5.0 ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION PLAN

The TANCO Mine has now been in operation for over 40 years. The physical footprint of the operation is established and there are no plans to expand that footprint beyond what has been developed to date. The environmental setting, detailed in Section 4.0, documents the current state of the natural and human environment as they have been affected by the facility from the start of operations in 1969 to the present. This section assesses the environmental impacts of the facility that are associated with the continuing operation of the facility through to the end of mine life and then in the post-closure state.

5.1 EFFECTS OF CONTINUING OPERATIONS

The TANCO Mine is expected to continue operating for at least another 7 years on the basis of the remaining pollucite ore reserve. The discovery of additional pollucite resources remains a possibility and this would have the potential to extend the mine life beyond 7 years. However, the following analysis of the environmental effects of continuing operations has been limited to the established 7 year mine life.

As detailed in Section 3.15, emissions from the facility to air and land are contained within the site boundaries and this condition is expected to continue through the remainder of the period of operations. In this regard there is no incremental effect of the operation on air quality in the adjacent natural environment. Effects of the operation on terrestrial natural resources occurred at the time the facilities were first constructed in 1968/69, but were not documented or assessed at that time, as was the convention. With no plans to expand either the physical footprint of the facility over the remainder of the mine life, and no plans to alter airborne emissions from the facility, no further consideration of either environmental impact pathway has been made in this assessment. The only continuing off-site emission from the facility to the natural environment is the West Discharge, and the assessment of the continuing effects of the TANCO Mine on the natural environment has therefore been focused on the aquatic environment.

Interactions between the TANCO Mine and the human environment are primarily related to traffic on provincial roads and the support/demand on the regional skilled workforce. In the absence of planned changes to the TANCO operation, the workforce also is not expected to change materially over the remainder of the mine life.

5.2 Aquatic Resources

The West Discharge drains the active West Tailings Management Area and is the only mine effluent discharge to the natural environment. The volume and quality of effluent released through the West Discharge is primarily determined by the conventional tantalum and spodumene mining and milling operation. The water balance for the West TMA is dominated by sources originating from the conventional mining operation. The dominant source of West Discharge flow is the water content of the conventional tailings, which accounts for 75 to 90% of the annual flow in the West Discharge at full mine production.

The geographic extent of the effect of the West Discharge on the aquatic environment is limited to Bernic Lake and its effluent stream. The mine has no measureable effects on water quality in the Bird River (Wardrop 2009a). This condition is not expected to change over the remainder of the TANCO Mine life.

To date, the primary effect of the operation on water quality in Bernic Lake has been increased total phosphorus concentrations and the consequent increases in the standing crops of algae and zoobenthos. Total suspended solids (TSS) concentrations also are elevated in comparison to the nearby Tulabi Lake. The increased TSS is related to the discharge of algae from the West TMA and the stimulation of algal growth in Bernic Lake. Essentially all of the TSS is organic, as indicated by the proportion of volatile to fixed solids.

The magnitude of the effect varies over the lake, with the largest effect found closest to the mine discharge but it is evident that an overall increase in algal and benthic invertebrate production has occurred in the lake.

The trophic state of Bernic Lake has moved from oligotrophic to mesotrophic. The lake is more productive than it was in its natural state, but the increase in productivity has not been so severe as to cause a degradation of conditions that would begin to cause the exclusion of key fish species. The water column remains well-oxygenated in summer, although there is evidence of near-bottom oxygen depletion during summer stratification (Tetra Tech 2011b). The lake is populated with warm water fish species, all of which are tolerant of these conditions and which are commonly found in warm water bodies in southern Manitoba.

No quantitative studies of the Bernic Lake fish community have been conducted. Studies of fish have not been required as part of the EEM biological study program at the mine because of the small size of the effluent plume in Bernic Lake. Increased fish growth rates and condition factors are expected responses to the increased primary and secondary productivity in the lake.

Several parameters have increased in concentration as a result of the continuing mine discharge. For most parameters that are currently monitored in Bernic Lake it is necessary to infer the occurrence of changes by comparing concentrations with a local reference lake, Tulabi Lake. A concentration in Bernic Lake that differs from the concentration in Tulabi Lake by at least a factor of 2 is taken to represent a significant change. In this regard, concentrations of nitrate, total and dissolved antimony, total and dissolved beryllium, total and dissolved cesium, total and dissolved lithium, total and dissolved manganese, total and dissolved rubidium, total and dissolved silicon, and total and dissolved strontium in Bernic Lake were at least twice the concentrations in the reference lake. These parameters do not have guidelines under MWQSOG/CCME however none is a likely cause of the observed effects on the basis of the relatively low concentrations measured in Bernic Lake and considering the nature of the ecological responses observed in the lake and also in comparison to concentrations demonstrated to have any form of toxic effect (Tetra Tech 2011b).

The current mesotrophic condition of Bernic Lake has developed as a result of the mine effluent discharge since the start of operations in 1969. The lake can be expected to be at equilibrium with the mine effluent discharge such that continuation of operations over the next 7 years is not expected to cause further change in water quality or lake productivity. The period of operation to date covers approximately 4 times the lake residence time of 10 years. Approximately 3 lake residence times, or 30 years in the case of Bernic Lake, are required for the 95% response to a change in the loading of any parameter (Sas 1989, Thomann and Mueller 1987). On this basis, Bernic Lake has likely been at equilibrium with the mine effluent discharge for approximately a decade.

In the absence of planned changes to the operation, mine effluent quality and annual volume are not expected to change markedly over the remaining period of mine operations and, therefore, the effects of the continuing operations on Bernic Lake water quality and on fish and fish habitat are also expected to be similar to those documented. The present mesotrophic condition is expected to continue through to the end of operations. Although this represents a measurable change from the pre-mining condition of Bernic Lake, the changes that have occurred are not considered to be adverse. Primary productivity, as indicated by algal standing crop, has increased but not to the extent that water quality degradation has occurred. The water column of the lake remains well-oxygenated and available for use by the resident secondary and tertiary producers. Zoobenthos abundance has increased in response to the increased primary production and increased fish growth rates and condition would be expected to occur as well. Further, these effects are limited to Bernic Lake. No measurable effects extend beyond the outflow of Bernic Lake.

5.2.1 Effects of CPF Residue Placement and Storage in the East TMA

A secondary influence on both the quantity and quality of mine effluent reporting to Bernic Lake is the flow of tailings porewater (also called the phreatic flow) from the East TMA (ETMA). Prior to June 2004, this flow reported directly to the lake via the East Discharge. This flow was discontinued in June 2004 and was replaced by the pumping of accumulated phreatic flow from the surge pond in the East TMA over to the West TMA. ETMA contains conventional tantalum and spodumene tailings and is the location of the CPF residue stockpile and the two CPF containment cells. Since the start of CPF residue drystacking, the phreatic flow quality has continued to be representative of the conventional tailings porewater quality. Monitoring of the ETMA tailings porewater quality in the area closest to the surge pond has repeatedly confirmed that porewater quality has not been affected by either the CPF residue stockpile or by CPF containment cell leakage (Wardrop 2009b, 2010b and 2010c).

TANCO is planning to continue using the current method of CPF residue management - drystacking in the Old TMA - through to the end of mine life. The drystacking will either be accomplished using the current method, or with a modification that does not involve discharging solids to the CPF containment cells. In the current method the two CPF containment cells are used alternately, with one cell being emptied of residue while the other cell is being filled. With the modified residue management method the solids would be recovered from the liquid in the CPF Plant by filtration and then would be directly drystacked. At this time TANCO has not made a decision regarding implementation of the alternative solids recovery approach.

All residue will be dry stacked in the Old TMA and the final residue pile will be closed out on surface. The initial assessment of the effects of the residue dry stack on shallow groundwater quality within the Old TMA, and ultimately on receiving water courses, that was completed in 2011 indicated there might be a limit to the quantity of residue that could be drystacked without having an adverse effect on the receiving environment (Agassiz North 2001). This limit was not related to the physical capacity of the Old TMA to contain the expected residue production but was related to the potential effect on shallow groundwater quality within the Old TMA and management of the residue stockpile size to prevent an adverse effect on water quality in the ultimate receiving watercourses. For this reason, the potential environmental effect of each incremental increase in the residue stockpile footprint was assessed and a Notice of Alteration submitted to Manitoba Conservation for approval as a minor change to Environment Act License No. 973.

The potential for a limit to the residue drystack capacity identified in the initial impact assessment was based on the worst case assumption that all precipitation falling on the dry stack would flow through the stack (as infiltration of meteoric precipitation), leaching residue constituents as found in the steady state phase of the 20 week residue column leach tests. The residue leachate was then expected to pass into the shallow groundwater of the Old TMA and gradually travel toward the 4 points of discharge to surface waters (i.e., the North, East, West, and Main dams of the Old TMA; Figure 4.3). The ultimate concentrations of residue leachate parameters in the shallow groundwater were estimated to be a function of the area of the residue dry stack, and the final concentrations at the discharge points were considered to be a function of the leachate concentration and the travel time. Travel time to the point of discharge was important because the longer the travel time, the more dilution there would be from shallow groundwater that had not been affected by residue leachate.

The model of leachate behaviour in the Old TMA led to the development of the protocol for CPF residue stockpile establishment and management:

- Locate the stockpile as far from points of discharge to the receiving environment as possible;
- Locate the residue stockpile at a groundwater drainage divide so that stockpile seepage is divided among as many flowpaths as possible; and,
- Minimize the total area of the stockpile.

Considerable monitoring of the groundwater system in the Old TMA has been conducted since the initial impact assessment was completed and much has been learned about the behaviour of the residue leachate. These findings are synthesized in the hydrogeochemistry study completed by Tetra Tech (2011a) with the key findings summarized here.

The first key finding is that the elevated concentrations of leachate signature parameters found in the saturated tailings under and immediately adjacent to the residue stockpile are not a product of leaching as meteoric precipitation passes through the pile. The residue provides too effective an infiltration cap for this mechanism to explain the observed leachate parameter concentrations in the saturated tailings. The mass loading from this pathway is nowhere near adequate to account for the observed concentrations. The most likely explanation is direct rinsing of the residue by groundwater in the saturated tailings. The residue mass consolidates the underlying tailings such that the bottom of the residue is in direct contact with the saturated zone, and allows for the direct leaching into the saturated zone and accounting for the observed concentrations of residue leachate parameters under the pile.

Most importantly, the physical establishment of the residue drystack, and related consolidation of the underlying conventional tailings, has been found to create a groundwater depression beneath the residue pile and the residue itself functions as a cover, preventing the recharge of groundwater in the saturated tailings beneath the residue pile. Consequently, there is no hydrologic movement of groundwater much beyond a distance of approximately 10 m from the residue pile. The abundant hydrologic recharge to areas adjacent to the residue pile combined with the recharge deficient area beneath the pile effectively creates a hydrological barrier around the pile, preventing lateral movement by advective conveyance. The affected groundwater under the residue pile is effectively trapped there and, contrary to previous expectations, does not move toward any of the points of discharge to surface watercourses. In addition, because the overburden groundwater system is effectively isolated from the tailings groundwater system, this affected groundwater also is not expected to move downward.

Any lateral movement of residue leachate signature parameters beyond a distance of approximately 10 m from the residue pile is not a function of groundwater movement through the saturated tailings. Surface runoff is the only mechanism that can satisfactorily explain the occurrence of elevated residue signature parameter concentrations beyond a distance of 10 m from the residue pile.

On the basis of the documented behaviour of the residue over the past decade and the now much better understood interactions with the saturated tailings and surface runoff, it is possible to reasonably predict conditions through the life of mine and into closure.

The continuation of CPF plant operations over the remaining 7 year life of mine will generate an estimated 560,000 m^3 of residue, which represents an approximate 66% increase in the quantity of residue in the stockpile (140,000 m^3 of residue will remain in the Containment Cells). The stockpile will be expanded in phases (Figure 3.6), and by the end of mine life in 2018, is expected to occupy approximately 89,000 m^2. Based on monitoring to date, the area of saturated underlying conventional tailings will expand accordingly, with the margin of the affected zone extending no more than approximately 10 metres from the residue stockpile. The capping effect of the residue will prevent migration of the residue leachate-affected saturated groundwater zone to any of the points of discharge to surface waters.

As the area of the stockpile grows and moves closer to points of discharge to surface waters, the importance of surface runoff as a mechanism for transport of residue leachate increases. In particular, the potential for surface runoff to carry residue leachate to either of the East dam or the West dam increases as the southern margin of the stockpile is extended. Runoff transport of leachate to the main dam is not likely due to the distance, even at the end of mine life.

The influence of runoff from the northern half of the stockpile is not expected to increase over the remainder of the life of mine. This portion of the stockpile is already at final height and will not be extended any closer to the northern margin of the Old TMA.

TANCO’s plan to control surface runoff from the residue stockpile includes progressive re-vegetation of the stockpile, as portions reach the final pile height, and runoff control dyking to contain runoff during residue placement.

In consideration of this expanded understanding of CPF residue and residue leachate behaviour in the East TMA, it is now possible to plan residue drystacking through to the end of mine life. We now know the capacity of the East TMA to accommodate residue is not limited by the dilution capacity of the groundwater system but by physical space within the East TMA. With progressive re-vegetation of the dry stack, the full life of mine CPF residue production can be accommodated without adversely affecting the quality of the receiving environment.

5.3 CONTINUING EFFECTS POST-CLOSURE

Once site reclamation has been completed and the site has achieved full closed-out status all structures will have been removed, the mine site graded, scarified, and vegetated, natural flows restored through the two tailings areas, and both tailings areas and the residue pile will have established vegetation communities, The vegetated mine site and upland areas will progress through a seral succession as vegetation species from the adjacent forested areas colonize the site so that, over a period of several decades, the site will progressively become more similar to the surrounding undisturbed areas. Low lying wetter areas toward the southern end of the East TMA, in the West TMA, and around the polishing pond will see the development of wetland vegetation communities,

Discontinuation of mine water and tailings discharges to the West TMA will reduce phosphorus loading and established vegetative cover in both TMAs will contribute to further phosphorus retention from the conventional tantalum and spodumene tailings. Based on the hydrogeochemistry study of the residue stockpile, leaching of residue constituents into surface runoff should be effectively eliminated once vegetative cover is established.

Discharges to surface waters from the site will include surface runoff from the closed out East and West TMAs. Based on the above, runoff quality from both TMAs is expected to meet the Manitoba Water Quality Standards Objectives and Guidelines once the vegetative cover has become established.

5.4 CUMULATIVE EFFECTS ANALYSIS

Cumulative effects are those effects that may result from the interaction of a project with other existing or planned projects. Such interactions occur when the zone of effect of one project overlaps the zone of effect of another project to cause a greater effect than would be the case if the effects of each project were independent. This cumulative effects analysis (CEA) considers effects on both the natural environment and the human (social/cultural/economic) environment.

The existing and planned projects and activities within the Study Area considered in the CEA were identified through review of the following information sources:

- Environment Act Licenses issued by Manitoba Conservation;
- Environment Act License proposals currently under review by Manitoba Conservation;
- Discussions with community, provincial, and federal agency representatives with responsibility for the project study area; and,
- Information obtained in the course of the Community Engagement program.

The following projects were identified from these sources for consideration in the CEA:

- San Gold Mine
- Tembec Industries Inc.'s (Tembec) Forest Management Licences (FML) 01
- Manitoba Hydro's Pointe du Bois spillway replacement

- Regional recreation and tourism
- East Side Road

In the case of the TANCO Mine, the potential for interaction with these projects and resultant cumulative effects on components of the natural environment is negligible. The effects of the mine are localized to the Bernic Lake watershed and this watershed is isolated from exposure to the other projects.

San Gold's Rice Lake Mine and Mill are located approximately 65 km north of the TANCO Mine. The Rice Lake Mine was originally built in 1934 and San Gold employs approximately 350 people. There is no overlap of the zones of effect of the two operations.

Tembec holds FML 01 which covers the area surrounding the Mine. Forest harvest from the FML was historically used to supply the Tembec mill in Pine Falls. Mill operations were shut down in September 2009 due to a labour dispute and Tembec announced in September 2010 the mill would be closed permanently and would be decommissioned. Consequently, commercial forestry operations in the study area have largely been curtailed and, with decommissioning of the mill no resumption of significant forest harvest activity in the study area is anticipated

Manitoba Hydro operates six generating stations along the Winnipeg River in Manitoba, including Pointe du Bois, Slave Falls, Seven Sisters Falls, McArthur Falls, Great Falls and Pine Falls. The spillway facilities at Pointe du Bois are being replaced and include the following components (Manitoba Hydro 2010):

- A new primary spillway immediately downstream of the existing rockfill dam on the east side of the Winnipeg River;
- A new secondary spillway west of the primary spillway;
- New concrete and earthfill dams;
- Stability measures for the existing east and west gravity dams;
- Decommissioning of the existing spillway structure.

The Pointe du Bois spillway project is located on the Winnipeg River and, as such, is not expected to interact with the TANCO Mine.

Recreation and tourism in the area includes cottages, camping and outfitting. There are two cottage developments near Bernic Lake in Nopiming Provincial Park: Bird Lake has 120 cottage lots and one lodge and Booster Lake has 65 cottage lots. Bird River is also a popular destination for canoeists. Potential interactions between TANCO's operation and the area's recreation and tourism are mainly related to traffic along PR 315. As described in Section 4.4.6, TANCO traffic represents a small percent of the total traffic hence cumulative effects of the TANCO mine with the area's recreation and tourism are insignificant.

The Manitoba East Side Road Authority is proposing to construct, operate and maintain and all-season road from Provincial Road 304 at Manigotagan to Berens River. Manigotagan is over 90 km away from Bernic Lake and there will be no interaction between the two projects.

5.5 Effects of the Environment on the Project

5.5.1 Climate Change

Manitoba's northerly latitude and central location in North America means the province will face earlier and more severe climate changes than many other parts of the world (Manitoba Climate Change and Green Initiatives 2010). Predictions suggest Manitoba will see warmer and wetter winters along with longer, warmer and drier summers. In the winter and spring, Manitoba will likely experience an increase in flooding due to warmer temperatures that will increase rain-on-snow precipitation and the frequency of winter thaws.

The remaining seven year mine life is too short to be materially affected by climate change, with any significant climatic changes not occurring until the closed out period. Designs of water management structures that remain at closure will need to handle extreme precipitation conditions in any event and therefore climate change is not expected to affect the closed out mine site.

5.6 Accidents and Malfunctions

TANCO has developed an Emergency Response Plan (ERP; Appendix H) that deals with the following types of accidents and malfunctions:

- Bulk spills of dangerous goods/petroleum products
- Specific procedures for handling:
  - Sulphuric acid spill
  - Formic acid spill
  - Lime slurry spill
  - Barium carbonate and barium hydroxide solid spill
  - Cesium products spill
  - Cesium hydroxide product spill
- Incidents involving nuclear devices

- Fires
- First Aid emergencies

TANCO maintains a standard of emergency preparedness that will provide timely and coordinated response to an emergency in order to minimize the effects of the emergency or disaster on TANCO employees, the public, the minesite and the environment (Section 3.18).

An uncontrolled release of hazardous materials to the environment may have a lasting and residual effect. However, the probability of an uncontrolled release is low due to the secondary containment and controls built into the operation and TANCO's active application of their emergency response plan and their overall commitment to minimize their impact on the environment (Section 3.18).