1.1	88,000	93,700
Threehouse Lake	2011	2.8	1.3	1,065,400	1,401,200
Ghost Lake	2011	4.4	1.6	607,100	967,700
Arm Lake	2011	1.3	0.8	127,800	107,100
Tern Lake	2007	2,2	1,6	153,150	246,701
Tern Ditch Pond	2010	1.0	0.5	75,125	39,750
Lalor Lake	2007	2.1	1.2	413,650	477,823
Maw Lake	2007	1.4	0.7	163,675	120,918

Notes:
m = metre

Most lakes mapped in the study (*e.g.,* Arm Lake, Gaspard Lake, Nutt Lake, and Unnamed Lake 1) show typical headwater lake bathymetry, *i.e.*, steep slopes near shore, an immediate transition to gentle slopes, and shallow depth. Ghost Lake and Threehouse Lake have a more complicated bottom with island and reef structures, but their relatively shallow average depth for their surface area is more typical of a headwater lake, despite their larger size.

4.3.4 Surface Water Quality

In the fall 2007, North/South Consultants collected water samples from six waterbodies located in the area around the newly-discovered Lalor deposit (which became the Project Area of the Lalor Mine). In the summer of 2010, AECOM collected water samples from six waterbodies in the Project Area of the proposed Lalor Concentrator. AECOM collected water samples from 13 waterbodies located in the Project Region between the years 2011 and 2015.

The chemistry concentrations of water samples collected in these sampling events will function as a baseline reference for the quality of lakes and other waterbodies within the potential area of influence of the existing Lalor Mine. This section sets out a summary of the results and overall conclusions of the sampling programs.

4.3.4.1 Sampling Events

Table 4-6 summarizes the sampling effort (*i.e.,* number of samples collected) by North/South Consultants and AECOM for years 2007, 2010, and 2011 to 2015 for each waterbody by sampling event.

Table 4-6. Water Sampling Effort in Project Region (2007-2015)

Baseline Study	2007 [1]	2010 [2]	2011-2015 [3]								
Waterbody	**Sept 2007**	**Jul 2010**	**May 2011**	**Sept 2011**	**Jun 2012**	**Jun 2013**	**Oct 2013**	**Jun 2014**	**Sept 2014**	**Jun 2015**	**Sept 2015**
Anderson Bay (of Wekusko Lake)	-	-	10	10	-	2	2	2	2	2	2
Anderson Creek	-	-	2	2	1	3	3	3	3	3	3
Unnamed Creek 1 (2011)	-	-	1	1	-	-	-	-	-	-	-
Unnamed Lake 1 (2011)	-	-	1	1	-	-	-	-	-	-	-
Nutt Lake	-	-	1	1	-	-	-	-	-	-	-
Gaspard Lake	-	-	1	1	-	-	-	-	-	-	-
Threehouse Lake	-	-	3	3	-	-	-	-	-	-	-
Threehouse Creek	-	-	1	1	-	-	-	-	-	-	-
Ghost Lake	-	-	3	3	-	-	-	-	-	-	-
Ghost Creek	-	-	1	1	-	-	-	-	-	-	-
Arm Lake	-	-	1	1	-	-	-	-	-	-	-
Tern Creek	1	1	-	-	-	-	-	-	-	-	-
Tern Lake	1	1	-	-	-	-	-	-	-	-	-
Tern Ditch Pond	-	1	-	-	-	-	-	-	-	-	-
Tern Ditch	1	1	1	1	-	-	-	-	-	-	-
Lalor Lake	3	3	-	-	-	-	-	-	-	-	-
Maw Lake	3	3	-	-	-	-	-	-	-	-	-
Unnamed Creek 1 (2007)	1	1	-	-	-	-	-	-	-	-	-
Snow Lake	-	-	2	2	-	-	-	-	-	-	-

Notes: Locations of waterbodies illustrated on ***Figure 15****.*
[1] North/South Consultants Inc. (2008).
[2] AECOM, 2012a.
[3] AECOM, 2016.

4.3.4.2 Sampling Methodology

Surface grabs were collected from sample locations less than 3 m while a mid-column water sample was collected in an acrylic Kemmerer bottle sampler at sample locations deeper than 3 m.

In situ water quality parameters such as pH, temperature, specific conductance, turbidity, and dissolved oxygen (DO) were measured. Water quality samples were analyzed for the following parameters:

- Routine parameters (*e.g.,* physical and nutrients).
- Major ions (*i.e.,* chloride, sulphate, bromide and silicate).
- Total and dissolved metals.
- Total and dissolved mercury.
- Biological parameters (*i.e.,* chlorophyll *a* and pheophytin *a*).

Detailed methodology, results and discussion of sediment sampling can be found in:

- Aquatic Baseline Study in the Lalor Lake Area: Fall 2007 (North/South Consultants Inc, 2008).
- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Lalor Mine *Environment Act* Proposal Report (AECOM, 2012b).
- Baseline Water and Sediment Quality Assessment at Anderson Creek (AECOM, 2013a).
- Environmental Assessment of the Proposed Expansion of the Anderson Tailings Impoundment Area (AECOM, 2016).

4.3.4.3 Applicable Surface Water Quality Guidelines

Water quality data was compared to the Provincial and Federal guidelines and objectives that have been generated for various water quality parameters, with the purpose of protecting aquatic life and human health (*i.e.,* drinking water or protection of freshwater aquatic life) as listed in **Table 4-7**.

Table 4-7. Applied Water Quality Guidelines (2007-2015)

Baseline Survey	Sediment Quality Guideline
2007 (North/South Consultants)	• Manitoba Water Quality Standards, Objectives and Guidelines (*MWQSOG*) (Williamson, 2002).
2010 (AECOM)	• Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the Protection of Aquatic Life (*CWQG*) (CCME, 2011a).
2011-2015 (AECOM, 2016)	• Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the Protection of Aquatic Life (*CWQG*) (CCME, 2011a). • Manitoba Water Quality Standards, Objectives and Guidelines (*MWQSOG*) (Williamson, 2011).

The trophic status of waterbodies were determined using categories based on total phosphorus concentration thresholds as developed by CCME (2004) and Dodds *et al.* (1998) (**Table 4-8**).

Table 4-8. Trophic Categories for Freshwater Aquatic Ecosystems Based on Total Phosphorus (mg/L) Concentrations

Trophic Status	Lake TP Thresholds (CCME, 2004)	River TP Thresholds (Dodds *et al.*, 1998)
Ultra-Oligotrophic	<0.004	-
Oligotrophic	0.004 – 0.01	<0.025
Mesotrophic	0.01 – 0.02	0.025 – 0.075
Meso-eutrophic	0.02 – 0.035	-
Eutrophic	0.035 – 0.10	>0.075
Hyper-eutrophic	>0.10	-

4.3.4.4 Results

The following is a summary of the water quality data collected during the aquatic investigations undertaken between 2007 and 2015. Detailed results can be found in previously submitted documents (listed in **Section 4.3.4.2**).

4.3.4.4.1 Anderson Bay (of Wekusko Lake)

Anderson Bay has been sampled extensively since 1968 (**Section 4.3.1**). A summary of the results of water quality studies conducted by AECOM on behalf of HBMS is presented here. In total, 32 samples have been collected from Anderson Bay since spring 2011 (**Table 4-6**).

In 2011, where water temperatures were measured at two different depths, 0.25 m and 0.1 m, Anderson Bay was not thermally stratified. Water temperatures ranged from 8°C to 13°C in May and from 11°C to 14°C in September 2011. In June 2013, 2014, and 2015, water temperatures were slightly warmer, with surface temperatures ranging from 16°C to 18°C. In all sampling events, the water was well-oxygenated. Anderson Bay was alkaline with field-measured pH reaching as high as 9.45 in the fall of 2011, but typically has neutral pHs of 6.97 to 7.87 in subsequent years. In 2011, two laboratory-measured pH values were outside the *CWQG* guideline range of 6.5 to 9.0.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Anderson Bay was considered *meso-eutrophic* in 2011 to 2013 and *mesotrophic* in 2014 and 2015.

Some variability in water quality was observed within Anderson Bay, with inshore stations showing higher levels of some parameters, including dissolved solids, chloride, and sulfate. Overall, there were no consistent differences in limnological parameters between spring and fall.

Concentrations of most metals and metalloids were low and below the *CWQG* guidelines that were selected for this assessment. However, exceedances of aluminum, arsenic and iron have been reported in Anderson Bay.

- Aluminum exceeded *CWQG* guideline (0.1 mg/L) at eight sampling locations in spring 2011 but only at two sampling locations in fall 2011. Aluminum also exceeded in 2013 and 2014 at two sampling locations.
- Arsenic exceeded *CWQG* guideline (0.005 mg/L) at one sampling location in 2015.
- Iron exceeded *CWQG* guideline (0.3 mg/L) at AND-01A in spring 2011, spring 2013, and fall 2013 but has been below guidelines in 2014 and 2015.

For the above-noted parameters (*i.e.,* aluminum, arsenic and iron), the water concentrations in Anderson Creek were within the normal range, it does not appear that the higher concentrations in Anderson Bay could be caused by the discharge from the TIA.

4.3.4.4.2 Anderson Creek

Anderson Creek has been sampled extensively since 2011. Two samples were collected in both spring and fall of 2011; one sample in summer 2012; and two samples biannually in the years 2013 to 2015 (**Table 4-6**).

Water temperatures in Anderson Creek are highest in the summer, followed by spring, then the fall. Turbidity is generally higher in fall, likely due to the higher primary productivity in fall. Water in Anderson Creek is generally well-oxygenated with the majority of DO concentrations ranging from 6.7 mg/L to 16.0 mg/L. Anderson Creek has a neutral pH ranging from 6.8 to 8.9, with more alkaline pH in the spring. Specific conductivity showed little variation among sampling stations in each sampling event and ranged from 0.135 mS/cm to 0.656 mS/cm, with lowest specific conductivity measured in October 2013.

According to the Dodds *et al.* (1998) classification scheme for riverine trophic status based on total phosphorus concentrations, Anderson Creek was considered *oligotrophic* in 2011, 2012, 2013 and *mesotrophic* in 2014 and 2015.

With the following exceptions, concentrations of most metals and metalloids were low and below the *CWQG* guidelines selected for this assessment:

- Aluminum concentrations exceeded *CWQG* (0.1 mg/L) in Anderson Creek in 2011, 2013, 2014, and 2015. The highest aluminum concentrations were reported in June 2014 (0.778 mg/L), which more than doubled from the previous sampling event and were more than three times (3X) the 2011 levels.
- Cadmium concentrations exceeded *CWQG* (0.000075 mg/L) in 2011, 2014, and 2015. 2014 showed levels more than five times (5X) the *CWQG* and 10 times (10X) 2011 and 2012 levels.
- Copper exceeded *CWQG* (0.004 mg/L) in 2011, 2013, 2014, and 2015. June 2014 reported the highest copper concentrations among sample events with concentrations more than five times (5X) the *CWQG* and more than 10 times (10X) higher than fall 2013 levels.
- Iron concentrations exceeded *CWQG* guideline (0.3 mg/L) in 2011, 2013, 2014 and 2015. The highest iron concentration was 0.96 mg/L reported in June 2014. All samples collected in June 2014 exceeded the lead *CWQG* (0.007 mg/L). These levels increased by at least forty times (40X) from October 2013 levels and have dropped back to low levels in 2015.
- The highest recorded concentration was 0.0035 mg/L in June 2015.
- Zinc levels in water samples exceeded *CWQG* (0.03 mg/L) in all water samples collected in all sampling events, except October 2013, where one sample was slightly below guidelines. Total zinc concentrations increased by 91% at each of the sampling locations in Anderson Creek in June 2014 when compared to October 2013 levels and remained greater than five times (5X) *CWQG* in 2015.

Relative concentrations of total metals (to the detection limit) show no consistent trend with increasing distance from PR 392.

4.3.4.4.3 Unnamed Creek 1 (2011)

A sample for water chemistry was collected from Unnamed Creek 1 (2011) in both spring and fall 2011 (**Table 4-6**).

Unnamed Creek 1 is a small creek that has been impounded by significant beaver activity as it crosses through a culvert under the former rail bed towards Anderson TIA. pH values were higher in spring than in fall. Turbidity was higher in fall as compared to spring, due to the increased productivity.

According to the Dodds *et al.* (1998) classification scheme for trophic status based on total phosphorus concentrations, Unnamed Creek 1 was considered *mesotrophic* in spring and fall. Similar to the other creeks in the Snow Lake area, Unnamed Creek 1 was highly productive, with elevated concentrations of nutrients (highest concentration of total phosphorus of all waterbodies examined), chlorophyll *a* and phaeophytin *a*.

Concentrations of most metals and metalloids were low and below the applicable water quality guidelines with the exception of:

- In fall 2011, the concentration of fluoride in Unnamed Creek 1 was equal to the *CWQG* of 0.12 mg/L.
- The concentration of ammonia in fall 2011 was 0.17 mg/L, which exceeded the *CWQG* (0.007 mg/L).
- The concentrations of aluminum in 2011 (0.12 mg/L in spring and 0.14 mg/L in fall) and were higher than the *CWQG* of 0.1 mg/L.
- Iron (0.7 mg/L in spring and 3.1 mg/L in fall) was higher than the *CWQG* of 0.3 mg/L.

None of the *MWQSOG* values were exceeded.

4.3.4.4.4 Unnamed Lake 1 (2011)

A sample for water chemistry was collected from Unnamed Lake 1 (2011) in both spring and fall 2011 (**Table 4-6**).

Unnamed Lake 1 (2011) was the smallest lake located along the former rail bed. Water temperatures in Unnamed Lake 1 ranged from 12°C to 11°C in the spring and fall 2011, respectively. pH values were lower in the spring than in the fall. Turbidity was higher in fall as compared to spring, likely due to the higher primary productivity in fall. In both spring and fall, the water was well-oxygenated with DO concentrations greater than 8 mg/L.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Unnamed Lake 1 (2011) was considered *meso-eutrophic* in both spring and fall.

Concentrations of most parameters were low and below the applicable water quality guidelines, with the exception of:

- Baseline ammonia concentrations in Unnamed Lake 1 (2011) were 0.128 mg/L in fall 2011, exceeding the *MWQSOG* of 0.0067 mg/L.

None of the *CWQG* guideline values were exceeded.

4.3.4.4.5 Nutt Lake

A sample for water chemistry was collected from Nutt Lake in both spring and fall 2011 (**Table 4-6**).

Water temperatures in Nutt Lake ranged from 15°C to 11°C in the fall and spring 2011, respectively. Values of pH and turbidity were lower in the spring than in the fall. In both spring and fall, the water was well-oxygenated with DO concentrations greater than 8 mg/L.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Nutt Lake was considered *mesotrophic* in both spring and fall.

Baseline concentrations of most metals and metalloids were low and below the applicable water quality guidelines with the exception of:

- In the sample collected from Nutt Lake in spring 2011, the total iron concentration was 0.4 mg/L, exceeding the *CWQG* of 0.3 mg/L.
- Ammonia concentrations in Nutt Lake in both spring (0.064 mg/L) and fall (0.062 mg/L) 2011 exceeded the *MWQSOG* value of 0.0067 mg/L.

4.3.4.4.6 Gaspard Lake

A sample for water chemistry was collected from Gaspard Lake in both spring and fall 2011 (**Table 4-6**).

Gaspard Lake is a shallow lake located north of the former rail bed. Water temperatures ranged from 11°C to 15°C in the fall and spring, respectively. Values of pH and conductivity in Gaspard Lake were lower in the fall than in the spring. In both spring and fall 2011, the water was well-oxygenated.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Gaspard Lake was considered *mesotrophic* in both spring and fall. Nutrient concentrations were very low.

Baseline concentrations of most metals and metalloids were low and below the applicable water quality guidelines with the exception of:

- For samples collected from Gaspard Lake in spring and fall 2011, total iron concentrations (1.2 mg/L and 0.5 mg/L for spring and fall, respectively) exceeded the *CWQG* of 0.3 mg/L.

None of the *MWQSOG* values were exceeded.

4.3.4.4.7 Threehouse Lake

Three samples for water chemistry were collected from Threehouse Lake in both spring and fall 2011 (**Table 4-6**).

Threehouse Lake was the largest lake assessed along the former rail bed. Water temperatures in Threehouse Lake ranged from 17°C to 11°C in the spring and fall, respectively. Turbidity was generally higher in fall as compared to spring, likely due to the higher primary productivity in fall. In both spring and fall, the water was well-oxygenated with DO concentrations greater than 9 mg/L.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Threehouse Lake was considered *mesotrophic* in both spring and fall.

Concentrations of most metals and metalloids were low and below the applicable water quality guidelines with the exception of:

- Iron concentrations in the spring ranged from 0.56 mg/L to 0.65 mg/L, exceeding the *CWQG* of 0.3 mg/L.

None of the *MWQSOG* values were exceeded in Threehouse Lake.

4.3.4.4.8 Threehouse Creek

A sample for water chemistry was collected from Threehouse Creek in both spring and fall 2011 (**Table 4-6**).

Threehouse Creek is an off-take channel constructed during construction of the former rail bed and flows northward through a culvert under the former rail bed from Threehouse Lake and joins with Ghost Creek to form Tern Creek which flows through Tern Lake to Snow Lake. Water temperatures ranged from 10⁰C to 17⁰C in the fall and spring, respectively. Values of pH and conductivity were higher in spring than in fall, while dissolved oxygen concentrations and turbidity were generally higher in fall as compared to spring.

According to the Dodds *et al.* (1998) classification scheme for trophic status based on total phosphorus concentrations, Threehouse Creek was considered *oligotrophic* in spring and *mesotrophic* in fall 2011.

Baseline concentrations of most metals and metalloids were low and below the applicable water quality guidelines with the exception of:

- In fall 2011, the concentration of aluminum in Threehouse Creek was 0.12 mg/L compared to the *CWQG* of 0.1 mg/L.
- Baseline concentrations of iron ranged from 0.3 mg/L to 0.6 mg/L compared to the CWIQG of 0.3 mg/L.

None of the MWQSOG values were exceeded.

4.3.4.4.9 Ghost Lake

Three samples for water chemistry were collected from Ghost Lake in both spring and fall 2011 (**Table 4-6**).

Water temperatures in Ghost Lake ranged from 12°C to 17°C in the fall and spring, respectively. Turbidity was generally slightly higher in fall as compared to spring, likely due to the higher primary productivity in fall. In both spring and fall, the water was well-oxygenated with average Dissolved Oxygen (DO) concentrations of 10 mg/L and 9 mg/L, respectively.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Ghost Lake was considered *mesotrophic* in spring and *oligotrophic* in fall. Nutrient concentrations (*e.g.,* total Kjeldahl nitrogen, total phosphorus) were lower on average than Threehouse Lake, another similar sized waterbody along the former rail bed.

Concentrations of most metals and metalloids were low and none of the *MWQSOG* or *CWQG* values were exceeded in baseline samples collected from Ghost Lake, with the exception of:

- Cadmium concentration in Ghost Lake at one station in fall 2011 was 0.000028 mg/L, exceeded the *CWQG* (0.00001 mg/L).

4.3.4.4.10 Ghost Creek

A sample for water chemistry was collected from Ghost Creek in both spring and fall 2011 (**Table 4-6**).

Ghost Creek is an off-take channel built during the construction of the former rail bed. Ghost Creek flows northward through a culvert under the former rail bed and joins with Threehouse Creek to form Tern Creek which flows through Tern Lake to Snow Lake. Water temperatures in Ghost Creek ranged from 20^{0}C to 11^{0}C in the spring and fall, respectively. Values of pH, conductivity and turbidity were higher in the spring than in the fall. DO concentrations in fall were on average lower than in spring, with some concentrations reaching levels that may adversely affect aquatic life.

According to the Dodds *et al.* (1998) classification scheme for lake trophic status based on total phosphorus concentrations, Ghost Creek was considered *meso-eutrophic* in spring and fall 2011. Similar to the other creeks along the former rail bed, Ghost Creek was highly productive, with high nutrient concentrations and elevated concentrations of chlorophyll *a* and phaeophytin *a*.

Concentrations of most metals and metalloids were low and below the *CWQG* with the exception of:

- Iron concentrations in Ghost Creek were 0.5 mg/L and 1.2 mg/L, in spring and fall, respectively, exceeding the *CWQG* (0.3 mg/L).
- Arsenic concentration in Ghost Creek in the fall 2011 was 0.01 mg/L, exceeding the *CWQG* (0.005 mg/L).

None of the *MWQSOG* values were exceeded in samples collected from Ghost Creek.

4.3.4.4.11 Arm Lake

A sample for water chemistry was collected from Arm Lake in both spring and fall 2011 (**Table 4-6**).

Arm Lake is a shallow lake located north of the former rail bed. Water temperatures in 2011 ranged from 10°C to 13°C in the fall and spring, respectively. Values of pH and conductivity were lower in the fall than in the spring. In both spring and fall, the water was well-oxygenated.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Arm Lake was considered *oligotrophic* in both spring and fall. Baseline nutrient concentrations were very low.

Several metal concentrations in Arm Lake in spring and fall were below detection limit and none exceeded the *CWQG* or *MWQSOG* values.

4.3.4.4.12 Tern Creek

Tern Creek is formed near Arm Lake following the confluence of Threehouse Creek and Ghost Creek. It drains northward into Tern Lake and eventually into Snow Lake. Tern Creek was sampled for water chemistry baseline characterization in 2007 and 2010 (**Table 4-6**).

In summer 2010, water temperatures were high (greater than 20°C. Water was well-oxygenated with a DO concentration of 9.5 mg/L in summer 2010. In fall 2007, the DO concentration was reduced (6.4 mg/L) but was above the most stringent water quality objective for the protection of cool-water aquatic life.

According to the Dodds *et al.* (1998) classification scheme for trophic status based on total phosphorus concentrations, Tern Creek was considered *oligotrophic* in fall 2007 and summer 2010.

Baseline concentrations of most metals and metalloids were low and below the applicable water quality guidelines with the exception of summer 2010:

The concentration of aluminum (0.278 mg/L), exceeding the *CWQG* (0.1 mg/L).

4.3.4.4.13 Tern Lake

Tern Lake is a shallow lake located north of the former rail bed. Tern Lake was sampled for water chemistry baseline characterization in 2007 and 2010 (**Table 4-6**).

Water temperature in 2007 was 11°C and in 2010 was 19.5°C, slightly lower than the overall average of waterbodies assessed in summer 2010. Values of pH and conductivity were similar to other waterbodies in the area. Water was well-oxygenated and clear in 2007 and 2010.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Tern Lake was considered *mesotrophic* in fall 2007 and summer 2010.

Concentrations of metals and metalloids were low and several concentrations were below the analytical detection limit in both 2007 and 2010. All concentrations were below the applicable water quality guidelines.

4.3.4.4.14 Tern Ditch

Tern Ditch flows north through a culvert under the Lalor Access Road to join Tern Creek, which flows into Snow Lake. One sample for water chemistry were collected from Tern Ditch in each of the years 2007, 2010, and 2011 (**Table 4-6**).

Water temperatures were generally higher in Tern Ditch than other similar sized creeks in the Snow Lake area studied by AECOM in 2011 during the environmental baseline aquatic assessments. In 2010, the water temperature in Tern Ditch was 23.6°C, which was the highest water temperature recorded during that investigation. Values of pH and dissolved oxygen concentrations were higher in spring than in fall in 2011, while conductivity and turbidity were generally higher in fall as compared to spring.

According to the Dodds *et al.* (1998) classification scheme for trophic status based on total phosphorus concentrations, Tern Ditch was considered *mesotrophic* in spring and fall 2011 and summer 2010. Similar to the other creeks in the Project Area, Tern Ditch was highly productive, with elevated concentrations of nutrients and chlorophyll *a*.

In the sample collected from Tern Ditch in 2007, baseline concentrations of most metals and metalloids were low and below the *MWQSOG* with the exception of:

- The concentration of total aluminum in Tern Ditch (0.61 mg/L) was six times (6X) higher than the *CWQG* (0.1 mg/L).
- Total iron concentration (1.73 mg/L) in Tern Ditch in 2007 was at least five times (5X) greater than the CWQG (0.3 mg/L).

The Tern Ditch 2010 sample had the highest concentrations of most metals and the most exceedances over the *CWQG* (aluminum, arsenic and iron) compared to other waterbodies assessed in 2010. The exceedances are as follows:

- The concentration of total aluminum in Tern Ditch (0.39 mg/L) was at least three times (3X) higher than the *CWQG* (0.1 mg/L).
- Arsenic concentration (0.0087 mg/L) exceeded the *CWQG* (0.005 mg/L).
- Total iron concentration (1.1 mg/L) in Tern Ditch was at least three times (3X) greater than the *CWQG* (0.3 mg/L).

In the samples collected in 2011, baseline concentrations of most metals and metalloids were low and below the *CWQG* with the exception of:

- The concentration of aluminum (0.15 mg/L), exceeding the *CWQG* (0.1 mg/L).
- The concentration of iron in Tern Ditch was 0.55 mg/L compared to the *CWQG* of 0.3 mg/L.

None of the *MWQSOG* values were exceeded in 2011.

4.3.4.4.15 Tern Ditch Pond

Tern Ditch Pond was sampled only in 2010 (**Table 4-6**). Tern Ditch Pond is a shallow headwater lake that, at the time of assessment, was well oxygenated and showed no thermal stratification. Tern Ditch Pond had moderately hard water that was coloured and had a neutral pH.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Tern Ditch Pond was classified as *mesotrophic* in summer 2010.

Concentrations of all metals and metalloids in Tern Ditch Pond were below the applicable water quality guideline in 2010.

4.3.4.4.16 Lalor Lake

Lalor Lake is the closest waterbody to the Lalor Mine. It has been sampled to characterize baseline water chemistry in 2007 and 2010 (**Table 4-6**).

Water temperatures in Lalor Lake ranged from 13.2°C to 13.5°C in fall 2007 and 19.6°C to 19.9°C in summer 2010. Field pH values in 2010 (ranging from 9.00 to 9.03) were greater than the *CWQG* but were within the *CWQG* in 2007 (ranging from 7.80 to 8.16). DO concentrations were high in Lalor Lake in fall 2007 (greater than 9.0 mg/L) and summer 2010 (greater than 11.5 mg/L).

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Lalor Lake was considered *oligotrophic* in fall 2007 and *mesotrophic* in summer 2010.

Concentrations of metals and metalloids were low and several concentrations were below the analytical detection limit in samples collected in 2007 and 2010. All concentrations were below the *CWQG*.

4.3.4.4.17 Maw Lake

Maw Lake is the downstream from Lalor Lake. It was sampled in 2007 and 2010 to characterize baseline water chemistry (**Table 4-6**).

In fall 2007, water temperatures were similar to those measured in other waterbodies (ranging from 12.1°C to 12.8°C. Water temperatures were high in Maw Lake in summer 2010 (20.4°C on average). In both 2007 and 2010, the water was well-oxygenated with DO concentrations greater than 8 mg/L. Specific conductivity in Maw Lake (was lower than in Lalor Lake in both 2007 and 2010, which is located upstream.

According to the CCME classification scheme for lake trophic status based on total phosphorus concentrations, Maw Lake was considered *oligotrophic* in fall 2007 and *mesotrophic* in summer 2010.

Concentrations of metals and metalloids were low and several concentrations were below the analytical detection limit; all concentrations were below the applicable water quality guidelines in samples collected in both sampling events.

4.3.4.4.18 Unnamed Creek 1 (2007)

Maw Lake drains northward towards Varnson Lake through Unnamed Creek 1 (2007). Unnamed Creek 1 (2007) was sampled only in 2007 to characterize baseline water chemistry (**Table 4-6**).

Unnamed Creek 1 (2007) had some differences in routine parameters compared to the other lakes in the drainage (Lalor Lake and Maw Lake). Total dissolved solids (TDS), pH, and nutirients, for example, were lower in the creek than in lakes upstream and downstream, while hardness and alkalinity were intermediate to the lakes upstream and downstream. The DO concentration was relatively low (5.12 mg/L) and did not meet the most stringent *MWQSOG* for cool-water species (6.0 mg/L).

According to the Dodds *et al.* (1998) classification scheme for trophic status based on total phosphorus concentrations, Unnamed Creek 1 (2007) was considered *oligotrophic* in fall 2007.

Concentrations of metals and metalloids were low and several concentrations were below the analytical detection limit; all concentrations were below the *MWQSOG* in the sample collected from Unnamed Creek 1 (2007).

4.3.4.4.19 Snow Lake

Snow Lake receives drainage from Snow Creek and Tern Creek, as well as several other creeks. Water samples were collected from the eastern basin of Snow Lake in both spring and fall 2011 (**Table 4-6**). Snow Lake was the deepest waterbody sampled in the environmental baseline aquatic assessments in the Snow Lake area in 2011 (for example, station SNL-01 had a maximum depth of 16 m).

In spring 2011, water temperature and dissolved oxygen concentrations were stable in the top 7 m in both basins of Snow Lake. DO concentrations dropped steadily as depth increased until reaching bottom (at SNL-01). This pattern (*i.e.,* DO gradient but no accompanying temperature gradient) is typical of winter stratification, prior to spring turnover. In fall 2011, there was a similar pattern at SNL-02. A combination of depth and strong winds may have prevented the development of a thermocline over the summer in Snow Lake, even with the development of an oxygen gradient.

According to the CCME classification scheme for lake trophic status based on Total Phosphorus concentrations, Snow Lake was considered *mesotrophic* in both spring and fall 2011.

Concentrations of most metals and metalloids were low and below the applicable water quality guidelines with the exception of:

- The copper concentration at one Snow Lake station in fall 2011 (0.00217 mg/L) exceeded the *CWQG* of 0.00216 mg/L.

None of the *MWQSOG* values were exceeded in Snow Lake.

4.3.4.5 Surface Water Quality Summary

Waterbodies in the area had different chemical characterization. In general, water was well-oxygenated and protective of all life stages (with few exceptions). Water tended to be clear and alkaline. The majority of waterbodies were *mesotrophic* or *oligotrophic*, with higher total phosphorus concentrations in the fall as compared to spring. In general, levels of nutrients were low but typical of boreal lakes.

Waterbodies with several sampling stations showed limited spatial variation with the exception of Anderson Bay. Within Anderson Bay, differences were observed between near shore and offshore sites for parameters such as dissolved solids and conductivity, however water conditions were good at all Anderson Bay sites. Some differences were observed between spring and fall samples; however, these differences are consistent with changes in aquatic productivity during the open water season.

Total aluminum, arsenic, cadmium, copper, iron, lead, selenium, and zinc concentrations exceeded applicable water quality guidelines in at least one baseline sample in several of the waterbodies assessed in the Project Region between 2007 and 2015 (**Table 4-9**).

Table 4-9. Number of Samples with Metal Concentrations in Exceedance of Applicable Water Quality Guidelines (2007-2015)

Waterbody	Total Number of Samples	Aluminum	Arsenic	Cadmium	Copper	Iron	Lead	Selenium	Zinc
Anderson Bay (of Wekusko Lake)	**32**	15	1	-	-	3	-	-	-
Anderson Creek	**22**	20	-	13	15	10	-	15	22
Unnamed Creek 1 (2011)	**2**	1	-	-	-	1	-	-	-
Unnamed Lake 1 (2011)	**1**	-	-	-	-	-	-	-	-
Nutt Lake	**2**	-	-	-	-	1	-	-	-
Gaspard Lake	**2**	-	-	-	-	2	-	-	-
Threehouse Lake	**6**	-	-	-	-	3	-	-	-
Threehouse Creek	**2**	1	-	-	-	2	-	-	-
Ghost Lake	**6**	-	-	1	-	-	-	-	-
Ghost Creek	**2**	-	1	-	-	2	-	-	-
Arm Lake	**2**	-	-	-	-	-	-	-	-
Tern Creek	**2**	1	-	-	-	1	-	-	-
Tern Lake	**2**	-	-	-	-	-	-	-	-
Tern Ditch Pond	**1**	-	-	-	-	-	-	-	-
Tern Ditch	**2**	2	1	-	-	1	1	-	-
Lalor Lake	**11**	-	-	-	-	-	-	-	-
Maw Lake	**6**	-	-	-	-	-	-	-	-
Unnamed Creek 1 (2007)	**1**	-	-	-	-	-	-	-	-
Snow Lake	**4**	-	-	-	2	-	-	-	-

*Notes: Locations of waterbodies illustrated on **Figure 15**.*

4.3.5 Sediment Quality

The chemistry concentrations of sediment samples collected in the sampling events (**Table 4-3**) will function as a baseline reference for the quality of lakes and other waterbodies within the potential zone of influence of the Lalor Mine.

This section sets out a summary of the results of the AECOM sampling program and overall results about sediment chemistry based upon AECOM's sampling program.

4.3.5.1 Sampling Events

Sediment quality samples were collected in conjunction with the surface water quality samples in 2007, 2010, 2011, and 2012 (**Table 4-10**).

Table 4-10. Sediment Chemistry Sampling Effort in Project Region (2007-2012)

Baseline Survey	2007 [1]	2010 [2]	2011-2015 [3]		
Waterbody	**Sept 2007**	**Jul 2010**	**May 2011**	**Sept 2011**	**Jun 2012**
Anderson Bay (of Wekusko Lake)	-	-	30	30	-
Anderson Creek	-	-	6	6	3
Unnamed Creek 1 (2011)	-	-	3	3	-
Unnamed Lake 1 (2011)	-	-	3	3	-
Nutt Lake	-	-	3	3	-
Gaspard Lake	-	-	3	3	-
Threehouse Lake	-	-	9	9	-
Threehouse Creek	-	-	3	3	-
Ghost Lake	-	-	9	9	-
Ghost Creek	-	-	3	3	-
Arm Lake	-	-	3	3	-
Tern Creek	1	1	-	-	-
Tern Lake	1	1	-	-	-
Tern Ditch Pond	-	1	-	-	-
Tern Ditch	1	1	3	3	-
Lalor Lake	5	4	-	-	-
Maw Lake	3	3	-	-	-
Unnamed Creek 1 (2007)	1	-	-	-	-

Notes: Locations of waterbodies illustrated on ***Figure 15****.*
[1] North/South Consultants Inc. (2008).
[2] AECOM, 2012a.
[3] AECOM, 2016.

4.3.5.2 Sampling Methodology

For all sampling events, sediment quality samples were collected using an Ekman sediment grab. Where triplicates were collected in 2007, each grab was separated approximately 2 m from each other. Triplicate samples were collected at each station in 2011, separated approximately 25 m from each other. Triplicate samples were not collected in 2010. The top 5 cm of sediments were submitted for the analysis of the following parameters:

- Total metals.
- Total mercury.
- Nutrients (*i.e.,* phosphorus, nitrogen and total organic carbon).
- Moisture.
- Particle size.

Detailed methodology, results and discussion of sediment sampling can be found in:

- Aquatic Baseline Study in the Lalor Lake Area: Fall 2007 (North/South Consultants Inc, 2008).
- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Lalor Mine *Environment Act* Proposal Report (AECOM, 2012b).

- Baseline Water and Sediment Quality Assessment at Anderson Creek (AECOM, 2013a).
- Environmental Assessment of the Proposed Expansion of the Anderson Tailings Impoundment Area (AECOM, 2016).

4.3.5.3 Applicable Sediment Quality Guidelines

Sediment quality data was compared to the Provincial and Federal guidelines and objectives that have been generated for various water quality parameters, with the purpose of protecting aquatic life and human health (*i.e.,* drinking water or protection of freshwater aquatic life) as listed in **Table 4-11**.

Table 4-11. Applied Sediment Quality Guidelines (2007-2012)

Baseline Survey	Sediment Quality Guideline
2007 (North/South Consultants, 2008)	• Manitoba Interim Sediment Quality Guidelines (*ISQG*) and Probable Effect Level (*PEL*) (Williamson, 2002). • Ontario Sediment Quality Guidelines (*OSQG*) (Persaud *et al.*, 1993).
2010 (AECOM, 2012a)	• Manitoba Interim Sediment Quality Guidelines (*ISQG*) and Probable Effect Level (*PEL*) (Williamson, 2002). • Canadian Council of Ministers of the Environment Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Residential/Parkland Use (*RPL*) (CCME, 2007).
2011 & 2012 (AECOM, 2016)	• Manitoba Interim Sediment Quality Guidelines (*ISQG*) and Probable Effect Level (*PEL*) (Williamson, 2011).

Sediments with measured chemical concentrations equal to or lower than *ISQG* are considered by the province to be acceptable quality. Sediments with measured chemical concentrations between the *ISQG* and the *PEL* are considered by the province to represent potential hazards to exposed organisms. Sediments with a measured chemical concentration equal to or greater than the *PEL* are considered to represent significant and immediate hazards to exposed organisms by the province.

4.3.5.4 Results

The following is a summary of the water quality data collected during the aquatic investigations undertaken between 2007 and 2012. Detailed results can be found in previously submitted documents (listed in **Section 4.3.5.2**).

4.3.5.4.1 Anderson Bay (of Wekusko Lake)

Three replicates from ten sample locations in both spring and fall 2011 from Anderson Bay were submitted for laboratory analysis (60 samples in total).

- Sediment samples were collected for grain size analysis in both spring and fall. Samples were primarily composed of silt and clay and described as clay, silty clay, silty clay loam, and silt loam.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- The majority (70%) of arsenic concentrations were between the *ISQG* (5.9 mg/kg) and *PEL* (17.0 mg/kg) sediment guidelines. The lowest concentration of arsenic was 4.00 mg/kg while the highest arsenic concentration recorded was 23.3 mg/kg.
- All cadmium concentrations were below *PEL* (3.5 mg/kg).
- For chromium, 90% of concentrations exceeded *ISQG*, but, none exceeded *PEL* (90 mg/kg). Chromium concentrations ranged from 18.9 mg/kg to 78 mg/kg.

- For copper, 57% of concentrations exceeded the *ISQG*, but none exceeded *PEL*. In general, increased copper concentrations were observed in sample locations closer to the north end of Anderson Bay and concentrations decreased as sample locations extended further into Wekusko Lake.
- Lead concentrations were well below both the *PEL* and *ISQG*. The highest lead concentration observed was 17.7 mg/kg and lowest concentration was 4.75 mg/kg.
- A quarter of mercury concentrations were below the detection limit (0.05 mg/kg). All mercury concentrations greater than the detection limit were below the *ISQG* (0.17 mg/kg) and ranged from 0.05 mg/kg to 0.099 mg/kg.
- The highest zinc concentrations were reported as high as 1,070 mg/kg and lowest at 31 mg/kg. The stations closest to the outflow of Anderson Creek had zinc concentrations above *ISQG* (123 mg/kg) and *PEL* (315 mg/kg). Stations extending further into Wekusko Lake had zinc concentrations above *ISQG* but below *PEL*.

4.3.5.4.2 Anderson Creek

AECOM submitted all three replicates from two sample locations in both spring and fall of 2011 and three replicates from one sample location in spring 2012 (15 samples in total).

- Sediment samples were collected for grain size analysis in both spring and fall. All samples were classified as clay and had clay content ranging from 51.6% to 70.0%, silt content ranging from 12.5% to 20.6%, and sand ranging from 17.0% to 27.8%.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- Arsenic concentrations ranged from 40.9 mg/kg to the lowest of 4.66 mg/kg in September 2011. Only one sample exceeded arsenic *PEL*.
- Cadmium concentrations were highest at 3.72 mg/kg. The cadmium *PEL* was exceeded at one sampling location and *ISQG* were exceeded at two locations.
- The highest chromium concentration from a sample location was 92.9 mg/kg. As the sample locations approached PR 392 and the Anderson TIA discharge, chromium concentrations increased. The chromium *ISQG* was exceeded in all samples and the chromium *PEL* was exceeded in two samples in May 2011 and June 2012 respectively.
- The copper *ISQG* was exceeded in two or more replicates from each sample location in 2011 and 2012. The *PEL* guideline was not exceeded.
- All mercury concentrations were below laboratory detection limits.
- Average lead and zinc concentrations in samples also increased as sample locations approached PR 392 and the Anderson TIA discharge. Lead concentrations ranged from 10.5 mg/kg to 39.5 mg/kg (only one sample at 39.5 mg/kg was recorded which exceeded lead *ISQG*). The highest zinc concentration was 1,860 mg/kg, with one or more replicates from each sample location having exceeded zinc *ISQG*. As well, one or more replicates also exceeded both lead and zinc *PEL* in two locations.

4.3.5.4.3 Unnamed Creek 1 (2011)

Three replicates from one sample location in both spring and fall 2011 from Unnamed Creek 1 were submitted for laboratory analysis (6 samples in total).

- Unnamed Creek 1 sediments had low moisture content (69% ± 26.6%) and were composed primarily of silt and clay. Sediments from Unnamed Creek 1 had comparable total and organic carbon and nutrients (i.e., total nitrogen and total phosphorus) compared to other creeks located along the former rail bed.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- Four replicates had concentrations of arsenic greater than the *ISQG*; one arsenic concentration was also greater than the *PEL*.

- None of the cadmium concentrations were greater than the ISQG or PEL; the highest cadmium concentration was 0.57 mg/kg.
- All chromium concentrations (ranging from 41.9 mg/kg to 71 mg/kg) were greater than the *ISQG* (37.3 mg/kg); none were greater than the *PEL*.
- The copper *ISQG* (35.7 mg/kg) was exceeded in three replicates. No replicates had concentrations that exceeded the *PEL* (197 mg/kg).
- The lead *ISQG* (35 mg/kg) and *PEL* (91.3 mg/kg) were not exceeded in any replicate; the highest lead concentration was 11 mg/kg.
- Two of replicates had mercury concentrations less than the analytical detection limit; none of the concentrations exceeded either the *ISQG* or *PEL*.
- All zinc concentrations (ranging from 137 mg/kg to 1,190 mg/kg) exceed the *ISQG* (123 mg/kg) and two exceed the *PEL* (315 mg/kg).

4.3.5.4.4 Unnamed Lake 1 (2011)

Three replicates from one sample location in both spring and fall 2011 from Unnamed Lake 1 (2011) were submitted for laboratory analysis (6 samples in total).

- Unnamed Lake 1 sediments, similar to other waterbodies located along the former rail bed, had high moisture content (97% ± 1.9%) and composed primarily of silt and clay. Total phosphorus concentrations in sediment were among the highest compared to other waterbodies located along the former rail bed.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- Four of six arsenic concentrations were between the *ISQG* and *PEL*.
- Cadmium concentrations in four samples exceeded the *ISQG* and none exceeded the *PEL*.
- All chromium concentrations were below the *ISQG* and the *PEL*.
- For copper, five samples had concentrations (ranging between 39 mg/kg to 42.6 mg/kg) that exceeded the *ISQG* and none exceeded the *PEL.* Copper concentrations in sediments from Unnamed Lake 1 were, on average, higher than in other waterbodies located along the former rail bed.
- All lead concentrations (the highest of which was 25.3 mg/kg) were all below the *ISQG* (35 mg/kg).
- One of six mercury concentrations (0.176 mg/kg) was above the *ISQG* (0.17 mg/kg).
- Zinc concentrations, ranging from 71 mg/kg to 113 mg/kg, were all below the *ISQG* (123 mg/kg).

4.3.5.4.5 Nutt Lake

Three replicates from one sample location in both spring and fall 2011 from Nutt Lake were submitted for laboratory analysis (6 samples in total).

- Nutt Lake sediments had high moisture content (96% ± 1.9%) and were composed primarily of silt and clay, similar to other waterbodies located along the former rail bed. The sediments from Nutt Lake had similar total and organic carbon to other waterbodies located along the former rail bed (*e.g.,* Gaspard Lake and Ghost Lake). Total phosphorus concentrations in sediments from Nutt Lake were among the lowest compared to other waterbodies along the former rail bed.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- Half of the sediments collected from Nutt Lake in 2011 had concentrations of arsenic that exceeded the *ISQG*, with concentrations ranging from 3.2 mg/kg to 11.2 mg/kg.
- Four of six cadmium concentrations, ranging from 0.49 mg/kg to 1.1 mg/kg, exceeded the *ISQG*.
- Chromium concentrations in all samples were lower than the *ISQG* and *PEL*.

- None of the copper concentrations exceeded the *ISQG* or *PEL*.
- Lead concentrations in Nutt Lake ranged from 3.2 mg/kg to 29.7 mg/kg; none exceeding either the *ISQG* or the *PEL*.
- All of the mercury concentrations were below the ISQG (0.17 mg/kg); the highest was 0.166 mg/kg and lowest was 0.05 mg/kg.
- Zinc concentrations in sediments from Nutt Lake exceeded the *ISQG* (123 mg/kg) in two of six samples (129 mg/kg and 132 mg/kg).

4.3.5.4.6 Gaspard Lake

Three replicates from one sample location in both spring and fall 2011 from Gaspard Lake were submitted for laboratory analysis (6 samples in total).

- Gaspard Lake sediments had high moisture (94% ± 2.3%) and were composed primarily of silt and clay. The sediments from Gaspard Lake had similar total and organic carbon compared to other waterbodies located along the former rail bed (*e.g.,* Ghost Lake and Nutt Lake).

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- All samples collected from Gaspard Lake in 2011 had concentrations of arsenic (average 14.8 mg/kg) that exceeded the *ISQG* (5.9 mg/kg).
- Two samples had concentrations of cadmium (0.83 mg/kg and 0.66 mg/kg) that exceeded the *ISQG* (0.6 mg/kg).
- Chromium concentrations ranged from 6.6 mg/kg to 13 mg/kg and none exceeded the *ISQG* or *PEL*.
- Copper concentrations were all below the *ISQG* and *PEL*.
- For lead, none of the concentrations exceeded the *ISQG* or *PEL*.
- Only one sample had a concentration of zinc (151 mg/kg in spring 2011) that exceeded the *ISQG* (123 mg/kg).

4.3.5.4.7 Threehouse Lake

Three replicates from three sample locations in both spring and fall 2011 from Threehouse Lake were submitted for laboratory analysis (18 samples in total).

- Threehouse Lake sediments had high moisture content (98% ± 0.4%) and were composed primarily of silt and clay, with more sand content than Ghost Lake, a similar-sized lake located along the former rail bed. The sediments from Threehouse Lake had similar total and organic carbon to other waterbodies located along the former rail bed (e.g., Gaspard Lake and Ghost Lake). Total Phosphorus concentrations in the sediment were among the highest compared to other waterbodies located along the former rail bed.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- All sediments collected from Threehouse Lake in 2011 had concentrations of arsenic that exceeded the ISQG (5.9 mg/kg) and 8 of 18 concentrations also exceed the *PEL* (17 mg/kg). Arsenic concentrations ranged from 12.7 mg/kg to 23.6 mg/kg.
- For cadmium, 77% of concentrations were between the *ISQG* and the *PEL*. No cadmium concentrations exceeded the *PEL*.
- Chromium concentrations ranged from 4.9 mg/kg to 14.5 mg/kg and none exceeded the *ISQG* or *PEL*.
- All copper concentrations were below the *ISQG* (35.7 mg/kg) and *PEL* (197 mg/kg).
- None of the lead concentrations (the highest of which was 26.9 mg/kg) exceeded the *ISQG* (35 mg/kg).
- Mercury concentrations, which ranged from 0.05 mg/kg to 0.14 mg/kg, were all below the *ISQG*.

- Zinc concentrations in sediments from Threehouse Lake exceeded the *ISQG* (123 mg/kg dw) in 3 of 18 samples and none exceeded the *PEL*.

To identify spatial trends within each of the major waterbodies, AECOM compared concentrations of chemicals of potential concern using one-way ANOVA comparisons between stations in each waterbody. The results indicate no spatial trends in chemical composition within Threehouse Lake.

4.3.5.4.8 Threehouse Creek

Three replicates from one sample location in both spring and fall 2011 from Threehouse Creek were submitted for laboratory analysis (6 samples in total).

- Threehouse Creek sediments had moderate moisture content (84% ± 11.6%) and were composed primarily of silt and clay. Sediments from Threehouse Creek had comparable total and organic carbon and nutrients (*i.e.,* total nitrogen and total phosphorus) compared to other creeks located along the former rail bed.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- All concentrations of arsenic, which ranged from 7.6 mg/kg to 39 mg/kg, exceeded the *ISQG* (5.9 mg/kg). Two replicates in spring and fall had arsenic concentrations that were greater than both the *ISQG* and the *PEL* (17 mg/kg).
- None of the cadmium concentrations exceeded the *ISQG* or the *PEL*; concentrations ranged from 0.17 mg/kg to 0.44 mg/kg.
- One replicate sample in both spring and fall had concentrations of chromium that were between the *ISQG* (37.3 mg/kg) and the *PEL* (90 mg/kg).
- Three replicates had copper concentrations that were between the *ISQG* (35.7 mg/kg) and the *PEL* (197 mg/kg). The highest copper concentration was 39.6 mg/kg.
- Lead concentrations in all replicates were below the *ISQG* (35 mg/kg), with concentrations ranging from 4.9 mg/kg to 9.8 mg/kg).
- All mercury concentrations were below the *ISQG* and PEL; two concentrations were below the analytical detection limit
- Four of six replicates had concentrations of zinc that exceeded the *ISQG* (123 mg/kg). None exceeded the *PEL* (315 mg/kg).

4.3.5.4.9 Ghost Lake

Three replicates from three sample locations in both spring and fall 2011 from Ghost Lake were submitted for laboratory analysis (18 samples in total).

- Ghost Lake sediments had high moisture content (97% ± 0.9%) and were composed primarily of silt and clay, similar to Threehouse Lake, a similar sized waterbody located along the former rail bed. The sediments from Ghost Lake had similar total and organic carbon compared to other waterbodies located along the former rail bed (*e.g.,* Gaspard Lake and Nutt Lake).

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- All sediments collected from Ghost Lake in 2011 had arsenic concentrations that exceeded the *ISQG* (5.9 mg/kg) and *PEL* (17 mg/kg). Arsenic concentrations ranged from 18.3 mg/kg to 63 mg/kg.
- Two-thirds of samples collected from Ghost Lake in 2011 had cadmium concentrations that were between the *ISQG* (0.6 mg/kg) and the *PEL* (3.5 mg/kg).
- None of the chromium concentrations exceeded the *ISQG* (37.3 mg/kg). The highest Chromium concentration in Ghost Lake sediments was 12.2 mg/kg and the lowest was 8.1 mg/kg.

- For copper, 44% of concentrations exceeded the *ISQG* (35.7 mg/kg), and one concentration exceeded the *PEL* (197 mg/kg).
- Six samples had concentrations of lead that exceeded the *ISQG* (35 mg/kg) and none exceeded the *PEL*.
- Mercury concentrations in sediments from Ghost Lake ranged from below detection limit (0.05 mg/kg) to 0.3 mg/kg, and 7 of 18 mercury concentrations exceeding the *ISQG* of 0.17 mg/kg.
- For zinc, 11 of 18 concentrations were above the *ISQG* (123 mg/kg) and 8 exceed the PEL (315 mg/kg).

In general, Ghost Lake sediments had higher average concentration of metals (e.g., arsenic, cadmium, and copper), compared to other waterbodies along the former rail bed. AECOM compared concentrations of chemicals of potential concern using one-way ANOVA comparisons between stations in each waterbody. The results indicate no spatial trends in chemical concentrations within Ghost Lake.

4.3.5.4.10 Ghost Creek

Three replicates from one sample location in both spring and fall 2011 from Ghost Lake were submitted for laboratory analysis (6 samples in total).

- Ghost Creek sediments had high moisture content (91% ± 6.5%) and composed primarily of silt and sand. Sediments from Ghost Creek had the highest total and organic carbon and nutrients (*i.e.,* total nitrogen and total phosphorus) compared to other creeks located along the former rail bed.

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- All concentrations of arsenic (which ranged from 24.7 mg/kg to 50.3 mg/kg) were greater than both the *ISQG* (5.9 mg/kg) and the *PEL* (17 mg/kg).
- Only one sample from Ghost Creek had a concentration of cadmium (0.65 mg/kg) and copper (36.5 mg/kg) that exceeded the *ISQG* (0.6 mg/kg and 35.7 mg/kg respectively). This replicate sample was the only incidence of exceedance for cadmium and copper in Ghost Creek.
- All chromium concentrations were below the *ISQG* (37.3 mg/kg) and the PEL (90 mg/kg). The highest chromium concentration measured in Ghost Creek in 2011 was 14 mg/kg.
- The highest concentration of lead in sediment samples collected from Ghost Creek in 2011 was 15.7 mg/kg; none exceeded the *ISQG* or the *PEL*.
- All mercury concentrations were below both the *ISQG* and PEL; concentrations ranged from 0.07 mg/kg to 0.14 mg/kg.
- All six zinc concentrations were greater than the *ISQG* (123 mg/kg) and five of six zinc concentrations were greater than the *PEL* (315 mg/kg).

4.3.5.4.11 Arm Lake

Three replicates from one sample location in both spring and fall 2011 from Arm Lake were submitted for laboratory analysis (6 samples in total).

- Sediment collected from Arm Lake had high moisture and composed primarily of silt and clay. The Arm Lake sediments had higher total and organic carbon than other waterbodies located along the former rail bed (*e.g.,* Gaspard Lake and Unnamed Lake 1).

Metal concentrations exceeding applicable sediment quality guidelines are summarized as follows:

- Samples collected from Arm Lake in 2011 had concentrations of arsenic (average of 11.5 mg/kg) greater than the *ISQG* (5.9 mg/kg) but none exceeded the PEL (17 mg/kg).
- Only one sample collected from Arm Lake in 2011 had a concentration of cadmium (0.7 mg/kg) that exceeded the *ISQG* (0.6 mg/kg).
- All chromium concentrations were below the *ISQG* (37.3 mg/kg) and ranged from 4.3 mg/kg to 8.6 mg/kg.

- Copper concentrations in Arm Lake in 2011 were below the *ISQG* (35.7 mg/kg) and ranged from 17.7 mg/kg to 27.4 mg/kg.
- Lead concentrations, ranging from 2.1 mg/kg to 14.4mg/kg, were all below the *ISQG* of 35 mg/kg.
- All mercury concentrations were below the *ISQG* (0.17 mg/kg) and ranged from 0.06 mg/kg to 0.15 mg/kg.
- Only one sample collected from Arm Lake in 2011 had a zinc concentration (124 mg/kg) that exceeded the *ISQG* (123 mg/kg).

4.3.5.4.12 Tern Creek

Two sediment samples have been collected from Tern Creek; one in each of the sampling events that occurred in 2007 and 2010.

- Sediment was characterized as sandy loam and had slightly lower moisture content (74%) compared to the other waterbodies assessed in the area.

Exceedances over applicable sediment quality guidelines in the 2007 sediment sample are as follows:

- Total nitrogen (2.07 µg/g) exceeded *OSQG* for total Kjeldahl nitrogen (0.055 µg/g), which was compared for context.
- The phosphorus concentration (810 µg/g) exceeded the *OSQG* (600 µg/g).
- The *OSQG* (10 µg/g) for total organic carbon was exceeded in the Tern Creek sample in 2007, which had a concentration of 25.6 µg/g.
- The arsenic concentration in the sediment sample from Tern Creek in 2007 (22.1 µg/g) was over three times (3X) the *ISQG* (5.9 µg/g).
- The cadmium concentration (0.64 µg/g) was just over the *ISQG* (0.6 µg/g).
- The *OSQG* for nickel (16 µg/g) was exceeded in the 2007 sample (22.2 µg/g).

In the sample collected from Tern Creek in 2010, only one metal concentration exceeded applicable sediment quality guidelines:

- The concentration of selenium (1.1 mg/kg) was slightly higher than the *RPL* (1 mg/kg).

4.3.5.4.13 Tern Lake

Two sediment samples have been collected from Tern Lake; one in each of the sampling events that occurred in 2007 and 2010.

- Sediment was characterized as silty-clay and had high moisture content.

Concentrations of most metals in the 2007 sample were lower compared to upstream waterbodies (Tern Creek) and none of the metal concentration exceeded applicable sediment quality guidelines. Concentrations of nutrients were similar to other waterbodies; concentrations of nitrogen and total organic carbon exceeded sediment quality guidelines as follows:

- Total nitrogen (0.85 µg/g) exceeded *OSQG* for total Kjeldahl nitrogen (0.055 µg/g), which was compared for context.
- The *OSQG* (10 µg/g) for total organic carbon was exceeded in the Tern Lake sample in 2007, which had a concentration of 15.6 µg/g.

In 2010, the Tern Lake sediment had concentrations of arsenic, chromium, copper and zinc that exceeded at least one applicable sediment quality guideline:

- The concentration of arsenic in Tern Lake was 29.7 mg/kg, which exceeded all three sediment quality guidelines applied (*RPL*, *ISQG,* and *PEL*). The concentration of arsenic in Tern Ditch was similar to Tern Lake

(24.8 mg/kg); concentrations in the other sediment samples collected in 2010 ranged from 1.7 mg/kg to 7.7 mg/kg.

- The concentration of cadmium (0.67 mg/kg) in Tern Ditch was also higher than any other waterbody and exceeded the *ISQG* (0.6 mg/kg).
- The concentration of selenium (1.1 mg/kg) in Tern Ditch was also higher than any other waterbody and exceeded the *RPL* (1 mg/kg).
- Concentrations of zinc in Tern Ditch (140 mg/kg) and Tern Lake (190 mg/kg) exceeded the *ISQG* (123 mg/kg) and were higher than other waterbodies (concentrations ranged from 60 mg/kg to 110 mg/kg).

4.3.5.4.14 Tern Ditch Pond

One sediment sample was collected from Tern Ditch Pond in 2010.

- Tern Ditch Pond sediment had high moisture content (87%) and was characterized as silt clay. Nutrient content in 2010 was similar to other waterbodies in the Snow Lake area.

Concentrations of metals in the sediment sample collected from Tern Ditch Pond were generally low and all were within applicable sediment quality guidelines. Tern Ditch Pond sediment chemistry concentrations were among the lowest measured in 2010.

4.3.5.4.15 Tern Ditch

In total, eight sediment samples (one in 2007, one in 2010 and six in 2011) were collected from Tern Ditch to establish baseline chemistry conditions.

- Tern Ditch sediments had high moisture content (83% in 2010 and 88% ± 2.7% in 2011). Nutrient content in 2010 and 2011 was similar and higher respectively, compared to other creeks in the Snow Lake area.

One sediment sample in 2007 from Tern Ditch was submitted for laboratory analysis. Sediment chemistry in Tern Ditch was similar to that observed in Term Creek and most parameters were below applicable sediment quality guidelines with the exception of:

- The concentration of arsenic in Tern Ditch was 24.7 µg/g, which exceeded the sediment quality guidelines applied (*ISQG* and *PEL*).
- Total nitrogen (average of 1.32 µg/g) exceeded *OSQG* for total Kjeldahl nitrogen (0.055 µg/g), which was compared for context.
- The *OSQG* (10 µg/g) for total organic carbon was exceeded in the Tern Ditch sample, which had a concentration of 31.4 µg/g.

In 2010, Tern Ditch sediments had concentrations of arsenic, chromium, copper, and zinc that exceeded at least one applicable sediment quality guideline:

- The concentration of arsenic in Tern Ditch was 24.8 mg/kg, which exceeded all three sediment quality guidelines applied (*RPL*, *ISQG* and *PEL*). The concentration of arsenic in Tern Ditch was similar to Tern Lake (29.7 mg/kg); concentrations in the other sediment samples collected in 2010 ranged from 1.7 mg/kg to 7.7 mg/kg.
- The concentration of chromium (45 mg/kg) in Tern Ditch was also higher than any other waterbody and exceeded the *ISQG* (37.3 mg/kg).
- The *ISQG* of copper (35.7 mg/kg) was exceeded in Tern Ditch (39 mg/kg).
- Concentrations of zinc in Tern Ditch (140 mg/kg) and Tern Lake (190 mg/kg) exceeded the *ISQG* (123 mg/kg) and were higher than other waterbodies (concentrations ranged from 60 mg/kg to 110 mg/kg).

One sample from one location in both spring and fall 2011 from Tern Ditch were submitted for laboratory analysis (two samples in total). The results from 2011 are summarized as follows:

- There were no exceedances of the *ISQG* or *PEL* for arsenic, cadmium, chromium, copper, lead, mercury, and zinc in Tern Ditch in 2011. In general, Tern Ditch metals concentrations were the lowest compared to the other waterbodies sampled in 2011.

4.3.5.4.16 Lalor Lake

In total, nine sediment samples (five in 2007 and four in 2010) were collected from Lalor Lake to establish baseline chemistry conditions.

- Lalor Lake sediments were composed primarily of silt and sand. Sediments from Lalor Lake had similar total organic and inorganic carbon and nutrient content (i.e., total nitrogen and total phosphorus) compared to Maw Lake, which is immediately downstream.

Relative to other lakes assessed in 2007, Lalor Lake sediments contained higher concentrations of arsenic and molybdenum. Exceedances over applicable sediment quality guidelines in 2007 sediment samples are as follows:

- Total nitrogen (average of 2.9 µg/g) exceeded OSQG for total Kjeldahl nitrogen (0.055 µg/g), which was compared for context.
- All but one phosphorus concentration exceeded the OSQG (600 µg/g), with values ranging from 530 µg/g to 720 µg/g.
- The *OSQG* (10 µg/g) for total organic carbon was exceeded in all Lalor Lake samples in 2007, which had concentrations ranging from 29.4 µg/g to 32.1 µg/g.
- All concentrations of nickel in 2007 (ranging from 20.9 µg/g to 28.6 µg/g) exceeded the *OSQG* (16 mg/L).

In the samples collected from Lalor Lake in 2010, some metal concentrations exceeded applicable sediment quality guidelines:

- Copper concentrations (ranging from 42 mg/kg to 46 mg/kg) all exceeded *ISQG* (35.7 mg/kg) but not the *RPL* (63 mg/kg) and *PEL* (197 mg/kg).
- One of the four samples had a lead concentration (35.3 mg/kg) that was nearly an order of magnitude higher than the concentrations of the other three samples (ranging from 3.5 mg/kg to 5.1 mg/kg). The lowest applicable sediment quality guideline was the *ISQG* (35 mg/kg).
- All four concentrations of selenium were higher than the *RPL* (1 mg/kg) and ranged from 1.1 mg/kg to 1.5 mg/kg.

4.3.5.4.17 Maw Lake

In total, six sediment samples (three in 2007 and three in 2010) were collected from Maw Lake to establish baseline chemistry conditions.

- In general, Maw Lake sediments were characterized as silty-clay with high (>82%) moisture content. The concentrations of nutrients were similar to those measured in Lalor Lake (upstream) and Varnson Lake (downstream) in 2007 and 2010.

Exceedances over applicable sediment quality guidelines in 2007 sediment samples are as follows:

- Total nitrogen (ranging from 2.8 µg/g to 3.4 µg/g) exceeded the *OSQG* for total Kjeldahl nitrogen (0.055 µg/g), which was compared for context.
- Two (of three) phosphorus concentrations exceeded the *OSQG* (600 µg/g), with values ranging from 570 µg/g to 830 µg/g.
- The *OSQG* (10 µg/g) for total organic carbon was exceeded in all Maw Lake samples in 2007, which had concentrations ranging from 28.2 µg/g to 32.4 µg/g.
- Arsenic concentrations in two samples from Maw Lake in 2007 exceeded the *ISQG* (5.9 µg/g). Arsenic concentrations in 2007 ranged from 4.55 µg/g to 7.24 µg/g.

- Similarly, two samples had cadmium concentrations that exceeded the *ISQG* (0.6 µg/g). Cadmium concentrations in 2007 ranged from 0.56 µg/g to 0.70 µg/g.
- The *ISQG* for copper (35.7 µg/g) was exceeded in two of three samples collected from Maw Lake in 2007; copper concentrations ranged from 35 µg/g to 38 µg/g.

In 2010, concentrations of arsenic, cadmium, copper, and selenium exceeded at least one applicable sediment quality guideline as follows:

- Arsenic concentrations in two samples from Maw Lake in 2010 exceeded the *ISQG* (5.9 µg/g). Arsenic concentrations in 2007 ranged from 1.7 µg/g to 7.7 µg/g.
- Two samples had cadmium concentrations that exceeded the *ISQG* (0.6 µg/g). Cadmium concentrations in 2007 ranged from 0.24 µg/g to 0.98 µg/g.
- The *ISQG* for copper (35.7 µg/g) was exceeded in all three samples collected from Maw Lake in 2010; copper concentrations ranged from 54 µg/g to 62 µg/g.
- The RPL for selenium (1 µg/g) was exceeded in two samples collected from Maw Lake in 2010; the third concentration was equal to the *RPL* guideline. Selenium concentrations ranged from 1.0 µg/g to 1.9 µg/g.

4.3.5.4.18 Unnamed Creek 1 (2007)

One sample for sediment chemistry characterization was collected in 2007 from Unnamed Creek 1 (2007).

- The sample was characterized as clay with concentrations of nutrients similar to those measured in Maw Lake (upstream) in 2007.

Exceedances over applicable sediment quality guidelines in the sediment sample collected from Unnamed Creek 1 (2007) are as follows:

- Total nitrogen (2.6 µg/g) exceeded the *OSQG* for total Kjeldahl nitrogen (0.055 µg/g), which was compared for context.
- Total phosphorus (710 µg/g) exceeded the *OSQG* (600 µg/g).
- The *OSQG* (1 µg/g) for total organic carbon was exceeded with a concentration of 32 µg/g.
- Cadmium concentration (0.63 µg/g) was greater than the *ISQG* (0.6 µg/g).
- The nickel concentration (16.9 µg/g) was greater than the *OSQG* (16 µg/g).
- The *ISQG* for copper (35.7 µg/g) was exceeded in the sample collected from Unnamed Creek 1 (2007); the copper concentrations was 105 µg/g.

4.3.5.5 Sediment Quality Summary

Surficial sediments were collected from 18 waterbodies in Project Area and analysed for particle size distribution, major elements (*e.g.*, nitrogen, phosphorus, and carbon), and chemicals of potential concern to determine baseline characteristics of the sediments in years 2007, 2010, 2011, and 2012. In total, 182 sediment samples were analyzed.

Concentrations of arsenic, cadmium, chromium, copper, and zinc more frequently exceeded the applicable sediment quality guidelines compared to others (**Table 4-12**). Across all waterbodies and baseline surveys combined, 81% of samples had arsenic concentrations that exceeded at least one applicable sediment quality guideline and approximately half of samples had cadmium, chromium, copper and zinc concentrations that exceeded at least one applicable sediment quality guideline.

Table 4-12. Number of Samples with Metal Concentrations in Exceedance of Applicable Sediment Quality Guidelines (2007-2012)

Waterbody	Sampling Event	n	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Zinc
Anderson Bay (of Wekusko Lake)	2011	60	54	29	54	34	0	0	-	-	46
Anderson Creek	2011 & 2012	15	10	4	15	13	1	0	-	-	15
Unnamed Creek 1 (2011)	2011	6	5	0	6	3	0	0	-	-	6
Unnamed Lake 1 (2011)	2011	6	4	4	0	5	0	1	-	-	0
Nutt Lake	2011	6	3	4	0	0	0	0	-	-	1
Gaspard Lake	2011	6	6	2	0	0	0	1	-	-	1
Threehouse Lake	2011	18	18	14	0	0	0	0	-	-	3
Threehouse Creek	2011	6	6	0	2	3	0	0	-	-	4
Ghost Lake	2011	18	18	12	0	8	6	7	-	-	11
Ghost Creek	2011	6	6	1	0	1	0	0	-	-	6
Arm Lake	2011	6	6	1	0	0	0	0	-	-	1
Tern Creek	2007	1	1	1	0	0	0	0	1	-	1
	2010	1	0	0	0	0	0	0	0	1	0
Tern Lake	2007	1	0	0	0	0	0	0	0	-	0
	2010	1	1	1	0	0	0	0	0	1	1
Tern Ditch Pond	2010	1	0	0	0	0	0	0	0	0	0
Tern Ditch	2007	1	1	0	0	0	0	0	0	-	0
	2010	1	1	0	1	1	0	0	0	-	1
	2011	6	0	0	0	0	0	0	-	-	0
Lalor Lake	2007	5	4	1	1	5	0	0	0	-	0
	2010	4	0	0	0	4	1	0	0	4	0
Maw Lake	2007	3	2	2	0	2	0	0	0	-	0
	2010	3	2	2	0	3	0	0	0	3	0
Unnamed Creek 1 (2007)	2007	1	0	1	0	1	0	0	0	-	0
	Total	**182**	**148**	**79**	**79**	**83**	**8**	**9**	**1**	**9**	**97**

Notes: Locations of waterbodies illustrated on ***Figure 15****. Refer to* ***Table 4-11*** *for list of applicable sediment quality guidelines. Only metals with at least one exceedance are listed here.*
n = Number of samples.
" – " = No applicable sediment quality guideline.

In general, sediment quality was low (*i.e.,* had more *ISQG* or *PEL* exceedances) in Anderson Creek and Ghost Lake, and sediments with elevated metal concentrations were observed in most waterbodies along the former rail bed. Tern Ditch, Tern Lake, Tern Ditch Pond, and Anderson Bay (in Wekusko Lake) typically had higher sediment quality (*i.e.,* fewer *ISQG* or *PEL* exceedances).

Comparisons between sampling sites within the larger waterbodies show that elevated levels are uniformly distributed over a large area, while at other sites (*e.g.*, Anderson Bay) differences are observed between near shore and offshore sites.

4.3.6 Lower Trophic Levels

AECOM completed a study of aquatic invertebrate diversity and community composition in order to evaluate potential downstream impacts from discharge from the TIA. Lower trophic level biota includes phytoplankton, zooplankton and benthic invertebrates. There are no provincial regulatory requirements for evaluating impacts to lower trophic level biota in the receiving environment so standard analysis of community structure was completed.

This section sets out a summary of the results of the AECOM sampling program and overall conclusions about lower trophic level biota based upon both AECOM's sampling program and the EEM studies.

4.3.6.1 Sampling Events

As part of an aquatic assessment studies conducted in 2007, 2010 and 2011, AECOM collected samples for taxonomic identification and enumeration of phytoplankton, zooplankton and benthic invertebrates from 16 waterbodies located in the Project Region (**Table 4-13**).

Table 4-13. Lower Trophic Level Sampling Effort in Project Region (2007 – 2011)

Baseline Study	2007 [1]	2010 [2]	2011-2015 [3]	
Waterbody	Sept 2007	Jul 2010	May 2011	Sept 2011
Anderson Bay (of Wekusko Lake)	-	-	PP, ZP	PP, ZP, BIC
Anderson Creek	-	-	PP, ZP	BIC
Unnamed Creek 1 (2011)	-	-	PP, ZP	BIC
Unnamed Lake 1 (2011)	-	-	PP, ZP	PP, ZP, BIC
Nutt Lake	-	-	PP, ZP	PP, ZP, BIC
Gaspard Lake	-	-	PP, ZP	PP, ZP, BIC
Threehouse Lake	-	-	PP, ZP	PP, ZP, BIC
Threehouse Creek	-	-	PP, ZP	BIC
Ghost Lake	-	-	PP, ZP	PP, ZP, BIC
Ghost Creek	-	-	PP, ZP	BIC
Arm Lake	-	-	PP, ZP	PP, ZP, BIC
Tern Lake	PP, ZP, BIC	PP, ZP	-	-
Tern Ditch Pond	-	PP, ZP	-	-
Tern Ditch	-	-	PP, ZP	BIC
Lalor Lake	PP, ZP, BIC	PP, ZP	-	-
Maw Lake	PP, ZP, BIC	PP, ZP	-	-

Notes: Locations of waterbodies illustrated on ***Figure 15.***
PP = phytoplankton.
ZP = zooplankton.
BIC = benthic invertebrate community.
[1] North/South Consultants Inc. (2008).
[2] AECOM, 2012a.
[3] AECOM, 2016.

4.3.6.2 Sampling Methodology

Phytoplankton, zooplankton, and benthic invertebrate samples were collected as follows and submitted to ALS Laboratory Group for taxonomic identification and enumeration. Analysis of presence/absence and abundance was completed.

Phytoplankton: Phytoplankton samples were retrieved by directly filling sample bottles at approximately 0.3 m below the water surface in conjunction with the water quality sampling. The samples were preserved with Lugol's solution and submitted for analysis of biomass and taxonomic identification.

Zooplankton: In conjunction with water quality sampling, zooplankton samples were collected using a 63 µm mesh conical tow net, towed at a water depth of approximately 0.3 m for either 5.5 m (North/South Consultants, 2008), 7.3 m (AECOM, 2012a) or 6 m (AECOM, 2016). Samples were fixed with a preservative and submitted for analysis of biomass and taxonomic enumeration.

Benthic Invertebrates: Samples for benthic invertebrate identification and enumeration were retrieved using an Ekman or Petit Ponar sediment grab. Three replicate samples were collected at each station (in 2011), separated approximately 25 m from each other. Samples were retrieved to surface and sieved through a 500µm sieve to remove fine materials prior to being preserved and submitted for taxonomic identification and enumeration.

Detailed methodology, results and discussion of sediment sampling can be found in:

- Aquatic Baseline Study in the Lalor Lake Area: Fall 2007 (North/South Consultants Inc, 2008).
- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Environmental Assessment of the Proposed Expansion of the Anderson Tailings Impoundment Area (AECOM, 2016).

4.3.6.3 Results

This section sets out the results of the lower trophic level biota sampling programs.

4.3.6.3.1 Anderson Bay (of Wekusko Lake)

Phytoplankton: Phytoplankton samples for taxonomic identification were collected in Anderson Bay. The analytical laboratory identified nine classes of phytoplankton in samples collected, with Chrysophyceae (yellow-green algae) as the most abundant in both spring and fall in Anderson Bay (1.4×10^6 n/L and 3.4×10^6 n/L respectively). In the fall, Euglenophyceae (flagellates) and Dinophyceae (dinoflagellates) tied for being the least abundant overall (2.0×10^3 n/L). Phytoplankton abundance was highest in the fall as compared to spring, three times more, corresponding to higher primary productivity in fall. Seasonal changes in primary productivity, competition and/or water physiochemistry (*e.g.*, temperature, total suspended solids) can cause shifts in phytoplankton community structure and abundance.

Zooplankton: One zooplankton sample was submitted from each of two sampling stations in spring and fall from Anderson Bay. The percentage of individuals that were either damaged, too young to identify or unidentified to species was 5.1% in the spring and 0.8% in the fall. The analytical laboratory identified 18 species in four classes and a fifth class was identified (Rotifera), but not to species. Monogononta (5.8 n/L in spring and 137.8 n/L in fall) was the most abundant zooplankton class in spring and fall. Of the classes identified, Branchiopoda was the only class that was identified in the fall and not in the spring. Including the unidentified species, the total number of zooplankton species identified in the spring was 8.3 n/L and in the fall was 202.1 n/L.

Benthic Invertebrates: In total, there were 17 orders of benthic invertebrates identified in the samples collected in Anderson Bay. The dominant order identified was Diptera (true flies), specifically the Chironomidae family (non-biting midges). Diptera accounted for 38% of the total density of the benthic invertebrate community (BIC) identified in Anderson Bay. Family richness ranged from 6 to 16 and the highest density recorded was 4,353 n/m^2. Evenness ranged from 0.22 to 0.71. The most diverse community had an Simpson's Diversity Index (SDI) value of 0.83. The station with the lowest diversity had an SDI value of 0.47 (located near the centre of Anderson Bay, on the east side). Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxa were present in low numbers, ranging from 0% to 12%.

4.3.6.3.2 Anderson Creek

Phytoplankton: Phytoplankton samples for taxonomic identification were collected at one station in Anderson Creek. The analytical laboratory identified nine classes of phytoplankton in the sample collected, with Fragilariophyceae (pennate diatoms) as the most abundant (8.1×10^5 n/L) and Chrysophyceae (yellow-green algae) as the second most abundant (5.1×10^5 n/L). Euglenophyceae (flagellates) were found to be the least abundant phytoplankton class (2.0×10^3 n/L).

Zooplankton: One zooplankton sample was submitted from Anderson Creek. The percentage of individuals that were either damaged, too young to identify or unidentified to species was 0.5%. The analytical laboratory identified 17 species in three classes. Monogononta (rotiferans) was the most abundant zooplankton class (70.3 n/L). Not including the unidentified species, the total number of zooplankton species identified was 73.7 n/L.

Benthic Invertebrates: Six orders of benthic invertebrates were identified in the samples collected in Anderson Creek. The dominant order identified was Veneroida (bivalves), specifically the Pisiidae family and including the unidentified species. Veneroida accounted for 23% of the total density in Anderson Creek. Total density was 86 n/m^2. Family richness was fairly low, with values of 2-3. Evenness values were 0.89 and 1.00. The SDI values for the two samples were 0.63 and 0.50 respectively. There were no EPT taxa and no unidentified organisms in the samples collected.

4.3.6.3.3 Unnamed Creek 1 (2011)

Phytoplankton: Unnamed Creek 1 (2011) had the lowest total phytoplankton abundance (0.7 x 10^6 n/L) and species diversity compared to other creeks located along the former rail bed (*e.g.,* Threehouse Creek) in the spring. The phytoplankton community structure in Unnamed Creek 1 was comparable to other creeks examined along the former rail bed (*e.g.,* Ghost Creek). Chrysophyceae dominated the phytoplankton community in Unnamed Creek 1 (2011), comprising 48% of the total phytoplankton abundance. Cyanophyceae was the sub-dominant group, comprising 42% of the total abundance.

Zooplankton: Total zooplankton abundance in Unnamed Creek 1 (2011) was 11,720 n/L in spring, highest of all 13 waterbodies assessed in the Project Region. Two groups, Ciliata and Euglenoidea, dominated the total zooplankton abundance comprising 95% and 5%, respectively of the total abundance. The sample was collected in Unnamed Creek 1 (2011), adjacent to the former rail bed and within a large beaver impoundment area.

Benthic Invertebrates: The benthic invertebrate sample was collected in Unnamed Creek 1 (2011) at a water depth of 0.25 m and sediments were characterized as organic with fine mineral soils and some organic debris. Benthic invertebrate density in Unnamed Creek 1 (2011) was 4,569 n/m^2. Benthic invertebrate density and family richness in Unnamed Creek 1 (2011) were higher than other waterbodies examined along the former rail bed (*e.g.,* Ghost Creek). Cladocera, a group not represented in other creeks examined along the former rail bed, and Chironomidae dominated the benthic invertebrate community in Unnamed Creek 1.

4.3.6.3.4 Unnamed Lake 1 (2011)

Phytoplankton: Unnamed Lake 1 (2011) had higher total phytoplankton abundance in the fall (24 x 10^6 n/L) than in spring (7.7 x 10^6 n/L). Compared to other lakes examined along the former rail bed, Unnamed Lake 1 (2011) had the highest fall total phytoplankton abundance. Unnamed Lake 1 (2011) in the fall had the highest concentration of chlorophyll *a* (7.2 mg/L) compared to other lakes along the former rail bed. Species diversity in Unnamed Lake 1 (2011) was comparable to other waterbodies located along the former rail bed (*e.g.,* Nutt Lake). Chrysophyceae and Cyanophyceae were the dominant and sub-dominant group in Unnamed Lake 1 (2011) with 84% and 97% of the total abundance in these two groups for spring and fall, respectively.

Zooplankton: Total zooplankton abundance in Unnamed Lake 1 (2011) was 158 n/L in spring and 169 n/L in fall. Species diversity in Unnamed Lake 1 (2011) was the highest compared to other lakes examined along the former rail bed. In spring, Monogononta was the dominant group in Unnamed Lake 1 (2011), comprising approximately 90% of the total zooplankton abundance. The sub-dominant group was Monogononta in the spring. In fall, the dominance shifted to Ciliata (54% of the total zooplankton abundance) and the sub-dominant group was Monogononta (41% of the total zooplankton abundance).

Benthic Invertebrates: A benthic invertebrate sample was collected in Unnamed Lake 1 (2011) at a water depth of 1.0 m, and sediments were characterized as organic with roots. Benthic invertebrate density in Unnamed Lake 1 was 3,297 n/m^2. Benthic invertebrate density in Unnamed Lake 1 (2011) was highest compared to other waterbodies examined along the former rail bed. Chironomidae and Hyalellidae were the most abundant benthic invertebrate families in Unnamed Lake 1 (2011).

4.3.6.3.5 Nutt Lake

Phytoplankton: One sample for phytoplankton community analysis was collected from Nutt Lake in both spring and fall. In total, there were 42 genera in 7 classes of phytoplankton in the samples collected from Nutt Lake. Total phytoplankton abundance in Nutt Lake was higher in the fall (15 x 10^6 n/L) than in spring (7.0 x 10^6 n/L). Species diversity and total abundance in Nutt Lake was comparable to other waterbodies located along the former rail bed (*e.g.,* Threehouse Lake). Chrysophyceae dominated the phytoplankton community in Nutt Lake, composing 90% and 63% of the total phytoplankton abundance in the spring and fall, respectively. Cyanophyceae was the sub-dominant group in the spring and fall, comprising 4% and 31% of the total abundance, respectively.

Zooplankton: In total, 24 species in 7 classes of zooplankton were identified in the samples collected from Nutt Lake. Across all waterbodies assessed, Eutardigrada (a class of waterbears) was present only in Nutt Lake. Total zooplankton abundance in Nutt Lake was 117 n/L in spring and 101 n/L in fall. Species diversity in Nutt Lake was slightly higher compared to other waterbodies located along the former rail bed and was lower in the spring than in the fall. Monogononta was the dominant group in both spring and fall in Nutt Lake, comprising 87% and 52% respectively, of the total zooplankton abundance. The sub-dominant groups were Copepoda and Ciliata in the spring and fall, respectively.

Benthic Invertebrates: Eleven genera in six orders of benthic invertebrates were identified in the sample collected in Nutt Lake at water depth of 1.1 m, where sediments were characterized as organic. Benthic invertebrate density in Nutt Lake was 1,897 n/m². Benthic invertebrate density and family richness in Nutt Lake were similar to Arm Lake, another lake located along the former rail bed. Hyalellidae and Calamoida (a copepod family) were the most abundant benthic invertebrate families.

4.3.6.3.6 Gaspard Lake

Phytoplankton: There were 26 genera in 10 classes of phytoplankton identified in the samples collected from Gaspard Lake. Total phytoplankton abundance in Gaspard Lake was higher in the fall (6.6 x 10^6 n/L) than in spring (1.5 x 10^6 n/L). Species diversity in Gaspard Lake was the lowest compared to other waterbodies located along the former rail bed (*e.g.,* Nutt Lake or Threehouse Lake). Yellow-green algae (Chrysophyceae) dominated the phytoplankton community in Gaspard Lake, composing at least 89% of the total phytoplankton abundance. Blue-green algae (Cyanophyceae) was the sub-dominant group in the fall (5% of the total abundance) and pennate diatoms (Fragilariophyceae) sub-dominant in the spring (1% of the total abundance).

Zooplankton: Eighteen genera in six classes of zooplankton were identified in the samples collected from Gaspard Lake. Total zooplankton abundance in Gaspard Lake was 128 n/L in spring and 412 n/L in fall. The total zooplankton abundance in fall was higher in Gaspard Lake compared to other lakes located along the former rail bed. Monogononta was the dominant class in both spring and fall in Gaspard Lake, comprising 93% and 66%, respectively of the total zooplankton abundance. The sub-dominant group was ciliated protists (Ciliata) in the spring and fall, comprising 4% and 34% respectively, of the total zooplankton abundance.

Benthic Invertebrates: One sample benthic invertebrate sample was collected in Gaspard Lake at water depths of 1.2 m, where sediments were organic with fines and aquatic vegetation. Four genera in three orders of benthic invertebrates was identified in the Gaspard Lake sample. Benthic invertebrate density in Gaspard Lake was 129 n/m². Benthic invertebrate density and family richness in Gaspard Lake were comparable to other waterbodies located along the former rail bed (*e.g.,* Ghost Lake). Chironomidae and Caenidae were the most abundant benthic invertebrate families. Caenidae belongs to Ephemeroptera, a known disturbance-intolerant group of organisms. In general, a higher density of Ephemeroptera in a population indicates a healthier population and benthic habitat.

4.3.6.3.7 Threehouse Lake

Phytoplankton: In total, 31 genera in 7 orders were identified in the samples collected from Threehouse Lake in 2011. Total phytoplankton abundance in Threehouse Lake was higher in the fall (18 x 10^6 n/L) than in spring (6.1 x 10^6 n/L). Species diversity and total abundance in Threehouse Lake was comparable to other waterbodies located along the former rail bed (*e.g.,* Nutt Lake). Chrysophyceae dominated the phytoplankton community in Threehouse Lake, comprising at least 91% of the total phytoplankton abundance. Similar to Gaspard Lake, Cyanophyceae was the sub-dominant group in the fall (8% of the total abundance) and Fragilariophyceae sub-dominant in the spring (2% of the total abundance).

Zooplankton: Total zooplankton abundance in Threehouse Lake was 73 n/L in spring and 226 n/L in fall. Species diversity and total abundance (in spring) in Threehouse Lake was comparable to other lakes located along the former rail bed. Monogononta was the dominant group in both spring and fall in Threehouse Lake, comprising approximately 70% of the total zooplankton abundance. The sub-dominant group was *Ciliata* in both the spring and fall.

Benthic Invertebrates: Benthic invertebrate samples were collected in Threehouse Lake at water depths between 1.0 m to 1.4 m, where sediments were characterized as organic. Benthic invertebrate density in Threehouse Lake was on average 409 n/m². Benthic invertebrate density and family richness in Threehouse Lake were similar to Ghost Lake, another lake located along the former rail bed. Chironomidae were the most abundant benthic invertebrate families at all three stations in Threehouse Lake. At one station in Threehouse Lake, Chironomidae was the only benthic invertebrate family in the sample. The sub-dominant groups were different between the remaining two stations in Threehouse Creek and included Glossiphoniidae (leeches) and Cladocera (water flea). Only one of the three stations had individuals representing Ephemeroptera, the disturbance-intolerant group.

4.3.6.3.8 Threehouse Creek

Phytoplankton: Total phytoplankton abundance in Threehouse Creek was 1.1 x 10^6 n/L in the spring. Species diversity and phytoplankton community structure in Threehouse Creek was comparable to other creeks examined along the former rail bed (*e.g.,* Ghost Creek). Chrysophyceae dominated the phytoplankton community in Threehouse Creek, composing 51% of the total phytoplankton abundance. Cyanophyceae was the sub-dominant group, comprising 39% of the total abundance.

Zooplankton: Total zooplankton abundance in Threehouse Creek was 28 n/L in spring. Species diversity in Threehouse Creek was comparable to other creeks examined in the Project Region. Monogononta was the dominant group in Threehouse Creek, comprising approximately 92% of the total zooplankton abundance. The sub-dominant group was Copepoda.

Benthic Invertebrates: The benthic invertebrate sample was collected in Threehouse Creek at a water depth of 0.5 m, and sediments were characterized as organic with fine mineral soils and some woody/organic debris. Benthic invertebrate density in Threehouse Creek was 1,638 n/m². Benthic invertebrate density and family richness in Threehouse Creek were lower than other waterbodies examined along the former rail bed (*e.g.,* Ghost Creek). Chironomidae dominated the benthic invertebrate community in Threehouse Creek. Pisiidae were also represented in the sample collected from Threehouse Creek (86 n/m²).

4.3.6.3.9 Ghost Lake

Phytoplankton: There were 33 genera in 10 classes of phytoplankton identified in the samples collected from Ghost Lake. Total phytoplankton abundance in Ghost Lake was higher in the spring (7.9 x 10^6 n/L) than in fall (7.3 x 10^6 n/L). Compared to other lakes located along the former rail bed, Ghost Lake had the highest spring total phytoplankton abundance. Species diversity in Ghost Lake was comparable to other waterbodies located along the former rail bed (*e.g.,* Nutt Lake or Threehouse Lake). Chrysophyceae (yellow-green algae) dominated the phytoplankton community in Ghost Lake, composing 63% and 95% of the total phytoplankton abundance in the spring and fall, respectively. Cyanophyceae (blue-green algae) was the sub-dominant group in the spring and fall, composing 31% and 2% of the total abundance, respectively.

Zooplankton: Seventeen genera in five classes of zooplankton were identified in the samples collected in Ghost Lake. Total zooplankton abundance in Ghost Lake was 82 n/L in spring and 110 n/L in fall. Species diversity in Ghost Lake was similar to other waterbodies located along the former rail bed and was lower in the spring than in the fall. Monogononta was the dominant group in both spring and fall in Ghost Lake, comprising 65% and 78% respectively, of the total zooplankton abundance.

Benthic Invertebrates: Three benthic invertebrate samples were collected in Ghost Lake in fall at water depths between 1.1 m to 1.5 m, where sediments were organic and aquatic vegetation was present. Seven species in five orders were identified in the samples collected from Ghost Lake. Benthic invertebrate density in Ghost Lake was on average 244 n/m². Benthic invertebrate density and family richness in Ghost Lake were comparable to other waterbodies located along the former rail bed (*e.g.,* Gaspard Lake). The three stations sampled in Ghost Lake had different benthic invertebrate communities. The first sample was dominated by Chironomidae and Caenidae, the second sample was composed of Unionicolidae (mites) and Pisiidae (bivalve mollusc), and the density of the third sample was evenly distributed among Hyalellidae, Chironomidae and Limnesiidae (caddisflies). The difference among stations is likely due to the heterogeneity of habitat, food availability, competition, or non-biotic factors (*e.g.,* sediment quality).

4.3.6.3.10 Ghost Creek

Phytoplankton: Total phytoplankton abundance in Ghost Creek was 6.8×10^6 n/L in the spring, the highest abundance as compared to other creeks examined along the former rail bed (*e.g.*, Threehouse Creek). Species diversity and phytoplankton community structure in Ghost Creek was comparable to other creeks examined along the former rail bed (*e.g.,* Threehouse Creek). Chrysophyceae dominated the phytoplankton community in Ghost Creek, composing 66% of the total phytoplankton abundance. Similar to Threehouse Creek, Cyanophyceae was the sub-dominant group, comprising 22% of the total abundance.

Zooplankton: Total zooplankton abundance in Ghost Creek was 43 n/L in spring, the highest total abundance of all but one of the other creeks examined along the former rail bed. Species diversity in Ghost Creek was comparable to other creeks examined in the Project Region. Monogononta was the dominant group in Ghost Creek, comprising approximately 92% of the total zooplankton abundance. The sub-dominant group was Copepoda.

Benthic Invertebrates: The benthic invertebrate sample was collected in Ghost Creek at a water depth of 0.5 m and sediments were characterized as organic. Benthic invertebrate density in Ghost Creek was 3,060 n/m². Benthic invertebrate density and family richness in Ghost Creek were comparable to other waterbodies examined along the former rail bed. Chironomidae and Cyclopoida dominated the benthic invertebrate community in Ghost Creek.

4.3.6.3.11 Arm Lake

Phytoplankton: In total, there were ten classes of phytoplankton identified in the samples collected from Arm Lake. Phytoplankton abundance in Arm Lake was higher in the fall (7.4×10^6 n/L) than in spring (2.5×10^6 n/L). Species diversity in Arm Lake was higher compared to other waterbodies examined along the former rail bed. Yellow-green algae (Chrysophyceae) dominated the phytoplankton community in Arm Lake, composing at least 92% and 97% of the total phytoplankton abundance in the spring and fall 2011, respectively. Blue-green algae (Cyanophyceae) was the sub-dominant group in the spring and green algae (Chlorophyceae) was the sub-dominant in the fall.

Zooplankton: There were six classes of zooplankton including one unique to Arm Lake (Bdelloidea). Total zooplankton abundance in Arm Lake was 116 n/L in spring and 91 n/L in fall. Species diversity of zooplankton in Arm Lake was similar to other waterbodies located along the former rail bed. Monogononta (rotiferans) was the dominant group in both spring and fall in Arm Lake, comprising approximately 90% of the total zooplankton abundance. The sub-dominant group was Copepoda in the spring and fall, comprising 7% and 9%, respectively, of the total zooplankton abundance.

Benthic Invertebrates: Benthic invertebrate samples were collected in Arm Lake at water depths of 1.0 m, where sediments were organic with fines and aquatic vegetation. There were four orders of benthic invertebrates identified in the sample collected in Arm Lake. Benthic invertebrate density in Arm Lake was 1,724 n/m². Benthic invertebrate density and family richness in Arm Lake were median values compared to other waterbodies located along the former rail bed. Chironomidae (non-biting midges) and Caenidae were the most abundant benthic invertebrate families in Arm Lake in 2011. Caenidae belongs to Ephemeroptera (mayflies), a disturbance-intolerant group of organisms. In general, a higher density of Ephemeroptera in a population indicates a healthy population and benthic habitat. EPT taxa were present in moderate numbers, accounting for 20% of the density.

4.3.6.3.12 Tern Lake

Lower trophic level samples were collected from Tern Lake in 2007 and 2010 (benthic invertebrate samples were not collected in 2010).

Phytoplankton: In 2007, Tern Lake had a relatively high concentration of chlorophyll *a* (11 µg/L) but the lowest biomass (125 mg/m^3). The phytoplankton community in Tern Lake in 2007 differed from the other lakes in the survey: Chrysophyceae dominated in terms of biomass, followed by Cryptophyceae. Tern Lake in 2010 had high species diversity, with Cyanophyceae being the dominant class. The total phytoplankton abundance in Tern Lake in 2010 was 0.03 x 10^6 n/L, the lowest of the lakes examined in 2010. In 2010, Peridineae accounted for 20% of the phytoplankton abundance; whereas this class accounted for less than 2% in each of the other waterbodies examined at the same time.

Zooplankton: In both 2007 and 2010, the zooplankton community in Tern Lake was diverse and the total abundance (2.5 n/L in 2007 and 17.2 n/L in 2010) was highest compared to the other lakes examined at the same times. The most abundant zooplankton was the copepod genus *Diaptomus* (2 n/L) in 2007. In 2010, the zooplankton community in Tern Lake was dominated by a Monogononta (rotiferans) genus *Keratella* (9.4 n/L).

Benthic Invertebrates: Three samples were collected from Tern Lake in 2007, at water depths ranging from 1.1 m to 1.6 m. Sediments were described as organic and soft, with some vegetation present in two samples. Benthic invertebrate density in Tern Lake was on average, 12,681 n/m², the highest density compared to other lakes at the time of the study. Tern Lake was the only lake where crustaceans were not detected. The most abundant invertebrates were Chironomidae. The healthy benthic invertebrate community could be the result of better habitat quality, reduced predation and competition and other non-biotic factors (*e.g.,* sediment quality).

4.3.6.3.13 Tern Ditch Pond

Phytoplankton: Total phytoplankton abundance in Tern Ditch Pond was 0.19 x 10^6 n/L in 2010, higher than other waterbodies examined in the 2010 survey. Nearly 80% of the phytoplankton community in Tern Ditch Pond was composed of species in classes Chlorophyceae and Chrysophyceae, which on average typically composed less than 10% of the community in other waterbodies.

Zooplankton: Total zooplankton abundance in Tern Ditch Pond was 5.4 n/L in 2010, lowest among the other waterbodies examined in the Project Area in 2010. The zooplankton community in Tern Ditch Pond (similar to the phytoplankton community) differed from the other waterbodies in 2010; Branchiopoda accounted for 39% of the abundance in Tern Ditch Pond, whereas this class composes less than 5% of the communities in the other waterbodies.

Benthic Invertebrates: There were no benthic invertebrates samples collected from Tern Ditch Pond.

4.3.6.3.14 Tern Ditch

Phytoplankton: Total phytoplankton abundance in Tern Ditch was 7.7 x 10^6 n/L in the spring, higher than other creeks examined along the former rail bed (e.g., Ghost Creek). In the spring, Tern Ditch had the highest chlorophyll a concentration (67 mg/L) compared to other creeks located along the former rail bed. Species diversity and phytoplankton community structure in Tern Ditch was comparable to other creeks examined along the former rail bed (*e.g.* Threehouse Creek). Chrysophyceae dominated the phytoplankton community in Tern Ditch, composing 95% of the total phytoplankton abundance. Cyanophyceae was the sub-dominant group, comprising 2% of the total abundance.

Zooplankton: Total zooplankton abundance in Tern Ditch was 22 n/L in spring, lowest among the other creeks examined in the Project Area. Species diversity in Tern Ditch was comparable to other creeks examined in the Project Region. The zooplankton community in Tern Ditch had representatives from most of the classes, suggesting a healthy community. Copepoda was the dominant group in Tern Ditch, comprising approximately 73% of the total zooplankton abundance. The sub-dominant group was Monogononta.

Benthic Invertebrates: The benthic invertebrate sample was collected in Tern Ditch at a water depth of 0.5 m, and sediments were characterized as organic. Benthic invertebrate density in Tern Ditch was 21,466 n/m². Benthic invertebrate density and family richness in Tern Ditch were higher compared to all other waterbodies examined in the Project Region. Although Chironomidae and Ceratopogonidae dominated the benthic invertebrate community in Tern Ditch, high abundances of Caenidae and Ostracoda were also observed. The healthy benthic invertebrate community could be the result of better habitat quality, reduced predation and competition and other non-biotic factors (*e.g.,* sediment quality).

4.3.6.3.15 Lalor Lake

Lower trophic level samples were collected from Lalor Lake in 2007 and 2010 (benthic invertebrate samples were not collected in 2010).

Phytoplankton: In 2007, the phytoplankton biomass was 311 mg/m^3 and consisted of 22 taxa. Although the phytoplankton biomass in Lalor Lake was higher than Maw Lake or Tern Lake, productivity of the lake was considered to be low based on chlorophyll *a* concentrations (ranging from <1 mg/L to 1 mg/L) in 2007. The total phytoplankton abundance of Lalor Lake in 2010 was 0.13 x 10^6 n/L, with 70% of the total abundance in class Myxophyceae (Cyanophyceae, blue-green algae).

Zooplankton: The zooplankton community diversity was low (only one genus, *Diaptomus*, was detected); and was lowest compared to other waterbodies examined in 2007. The total zooplankton abundance was 0.31 n/L in 2007 and 13.3 n/L in 2010. The dominant class of zooplankton in Lalor Lake was Copepoda in 2007 and Monogonata in 2010. The diversity of the zooplankton community in 2010 was comparable to Maw Lake (14 species) and higher than 2007 community diversity.

Benthic Invertebrates: Six samples were collected from Lalor Lake in 2007, at water depths ranging from 1.2 m to 1.9 m. Sediments were characterized as organic and soft, with some vegetation present in some of the samples. Benthic invertebrate density in Lalor Lake was 2,565 n/m^2. Larval dipterans were the most abundant invertebrate group; most invertebrate groups were found at the majority of sites in Lalor Lake.

4.3.6.3.16 Maw Lake

Lower trophic level samples were collected from Maw Lake in 2007 and 2010 (benthic invertebrate samples were not collected in 2010).

Phytoplankton: In 2007, the phytoplankton biomass was 174 mg/m^3 and consisted of 22 taxa. The most abundant class of phytoplankton in 2007 was Cyanophyceae. The total phytoplankton abundance in 2010 was 0.07 x 10^6 n/L. The phytoplankton abundance was dominated by Myxophyceae (Cyanophyceae, blue-green algae), accounting for 52% of the total abundance.

Zooplankton: In both 2007 and 2010, Maw Lake had the highest abundance (0.43 n/L in 2007 and 20.9 n/L in 2010). Maw Lake had higher species diversity than Lalor Lake in 2007 and the highest species diversity compared to all other lakes examined in 2010. The dominant class of zooplankton in Maw Lake was Copepoda in 2007 and Monogonata in 2010.

Benthic Invertebrates: Six samples were collected from Maw Lake in 2007, at water depths ranging from 0.8 m to 1.3 m. Sediments were characterized as organic and soft. A pungent odor noted in samples with no vegetation present, while odourless samples contained aquatic vegetation. Benthic invertebrate density in Maw Lake was, on average, 1,377 n/m^2. Class Insecta (mainly chironimids) comprised the majority of the community.

4.3.6.4 Lower Trophic Level Summary

Results of the lower trophic level sampling programs are presented in **Table 4-14.**

Phytoplankton: Phytoplankton abundance ranged widely across surveys and waterbodies. In 2007, density ranged from 125 mg/m^3 (Tern Lake) to 311 mg/m^3 (Lalor Lake). Across the AECOM surveys (conducted in 2010 and 2011), phytoplankton abundance ranged from 0.03 x 10^6 n/L (Tern Lake in summer 2010) to 24 x 10^6 n/L (Unnamed Lake 1 (2011) in fall 2011). In general, Chrysophyceae dominated the phytoplankton communities.

Zooplankton: Zooplankton abundance in ranged from 0.31 n/L (Lalor Lake in 2007) to 11,720 n/L (Unnamed Creek 1 (2011). In general, the zooplankton communities were dominated by Monogononta, followed by Copepoda. Tern Ditch Pond was the only waterbody whose zooplankton community was dominated by Branchiopoda. In general, zooplankton abundance in the fall was lower than in spring. Eutardigrada was found only in Nutt Lake.

Benthic Invertebrates: Across surveys and waterbodies, benthic invertebrate density ranged from 86 n/m^2 (Anderson Creek) to 21,466 n/m^2 (Tern Ditch). Insecta, mainly chironomids dominated the benthic invertebrate communities in nearly all waterbodies. Crustacea dominated the communities in Unnamed Lake 1 (2011) and Nutt Lake.

Table 4-14. Lower Trophic Level Results (2007 – 2011)

Waterbody	Sampling Event	Phytoplankton		Zooplankton		Benthic Invertebrates	
		Total Abundance (x 10^6 n/L)	Dominant Class (%) [1]	Total Abundance (n/L)	Dominant Class (%) [2]	Average Total Density (n/m^2)	Dominant Class (%) [3]
Anderson Bay (of Wekusko Lake)	May 2011	2.0	Chrysophyceae (74%)	8.3	Monogononta (70%)	-	-
	Sept 2011	7.4	Chrysophyceae (46%)	202.1	Monogononta (68%)	2,862	Insecta (43%)
Anderson Creek	May 2011	1.5	Fragilariophyceae (52%)	74.1	Monogononta (95%)	-	-
	Sept 2011	-	-	-	-	86	Insecta (50%)
Unnamed Creek 1 (2011)	May 2011	0.7	Chrysophyceae (48%)	11,720	Ciliata (95%)	-	-
	Sept 2011	-	-	-	-	4,569	Insecta (44%)
Unnamed Lake 1 (2011)	May 2011	7.7	Chrysophyceae (48%)	158	Monogononta (90%)	-	-
	Sept 2011	24	Chrysophyceae (51%)	169	Ciliata (54%)	3,297	Crustacea (72%)
Nutt Lake	May 2011	7.0	Chrysophyceae (90%)	117	Monogononta (87%)	-	-
	Sept 2011	15	Chrysophyceae (63%)	101	Monogononta (52%)	1,897	Crustacea (63%)
Gaspard Lake	May 2011	1.5	Chrysophyceae (89%)	128	Monogononta (93%)	-	-
	Sept 2011	6.6	Chrysophyceae (96%)	412	Monogononta (66%)	129	Insecta (83%)
Threehouse Lake	May 2011	6.1	Chrysophyceae (96%)	73	Monogononta (72%)	-	-
	Sept 2011	18	Chrysophyceae (91%)	226	Monogononta (70%)	409	Insecta (88%)
Threehouse Creek	May 2011	1.1	Chrysophyceae (51%)	28	Copepoda (60%)	-	-
	Sept 2011	-	-	-	-	1,693	Insecta (87%)
Ghost Lake	May 2011	7.9	Chrysophyceae (63%)	82	Monogononta (65%)	-	-
	Sept 2011	7.3	Chrysophyceae (95%)	110	Monogononta (78%)	244	Insecta (65%)

Waterbody	Sampling Event	Phytoplankton		Zooplankton		Benthic Invertebrates	
		Total Abundance (x 10^6 n/L)	Dominant Class (%) [1]	Total Abundance (n/L)	Dominant Class (%) [2]	Average Total Density (n/m^2)	Dominant Class (%) [3]
Ghost Creek	May 2011	6.8	Chrysophyceae (66%)	43	Monogononta (92%)	-	-
	Sept 2011	-	-	-	-	3,060	Insecta (94%)
Arm Lake	May 2011	2.5	Chrysophyceae (92%)	116	Monogononta (93%)	-	-
	Sept 2011	7.4	Chrysophyceae (97%)	92	Monogononta (89%)	1,724	Insecta (93%)
Tern Lake	Sept 2007	125 mg/m^3	Chrysophyceae (42%)	2.5	Copepoda (99%)	12,681	Insecta (78%)
	Jul 2010	0.03	Myxophyceae (66%)	17.2	Monogononta (61%)	-	-
Tern Ditch Pond	Jul 2010	0.19	Chlorophyceae (52%)	5.4	Branchipoda (39%)	-	-
Tern Ditch	May 2011	7.7	Chrysophyceae (95%)	22	Copepoda (73%)	-	-
	Sept 2011	-	-	-	-	21,466	Insecta (81%)
Lalor Lake	Sept 2007	311 mg/m^3	Cyanophyceae[4] (90%)	0.31	Copepoda (100%)	2,565	Insecta (90%)
	Jul 2010	0.13	Myxophyceae (70%)	13.3	Monogononta (46%)	-	-
Maw Lake	Sept 2007	174 mg/m^3	Cyanophyceae (82%)	0.43	Copepoda (97%)	1,377	Insecta (84%)
	Jul 2010	0.07	Myxophyceae (52%)	20.9	Monogononta (75%)	-	-

Notes:

[1] Abundance (n/L) for samples collected in 2011; biovolume (mm^3/L) for samples collected in 2010; biomass (mg/m^3) for samples collected in 2007, were used to determine the dominant phytoplankton class.
[2] Abundance (n/L) for samples collected in 2011, 2010, and 2007 was used to determine the dominant zooplankton class.
[3] Density (n/m^2) for samples collected in 2011, 2010, and 2007 was used to determine the dominant benthic invertebrate order.
[4] Cyanophyceae = Myxophyceae

4.3.7 Fish and Fish Habitat

In assessing the potential impact of the proposed Alteration on the Lalor Mine, AECOM considered the results of baseline assessments carried out in 2007, 2010, 2011 and 2012. This section summarizes the results of the fish and fish habitat investigations conducted as part of these studies.

4.3.7.1 Sampling Events

The fish community was assessed as part of the environmental baseline aquatic assessments conducted in 2007, 2010, 2011, and 2012. Fishing effort was conducted in June 2012 to capture small-bodied fish for metals analysis (refer to **Section 4.3.7.2**). Fishing effort was conducted in 15 waterbodies located in the Project Region (as provided in **Table 4-15**).

Table 4-15. Fishing Sampling Effort in Project Area (2007 – 2011)

Waterbody	Sampling Event	Minnow Trap (hrs)	Standard Gill Net (hr/m^2) [1]	Backpack Electrofishing (sec)	Seine Net (m^2)
Anderson Bay (of Wekusko Lake)	May 2011	173.7	57.6	-	-
	Sept 2011	-	5.9	-	-
	June 2012	204.5	1.8	-	-
Anderson Creek	May 2011	67.1	-	783	-
Unnamed Creek 1 (2011)	May 2011	86.5	-	-	-
Unnamed Lake 1 (2011)	May 2011	113.1	22.4	-	-
Nutt Lake	May 2011	82.8	21.8	-	-
Gaspard Lake	May 2011	113.1	22.8	-	-
Threehouse Lake	May 2011	77.2	39.1		
Threehouse Creek	May 2011	83.6	-	-	-
	June 2012	18.2	-	-	-
Ghost Lake	May 2011	108.9	43.6	-	-
	June 2012	96 [1]	-	-	-
Ghost Creek	May 2011	86.7	-	-	-
Arm Lake	May 2011	107.7	-	-	-
Tern Lake	Sept 2007	193.03	47.75	-	-
Tern Ditch Pond	July 2010	264.03	108	-	609.6
Tern Ditch	May 2011	50.6	-	52	-
Lalor Lake	Sept 2007	97.92	80.92	-	-
Maw Lake	Sept 2007	92.62	23.25	-	-
Unnamed Creek (2007)	Sept 2007	-	30	-	-

Notes: *Locations of waterbodies illustrated on* ***Figure 15****.*
MT = *Minnow traps.*
GN = *Gill net.*
SN = *Seine net.*
HN = *Hoop net.*
[1] *Effort estimated.*

4.3.7.2 Sampling Methodology

Fish communities were assessed using a number of collection methods:

- Seine net.
- Backpack electrofisher.
- Standard Gang gill nets.
- Swedish Gang gill nets.

- Minnow traps.

All captured fish were identified to species, enumerated, measured and weighed. A general health assessment was also conducted for any captured individuals. Condition was calculated for individual fish as described in Environment Canada, 2002.

Habitat indicators, including physical habitat variables (depth, flow, cover, etc.), connectivity to fish bearing waters and water quality (pH, dissolved oxygen) were considered in the evaluation for fish habitat following guidance in DFO (1998). Habitat was assessed concurrently with the fish sampling programs.

The detailed methodology, results and discussion of these fish and fish habitat baseline studies can be found in:

- Aquatic Baseline Study in the Lalor Lake Area: Fall 2007 (North/South Consultants Inc, 2008).
- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Lalor Mine *Environment Act* Proposal Report (AECOM, 2012b).
- Environmental Assessment of the Proposed Expansion of the Anderson Tailings Impoundment Area (AECOM, 2016).

Fish from Anderson TIA, Anderson Creek, Anderson Bay, Ghost Lake, and Threehouse Lake were sub-sampled and submitted for metal residue analysis. None of the concentrations of arsenic or lead in any fish sampled exceeded the *MWSQOG* aquatic life tissue residue guidelines for human consumption. Detailed results of these investigations can be found in the reports mentioned above.

4.3.7.3 Results

Fish species known to be present in the Nelson River watershed, where the Project Area is located, are listed in **Table 4-16**.

Table 4-16. List of Expected Fish Species in the Project Region

Family Name	Common Name	Species Name	Distribution
Petromyzontidae	Silver Lamprey	*Ichthyomyzon unicuspis*	N
Acipenseridae	Lake Sturgeon	*Acipenser fulvescens*	N
Hiodontidae	Mooneye	*Hiodon tergisus*	N
Cyprinidae	Lake Chub	*Couesius plumbeus*	N
	Carp	*Cyprinus carpio*	I
	Pearl Dace***	*Margariscus margarita*	N
	Emerald Shiner***	*Notrophis atherinoides*	N
	River Shiner***	*Notropis blennius*	0
	Blacknose Shiner***	*Notropis heterolepis*	N
	Spottail Shiner***	*Notropis hudsonius*	N
	Fathead Minnow***	*Pimephales promelas*	N
	Longnose Dace	*Rhinichthys cataractae*	N
Catostomidae	Longnose Sucker***	*Catostomus catostomus*	N
	White Sucker***	*Catostomus commersoni*	N
	Shorthead Redhorse	*Moxostoma erythurum*	N
Ictaluridae	Channel Catfish	*Ictalurus punctatus*	R
Esocidae	Northern Pike***	*Esox lucius*	N
Umbridae	Central Mudminnow***	*Umbra limi*	0
Osmeridae	Rainbow Smelt	*Osmerus mordax*	I

Family Name	Common Name	Species Name	Distribution
Salmonidae	Cisco***	*Coregonus artedi*	N
	Lake Whitefish***	*Coregonus clupeaformis*	N
	Rainbow Trout	*Oncorhynchus mykiss*	I
	Brook Trout	*Salvelinus fontinalis*	N
	Lake Trout	*Salvelinus namaycush*	N
Percopsidae	Trout-perch***	*Percopsis omiscomaycus*	N
Gadidae	Burbot	*Lota lota*	N
Gasterosteidae	Brook Stickleback***	*Culaea inconstans*	N
	Ninespine Stickleback	*Pungitius pungitius*	N
Cottidae	Slimy Sculpin	*Cottus cognatus*	N
Percidae	Iowa Darter***	*Etheostoma exile*	0
	Johnny Darter***	*Etheostoma nigrum*	N
	Yellow Perch***	*Perca flavescens*	N
	River Darter	*Percina shumardi*	N
	Sauger	*Sander canadensis*	N
	Walleye***	*Sander vitreus*	N
Sciaenidae	Freshwater Drum	*Aplodinotus grunniens*	N

Source: *Stewart and Watkinson, 2004.*
Note: *Estuarine species are excluded from this list.*
N = *Native.*
I = *Introduced*
0 = *Not previously captured in this watershed.*
**** =* *captured during aquatic assessments.*

4.3.7.3.1 Anderson Bay (of Wekusko Lake)

In spring 2011, two standard gang gill nets, one small gang gill net and seven minnow traps were deployed in Anderson Bay. In fall 2011, one standard gang gill net and one small gang net were utilized and in summer 2012, two small gang gill nets and four minnow traps were deployed in Anderson Bay during the baseline study. A total of 941 individuals, which represented 15 species, were captured in Anderson Bay. In 2011, the most commonly caught species in Anderson bay was Brook Stickleback, followed by Yellow Perch and Fathead Minnows. The most common species caught in 2012 was Brook Stickleback, followed by Emerald Shiner and Yellow Perch.

A diversity of fish habitat types were observed in Anderson Bay. Riparian vegetation included coniferous forest, mixed forest, grasses, shrubs and wetland. Cover included boulders, overhanging vegetation, emergent and submergent vegetation and limited amount of woody debris. A complex bottom topography, including the presence of islands and small shoals, provide ample habitat for a variety of species. In addition, as part of Wekusko Lake, fish inhabiting Anderson Bay have access to the rest of the lake and vice versa.

4.3.7.3.2 Anderson Creek

Three minnow traps, three electrofishing transects and one dip net was used in Anderson Creek during the baseline study. In total, 215 individuals, representing four fish species, were captured. The fish species captured were Brook Stickleback, Fathead Minnow, Iowa Darter, and Pearl Dace. Brook Stickleback represented 60% of the fish caught and Pearl Dace represented 38% of the fish caught.

Pearl Dace, in spawning condition, and large schools of young-of-year Brook Stickleback were observed in Anderson Creek. Although most fish captured were in good health, there was a general occurrence of a black spot parasite, infesting Brook Stickleback. Black spot parasite is common in earthen bottom waterbodies. As this parasite requires piscivorous birds, snails and fish to complete its life cycle, its presence indicates a healthy ecosystem. In general, the presence of this parasite in a fish does not affect its growth or survival.

4.3.7.3.3 Unnamed Creek 1 (2011)

No fish were captured in Unnamed Creek 1 (2011).

Unnamed Creek 1 (2011) provides very limited habitat for small bodied fish and none for large bodied fish. Fishing effort in Unnamed Creek 1 (2011) was performed in a series of beaver ponds and small pools. Coniferous and mixed forest comprised the majority of riparian vegetation in Unnamed Creek 1 (2011). Cover was provided by overhanging vegetation, and woody debris. Organics were the dominant substrate. There was no visible connectivity between Unnamed Creek 1 (2011) and other larger waterbodies in the area.

4.3.7.3.4 Unnamed Lake 1 (2011)

No fish were captured in Unnamed Lake 1 (2011).

Unnamed Lake 1 is a depressional low, with organic substrate and homogenous bottom topography. At most, this waterbody may provide habitat for small bodied fish. However, there is no visible connectivity to other waterbodies. Coniferous forest dominated the riparian vegetation. Cover was provided by undercut banks and overhanging vegetation.

4.3.7.3.5 Nutt Lake

No fish were captured in Nutt Lake.

Riparian vegetation was largely mixed forest or wetland. Cover types included undercut banks, boulder, and overhanging vegetation. The substrate was dominated by organics. Fish habitat may be, at most, available for small bodied fish but there is nearly no connectivity to other waterbodies.

4.3.7.3.6 Gaspard Lake

A total of 121 Brook Stickleback were captured in Gaspard Lake, with 45 individuals captured in a small gang index gill net and the remaining in baited minnow traps. Brook Stickleback from Gaspard Lake had the highest mean length and weight (65 mm and 2.1 g, respectively) compared to other waterbodies examined in 2011.

Riparian structures included bedrock, wetland, and coniferous and mixed forests. Cover included overhanging vegetation and undercut banks. Substrate was dominated by organics or bedrock. Given the limited habitat suitability and lack of connectivity to larger waterbodies, Gaspard Lake does not provide habitat for large-bodied fish.

4.3.7.3.7 Threehouse Lake

A total of 28 Brook Stickleback were captured in Threehouse Lake, with a small gang index gill net and baited minnow traps. Brook Stickleback from Threehouse Lake were often in good health and comparable in terms of size to Brook Stickleback captured from other waterbodies along the former rail bed.

Similar to other waterbodies located along the former rail bed, Threehouse Lake provides ample habitat for small-bodied fish, but none for large-bodied fish. Grasses, wetland and mixed forests comprised the majority of riparian vegetation in Threehouse Lake. Cover was provided by undercut banks, overhanging vegetation, submergent vegetation and woody debris. Organics were the dominant substrate.

4.3.7.3.8 Threehouse Creek

A total of 105 Brook Stickleback were captured in Threehouse Creek, with baited minnow traps in 2011 and 2012. Brook Stickleback from Threehouse Creek were often in good health and comparable in terms of size to Brook Stickleback captured from other waterbodies assessed in the Snow Lake area.

Threehouse Creek provides habitat for small bodied fish and none for large bodied fish. Grasses and shrubs comprised the majority of riparian vegetation in Threehouse Creek. Cover was provided by undercut banks and overhanging vegetation. Organics were the dominant substrate.

4.3.7.3.9 Ghost Lake

A total of 317 Brook Stickleback were captured in Ghost Lake in 2011 and 2012. Brook Stickleback from Ghost Lake were often heavily parasitized by black spot.

Similar to other waterbodies located along the former rail bed, Ghost Lake provides ample habitat for small bodied fish but none for large bodied fish. Grasses, shrubs and coniferous forests comprised the majority of riparian vegetation in Ghost Lake. Cover was provided by boulders and woody debris. Boulder, bedrock and organics were the dominant substrate.

4.3.7.3.10 Ghost Creek

A total of 544 Brook Stickleback were captured in Ghost Creek, with baited minnow traps. Brook Stickleback from Ghost Creek were often in good health and comparable in terms of size to Brook Stickleback captured from other waterbodies located along the former rail bed.

Similar to other waterbodies along the former rail bed, Ghost Creek provides ample habitat for small bodied fish but none for large bodied fish. Grasses and shrubs comprised the majority of riparian vegetation in Ghost Creek. Cover was provided by boulders and overhanging vegetation. Organics were the dominant substrate.

4.3.7.3.11 Arm Lake

Only 14 Brook Stickleback were captured in Arm Lake. In comparison with other Brook Stickleback captured in other waterbodies in the Snow Lake area, those captured in Arm Lake were heavier on average. This could be related to greater habitat or food quality, sexual maturity or reduced competitive pressure in Arm Lake.

Arm Lake is a shallow lake with limited connectivity to larger waterbodies. The majority of cover was provided by emergent vegetation, with wetland and flooded shorelines. Organic substrate also dominated the lake. Fish habitat is provided for small bodied fish, but not for large bodied fish.

4.3.7.3.12 Tern Lake

A single gill net and four minnow traps were set in Tern Lake in September 2007. No large-bodied fish and only 20 Brook Stickleback were captured.

Tern Lake is a small, shallow, circular lake surrounded by mainly softwood trees. A narrow band of bog habitat, consistent predominately of grass surrounds the lake. Bedrock outcrops interrupt the bog habitat at two locations on the southern shore of Tern Lake. The dominant substrate around the margins of the lake consists of vegetation and silt. Sporadic occurrences of coarse sand and gravel can be found in the lake. The sediments in the middle of the lake are composed primarily of soft flocculents.

4.3.7.3.13 Tern Ditch Pond

Six minnow traps and two gill nets were set in Tern Ditch Pond; seining was also attempted. In total, 26 Brook Stickleback were captured, primarily in the seine nets, followed by the minnow traps. Brook Stickleback from Tern Ditch Pond had high condition (0.97 g/mm^3).

Tern Ditch Pond was a shallow ponded area south of the Lalor Access Road. The shoreline was dominated by a marshy/bog habitat, interrupted periodically (on the south shore and near the outlet to Tern Ditch) by bedrock outcrops. Small patches of submerged and emergent vegetation provided cover for small-bodied fish. The substrate was dominated by silty/clay with organics. Smaller areas of boulder substrate were distributed sporadically in the northeastern portion of Tern Ditch Pond.

4.3.7.3.14 Tern Ditch

A total of 47 Brook Stickleback were captured in Tern Ditch, with a backpack electrofisher and baited minnow traps. Brook Stickleback from Tern Ditch were often in good health and comparable in terms of size to Brook Stickleback captured from other waterbodies assessed in the Snow Lake area.

Tern Ditch provides limited habitat for small bodied fish and none for large bodied fish. Grasses and shrubs comprised the majority of riparian vegetation in Tern Ditch. Cover was provided by undercut banks, overhanging vegetation, emergent and submergent vegetation and limited amounts of woody debris. Organics were the dominant substrate.

4.3.7.3.15 Lalor Lake

Three gill nets and eight minnow traps were set in Lalor Lake; only forage fish were captured. In total, 35 Brook Stickleback, 17 Fathead Minnow and 1 Central Mudminnow were captured. In the northern portions of their ranges, these species are often associated with each other and bog habitats.

Lalor Lake is shallow, with a relatively small surface area and a small island near the centre, towards the western shore. The shoreline vegetation is mainly composed of black spruce with overhanging willows and shrubs. Bedrock shorelines are also present. A bog habitat is located on the north shore, near the outlet (which drains north to Maw Lake). The shoreline substrates are varied, ranging from soft fines to cobble to vegetation (including dead leaves and woody debris). Shallow areas were predominately aquatic vegetation with small patches of coarse sand and gravel.

4.3.7.3.16 Maw Lake

One gill net and five minnow traps were set in Maw Lake in 2007; seine netting was also employed. No large-bodied fish were captured; 8 Brook Stickleback, 53 Fathead Minnow and 1 Central Mudminnow were captured. Fathead Minnow were more abundant in the gill nets; Brook Stickleback were more abundant in the seine net; only a single Central Mudminnow was captured in a minnow trap.

Maw Lake is a shallow circular lake. Shoreline vegetation was similar to Lalor Lake and was composed primarily of shrub willow. There were three bog areas along the shore and a single high bedrock outcrop was present on the northeast shore. Nearshore substrates were fine and organic; the bottom of the lake was mainly soft organics with some dense clusters of submerged aquatic vegetation.

4.3.7.3.17 Unnamed Creek 1 (2007)

One seine net haul in Unnamed Creek (2007) captured one Central Mudminnow and one Fathead Minnow.

The creek was a low velocity stream that drains into Varnson Lake from Maw Lake. The shores of the creek were unstable due to the hummocky terrain and the channel flows through a wide bog area that is predominately composed of sedges. The creek was approximately 2 m wide and 1.5 m with an estimated velocity of 0.5 m/s.

4.3.7.3.18 Snow Lake

Fish collections were not conducted in Snow Lake during the environmental baseline aquatic assessments in 2011. The fish community of Snow Lake is composed of Northern Pike, Walleye, White Sucker, Cisco, Lake Whitefish, Yellow Perch, Spottail Shiner, and Ninespine Stickleback (Beck, 1984; Stewart-Hay, 1963). There was a commercial gill net fishery in Snow Lake from 1989-90 targeting Lake Whitefish, but operation was suspended due to the high by-catch (~41% of round weight) of Walleye and Northern Pike. There is anecdotal evidence of a failed commercial trap net fishery on Snow Lake in 1998. Personal communications with Grant McVittie, Regional Fisheries Manager, indicated that recreational fishers do not target Snow Lake due to the proximity of better fishing locations (*i.e.,* Wekusko Lake and Trampling Lake); however, good Northern Pike and Walleye fishing are available in Snow Lake. The fish community in the northwest or southeast arms is likely not different, with the possible exception of fewer Walleye in the northwest arm due to the shallower water.

4.3.7.4 Fish and Fish Habitat Summary

Minnow traps, gill nets, backpack electrofisher, and seine nets were used to collect fish in the selected waterbodies. In total, 18 fish species were captured in the aquatic surveys conducted in 2007, 2010, 2011, and 2012. No fish were captured in Nutt Lake, Unnamed Lake 1 (2011), and Unnamed Creek 1 (2011). In general, the larger waterbodies (*i.e.* Anderson Bay of Wekusko Lake) had the highest species diversity. For most other waterbodies, Brook Stickleback were the most abundant (sometimes only) species captured, typical of headwater waterbodies. In spring, several species were captured in spawning condition (*i.e.* Yellow Perch, White Sucker, Brook Stickleback, and Pearl Dace). Large school of Young-of-Year Brook Stickleback and spawning Pearl Dace were captured and observed in Anderson Creek, adjacent to PR 392. In general, fish were in good health and condition. External parasites (white cysts or black spot) and fin erosion were present in fish from most waterbodies.

Brook Stickleback was selected to compare fish health across waterbodies as it was the most commonly captured fish species (**Table 4-17**). On average, Brook Stickleback captured in Gaspard Lake were the longest (65.7 mm) and Brook Stickleback captured in Lalor Lake were the heaviest (2.4 g). Average condition factors ranged from 0.64 g/mm^3 (Anderson Bay) to 1.19 g/mm3 (Lalor Lake). The lower condition factor of Brook Stickleback in Anderson Bay may be due to higher predation of larger fish in the Lake causing higher stress in the fish, resulting in fish that are less plump. The predation levels in Lalor Lake would likely not exist to the same extent as in Anderson Bay, allowing the Brook Stickleback in Lalor Lake to have higher condition factor. Size differences could be the result of a number of factors, including: habitat availability, nutrient enrichment, general fish health, inter- and intra-specific competition (related to habitat availability and fish community composition), food type and availability, and season (including spawning condition).

The majority of cover in these waterbodies included vegetation (overhanging, submergent, and emergent) and cobble. All lakes provided diverse cover types and varying degrees of shoreline complexity. As several fish species were captured in spawning condition, the majority of waterbodies provided spawning and rearing habitat. Foraging habitat for large-bodied fish is predominately available in Wekusko Lake (*i.e.*, Anderson Bay). Although the creeks and lakes along the route of the Pipeline System provided a diversity of habitats, their shallow depth and limited connectivity to other waterbodies suggests that they cannot support populations of large-bodied fish.

Table 4-17. Summary Statistics for Brook Stickleback in the Project Area

Waterbody	Length (mm)					Weight (g)					Condition (g/mm³)				
	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD	n	Min	Max	Mean	SD
Anderson Bay (of Weskusko Lake)	111	39	65	52.4	4.7	109	0.1	1.9	0.92	0.29	109	0.07	1.35	0.64	0.19
Anderson Creek	143	20	65	40.9	13.8	84	0.1	1.8	0.95	0.36	84	0.06	1.31	0.67	0.15
Gaspard Lake	100	44	86	65.7	10.0	100	0.5	4.9	2.06	0.88	100	0.36	1.03	0.69	0.11
Threehouse Creek	60	45	76	56.0	6.9	60	0.1	3.0	1.30	0.60	60	0.08	1.75	0.71	0.19
Threehouse Lake	28	49	72	59.3	6.0	28	0.7	2.4	1.54	0.50	28	0.40	1.20	0.73	0.18
Ghost Lake	100	50	79	63.5	5.7	100	0.6	4.2	1.94	0.68	100	0.38	1.20	0.74	0.15
Ghost Creek	100	44	76	57.9	7.1	100	0.6	3.6	1.60	0.57	100	0.54	2.11	0.81	0.19
Arm Lake	14	46	69	55.6	7.2	14	1.2	3.7	1.91	0.81	14	0.73	1.36	1.07	0.18
Tern Lake	20	36	69	57.4	7.4	45	0.4	2.9	1.55	0.58	20	-	-	0.78	-
Tern Ditch Pond	26	34	67	48.0	9.1	26	0.5	2.5	1.20	0.59	26	0.58	1.64	0.97	0.22
Tern Ditch	47	46	71	62.0	5.1	46	0.8	2.5	1.76	0.44	46	0.57	1.02	0.73	0.09
Lalor Lake	47	21	72	52.3	11.0	47	0.2	3.0	2.40	1.47	47	-	-	1.19	-
Maw Lake	45	22	73	39.8	13.5	45	0.1	3.7	0.76	0.97	45	-	-	0.95	-

Notes: Summary statistics calculated only when count is greater than five (5); gear and years are combined above.
mm = millimetre
g = gram
n = count
Min = minimum
Max = maximum
SD = standard deviation.

4.3.8 Aquatic Habitat Assessments

4.3.8.1 Scope of Assessment

In 2011 and 2012, aquatic habitat assessments were conducted in the Project Area, which included locations at the Paste Facility and the Pipeline System Components (including the operational site of the Anderson TIA, the former rail bed, Chisel Access Road, the Lalor Access Road and the Lalor site). Sites for habitat assessment were selected based on presence of culverts, large areas of standing water, or identified drainage features on NTS maps.

Figure 15 identifies the locations of these aquatic habitat assessments.

4.3.8.2 Methodology

Habitat indicators, including physical habitat variables (depth, flow, cover, etc.), connectivity to fish bearing waters and water quality (pH, dissolved oxygen) were considered in the evaluation for fish habitat following guidance in DFO (1998). Watercourses provided **Critical**, **Important**, **Marginal** or **No Fish Habitat.**

The detailed methodology, results and discussion of these fish and fish habitat baseline studies can be found in:

- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Lalor Mine *Environment Act* Proposal Report (AECOM, 2012b).
- Environmental Assessment of the Proposed Expansion of the Anderson Tailings Impoundment Area (AECOM, 2016).

4.3.8.3 Results

4.3.8.3.1 Paste Facility

A random meander examination of the Lalor site was completed in search of aquatic habitat in June 2012. The area is generally low lying and wet, typical of the surrounding area. There does not appear to be any connectivity to surrounding water bodies and given the shallow depths which would freeze to bottom in winter and inadequate substrate and cover it is unlikely that any of these wet areas provide fish habitat or support fish. The Lalor site is categorized as **No Fish Habitat**.

4.3.8.3.2 Pipeline System Component: Anderson Booster Pump Station

The Anderson Booster Pump Station will be located near the existing tailings discharge point at the Anderson TIA, on the operational site of the Anderson TIA. The area on which the Anderson Booster Pump Station will be located is an area already occupied by HBMS infrastructure associated with the operation of the Anderson TIA and lies behind gates that restrict access to HBMS and HBMS authorized persons. There is **No Fish Habitat** at this location.

4.3.8.3.3 Pipeline System Component: Makeup Water Pumphouse

The Makeup Water Pumphouse will be located on the shoreline of the Anderson TIA, on the operational site of the Anderson TIA. The area on which the Makeup Water Pumphouse will be located is an area already occupied by HBMS infrastructure associated with the operation of the Anderson TIA and lies behind gates that restrict access to HBMS and HBMS authorized persons. There is **No Fish Habitat** at this location.

4.3.8.3.4 Pipeline System Component: Anderson Site Ancillary Pipelines

The ancillary pipelines provide process water for the Anderson Booster Pump Station from the Anderson Water Tank and the Makeup Water Pumphouse. All the ancillary pipelines are located in areas already occupied by HBMS infrastructure associated with the operation of the Anderson TIA and, which lie behind gates that restrict access to HBMS and HBMS authorized persons. There is **No Fish Habitat** at the locations of the ancillary pipelines.

4.3.8.3.5 Pipeline System Component: Portion 1, Origin of Tailings Pipe

The tailings pipeline from Stall Concentrator currently runs parallel to an access road before redirecting into Anderson TIA. *AD02* and *AD03* are watercourse crossings sites along the same unnamed waterway.

AD03 is at a culvert along one of the internal access roads used in the operation of the Anderson TIA. *AD03* is a large drainage channel to the north of the tailings pipe. The culvert is blocked causing a small ponded area on the north side. On the south side of the road, water trickles towards Anderson TIA through an ill-defined channel overgrown with deciduous trees. AECOM field teams followed the waterway 150 m north at which point they encountered a second culvert and road. This section of road appears to be the extension of the former rail bed. Water in the channel between the culverts is shallow with low flow. The culverts were perched 0.6 m and 0.4 m and there are several small waterfalls which would prevent fish passage upstream. Substrate is sand and silt with no defined channel. Water is shallow (0.02 m) with no instream vegetation and no fish cover. The waterway at *AD03* provides **No Fish Habitat** as there is no suitable fish cover and water would freeze to bottom in winter.

AD02 is a habitat location upstream from *AD03*; there are no culverts at this location. The unnamed creek cuts through silt/sand substrate in the covered forest. It appeared to be an engineered channel with uniform depth and width. Water is shallow and there is limited cover and suitable substrate in the area assessed; this location provides **No Fish Habitat** as a result.

4.3.8.3.6 Pipeline System Component: Portion 2, Anderson Tailings Pipe

Portion 2 contains Pipe 3 and runs from the Anderson BPS to the Anderson TIA. This area is already occupied by HBMS infrastructure associated with the operation of the Anderson TIA and lies behind gates that restrict access to HBMS and HBMS authorized persons. There is **No Fish Habitat** at the site of the Anderson Tailings Pipe.

4.3.8.3.7 Pipeline System Component: Portion 3, Between Operational Site of the Anderson TIA and Chisel Access Road

Portion 3 will run from the Anderson BPS to the Chisel Access Road. Portion 3 lies almost entirely within the ROW for a former rail bed. Portion 3 will be occupied by the tailings pipe and the return water pipe. This ROW is owned by HBMS pursuant to Certificate of Title No. 1701932 (Plan No. 784). Currently, HBMS maintains the rail bed as an access road. It is accessible to car and truck traffic for most of its length and to off-road vehicles for its full length. **Figure 02** contains a photo which displays the current condition of the rail bed. Access to the rail bed is and will continue to be restricted to HBMS and HBMS authorized persons.

17 culverts were identified along the former rail bed. The land surrounding the former rail bed is typical of mature boreal forest found throughout the area. Wetlands are interspersed between bedrock outcroppings and old growth spruce stands. Prior to the development of the former rail bed, the low-lying areas would have been somewhat uniformly saturated, collecting water from the surrounding higher areas. Installation of culverts and excavation of ditches provided an area for water to collect and small shallow pools have developed.

Two culvert locations (*RB02*, *RB03*) were identified as potentially fish bearing and able to provide marginal fish habitat due to their connectivity to larger waterbodies and sufficient depth to prevent freezing to the bottom (**Figure 15**).

RB02 crosses Ghost Creek, which is an off–take ditch constructed during early railway construction (in late 1950's). Ghost Creek originates upstream from Ghost Lake and flows approximately 700 m north to join with Threehouse Creek to form Tern Creek. Tern Creek drains northward into Tern Lake and ultimately, to Snow Lake. There are two 1.63 m diameter culverts at RB02. The channel is uniform upstream and downstream at 7 m wide and ~1 m deep. The banks are vertical and provide little riparian habitat. Upland vegetation is a mix of wetland, grasses, deciduous forest and coniferous trees. The substrate is highly organic, but moderate amounts of cover are provided by small woody debris, overhanging vegetation and instream vegetation. Fishing effort during the spring 2011 baseline survey captured Brook Stickleback. *RB02* provides **Marginal Habitat** as the limited cover and water depth may provide habitat for small-bodied species, but it is unlikely that large-bodied species utilize this waterway.

RB03 crosses Threehouse Creek, which also is an off-take ditch, constructed during early railway construction (in late 1950's). Threehouse Creek originates upstream from Threehouse Lake and approximately 300 m north of the former rail bed, runs along Arm Lake. Approximately 400 m past Arm Lake, Threehouse Creek joins with Ghost Creek to form Tern Creek which drains into Tern Lake and ultimately, into Snow Lake. There are two 1.95 m culverts at *RB03*. Threehouse Creek is straight, 5 m wide and 2 m deep with vertical banks. Upstream of the rail bed, Threehouse Creek flows through a fen, where the banks are floating vegetation mats. A beaver dam upstream from the former rail bed blocks Threehouse Creek. Two beaver runs, which cross this beaver dam, are lower and could potentially be submerged during high water events to allow water flow. At the time of assessment, water appeared at equilibrium across the culverts. The substrate is highly organic, but moderate amounts of cover are provided by small woody debris, overhanging vegetation and in-stream vegetation. Fishing effort at this location during the spring 2011 baseline survey captured Brook Stickleback. *RB03* provides **Marginal Habitat** as the limited availability of cover and water depth may provide habitat for small-bodied species but it is unlikely that large-bodied species utilize this waterway.

The remaining 15 culverts examined along the existing rail bed were characterized as drainage features, essentially shallow, stagnant ponds, or beaver impoundments, which formed after the installation of culverts and excavation of ditches. Because of the limited availability of cover, lack of connectivity and low water depths (sometimes even dry channels such as at *RB01* and *RB11*), these are classified as **No Fish Habitat**.

Portion 3 will be linked to Portion 4 by crossing a distance of about 150 m. A Manitoba Hydro transmission line runs beside the Chisel Access Road, within a cleared ROW. The link between Portions 3 and 4 transects the Manitoba Hydro ROW. Please see **Figure 09,** which illustrates the link.

One low-lying saturated area was identified along the edge of the Manitoba Hydro transmission line corridor (PL01) and a small channel on the edge of the corridor (LP01).

PL01 is where Ghost Creek crosses beneath the hydro transmission line, north of the former rail bed. Water appears to be draining from the surrounding highlands into the low area and draining into wetland type areas. Aquatic vegetation present at some points indicates that this area is frequently wet. However, lack of connectivity and shallow water that likely freezes to bottom in winter, indicates that this site provides **No Fish Habitat**.

LP01 was a small channel found within 10 m from the edge of the ROW. During rain events, the low-lying area observed within the transmission line ROW could drain into this channel, but it is unlikely that the area is used by fish. The channel was approximately 50 cm below the forest floor, with no banks containing the channel. Substrate was organic with marsh marigolds and various emergent vegetation species present. Although it appears this channel is a permanent fixture, due to the same reasons given at site PL01, this site provides **No Fish Habitat**.

4.3.8.3.8 Pipeline System Component: Portion 4, Chisel Access Road Between Former Rail Bed and Lalor Access Road

The Pipeline System route along either side of Chisel Access Road from the Lalor Access Road to and including the crossover point to the former rail bed was surveyed for aquatic habitat. The area was typical of the Project Area with bedrock outcrops and low lying areas. Along Chisel Access Road, small impounded low lying areas were observed which were likely created during development of the road. Tadpoles were observed in these wet areas but it is unlikely that they would support fish due to the lack of connectivity to larger water bodies and the shallow water depth which would freeze to the bottom in winter. The substrate and surrounding vegetation is dominated by terrestrial species. The area along Chisel Access Road provides **No Fish Habitat**.

4.3.8.3.9 Pipeline System Component: Portion 5, Lalor Access Road

LR01 is a pair of culverts installed in Tern Ditch. Tern Ditch is an engineered off-take ditch, which was installed to allow for drainage of Tern Pond towards Snow Lake. The channel was uniform, approximately 5 m wide and up to 2 m deep. Vertical banks contained the stream with little to no riparian habitat. The substrate was highly organic with the occasional undercut bank or small woody debris providing limited cover. Two 0.9 m diameter culverts were perched above the stream substrate by approximately 0.2 m on the north side of the road. Cobble covered the channel bed approximately 5 m from the base of the culverts on either side of the road before the natural, highly organic substrate began. Although the cobble provides unique habitat in the channel, it was virtually inaccessible to fish on the north side of the road due to the perched culvert and low water levels. Fishing effort conducted during the spring 2011 baseline survey captured Brook Stickleback in Tern Ditch. *LR01* provides **Marginal Habitat** as the cover and water depth may provide habitat for small-bodied species, but fish passage and utilization is limited by low water levels through a perched culvert.

LR02 is a culvert near the quarry along the Lalor Access Road. Installation of the 0.6 m diameter culvert has channelized the water from the saturated lowland surrounding the road to create a stream. The channel on the south side of the road has been excavated adjacent to the tree line and a channel has been created to connect a wetter area to the west to the culvert location. The culvert opening on the north side of the road was perched 0.4 m, with water running down gravel before reaching the natural channel. A thick white gelatinous residue of unknown origin coated the substrate along the gravel. There was little observed in-stream habitat or cover. Due to poor connectivity to fish bearing waterways, shallow water that likely freezes to the bottom in winter and impediments to fish passage *LR02* categorically provides **No Fish Habitat**.

4.3.8.3.10 Pipeline System Component: Lalor Site Ancillary Pipelines

The Lalor Site Ancillary Pipelines lie entirely within the existing site of Lalor Mine. These pipelines connect the Lalor Mine Water Treatment Plant and the Paste Facility. As described above, there is **No Fish Habitat** on the Lalor site.

4.3.8.4 Summary of Aquatic Habitat Assessments

The route of the Pipeline System lies entirely within areas that have been developed and/or are currently occupied for mining purposes. There are 20 locations which contain existing culverts along the Pipeline System route; classifications are summarized in **Table 4-18**.

Table 4-18. Classification of Aquatic Habitats Examined in the Project Area

Project Component	Site ID/Name	Habitat Classification
Paste Facility	Lalor site	No Fish Habitat
Pipeline System Component: Anderson Booster Pump Station	Operational Site of Anderson TIA	No Fish Habitat
Pipeline System Component: Makeup Water Pumphouse		No Fish Habitat
Pipeline System Component: Anderson Site Ancillary Pipelines		No Fish Habitat
Pipeline System Component: Portion 1, Origin of Tailings Pipe	AD03	No Fish Habitat
	AD02	No Fish Habitat
Pipeline System Component: Portion 2, Tailings Pipe	Operational Site of Anderson TIA	No Fish Habitat
Pipeline System Component: Portion 3, Between Operational Site of Anderson TIA and Chisel Access Road	RB01	No Fish Habitat
	RB02	Marginal Fish Habitat
	RB03	Marginal Fish Habitat
	RB04 to RB17	No Fish Habitat
	PL01	No Fish Habitat
	LP01	No Fish Habitat
Pipeline System Component: Portion 4, Chisel Access Road Between Former Rail Bed and Lalor Access Road	Chisel Access Road	No Fish Habitat
Pipeline System Component: Portion 5, Lalor Access Road	LR01	Marginal Fish Habitat
	LR02	No Fish Habitat
Pipeline System Component: Lalor Site Ancillary Pipelines	Lalor site	No Fish Habitat

Of the 25 areas assessed for aquatic habitat, 22 are classified as **No Fish Habitat**, due to lack of connectivity to fish-bearing water ways and shallow water that will likely freeze to bottom in winter. Three sites are classified as **Marginal Fish Habitat** because they provide sufficient conditions to support forage fish but are unlikely to support large-bodied fish.

4.3.9 Protected Species

The Manitoba Conservation Data Centre (CDC) provides a ranking of species of conservation concern for the Churchill River Upland Ecoregion. The term “species of concern” includes species that are rare, distinct, or at risk throughout their range or in Manitoba and need further research. Species are evaluated and ranked based on their range-wide (global) status, and their province-wide (sub-national) status according to a standardized procedure used by all Conservation Centres and Natural Heritage Programs. Only one aquatic species is listed as species of special concern in the Churchill River Upland Ecoregion (**Table 4-19**).

Table 4-19. Aquatic Species of Special Concern in the Churchill River Upland Ecoregion

Common Name	Scientific Name	CDC Rank	*SARA* Status	*ESEA* Status
Shortjaw Cisco	*Coregonus zenithicus*	Globally ranked uncommon throughout its range; provincially ranked uncommon.	Threatened	Not Ranked

Source: Manitoba Sustainable Development, 2016a; Manitoba Sustainable Development, 2016b and Government of Canada, 2016.

The Shortjaw Cisco is also considered a protected species. Protected species are species that are endangered, threatened or are of special interest as defined by either Federal or Provincial legislation. In the Province of Manitoba, endangered, threatened or special interest species are protected by the provincial *Endangered Species and Ecosystems Act* (*ESEA*) which may have species that overlap with the federal *Species at Risk Act* (*SARA*).

The Shortjaw Cisco has been recorded Manitoba lakes including Lake Athapapuskow, Clearwater Lake, Lake Winnipeg, George Lake, Reindeer Lake and Lake Athabasca (COSEWIC, 2003). However, there have been no reported occurrences in the Grass River sub-basin in the Nelson River Basin.

4.4 Groundwater

There is no comprehensive report describing the regional groundwater flow system. However, based on conditions in similar environments, the regional shallow groundwater flow, in particular in the overburden, is likely controlled by the topography and bedrock surface in and around the Project Region. Locally, the topography of the buried bedrock surface can have a significant effect on groundwater flow direction. Recharge of shallow groundwater can be expected to occur in elevated areas. From there, shallow groundwater flow will generally follow the topography and drain to the low-lying areas where it will discharge to surface waterbodies and wetlands. Shallow groundwater tables are high in most peat lands and in low areas bordering the peat lands. Shallow groundwater levels in the area are generally at or near surface in the spring and early summer and drop as the year progresses. Locally, the topography of the buried bedrock surface can have a significant effect on groundwater flow direction. Bedrock groundwater wells, when present, are likely connected to fractures or discontinuities that are connected to the local water table and are not likely regionally interconnected.

A review of the Groundwater Information Network (2016) online mapping service was completed to determine the registered wells within the Project Region. The search found a total of seven registered groundwater wells within the Project Region. Of the seven groundwater wells, four were registered as domestic wells and three were registered as “missing.” According to the well logs, the domestic groundwater wells were registered as production use and the “missing” groundwater wells were registered as test wells. Two of the domestic groundwater wells indicate that the “well status” is “active” and the remaining five indicate that the “well status” is “unknown.”

4.5 Terrestrial Environment

Vegetation in the Reed Lake Ecodistrict is typical of the northern Boreal forest region with Black Spruce (*Picea mariana*), Jack Pine (*Pinus banksiana*), Trembling Leaf Aspen (*Populus tremuloides*), and White Spruce (*Picea glauca*). The bog peat-lands have stunted Black Spruce, moss, and ericaceous shrub vegetation, while fens have sedge (*Carex sp*.), shrub, and Tamarack (*Larix laricina*) in varying mixtures. Forest composition is reflective of a forest fire history (Smith *et al*., 1998).

4.5.1 Flora

The Project Region is a boreal forest biome typical of the rocky outcrop and bog landscape. Rock outcrops are primarily igneous and common, forming open lichen woodlands of White Spruce and Jack Pine. Black Spruce bog has developed in the areas between rocky outcrops and created deep deposits of sphagnum moss that restrict drainage. The bog is mature with large areas of even-aged Black Spruce stands. One indication of tree stand density is the relative lack of understory shrubs. Speckled Alder (*Alder rugosa*) dominates the shrub layer in openings created by watercourses. There were no Hazel, Saskatoon, Chokecherry, or other typical understory shrubs noted during the surveys. Ground cover is moss with typical boreal ground plants such as Bunchberry (*Cornus canadensis*) and Solomon's Seal (*Polygonatum biflorum*). Soil development has occurred in pockets between rock outcrops with good drainage. Jack Pine grows in sporadic open sandy areas.

Historical disturbance in the Project Area had opened up a portion of the forest canopy prior to the first terrestrial surveys in 2007. Most of this activity comprised of narrow cut lines and drag roads that grow in rapidly. Re-growth in these areas consists largely of hardwoods, but these areas also offer some growth opportunity for shrubs that were largely lacking in other parts of the forest stand. Although forest re-growth is a minor component of the forest canopy, it is extensive and likely important in terms of offering linear features that present more diversity than the surrounding forest and providing openings in an otherwise dense canopy.

A list of confirmed vegetation (based on desktop review and supported by field observations in 2007, 2010, 2011, and 2012) is provided in **Table 4-20**. It should be noted that the spring 2012 survey did not reveal any species not previously observed in the work conducted in 2007, 2010, and 2011.

Table 4-20. Vegetation Observed During Terrestrial Field Surveys (2007 – 2012)

Awned Hair Cap Moss (*Polytrichum piliferum*)	Marsh Cinquefoil (*Potentilla palustris*)
Balsam Fir (*Abies balsamea*)	Mountain Cranberry (*Vaccinium visit-idaea*)
Bearberry (*Arctostaphylos uva-ursi*)	Northern Reindeer Lichen (*Cladina stellaris*)
Black Spruce (*Picea mariana*)	Paper Birch (*Betula papyrifera*)
Bog Cranberry (*Vaccinium vitis-idaea*)	Perennial Sow Thistle (*Sonchus arvensis*)*
Bunchberry (*Cornus canadensis*)	Reed Canary Grass (*Phalaris arundinacea*)
Canada Anemone (*Anemone canadensis*)	Rough Cinquefoil (*Potentilla norvegica*)
Canada Bluejoint (*Calamagrostis canadensis*)	Sedge (*Carex sp*.)
Canada Buffaloberry (*Sheperdia canadensis*)	Shore-Growing Peat Moss (*Sphagnum riparium*)
Canada Thistle (*Cirsium arvense*)*	Snowberry (*Symphoricarpos albus*)
Cladonia (*Cladonia sp.)*	Solomon's Seal (*Polygonatum biflorum*)
Common Reed Grass (*Phragmites australis*)	Speckled Alder (*Alder rugosa*)
Common Cattail (*Typha latifolia*)	Sphagnum moss (*Sphagnum sp*.)
Drooping Wood-Reed (*Cinna latifolia*)	Squarrose Peat Moss (*Sphagnum squarrosum*)
Dwarf Billberry (*Vaccinium caespitosum*)	Stiff Club Moss (*Lycopodium annotinum*)
Early Blue Violet (*Viola adunca*)	Stinging Nettle (*Urtica dioica*)*
Fairy Slipper Orchid (*Calypso bulbosa*)	Tall Cotton-Grass (*Eriophorum angustifolium*)
Fern (*Matteuccia sp*.)	Tamarack (*Larix laricina*)
Finger Felt Lichen (*Peltigera neopolydactyla*)	Trembling Leaf Aspen (*Populus tremuloides*)
Girgensohn's Peat Moss (*Sphagnum girgensohnii*)	Tufted Moss (*Aulacomium palustre*)
Ground Cedar (*Lycopodium complanatum*)	Velvet Leaf Blueberry (*Vaccinium myrtilloides*)
Ground Pine (*Lycopodium obscurum*)	Wavy Dicranum (*Dicranum undulatum*)
Jack Pine (*Pinus banksiana*)	Wax Paper Lichen (*Parmelia sulcata*)
Labrador Tea (*Ledum groenlandicum*)	White Spruce (*Picea glauca*)
Large Cranberry (*Vaccinium macrocarpon*)	Wild Mint (*Mentha arvensis*)
Leatherleaf (*Chamaedaphne calyculata*)	Wintergreen (*Pyrola asarifolia*)
Lily of the Valley (*Maianthemum canadense*)	

Note: Invasive species are noted with an asterix.

4.5.1.1 Terrestrial Field Surveys

AECOM's baseline terrestrial surveys carried out in September 2007, July 2010, May/June 2011, and June 2012 included a review of local geology, soil, vegetation, and wildlife located within the Project Site and targeted sections of the Project Area. The field survey consisted of a random meander survey by qualified AECOM biologists.

Detailed methodology, results and discussion of terrestrial field studies can be found in:

- Proposed Lalor Mine Environmental Baseline Assessment (AECOM, 2012a).
- Lalor Mine *Environment Act* Proposal Report (AECOM, 2012b).
- Lalor Vegetation Regional Analysis (AECOM, 2012d).
- Environmental Assessment of the Proposed Expansion of the Anderson Tailings Impoundment Area (AECOM, 2016).

4.5.1.1.1 Lalor Site (Paste Facility and Lalor Site Ancillary Pipelines)

The Lalor site is located in a typical boreal stand common throughout the Project Area. Tree growth is primarily small Black Spruce on bog, high stand density and poor species diversity due to the relatively low productivity of this environment. No unusual plant communities and no species at risk were observed during the terrestrial surveys of the Lalor site.

The perimeter of the Lalor site creates an abrupt edge to the forest environment, where the Black Spruce stand is generally very dense with some openings to the west and along local lakes and wetlands. There is typically little variety in these stands. There were numerous White Birch trunks (mostly dead stands) surrounding the Lalor site. This may indicate a general increase in wet ground conditions in the general area, possibly due to blockage of local drainage by beavers which pre-dates development at the Lalor site.

4.5.1.1.2 Pipeline System Component: Portion 3, Between the Operational Site of Anderson TIA and the Chisel Access Road

The former rail bed to the Anderson TIA provides a linear opening in the local forest canopy with second growth Aspen and shrubs along the edge of the ROW. Although the route is heavily overgrown along the sides with secondary growth, it still shows signs of historical disturbance. The parent forest adjacent to the former rail bed is mixed wood upland with few low lying wet areas. Typical understory and shrub growth is present throughout this forest stand. The one exception to the upland nature of the rail bed route is a low wet area currently flooded by beavers.

The operational site of the Anderson TIA is adjacent to the Anderson TIA, and the route of the Pipeline System will run through it to terminate at the Anderson Booster Pump Station. This area is primarily open with grassy understory, some shrubby growth and re-growth of poplar and brushy species. The shoreline of Anderson TIA supports a typical shoreline Aspen stand with extensive shrubby growth along the edge of the water.

The route of the Pipeline System continues along one of the internal access roads used in the operation of the Anderson TIA. It was not assessed for floral communities but is expected to contain similar vegetation to the other areas assessed during the 2007, 2010, 2011, and 2012 terrestrial surveys.

4.5.1.1.3 Pipeline System Component: Portion 4, Chisel Access Road between Former Rail Bed and Lalor Access Road

The terrestrial environment along Chisel Access Road, between the Lalor Access Road and the former rail bed, is similar to what characterizes the Lalor site. The road itself has a wide ROW with pads for infrastructure and drilling developed along the road. Along the east side of Chisel Access Road is a wet, closed canopy forest stand of mixed Black spruce and Trembling Leaf Aspen interspersed with Tamarack. Ground cover alternates from wet Alder (*Alnus crispa*) bog to rocky outcrops.

Adjacent to the forest stand, along the east side of the highway, is an upland mixed forest. The size of the trees suggests a more productive forest environment than that surrounding the Lalor site. The west side of the road is an open Black Spruce upland founded on a deep moss layer. This side of the road is dry with a dense forest canopy and typical sparse boreal ground cover. Fairy Slipper Orchids (*Calypso bulbosa*) were noted throughout the forest floor on the west side of the road. This forest stand is fairly uniform from the location of the Chisel North Mine to the crossover point to the former rail bed.

4.5.1.1.4 Pipeline System Component: Portion 5, Lalor Access Road

The Lalor Access Road is located in very similar plant communities to those around the Lalor site. As with the Lalor site, the low diversity of plant communities and extremely dense Black Spruce stand offers a very restricted habitat for wildlife.

4.5.2 Fauna

The Churchill River Upland Ecoregion provides habitat for Moose (*Alces alces*), Boreal Woodland Caribou (*Rangifer tarandus caribou*), Black Bear (*Ursus americanus*), Lynx (*Lynx lynx*), Timber Wolf (*Canis lupus*), Beaver (*Castor canadensis*), Muskrat (*Ondatra zibethicus*), and Snowshoe Hare (*Lepus americanus*). Various bird species including Sandhill Crane (*Grus canadensis*), grouse, waterfowl (*i.e*., ducks, geese, and pelicans) along with many other birds are found in this ecoregion (Smith *et al.*, 1998).

During the field studies conducted between the years 2007 and 2012 in the Project Region, signs of Black Bear and Moose in the Project Region were apparent. Wildlife directly observed included waterflowl, Common Raven (*Corvus corax*), Coyote (*Canis latranus*), Red Fox (*Vulpes fulva*), Whitetail Deer (*Odocoileus virginianus*), Timber Wolf, River Otter (*Lutra canadensis*), Beaver, eagles, American White Pelican (*Pelicanus erthrorhyncos*), cranes (*Grus* sp.), loons (*Gavia* sp.), and frogs.

The density of the forest canopy and poor diversity of plant life under the trees makes the Project Area generally poor in terms of wildlife diversity. Upland rocky outcrops that promote hardwood growth and open areas in lichen outcrops provide some variation in wildlife habitat quality and diversity within the Project Area.

Wildlife populations have open access to a large area of natural woodland in the region that provides river and lakeshore edge habitat and many burned areas in various stages of re-growth. Such areas provide a large diversity of habitats that favours wildlife populations and adjoin the immediate areas. Wildlife species can make use of the Project Area to the extent that it benefits them, but are not restricted to it. There is no restriction on wildlife species in terms of moving to more favourable areas within the general region.

There is no specific critical wildlife habitat on the Project Site (such as calving or over-wintering areas) and, based on site conditions and limited field observations, it is expected that there is no critical wildlife value in the Project Area. At both the site of the Paste Facility and along the route of the Pipeline System, the low diversity of plant communities and extremely dense Black Spruce stand offer a very restricted habitat for wildlife.

4.5.3 Protected Species

Twenty-eight species of fungi, plants, and vertebrate animals are listed as terrestrial species of special concern by the CDC in the Churchill River Upland Ecoregion (**Table 4-21**).

Table 4-21. List of Terrestrial Species of Special Concern in the Churchill River Upland Ecoregion

Common Name	Scientific Name	CDC Rank
Flooded Jellyskin	*Leptogium rivulare*	Globally ranked between demonstrably widespread, abundant, and secure throughout its range to uncommon throughout its range; provincially ranked very rare.
Bog Adder's-mouth	*Malaxis paludosa*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; provincially ranked very rare.
Few-Flowered Sedge	*Carex pauciflora*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; provincially ranked uncommon.
Few-Fruited Sedge	*Carex oligosperma*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; provincially ranked uncommon but status is uncertain.

Common Name	Scientific Name	CDC Rank
Fragrant Shield Fern	*Dryopteris fragrans*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; provincially ranked uncommon to widespread, abundant, and apparently secure.
Arethusa	*Arethusa bulbosa*	Globally ranked as widespread, abundant and secure throughout its range; provincially ranked rare.
Reed Grass	*Calamagrostis lapponica*	Globally ranked demonstrably widespread, abundant, secure throughout its range; provincially ranked rare.
Quillwort	*Isoetes lacustris*	Globally ranked demonstrably widespread, abundant, secure throughout its range; provincially ranked rare.
Limestone Oak Fern	*Gymnocarpium robertianum*	Globally ranked demonstrably widespread, abundant, secure throughout its range; provincially ranked very rare.
Long-Fruited Sedge	*Carex michauxiana*	Globally ranked demonstrably widespread, abundant, secure throughout its range; provincially ranked rare.
Moor Rush	*Juncus stygius ssp. americanus*	Globally ranked demonstrably widespread, abundant and secure throughout its range; provincially ranked very rare, but status is uncertain.
Northern Oak Fern	*Gymnocarpium jessoense*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; provincially ranked uncommon to widespread, abundant, and apparently secure.
Northern Woodsia	*Woodsia alpine*	Globally ranked widespread, abundant, apparently secure throughout its range; provincially ranked very rare.
Oregon Cliff Fern	*Woodsia oregana ssp. cathcartiana*	Globally ranked demonstrably widespread, abundant, secure throughout its range while its subspecies is widespread, abundant, and apparently secure throughout its range; provincially ranked very rare.
Pallas Buttercup	*Ranunculus pallasii*	Globally ranked widespread, abundant, apparently secure throughout its range; provincially ranked rare.
Round-Leaved Bog Orchid	*Platanthera orbiculata*	Globally ranked demonstrably widespread, abundant, secure throughout its range; provincially ranked uncommon.
Small Water-Lily	*Nymphaea tetragona*	Globally ranked demonstrably widespread, abundant, secure throughout its range; provincially ranked rare.
Smooth Woodsia	*Woodsia glabella*	Globally ranked demonstrably widespread, abundant, apparently secure throughout its range; provincially ranked rare.
Spatulate Moonwort	*Botrychium spathulatum*	Globally ranked uncommon throughout its range; provincially ranked very rare.
Wahlenberg's Wood-rush	*Luzula wahlenbergii*	Globally ranked widespread, abundant, apparently secure throughout its range; provincially ranked rare.
White Beakrush	*Rhynchospora alba*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; provincially ranked uncommon but status is uncertain.
Whip-poor-will	*Caprimulgus vociferus*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; breeding occurrences rated uncommon in province.
Common Nighthawk	*Chordeiles minor*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; breeding occurrences rated uncommon in province.
Olive-sided Flycatcher	*Contopus cooperi*	Globally ranked widespread, abundant, and secure throughout its range; breeding occurrences rated uncommon or widespread, abundant, and secure in the province.
Western Wood-pewee	*Contopus sordidulus*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; breeding occurrences rated uncommon in province.
Rusty Blackbird	*Euphagus carolinus*	Globally ranked widespread, abundant, and secure throughout its range; breeding occurrences rated uncommon or widespread, abundant, and secure in the province.
Great Gray Owl	*Strix nebulosi*	Globally ranked demonstrably widespread, abundant, and secure throughout its range; breeding occurrences rated as widespread, abundant, and secure in the province.
Boreal Woodland Caribou	*Rangifer tarandus caribou*	Globally ranked demonstrably widespread, abundant, and secure throughout its range while its subspecies is widespread, abundant, and apparently secure throughout its range; provincially ranked widespread, abundant, and apparently secure.

Source: Manitoba Sustainable Development, 2016a.

Field observations confirmed that wildlife habitats within the Project Area are typical for the region, with no unique or rare habitats encountered. No terrestrial species listed as species of special concern by the Manitoba CDC were observed in the areas examined during the biophysical surveys.

Of the 28 terrestrial species listed as species of special concern by the Manitoba CDC (**Table 4-21**), nine are protected species, under either (or both) the provincial *ESEA* or federal *SARA*. The protected species with potential to occur in the Churchill River Upland Ecoregion are listed in **Table 4-22**.

Table 4-22. List of Protected Species within the Churchill River Upland Ecoregion

Common Name	Scientific Name	SARA Status	ESEA Status
Flooded Jellyskin	*Leptogium rivulare*	Threatened	Not Ranked
Boreal Woodland Caribou	*Rangifer tarandus caribou*	Threatened	Threatened
Monarch	*Danaus plexippus*	Special Concern	Not Ranked
Whip-poor-will	*Caprimulgus vociferus*	Not Ranked	Threatened
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Threatened
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Not Ranked
Northern Leopard Frog	*Lithobates pipiens*	Special Concern	Not Ranked
Yellow Rail	*Coturnicops noveboracensis*	Special Concern	Not Ranked

Sources: Manitoba Sustainable Development, 2016b and Government of Canada, 2016.

The extent of the recently discovered population of **Flooded Jellyskin** near Flin Flon, Manitoba is not known. This lichen was found in Peyuk Lake, 30 km east of Flin Flon and 93 km west-south-west from the Lalor site (COSEWIC, 2004). This is also the northern-most occurrence of this species. There is no overlap with this species' range with the Project Region.

According to Manitoba Conservation Fact Sheets, Manitoba recognizes three varieties of caribou: Coastal, Barren Ground and Boreal Woodland (Manitoba Sustainable Development, 2016c). The **Boreal Woodland Caribou** was designated as threatened under *ESEA* in June 2006 (Manitoba Boreal Woodland Caribou Management Committee, 2015). The Provincial recovery strategy plan for Woodland Boreal Caribou identifies 15 known ranges of the species (Manitoba Boreal Woodland Caribou Management Committee, 2015). One of the Management Units, the Atikaki-Berens, overlaps with the Project Region. Although the Project Region contains potentially suitable habitat for Boreal Woodland Caribou, there are no known herds whose range overlaps with the Project Region.

The range of the **Monarch** Butterfly can extend to the 54^0 Latitude of the Prairie Provinces. However, the bulk of occurrences are south of the 50^0 Latitude. Recorded occurrences are limited in the northern regions such as Thompson, The Pas, and Grand Rapids, however these are generally considered vagrants (COSEWIC, 2010). The Project Region falls within the limits of the species' distribution, but no monarch butterflies were recorded during the terrestrial investigations.

The **Whip-poor-will** is a well-known, nocturnal bird. It is an aerial foraging insectivore. The Whip-poor-will breeds in southern Manitoba and would be on the edge of its range in the Project Region (COSEWIC, 2009a).

The **Common Nighthawk** breeds across western Canada, including in Manitoba below the treeline. The breeding habitat includes ground devoid of vegetation such as sand dunes, beaches, logged areas, burned-over areas, forest clearings, rocky out crops, rock barrens, prairies, peat bogs, and pastures. They have not been observed in the Project Region and are unlikely to nest within the Project Site (COSEWIC, 2007).

The **Olive-sided Flycatcher** breeds in boreal, sub-boreal, interior and coastal forest regions, including Manitoba (Environment Canada, 2015). There have been no observations in the Project Region during terrestrial investigations

The **Rusty Blackbird** breeding range includes a large portion of North America (COSEWIC, 2006). There have been no observations in the Project Region during terrestrial investigations.

The **Northern Leopard Frog** range overlaps with the Project Region (COSEWIC, 2009b); however, none were observed during the terrestrial investigations.

The **Yellow Rail** distribution in Manitoba is scattered through locations south of the Boreal Shield Ecozone and is concentrated in the Boreal Plains and Aspen Parkland portions of the Prairie Ecozone (COSEWIC, 2009c). Although there is potential for the Yellow Rail to occur in the Ecozone, there are no known occurrences of Yellow Rail within the Project Region.

4.5.4 Migratory Birds

The only migratory birds that were observed during field investigations were waterfowl. No bird species that are protected under the *Migratory Birds Convention Act, 1994* were observed in the area.

The type of habitat around the Lalor site is classified as bog and floating bog, which has very low value for migratory waterfowl nesting. Open water lakes such as Lalor Lake and Chisel Lake provide some nesting habitat in shoreline areas, and brood water along the shoreline of lakes. A survey of Anderson TIA recorded four species of ducks, mergansers, loons, grebes, geese and two species of gull. Nesting and brooding of these species is largely confined to the major lakes in the Project Area. The immediate site of the Lalor site and the surrounding Black Spruce bog offer little value for waterfowl at any stage of nesting and brooding.

Water crossings along some portions of the Pipeline System route offer potential nesting areas for waterfowl. To be suitable waterfowl habitat, there should be brooding areas within close proximity to the potential nesting area. This combination occurs only at LR01, RB02 and RB03.

Common Goldeneye (*Bucephala clangula*) are tree nesters that make use of boreal areas. They would be the most likely species making use of the drainages in the Project Area. However, previous terrestrial surveys conducted by AECOM have not observed Common Goldeneye. This species prefers larger trees, available in mixed upland woods around the margins of the larger lakes in the Project Area. Mixed wood upland wood in this area are isolated by the large Black Spruce bogs, making them unattractive to this species since there are no nearby waterbodies offering suitable brood areas for young ducks.

Mallards (*Anas platyrhynchos*) are ubiquitous across western Canada and will nest in all available habitats. They prefer ground nesting in heavy cover but will also nest in shrubs and trees on rare occasions. Mallards prefer marshy areas on the margins of lakes and are most likely to nest in the major lakes in the Project Area. No mallards were seen in the vicinity of the Lalor site during the previous terrestrial environmental surveys. One Mallard was seen on Anderson TIA in June 2012.

Canada Geese (*Branta canadensis*) are also boreal nesters, and one was seen on Anderson TIA in June 2012. Geese do not nest in trees, preferring large accumulations of reeds and grass. They have been known to nest on beaver lodges. The dense boreal forest cover in the Project Region is not suitable goose nesting habitat. The margins of the larger lakes in the region could be potential goose nesting and brooding habitat.

Loons, mergansers and grebes are strictly over-water nesters and require large open wetlands or lake margins. The dense nature of the black spruce bog around the Lalor site does not present nesting habitat appropriate for waterfowl. The most common nesting habitat in the Project Region is the marshy edges of major lakes, and the mixed upland woods common around the margin of these lakes.

4.6 Socio-Economic Environment

The Project Site is located inside the municipal boundaries of the Town of Snow Lake. The Snow Lake Mining District has been developed for mining purposes for over 50 years.

4.6.1 Parks and Natural Areas

There are no national or Provincial parks in the Project Site or the Project Area. The only Provincial Park in the Project Region is the Wekusko Falls Provincial Park.

Wekusko Falls Provincial Park (0.88 km^2) is located approximately 15 km southeast of the Lalor site. The Park flanks the Grass River as it drops 12 m over a series of rapids and falls, known as Wekusko Falls. The Park is classified as a Recreation Park. (Manitoba Sustainable Development, 2016d).

The Grass River Provincial Park (2,279 km^2) is located approximately 25 km southwest of the Lalor site. This Provincial park is also classified as a Natural Park and its purpose is to preserve natural areas that represent the Churchill River Upland portion of the Precambrian Boreal Forest. Woodland Caribou are found year round throughout the park, and usually in areas with mature forest and treed muskeg. (Manitoba Sustainable Development, 2016e).

The Cormorant Provincial Forest (1,479 km^2) is located approximately 80 km southwest of the Lalor site. The Provincial forest was established in 1947, and is the most northern Provincial forest. The park includes Clearwater Lake Provincial Park, extensive cross country ski trails and a ski chalet used by Manitoba Forestry for education. (Manitoba Conservation, 2011)

The Clearwater Lake Provincial Park (593 km^2) is located approximately 105 km southwest of the Lalor site. The park is characterized by Clearwater Lake which comprises almost half of the park. The park is classified as a Natural Park, with a purpose to preserve areas representative of the Mid-Boreal portion of the Manitoba Lowlands Natural Region; while accommodating diversity of recreational and resource use. (Manitoba Sustainable Development, 2012f)

The Saskeram Wildlife Management Area (WMA) is located approximately 130 km southwest of the Lalor site, occupies an area of 958 km^2, and encompasses a large portion of the Saskatchewan River delta and floodplain, providing breeding and staging area for waterfowl, and habitat for moose, wolves, black bears, and furbearers. (Manitoba Sustainable Development, 2016g).

The Tom Lamb WMA is located approximately 85 km southwest of the Project Site and occupies an area of 2,083 km^2. The area within the WMA is flat with several limestone ridges and river levees with Aspen, jack pine, and black spruce growing along the ridges and poplar, willow Manitoba maple and green ash growing along the levees. The WMA is a breeding and staging area for waterfowl and provides habitat for furbearers, moose, wolves and black bears. Bald eagles use the WMA for feeding, staging and occasionally for nesting. (Manitoba Conservation, 2016g).

Figure 16 shows the above-mentioned parks and natural areas.

4.6.2 Heritage Resources

Information from the Historic Resources Branch of Manitoba Culture, Heritage and Tourism does not indicate any known historic or heritage resources within the Project Site.

Figure 17 illustrates the location of known sites found within the Project Area and Project Region.

4.6.3 Economy

In the 2011 census conducted by Statistics Canada, the population of Snow Lake was 723 residents (Statistics Canada, 2012) with the majority of these residents employed at, or supported by, the mines located throughout the area. Many other Snow Lake residents are employed in the industries and services that support the region's mining operations.

The Snow Lake area has had an active mining history for over 50 years. HBMS has played an integral part in this history since the late 1950s, by operating ten mines in the area including: Photo Lake, Chisel Lake, Stall Lake, Osborne Lake, Spruce Point, Ghost Lake, Anderson Lake, Chisel North and Lalor.

In addition to mining activities, extensive forestry operations have occurred within the region and surrounding area, with wood sent to the pulp and paper mill operation in The Pas, Manitoba (**Section 4.6.4.5**). Trapping, fishing, and hunting are also popular activities in the region (**Section 4.6.4**).

4.6.4 Regional Resource Use

4.6.4.1 Trappers

The Manitoba Conservation office in Snow Lake has confirmed that there are two registered trap lines (RTLs) in the area of Cook Lake and Lalor Lake. These lines include RTL 23 and RTL 14 that are owned by Martin McLaughlin and Jim Schollie, respectively. Manitoba Conservation has confirmed that the area of Anderson Creek and Wekusko Bay is registered as RTL 13. This trap line is owned by Russell Bartlett (assisted by Greg Foord).

Figure 17 shows these trapline boundaries.

4.6.4.2 Cottages or Remote Residences

There are no cottages or residences on the Anderson TIA. The closest cottages and remote residences are the Wekusko Lake cabin subdivisions on Berry Bay, Taylor Bay, and Bartlett's Landing. There are approximately ten residences on Anderson Bay. Cottages on Cook Lake are seasonal, while those along Berry and Anderson Bay are all season. The five cabins along Cook Lake have been on the lake for approximately 20 years and, according to the Province of Manitoba, five cabins is the maximum allocation for that lake. These cottages and remote residences can be found on **Figure 17**.

4.6.4.3 Lodge Owners

There are five lodges located in the Snow Lake region. The Diamond Willow Inn & Willow House is located in the Town of Snow Lake at 200 Lakeshore Drive and is approximately 3 km northwest of the Anderson TIA. Wekusko Falls Lodge and Tawow Lodge Ltd. (Herb Lake Landing) are located approximately 10 km and 25 km southeast of the Anderson TIA, respectively. Burntwood Lodge is a fly in fishing lodge located on Burntwood Lake and is approximately 60 km northwest of the Lalor site. Grass River Lodge is located on Reed Lake and is approximately 23 km southwest of the Lalor site, with outpost cabins on Dolomite Lake (50 km southwest of the Lalor site) and Moody Lake (40 km northwest of the Lalor site).

4.6.4.4 Snowmobilers

The Snow Lake area is home to the Snow Lake Sno-Drifters snowmobiling club. The club maintains snowmobile trails in and around the Town of Snow Lake.

4.6.4.5 Forestry

The Cormorant Provincial Forest is located approximately 95 km southwest of the Anderson TIA and covers an area of 1,479 km^2. Provincial forests are Crown lands managed by Manitoba Natural Resources on a sustainable yield basis. A licence or permit allows harvesting of trees on Crown lands and also indicates the quantity of each type of trees that can be harvested. Harvesting companies must regenerate forest lands that they have harvested according to their Forest Management License. A forest renewal fee is paid by individuals or small companies for reforestations (Manitoba Sustainable Development, 2016h).

Tolko Industries Ltd. (Manitoba Solid Wood Division, Woodlands), located in The Pas, Manitoba has three Forest Sections (Highrock, Nelson River, and Saskatchewan River) where wood may be harvested. These Forest Sections include areas surrounding Snow Lake, Flin Flon, and Grass River Provincial Park (Tolko Industries Ltd., 2016). In November 2016, the mill in The Pas was purchased by the Canadian Kraft Paper Industries Limited.

4.6.4.6 Fisheries – Recreational and/or Commercial

Given the proximity to the Town of Snow Lake, there are recreational opportunities such as fishing, swimming, canoeing, and snowmobiling in and around the Project Region. Recreational fishing in Wekusko Lake increased after 1960 with the completion of PR 392.

Personal communications with Grant McVittie, Regional Fisheries Manager in The Pas, indicated a commercial gill net fishery operated in Snow Lake from 1989 to 1990 targeting Lake Whitefish, but was suspended due to the high bycatch (~41% of round weight) of Walleye and Northern Pike. The commercial fishery in Snow Lake is not currently active. Wekusko Lake has an active commercial fishery for Walleye, Sauger, Whitefish and Northern Pike.

4.6.5 Indigenous Communities

Based on Government of Manitoba and Federal sources, there is no Indian Reserve or RTL zone associated with an Indigenous community within the Project Region. The Indigenous communities in closest proximity to the Project Region are the Mathias Colomb Cree Nation, Nisichawayasihk Cree Nation, Mosakahiken Cree Nation, Opaskwayak Cree Nation, Cross Lake First Nation, and Norway House Cree Nation.

Figure 18 illustrates the locations of these Indigenous communities relative to the Lalor Mine.

5. Environmental Assessment and Mitigation Measures

5.1 Effects Assessment Methods

This section contains the results of the environmental assessment.

Applying professional judgment and a thorough understanding of the components of the proposed Project (outlined in **Section 2** of this application); AECOM determined the potential for each component of the proposed Project to interact with each environmental component (presented in **Table 4-1** above). The assessment includes any effects on social components resulting from residual adverse environmental effects.

The assessment takes into account mitigation measures that have been incorporated into the proponent's proposed plan, as well as environmental protection practices and procedures included in the proponent's standard of operation (such as compliance with International Organization for Standardization (ISO) certified safety and environmental management systems and the drafting of the tender documents to include requirements for mitigation measures outlined below). In addition, AECOM has taken into account that this Project consists not of a new development, but rather planning and implementation of a mitigation measure applied to existing operations, which is designed to reduce the environmental impact of Lalor Mine and related existing operations. Lalor Mine and the related operations have been and continue to be operated in compliance with regulatory criteria and well-established HBMS operating practices. These regulatory criteria include the full range of monitoring and reporting requirements contained in the MMER and applicable Manitoba environmental licenses.

The assessment includes AECOM's assessment of the sufficiency of such measures and recommendations for any additional measures which, in our view, would be advisable. Significance of effects is commented on where applicable regulatory criteria exist. In the absence of such criteria, AECOM has provided an overall characterization of the impact taking into consideration the magnitude, reversibility, direction (positive, neutral, or adverse), duration, and frequency of the effects.

Environmental effects that may be caused as a result of accidents and malfunctions are discussed separately in **Section 5.11.5**. Definitions of the terms used to guide the effects assessment are provided in **Table 5-1**.

Table 5-1. Terms Used in Effects Assessment

TERM	DEFINITION			
Project Phase:	Refers to the phase of the Project as construction, operation and maintenance (“operation”), or closure.			
Potential Effect:	Potential change that the proposed Project may cause the environment.			
Magnitude of Effect:	Refers to the estimated percentage of population or resource that may be affected by activities associated with the construction, operation, and closure of the Anderson TIA. Where possible and practical, the population or resource base has been defined in quantitative or ordinal terms (e.g., hectares of soil types, units of habitat). Magnitude of effect has been classified as less than (<) 1%, 1% to 10%, or greater than (>) 10% of the population or resource base. Where the magnitude of an effect was determined as virtually immeasurable and represented a non-significant change from background in the population or resource, the effect was considered Negligible. An exception to this is in terms of potential human health effects where, for example health issues due to water-borne diseases amounting to 1% of the population being affected would still be considered major.			
	Negligible (immeasurable)	Minor (<1%)	Moderate (1 to 10%)	Major (>10%)
Direction of Effect:	Refers to whether an effect on a population or resource is considered to have a positive, adverse, or neutral effect.			
	Positive	Adverse	Neutral	
Duration of Effect:	Refers to the time it takes a population or resource to recover from an adverse effect. If quantitative information was lacking, duration was identified as short term (<1 year), moderate term (1 to 10 years), and long term (>10 years).			
	Short term (>1 year)	Moderate term (1 to 10 years)	Long term (>10 years)	
Frequency:	Refers to the number of times an activity occurs over the Project phase, and is identified as once, rare, intermittent, or continuous.			
	Once	Rare	Intermittent	Continuous
Scope of Effect:	Refers to the spatial area potentially affected by the effect and categorized as Project Site, Project Area, or Project Region as defined in **Section 3.2**. Where possible, quantitative estimates of the resource affected were provided.			
	Project Site	Project Area	Project Region	
Reversibility:	Refers to the extent to which an adverse effect is reversible or irreversible over a 10-year period.			
	Reversible	Irreversible		
Residual Effect:	A qualitative assessment of the residual adverse effect remaining after implementing appropriate mitigation measures.			
	Negligible (immeasurable)	Minor (<1%)	Moderate (1 to 10%)	Major (>10%)

5.2 Topography

Magnitude of Effect: Negligible
Direction of Effect: Neutral
Duration of Effect: Long term
Frequency: Once
Scope of Effect: Project Site
Reversibility: Irreversible

Sources of changes to site topography include activities such as clearing, levelling, trenching, and stockpiling of materials during construction of the Paste Facility and Pipeline System.

With respect to the proposed Paste Facility component (which includes the plant building, cement silos, thickener, filter feed tanks, and emergency containment system), some additional levelling may be required.

With respect to the proposed Pipeline System, small portions of the former rail bed will require additional clearing (described in more detail in **Section 5.9.1**) and levelling to create the ROW for the tailings and return water pipes. Some additional clearing may also be required at the location of the operational site of the Anderson TIA for the construction of the Anderson Booster Pump Station.

The changes in topography as a result of construction and closure of the Paste Facility and Pipeline System ROW are assessed to be Negligible when taking into account the following:

- Wherever practicable, existing access roads and laydown areas will be used in order to minimize changes to topography.
- The Project Site consists of previously levelled and disturbed areas such as the Lalor site, former rail bed, and the operating site of the Anderson TIA and therefore minimal clearing and levelling will be required. Any additional levelling activities for the Paste Facility will be minimal and are within the scope of operations of Lalor Mine.
- All changes to topography will occur inside the boundary of HBMS operations on land to which only HBMS has access.
- The closure phase will include restoration of any changes to topography of the site to match the pre-construction condition of the surrounding area to the extent practical. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

5.2.1 Overall Impact to Topography

Overall, the residual impact on topography caused by the Project is assessed to be Negligible. The change in topography, while permanent, will impact only features which are limited to the Project Site, and not unique in the Project Region.

5.3 Soil

5.3.1 Erosion

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Moderate term
Frequency: Once
Scope of Effect: Project Site
Reversibility: Reversible

High wind and precipitation events can lead to soil erosion, which can consequentially affect other components of the environment (*e.g.* air quality, water quality, or vegetation). Activities that can result in elevated erosion potential include clearing, grubbing, and excavation.

The effect on soil erosion is assessed as Negligible for the following reason:

- The site for the Paste Facility has already been cleared, levelled, and covered with crushed non-acid generating (NAG) rock as a part of the construction of the Lalor Mine.

Construction of the Pipeline System component could result in increased potential for soil erosion, through clearing, grubbing, excavating, and placing fill. This could consequentially affect surface water quality along Portions 2-5 of the Pipeline System route. The effect on soil erosion during construction of the Pipeline System is assessed to be Negligible for the following reasons:

- The Project Site consists of previously levelled and disturbed areas such as the Lalor site, former rail bed, and operating site of the Anderson TIA, and therefore minimum clearing and levelling will be required.
- Any activities that occur near culverts or other watercourses along the route will be carried out in accordance with applicable DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat" or other applicable standards.
- Erosion and sediment control (ESC) measures will be in place to prevent the generation and movement of sediment-laden water.
- Excavated materials will be stockpiled, compacted and reused, where appropriate.
- All rock used to widen the former rail bed will be non-acid generating and will be clean and free of silt and other materials.
- Excavation activities will not occur during high rain or wind events, to minimize the erosion potential of exposed soils.

At the time of closure, HBMS will undertake the following measures for effective reversibility of the Project Site to the extent possible:

- Contour disturbed areas to match the surrounding topography to the extent possible.
- Apply soil to disturbed areas.
- Allow all disturbed areas to naturally re-vegetate.

The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

5.3.2 Materials and Waste Management

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Site
Reversibility: Reversible

Wastes such as sewage, used oils, rags, drums, and miscellaneous garbage can potentially affect soil quality, which can in turn affect other environmental components (*e.g.* vegetation, groundwater, and surface water).

The impact on soil quality from wastes is assessed to be Negligible because the following HBMS waste management practices will be followed:

- Wastes generated during construction will be collected in garbage bins maintained at specific locations throughout the Project Site. The bins will be emptied on a regular basis for recycling and/or disposal at a licensed waste disposal facility.

- Waste oils and other hazardous materials generated (chemicals, reagents, waste oil, lubricants, or petroleum products) will be removed by a licensed hazardous materials handler for appropriate disposal or recycling.

5.3.3 Overall Impact to Soil

The mitigation measures listed above to minimize the impact on soil (due to erosion and materials and wastes) are deemed sufficient. Therefore, the overall residual impact on soil as a result of the Project is assessed to be Negligible.

5.4 Air

5.4.1 Dust

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Area
Reversibility: Reversible

Dust and particulate matter have the potential to adversely affect air quality with consequent effects on human health (*e.g.* respiratory concerns and safety concerns related to impaired visibility on roads) and vegetation (decreased growth due to deposition). Dust occurs primarily during the summer and fall, with greater likelihood for an increase in dust during dry and windy conditions. Sources of dust include activities such as clearing, levelling, crushing, movement of traffic on roads, stockpiling materials, and operation of the Paste Facility.

Dust may be produced during the construction and closure phases of the Paste Plant (such as clearing, grubbing, stockpiling, transport materials and/or employees, and general use of equipment). The dense nature of the vegetation immediately surrounding the Project Site is expected to mitigate wind effects and overall potential dust migration, limiting its effects to the Project Site and the immediate Project Area.

No vegetation clearing or soil disturbance will be required during construction of the Paste Facility; however limited excavation in the crushed rock pad may be required for building foundations, which will contribute to the potential generation of dust.

The effect of dust during construction and closure activities is assessed to be Negligible when taking into account the following mitigation measures:

- Areas to be cleared will be minimized where practical; project components lie mainly on previously disturbed areas.
- Stockpiles materials will be compacted and re-used, where practicable. Material stockpile heights will be limited.
- Clearing and levelling at the Lalor site has been completed as part of the development of the approved Lalor Mine.
- Trucks hauling materials will be covered to minimize dust coming off loads.
- Re-vegetation of disturbed areas will occur as part of site closure activities and will provide long term mitigation of dust effects upon completion of closure activities.

The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

Dust will also be generated by vehicle and equipment movement on site, on the Lalor Access Road, and along the Pipeline System ROW. **Section 2.10** outlines the traffic volumes expected during the construction, operation, and closure phases. Construction equipment, employee vehicles, and material delivery trucks will travel to and from site during the construction of the Project and will result in an average increase in daily traffic of approximately two to four vehicles per day. The traffic increase during the closure phase is estimated to be the same as during the construction phase. During the operation phase of the proposed alteration, an average of approximately two vehicles per day, including employee vehicles and warehouse delivery trucks/vehicles, will travel to and from the site. The vehicles may travel along PR 395, the Chisel Access Road, the Lalor Access Road, and the Pipeline System ROW, all of which are unpaved.

The effect of dust from traffic during the construction, closure, and operation phases is assessed to be Negligible when taking into account the following mitigation measures:

- If required, dust suppression activities, such as the use of approved dust control agents will be undertaken on unpaved roads.
- The increase in traffic during construction and closure phases (when traffic volumes are highest) is temporary.
- Speed limits on main roads and access roads will be adhered to at all times. The Lalor Access Road has a speed limit of 40 km/hr, which will continue to be imposed. The same speed limit (or less) will apply to the Pipeline System ROW. The Lalor site has a speed limit of 20 km/hr, which will continue to be imposed. The speed limits on all roads will be adhered to.
- Vegetated buffers will be maintained to minimize the transport of dust generated on site.

During operation, dust will be generated during the offloading of cement and mixing paste backfill. Delivery of cement will occur on a daily basis. The effect of dust during the operation of the Paste Facility is assessed to be Negligible for the following reasons:

- The cement silos will be equipped with a dust collection system will be used during cement offloading.
- The paste batch mixer will be equipped with a wet scrubber as described in **Section 2.1.1.3.3**.
- During operation, all activities will be carried out in accordance with *The Workplace Safety and Health Act* and the HBMS Occupational Health and Safety Standard (OHSAS) 18000 certified management system, which will avoid potential effects on health and safety. These systems include measures to protect worker safety with respect to air quality (*i.e.* dust). If needed, appropriate personal protective devices (*e.g.* respirators) will be provided to employees.

5.4.2 Emissions

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Area
Reversibility: Reversible

Sources of emissions associated with the proposed alteration include: vehicles and exhausts from diesel construction equipment (general vehicle movement on site, using equipment for grading, placing materials etc.).

As described in **Sections 2.9** and **2.10**, 25 pieces of equipment will be required during both the construction and closure phases. Emissions from these are anticipated to be limited to the Project Site and the Project Area. Construction is anticipated to take eight months beginning in spring 2017. Closure will take place mainly in the summer months, over a three year period.

As indicated in **Section 2.10**, it is expected that during construction, on average, a maximum of four vehicles and, during operation, a maximum of three vehicles will access public roads in vicinity of the Lalor Mine.

Table 5-2 presents the percentage changes associated with these numbers.

Table 5-2. Traffic Changes

	Provincial Road 395	Provincial Road 392	Provincial Trunk Highway 39	Provincial Trunk Highway 10
AADT (MI, 2015)[1]	420	220 to 730	300 to 320	580 to 2200
Maximum Vehicles - Construction Phase	4	4	1	1
Percentage Change	0.95%	0.55% to 1.8%	0.31% to 0.33%	0.04% to 0.17%
Maximum Vehicles - Operation Phase	3	3	3	3
Percentage Change	0.71%	0.41% to 1.4%	0.94% to 1.0%	0.14% to 0.52%

Notes:
AADT = Annual Average Daily Traffic.
[1] The numbers presented represent the range of AADT along the route between the Lalor Mine and the City of Flin Flon.

The increase in traffic during construction along public and private roads (e.g. Lalor Access Road, PR 395, and PR 392) is temporary, and exhaust emissions as a result of this increase are Negligible in relation to air quality in the Project Area.

The effect of equipment and vehicle use on emissions is anticipated to be Negligible as a result of the implementation of the following mitigation measures:

- Vehicles and equipment will be well maintained.
- Vehicle idling will be kept to a minimum.
- All vehicles used for the Project will comply with Environment Canada's *On-Road Vehicle and Engine Emission Regulations* as required.

5.4.3 Noise and Vibration

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Area
Reversibility: Reversible

An increase in noise levels at the Project Site and within the Project Area could potentially affect people, wildlife, and infrastructure (from vibration) in the surrounding area. Since the effect of noise is confined to the Project Site, no assessment is required with respect to wildlife.

Sources of noise during construction would be typical of heavy equipment such as dump trucks, front end loaders, and excavators.

Other locations with human receptors within the general vicinity of the Project Area include cottages, remote residences, and lodges. The closest residences are at the Town of Snow Lake (approximately 8 km east of the site of the Lalor Mine). The closest cottages and remote residences are the seasonal cottages on Cook Lake (1 km), and the cabin subdivisions on Berry Bay, Taylor Bay, and Bartlett's Landing (approximately 14 km southeast). These receptors are too distant to be disturbed by everyday noise at the Project Site. There have been no known noise complaints in recent history associated with the operations in the Snow Lake area. For these reasons, the focus of the assessment of noise-related effects is for employees working at the Project Site.

During the operation phase, sources of noise outside of the Paste Facility include vehicle movement and trucks loading/unloading (cement or other materials for operation), dust suppression system for the cement silos, and other general equipment used on site. Inside the Paste Facility, noise will be generated by compressors, generators, pumps, and the paste batch mixer. The Paste Facility will be located within an active mine site that has noise associated with its operation.

At the Anderson BPS and the Makeup Water Pumphouse, noise will be generated by the pumps.

Measures to mitigate noise related effects for employees on the Project Site include:

- The compressors, generators, pumps, and paste batch mixer will be enclosed in the Paste Facility.
- The pumps for the Anderson BPS and Makeup Water Pumphouse will be enclosed in the pump house buildings.
- HBMS provides hearing protection as required to ensure employees working on site are protected from noise during construction, operation, and closure activities.

All closure activities will be carried out in accordance with *The Workplace Safety and Health Act* and the HBMS Occupational Health and Safety Standard (OHSAS) 18000 certified management system, which will avoid potential effects on health and safety.

5.4.4 Overall Impact on Air

The mitigation measures proposed above are sufficient to mitigate any adverse effects due to dust, emissions, and noise and vibration during the construction, operation, and closure phases. Residual effects on air quality are therefore assessed to be Negligible.

5.5 Climate

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Area
Reversibility: Irreversible

Sources of greenhouse gas (GHG) emissions associated with the proposed alteration include: vehicle exhausts and exhausts from diesel construction equipment (*e.g.* general vehicle movement on site, using equipment for grading, and placing materials).

During construction and closure, GHG emissions are expected to be typical of construction activities and will be limited in duration. During operation, GHG emissions will be limited to vehicle use (as described in **Section 5.4.2**). GHG emissions associated with the operation of the Lalor Mine will be reduced because the paste backfill process will replace the distribution of waste rock fill underground, which is carried out by large rock trucks which are consuming fossil fuel.

The effect of GHG emissions from the Project is assessed to be Negligible with the implementation of mitigation measures listed in **Section 5.4.2**.

5.5.1 Overall Impact on Climate

The mitigation measures proposed above are sufficient to mitigate any adverse effects due to GHG emissions. Residual effects on climate are therefore assessed to be Negligible.

5.6 Groundwater

Magnitude of Effect: Negligible
Direction of Effect: Neutral
Duration of Effect: Short term
Frequency: Rare
Scope of Effect: Project Site
Reversibility: Reversible

Activities such as handling fuels, lubricants, and waste can potentially affect groundwater quality. Two boreholes into which paste backfill will discharge and an underground piping distribution network that connects the boreholes to the stopes in the Lalor Mine will be constructed (discussed in detail in **Section 2.1.1.4**). The casing will be grouted in place to provide support and prevent groundwater from entering the boreholes.

Groundwater quality impacts therefore are assessed to be Negligible with the implementation of the mitigation measures identified in **Section 5.11.5** (Accidents and Malfunctions) and **Section 5.3.2** (Materials and Waste Management).

The direct footprint of project components can change surface-to-groundwater recharge pathways, which has the potential to affect groundwater quantity. In this case, however, the only change in direct footprint will be the addition of the small building comprising the Paste Facility. The impact of this change in footprint is negligible.

The overall effect on groundwater quantity is assessed to be Negligible. There are numerous pathways on the site for groundwater recharge, the project components lie primarily on previously disturbed areas, and there are no withdrawals of groundwater proposed for the Project.

5.6.1 Overall Impact on Groundwater

With the implementation of the mitigation measures described above, there will be a Negligible effect on groundwater.

5.7 Surface Water

Surface water quality may be affected by erosion, materials and waste management, and wastewater management. Surface water quantity may be affected by water withdrawal.

5.7.1 Surface Water Quality

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Once
Scope of Effect: Project Site
Reversibility: Reversible

Changes in surface water quality can affect aquatic resources in downstream waterbodies, which can have consequential effects on recreational, subsistence or commercial fishing. Potential effects of accidents and malfunctions are addressed in **Section 5.11.5**, potential effects on aquatic resources are addressed in **Section 5.8**, and potential effects on resource use are addressed in **Section 5.11.1**.

5.7.1.1 Erosion

The proposed alteration does not require undertaking any activities in or near Lalor Lake and therefore there will be no effect on surface water quality of Lalor Lake.

Surface water quality along the route of the Pipeline System could potentially be affected by various construction activities such as clearing or excavating. In total, the route of the Pipeline System traverses 20 locations which contain existing culverts. None of the culverts will be replaced as a part of the construction of the Pipeline System.

The potential impact to surface water quality in waterbodies along the Pipeline Route is assessed to be Negligible when taking into account the mitigation measures that will be followed:

- To prevent potential effects on surface water quality in culverts during construction, all physical activities near culvert locations will be carried out in accordance with DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat."
- Implementation of the measures to mitigate soil erosion (**Section 5.3.1**).

5.7.1.2 Waste Management

Surface water quality may be affected by improper handling of waste and materials; the risk of this occurring is assessed to be Negligible because of the reasons identified in **Section 5.3.2**. Measures listed in **Section 5.12.2** will be implemented to minimize risks of spills and leaks.

5.7.1.3 Wastewater Management

Wastewater generated by the Paste Facility include: return water and sanitary sewage. The effect of wastewater on surface water quality is assessed to be Negligible for the following reasons:

- Currently annually, tailings slurry (comprised of approximately 900,000 tonnes of solids and approximately 2,600,000 m^3 of water) is deposited into the Anderson TIA from the Stall Concentrator. The operation of the Paste Facility will divert 85% of those solids and 8% of the overlying water from being discharged into the Anderson TIA for use in the paste backfill process. The reduction in both the solid and liquid components of the waste deposited into the Anderson TIA can be expected to improve the overall surface water quality inside the TIA and may also result in some improvement in the quality of the water discharged from the TIA (because of the greater the proportion of freshwater inputs, such as precipitation and runoff).
- Measures listed in **Section 5.12.2** will be implemented to minimize risks of spills and leaks.
- Wastewater generated during the operation of the Paste Facility will be managed using existing licensed treatment facilities. The existing facilities will continue to operate in accordance with the applicable *Environment Act* licenses/Clean Environment Commission Orders.
- HBMS will continue regular monitoring as prescribed by the MMER of the effluent discharged from Anderson TIA into Anderson Creek to ensure that it meets MMER criteria (and therefore the limits laid out under the CEC Order No. 766). Water quality at the final discharge point of the TIA is and at all times has been in compliance with applicable regulatory requirements. No treatment, other than retention in the TIA, has ever been required.
- During operation, return water from the Paste Plant (**Section 2.1.4.4**) will be deposited into the Anderson TIA. This water will not contain tailings; therefore, it will not affect the surface water quality of the Anderson TIA.

5.7.1.4 Overall Impact on Surface Water Quality

The mitigation measures proposed above are deemed sufficient to mitigate potential effects on surface water quality. Residual effects are therefore assessed to be Negligible.

5.7.2 Surface Water Quantity

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Area
Reversibility: Reversible

Surface water quantity may be affected by water withdrawal, with consequential effects on surface water quality and groundwater.

It is estimated that during operation up to 79,300 m^3/year of fresh water will be required at the Lalor Paste Plant. The freshwater will be supplied from the Snow Lake via the Anderson Water Tank and from Chisel Lake via the

Lalor WTP (described above in **Sections 2.1.3.3 and 2.1.3.9**). The fresh water requirements are reduced, where practicable, through the use of water from other sources (*e.g.* makeup water from Anderson TIA and treated water from Chisel North WTP). As the need for fresh water is accommodated within existing approved limits, any effect on quantity of surface waterbodies is expected to be Negligible.

5.7.2.1 Overall Impact on Surface Water Quantity

For the reasons above, the overall residual impact on surface water quantity in waterbodies in the Project Area is deemed to be Negligible.

5.8 Aquatic Resources

Effects on aquatic resources occur primarily through changes in habitat quality or quantity. Reduced quantity and quality of habitat can reduce the abundance, diversity, or community composition of aquatic resources, with secondary effects on organisms higher in the food chain. Habitat quality may be affected by changes in surface water quality, surface runoff (elevated concentration of metals or other contaminants), air dispersion (dust), or any accidental leaks or spills during the construction phase of the Project. Habitat quantity can be reduced through direct changes in habitat caused by construction activities.

5.8.1 Fish and Fish Habitat

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Moderate term
Frequency: Intermittent
Scope of Effect: Project Site/Area
Reversibility: Reversible

The proposed alteration does not require undertaking any activities in or near Lalor Lake; therefore, there will be no effect on fish or fish habitat in Lalor Lake. The closest body of water to the Paste Facility is Lalor Lake. The fish habitat within Lalor Lake itself was assessed to be marginal and does not support large-bodied fish. In addition, the construction and closure of the Paste Facility will have no effect on fish and fish habitat with the implementation of the mitigation measures identified in **Section 5.3** (soil), **Section 5.4** (air), **Section 5.7** (surface water), and **Section 5.11.5** (accidents and spills).

As described in **Section 2.1.4.9**, the route of the Pipeline System traverses a total of 20 locations which contain existing culverts. Only three of the 20 culverts are in water crossings located in streams or off-take ditches which may lead to potentially fish bearing waterbodies (shown on **Figure 15**). These three culvert locations contain marginal fish habitat. The remaining 17 culverts were placed (at the time of the construction of the Lalor Access Road or former rail bed) in drainage features, either natural or engineered, that traversed that linear feature and are not connected to any potentially fish bearing habitat. None of these culverts will be replaced during construction of the Pipeline System. The effect on fish and fish habitat is assessed to be Negligible for the following reasons:

- The watercourses along the Pipeline System ROW do not contain unique or rare fish habitat.
- Any activities that occur near these culverts will be carried out in accordance with applicable DFO “Measures to Avoid Causing Harm to Fish and Fish Habitat” or other applicable standards.
- The mitigation measures identified in **Section 5.3** (soil), **Section 5.4** (air), **Section 5.7** (surface water), and **Section 5.11.5** (accidents and malfunctions) are assessed to be sufficient to prevent potential effects on fish and fish habitat.

During operation, the proposed alteration will not have any effect on fish and fish habitat downstream of the Anderson TIA as the only material that will be discharged into the Anderson TIA will be return water from the tailings dewatering process (discussed in more detail in **Section 5.7.1.3**).

5.8.2 Lower Trophic Level Biota

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Moderate term
Frequency: Intermittent
Scope of Effect: Project Site/Area
Reversibility: Reversible

Lower trophic level biota can be affected by a change in surface water quality and habitat disruption.

The nearest waterbody to the Paste Facility is Lalor Lake. The proposed alteration does not require undertaking any activities in or near Lalor Lake and therefore there will be no effect on lower trophic biota.

There is also a potential for surface runoff to adversely affect surface water quality along the Pipeline System ROW. Taking into account the proposed mitigation measures in **Section 5.3.1** (soil erosion) and **Section 5.7** (surface water), the effect on lower trophic biota along the Pipeline System is assessed to be Negligible.

5.8.3 Protected Aquatic Species

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Moderate term
Frequency: Intermittent
Scope of Effect: Project Site/Area
Reversibility: Reversible

Protected aquatic species can be impacted by project activities and components through changes in habitat quality and quantity. The pathway of effect would be primarily through indirect effects on other environmental components. It is assessed that the mitigation measures applied to those components are sufficient to prevent the potential effect on protected species (*e.g.* **Sections 5.3.1, 5.4**, and **5.7**).

As well, it is unlikely that protected species occur in any area which could be potentially affected by the Project. As noted in **Section 4.3.9**, only one aquatic species is protected federally: Shortjaw Cisco. No Shortjaw Cisco were collected in the aquatic surveys undertaken as part of the baseline investigations. It is assessed that Shortjaw Cisco are not likely present in any area which could be affected by the Project. For these reasons, the residual effect on Shortjaw Cisco is assessed to be Negligible.

5.8.4 Overall Impact on Aquatic Resources

For the reasons listed in the sections above, the residual effects on aquatic resources are assessed to be Negligible.

5.9 Terrestrial Flora Species

Effects on protected and other terrestrial flora include clearing and dust deposition.

5.9.1 Clearing

Magnitude of Effect: Minor
Direction of Effect: Adverse
Duration of Effect: Moderate term
Frequency: Once
Scope of Effect: Project Site
Reversibility: Reversible

As the Lalor site has been previously cleared for the Lalor Mine and no additional clearing will be required for the components located at the Lalor site, only the vegetation cover along the Pipeline System is considered as part of this analysis. The relevant portion of the Project site is comprised of a 10 m ROW around the components of the proposed alteration that are located off the Lalor Mine site.

The Forestry Branch of Manitoba Conservation Forest Management Units (FMU) is the most detailed vegetation identification information available for the undeveloped portions of the province. Each FMU identifies the vegetation cover class of the FMU by identifying the species composition based on a hierarchical series of attributes (*i.e.* land cover, productivity, tree type, and species composition). This cover class identifies a unique area of tree canopy that combines a series of attributes and species composition that can be used to determine a general habitat classification.

The cover classes present on the relevant portion of the Project Site were determined by clipping the footprint of the Pipeline System (11.9 ha) from the FMU that covers the Project Area (6,518 ha) and surrounding Project Region (55,529 ha). The relevant portion of the Project site includes a total of seven different cover classes: five vegetated cover classes and one water cover class as shown in **Table 5-3** (illustrated on **Figure 19**).

Table 5-3. Cover Classes and Areas

Cover Class	Species Composition or Subtype	Area (ha) of Cover Class			Relevant Portion of the Project Site as a % of	
		Relevant Portion of Project Site	Area	Region	Area	Region
Jack Pine	71-100%	0.07	337	3,016	0.02%	0.002%
Jack Pine	40-70% with Spruce	1.41	926	6,095	0.15%	0.02%
Treed Muskeg	With Black Spruce	6.84	1,745	10,113	0.39%	0.07%
Treed Muskeg	With Tamarack Larch	0.20	23.0	582	0.87%	0.03%
Black Spruce	71-100%	2.48	609	4,852	0.41%	0.05%
Water		0.16	974	11,544	0.02%	0.001%
Classes not found within the relevant portion of the Project Site		-	1,650	18,245	-	-
Total		11.92	6,518	55,529	0.18%	0.02%

Notes: Vegetation analysis illustrated on Figure 19.

To determine if the vegetation was unique to the relevant portion of the Project Site, vegetation communities that may be lost were compared to communities available in the Project Area and Project Region. The remaining areas of these eight vegetated cover classes were calculated and the percentages of each within the Project Area and Project Region were determined. It is worth noting that the Project Area and Project Region contain cover classes not found in the relevant portion of the Project Site (with combined area of approximately 1,650 ha and 18,245 ha respectively). The results are as follows:

- Of the five different vegetated cover classes, the largest area within the footprint of the relevant portion of the Project Site was *Treed Muskeg with Black Spruce* and the smallest cover class disturbed was *Jack Pine (71-100%)*.
- The least common cover class in the Project Area and Region is *Treed Muskeg with Tamarack Larch* (23 ha and 582 ha) with 0.2 ha disturbed by the relevant portion of the Project Site (representing 0.9% and 0.03% of the total available in the Project Area and Region respectively). The portion of this cover class which will be impacted at the relevant portion of the Project Site represents a very tiny fraction of the cover class contained within the Project Area and Region.

These cover classes are common to the area surround the Project Region. In addition to that, where possible during closure, the relevant portion of the Project Site will be returned to native conditions to the maximum extent possible. Once the infrastructure on the site has been removed and the site has been re-graded, disturbed areas will be re-vegetated with appropriate vegetation species as applicable. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

Based on HBMS mine closure experience in the Snow Lake region, the growth of grasses and mosses is apparent within the first few years following closure, whereas trees and shrubs take longer to establish through natural succession and may be evident within a five to ten year period following closure. However, to ensure the success of re-vegetation efforts at the Project Site, monitoring will occur regularly with subsequent re-vegetation occurring, if required. Once re-vegetation efforts are determine to be successful, monitoring will be scaled back or suspended.

5.9.2 Dust Deposition

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Intermittent
Scope of Effect: Project Site
Reversibility: Reversible

As noted in **Section 5.4.1**, dust generated during the construction and closure phases of the proposed alteration can potentially affect vegetation in the area by interfering with the photosynthetic ability of the vegetation. However, assuming implementation of the mitigation measures noted in **Section 5.4.1**, effects on terrestrial flora due to dust are assessed to be Negligible.

5.9.3 Protected Flora Species

Magnitude of Effect: Negligible
Direction of Effect: Neutral
Duration of Effect: Moderate term
Frequency: Intermittent
Scope of Effect: Project Site
Reversibility: Reversible

Protected terrestrial species can be impacted by project activities and components through changes in habitat quality and quantity. The pathway of effect is primarily through indirect effects on other environmental components and the mitigation measures applied to those components will sufficiently mitigate the potential effect on protected species (*e.g.* **Sections 5.9.1**, **5.4**, and **5.7**).

Of the species of special concern listed by the Manitoba CDC (Manitoba Sustainable Development, 2016a), only one terrestrial flora species is protected federally under the federal *SARA*: the Flooded Jellyskin. The federally-protected Flooded Jellyskin (lichen species) is known to occur in the Churchill River Upland Ecoregion; however, the nearest recorded occurrence is 93 km west-south-west of the Lalor site (COSEWIC, 2004). No Flooded Jellyskin were observed in the terrestrial surveys undertaken as part of the baseline investigations. It is assessed that Flooded Jellyskin are not likely present in any area which could be affected by the Project. For both these reasons, the residual effect on Flooded Jellyskin is assessed to be Negligible.

5.9.4 Overall Impact on Terrestrial Flora Species

For the reasons presented above, the overall residual impact on terrestrial flora species (including protected flora species) due to clearing and dust deposition is assessed to be Negligible.

5.10 Terrestrial Fauna Species

Clearing (loss of habitat), noise (disturbance), vehicle collisions (mortality), and light pollution are potential sources of effects on protected and other terrestrial fauna species.

5.10.1 Loss of Habitat

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Moderate term
Frequency: Once
Scope of Effect: Project Site
Reversibility: Reversible

Loss of vegetation through clearing can affect fauna by reducing the amount of habitat available. The potential impact of loss of habitat on terrestrial fauna species is assessed to be Negligible for the following reasons:

- No critical wildlife habitat was observed on the Project Site (such as calving or over-winter areas) and, based on site conditions and field observations, it is assessed that there is no critical wildlife in the Project Area. As discussed in **Section 4.5.1**, the site of the Lalor Mine has been previously cleared and the balance of the Project Site is characterized by little variety in plant habitats.
- As described in **Section 5.9.1**, the cover classes affected by the construction of the Pipeline System are not unique to the Project Area and there are similar habitats in the area which wildlife disturbed by the clearing activities can occupy.
- Nesting birds that may make use of the edge habitat available along the route of the Pipeline System will be able to continue to use this habitat following the development of the Project. Any clearing will be done outside of nesting season (April 15 to July 31). There will be no net loss of edge habitat due to clearing.
- As observed during field investigations, water crossings along Portion 5 (at culvert location LR01 under the Lalor Access Road), and Portion 3 (at culverts RB02 and RB03 under the former rail bed) of the Pipeline System offer potential brooding areas for waterfowl. The proximity of these brooding areas to potential nesting areas (edge habitat) makes these suitable waterfowl habitats. However, no brooding areas will be affected by Project activities, and as described above, there will be no net loss of edge habitat so the amount of suitable waterfowl habitat will remain.

At closure, the Project Site will be returned to the native conditions to the extent possible. The restoration of vegetation during closure will provide for restoration of available habitat. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

5.10.2 Noise

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Area
Reversibility: Reversible

As described in **Section 5.4.3**, noise generated during construction, operation, and closure phases of the proposed alteration has the potential to deter wildlife from the area. During construction, noise will be generated to varying degrees as described above. The potential impact on terrestrial fauna as a result of noise is assessed to be Negligible for the following reasons:

- It is anticipated that local fauna are likely already accustomed to some level of noise based on the existing activity in the area (*e.g.* Lalor Mine, Chisel North mine site, PR 395, PR 392, and the Stall Concentrator).
- Since the habitat in the Project Site is common and no specific or critical value to wildlife was identified, if local fauna are deterred from the Project Site, it is not anticipated that this will substantially affect wildlife as similar habitats are available in the Project Area and Region.

5.10.3 Risk of Vehicle Collisions

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Continuous
Scope of Effect: Project Site
Reversibility: Reversible

With the anticipated increase in traffic on local public roads (discussed in more detail in **Section 5.4.2**), there is potential for increased wildlife collisions. Moose, coyotes, and wolves may pass through the Project Area, including provincial highways and local roads. Edge vegetation and the open nature of these roads allows for ease of migration, making the area attractive to wildlife. The potential risk of collisions as a result of the Project is assessed to be Negligible for the following reasons:

- As local wildlife populations are considered low, the potential for increased wildlife collisions is also considered low.
- HBMS experience in the local area indicates that wildlife collisions are rare.
- Speed limits on access roads, local roads, and Provincial highways will continue to be implemented.

5.10.4 Light Pollution

The Paste Plant will operate 24 hours per day and 362 days a year, resulting in the need for lighting on the site at all times to allow for a safe working environment. Light pollution has the potential to adversely affect animal behaviour by interfering with their biological cycles.

The Lalor Mine already operates 24 hours per day, 365 days a year, utilizing lighting during all hours of darkness. With the addition of the Paste Plant, some additional lighting will be required, consistent with the type of lighting already present on the site. To minimize the light disturbance, HBMS has selected lighting that directs light down to the mine site only. With selection of this lighting, residual disturbance from light would be limited to the Project Site and the area immediately surrounding the site. Since the area is already developed, the effect of additional light pollution is assessed to be Negligible.

5.10.5 Protected Fauna Species

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Moderate term
Frequency: Once
Scope of Effect: Project Site/Area
Reversibility: Reversible

Protected terrestrial species can be impacted by project activities and components through changes in habitat quality and quantity. The pathway of effect is primarily through indirect effects on other environmental components. The mitigation measures applied to those components will sufficiently mitigate any potential effect on protected species (*e.g.* **Sections 5.7**, **5.4**, and **5.9.1**).

As noted in **Section 4.5.3**, there are 27 terrestrial wildlife species of Special Concern listed by the Manitoba CDC (Manitoba Sustainable Development, 2016a), none of which were observed in the areas examined during the extensive biophysical surveys of the Project Area. Of the species of Special Concern, eight terrestrial fauna species are protected either federally under *SARA* or provincially under the *Endangered Species and Ecosystems Act (ESEA)*: Boreal Woodland Caribou, Monarch Butterfly, Whip-poor-will, Common Nighthawk, Olive-sided Flycatcher, Rusty Blackbird, Northern Leopard Frog, and Yellow Rail. The potential impact of the proposed alteration on protected fauna species is assessed to be Negligible for the following reasons:

- The Provincial recovery strategy plan for Boreal Woodland Caribou identifies 15 known ranges of the species (Manitoba Woodland Caribou Management Committee, 2015). One of the Management Units, the Atikaki-Berens, overlaps with the Project Region. Although the Project Region contains potentially suitable habitat for Boreal Woodland Caribou, there are no known herds whose range overlaps with the Project Region.
- The Project Site continues to be an active mining area which is operated by HBMS 24 hours per day, 365 days a year, for a considerable period of time. There are no recorded sightings of caribou within the general region.
- The range of the Monarch butterfly can extend to the 54º Latitude of the Prairie Provinces. However, the bulk of occurrences are south of the 50º Latitude. Recorded occurrences are limited in the northern regions such as Thompson, The Pas and Grand Rapids, and these are generally considered vagrants (COSEWIC, 2010). The Project Region falls within the limits of the species' distribution, but no Monarch butterflies were recorded during terrestrial investigations.
- The Whip-poor-will is a well-known, nocturnal bird. It is an aerial foraging insectivore. The Whip-poor-will breeds in southern Manitoba and therefore would be unlikely to be found in the Project Region (COSEWIC, 2009a).
- The Common Nighthawk breeds across western Canada, including Manitoba below the treeline. The breeding habitat includes ground devoid of vegetation such as sand dunes, beaches, logged areas, burned-over areas, forest clearings, rocky out crops, rock barrens, peat bogs, and pastures. They have not been observed in the Project Region and are unlikely to nest within the Project Site (COSEWIC, 2007).
- The Olive-sided Flycatcher breeds in boreal, sub-boreal, interior and coastal forest regions, including Manitoba (Environment Canada, 2015). There have been no observations in the Project Region during terrestrial investigations.
- The Rusty Blackbird breeding range includes a large portion of North America (COSEWIC, 2006). There have been no observations in the Project Region during terrestrial investigations.
- The range for the Northern Leopard Frog overlaps with the Project Region, but none were spotted during the terrestrial investigations (COSEWIC, 2009b).
- The Yellow Rail distribution in Manitoba is scattered through locations south of the Boreal Shield Ecozone and is concentrated in the Boreal Plains and Aspen Parkland portions of the Prairie Ecozone (COSEWIC, 2009c). Although there is potential for Yellow Rail to occur in the Ecozone, there are no known occurrences of Yellow Rail within the Project Region.

5.10.6 Overall Impact on Terrestrial Fauna Species

For the reasons outlined above, the residual impact (loss of habitat, noise, light pollution, and risk of vehicle collisions) on terrestrial fauna species (including protected fauna species) is assessed to be Negligible.

5.11 Socio-Economic Effects

5.11.1 Land and Resource Use

Magnitude of Effect: Negligible
Direction of Effect: Neutral
Duration of Effect: Moderate term
Frequency: Once
Scope of Effect: Project Site/Area
Reversibility: Reversible

Land and resource uses and users in the Project Region that may be indirectly impacted include:

- Harvesting and trapping opportunities.
- Fishing (recreational, subsistence, and commercial).

- Recreational use of existing trails.
- General use of the Project Area and Region.

The potential impact on land and resource use is assessed to be Negligible for the following reasons:

- The Project Site has been developed for mining purposes for nearly 40 years. The Project will not change the land and/or resource use at the Project Site. All of the components of the proposed alteration are contained within land that is held by HBMS under lease or in fee simple and which is already occupied and used by HBMS for mining purposes.
- As presented in this report, residual environmental effects on environmental components have been assessed to be Negligible in magnitude.
- No activity, component or impact of the proposed alteration will impede access to downstream resources or affect any current user's ability to continue to exercise any recreational, commercial or subsistence use of these resources.
- All trappers with rights in the area to be affected have been identified and HBMS maintains communication with them and works with them to ensure that access to their traplines is not impacted as a result of HBMS projects.
- With respect to snowmobile trails, HBMS has discussed the proposed alteration with members of the Sno-Drifters snowmobiling club. The club has no concerns with the proposed alteration. Prior to commencement of construction, HBMS will notify the club, to ensure that snowmobilers do not interfere with the construction or operation of the proposed alteration.

The proposed Project will not cause any impact on either Park or Park users as residual environment effects that extend into the Project Region (Wekusko Falls Provincial Park is the only park within the Project Region) have been assessed as Negligible.

5.11.2 Heritage Resources

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short Term
Frequency: Rare
Scope of Effect: Project Site
Reversibility: Irreversible

Project activities such as clearing or excavating can potentially affect heritage resources. However, as described in **Section 4.6.2**, there are no known heritage resources at the Project Site and the potential for any to be found is minimal. There will be no further disturbance beyond the Project Site. Therefore, the potential effects on heritage resources are anticipated to be Negligible.

In the unlikely event that heritage resources are identified, the following measures will be implemented:

- If artifacts or historical features of skeletal remains are encountered during construction activities, work activities will stop immediately around the affected area with the find reported to the site supervisor. A qualified archaeologist would investigate and assess the find prior to continuation of work.
- If skeletal remains are encountered, the find will be immediately reported to the site supervisor and the RCMP.

5.11.3 Aesthetics

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Short term
Frequency: Intermittent
Scope of Effect: Project Site

Reversibility: Reversible

Project activities during construction and operation could potentially impact the aesthetics of the Project Site. This potential impact is assessed to be Negligible for the following reasons:

- Project components are located in areas that have been previously disturbed as part of the Lalor Mine, Anderson TIA, or other HBMS activity in the area.
- The site will be inspected on a regular basis for loose waste and debris in order to maintain a clean site.
- Waste and debris will be stored in bins and removed from the site on a regular basis.
- During the closure phase, the Project Site will be re-vegetated and returned to native conditions to the extent possible. The Closure Plan for the Lalor Mine will be updated to include the closure activities associated with the proposed alteration.

5.11.4 Effects on Indigenous Peoples

As noted above in **Section 1.4**, HBMS has operated in the Snow Lake district for over 50 years. The Lalor Mine site has been in continuous occupation since 2007. The route of the proposed Pipeline System lies within land that has been under use, occupation, and control by HBMS for decades. The route of the Chisel Access Road itself is owned by the Town of Snow Lake and leased to HBMS. All of the components of the proposed alteration are contained within land that is held by HBMS under lease or in fee simple and which is already occupied and used by HBMS for mining purposes.

Based on Government of Manitoba and Federal sources, there is no Indian Reserve or Registered Trap Line zone within the Project Region. **Figure 18** shows the locations of these indigenous communities relative to the Project Region.

The Project does not require access to, use or occupation of, or the exploration, development, and production of lands and resources currently used for traditional purposes by indigenous peoples. All elements of the proposed alteration will be on land which HBMS holds under lease or in fee simple, and is occupied and used by HBMS for mining purposes as follows:

- The Paste Facility component lies within the Lalor Mine site. It lies on land that has been under continuous use for mining purposes since at least 2007.
- Portions 1 and 2 of the Pipeline System are located on land which the proponent has used for mining purposes since the late 1970's. These portions lie behind the gates of existing HBMS projects, which excludes users other than the proponent, on land that has been taken up for mining purposes for over 30 years.
- Portion 3 of the Pipeline System falls within the ROW for a former rail bed, which is owned by HBMS pursuant to Certificate of Title No. 1701932 (Plan No. 784). This is private land to which no one other than HBMS employees and/or contractors have a right of access.
- Portion 4 of the Pipeline System will lie within the ROW for the Chisel Access Road, which is leased to HBMS by the Town of Snow Lake and which is in daily use for industrial traffic. In addition, Provincial regulations prohibit hunting within 300 m of roadways.
- Portion 5 of the Pipeline System, which follows the Lalor Access Road, lies on land which is controlled by gated access, and which has been under continuous use by HBMS for mining purposes since at least 2007.

The Anderson BPS, Makeup Water Pumphouse, and Anderson Ancillary Pipes will lie within the site of the Anderson TIA, near the existing tailings discharge point, on land which the proponent has used for mining purposes since the late 1970's.

5.11.5 Overall Impact on Socio-Economic Environment

For the reasons outlined above, the residual impact on components of the socio-economic environment (land and resource use, heritage resources, aesthetics, and indigenous peoples) is assessed to be Negligible.

5.12 Accidents and Malfunctions

To prevent accidents and malfunctions, all phases of the Project will be conducted in accordance with applicable regulatory requirements. The following sections provide additional details on precautionary measures that will be implemented by HBMS to further minimize the potential for accidents and malfunctions to occur.

5.12.1 Worker Health and Safety

Worker protection in Manitoba is regulated through standards, procedures, and training required under *The Workplace Safety and Health Act*. Safety equipment and personal protective equipment are supplied to employees or are located at the safety office at the Lalor Mine, where needed.

5.12.2 Spills and Leaks

Environmental effects may occur due to fuel and chemical spills from diesel fuel, lubricants, oils, and hydraulic fluids. Effects may also occur in the case of a tailings spill from the tailings pipe which will run from the Anderson BPS to the Paste Facility or at the Paste Facility itself. An accidental release of hazardous materials and/or equipment fluids could occur from improper storage and handling procedures. Accidental releases have the potential to affect air, surface water, groundwater, and soils, with consequential effects on vegetation, aquatic resources, and possible human health and safety.

5.12.2.1 Standard Spill and Leak Prevention Measures

The following HBMS standard procedures will be employed to prevent spills from occurring during Project activities:

- Any diesel tanks used on site will be self-contained aboveground storage tank(s).
- When servicing requires drainage or pumping of lubricating oils or other fuels from equipment, a groundsheet of suitable material and size will be spread on the ground to catch all fluid in the event of a leak or spill. An adequate supply of suitable absorbent material and any other supplies and equipment necessary to immediately clean up spills will also be available.
- Storage and disposal of liquid wastes and filters from equipment maintenance, and any residual material from spill clean-up will be contained in an environmentally safe manner and in accordance with any existing regulations.
- Waste oils, fuels, and hazardous wastes (if any) will be handled in a safe manner. Staff will be required to transport, store, and handle all such substances as recommended by the suppliers and/or manufacturers and in compliance with applicable Federal, Provincial, and Municipal regulations. Manitoba Sustainable Development will be notified immediately if a reportable spill occurs.
- Fuels, oils, or other hazardous materials will be stored only in designated areas.
- HBMS will ensure that fuel handlers are trained and qualified, and that appropriate emergency response measures are in place and readily available.
- Storage sites will be inspected periodically for compliance with requirements as applicable.
- Investigation and remediation of spills will be undertaken, if necessary.
- Remediation of soils, as required, will be undertaken as part of closure activities.
- Personnel on site will be trained in how to deal with spills, including knowledge of how to properly deploy site spill kit materials.
- Service and repairs of equipment shall only be performed by trained personnel.
- Vehicles and equipment will be maintained to minimize leaks. Regular inspections of hydraulic fuel systems on machinery will be completed on a routine basis; when detected, leaks will be repaired immediately.

5.12.2.2 Pipeline System Leak Detection

In addition to the above general measures to avoid accidental spills, leak detection for Pipe 1 (tailings pipe) will be provided by flow and pressure monitoring stations along the pipe to detect anomalies. Communication to the paste plant process control system will be provided by fibre optic cable running the length of the pipeline. In the event of an alarm, site personnel will be dispatched to visually inspect the length of the pipeline to determine if there is a problem. The pipeline will be inspected daily by HBMS personnel.

5.12.2.3 Emergency Spill Containment System

An emergency containment system constructed at the Paste Facility will consist of a spill swale and a lined temporary containment pond (as described in **Section 2.1.1.5.1**). It will have capacity to contain approximately 110% of the largest filter feed tank volume. The emergency containment pond will temporarily hold tailings in the event of an emergency; tailings will be pumped back into the filter feed tank once normal operation resumes. The containment pond will be periodically inspected by HBMS personnel.

5.12.2.4 Summary

With the above noted mitigation measures employed as necessary, and assuming implementation of safe work practices, the risk of spills is assessed to be appropriately mitigated.

5.12.3 Fires and Explosions

The presence of mechanical equipment, fuels, and other hazardous materials creates a potential for fires and explosions. Such incidents can harm on-site personnel, cause equipment damage and lead to a release of contaminants, resulting in consequent effects to other environmental components (air, surface water, groundwater, flora, fauna, aquatic resources, and aesthetics). Potential socio-economic effects may occur if a site shut-down is required in the event of a large accident (such as incidents that may require evacuation, disruption of traffic, etc.).

The components of the proposed alteration have the potential to be affected by off-site forest fires during the summer months. Effects could include loss of infrastructure or affect access to the site. The Paste Facility, Anderson Booster Pump Station, and Makeup Water Pumphouse will be built on crushed rock pads. This crushed rock is anticipated to act as a fire barrier for the site.

The Project Site is already equipped with appropriate fire control measures. In addition, the following measures will be implemented:

- The mine rescue team at the Lalor Mine has been trained for fire and explosion response with HBMS call out procedures implemented and will have the ability to respond to any fire or explosion emergencies associated with the proposed alteration.
- Storage and use of hazardous materials, including flammable waste, will be in compliance with regulatory requirements (as described in **Section 5.12.2**).
- Smoking will be restricted to designated areas.

With the measures outlined above, and assuming implementation of typical safe work practices, the risk of fires and explosions is assessed to be appropriately mitigated.

5.12.4 Transportation Accidents

An increase in traffic has the potential to increase the likelihood for transportation accidents, including vehicular and wildlife collisions. Wildlife collisions are discussed above in **Section 5.10.3**. Transportation accidents can consequently result in release of pollutants in the environment (diesel, oils, etc.), or materials that the vehicles colliding are transporting (cement, etc.). Such accidental releases to the environment could potentially result in secondary effects on other environmental components (groundwater contamination through seepage, decline in surface water quality through runoff) or tertiary effects on flora (decline of growth potential due to soil contamination), fauna, aquatic resources, and human health. Potential socio-economic effects may occur if road shutdowns are required in the event of a large accident (traffic interruptions could disrupt business and activity if people are not able to commute to work).

As discussed in **Section 5.4.2**, the increase in traffic on public and private roads (e.g. Lalor Access Road, PR 395, and PR 392) during construction is considered Negligible. HBMS will continue with the following measures to reduce the risk of transportation accidents:

- Vehicle speed limits will continue to be imposed (e.g. 20 km/hr at the Lalor site and 40 km/hr along the Lalor Access Road).
- Personnel retained to drive and operate vehicles will have a valid Manitoba Driver's License with a copy provided to HBMS personnel.
- Speed limits on access roads, local roads, and Provincial highways will continue to be implemented. Signage and speed limits on PR 395, PR 392, PTH 39, and PTH 10 are regulated by the Province of Manitoba.

The above-noted mitigation measures are assessed to mitigate the potential risk for transportation accidents occurring during all phases of the proposed alteration.

5.12.5 Power Failure

During construction and operation there is potential for environmental effects due to power failure. Site power may be lost due to power line failure, fire/explosion and/or severe weather.

The Paste Facility, the leak detection system, the Makeup Water Pumphouse, and the Anderson BPS require power to operate. To prevent effects due to power failure, backup power will be supplied to the site via diesel generators to provide for the safe evacuation of the mine. HBMS will provide backup power for all critical infrastructure and equipment.

The supply of backup power is anticipated to appropriately mitigate the potential risks of a power failure during construction and operation.

5.13 Summary of Environmental Effects and Mitigation Measures

The potential environmental effects of the construction and operation of the proposed alteration are considered Negligible, as described in previous sections of this chapter.

Table 5-4 summarizes potential environmental effects of the proposed Project and the design features, standard operating procedures and other mitigation measures that will be implemented.

Table 5-5 summarizes potential accidents and malfunctions and measures to reduce the risk of such occurrences.

Table 5-4. Summary of Environmental Assessment and Mitigation Measures

Environmental and Social Component	Project Phase	Sources of Potential Effects	Summary of Measures	Residual
Topography	Construction	Clearing, leveling, trenching, stockpiling materials during construction of Paste Facility and Pipeline System	Whenever practicable, existing access roads and laydown areas will be used in order to minimize changes to topography.	Negligible
			All changes to topography will occur inside the boundary of HBMS operations on land which only HBMS has a right to access.	
			The Project Site consists of previously levelled and disturbed areas such as the Lalor site, former rail bed, and operation site of Anderson TIA, therefore minimum clearing and levelling will be required. Any additional levelling activities for the Paste Facility will be minimal and have already been approved under the Lalor Mine.	
	Closure	Restoration of the Project Site, including contouring.	Closure phase will include restoration of any changes to topography to match the pre-construction condition of the surrounding area to the extent practical.	
Soil - Erosion	Construction	Clearing and grubbing will be required for construction of the Pipeline System.	The site for the Paste Facility has already been cleared, levelled, and covered with crushed non-acid generating (NAG) rock as a part of the construction of the Lalor Mine.	Negligible
			Any activities that occur near culverts or other watercourses along the route will be carried out in accordance with applicable DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat" or other applicable standards.	
			All rock used to widen the former rail bed will be non-acid generating and will be clean and free of silt and other materials.	
			The Project Site consists of previously levelled and disturbed areas such as the Lalor site, former rail bed, and operational site of the Anderson TIA, therefore minimum clearing and levelling will be required.	
			Erosion and Sediment Control (ESC) methods will be in place to prevent the generation and movement of sediment-laden water.	
		Stockpiling and excavation.	Excavated materials will be stockpiled, compacted and reused, where appropriate.	
			Excavation activities will not occur during high rain or wind events, which will minimize the erosion potential of exposed soils.	
	Closure	In order to ensure reversibility of the Project Site, HBMS will undertake the following (to the extent possible).	Apply soil to disturbed areas.	
			Allow all disturbed areas to naturally re-vegetate.	
			Contour disturbed areas to match the surrounding topography to the extent possible.	
Soil – Materials and Waste Management	Construction, Operation, and Closure	Wastes such as used oils, rags, drum and miscellaneous garbage can potentially affect soil quality, which can have subsequent effects on other environmental components (*e.g.,* vegetation, groundwater, and surface water).	Wastes generated during construction will be collected in garbage bins maintained at specific locations throughout the Project Site. The bins will be emptied on a regular basis for recycling or disposal at a licensed waste disposal facility.	Negligible
			Waste oils and other hazardous materials generated (chemicals, reagents, waste oil, lubricants or petroleum products) will be removed by a licensed hazardous materials handler for appropriate disposal or recycling.	
Air - Dust	Construction and closure	Dust may be produced during construction activities (clearing, grubbing, stockpiling, transporting materials and/or employees, and general use of construction equipment).	Areas to be cleared will be minimized where practical; project components lie mainly on previously disturbed areas.	Negligible
			Clearing and levelling at the Lalor site has been completed as part of the development of the approved Lalor Mine.	
			Stockpiled materials will be compacted and re-used, where practicable. Material stockpile heights will be limited.	
			Trucks hauling materials will be covered to minimize dust coming off loads.	
			Re-vegetation of disturbed areas will occur as part of site closure activities and will provide long term mitigation of dust effects upon completion of closure activities.	
		Dust generation from construction traffic along the main roads and on site.	The increase in traffic during construction and closure phases (when traffic volumes are highest) is temporary.	
			If required, dust suppression activities, such as the use of approved dust control agents, will be undertaken.	
			Speed limits on main roads and access roads will be adhered to at all times. The Lalor Access Road has a speed limit of 40 km/hr, which will continue to be imposed. The same speed limit (or less) will apply to the Pipeline System ROW. The Lalor site has a speed limit of 20 km/hr, which will continue to be imposed. The speed limits on all roads will be adhered to.	

Environmental and Social Component	Project Phase	Sources of Potential Effects	Summary of Measures	Residual
			Vegetated buffers will be maintained to minimize the transport of dust generated on site.	
	Operation	During operation, dust will be generated during the offloading of cement and mixing paste backfill. Delivery of cement will occur on a daily basis.	The cement silos will be equipped with a dust collection system will be used during cement offloading.	
			The paste batch mixer will be equipped with a wet scrubber as described in **Section 2.1.1.3.3**.	
			The increase in traffic during operation is limited to 2.25 vehicles per day.	
Air - Emissions	Construction	Exhaust emissions will be generated during delivery of materials and employees to the site, and other operation of vehicles. Emissions will also be generated during construction of the water retention dams, spillway, seepage collection system, as well as preparation activities (such as clearing and grubbing of laydown areas, temporary trails).	The increase in traffic during construction along PR 395 and PR 392 is temporary and exhaust emissions as a result of this increase are Negligible in relation to air quality in the Project Region.	Negligible
			Vehicles and equipment will be well maintained.	
			Vehicle idling will be kept to a minimum.	
			All vehicles used for the proposed Project will comply with Environment Canada's *On-Road Vehicle and Engine Emission Regulations* as required.	
Air – Noise and Vibration	Construction and Closure	Sources of noise would be typical of heavy equipment such as bulldozers and excavators.	HBMS will provide hearing protection as required to ensure employees working on site are protected from noise during construction and closure activities.	Negligible
			All closure activities will be carried out in accordance with *The Workplace Safety and Health Act* and HBMS' Occupational Health and Safety Standard (OHSAS) 18000 certified management system, which will avoid potential effects on health and safety.	
	Operation	Operation of the proposed alteration; generation of paste backfill, operation of pumps, including the delivery of materials and employees.	HBMS will provide hearing protection as required to ensure employees working on site are protected from noise during construction, operation, and closure activities.	
			The compressors, generators, pumps, and paste batch mixer will be enclosed in the Paste Facility.	
			The Paste Facility is located on an active mine site that has noise associated with its operation.	
Climate	Construction and Closure	Sources of GHG emissions are: vehicles and exhausts from diesel construction equipment (general vehicle movement on-site, using equipment for grading, placing materials, etc.).	The implementation of mitigation measures listed in **Section 5.4.2**.	Negligible
Surface Water – Quality	Construction and Closure	Water quality may be affected due to erosion.	Measures listed in **Section 5.3.1** will be implemented to minimize risks of erosion.	Negligible
			To prevent potential effects on surface water quality in culverts during construction, all physical activities near culvert locations will be carried out in accordance with DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat."	
	Construction and Closure	Water quality may also be affected as a result of improper handling of solid and construction waste.	Surface water quality may be affected by improper handling of waste and materials; the risk of this occurring is assessed to be Negligible because of the reasons identified in **Section 5.3.2**.	
			Measures listed in **Section 5.12.2** will be implemented to minimize risks of spills and leaks.	
	Operation	Deposition of liquid wastes during operation.	Measures listed in **Section 5.12.2** will be implemented to minimize risks of spills and leaks.	
			Wastewater generated during the operation of the proposed alteration will be managed using existing licensed treatment facilities. The existing facilities will continue to operate in accordance with their *Environment Act* licenses/Clean Environment Commission Orders.	
			During operation, return water from the Paste Facility (**Section 2.1.4.4**) will be deposited into the Anderson TIA. This water will not contain tailings; therefore, it will not affect the surface water quality of the Anderson TIA.	
			HBMS will continue regular monitoring as prescribed by the MMER of the effluent discharged from Anderson TIA into Anderson Creek to ensure that it meets MMER criteria (and therefore the limits laid out under the CEC Order No. 766).	

Environmental and Social Component	Project Phase	Sources of Potential Effects	Summary of Measures	Residual
Surface Water – Quantity	Operation	The process for creating paste backfill requires freshwater.	The need for freshwater is accommodated within existing approved limits.	Negligible
			The freshwater requirements are reduced, where practicable, through the use of water from other sources (*e.g.* makeup water from Anderson TIA and treated water from Chisel North WTP).	
Aquatic Resources – Fish and Fish Habitat	Construction and Closure	Changes to surface water quality (**Section 5.7.1**), through deposition of dust (**Section 5.4.1**), soil erosion (**Section 5.3.1**), spills or leaks (**Section 5.12.2**), or changes to the lower trophic level biota (**Section 5.8.2**) can impact fish the quality of fish habitat.	The implementation of the mitigation measures identified in **Section 5.3** (soil), **Section 5.4** (air), **Section 5.7** (surface water), lower trophic level biota (**Section 5.8.2**), and **Section 5.11.5** (accidents and spills).	Negligible
			The watercourses along the Pipeline System ROW do not contain unique or rare fish habitat.	
		Potential sources of impacts to habitat quantity include any disturbance to the bank and bed of fish-bearing watercourses.	Any activities that occur near these culverts will be carried out in accordance with applicable DFO "Measures to Avoid Causing Harm to Fish and Fish Habitat" or other applicable standards.	
	Operation	Deposition of liquid wastes during operation	During operation, the proposed alteration will not have any effect on fish and fish habitat downstream of the Anderson TIA as the only material that will be discharged into the Anderson TIA will be return water from the tailings dewatering process.	
Aquatic Resources – Lower Trophic Level Biota	Construction and Closure	Lower trophic level biota can be affected by change in surface water quality and habitat disruption.	Measures listed in **Section 5.3.1** will be implemented to minimize risks of soil erosion.	Negligible
			Measures listed in **Section 5.7** will be implemented to minimize risks of changes to surface water quality and quantity.	
Aquatic Resources – Protected Aquatic Species	Construction and Closure	Shortjaw Cisco is a federally-listed species under SARA, may occur in the Project Region.	This species was not observed during the biophysical surveys and has not been reported in the Grass River sub-basin in the Nelson River Basin.	Negligible
Terrestrial Flora - Clearing	Construction and Closure	The clearing associated primarily with the construction of the Pipeline System.	The cover classes disturbed by the Project are common to the area surrounding the Project Area and Project Region.	Negligible
			Where possible during closure, the Project Site will be returned to native conditions to the maximum extent possible.	
			Once the infrastructure on the site has been removed and the site has been re-graded, disturbed areas will be re-vegetated with appropriate vegetation species as applicable.	
			To ensure the success of re-vegetation efforts at the Project Site, monitoring will occur regularly with subsequent re-vegetation occurring, if required. Once re-vegetation efforts are determined to be successful, monitoring will be scaled back or suspended.	
Terrestrial Flora– Dust Deposition	Construction and Closure	Dust may be produced during construction activities (clearing, grubbing, stockpiling, transporting materials and/or employees, and general use of construction equipment).	Measures listed in **Section 5.4.1** will be implemented to minimize risks of dust.	Negligible
Terrestrial Flora– Protected Flora Species	Construction and Closure	The federally-protected Flooded Jellyskin (lichen species) is known to occur in the Churchill River Upland Ecoregion, and may occur in the Project Region.	This lichen species was not observed during the biophysical surveys.	Negligible
Terrestrial Fauna– Loss of Habitat	Construction and Closure	Loss of vegetation through clearing and flooding can affect terrestrial fauna by reducing the amount of habitat available.	No critical wildlife habitat was observed on the Project Site (such as calving or over-winter areas) and, based on site conditions and field observations, it is assessed that there is no critical wildlife in the Project Area. As discussed in **Section 4.5.1**, the Project Site is characterized by little variety in plant habitats.	Negligible
			As described in **Section 5.9.1**, the cover classes affected by the construction of the Pipeline System are not unique to the area and there are similar habitats in the area which wildlife disturbed by the clearing activities can occupy.	
			Nesting birds that may make use of the edge habitat available along the route of the Pipeline System will be able to continue to use this habitat following the development of the Project. Any clearing will be done outside of nesting season (April 15 to July 31). There will be no net loss of edge habitat due to clearing.	
			As observed during field investigations, water crossings along Portion 5 (at culvert location LR01 under the Lalor Access Road), and Portion 3 (at culverts RB02 and RB03 under the former rail bed) of the Pipeline System offer potential brooding areas for	

Environmental and Social Component	Project Phase	Sources of Potential Effects	Summary of Measures	Residual
			waterfowl. The proximity of these brooding areas to potential nesting areas (edge habitat) makes these suitable waterfowl habitats. However, no brooding areas will be affected by Project activities, and as described above, there will be no net loss of edge habitat so the amount of suitable waterfowl habitat will remain.	
			To the extent practicable, previously cleared areas will be used for temporary trails and/or laydown areas to minimize the area to be cleared.	
			At closure, the Project Site will be returned to the native conditions to the extent possible. The restoration of vegetation during closure will provide for restoration of available habitat.	
Terrestrial Fauna–Noise	Construction and Closure	Sources of noise would be typical of heavy equipment such as bulldozers and excavators.	It is anticipated that local fauna are likely already accustomed to some level of noise based on the existing activity in the area (Lalor Mine, PR 395, PR 392 and the Stall Lake Concentrator).	Negligible
			The implementation of the mitigation measures identified in **Section 5.4.3**.	
	Operation	Noise associated with the operation of the Paste Facility (mixing paste backfill)	Since the habitat in the Project Site is common and no specific or critical value to wildlife was identified, if local fauna are deterred from the Project Site, it is not anticipated that this will substantially affect wildlife as similar habitats are available in the Project Area and Region	Negligible
			It is anticipated that local fauna are likely already accustomed to some level of noise based on the existing activity in the area (Lalor Mine, Chisel North mine site, PR 395, PR 392, and the Stall Concentrator).	
Terrestrial Fauna–Risk of Vehicle Collisions	Construction and Closure	With the anticipated increase in traffic on local public roads (discussed in more detail in **Section 5.4.2**), there is potential for increased wildlife collisions.	As local wildlife populations are considered low, the potential for increased wildlife collisions is also considered low.	Negligible
			HBMS' experience in the local area indicates that wildlife collisions are rare.	
			Continued implementation of speed limits on the temporary trails, local roads and Provincial highways.	
Terrestrial Fauna–Light Pollution	Construction, Closure, and Operation	Lighting for construction activities and during operation will be required for safety. The Paste Plant will operate 24 hours per day and 362 days a year, resulting in the need for lighting on the site at all times to allow for a safe working environment	To minimize the light disturbance, HBMS has selected lighting that directs light down to the mine site only. With selection of this lighting, residual disturbance from light would be limited to the Project Site and the area immediately surrounding the site.	Negligible
			This area is already developed and additional lighting requirements will be minimized, where practical and safe.	
Terrestrial Fauna–Protected Fauna Species	Construction and Closure	Boreal Woodland Caribou is a provincially-listed mammal which a Management Unit which overlaps with the Project Region.	There are no known herds whose range overlaps with the Project Region.	Negligible
		Monarch butterfly, a federally-listed insect has a range which overlaps with the Project Region.	The Project Region falls within the limits of the species' distribution, but no monarch butterflies were recorded during the terrestrial investigations.	
		Norther Leopard Frog is a federally-listed amphibian whose range overlaps with the Project Region.	The range overlaps with the Project Region, but none were observed during the terrestrial investigations.	
		Yellow Rail is a federally-listed bird whose range extends into the Ecozone.	Although there is potential for the Yellow Rail to occur in the Ecozone, there are no known occurrences of Yellow Rail within the Project Region.	
		Whip-poor-will is a federally-listed bird whose range extends into the Ecozone.	Although there is potential for the Whip-poor-will to occur in the Ecozone, there are no known occurrences within the Project Region.	
		Common Nighthawk is a federally-listed bird whose range extends into the Ecozone.	Although there is potential for the Common Nighthawk-will to occur in the Ecozone, there are no known occurrences within the Project Region.	
		Olive-sided Flycatcher is a federally-listed bird whose range extends into the Ecozone.	Although there is potential for the Olive-sided Flycatcher to occur in the Ecozone, there are no known occurrences within the Project Region.	
		Rusty Blackbird is a federally-listed bird	Although there is potential for the Rusty Blackbird to occur in the Ecozone, there are no known occurrences within the Project	

Environmental and Social Component	Project Phase	Sources of Potential Effects	Summary of Measures	Residual
		whose range extends into the Ecozone.	Region.	
Socio-Economic – Land and Resource Use	Construction and Operation	Land and resource uses in the Project Region that may indirectly be impacted by environmental effects of the proposed Project include; harvesting and trapping opportunities; fishing (recreational, subsistence and commercial); recreational use of existing trails and parks; and general use of the Project Area and Region.	The Project Site has been developed for mining purposes for nearly 40 years. The Project will not change the land and/or resource use at the Project Site. All of the components of the proposed alteration are contained within land that is held by HBMS under lease or in fee simple and which is already occupied and used by HBMS for mining purposes.	Negligible
			As presented in this report, residual environmental effects on environmental components have been assessed to be Negligible in magnitude.	
			No activity, component or impact of the proposed alteration will impede access to downstream resources or affect any current user's ability to continue to exercise any recreational, commercial or subsistence use of these resources.	
			All trappers with rights in the area to be affected have been identified and HBMS maintains communication with them and works with them to ensure that access to their traplines is not impacted.	
			With respect to snowmobile trails, HBMS has discussed the proposed Project with members of the Sno-Drifters snowmobiling club. The club has no concerns with the Project. Prior to commencement of construction, HBMS will notify the club, to ensure advance notification to the club's members.	
			The proposed Project will not cause any impact on either Park or Park users as residual environment effects that extend into the Project Region (Wekusko Falls Provincial Park is the only park within the Project Region) have been assessed as Negligible.	
Socio-Economic – Heritage Resources	Construction	Project activities such as clearing or excavating can potentially affect heritage resources.	There are no known heritage resources at the Project Site and the potential to find any is low. No further disturbance beyond the Project Site will occur.	None
			If artefacts or historical features of skeletal remains are encountered during closure activities, work activities would stop immediately around the affected area with the find reported to the site supervisor. A qualified would archaeologist investigate and assess the find prior to continuation of work.	
			If skeletal remains are encountered, the find will be immediately reported to the site supervisor and the RCMP.	
Socio-Economic – Aesthetics	Construction	Project activities during preparation and construction could potentially impact the aesthetics of the Project Site.	Project components are located primarily in areas that have been previously disturbed as part of the construction of the Anderson TIA or other HBMS activity in the area.	None
			The site will be inspected on a regular basis for loose waste and debris in order to maintain a clean site.	
			Waste and debris will be stored in bins and removed from the site on a regular basis.	
			During the closure phase, the disturbed areas will be contoured, where required, and allowed to naturally re-vegetate.	
Socio-Economic – Effects on Aboriginal Peoples	Construction	Aboriginal users in the Project Region may indirectly be impacted by environmental effects of the proposed Project.	As noted above in **Section 1.4**, HBMS has operated in the Snow Lake district for over 50 years. It has been in continuous occupation of the site of the Paste Facility component since 2007. The route of the proposed Pipeline System is adjacent to a highway used for industrial traffic or is on land that has been under use, occupation, and control by HBMS for decades. All of the components of the proposed alteration are contained within land that is held by HBMS under lease or in fee simple and which is already occupied and used by HBMS for mining purposes.	None
			Based on Government of Manitoba and Federal sources, there is no Indian Reserve or Registered Trap Line zone associated with First Nation/Aboriginal community use or other Aboriginal interest located within the Project Region. **Figure 18** shows the locations of these First Nations relative to the Project Region.	None
			The Project does not require access to, us or occupation of, or the exploration, development, and production of lands and resources currently used for traditional purposes by Aboriginal peoples. All elements of the proposed alteration will be on land which HBMS holds under lease or in fee simple, and is occupied and used by HBMS for mining purposes (described in **Section 5.11.4**).	None

Table 5-5. Summary of Potential Accidents and Malfunctions and Measures to Mitigate Risk of Occurrence

Risks Associated with Accidents and Malfunctions	Project Phase	Possible Consequences	Measures to Reduce Risk of Occurrence	Conclusion
Worker Health and Safety	Construction, operation and closure	Workplace accidents (worker safety)	Worker protection in Manitoba is regulated through standards, procedures and training required under *The Workplace Safety and Health Act*.	Risk is assessed to be appropriately mitigated
			Safety equipment and personal protective equipment will either be supplied to the employees or be located throughout the facility, where needed.	
Spills	Construction, operation and closure	Chemical spills from diesel fuel, lubricants, oils, hydraulic fluids, and transporting reagents (air quality, water quality, groundwater quality, fauna, flora and aquatic species, human health and safety).	Diesel tanks will be a self-contained aboveground storage tank	Risk is assessed to be appropriately mitigated
			When servicing requires drainage or pumping of lubricating oils or other fluids from equipment, a groundsheet of suitable material and size shall be spread on the ground to catch all fluid in the event of a leak or spill. An adequate supply of suitable absorbent material and any other supplies and equipment necessary to immediately clean up spills will also be available.	
			Storage and disposal of liquid wastes and filters from equipment maintenance, and any residual material from spill clean-up will be contained in an environmentally safe manner and in accordance with any existing regulations.	
			Waste oils, fuels and hazardous wastes (if any) shall be handled in a safe manner. Staff will be required to transport, store and handle all such substances as recommended by the suppliers and/or manufacturers and in compliance with applicable Federal, Provincial and Municipal regulations. Manitoba Conservation shall be notified immediately if a reportable spill occurs.	
			Fuels, oils or other hazardous materials will be stored only in designated areas.	
			HBMS will ensure that fuel handlers are trained and qualified, and that appropriate emergency response measures are in place and readily available.	
			Storage sites will be inspected periodically for compliance with requirements as applicable.	
			Investigation and remediation of spills will be undertaken, if necessary.	
			Remediation of soils, as required, will be undertaken as a part of closure activities.	
			Appropriate personnel will be trained in how to deal with spills, including knowledge of how to properly deploy site spill kit materials.	
			Service and repairs of equipment shall only be performed by trained personnel.	
			Vehicles and equipment will be maintained to minimize leaks. Regular inspections of hydraulic and fuel systems on machinery will be completed on a routine basis; when detected, leaks will be repaired immediately.	
	Operation	Transport and handling of tailings as part of the Pipeline System and in the Paste Facility as part of the backfill process.	In addition to the above general measures to avoid accidental spills, leak detection for Pipe 1 (tailings pipe) will be provided by flow and pressure monitoring stations along the pipe to detect anomalies. Communication to the paste plant process control system will be provided by fibre optic cable running the length of the pipeline. In the event of an alarm, site personnel will be dispatched to visually inspect the length of the pipeline to determine if there is a problem. The pipeline will be inspected daily by HBMS personnel.	Risk is assessed to be appropriately mitigated
			An emergency containment system constructed at the Paste Facility will consist of a spill swale and a lined temporary containment pond (as described in **Section 2.1.1.5.1**). It will have capacity to contain approximately 110% of the largest filter feed tank volume. The emergency containment pond will temporarily hold tailings in the event of an emergency; tailings will be pumped back into the filter feed tank once normal operation resumes. The containment pond will be periodically inspected by HBMS personnel.	
Fires and Explosions	Construction, operation and closure	Fires (loss of infrastructure, business activity, worker health and safety, loss of wildlife habitat).	The mine rescue team at the Lalor Mine will be trained for fire and explosion response with HBMS call out procedures implemented. This team will be trained to respond to any fire and explosion emergencies for the Anderson TIA.	Risk is assessed to be appropriately mitigated
			Storage and use of hazardous materials, including flammable waste, will be in compliance with regulatory requirements (as described in **Section 5.12.2**).	
			Smoking will be restricted to designated areas.	
Transportation Accidents	Construction, operation and closure	Vehicular collisions (human health and safety, traffic disruption, road closure, release of contaminants) and wildlife collisions (loss of wildlife, human health and	The temporary trails will have a speed limit of 20 km/hr. The speed limits on all roads will be adhered to at all times.	Risk is assessed to be appropriately mitigated
			Appropriate road signage will be provided along the temporary trails, where necessary.	
			Personnel retained to drive vehicles will have a valid Manitoba Driver's License with a copy provided to HBMS personnel.	

Risks Associated with Accidents and Malfunctions	Project Phase	Possible Consequences	Measures to Reduce Risk of Occurrence	Conclusion
		safety, road closures)		
Power Failure	Operation	Equipment malfunctions (loss of power), accidents and explosions	Backup power will be available (diesel generators) to ensure safe shutdown of concentrator processes until power is restored.	Risk is assessed to be appropriately mitigated

5.14 Potential Effect of Environment on Proposed Alteration

As with Lalor Mine itself, the proposed alteration has been designed to withstand extremes of weather and climate at both ends of the spectrum.

6. Monitoring and Follow-Up

Follow-up programs verify the accuracy of the environmental assessment of a project and determine the effectiveness of measures taken to mitigate the adverse environmental effects of the project. For the proposed alteration of the Lalor Mine, mitigation measures described in this report (and summarized in **Table 5-4**) will be implemented. Monitoring programs associated with the Lalor Mine will continue to be appropriate, given the proposed alteration. As noted above the addition of the proposed alteration is expected to have an overall positive environmental impact on the effects associated with Lalor Mine.

6.1 Continuing Monitoring Associated with the Operation of Lalor Mine

6.1.1 Environmental Effects Monitoring

During the operation of the Lalor Mine, EEM conducted under the *Metal Mining Effluent Regulations* for the Chisel North WTP and the Anderson TIA will continue. Monitoring will include examining the potential effects of effluent on fish population, fish tissue and on benthic invertebrate communities in local waterbodies potentially influenced by the Lalor Mine support facilities.

Studies have been conducted in accordance with EEM in 2004, 2007, 2009, 2011, and 2014 for the Anderson TIA. These monitoring activities are anticipated to continue through operation of the Lalor Mine and following closure until it can be demonstrated that no adverse effects are occurring.

6.1.2 Water Quality Monitoring

HBMS will continue to collect water samples at the Anderson TIA discharge point once per week while water discharges from the TIA.

6.1.3 Environment Act Licence Monitoring

Monitoring programs required under existing *Environment Act* licence/CEC Orders for Anderson TIA and other infrastructure (*e.g.* Chisel North WTP and Chisel Lake pumphouse), and the Lalor Mine will continue to be conducted by HBMS.

6.1.4 Success of Re-vegetation Efforts

It continues to be anticipated that the end-use of the Lalor site will consist of a natural space with no planned residential, commercial, or industrial development. Based on HBMS closure experience in the Snow Lake region, the growth of grasses and mosses is apparent within the first few years following closure, whereas trees and shrubs take longer to establish.

Vegetation in areas temporarily disturbed by construction activities is expected to naturally encroach and establish. If, during periodic inspections of the project components, these areas have not successfully been re-vegetated, artificial re-vegetation efforts may occur to encourage re-vegetation. To ensure the success of the re-vegetation program, a re-vegetation monitoring program will be implemented. The monitoring program will determine the success of the re-vegetation program, and determine if follow-up reseeding or replanting is required. The monitoring program will include quarterly monitoring during the growing season until the seedlings appear to be established, following which, quarterly monitoring will continue for a minimum of two years, before a successful re-vegetation program can be declared.

6.2 Lalor Mine Closure Plan Update

Once the proposed alteration has been constructed, the Lalor Mine Closure Plan, submitted to the Director of Mines in accordance with Manitoba Mine Closure Regulation 67/99 on September 30, 2014, will be updated to include the proposed alteration and it will be submitted to the Director of Mines for approval, along with any additional financial assurance that may be required.

The additions to the Lalor Mine Closure Plan will contemplate the activities listed in **Section 2.18** in relation to the new facilities to be constructed in accordance with the proposed alteration.

7. Conclusions

In summary, the proposed alteration is essentially a mitigation measure to be added to the operation of Lalor Mine. With the implementation of the design features and the standard operating and mitigation measures described in the report, the residual environmental impacts of the proposed alteration will be Negligible in magnitude. The measures described to mitigate the risk of occurrence of accidents and malfunctions are deemed to be appropriate in mitigating such risks. Therefore, it is our opinion that based on the available information and documented assumptions, the overall potential adverse effects of the proposed alteration will be Negligible in magnitude. When compared with the environmental and health and safety benefits that will be achieved, it is assessed that the proposed alteration will improve the environmental management of the Lalor Mine and that the overall net impact of the proposed alteration will be beneficial.

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Appendix A *Notice of Alteration* Form

Notice of Alteration Form

Manitoba
Sustainable Development

Client File No. : 5,583.00	Environment Act Licence No. : 3096
Legal name of the Licencee: Hudson Bay Mining and Smelting Co., Limited	
Name of the development: Lalor Mine	
Category and Type of development per Classes of Development Regulation: Mining Mines, other than pits and quarries	
Licencee Contact Person: Jay Cooper Mailing address of the Licencee: PO BOX 1500, #1 Company Road City: Flin Flon Province: MB Postal Code: R8A 1N9 Phone Number: (204) 687-2667 Fax: (204) 687-2173 Email: jay.cooper@hudbayminerals.com	
Name of proponent contact person for purposes of the environmental assessment (e.g. consultant): Somia Sadiq	
Phone: (204) 928-8494 Fax: (204) 284-2040	Mailing address: 99 Commerce Drive Winnipeg, MB R3P 0Y7
Email address: somia.sadiq@aecom.com	
Description of Alteration *(max 90 characters):* HBMS proposes to alter the Lalor Mine to add a paste backfill plant ("Lalor Paste Plant"). Tailings from the Stall Concentrator will be diverted from the Anderson Tailings Impoundment area and used to create paste backfill at the Lalor Paste Plant (for use in the Lalor Mine).	
Alteration fee attached: Yes: ☑ No: ☐ If No, please explain:	
Date: 16-12-16	Signature: [signature] Printed name: JAY COOPER

A complete Notice of Alteration **(NoA)** consists of the following components:

- ☑ **Cover letter**
- ☑ **Notice of Alteration Form**
- ☑ **4 hard copies and 1 electronic copy of the NOA detailed report** (see "Information Bulletin - Alteration to Developments with Environment Act Licences")
- ☑ **$500 Application fee, if applicable** (Cheque, payable to the Minister of Finance)

Submit the complete NOA to:

Director
Environmental Approvals Branch
Manitoba Sustainable Development
Suite 160, 123 Main Street
Winnipeg, Manitoba R3C 1A5

For more information:

Phone: (204) 945-8321
Fax: (204) 945-5229
http://www.gov.mb.ca/conservation/eal