4.0 PROJECT DESCRIPTION

4.1 Main Project Components

Rainy River Resources (RRR) proposes to construct, operate and eventually reclaim a new open pit and underground gold mine at the Rainy River Project (RRP) property. The site layout places the required mine-related facilities near the open pit to the extent practical, and on lands to which RRR has access or reasonably expects to gain access. Figure 4-1 provides a site plan showing the proposed RRP site. The site plan will be refined further as a result of ongoing consultation activities, land purchase agreements and engineering studies.

The RRP is designed to:

- Use well established, conventional technologies commonly used in northern Ontario gold mines and process plants;
- Respect the interests of other property owners and land users in the area;
- Minimize the overall footprint and associated environmental impacts; and
- Render the site suitable for other compatible land uses and functions after the mine has closed and the land has been reclaimed.

The major proposed project components are expected to include:

- Open pit and underground gold mine;
- Ore process plant;
- Explosives manufacturing and storage facilities;
- Stockpiles to store overburden, mine rock[1], run of mine ore and low grade ore;
- Tailings management area;
- Other buildings, facilities and areas;
- Onsite access roads;

[1] Mine rock, also called waste rock or development rock, is rock that must be extracted to gain access to the mineralized ore.

- Aggregate extraction;

- Water management facilities and drainage works, including ponds, watercourse diversions and a constructed wetland;

- Domestic and industrial waste handling;

- Re-alignment of a section of Highway 600; and

- 230 kV transmission line.

This section provides a description of the proposed RRP based on the Feasibility Study (BBA 2013a). As engineering studies progress and consultations with government agencies, Aboriginal groups and the public continues, some of the details of the RRP described in the following sections may change.

4.2 Existing Facilities and Infrastructure

The principal features of the site and local area are related to limited ranching and logging practices in the area, and ongoing mineral exploration. Areas of abandoned farmland are evident throughout the local area, where abandoned farmlands are returning to scrub and successional forest communities, including in some cases small, dispersed wetlands. The natural environment local study area (NLSA) has a dominant cover of mixed poplar forests, which occupy greater than 50% of the landscape. Poplar forests, principally of Trembling Aspen, are indicative of disturbed lands recovering from past forestry and farming activities, or regrowth following past fires.

As the RRP site is an active mineral exploration area, a number of exploration-related facilities and infrastructure components are currently present on the RRP site. These generally include (as shown in photographs in Appendix A):

- Office, warehousing, core-sheds / core racks and yard facilities; and

- Drill sites, test trenches and associated equipment used to define the ore resource and to investigate geotechnical and hydrogeological conditions.

Initial mineral exploration of the RRP property was conducted between 1967 and 1989 by various companies and government agencies. More concerted mineral exploration efforts were conducted by Nuinsco Resources Limited between 1990 and 1994. RRR took over the property in 2005 and has been conducting exploration since that time. To date RRR has completed over 1,800 diamond drill holes to date totalling almost 780,000 m, and have undertaken or commissioned extensive environmental, geotechnical, mineralogical, engineering, logistics and economic studies in support of potential property development. RRR has also worked closely with local land owners and Aboriginal groups to communicate its interests in the RRP property, and to establish protocols for pursuing these activities.

4.3 Open Pit Mine

4.3.1 Open Pit Design

The open pit mine plan has been designed using computer modelling, based on the known mineral resources, to determine the optimum pit plan and design. The open pit is designed as a single, two-lobe pit. The ultimate pit is anticipated to measure approximately 1,500 m by 1,700 m and will be up to approximately 400 m deep (Figure 4-2).

Open pit mining will occur at a rate of approximately 21,000 tpd of ore production averaged over the life of the mine. Over the life of the mine, approximately 110 to 120 Mt of ore, 70 to 80 Mt of overburden and 350 to 400 Mt of mine rock will be extracted. For the purpose of this document, a 20% contingency should be added to the above rate and tonnages to allow for operational flexibility and design changes resulting from the ongoing exploration program and engineering analyses. As currently proposed, open pit mining would occur over an approximate 13 year period, including 2 years of pre-production.

4.3.2 Site Preparation

Before mining of ore can begin in the RRP open pit, a number of activities must occur as follows:

- Initiate overburden removal (stripping);
- Establish water management and flood protection infrastructure;
- Divert West Creek around the pit perimeter; and
- Construct support buildings and infrastructure.

4.3.2.1 Overburden Stripping

Overburden stripping is necessary to gain access to the bedrock and allow extraction of ore. At the proposed open pit location, overburden ranges from approximately 25 to 45 m thick. This material will be stripped progressively over an estimated six years beginning during the construction phase and continuing for the first part of operation.

Excavated overburden will be stripped from the pit surface using diesel and electric shovels, excavators, bulldozers and/or comparable equipment, and will be transported by haul truck directly to the overburden stockpile positioned west of the open pit (Figure 4-1) or alternatively, trucked directly to the applicable construction site if intended for re-use. Overburden will be a primary material used for construction at the RRP site and will also be used extensively in site reclamation. The overburden stockpile will be developed close to the open pit first (subject to final design) and proceeding toward the northwest thereafter.

Overburden will be stripped in a series of benches of approximately 10 m thickness. The overall angle of the overburden slopes will depend on the thickness of overburden and will generally range from a ratio of 3 horizontal width to 1 vertical height (3H:1V) for overburden thicknesses of less than 25 m thick; to 4H:1V or flatter for overburden when thicker than 40 m in order to ensure an appropriate factor of safety. Steeper slopes of 2.75H:1V may be used temporarily during the initial pit development in overburden of less than 25 m thick. A 20 m wide bench will be established at the overburden / bedrock interface, to account for sloughing, to increase worker safety, and to facilitate remediation and potential mitigation.

Once the overburden is placed at the final slope angle, the slopes will be progressively revegetated to ensure longer term stability. Additional erosion protection such as armouring with non-potentially acid generating (NPAG) rock and slope drainage will be added as necessary. Ditching will be placed around the overburden stockpile to capture runoff and allow RRR to monitor runoff quality.

4.3.2.2 Water Management

Non-contact surface water runoff will be diverted from entering the pit by ditching or other means as needed. This diversion will reduce the quantity of water flowing over the overburden slopes and the quantity of water interacting with mining operations that will require pumping and treatment. The water will be diverted to the West Creek diversion to the north or Pinewood River to the south (Figure 4-1; Section 4.12.7.4).

Water within the overburden and country rock will need continual removal (dewatering) during construction and throughout mine operation in order to safely extract the overburden and rock. Excess water can affect the stability of overburden slopes and pit walls, and hinder stripping and mining activities. Open pit dewatering will start during overburden stripping and will continue during mining operations. During the pre-stripping phase, RRR expects to use ditching and sumps to help dewater the overburden and facilitate overburden handling. This water will contain elevated suspended solids and potentially other parameters related to heavy equipment operation. The water will therefore be contained and if necessary, treated before it is discharged to the environment. Sump(s) will be developed in the base of the open pit to remove excess water that enters the pit, such as from direct precipitation and groundwater inflow. Water from the sump will be pumped to the mine rock pond for re-use or temporary storage. RRR does not plan to use dewatering wells such as those used at some other Ontario mining projects, as the overburden is clay-rich and the use of wells to dewater overburden is not expected to be successful in such conditions.

West Creek passes through the proposed open pit development area and must be diverted before pre-stripping activities can advance. The RRP is not financially viable without the diversion of West Creek as it is centred directly over the main ore body. The site plan has been developed to allow for re-routing of the creek to the west of the pit and proposed western stockpiles (Figure 4-1). The new channel will be positioned far enough from the pit perimeter to ensure the integrity and stability of the new channel, and to avoid future open pit operations and related infrastructure. The proposed re-alignment will pass through very similar terrain to that along the existing channel and is expected to provide like-for-like fish habitat replacement. The diversion will be constructed and stabilized before the original channel is closed in order to ensure continual safe passage of any fish.

The open pit is situated within 250 m of the Pinewood River. Given the natural topography of the area, if the water level in the river rises more than 1 m, flood waters could potentially enter the pit. Flood mitigation analysis has determined that a flood protection berm will likely be required parallel to the south face of the open pit to ensure that Pinewood River does not spill into the pit during the environmental design flood (a 24 hour, 100 year return period storm event), and cause excessive erosion of the overburden slope or flood the pit (AMEC 2012i). The preliminary flood protection design includes a 2.24 m high berm (including 0.3 m freeboard) having 3H:1V slopes and length of 3,600 m, situated approximately 120 m from the Pinewood River. An access road may be constructed on top of the berm. In the event of extreme flood conditions, monitoring will be conducted to ensure sufficient time to evacuate workers from the vicinity.

The access road on the north side of the pit will also protect the pit in part, from an overflow of the West Creek diversion channel, although this is a smaller watercourse.

4.3.2.3 Related Buildings and Infrastructure

Mine haul roads will be established to connect the open pit to various stockpiles, the primary crusher and associated mine buildings (the maintenance shop and truck wash). The total length of the mine haul roads outside the pit limit is approximately 5,400 m. All haul roads will be designed to ensure proper visibility and to limit potential conflicts with other smaller mine-related vehicles. The haul roads will not intersect any public roads. Haul roads will be approximately 34 m wide, in order to accommodate two-way heavy equipment traffic.

A maintenance facility will be required in order that heavy equipment can be maintained onsite. Both the mine garage and truck wash buildings have been designed at a preliminary level with a rectangular shape and inclined roofs to make them suitable for a pre-engineered structure. The mine garage will be approximately 46 m by 96 m. It will have six maintenance bays, including two bays for auxiliary vehicles and one bay dedicated for welding, all serviced by a 50 t overhead crane. The building will include a 1,400 m^2 warehouse and a mechanical workshop which will also serve as a maintenance area for smaller site vehicles. A centralized lube distribution system for oils, grease and other fluids is proposed to feed every bay and allow consolidated storage and material management.

A truck wash facility is necessary at the RRP to ensure the ongoing operability of heavy equipment and to facilitate maintenance. The building is expected to accommodate two large mine haul trucks (54 m by 24 m), providing one area for washing and one area for tire changes only. The truck wash system will have sediment settling basins, a skimmer for hydrocarbon removal and a water filtration system or similar, to allow for continuous recycling of wash water to minimize fresh water requirements (only 5 to 10% of total needs).

A mine office and dry (change room and wash area) is proposed to be constructed adjacent to the maintenance shop for mine, maintenance and engineering office staff (dimensions of 44 m x 36 m). The facility will also have meeting rooms, a lunch room that can serve as a conference / training room and a room on the ground floor for daily shift meetings. The dry will consist of lockers and washrooms designed to accommodate a varying ratio of men to women to allow for variations in staffing.

The RRP will use a mix of ammonium nitrate / fuel oil (ANFO) and emulsion based explosive that will be manufactured onsite during operation from components transported to the site. Explosives will be required in order to extract rock in the open pit and underground mines, and potentially at quarries if any are developed. A platform for an explosive plant and magazine will be built at a safe distance north of the process plant area, remote from other facilities and from public access. The associated buildings and structures are expected to be constructed by the explosives supplier and will to consist of three separate facilities (explosives plant, powder magazine and caps magazine) or equivalent. The separation distances for these facilities from each other and from other RRP site infrastructure will comply with the Quantity Distance Principles User's Manual (NRCan 1995).

The components of the ANFO explosive are not individually reactive. The materials will explode only if mixed in certain proportions, placed under certain confined conditions and detonated with an external device. Detonators to start the blast and boosters as applicable will be required for each blast hole.

Both diesel and electric hydraulic shovels will be used in the open pit as the primary loading equipment. The open pit mine will require additional electrical infrastructure as compared to other pit operations. The electric hydraulic shovels will be powered by 7.2 kV trailing cables connected to local substation to step down the power. Establishment of a mine substation near the pit will minimize the length of 7.2 kV mine network required and shorten the total length of the trailing cables exposed to potential damage by mobile equipment and blast fly rock.

4.3.3 Open Pit Mining

The open pit mine will operate on two, 12 hour shifts, 365 days a year, with a typical ore output of 21,000 tpd. Rock will be broken at the face using explosives and will be loaded using a hydraulic shovel onto 225 t off highway haul trucks, for transport to the primary crusher or stockpiles (ore or mine rock). Approximately 0.32 kg of explosives will be consumed for each tonne of ore or mine rock mined. Annual explosive consumption will range from 10,000 to 19,000 t.

The primary mining fleet will consist of blast hole drill rigs, hydraulic mining shovels, front end loader and haul trucks. This fleet will be supported by tracked bulldozers, motor graders, auxiliary excavators and other miscellaneous support equipment.

Internal ramps will be approximately 20 to 34 m wide to accommodate one or two-way heavy equipment traffic. The ramp gradient will be approximately 10% on straight sections. Two exit ramps are proposed to accommodate hauling overburden to the west (to the overburden and west mine rock stockpile), and ore and mine rock to the east (run of mine, low grade ore or east mine rock stockpile).

In total, an estimated 110 to 120 Mt of ore will be mined from the open pit and processed at the RRP. A portion of this quantity (approximately 43 Mt) is low grade material that will be stored near the east mine rock stockpile for processing later in the mine life. Drainage from this area will be managed in the event that the low grade material is potentially acid generating (PAG). Further details regarding management of materials to mitigate acid generation are presented in Section 4.6.2.

4.4 Underground Mine

Underground mining will be used to access higher grade ore at depth that cannot be readily or reasonably be extracted by open pit mining, to augment the open pit source for controlled ore blending within the process plant. The current plan is to develop the underground workings to a depth of about 800 m below the surface with a production rate of up to approximately 1,500 tpd. A contingency factor of 20% should be applied to underground mining rates to allow for flexibility, and responsiveness to further data acquisition and analysis, and in recognition of the current engineering design confidence.

The underground mining of ore (and mine rock) will be preceded by a development phase taking approximately three years. During the development phase, a ramp from surface will be developed to access the underground ore. The main portal is expected to be located approximately 1.5 km northeast of the pit centre, and near the east mine rock stockpile (Figure 4-3). Supplemental portals may be developed over time within the side walls of the open pit once the bench has been depleted, for easier access the underground ore body and shorter haul distances. These portals will also provide additional ventilation to the underground mine along with additional emergency egress points.

Underground ramp dimensions are expected to be in the order of 6 m wide and 5.5 m high. Additional minor access(es) to surface will also be required, such as ventilation raises, to provide fresh air to the underground workings and allow for emergency egress.

RRR plans on mining underground approximately 300 to 400 m deeper than the proposed open pit using a combination of long hole open stoping and over hand cut and fill. Long hole open stoping is proposed for the steeper more consistent zones. Cable bolt support will be provided as appropriate. All primary stopes will be backfilled with cemented rockfill, while secondary stopes will be filled with uncemented rock. Cut and fill stopes will be developed in 5 m lifts and an average span (ore thickness) of 8 m (ranging from 5 to 15 m). Primary and secondary support will be provided to ensure stability. Based on the present mine plan no crown or sill pillars will be required and the stopes directly below the pit are relatively narrow and will be backfilled and are not anticipated to cause any instability to the open pit due to their limited extent.

Ore and mine rock will be extracted at the active mining face using explosives and transferred by load haul dump vehicles (LHD or scoop trams) to trucks for haulage to surface, along the ramp to the primary crusher or stockpiles (mine rock or low grade ore). The equipment to be used are typical of underground mining and are expected to include: jumbos, bolters, LHD vehicles, 50 t trucks, along with service vehicles such as scissor lifts, crane trucks, a grader, diamond drills and ANFO loader.

4.5 Minewater Management

Minewater will need to be removed from the open pit on a year round basis over the life of the mine in order to maintain a dry working environment. Minewater will be captured in a series of drains and/or sumps in the base of the open pit that will be relocated progressively as required. Snow in the pit will be extracted with the mined materials (ore or mine rock) or will melt and drain to the sumps. As a result, no special handling or treatment of snow is required.

The maximum pumping rate from the open pit sump(s) during the initial approximately six years of mine production is expected to be 10,000 m^3/d. The environmental design flood would result in a volume of 70,000 m^3 of water entering the pit. Portions of this volume would be stored in the pit and pumped out in the days following a storm event. If necessary, a second standby system could be put in place to provide increased capacity for stormwater management. Any such standby system would provide additional pumping capacity for pit dewatering, with water removed from the open pit being directed to either the mine rock pond, or to the TMA pond. There would be no direct release from these ponds to the environment.

Minewater will also need to be removed from the underground mine using sumps at low points within the mine workings. Pumping stations will be developed as necessary to bring the water to the surface for treatment and re-use. The volume of minewater from the underground mine is expected to be limited compared to that from the open pit, as the bedrock is not very permeable.

Minewater will contain suspended solids, as well as ammonia and hydrocarbon residuals. The acid rock drainage / metal leaching (ARD/ML) assessment of the leachability of the rock illustrated that the deposit does not contain a wide range of elevated metals and that readily soluble metals are not present in the RRP minewater. All minewater will report to the mine rock pond for eventual re-use in the process plant and will not be discharged directly to the environment. Details regarding the site water management approach are provided in Section 4.12 (and Appendix W-1) and a brief description is provided below.

Suspended solids in the water will come from heavy equipment use and blasting operations. Larger suspended solids will settle out in the mine sumps, and will be periodically removed to the east mine rock stockpile (or similar). The remaining fine suspended solids in the minewater, are expected to average from about 1,000 to 4,000 mg/L total suspended solids (TSS) based on other typical mining operations. Minor quantities of solids and dissolved phase metals will also be present in the minewater. The majority of the metals are expected to be in solid phase because of the slow kinetics of mineral oxidation. A large proportion of the fine suspended solids will remain in the minewater and will be pumped to the mine rock pond for use in the process plant and eventually discharged to the tailings management area within the tailings slurry (Section 4.12).

The minewater to be re-used in the process plant will also contain ammonia residuals derived from the use of ammonium nitrate based explosive materials (ANFO explosives); but also possibly ANFO emulsion or emulsion blend explosives. Typical ANFO explosives generate ammonia residuals of about 5 to 10% of the ammonia originally present in the explosive material. Emulsion and emulsion blend explosives typically produce a lower ratio of ammonia residuals and are better suited for blasting in wet conditions.

Minewater typically also contains hydrocarbon residuals from hydraulic hose breaks, fuel leaks and similar mishaps. Measures will be taken to prevent and clean up any hydrocarbon spills at source to ensure such materials do not enter the minewater as practical. Pumping minewater from below the sump surface will help keep hydrocarbon residuals from being pumped to the mine rock pond. Hydrocarbon collected in the sumps will be periodically removed using oil skimmers and/or similar absorbent materials. The absorbent materials will be handled and disposed of appropriately.

Minewater management during the post closure period is discussed in Section 4.19.

4.6 Stockpiles

Mine development is expected to generate approximately 70 to 80 Mt of overburden and 350 to 400 Mt of mine rock. Based on the current design, an estimated approximately 3 Mt of overburden and 13 Mt of NPAG mine rock will be used for tailings dams and other dyke / berm construction. The remainder of the overburden and mine rock will be stockpiled for permanent disposal on the RRP site, with a portion of the overburden and NPAG mine rock to be used during progressive and final site reclamation.

The principal criteria for selection of stockpile locations were the following:

- Areas reasonably close to the mine to minimize the overall RRP environmental footprint, reduce greenhouse emissions and to achieve economic efficiencies of operation;
- Provide for a smaller number of larger stockpiles that can be managed more efficiently, rather than having several smaller, scattered stockpiles;
- Position stockpiles in a manner such that drainage from the stockpiles can be suitably collected and managed in accordance with the Federal Metal Mining Effluent Regulation and Provincial environmental approval requirements;
- Minimize potential adverse effects to aquatic and terrestrial habitats, including potential adverse effects to Species at Risk (SAR);
- For mine rock, provide for an optimal closure scenario for potential ARD management using passive systems to the extent possible, but with a contingency arrangement for long term chemical treatment if required; and
- Land tenure and existing / potential land uses, including proximity to existing residences as potential noise receptors.

4.6.1 Overburden

The majority of the overburden will be removed during the construction phase and the first four years of operation. At the RRP, the overburden includes a relatively shallow organic horizon (an up to 3 m thick layer of topsoil and peat), underlain by glacial material of dominantly four types: up to approximately 4.6 m of glaciolacustrine silty clay (Brenna formation); a clay till (Keewatin till) of up to approximately 28 m thickness; another glaciolacustrine silty clay deposit (Whylie formation) of up to about 2 m thickness; and a sand till of up to about 13 m thickness (White Shell Till). The geochemical assessment of overburden concluded that these materials have no potential for acid generation or metal leaching due to the general absence of sulphides and metals.

The overburden will be trucked to the west stockpile for storage, or if possible, transported directly to the proposed construction or reclamation location. Opportunities are being investigated to co-dispose the overburden with NPAG mine rock in the western stockpile area, to better facilitate handling of the clay-rich materials under all weather conditions.

Stability analyses were carried out by the limit equilibrium method (GeoStudio SLOPE/W utilizing the Morgenstern-Price method) to determine the appropriate overburden stockpile design criteria for shorter term and long term stability. The geotechnical properties of the overburden materials (primarily clay) generally support stockpiles of 20 to 30 m height with relatively shallow side slopes (8H:1V) to ensure stability. The side slope angle may be altered and optimized during operation, based on observations during the initial stockpile development.

Ditches will be excavated around the overburden stockpile to direct runoff to a sediment control pond (Sediment Pond #1 or #2) for collection and settling of solids. The ponds will be designed to settle solids out of suspension effectively, and may include a multi-cell system with provision for flocculent usage if needed. This collected water may be re-used for appropriate uses onsite to reduce the quantity of fresh water required; or will be discharged to the West Creek diversion once water quality requirements are met.

As a result of the relatively shallow side slopes / height and the volume of overburden to be stored, a sizeable area will be required. The proposed stockpile has an area of approximately 165 ha, excluding related ditching and infrastructure. Internal roads will be constructed as necessary for effective deposition.

4.6.2 Mine Rock

Mine rock will be extracted from the open pit mine (and to a lesser extent from the underground mine) to gain access to the ore. The rock will be classified according to its geochemical characteristics to ensure effective management. Geochemistry studies are well advanced to understand the extent of potential for acid generation and metal leaching from the mine rock (Section 5.5). As the rock has a relatively low readily dissolvable metal content, management of the rock had been dictated primarily by its acid generation potential. Depending on the acid generation potential, the mine rock will be permanently stockpiled in one of two different locations and classified as PAG or NPAG. A lesser quantity of NPAG (13 Mt) will be re-used in site construction. The mine rock segregation program as currently planned will consist of:

- Developing a detailed mine rock management strategy around the distribution of NPAG and PAG materials, including the selection of materials to be used for mine site construction; and

- Developing a program of ongoing testing (Leco furnace testing of blast hole drill cuttings) to be carried out during mining operations to assess the acid generating potential of the mine rock being removed, so that it can be directed to the appropriate mine stockpile location.

Mine rock segregation programs of the above type are standard industry practice where there are potential concerns over ARD.

The east mine rock stockpile has been designed to store and encapsulate PAG mine rock. Given the natural topography, this location will allow capture of runoff by gravity from the stockpile in ditches during construction and operation, to be directed to a mine rock pond for further management (Figure 4-1). The stockpile has been designed as an irregularly shaped structure to take advantage of land ownership aspects, as well as slope and site conditions. The stockpile will be developed closest to the open pit first (subject to final design) and progressing eastward, followed by north thereafter.

A height of up to approximately 40 m is expected, comprising an upper flatter surface and benched side slopes. Overall side slopes of approximately 6H:1V to 8H:1V are proposed, subject to additional investigations and operational monitoring results. Bench heights of up to 10 m could be used with internal slopes of 1.5H:1V to 2H:1V, although shallower bench heights and angles will likely be utilized initially. The stockpile is expected to cover an area of approximately 280 ha excluding associated ditches and infrastructure.

Ditches will be excavated around the east mine rock stockpile to direct runoff to a mine rock pond for collection (Figure 4-1). This collected water will be re-used in the process plant to reduce the quantity of fresh water required. On closure of the mine, the east mine rock stockpile drainage will be directed to flow by gravity into the open pit.

The west mine rock stockpile, located west of the open pit and immediately adjacent to the overburden stockpile, will store NPAG mine rock, possible co-disposed with overburden. The west mine rock stockpile will be approximately 50 m high and cover an area of approximately 225 ha. It will be developed west from the open pit, progressed westward over time. This stockpile is designed with ditches to capture runoff for direction to Sediment Pond #2 for monitoring, and further treatment if necessary. Sediment Pond #2 will be designed to settle solids out of suspension effectively, and may include a multi-cell system with provision for flocculent usage if needed. This collected water may be re-used for appropriate uses onsite to reduce the quantity of fresh water required; or will be discharged to Loslo Creek / Cowser Drain once water quality requirements are met.

A flood protection berm (likely with an access road on top) will be placed between the west mine rock stockpile and the Pinewood River, to facilitate access and enhance the stability of the west mine rock stockpile.

4.6.3 Ore

Ore transported to the surface from the open pit and underground mines will generally be taken directly to the primary crusher. A run of mine ore stockpile area will be located on the opposite side of the pad from the crusher.

A low grade ore stockpile will be developed adjacent to the east mine rock stockpile footprint area, for gradual or periodic ore feed blending during the first ten years of processing (Figure 4-1). The low grade ore stockpile will be the primary source of feed to the process plant during the last six years of mine life. It has been designed in a similar manner and beside the east mine rock stockpile, in order that drainage can be readily collected through ditching for re-use. The stockpile is expected to contain up to a maximum of 43 Mt of low grade ore for temporary storage.

4.7 Processing

4.7.1 Buildings and Structures

Ore will undergo size reduction and be processed within the primary crusher and process plant located northeast of the proposed open pit (Figure 4-1). The process plant and primary crusher have been designed for a throughput of approximately 21,000 tpd. A simplified ore processing circuit is shown in Figure 4-4.

The primary crusher will be located on bedrock outside the ultimate mine pit and blasting perimeter, near the open pit exit ramp. The majority of the structure will be below grade (up to approximately 30.5 m) in order to facilitate ore dumping and movement. A large pad will be constructed at the crusher to allow for mine truck circulation. The primary crusher building will house the gyratory crusher, surge pocket, apron feeder and the tail end of the stockpile feed conveyor that will transport ore to the crushed ore stockpile to feed the process plant.

A crushed rock stockpile will be required to ensure continuous feed to the process plant. A 20,000 t live capacity stockpile is proposed, having an overall capacity of 60,000 t. It will be developed on a pad of approximately 75 m diameter to allow ore and runoff containment. A reclaim tunnel will be installed under the crushed ore stockpile to send recovered ore to the process plant by means of a conveyor.

All ore processing will take place within the process plant which is also situated on bedrock to ensure equipment stability. The main processing building will house: the grinding and pebble crushing circuit, gravity circuit, cyanide leaching with carbon-in-pulp (CIP) gold adsorption, carbon stripping and electrowinning to produce a gold and silver sludge, and doré gold bar production using an induction furnace, as well as reagent preparation areas and the metallurgical laboratory. The thickeners, leach tanks, lime slaking and cyanide destruction areas will be located outside the main processing building.

4.7.2 Comminution

The run of mine ore from the open pit or low grade ore stockpile needs to be reduced in size by crushing and grinding to the consistency of sand or silt to improve the effectiveness of further processing. Trucks from the open pit or underground mine will dump ore directly into one of two dump pockets. Ore that is too large will be made smaller with a rock breaker, which will also be used to manipulate rocks bridging the mouth of the crusher.

The ore will be sequentially reduced in size through a series of steps:

- Hydraulic rock breaker as needed to reduce oversized ore to enable feed into the primary crusher;

- Primary crushing (gyratory crusher) to reduce the ore feed to <350 mm maximum diameter;

- Semi-autogenous grinding (SAG) mill to reduce the ore feed to 80% passing 2.4 mm or approximately 100% passing <80 mm;

- Pebble crushing to reduce the ore recycle to the SAG mill; and

- Secondary grinding (ball mill) to reduce the ore feed to 80% passing 0.075 mm or approximately 100% passing 0.15 mm.

Process water will be added to the ore to the mill to achieve a density of approximately 70 to 72% solids in the SAG and ball mill circuits. Milling involves grinding the ore within large revolving steel drums (the SAG and ball mills) with the aid of hardened steel grinding balls (approximately 63 to 125 mm diameter with the coarser media being used in the SAG mill), which cascade on the ore as the drum rotates. The SAG mill slurry is passed on to the ball mill, with the exception of oversized material which is screened off and passes through a pebble crusher before being returned to the SAG mill for additional grinding. The ball mill reduces the size of the material further and discharges as a slurry and is pumped to a cluster of cyclones.

4.7.3 Concentration and Separation

The ball mill discharge is combined with the SAG mill discharge and the tailings from the gravity circuit and pumped to the cyclone cluster. In the cyclones, gravity and hydraulic forces separate the larger and smaller ore particles in suspension. Smaller particles in the cyclones tend to remain in suspension, and are discharged as cyclone overflow to the leach circuit. Larger and denser particles tend to report to the cyclone underflow, with a portion of the underflow (mainly the smaller dense particles) reporting to the gravity separation circuit, and the remainder (mainly the larger particles) reporting to the ball mill for further grinding. The overflow from the cyclone cluster, properly sized to 80% passing 75 µm, is fed to the leach circuit by way of the pre-leach thickener.

Gravity concentration takes advantage of the high specific gravity of gold and silver to separate the heavier gold and silver particles from the less dense rock particles, to produce a concentrate with low mass and a high gold content. The gravity concentrate is then leached in an intense cyanidation reactor, to produce a pregnant solution laden with gold (in solution). The tailings from the gravity concentrators are returned to the ball mill circuit.

4.7.4 Leaching and Carbon Adsorption

The cyclone overflow from the crushing and grinding circuit will report to a 44 m diameter thickener, and then to a series of eight tanks for leaching, all located adjacent to the process plant. The tanks will be surrounded by a walled concrete slab to provide secondary containment.

The thickened ore slurry at approximately 62% solids content is diluted to approximately 50% solids and then passes through the following stages:

- Leaching of the feed slurry in a series of leach tanks to which oxygen and sodium cyanide are added, within an alkaline environment (pH >10.5) to keep the cyanide in solution; at lower pH values cyanide will start to volatilize to the atmosphere within the mill building (a situation that could produce unsafe conditions);

- Adsorption of the gold that is dissolved in cyanide solution onto activated carbon in the CIP circuit which is comprised of seven tanks containing approximately 20 t of activated carbon for approximately 115 minutes of total retention time;

- Transfer of the loaded (gold bearing) carbon from a CIP tank (approximately every two days) to the gold recovery circuit; and

- Discharge of the CIP rejects (tailings) to the pre-detoxification thickener, prior to the wastewater treatment circuit for cyanide destruction.

Most of the activated carbon used in the process will be reactivated for re-use in the CIP circuit. The finer fraction is an inert waste that will be stored in super bags for subsequent disposal offsite.

4.7.5 Gold Recovery

Gold recovery from the loaded carbon will be achieved using a conventional (or equivalent) carbon stripping and electrowinning circuit, the major steps of which are:

- Desorption of the washed loaded carbon with a higher strength, pressurized hot caustic cyanide solution, to produce a high strength pregnant (gold bearing) solution;

- Electrowinning gold from the pregnant solutions (CIP and gravity circuits), using steel wool cathodes to produce a gold and silver sludge; and

- Drying and smelting the electrowinning cathode sludge in an induction furnace to produce doré bars.

Gold recovery will occur in a secure area with limited access. RRR anticipates that approximately 12 doré bars will be poured each week during full production.

4.7.6 Cyanide Use and Destruction

The process plant will use whole ore cyanidation as the most effective means of gold recovery. Cyanide is the only technically and cost-effective means of gold recovery from gold-bearing ore at a commercial scale for this ore type, and is standard practice throughout the industry, including virtually all other active gold mines in Ontario. The cyanide leaching process at the RRP will be designed to meet all conditions for responsible management of cyanide as defined by industry best practices. This includes transportation and storage of sodium cyanide at the RRP (expected to be transported to site in a pellet format in sealed approved containers), as well as best practices during the mixing and use in the process plant, and in the destruction of cyanide components in tailings prior to pumping to the tailings management area.

Cyanide in liquid form (as dissolved sodium cyanide) will be added to the leach circuit at a rate of approximately 0.3 kg of cyanide per solid tonne of ore feed. Cyanide will be partially consumed during the leaching and CIP processes as a result of reactions with sulphur, oxygen and various metals. As a result, the final expected concentration of total cyanide in the leach circuit discharge (the tailings slurry prior to the cyanide destruction circuit) will be in the order of 100 to 200 mg/L. A pre-detoxification thickener will be installed to enable recycling of some of the residual cyanide back to the plant process water system. Total cyanide will occur as both free cyanide and as cyanide complexed with heavy metals.

Tailings produced in the process plant after the gold has been recovered will contain all of the mill feed (minus the gold and silver), plus residual process chemicals, most notably cyanide in its various forms, as well as lime and heavy metals dissolved in cyanide solution. Various processes are available for destroying or otherwise removing cyanide, but the most effective and proven process for destroying cyanide within tailings slurry before it leaves the process plant is the SO_2/Air treatment process or one of its derivatives.

In-plant SO_2/Air treatment of cyanide and metallo-cyanide complexes involves the following (or equivalent) reactions:

$$CN^- + SO_2(g) + H_2O + O_2(g) \rightarrow CNO^- + H_2SO_4(aq)$$

where the cyanide ion (CN^-) is oxidized to the cyanate ion (CNO^-) using copper as a catalyst. Cyanate then reacts with water (hydrolyzes) to form ammonia (NH_3) and carbon dioxide (CO_2) in accordance with the following reaction:

$$CNO^- + 2H_2O \rightarrow OH^- + NH_3 + CO_2$$

Cyanate hydrolyzation is a longer term reaction that will take place mainly in the tailings management area pond. Often, sodium metabisulphite ($Na_2S_2O_5$) or elemental sulphur is used in the process instead of SO_2, for easier reagent management, but the overall reaction produces a similar result, as per the following:

$$2CN^- + Na_2S_2O_5 + O_2(g) + H_2O \rightarrow 2CNO^- + Na_2SO_4 + H_2SO_4$$

Metallo-cyanide complexes are oxidized according to the following general reaction:

$$\text{Metal }(CN)_x^{y-x} + xSO_2(g) + xH_2O + xO_2(g) \rightarrow xCNO^- + xH_2SO_4(aq) + \text{Metal}^{y+}$$

The free metal ions are then precipitated by adding lime to form insoluble metal hydroxides, which subsequently become adsorbed onto tailings particle solids, and will be settled out of the slurry in the tailings management area.

Cyanide destruction will occur in tank(s) in a concrete containment area, outside the process plant building. Tailings will be retained for approximately 90 minutes to allow sufficient reaction time. Test work on two representative composite tailings slurry samples for the RRP was undertaken by SGS Lakefield. Study results (slurry liquid fraction) showed that the SO_2/Air treatment process is expected to be very effective for the destruction of cyanide and the precipitation of heavy metals. Test results show that total cyanide can be reduced from a pretest initial concentration of 130 to 150 mg/L to an after test concentration of less than 1 mg/L in the tailings supernatant.

4.7.7 Other Reagent Use

Reagents that will be used in gold processing and for wastewater treatment at the RRP are typical of Ontario mines and will include those listed in Table 4-1. In some cases equivalent reagents are available and could potentially be used. Consumption rates are approximate and are based on test work and operating practices at other existing process plants.

All process reagents will be stored according to supplier and safety guidance, in separated and as applicable, contained areas.

4.8 Tailings Management

Tailings are the primary by-product from the process plant. The means of tailings deposition and storage are critical to the operability and long term closure strategy for the RRP site. The principal criteria for selection of the tailings management area arrangement were the following:

- Select an area within reasonably close proximity to the mine site to minimize the overall project environmental footprint and to achieve economic efficiencies of operation;

- Provide for all tailings storage in a single location;

- Position the tailings management area in a manner such that drainage from the system can be collected and managed in an integrated manner, in accordance with Federal Metal Mining Effluent Regulation and Provincial environmental approval requirements;

- Provide for an optimal operations and closure scenario for potential ARD management using passive systems to the extent possible, but with an allowance for contingency chemical treatment if required;

- Minimize potential adverse effects to aquatic and terrestrial habitats including to SAR, recognizing the need to capture a sufficient area of upstream watershed so as to be able to maintain at least a partial water cover on the deposited tailings to minimize oxygen exposure and prevent ARD development; and

- Land tenure and existing / potential land uses.

The proposed tailings management area will cover approximately 800 ha (excluding associated external ponds and infrastructure) and provide storage capacity for approximately 85 Mm^3 (115 Mt) of tailings anticipated to be produced over the projected mine life (Figure 4-5). Tailings management area capacity is based on an average deposited tailings dry density of 1.4 t/m^3. The tailings management area has the potential for expansion should additional mineral resources be delineated during ongoing exploration.

The facility will be bounded by high ground in the northeast and by impoundment dams along the remaining perimeter. Dams will be constructed using mainly selective low permeability clay till (overburden) and NPAG mine rock from pit development. Internal drainage zones will consist of locally acquired sand and gravel or processed NPAG mine rock.

The tailings management area dams have been designed to meet the most severe flood and earthquake criteria, being the probable maximum flood and maximum credible earthquake in accordance with the Ontario *Lakes and Rivers Improvement Act* requirements. The designs are supported by geotechnical investigations of sub-surface conditions conducted in 2010 by Klohn Crippen Berger (KCB), and in 2011 and 2012 by AMEC (2013j). An observational design approach (Peck 1969) has been taken as a result of the presence of thick, highly plastic clay, as well as varved glaciolacustrine units.

Stability analyses for the tailings management area dam design were carried out using the limit equilibrium based computer software SLOPE/W 2007 (GeoStudio version 7.17). The following criteria were used in the geotechnical design of the tailings management area dam slopes, the:

- RRP site has low to moderate seismic risk, with 0.096 g horizontal peak ground acceleration for a 10,000 year return earthquake (AMEC 2012a); and
- Required minimum Factor of Safety values for the design slopes:
  - Short term, end of construction with induced pore pressures - 1.3;
  - Long term, when excess pore pressures have fully dissipated - 1.5;
  - Rapid drawdown condition (water management pond slope) - 1.2 to 1.3;
  - Worst case, with potentially slickenside upper varved clay - 1.0; and
  - Pseudo-static loading with a seismic coefficient of 50% of the peak ground acceleration - 1.0.

Based on the above criteria, a 4H:1V downstream side slopes are proposed for tailings management area dam sections of up to approximately 15 m height. The maximum dam section is about 23.5 m high for which a 5.5H:1V overall downstream side slope is proposed, supported by an appropriately sized mine rock toe berm. An appropriate side slope steepness will be used for the intervening dam heights. A steeper upstream slope is possible because of the buttressing effect of the deposited tailings.

The tailings management area dams will be constructed in stages largely of selected overburden and mine rock from open pit development. As practical, the mine rock will be placed directly by the mine truck fleet. The tailings dams are proposed to be comprised of four zones (Figure 4-6):

- Zone 1: will act as the water retaining element of the dam. Zone 1 will be placed in lifts with controlled compaction (selective clay - Whitemouth Lake till overburden from open pit development);
- Zone 2: proposed as upstream shell to support Zone 1. Zone 1 will be placed in compacted lifts (NPAG or PAG rock);
- Zone 3: a downstream shell zone designed for stability and to safely control the seepage flow through the toe of the dam (NPAG mine rock); and
- Zone 4: to act as filter / drain downstream of the core and on the foundation soils to ensure the integrity of Zone 1 and prevent piping (movement) of fines into the rockfill shell (select or processed sand and gravel aggregate or processed NPAG mine rock).

The final tailings management area design will include specification of appropriate filter and toe drains to ensure the long term stability of the dams. Emergency spillways will be provided for each stage of the tailings management area dams and water management pond to safely pass the probably maximum flood. Adequate freeboard will be maintained in the tailings management area and water manage pond to contain the environmental design flood corresponding to a 100-year 24-hour storm event. All spillways will be suitably armoured to withstand erosional effects of the flows.

Tailings management area dam construction will follow the observational approach outlined by Peck (1969). The observational method approaches the design based on the most likely or expected condition, while still accommodating a realistic worst case. Contingency plans are prepared that can be implemented should monitored conditions suggest they are appropriate in advance of any material change. The realistic worst case for the RRP has been defined as associated with the possible presence of slickensided or pre-sheared planes of low shear strength within the clays. It should be noted however, that there has been no evidence of the presence of slickensided clays found during the geotechnical investigations. Nonetheless the dams have been designed to be stable in the event that they do exist as the realistic worse case. The detailed design stage will consider and identify contingency measures that can be readily implemented, such as placing stabilizing berms or flattening the slopes, for implementation as required based on performance observations and monitoring data resulting from field instrumentation and observations.

As is the industry standard, the RRP tailings management area dams will be constructed in stages. The first stage of development will entail stripping of organics and unsuitable material and construction of starter dams to a maximum 10.5 m height (366.5 masl crest elevation) to contain approximately two years of tailings (10.4 Mm^3 including a 2 m freeboard at the crest). The dams will be raised sequentially over the life of the mine to the maximum height of 23.5 m (379.5 masl crest elevation) in order to contain approximately 85 Mm^3 of tailings (including freeboard at crest). During the staged dam raise, upstream dam slopes will be buttressed by the deposited tailings beach.

The treated tailings at 55% solids by mass will be pumped through an approximately 6.5 km length high density polyethylene pipeline from the process plant to the tailings management area for permanent storage. The pipeline will be situated within a ditch to provide secondary containment. Emergency retention ponds will be located along the route to allow the slurry to be temporarily flushed from the pipeline in the event of an extended power outage. Reclaimed water will be recycled to the process plant as needed from the tailings management area, by means of a parallel water pipeline (Section 4.12).

Tailings will be deposited from spigots located along the inside perimeter of the tailings management area dams in order to develop a tailings beach in front of the dam. Perimeter discharge is a standard practice that enhances dam stability by keeping ponded water away from the surrounding dams. The discharge locations will require lateral extension inward later in mine life to optimize tailings management area capacity. An internal pond will be developed within the central northern part of the basin to allow easy reclaim of water by barge of a few square metres in size and pump.

A large portion of the excess water contained within the tailings management area will need to be recycled to the process plant for process water. The pond will also allow for improved effluent water quality through the process of natural degradation, whereby tailings solids are settled and residual chemicals in the water column are passively precipitated, oxidized, taken up through biological processes and/or volatized to the atmosphere.

Ditching and sumps / collection ponds will be established around the tailings management area to capture seepage and direct it to either to the water management pond or to the water discharge pond. From there, the water will be either discharged to the environment if it meets applicable water quality criteria (through the constructed wetland or pipeline to the Pinewood River) or returned to the tailings management area pond. Fencing will be placed around the tailings management area as shown on Figure 4-5.

The tailings management area dams will be constructed to contain water from the 100 year, 24 hour storm event, with a spillway capable of passing the probable maximum precipitation (Appendix W-1).

4.9 Other Buildings, Facilities and Areas

The main administration building will be located at the main entrance to the RRP site on Roen Road south of the East Access Road. The building is expected to be comprised of nine, 4 m by 20 m modules that will house administration and safety and security staff only.

Standard communication equipment will be used to connect the RRP site with the regional communications network. A combined fibre optic self-healing loop backbone will interconnect all areas for communications. The line will be strung on the same poles as the 27.6 kV overhead distribution lines and can transmit voice, video and data on the following networks:

- Telemetry, data acquisition, and control between the process plant and exterior process equipment;
- Computer network between all departments;
- Local telephone services; and
- Computer network for maintenance on all electrical equipment data.

There will be no polychlorinated biphenyl containing equipment at the site.

There are no plans to develop an onsite construction accommodation complex or permanent accommodation complex as sufficient accommodations can be found in local communities. Most mine employees will seek out housing within area Municipalities that best suit their own family needs and their ability to reach the mine site on a daily basis. The vibrant business sector within the Rainy River District is expected to meet the RRP housing needs and the company continues to meet with local businesses interested in provision of various offsite accommodations. Although not expected, there is the potential for minor temporary accommodations to be developed within the RRP footprint by contractors which will meet all regulatory requirements. The construction workforce is expected to number approximately 400 personnel during the peak work period. It is expected that the number of fulltime permanent workers will number between 400 and 600 personnel for operations. Parking for employee vehicles and other service vehicles will be available at the site near to the process plant.

4.10 Onsite Access Roads

Onsite access will be provided through the existing local road network with extensions as appropriate to link new facilities. Internal haul roads and service roads will link the principal site facilities. Attention will be given to separating large haul truck traffic from other site vehicular traffic during ongoing design. Access to the outlying tailings management area and to the explosives plant area will be by means of existing roads resurfaced with NPAG crushed stone and upgraded as needed. The roads will be widened to allow for tailings and reclaim water pipelines, as well as for light traffic (emulsion tankers and pick-up trucks) as appropriate.

A number of minor watercourse crossings or upgrading of existing culverts will be required. The design of these crossings is in progress, but may include culverts or clear span bridges. Transport Canada has determined that the waterbodies within the footprint of various mine components (such as West Creek, Clark Creek and the Teeple Municipal Drain) are not navigable waters.

4.11 Aggregates

The primary source of construction material at the RRP site will be mineral waste from open pit development (overburden and NPAG mine rock). It is estimated that approximately 3 Mt of overburden and 13 Mt of NPAG mine rock will be re-used in site construction.

Several sand and gravel, and stone sources have been identified in reasonable proximity to the RRP site centroid (Figure 4-7). Additional aggregate will be required for specialized uses including tailings dam filters, concrete manufacturing and road construction, including the Highway 600 re-alignment which must be constructed to the Ministry of Transportation (MTO) standards. The material required can either be sourced from a local sand and gravel deposit or quarry, or developed by the crushing and processing of NPAG mine rock. There are a number of regional sources; however, closer supplies are preferred and are currently under investigation.

An existing sand and gravel pit located northwest of the proposed West Creek pond and south of Roen Road was purchased from the MTO and has been identified as a potential source for tailings dam filter materials. The pit has already had considerable extraction and remains open. Investigations suggest that reserves remain available at this pit.

An investigation was conducted by AMEC to assess the suitability of rock from various local sources for concrete manufacture and a number of locations have been identified that are expected to meet specifications.

4.12 Water Management

4.12.1 General Approach

The RRP water management system is designed for water conservation. Best engineering efforts have been made to ensure maximum reasonable recycling of water while reducing the volume of excess water that must be returned to the natural environment. Water management for the RRP has been designed to the extent practicable, to:

- Optimize the quantity and quality of excess water returned to the environment so as to minimize adverse flow and water quality effects to receiving water systems;
- Generate a reliable water source for mill operations and ancillary uses by maximizing the rate of water recycled to the process plant;
- Dewater the open pit and underground mine workings to ensure worker safety and operability;
- Manage acid rock drainage potentials both during operations, and following mine closure;
- Collect and control all site effluents in accordance with Metal Mining Effluent Regulations and anticipated Provincial permitting requirements;
- Minimize the number of final discharge points and the quantity of water discharged; and
- Maintain system operability and flexibility to respond to varying circumstances, including wet and dry hydrological cycles.

Excess water discharged to the environment must be capable of meeting applicable Federal and Provincial guidelines for the protection of aquatic life (including the Provincial Water Quality Objectives for the protection of aquatic life; PWQO), or other scientifically defensible alternatives in the receiving watercourse (the Pinewood River). The compliance criteria are determined through the Provincial environmental approval process on a case by case basis, with the default requirement being the application of PWQO to the receiver if other values cannot be determined to be more suitable. To achieve these objectives, an integrated and adaptable water management system has been developed as shown in Figures 4-8 and 4-9 and described in further detail in Appendix W-1. The principal water requirements at the RRP site are:

- Water for process plant operations (at start-up and continuously during operations) including clean recycle water for specialized functions, such as gland and seal water, and water for reagent mixing;
- Clean recycle water for truck wash facility make-up, and water used for dust control and other minor uses
- Drill water to support open pit and underground mining; and
- Potable water for staff consumption, washing / showers and sanitary uses.

The principal water discharge requiring management at the site will consist of the following:

- Minewater from the open pit and underground mine;
- Water associated with the treated (SO_2/Air) tailings effluent from the process plant;
- Runoff and seepage from the tailings management area and stockpiles (mine rock, low grade ore and overburden);
- Water from the truck wash facility and other minor sources;
- Treated domestic sewage water; and
- General site area runoff.

An integrated water management and treatment system has been designed that relies on recycling water from various constructed ponds for process water in order to minimize the volume of fresh water taken from local watercourses and reduce the quantity of treated water requiring discharge. The system has been designed to ensure a reliable water supply at all times of the year and to allow for contingencies, such as sequences of wet and dry years.

The system includes six primary constructed ponds for water management (the tailings management pond, water management pond, water discharge pond, mine rock pond, and sediment ponds #1 and #2), in addition to a small number of sediment and runoff / seepage control ponds that will ultimately report to one or more of these primary ponds, and one direct fresh water source for potable water (West Creek pond). The Pinewood River will provide fresh water for the start of operations and is proposed as a contingency water source during the remainder of mine life. A constructed wetland is proposed downstream of the tailings management area and will act as part of the water treatment system.

A number of pipelines are required to support the RRP water management system. The pipelines will be designed, constructed and managed according to industry standards, including continuous monitoring and/or inspections as appropriate. All of the outdoor pipelines are proposed to be high density polyethylene pipe and will generally be placed above ground to ensure easy inspection. The discharge and intake pipelines will cross under the Pinewood River; all other pipelines are expected to cross over minor watercourses as needed. The following major pipelines are proposed, pending final engineering design:

- Pipeline to pump minewater from open pit / underground mine to mine rock pond, size to be determined;

- Pipeline from the mine rock pond to the process plant to provide the majority of process water, 400 mm diameter;

- Tailings discharge to the tailings management area from process plant (outside), 650 mm diameter;

- Reclaim pipeline from the tailings management area to process plant to provide process water, 450 mm diameter;

- Freshwater pipeline from the water management pond to the process plant for process water make up and special uses, 180 mm diameter;

- Discharge of excess water from the water management pond to the Pinewood River, 750 mm diameter; and

- Freshwater intake from the Pinewood River during construction to build up a water supply in the water management pond, 750 mm diameter (same pipeline as above; different timing of use).

The tailings pipeline from the process plant to the tailings management area will be contained in a clay-lined trench. Two basins will be created the low points along the tailings pipeline for spill containment / pipeline dump. Each basin is sized to be able to hold 110% of the volume of the tailings pipeline. A pipeline break detection system is also proposed. Mag flow meters will be installed at both ends of the pipeline (at the process plant and where the tailings pipeline crosses the tailings management area dam). In addition, there are three pressure transmitters located along the tailings line. These instruments will signal if there is a failure in the line and the tailings pipeline will shut down.

4.12.2 Water Supply for Process Plant Start-up

A water inventory of not less than 3 to 5 Mm^3 will be required to support process plant start-up depending on the exact date of start-up, including consideration of temporary water losses to ice formation and other factors. The primary water reservoir to support process plant start-up will be the water management pond located immediately adjacent to, and southwest of the tailings management area. Construction of the water management pond is planned to start once regulatory approvals are obtained. RRR expects that the water management pond will be constructed and ready to receive water inflow by late 2015, or by early 2016 at the latest.

For the initial start-up, water will be taken from the Pinewood River and stored in the water management pond for future use. The water management pond will also receive direct precipitation. A water intake structure will be constructed on the Pinewood River downstream of McCallum Creek. This location was chosen because the Pinewood River catchment area (and therefore flow) increases substantially downstream of two major tributaries, Tait Creek and McCallum Creek, that enter the river at this point. A pumping station is expected to be developed by RRR on southern bank of the Pinewood River to draw water through an intake pipe placed on the river bed (pending regulatory approval).

It is proposed that up to 20% of the spring flow (April to June; or starting in March in the event of an early spring thaw), and up to 15% of the river flow from July through November, will be withdrawn from the Pinewood River and stored in the water management pond to develop the needed RRP water inventory. This approach is consistent with other Ontario mining projects. Water will be taken from the Pinewood River only during preparation for process plant start-up, and possibly into very early phrase processing operations in the event that extreme drought conditions were to be experienced during this early phase, such that insufficient water is otherwise not available from site catchments (Appendix W-1). Thereafter, RRR does not intend to take water directly from the Pinewood River, except possibly for contingency purposes.

The available water from the Pinewood River under the percentage flow restrictions described above is shown in Table 4-3 for average and low runoff conditions. If flows approaching or above mean annual flow conditions are encountered, the percentage takings from the river will be reduced, as there will be excess water available under these conditions.

Water taking rates at the proposed Pinewood River intake location will be determined according to river flows measured at the Water Survey of Canada Station 05PC023 (Pinewood River at Highway 617, watershed area 233 km^2). This station has been in operation since 2007 and records daily flows as real time data throughout the year. The available watershed catchment for the Pinewood River water intake location (207 km^2) will be adjusted for any watershed capture developed by the RRP upstream of this location. For example, if the West Creek pond and the tailings management area impoundment were to be in place at the time of taking, any water taken or captured by those impoundments, as well as water intercepted directly by the water management pond, will be deducted from the calculation of available water at the Pinewood River water intake.

4.12.3 Water Supply for Process Plant Operations

The process plant will require on an ongoing basis, approximately 20,400 m^3/d of water, virtually all of which will come from recycling. Process plant outputs will include an estimated 20,000 m^3/d of water discharged to the tailings management area as part of the tailings slurry discharge, and 400 m^3/d of water lost to evaporation in the process plant.

Process water for process plant operations will consist of recycled water from the mine rock pond, as well as from the tailings management area pond and the water management pond. All site contact water will report directly or indirectly to these three ponds, including mine water from the open pit and underground (Figure 4-10). Under typical, average annual operating conditions, an estimated:

- 9,660 m^3/d will derive from the mine rock pond;
- 8,630 m^3/d from the tailings management area pond;
- 1,610 m^3/d from the West Creek pond; and
- 500 m^3/d will enter the process plant with the ore.

Ample water storage is available in the water management pond and the tailings management area pond to provide for process plant water needs during the winter months or during prolonged summer or fall drought conditions.

In regards to water availability in the tailings management area pond, a portion of the water contained in the process plant slurry discharged to the tailings management area will be retained in the pore space within the deposited tailings. This expected water loss into permanent storage has been calculated to average 7,100 m^3/d. This value is based on a specific gravity of 2.82 for the ore and a settled tailings solids density of 1.41 t/m^3. The difference between the volume of water in the tailings slurry discharged to the tailings management area and the volume of water permanently stored within the tailings solids void space will be available water for recycling back to the process plant for processing. Excess tailings management area water not needed for processing will be discharged to the environment by way of the water management pond, either through the water discharge pond and constructed wetland to lower Loslo Creek / Cowser Drain and the Pinewood River; or directly to the Pinewood River downstream of the McCallum Creek outflow. Final compliance points for regulatory approval will be at the discharge from the constructed wetland and or end of pipe for the direct pipeline discharge (Appendix W-1).

Modelling indicates that once steady state conditions are achieved, minewater will need to be removed from the mine workings at a net rate of approximately 6,600 to 9,800 m^3/d (including direct precipitation and runoff reporting to the open pit) in order to maintain a reasonably dry and safe working environment. These values allow for the return of a small portion of minewater to support mining operations, such as for cooling water for mine drilling activities. Excess minewater will be pumped to the mine rock pond and will become part of the water inventory. The mine rock pond will also collect natural runoff and seepage from the east mine rock stockpile area. Water from upstream areas of the Clark Creek watershed will be routed away from the east mine rock stockpile by the Clark Creek diversion.

The mine rock pond will provide direct process water feed to the process plant and will be designed with a storage capacity of approximately 2.93 Mm^3. As the east mine rock stockpile will store PAG and NPAG rock, the mine rock pond will contain water with increased suspended solids, possibly low levels of dissolved metals and residual ammonia from blasting agents. Any excess water from the mine rock pond that cannot be used for processing will be directed to the tailings management area pond or the water management pond, to maintain a sufficient system water inventory for process plant operations during periods of low runoff (dry summer and fall periods, and winter).

4.12.4 Fresh Water and Other Water Requirements

Nominal fresh water requirements that are needed for specialized process plant functions, such as pump gland seal uses and reagent mixing, will be taken as reclaim water from the water management pond. Dust suppression water will also be taken from water management pond reclaim water or potentially other source on receipt of Provincial approvals.

The West Creek pond will be established in line with West Creek to supply potable water for domestic and sanitary uses. This is a small water requirement of approximately 100 to 200 m^3/d. The West Creek pond will contain natural, non-contact water, and therefore does not require further management or treatment prior to release.

Domestic and sanitary needs for freshwater will be met from the West Creek pond supported as required by local well water and bottled water, especially during the early construction phase before the West Creek pond has been established. Single wells in the area are expected to yield approximately 20 m^3/d. Potable water will be distributed to the process plant area and maintenance shop. Outlying areas will be supplied with bottled potable water.

The West Creek diversion channel will be kept separate from the constructed wetland downstream of the TMA, and the west stockpile perimeter runoff and seepage collection ditch, so as not to mix the natural creek water with excess water discharged from the tailings management area or stockpile contact water.

4.12.5 Tailings Management Area Water Management

The tailings slurry (after treatment for cyanide destruction and metals precipitation) will be pumped to the tailings management area from the process plant for permanent storage of the barren ore solids (the tailings), along with water permanently stored within the tailings pore spaces. The tailings management area will also provide temporary storage of the remainder of the water portion for future re-use, with excess water discharged periodically to the environment by way of the water management pond and ancillary facilities.

In addition to providing permanent and temporary storage functions, the tailings management area has been designed to optimize natural degradation processes to provide further water treatment. Natural degradation involves the removal of excess concentrations of elements contained in ponded waters through several complementary natural processes. RRP proposes to enhance these natural processes by ensuring there is sufficient retention time to allow the reactions to occur. As cyanide and metallo-cyanide complexes are inherently unstable, if effluent is retained in a pond for a sufficient length of time under the right conditions of temperature and ultraviolet light, the low quantities of residual cyanide and metallo-cyanide complexes will break down to simpler compounds without the use of chemical reagents or other active treatment systems. The principal cyanide loss mechanism in natural degradation is the volatilization of hydrogen cyanide gas to the atmosphere in extremely low concentrations. Once hydrogen cyanide enters the atmosphere, it reacts with hydroxyl radicals and oxygen found in the air and in the presence of sunlight (photolysis) through a series of reactions, to form carbon monoxide and nitrous oxide (Lary 2004). The metal ions left behind in the water solution react with hydroxyl ions to form insoluble metal hydroxide precipitates, or to otherwise adsorb onto suspended solids. Through these reactions, metals that were previously dissolved in solution, form a solid precipitate and settle by gravity with the tailings solids. This results in a clear water tailings management area pond above the tailings surface that is sufficiently low in cyanide, dissolved metals and total metals to be released to the environment in accordance with Federal and Provincial standards for the protection of aquatic life in the receiving water.

The treated tailings slurry will also contain ammonia from explosives residuals on the ore and the in-plant treatment process. The cyanide destruction process proposed (SO_2/Air treatment process) converts cyanide to cyanate, which in turn breaks down (hydrolyzes) to form ammonia and carbon dioxide, as described in Section 4.7.6. Ammonia is readily broken down through natural processes within a tailings management area if given sufficient retention time as proposed at the RRP. Ammonia is taken up as a nutrient (food source) in tailings ponds by bacteria and algae, and is also volatized to the atmosphere. AMEC internal data from the Holt-McDermott Mine indicates that ammonia reductions of up to 100 fold can be achieved in well managed aging ponds.

These natural degradation processes are most effective during warm weather conditions when biophysical activity is optimal. Natural degradation processes are also augmented by exposure to sunlight. RRR proposes to hold effluents that are planned for discharge to the environment for a sufficient period of time under warm weather conditions, to maximize the effects of natural degradation. Such effluent aging will take place mainly during the summer months (June through mid-September) in both the tailings management area pond and water management pond. Once the excess water is determined to be of suitable quality, it will be released to the Pinewood River; either directly through a pipeline discharge below the McCallum Creek outlet, or by way of the constructed wetland downstream of the tailings management area through the Loslo Creek / Cowser Drain.

4.12.6 Final Effluent Quality and Discharge

In order to assess the expected effectiveness of effluent treatment and aging at the RRP site, process plant effluent treated using the SO_2/Air treatment process in the laboratory was allowed to age for approximately 60 days under laboratory conditions that mimicked summer conditions (temperatures averaging approximately 20^{o}C, under a natural lighting regime); but without some of the biological components which further enhance natural degradation processes. Results are shown in Table 4-4 and are compared with PWQO and Canadian Environmental Quality Guidelines (CEQG) for the protection of aquatic life. The results indicate that a high quality effluent approaching PWQO and CEQG values can be achieved through a combination of in-plant cyanide destruction using SO_2/Air process combined with natural aging in the tailings management area and associated ponds.

For that component of the tailings management area discharge and seepage directed to the constructed wetland, further reductions in residual heavy metal and ammonia levels are expected, as wetlands adsorb residual heavy metals and take up residual ammonia as a nutrient. The efficiency of such uptake is seasonally dependant and is greatest during the active plant growing season.

To optimize both water quality and river flow effects, final effluent release to the Pinewood River at two separate locations is proposed: through constructed wetland to the Pinewood River at the Loslo Creek outflow (via lower Loslo Creek / Cowser Drain); and directly to the Pinewood River just downstream of the McCallum Creek outflow by pipeline. Figure 4-11 shows a schematic of the flow arrangements and typical annual average discharge rates. Further details are provided below. The rationale for using two separate discharge locations derives from the need to achieve water effective water quality treatment while at the same time minimizing adverse flow effects on the Pinewood River, under varying hydrologic operating conditions.

As the constructed wetland is located further upstream on the Pinewood River, and as the constructed wetland will provide additional effluent treatment beyond that provided by aging in the tailings management area and water management ponds, it would be most advantageous to discharge all treated effluent to the Pinewood River through the constructed wetland.

Discharging too much effluent through the constructed wetland would however, reduce the retention time and assimilative capacity of the wetland, and could also potentially cause excess erosion though the system. The release of effluent from the water management pond to the constructed wetland has therefore been capped at a nominal flow rate of 10,000 m^3/d. If operational experience with the constructed wetland indicates that greater flow through rates can be achieved, while still maintaining effective water quality treatment, this discharge rate could potentially be increased.

All effluent from the water management pond which is not discharged through the constructed wetland will be discharged by pipeline to the Pinewood River downstream of McCallum Creek to take advantage of increased river assimilative capacity at this point, since wetland polishing would not be available for this portion of the discharged effluent.

Under average runoff conditions, from 60 to 90 percent of the effluent discharged from the water management pond would pass through the constructed wetland, with higher percentage values (90%) applying to early phase (year 2) operations, and lower percentage values (60%) applying to later phase (year 15) operations. The reason for this change is that the total quantity of effluent discharge is expected to gradually increase over the life of the mine (Table 4-5). In low runoff years, virtually all of the effluent discharged from the water management pond would pass through the constructed wetland; but during or following years with higher than normal precipitation large qualities of effluent will also be discharged through the pipeline.

The Pinewood River watershed below the constructed wetland measures 106 km^2, and the river watershed at the McCallum Creek outflow measures 207 km^2. Site area catchments that would no longer flow to the Pinewood River as a result of the RRP development, totalling 21 km^2, would require deduction from these watershed areas to generate a revised watershed areas of 85 km^2 and 186 km^2, respectively, for calculating assimilative capacities.

Provincial MOE policies for determining receiving water assimilative capacity are based on achieving PWQO for the protection of aquatic life or other scientifically defensible criteria, under varying flow conditions including the lowest average 7-day river flow expected to occur once every 20 years (7Q20 condition). Data provided in Section 5.6.2 demonstrate that the Pinewood River will have zero flow more frequently than once every 20 years near the community of Pinewood where the watershed area is greater (461 km^2) than at the proposed discharge locations (461 km^2 versus 106 km^2 and 207 km^2). Consequently, if the 7Q20 criteria were to be applied to the RRP, aged effluent from the water management pond would have to achieve the PWQO (or alternative scientifically defensible criteria) without the benefit of any appreciable mixing in the receiver.

It is proposed that final effluent from the constructed wetland meet the water quality objectives and limits shown in Table 4-6. The proposed effluent objectives for Ontario Regulation 560/94 and related parameters, are based on the development of scientifically-based protection of aquatic criteria developed from the application of United States Environmental Protection

Agency (US EPA) hardness equations in the case of copper, lead, nickel and zinc; and on the absence of salmonid (trout) species in the case of free cyanide (US EPA 2009). The toxicity of copper, lead, nickel and zinc to aquatic life is a function of hardness, where hardness reduces metal toxicity by inhibiting metal uptake by aquatic organisms.

Background hardness values measured over two years, at monthly intervals, in the Pinewood River just downstream of the RRP site area, are shown in Table 4-6. The median and 75th percentile hardness values are 195 and 208.5 mg/L, respectively. An analysis of hardness versus river flow data shows that hardness increases during periods of reduced river flow, when water ionic strength becomes more concentrated, which means that hardness yields its greatest effect when it is most needed (i.e., when river assimilative capacity based purely on flow is low). Effluent released from the water management pond is expected to have a hardness value in excess of 200 mg/L, because of the use of lime ($CaCO_3$) in the process plant. Use of a 200 mg/L hardness level to calculate modified receiver targets for the protection of aquatic life is therefore scientifically defensible. The modified receiver targets for copper, lead, nickel and zinc, base on application of US EPA hardness equations for a hardness of 200 mg/L, are shown in Table 4-6.

The PWQO for protection of aquatic life value for free cyanide is 0.005 mg/L. However, Gensemer et al. (2007) recently conducted a review of the current ambient water quality criteria for cyanide and determined a recommended, revised continuous chronic criterion value for the protection of aquatic life of 0.0098 mg/L for free cyanide for waters without salmonids. The Pinewood River does not contain salmonid (trout) species, so a 0.01 mg/L free cyanide concentration is considered scientifically defensible for this parameter.

The 0.005 mg/L protection of aquatic life value for arsenic is viewed as being overly conservative, as it is based on growth inhibition to a single algal specie, and there is little evidence of a credible risk to other freshwater species including: fish, invertebrates and plants, so long as arsenic values are retained at ≤0.05 mg/L (CCME 2001). A modified receiver target of 0.01 mg/L is therefore proposed for arsenic as being more than adequate, and scientifically defensible for the protection of aquatic life in the Pinewood River.

Proposed final effluent objectives (as monthly averages) for the constructed wetland discharge to the environment are shown in Table 4-6, as being equivalent to the rounded modified receiver targets. It is proposed that final effluent limits (as monthly averages) be set at twice the objective values, recognizing that the receiver will generally provide some level of assimilation even under low flow conditions, and that hardness effects become more pronounced at lower receiver flows.

The direct release of water management pond effluent to the Pinewood River by pipeline downstream of the McCallum Creek outflow would occur during the spring and fall, to take advantage of extended aging in the tailings management area pond and water management pond, and higher receiver assimilative capacity. Water which is not discharged from the water management pond in the fall (mainly October and November) would be held over without any further inputs from the tailings management area pond, until the following spring for release. Release to the Pinewood River in this manner, unlike the much more regular discharge through the constructed wetland, would occur at variable rates depending on surplus water inventories. On average, mixing ratios in excess of 5:1 (receiver to effluent flows) are expected for this discharge including provision for effluent loading released upstream through the constructed wetland (Table 4-7).

Proposed effluent objectives / limits for the pipeline discharge to the Pinewood River at McCallum Creek are the following:

- Final effluent meets modified receiver target objectives defined in Table 4-6 for all Provincial Environmental Compliance Approval parameters, allowing discharge without restriction; or

- Undertake loading calculations for final effluent parameters which do not meet modified receiver target objectives.

The rationale behind the proposed hierarchical approach to pipeline discharge criteria relates to operator simplicity and ensuring environmental protection as per the following. If all parameters meet the modified receiver target objectives, then the effluent without provision for mixing would meet protection of aquatic life criteria for long term exposure. In this case, there would be no restriction on effluent discharge quantity, except that posed by pumping and pipeline constraints. This would be the simplest case for system operation.

If one or more Provincial Environmental Compliance Approval parameters do not meet the first criterion (all parameters consistent with modified receiver targets), then critical receiver to effluent mixing ratios would need to be attained, as per the second criterion, to ensure that modified receiver target objectives were attained in the Pinewood River. In the case of the second criterion, the allowable discharge would be restricted by loading calculations determined for the most critical parameter. To determine allowable loadings, the operator would have to know receiver quality and flows and final effluent quality, to calculate an allowable daily discharge volume with such calculations to be performed on a daily basis.

The critical aspect of using the loading-based approach is the achievement of rapid mixing in the receiver, as the loading-based approach assumes instantaneous mixing. Various means are available for achieving rapid mixing, including in-channel structures and diffusers.

Sediment ponds #1 and #2 would operate independent of the main RRP water inventory during the operations phase. Runoff and seepage collected by these facilities would discharge their effluents directly to the environment (the West Creek diversion), and not to the tailings management area water inventory, either directly or indirectly. Runoff and seepage discharging to these sediment ponds would contain suspended solids and residual ammonia (from the use of blasting agents) adhering to mine rock. The NPAG mine rock is not expected to be chemically reactive, such that soluble metals requiring treatment through lime addition (or other means) are not expected to occur in drainage to either of sediment ponds #1 or #2. The primary concern will be for the control of sediment fines concentrations (clays and fine silts).

To provide for the effective settlement of suspended fines, a pond retention time of approximately five days, together with the option of adding either a flocculent or a coagulant to assist with solids removal. The settling ponds are expected to be divided into two or more cells, to enhance performance efficiencies. Modified receiver targets for sediment ponds #1 and #2 will be based on application of US EPA hardness equations, and consideration of arsenic as per the above.

Further details on final effluent quality and discharge are provided in Appendix W-1.

4.12.7 Water Management Structures

4.12.7.1 Preliminary Pond Designs

A brief description of each of the primary water management ponds required for the site water balance is provided below. The preliminary design characteristics of each pond are summarized in Table 4-8.

The mine rock pond will be constructed to an elevation of 362 masl, with downstream and upstream side slopes constructed at 4H:1V. The dams will be constructed of NPAG mine rock fill with a low permeability clay-rich till core. Spillways will be designed to pass the probably maximum precipitation event. The pond has been sized to operate based on the largest monthly pond volume for the 20-year wet annual precipitation conditions on the ultimate footprint of the east mine rock stockpile and the open pit prior to the environmental design flood. Approximately 50% of the process plant make-up water will be provided from the mine rock pond. This rate was selected to ensure that the pond can be kept in balance year over year in mean annual precipitation conditions. Regulation of water recycling to the process plant will ensure there is adequate storage available to contain the environmental design flood with no discharge to the environment.

The stockpile pond will collect non-contact water from an area of approximately 304 ha and will route this water to the West Creek pond. The stockpile pond dam crest will be constructed to an elevation of 369 masl, with the dam being constructed as an NPAG rock-fill structure with a low permeability clay-till core.

The West Creek pond will be constructed inline with West Creek. The West Creek pond dam crest will be constructed to an elevation of approximately 364.9 masl, with downstream and upstream side slopes constructed at 4H:1V. The dams will be constructed of NPAG mine rock fill with a low permeability clay till core. The dam outflow will be constructed with an invert elevation of 365.5 masl and with a design flow of 141 m^3/s (equivalent to the probably maximum precipitation event), passing water to the West Creek diversion.

A pond is proposed to be constructed at the head of the Clark Creek diversion (Clark Creek Pond) to facilitate re-routing of the lower reach of Clark Creek. The dam for this pond will be constructed as a low grade impoundment, from locally available clay-rich till materials faced with NPAG rock as needed to prevent surface erosion. It will be constructed to an elevation of 380.25 masl, and will divert the Clark Creek flows south away from the east mine rock stockpile.

The tailings management area pond is internal to the tailings management area and can provide a relatively large volume of water to the process plant in extreme dry events. This pond has significant available storage capacity and can store excess water from precipitation. For preliminary purposes, RRR has sized the tailings management area to contain a minimum of 3.5 Mm^3 of accessible water prior to winter. The tailings management area has ample capacity to contain water from the environmental design flood event. The tailings management area perimeter dams will be constructed to an ultimate dam crest elevation of 379.5 masl, with downstream and upstream side slopes constructed at 5.5H:1V, and 3H:1V, respectively. The dams will be constructed primarily with NPAG mine rock with a low permeability clay-rich core, with filter zones of fine and processed sand, and processed rock. Spillways will be designed to pass events exceeding the 100 year 24 hour storm event.

The water management pond receives the decant flows from the tailings management area for additional aging (more than one month) and has a catchment area of 109 ha. It has been designed with a water holding capacity of approximately 6 Mm^3, and will be capable of containing the 100 year 24 hour storm event. The dam crest of the water management pond is 373.0 masl, with downstream and upstream side slopes constructed at 4H:1V and 4H:1V, respectively. The dams will be constructed primarily with clay-rich till, with an outer facing of NPAG mine rock to prevent surface erosion. The pond spillway will be designed to pass the PMP event. The water supply required for process plant start-up will be developed by constructing the water management pond in a single stage early in the project development in order to capture sufficient natural inputs (precipitation and runoff).

The water discharge pond will receive decanted water from the water management pond and runoff from the local catchment area (100 ha) and will decant low flows to the constructed wetland. The emergency spillway invert is 354.3 masl and the dam crest elevation is 355.2 masl. Flows in excess of the wetland capacity will be directed to the Pinewood River to prevent damage to the constructed wetland due to high flows.

A constructed wetland is proposed to be established downstream of the water discharge pond within the Cowser Drain (Loslo Creek) valley, upstream of the Pinewood River (Figure 4-12). The constructed wetland has been designed to take advantage of natural topography and to support the additional passive treatment (nutrient and metal removal) of a controlled volume of discharge (nominally 10,000 m^3/d) from the water discharge pond. This limited discharge will help mitigate periods of low flow in the Pinewood River and site surface water capture.

4.12.7.2 Runoff and Seepage Collection

Runoff and seepage collection systems are required for mine site facilities per Federal requirements. Runoff and seepage collected from the plant site area through drainage ditches and other collection systems will be pumped to the mine rock pond, either directly from process plant area external sumps, or indirectly in the case of any runoff and seepage that bypasses these facilities and enters the open pit. The majority of the east mine rock stockpile area will drain by gravity to the mine rock pond, but portions of the eastern and southeastern boundary of the mine rock stockpile outside the Clark Creek basin may require separate constructed collection systems that would require pumping to the mine rock pond depending on the final stockpile design. By this means, runoff from PAG mine rock stored in the east mine rock stockpile will drain by gravity to the mine rock pond. Runoff and seepage from the east mine rock stockpile is expected to contain elevated suspended solids and elevated residual ammonia from blasting agents. Any drainage associated with the stockpile will be captured by the mine rock pond during operations thereby containing it within the overall water management system, and will not be discharged directly to the environment.

Runoff and seepage collected in ditches along much of the south perimeter of the tailings management area will be routed through ditches to the water discharge pond. Ditches bordering the northwest and west margins of the tailings management area will drain by gravity to one or more runoff collection ponds. This water may be:

- Released directly to the environment if of suitable quality (determined by monitoring);
- Pumped back to the water management pond if the water quality is not suitable for direct discharge to the environment; or
- Maintained in the water management system to enhance the existing water inventory.

Ditches will also be excavated around the overburden and west mine rock stockpiles to direct runoff to sediment control ponds (sediment ponds #1 or #2) for collection and settling of solids. These ponds will be designed to settle solids out of suspension effectively, and may include a multi-cell system with provision for flocculent usage if needed. Effluent from these ponds will be discharged directly to the environment once water quality requirements are met. Runoff and seepage from the west mine rock stockpile may also contain elevated residual ammonia from blasting agents. Ammonia is readily broken down through natural processes by bacteria and algae, and is also volatized to the atmosphere. Sediment ponds #1 and 2 will provide a retention capacity approximately five days or longer, based on the wettest month of the 20-year annual wet conditions from the site wide water balance. During drier conditions the retention period will be longer.

A laboratory investigation has determined that additional treatment beyond use of a settling pond with sufficient retention time, would not be required to settle the clays likely to be released through runoff and erosion from the overburden stockpile present (AMEC 2013b). If necessary flocculants could be used to help settle suspended solids, if settling does not otherwise occur effectively.

4.12.7.3 Constructed Wetland

A constructed wetland is proposed to be established downstream of the water discharge pond within the Cowser Drain (Loslo Creek) valley, upstream of the Pinewood River (Figure 4-12). Constructed wetlands are manmade wetlands designed to improve water quality through the enhancement of natural water treatment processes. As constructed wetlands rely in part on biological processes, they are most effective in warm climates where the growing season is longer.

A literature survey completed by AMEC supports the view that constructed wetlands are a viable treatment option in northern climates for low volumes of water discharge, when the natural seasonality of biological treatment processes are accounted for in the design and operation (AMEC 2013c). Several studies show that constructed wetlands in cold climates can be used to treat water containing nitrogen compounds (ammonia, cyanate and thiocyanate) and heavy metals. The Musselwhite Mine treatment wetland located further north than the RRP for example, has been successfully operating for 13 years.

The RRP constructed wetland has been designed as a free water surface wetland. The wetland will resemble a natural marsh having areas of open water intersected by low height dams or berms. The preliminary design includes placement of five low height, low permeability dams or berms across the Cowser Drain valley to impede flow and allow the establishment of open water marsh environments. Once the wetland system is established and sufficient water is available, appropriate non-invasive wetland plants will be planted if natural colonization is considered insufficient, or if a specific species mix is desired. Open water within the system is expected to cover a maximum of 60 ha.

The main water quality function of the wetland will occur through nutrient (nitrogen) uptake by naturally occurring algae and bacteria, as well as additional volatilization of residual ammonia to the atmosphere. As a result, the wetland will be effective for use immediately following the completion of construction, with its effectiveness further improving over time. Use of this natural cleansing system has been well received by both First Nations and members of the general public in discussions held by RRR. The development of vascular vegetation is largely incidental to the overall wetland function, but it will help with minor residual metal uptake.

Water will be released from the water discharge pond at a flow rate designed to ensure sufficient retention time within the constructed wetland. Most of the discharge will occur during the plant growing season, in order to ensure maximum uptake by algae, bacteria and plants. Early winter use of the wetland will also occur, as permitted by weather. This winter release will help to maintain and enhance low flows in the Pinewood River in the winter. A sump may be placed in the southernmost wetland pond to allow greater flexibility in the release of wetland discharges to the Pinewood River.

Further details on constructed wetland function are provided in Appendix W-1.

4.12.7.4 Watercourse Diversions

As described in Section 4.3.2.2 West Creek passes through the proposed pit development area and requires diversion in order for the RRP to proceed. A diversion of approximately 4.5 km length is required to avoid site facilities. This diversion will pass around the north and west margins of the west overburden / mine rock stockpile, and will be situated parallel to but separate from the constructed wetland in order to avoid mixing of fresh water and effluent (Figures 4-1 and 4-11). The diversion will be constructed to provide like-for-like fish habitat replacement and will be stabilized before the original channel is closed in order to ensure continual safe passage of any fish. A trapezoidal channel is proposed, having a base width of 5 m, and side slopes of 4H:1V. The diversion is proposed to remain in place permanently.

The initial 450 m of the West Creek diversion channel will also operate as the emergency spillway for the West Creek pond and has been sized to convey the probable maximum flood (the 24-hr probable maximum precipitation event) without overflowing. An emergency spillway will be constructed in the channel to direct excess flow if needed onto adjacent land. The emergency spillway will be a rectangular spillway with a base width of 5 m to pass a design flow of 154.8 m^3/s.

The lower reaches of Clark Creek and the Teeple Municipal drain will be overprinted by the east mine rock stockpile. The upper reach of Clark Creek will be routed south via a new pond (Clark Creek pond) through an unnamed drainage to the Pinewood River, to reduce the volume of water requiring management in the mine rock pond and to avoid unnecessary environmental effects. A diversion of approximately 1.35 km is required to allow connection of the upper Clark Creek with an unnamed drainage (Figure 4-1). Clark Creek pond will be created to support the diversion. Both the pond and diversion are proposed to be permanent and will be constructed as like-for-like fish habitat replacement. The diversion channel is sized to pass the environmental design flood and is of a trapezoidal shape with a 3 m wide base and 4H:1V side slopes.

Two other minor freshwater drainage diversions are also proposed:

- Diversion of the stockpile pond away from the low grade ore stockpile and process plant area to West Creek pond; and

- Diversion of a minor West Creek drainage located adjacent to the proposed process plant site further away in order to avoid overprinting / direct impacts.

Both of these diversions are proposed to ensure that the original pond / drainage remain freshwater and can be routed into the West Creek pond.

4.12.8 Water Balance Overview

The water management approach described in the preceding sections, results in an overall site water balance for the operation phase as shown graphically in Figure 4-13 and described briefly below:

- The open pit and underground mine will be dewatered year round by pumping to the mine rock pond. For modelling purposes, it was assumed that dewatering from the open pit to the mine rock pond will require pumping for 10 months of the year from March through December. The quantities of minewater from the underground are of sufficiently low volume in comparison to the open pit minewater volume to be immaterial to the overall water balance.

- The mine rock pond will capture all runoff from the east mine rock stockpile (encapsulated PAG mine rock), low grade ore stockpile and some runoff from the process plant.

- The process plant make-up water will be supplied by the mine rock pond (nominally 50% of the process plant water requirement) and tailings management area pond (nominally 43% of the process plant water requirement). Both ponds will operate all year. During consecutive dry years and during the winter, the mine rock pond may not have sufficient capacity to supply the process plant. In this case, the tailings management area pond will temporarily supply the full make-up water to the process plant.

- Fresh water for the process plant will be taken from the water management pond (nominally 8% of the process plant water requirement).

- Surplus water from the tailings management area pond will be transferred to the water management pond from June through August where it will be allowed to further age before being discharged to the environment.

- Excess water from the water management pond will be discharged to the Pinewood River by way of the water discharge pond and the constructed wetland (the last effluent control point); with the remainder of the water management pond discharge being by pipeline direct to the Pinewood River, downstream of the McCallum Creek outflow.

Water will normally be discharged from the water management pond through the constructed wetland in all months except February and March. This discharge is intended to be at a more or less constant rate of approximately 2.4 Mm^3 from year to year, with an anticipated discharge rate of approximately 10,000 m^3/d in most months. During low runoff years less water would be available to discharge through the constructed wetland. Excess water management pond water not required for processing, and not discharged through the constructed wetland (via the water discharge pond), will be discharged by the pipeline directly to the Pinewood River mainly in the months of October, November, April and May.

The total pond inflows and major water transfers (tailings management area pond, water management pond transfer and the total effluent volume discharged to the environment) are shown graphically on Figure 4-13 for the average annual runoff condition, for year 15 of operations.

Further details are provided in Appendix W-1.

4.13 Fuel and Chemical Management

The primary chemicals to be used and stored at the RRP site are:

- Process-related chemicals and reagents (Section 4.7);
- Fuels (diesel, propane gas and gasoline; Table 4-2); and
- Equipment maintenance materials (oil, grease, lubricants and coolants).

Tables 4-1 and 4-2 provide an overview of the expected storage requirements at the RRP site. All chemicals will be transported, stored and handled in accordance with applicable regulations and good management practice. Tanks will be protected against possible vehicular collisions as appropriate and secondary containment will be provided as applicable. Care will be taken to ensure that incompatible materials are not stored in close proximity, within the warehouse or other areas.

The bulk of the fuel used at the RRP site will be diesel needed for the heavy equipment fleet. A fuel island will be established close to the primary crusher outside the blast radius of the open pit, but readily accessible by heavy equipment and particularly haul trucks. The fuel island will have a diesel fuel pump station for mining vehicles and a containerized lube top-off system for oil, grease, windshield washing fluid and coolants. Fuel will be stored in seven, 80,000 L double walled tanks, equivalent to approximately six days of consumption. Other vehicle maintenance liquids will be stored in double-walled tanks or equivalent.

A small quantity of gasoline will also be stored in a double-walled Enviro tank at the RRP site for use by site small vehicles, all terrain vehicles, snowmobiles, boats and gas-powered tools, along with propane. Alternatively, a dual compartment diesel and gasoline tank could be used, rather than a dedicated gasoline tank.

All liquid fuel transfer areas where there is a reasonable potential for spills, will be constructed to contain fuel that might inadvertently be spilled. Automatic shut-off valves and other such equipment as dictated by best practice will be installed to further reduce the risk of spills during fuel transfer operations. Oil / water separators will be installed in these locations to manage runoff.

Propane may be required at the RRP site for use in equipment and potentially for heating. Any storage of pressurized gases will be according to applicable regulations.

Equipment maintenance materials, such as engine oil, hydraulic oil, transmission fluid, gear oils and greases, will be stored in secured containers within the maintenance shop or warehouse. Lubricants will also be securely stored for use at the process plant.

Solvents, other cleaners and antifreeze will also be required for equipment and vehicle maintenance. These materials will be stored in secured containers in the maintenance garage and protected area of the warehouses. Solvents and cleaners will also be securely stored for use at the process plant.

4.14 Domestic and Industrial Waste Management

Non-hazardous solid waste, such as food scraps, refuse, fabric, metal tins, scrap metal, glass, plastic, wood, paper and similar materials, will be either be stored in a dedicated landfill onsite; or temporarily stored on the site for subsequent periodic transport to an existing offsite licenced landfill.

Anticipated waste volumes during the construction and operation phases for the RRP are expected to be in the order of 8,000 m^3 and 5,000 m^3 per year, respectively. The total quantity of solid wastes that require storage over the life of the RRP is therefore estimated at approximately 96,000 m^3 excluding the active reclamation phase of the project for which an onsite demolition waste landfill is proposed. Investigations were completed by K. Smart Associates (2013a,b) to assess the existing and future capacity of two existing Township of Chapple landfills, based on the existing environmental approvals from the MOE. Based on the information provided in Smart (2013a,b), there is sufficient space in the Shenston Landfill site which currently receives industrial waste (including from the Barwick oriented strandboard mill), to accommodate the construction and operation phase wastes from the RRP under existing approvals, while maintaining availability for other users for nearly 20 years (reduced from 215 years). The Richardson Landfill site also has significant capacity (greater than 50 years at current usage), but is not currently receiving industrial waste.

Non-hazardous demolition wastes related to closure of the RRP are expected to be stored in a dedicated demolition waste landfill, most likely within the overburden stockpile, or potentially within a portion of the east mine rock stockpile.

Waste oil and lubricants will be stored in double-walled or equivalent tanks or sealed containers in bermed areas, and periodically removed by licenced haulers to an offsite licenced facility(ies). Spent solvents and cleaners will also be stored in sealed containers and periodically removed for disposal at a licenced facility off site using appropriately licenced haulers. Waste antifreeze will be similarly stored on site, until a licenced transportation company can safely remove it for offsite disposal.

A bioremediation area may be developed for treatment of hydrocarbon affected soils rather than transporting these materials offsite. This need will be assessed during future engineering investigations. Similarly, an open burn area may be requested for burning of paper and clean wood wastes in accordance with Provincial approval requirements.

Domestic sewage during the construction and operation phases will be treated using a modular, packaged sewage treatment plant (membrane bioreactor, sequencing bioreactor or rotating biological contactor). Treated effluent from the sewage treatment plant will either be discharged directly to the environment, or may potentially combined with effluent discharged to the tailings management area. Outlying facilities may be serviced by septic tile fields or holding tanks for treatment in the onsite plant.

4.15 Offsite Access and Highway 600 Re-alignment

The RRP is currently accessed by means of Highway 600 which connects Rainy River to Kings Highway 71 (the Trans Canada Highway). At the RRP site, Highway 600 is a gravel-surfaced, two-lane roadway with a posted speed limit of 80 km/hr. The road provides both local land access and through traffic. It has been classified as a rural collector undivided facility (RCU80; TBT Engineering 2012).

Highway 600 currently crosses over a portion of the open pit and must be re-aligned to make the RRP economically feasible. The section that crosses the RRP site is proposed to be re-aligned south of the RRP site along a shorter and more direct route preferred by the Township of Chapple that maximizes use of existing road allowances (Figure 4-1). Limited RRP-related traffic will travel on the re-aligned Highway 600. The re-aligned Highway 600 is proposed to be constructed by RRR to Provincial (MTO) standards so that RRR can pursue transfer of the road to the Province after construction.

A new crossing of the Pinewood River is expected to be needed which will need to meet Federal (potentially related to navigable waters) and Provincial regulatory requirements. Investigations of the crossing location were undertaken in accordance with the *Environmental Guide for Fish and Fish Habitat* (MTO 2009).

The crossing will consist of a multi-cell culvert or spanning structure, to be designed in accordance with the Provincial, Highway Drainage Design Standards (MTO 2008) and the Canadian Highway Bridge Design Code (CSA 2006), as applicable. The standards will ensure that the structure will be sized to accommodate the required storm event and to ensure the unimpeded movement of fish by maintaining existing velocities, depths and gradients. Typically, spanning structures are clear span designs to limit inwater works. Culverts they are embedded with natural substrates within to maintain a natural corridor through the crossing.

As a result of the proposed re-alignment of Highway 600, a new access road will needed for the limited number of properties on Marr Road north of the RRP site. A new East Access Road will connect Highway 71 with Roen Road by means of Korpi Road, an existing municipal road that ends at Gallinger Road (Figure 4-1). The East Access Road will serve as the main access to the RRP site from Highway 71 and will reduce the overall distance RRP-related vehicular traffic will have to travel on existing local roads. Approximately 1.6 km of Korpi Road will need to be upgraded and widened to support RRP traffic. Improvements will also be required at the Korpi Road / Highway 71 intersection to support safe turns.

Highway 71 (the Trans Canada highway) south of the proposed East Access Road intersection, connects to Highway 11, which passes through International Falls (a United States border access), and provides access to Thunder Bay to the east. Highway 71 continues north from the proposed East Access Road, through Nestor Falls and Sioux Narrows, connecting to Highway 17 east of Kenora, which continues westward to the Ontario-Manitoba border and Winnipeg.

Access to the Canada-wide rail and freight transport network is also available at Emo (Canadian National Railway) and Thunder Bay (Great Lakes - St. Lawrence Seaway).

4.16 Power Supply

Electrical power demand for most of the construction phase is expected to be relatively low (approximately 2 to 3 MW), rising to around 5 MW before the process plant is commissioned. Power to support site preparation and initial construction will be derived from the existing local electrical grid supported by onsite diesel power as needed for outlying or higher demand areas. The RRP site is currently serviced by a local 7.2 kV distribution line. This line has been assessed and it is expected to be improved to support the majority of the construction phase so as not affect other users. Small diesel generators (<5 MW total power) used to support construction will be retained on the RRP site for emergency back-up power during temporary grid power outages.

During the latter part of construction, and into commissioning and operation, the power requirement at the RRP site will increase considerably. Up to approximately 57 MW of power is required during RRP operations. The primary power demand at the RRP will be the process plant and primary crusher, with the grinding circuits in the plant requiring approximately 25 MW of the total power draw.

Discussions with the Independent Electricity System Operator and Hydro One Networks have confirmed that there is sufficient capacity within the Ontario electrical grid in the region to provide the power demand required for the RRP. A 230 kV connection to the existing Hydro One Networks line between Fort Frances and Kenora (Line Segment K24F) is proposed (Figure 4-1). A 115 kV connection could also potentially supply the RRP. The closest point of access to regional electrical grid is located northeast of the proposed process plant, and provides access to Line Segment K24F (230 kV) and the regional 115 kV line (K6F) that connects Fort Frances and Kenora. The choice of a 230 kV connection was driven by a combination of anticipated demand, supply reliability and technical requirements associated with the large mill motor drives, but this requirement is subject to review and revision during detailed design.

Various alignments were considered for the proposed transmission line route. A 16.7 km route was selected that provides the greatest separation distance from existing homes to limit potential disturbance to existing local residents and also takes advantage of better ground conditions. A nominal 40 m right-of-way (ROW) will be cleared for construction of the 230 kV transmission line, with additional width required at turning points. One- or two-pole wood structures are proposed for the transmission line, although steel towers may be required at the connection point to the regional electrical grid, in order to cross over the existing 230 kV transmission line for connection purposes. Periodic clearing of the ROW will be required by RRR during operation to ensure its safe operation (maintaining clearance for conductors). Mechanical / manual clearing is proposed rather than use of approved chemicals.

A substation will be required at the RRP site near the process plant where the heavy electrical loads are present. A 230 kV tie-point switching station will be required on Line Segment K24F to allow connect to the regional grid. That station will be fed power from the local grid.

The transmission line will be constructed by RRR over an approximately six month period, avoiding the breeding bird and main tourist season as possible. Pending approvals, construction is proposed to start during the fall of 2014. The ROW will be cleared of woody vegetation (trees and shrubs) during the construction phase and kept clear for the life of the mine to ensure transmission line operability. It is expected that RRR will retain ownership of the line.

4.17 Other Offsite Facilities and Infrastructure

No other RRP facilities are proposed other than those described above, with the exception of offices leased in existing buildings. RRR currently has offices in Emo, Thunder Bay and Toronto. Other space / lands may be leased as needed, such as to support hiring and other activities.

Most mine employees will seek out housing within area Municipalities that best suits their own family needs and their ability to reach the mine site on a daily basis. The vibrant business sector within the Rainy River District is expected to meet housing needs in support of the RRP and RRR continues to meet with local businesses interested in provision of various offsite accommodations that would be needed by both single as well as attached employees.

4.18 Project Phases and Schedule

A preliminary schedule for the development of the RRP has been prepared which aims for gold production starting in 2016 (Figure 4-14). RRR plans to develop, construct, operate and decommission the RRP. The uncertainty in the timing of EA process and environmental approvals is understood. Environmental constraints may dictate the timing of some of the activities scheduled. The actual timeline for RRP development will therefore depend in part, on the timing of the Federal and Provincial EA process and subsequent environmental approvals.

The approximate duration of the major RRP phases are as follows:

- Construction: 2 years;
- Operation: 16 years; and
- Active reclamation: 2 years.

Construction activities will be sequenced according to personnel and equipment availability, scheduling constraints and site conditions (Table 4-9). Certain activities, such as those involving working in wet or poorly accessible terrain, are best carried out when the ground is frozen. Sequencing will also consider environmental aspects, such as fish spawning and bird nesting seasons.

During the RRP operation phase, overburden, ore and mine rock will be extracted from the mine for stockpiling or transport directly to the primary crusher for sizing. Sized ore will be processed to recover the gold and silver, and to produce doré bars for periodic shipment offsite. As the operation phase continues, mining will continue and the related overburden and mine rock stockpiles and the tailings management area will become progressively larger.

Solid and liquid wastes and water discharges will be managed to ensure regulatory compliance. Environment-related activities that will be carried out during the operation phase are anticipated to include:

- Water management;
- Ongoing management of chemicals and wastes;
- Air quality and noise management;
- Environmental monitoring and reporting; and
- Progressive site reclamation as practical.

4.19 Decommissioning and Reclamation Plan

Closure of the RRP site by RRR will be governed by the Ontario *Mining Act* and its associated Regulations and Codes. The *Act* requires that a Closure Plan be filed for any mining project before the project is undertaken, and that financial assurance be provided before any substantive development takes place to ensure that funds are in place to carry out the Closure Plan.

The objective of closure is to reclaim the mine site area to a naturalized and productive condition when mining ceases. The terms naturalized and productive are interpreted to mean a reclaimed site without infrastructure (unless otherwise negotiated), that while different from the existing environment, is capable of supporting plant, wildlife and fish communities; and other applicable land uses.

It is expected that the primary phase of active reclamation at the RRP will take approximately two years after operations cease. Thereafter, the site will be held in care and maintenance, until the open pit is fully flooded. Environmental monitoring and potentially effluent quality management by RRR will occur during this passive period of reclamation in accordance with the Closure Plan prepared and filed pursuant to the *Mining Act*.

Once the pit is flooded, an additional shorter period of active reclamation will occur to remove associated remaining project elements. A conceptual closure plan is provided in Appendix E and is described briefly in the text that follows. Environmental monitoring aspects are considered in Appendix E.

4.19.1 Open Pit and Underground Mine

Both the open pit and underground mine will flood naturally once dewatering activities cease. The open pit will be flooded to create a pit lake either passively through natural groundwater entry and precipitation inputs; or by active enhanced flooding of the open pit, using water pumped from an alternate source such as seasonal fresh water inputs (Attachment 1 in Appendix E). Flooding of the underground and open pit mine to surface is expected to take approximately 72 years using a moderately enhanced, flooding process. Consultation will be required to determine the preferred flooding approach.

Other measures to be taken to reclaim the open pit progressively or at closure may, or are likely to include:

- Remove all infrastructure and equipment within the open pit and underground mine and clean up any petroleum hydrocarbons and/or explosives;

- Shape and revegetate overburden pit slopes to a stable condition and to facilitate riparian habitat along the pit lake margins;
- Block the entrance to the open pit and install a boulder or traditional security fence around the pit perimeter during or following active mining operations to ensure safety while the pit is flooding; and
- Develop a spillway if needed, to allow the pit lake to eventually overflow to the Pinewood River.

Entrances to the underground mine will be blocked to ensure long term security.

4.19.2 Stockpiles

Progressive rehabilitation of mine rock and overburden stockpiles will be undertaken where practical once the maximum height of each stockpile has been reached and/or as each lift is completed, to minimize the amount of reclamation required at closure. All stockpiles will be re-shaped as necessary and stabilized if needed.

The overburden stockpile will be revegetated progressively, with final stabilization and revegetation occurring after overburden has been extracted for site reclamation.

The west mine rock stockpile will contain only NPAG mine rock. ARD / ML are not of concern, so RRR proposes to cover the stockpile with a layer of overburden and revegetate.

A multi-layered cover is proposed for the east mine rock stockpile as it will contain PAG. Encapsulation is proposed with a long term goal of controlling ARD. The side slopes will be progressively covered by a layer of compacted clay till to shed water, topped by a layer of NPAG to consume oxygen, another layer of compacted clay till, followed by a layer of clay till and a growth media to enable revegetation. The flat portion of the stockpile will have a similar cover, but will not include the lowest layer of clay till. Should a temporarily closure or early closure occur, the cover will be completed to ensure ARD / ML is properly managed.

RRR proposed to process all stockpiled ore during operation, therefore reclamation of the low grade or run of mine (high grade) stockpile should not be required. If necessary, the stockpiles will likely be reclaimed in a manner similar to that proposed for the east mine rock stockpile at early or final closure.

Revegetation will occur through seeding, hydroseeding and/or hand planting of tree seedlings as appropriate, to expedite the colonization by indigenous plant species. Investigations will be completed to determine the feasibility of establishing specific wildlife habitats, such as those that might be used by Species at Risk, following closure. The investigations will also determine whether any amendments are required to the native till (overburden) to improve its suitability to provide a base for revegetation.

4.19.3 Tailings Management Area

The principal concerns associated with closure of the tailings management area are long term slope stability, erosion control, drainage, vegetation cover and appearance, as well as prevention of ARD from the tailings. The tailings management area development plan currently provides for a water and overburden cover at closure to restrict oxygen contact with the tailings surface. Overflow spillway(s) will be developed or deepened to ensure efficient drainage of excess runoff.

4.19.4 Aggregate Sources

If quarries or pits are developed as aggregate sources during the construction and operation phases, these will be reclaimed according to Provincial approvals and standards, which may include natural flooding to create pond features.

4.19.5 Buildings, Machinery, Equipment and Infrastructure

A dedicated onsite demolition landfill is expected to be developed for the disposal of non-hazardous demolition wastes (such as concrete, steel, wallboard and other inert materials) generated by mine closure. It is expected that this demolition landfill will be developed within the east mine rock stockpile.

Salvageable machinery, equipment and other materials will be dismantled and taken off site for sale or re-use if economically feasible, or cleaned of oil and grease where appropriate and deposited within the onsite demolition landfill. Gearboxes or other equipment containing hydrocarbons that cannot be readily cleaned will be removed from equipment and machinery and trucked offsite for disposal at a licensed facility.

All above grade concrete structures will be broken up and demolished to near grade elevation. Concrete structures and below grade facilities (if any) will be infilled if needed. Affected areas will be contoured, covered with overburden as needed and revegetated.

4.19.6 Petroleum Products, Chemicals and Explosives

All petroleum products and chemicals will ultimately be removed from the site. Empty tanks will be sold as scrap, re-used off site, or cleaned to remove any residual fuel / chemicals and deposited within the demolition landfill.

An environmental site investigation will be conducted at the end of operations or early in the closure phase. Soil found to exceed acceptable criteria will be remediated onsite or transported off site to an approved disposal facility.

Any explosives will be depleted towards the end of operations. Any remaining explosives will be either detonated on site or hauled offsite by an authorized transportation company.

4.19.7 Roads, Pipelines and Power Distribution

Site roads may be scarified when no longer needed to support final reclamation, long term site management and environmental monitoring, assuming they are not required to support some other development on the site. Safety berms, if any, along the perimeter of haul roads will be re-shaped to near grade. Culverts will be removed and roads will be breached at the culvert locations on site to allow natural drainage.

Pipelines or pipeline sections will either be sealed and left in place; or purged if needed, dismantled and disposed of in the onsite demolition landfill.

Onsite power distribution lines and associated materials that have no salvage value will be dismantled and deposited in the demolition landfill. Other power equipment and materials will be taken off site for sale or re-use.

4.19.8 Site Drainage and Water Structures

The new alignment for the West Creek will naturalize over the life of the mine and will become the permanent creek channel, unless it is determined during closure planning that returning West Creek to its original route is preferred.

The Clark Creek diversion will remain in place to continue to divert drainage away from the east mine rock stockpile.

The pattern of general site drainage will remain in place at closure, with the exception of the removal of culverts at water crossings during site road reclamation activities. Water intake structure(s) at the Pinewood River (or other waterbodies if any) will be reclaimed by removing any structures and mechanical components for disposal in the demolition landfill.

4.19.9 Waste Management

At the end of reclamation activities, the onsite landfill(s) will be capped and revegetated in a manner consistent with the remainder of the site and environmental approval requirements.

4.19.10 Offsite Facilities

Highway 600 will remain in its re-aligned form, and will continue to provide local access. The re-aligned gravel-surfaced Highway 600 water crossing will remain in place after mine closure.

The East Access Road constructed to support the RRP development is expected to remain in place if needed to provide local residential access.

It is expected that the 230 kV transmission line constructed to support the RRP operations will not be required by other local users and will be removed at closure. The option remains to transfer the transmission line to another owner should demand exist at RRP closure. Assuming reclamation is required, electrical equipment will be removed and recycled / re-used or disposed of. Poles will be removed or cut at grade, and either re-used or disposed of.

Table 4-1: Anticipated Reagent Use and Handling

Reagent	Use	Consumption (approximate)*	Delivery (anticipated)	Storage / Handling
Lime (CaO)	pH adjustment; mix into a hydrated lime slurry in process plant	6,300 tpa	Fine powder in 30 t contained trucks	183 t silo; handled in accordance with industry standards for the protection of worker safety and the environment
Oxygen (O_2)	Required in leach circuit	4,700 tpa	Bulk liquid in 30 t tanker trucks; expected to be replaced by onsite oxygen plant	Stored in a pressurized holding vessel; handled in accordance with industry standards for the protection of worker safety and the environment
Sulphur dioxide (SO_2)	Cyanide destruction circuit	3,000 tpa	Liquid in 30 t tanker trucks	Stored in a pressurized holding vessel (approximately 64 m^3); handled in accordance with industry standards for the protection of worker safety and the environment
Sodium cyanide ($NaCN$)	Dissolution of gold; mixed with water and caustic soda to form a leach solution	2,100 tpa	Solid (briquettes) in 20 t containers carried by licenced carriers	Stored in containers inside the process plant; handled in accordance with industry standards for the protection of worker safety and the environment
Caustic soda ($NaOH$)	For cyanide mixing, carbon neutralization / stripping and electrowinning; diluted prior to use	950 tpa	Liquid in 30 t tanker trucks	Diluted in a 50 m^3 tank and stored in a 70 m^3 holding tanks; handled in accordance with industry standards for the protection of worker safety and the environment
Flocculant(s)	Slurry thickening (various); mixed into solution as appropriate	550 tpa	Solid, bulk (0.75 t) super bags	Bulk bags stored with secondary containment outdoors; handled in accordance with industry standards for the protection of worker safety and the environment
Copper sulphate ($CuSO_4{\cdot}5H_2O$)	Catalyst to aid in the cyanide destruction process; mixed with fresh water into solution	500 tpa	Solid, bulk (1 t) super bags	Bulk bags stored with secondary containment; handled in accordance with industry standards for the protection of worker safety and the environment
Nitric acid (HNO_3) (or similar)	Acid washing of loaded carbon; diluted prior to use	450 tpa	Liquid in 30 t tanker trucks	Stored in a 37 m^3 holding tank; handled in accordance with industry standards for the protection of worker safety and the environment
Activated carbon	Adsorption of gold in solution	250 tpa	Solid, Bulk (1 t) super bags	Bulk bags stored outdoors; inert material handled for dust control.
Other minor reagents include antiscalants (90 tpa), Leachaid (1.5 tpa) and standard industry fluxes, typically consisting of borax, silica sand and niter (7 tpa) for use in the induction furnace.				

Notes: * Based on test work, supplier recommendations and practices in existing plants

Table 4-2: Fuel and Related Tankage Summary

Material	Location(s)	Tank Volume
Diesel	Dispensing station (heavy vehicles) Explosive plant	7 x 80,000 L 25,000 L (estimate)
Gasoline	Dispensing station	1 x 25,000 L (estimate)
Coolant	Truck Shop	1 x 5,000 L
Engine Oil	Truck Shop	1 x 30,000 L
Hydraulic Oil	Truck Shop	1 x 10,000 L
Transmission Fluid	Truck Shop	1 x 10,000, 1 x 5,000 L
Axle Fluid	Truck Shop	1 x 30,000 L
Waste Oil	Truck Shop	2 x 30,000 L
Waste Coolant	Truck Shop	1 x 5,000 L
Gear oil, transmission fluid, windshield fluid and grease	Truck Shop	1,200 L replacement bins

Table 4-3: Water Availability from the Pinewood River below the McCallum Creek Outlet

Condition	Month								Total (m^3)
	Apr (m^3)	May (m^3)	Jun (m^3)	Jul (m^3)	Aug (m^3)	Sep (m^3)	Oct (m^3)	Nov (m^3)	
Mean	2,233,400	1,716,100	1,259,700	570,600	277,100	312,000	424,400	334,000	7,127,300
5th Percentile	755,900	580,800	426,400	193,100	93,800	105,600	143,600	113,000	2,412,300
10th Percentile	927,700	712,900	523,300	237,000	115,100	129,600	176,300	138,700	2,960,600
25th Percentile	1,305,700	1,003,300	736,4200	333,600	162,000	182,400	248,100	195,300	4,166,700

Notes: Tabled values represent a 20% taking of the spring flow (April to June) and a 15% taking for other months; no winter water taking (December to March) is proposed
Percentile values are calculated as annualized, not monthly, percentiles

Table 4-4: Laboratory Aging of Synthetic Process Plant Discharge

Parameter	Receiver[1] Target (mg/L)	Modified[2] Receiver Target (mg/L)	Canadian Environmental Quality Guideline (CEQG)	Cyanide Destruction Test at Time 0 (mg/L)	Cyanide Destruction 60-day Aging Test Results (mg/L)
Free cyanide	0.005	0.01[3]	0.005	0.07	<0.01
Total cyanide	-	-	-	0.2	<0.01
Aluminum	0.075	3.54[4]	0.1	0.1	<0.1
Antimony	0.02	-	-	0.07	0.036
Arsenic	0.005	-	0.005	0.004	0.003
Barium	-	-		0.023	0.029
Boron	0.2	-	1.5	0.04	0.05
Cadmium	0.0005	-	Equation[7]	0.00002	0.0015
Chromium	0.0089	-	0.0089	0.0008	<0.0005
Cobalt	0.0009	0.004[5]	-	0.0089	0.0016
Copper	0.005	0.017	Equation[7]	0.055	0.012
Iron	0.3	1.0[6]	0.3	0.038	<0.003
Lead	0.005	0.008	Equation[7]	0.0002	0.0005
Mercury	0.0002	-	0.000026	<0.00001	0.00001
Molybdenum	0.04	-	0.073	0.046	0.049
Nickel	0.025	0.094	0.025[7]	0.003	0.003
Selenium	0.1	-	0.001	0.009	0.002
Vanadium	0.006	-	-	0.0004	0.0003
Zinc	0.020	0.215	0.03	0.004	0.086
Un-ionized Ammonia	0.02	-	19	0.044	0.153
Cyanate	-	-	-	130	85
Thiocyanate	-	-	-	24	25

Notes:
1 Provincial Water Quality Objectives for the protection of aquatic life
2 Modified values for applicable metals derived from application of US EPA hardness equations assuming a blended river / effluent hardness of 200 mg/L as $CaCO_3$
3 Value for free cyanide derived from Gensemer et al. 2007
4 Value for aluminum derived from Gensemer 2009
5 Value for cobalt derived from Nagpal 2004
6 Value for iron derived from BC MOE 2008 and US EPA 2009
7 CEQG Notes: Cadmium = 10^0.86[log10(hardness)]-3.2 µg/L
CEQG for hexavalent chromium is 1 µg/L, CEQG for trivalent chromium is 8.9 µg/L
Copper = e0.8545[ln(hardness)]-1.465 * 0.2µg/L; Minimum of 2 µg/L
Lead = e1.273[ln(hardness)]-4.705; Minimum of 1 µg/L
Nickel is a minimum of 25 µg/L regardless of water hardness

Table 4-5: Annual Water Balance Data and Calculations Relating to Waters Reporting to the Water Management Pond

Component	Average Condition (m^3/a)	5th Percentile Condition (m^3/a)	95th Percentile Condition (m^3/a)
Pre-development Runoff[1]	4,095,000	1,386,000	8,274,000
Runoff Equivalent (mm)	195	66	394
Operating Water Losses			
Tailings Voids	2,590,000	2,590,000	2,590,000
Process Plant Evaporation	150,000	150,000	150,000
Dust Suppression	260,000	260,000	260,000
Operating Additions			
Mine Water (groundwater only)	1,241,000	1,241,000	1,241,000
Water Management Pond Discharges			
Year 2	2,703,543	186,877	5,012,742
Year 7	3,658,848	650,346	6,419,337
Year 15	4,217,233	696,208	7,447,994
Developed Site Net Water Production[2]			
Year 2	4,462,543	1,945,877	6,771,742
Year 7	5,417,848	2,409,346	8,178,337
Year 15	5,976,233	2,455,208	9,206,994
Developed Site Net Runoff Equivalent (mm)			
Year 2	213	93	322
Year 7	258	115	389
Year 15	285	117	438
Discharge through the Constructed Wetland[3]			
Year 2	2,440,000	686,877	2,440,000
Year 7	2,440,000	1,150,346	2,440,000
Year 15	2,440,000	1,696,208	2,440,000
Direct Pipeline Discharge			
Year 2	263,543	0	2,072,742
Year 7	1,218,848	0	3,479,337
Year 15	1,777,233	0	4,007,994
Predevelopment Runoff			
Pinewood River Runoff at Loslo Creek (106.2 km^2)	20,709,000	7,009,200	41,842,800
Pinewood River Runoff at McCallum Creek (207.1 km^2)	40,384,500	13,668,600	81,597,400

Notes:
1. Values apply to RRP site capture area directed to the tailings management area / water management pond (21 km^2)
2. Values calculated as water management pond discharge - mine water + (water lost to tailings voids, mill evaporation and dust suppression)
3. Values for the 5th and 95th percentiles include a storage transfer of 0.5 Mm^3 to the 5th percentile condition during years 2 and 7, and 1 Mm^3 during year 15, from the 95th percentile condition

Table 4-6: Constructed Wetland Operation and Proposed Effluent Objectives and Limits - V1

Table 4-6a: Receiver to Effluent Mixing Ratio Calculations

Month	Calculated Flows Pinewood River at Loslo Creek - Effective Watershed 85 km² (m³/month)			Proposed Discharge through Constructed Wetland – Year 15 (m³/month)			Typical Ratio of Receiver to Effluent Flows (m³/month)		
	Average Runoff	5th Percentile Low Runoff	95th Percentile High Runoff	Average Runoff	5th Percentile Low Runoff	95th Percentile High Runoff	Average Runoff	5th Percentile Low Runoff	95th Percentile High Runoff
Jan	107,514	36,167	217,479	50,000	34,758	50,000	2.15	1.04	4.35
Feb	64,344	21,645	130,156	0	0	0	-	-	-
Mar	265,456	89,297	536,965	0	0	0	-	-	-
Apr	4,585,546	1,542,535	9,275,671	300,000	208,550	300,000	15.29	7.40	30.92
May	3,523,449	1,185,255	7,127,254	310,000	215,502	310,000	11.37	5.50	22.99
Jun	2,586,303	870,008	5,231,589	150,000	104,275	150,000	17.24	8.34	34.88
Jul	1,562,063	525,463	3,159,751	310,000	215,502	310,000	5.04	2.44	10.19
Aug	758,572	255,177	1,534,445	310,000	215,502	310,000	2.45	1.18	4.95
Sep	854,143	287,326	1,727,765	300,000	208,550	300,000	2.85	1.38	5.76
Oct	1,161,713	390,790	2,349,921	310,000	215,502	310,000	3.75	1.81	7.58
Nov	914,301	307,562	1,849,455	300,000	208,550	300,000	3.05	1.47	6.16
Dec	189,381	63,706	383,080	100,000	69,517	100,000	1.89	0.92	3.83
Total / Average		-	-	2,440,000	1,696,208	2,440,000	6.51	3.15	13.16

Table 4-6b: Effluent Treatability Test Work Results, Receiver Standards, and Suggested Final Effluent Objectives / Limits

Parameter	Receiver Target (mg/L)	Modified Receiver Target (mg/L)	CND Test Time 0 (mg/L)	CND Test 60-day Aging (mg/L)	Additional Treatment	Receiver 75th Percentile (mg/L)	Wetland Monthly Average Objective (mg/L)	Wetland Monthly Average Limit (mg/L)	Comments on Objective Concentration
CNt	-	-	0.19	0.02	no	0.000	0.05	0.1	5 x CNf
CNf	0.005	0.01	0.07	<0.01	no	0.000	0.01	0.02	mod receiver
As	0.005	0.01	0.004	0.003	no	0.003	0.01	0.02	double IPWQO
Cu	0.005	0.017	0.055	0.012	no	0.002	0.02	0.04	mod receiver rounded
Pb	0.005	0.008	0.0002	0.0005	no	0.001	0.01	0.02	mod receiver rounded
Ni	0.025	0.094	0.003	0.003	no	0.003	0.1	0.2	mod receiver rounded
Zn	0.02	0.215	0.004	0.086	no	0.006	0.2	0.4	mod receiver rounded
NH3-U	0.02	0.02	0.07	0.153	yes	-	0.02	0.04	PWQO
Hardness	-	-	510	486	-	195 / 209			

Notes: Modified receiver targets for Cu, Pb, Ni and Zn based on application of US EPA hardness equations for a hardness value of 200 mg/L
Modified receiver target for CNf free based on non-salmonid recommended continuous chronic criterion of 0.01 mg/L from Gensemer et al. 2007
Modified receiver target for As based on a consideration of MOE PWQO and interim PWQO values, the CEQG value and US EPA value for this parameter

Table 4-6c: Metal Values based on Application of US EPA Hardness Equations

Parameter	Cu	PB	Ni	Zn
Hardness	200	200	200	200
Ln hardness	5.298	5.298	5.298	5.298
Factor	2.825	2.040	4.541	5.372
Concentration(ug/L)	16.868	7.689	93.763	215.222
Concentration (mg/L)	0.017	0.008	0.094	0.215
PWQO	0.005	0.005	0.025	0.02

Table 4-6d: Pinewood River Station S3 Hardness Data (mg/L)

Statistic	Value
Minimum	83
Maximum	450
Median	195
Standard Deviation	75.7
75th percentile	208.5
Number of samples	23

Table 4-7: Pinewood River Annualized Monthly Discharge Potential and Mixing Ratios at McCallum Creek for Year 15 (m^3)

Condition	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total / Mean
Pinewood River Flows													
Mean	230,206	137,772	568,388	9,818,464	7,544,326	5,537,731	3,344,653	1,624,237	1,828,870	2,487,433	1,957,681	405,497	35,485,257
5th Percentile	77,439	46,345	191,200	3,302,840	2,537,841	1,862,841	1,125,110	546,378	615,215	836,749	658,546	136,405	11,936,910
95th Percentile	465,662	278,686	1,149,738	19,860,849	15,260,709	11,201,756	6,765,585	3,285,517	3,699,450	5,031,595	3,960,009	820,242	71,779,797
Proposed Discharge[1]													
Mean	50,000	-	-	998,617	998,617	150,000	310,000	310,000	300,000	500,000	500,000	100,000	4,217,234
5th Percentile	34758	-	-	208,550	215,502	104,275	215,502	215,502	208,550	215,502	208,550	69517	1,696,208
95th Percentile	50,000	-	-	1,741,860	1,741,860	150,000	310,000	310,000	300,000	872,137	872,137	100,000	6,447,994
Mixing Ratios[2]													
Mean	4.6	-	-	9.8	7.6	36.9	10.8	5.2	6.1	5.0	3.9	4.1	8.4
5th Percentile[3]		-	-	-	-	17.9	5.2	2.5	2.9	3.9	3.2	-	7.0
95th Percentile[3]	9.3	-	-	11.4	8.8	74.7	21.8	10.6	12.3	5.8	4.5	8.2	11.1

Notes:
1. Discharge to occur to the Pinewood River downstream of McCallum Creek (effective watershed 207 - 21 km^2)
2. Mixing ratios assume that the discharge condition water storage (e.g., mean annual condition) matches with the discharge condition river flow, which is not necessarily the case, as wetter accumulation conditions could be followed by drier receiver conditions, and vice versa
3. Mixing ratios for 5th percentile and 95th percentile conditions are based on annualized monthly values

Table 4-8: Summary of RRP Ponds

Pond	Contact or Non-contact	Flow Pumped (P) / Decant or Spillway (D)	Water Requirement	Maximum Operating Pond (20-year wet year) (Mm^3)	Environmental Design Flood		Dam			Operating Period
					EDF Runoff (Mm^3)	Pond Volume including the EDF (Mm^3)	Crest Elevation (masl)	Average Height (m)	Length (m)	
West Creek Pond	Non-contact	Potable water (P)	Potable water	0.20	N/A	N/A	364.9	4.0	450	January to December
Clark Creek Pond	Non-contact	Not applicable	Not applicable							--
Mine Rock Pond	Contact	Process plant (P)	Process water	2.93	0.31	3.24	362.0	5.4	1,650	January to December
Sediment Pond #1	Contact	Overflow to West Creek Diversion (D)	May be used for dust control	*	*	*	*	*	*	--
Sediment Pond #2	Contact	Overflow to Loslo Creek / Cowser Drain (D)	May be used for dust control	*	*	*	*	*	*	--
TMA Pond	Contact	Water Management Pond (D)	Decanting for discharge	TBD	0.97	TBD	379.5	--	--	June to August
Water Management Pond	Contact	Environment (Pinewood River below McCallum Creek; P)	Process water, with excess discharged to the environment	6.64	0.13	6.77	373.0	6.7	3,750	October, November, March, April, May
	Contact	Water Discharge Pond (D)								January, June to September, December
Water Discharge Pond	Contact	Constructed Wetland (D)	Excess discharged to the environment	0.08	0.03	0.112	355.2	1.2	360	January, June to September, December

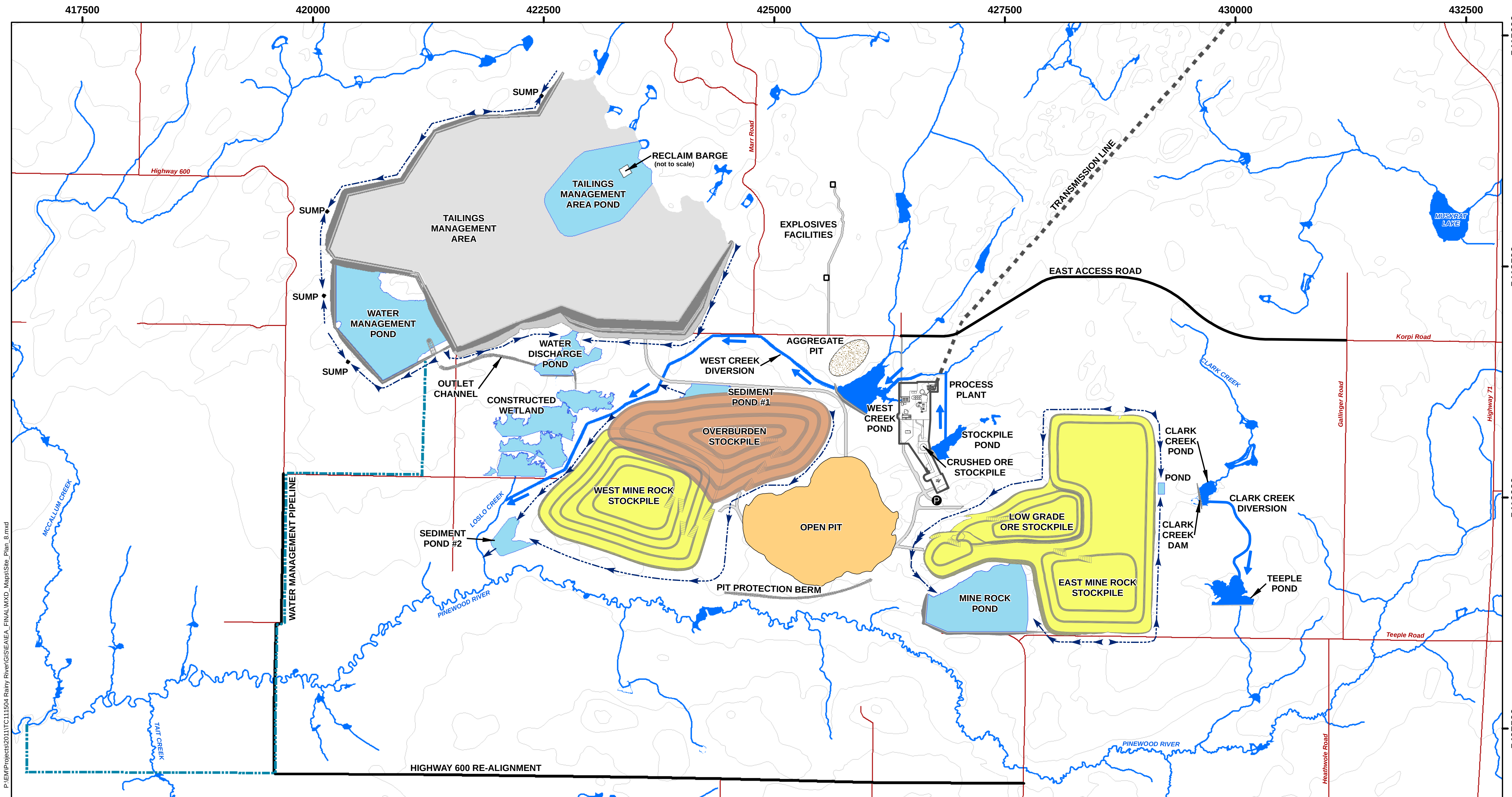
Notes: The maximum operating pond volume represents the largest monthly pond volume 20-year wet year
EDF - Environmental Design Flood, the 1:100 year 24 hour storm event for ponds collecting mine affected water
All elevations are based on preliminary pond capacity information and required confirmation
* Sediment ponds have not been designed as yet, but will be sized and designed to ensure adequate settling prior to discharge

Table 4-9: Project Phases and Scheduling

Activity	Comments
Pre-construction – Activities Ongoing or in Planning Stage	
Mineral exploration	Will extend into the construction and operation phases
Site investigations	May extend into the construction phase
Detailed engineering	May extend into the construction phase
Environmental approvals	Will extend into the construction and operation phases
Raising of capital	May extend into the construction phase
Contractual arrangements	May extend into the construction phase
Procurement	May extend into the construction phase
Staffing	May extend into the construction phase
Construction	
Develop aggregate sources	Dedicated on-site aggregate sources to be developed, along with use of existing mine rock stockpiled materials from previous site mining operations, and later in the construction phase, mine rock from planned mining operations
Construction of Highway 600 re-alignment and East Access Road	Re-alignment and site access needed prior to major RRP construction; redirection of public traffic
Develop pond(s)	Development of dams to capture runoff for process plant start-up (particularly the water management pond) and from mineral waste stockpiles
West Creek and Clark Creek diversions	Construction of diversions in sufficient time to allow for stabilization prior to connection to existing channels
Tailings management area construction	Construction of starter dams in preparation for receiving tailings
Overburden stripping the open pit	Establishment of drainage and initiation of overburden removal to access ore
Mine rock and ore extraction from the open pit	Mine rock removal to expose the ore body and preliminary ore extraction from the open pit, to provide ore feed for process plant commissioning
Process plant and primary crusher	Site preparation and excavation, foundations, building erection, equipment installation
Ancillary buildings	Site preparation and excavation, foundations, building erection, site telecommunications network as required
Fuel storage and fuelling facilities	Construction of site diesel fuel tank farm, auxiliary fuel tanks, and fuelling stations
Pinewood River fresh water intake / West Creek Pond	Construction of the structures and infrastructure for fresh water take
Habitat compensation	Construction of habitat compensation according to approval requirements and commitments
Upgrade mine site area roads	Establishment of new roads and upgrade existing roads as required to service the mine
Construct 230 kV transmission line	Establishment of power infrastructure to connect to the regional electrical grid and distribute to the RRP facilities
Explosives manufacturing facility and explosives magazines	Construction of the facility will be established to meet Federal regulatory requirements
Commissioning of process plant	Initiation of process plant activities and processing of ore at a reduced rate
Operations	
Continue overburden stripping in the open pit area, as required to expose the ore body	Overburden stripping is expected to continue into Year 6 of mining
Open pit and underground mining of an estimated ore and mine rock	Mine rock to be stockpiled or used for site development; ore will be processed or stockpiled

Activity	Comments
Stockpile overburden	Overburden from open pit stripping to be stockpiled
Stockpile mine rock	NPAG mine rock to be stockpiled west of the open pit or used in site construction; encapsulated PAG mine rock to be stockpiled east of the open pit
Ore processing	Ore to be processed to produce doré bars
Tailings management area construction and operation	Tailings management area to be developed and dams periodically raised through the mine operations; seasonal discharges to the environment from the tailings management area by means of the water management pond are expected
Fresh water supply	Fresh water drawn from the Pinewood River for start-up and initial operations and from West Creek Pond thereafter
Operation of all other site-related infrastructure	Other site-related infrastructure to include: roads and water lines; the power supply system; fuelling systems; maintenance operations; the shipment, storage and use of consumables; and other aspects needed to run the mine
Closure	
Flooding of the open pit and underground mine	Natural flooding is expected to take approximately 94 years with proposed moderately enhanced flooding taking 72 years; potentially ARD drainage to be directed to the open pit for management and/or treatment
Demolition of buildings and other infrastructure and the removal of machinery and equipment	Re-sale of machinery, equipment and scrap will be practiced as economically feasible; remaining non-hazardous materials will be disposed of on site at an approved facility; transmission line would be removed or transferred to Hydro One Networks (or other new owner)
Tailings management area pond and spillway stabilization and revegetation of exposed tailings solids	0.3 m overburden cover will be placed on exposed tailings solids to promote vegetation regrowth; remainder of surface to be maintained in a flooded condition
Restore site drainage to the extent practicable	Remove culverts not needed for post closure access; stabilize drainage ditches for long term erosion control; contour as required
Complete cover over east mine rock stockpile and if required the low grade ore stockpile	Cover to be placed progressively during operations and completed at closure if necessary.
Revegetate mine rock and overburden stockpiles	Fully revegetate stockpiles except west mine rock stockpile; 20% of west mine rock stockpile left as exposed NPAG mine rock to provide nesting habitat for the Common Nighthawk and to encourage species that prefer edge habitat such as whip-poor-will
Contour and assist revegetation of the general mine site area	Heavily compacted areas will be broken up to facilitate regrowth
Establish environmental and geotechnical monitoring programs	
Post-closure	
Continue to manage and treat any ARD runoff through the open pit	As needed
Carry out environmental and geotechnical monitoring	Per agreements

Note: Consultation with government, Aboriginal groups and local residents will occur during pre-construction, construction, operation, closure and early post-closure



LEGEND

Proposed Site Features

- Underground Portal
- Open Pit
- Process Plant
- Water Management Pipelines
- Site Roads
- Pond
- Aggregate Pit
- 230 kV Transmission Line
- Deposited Tailings
- Overburden Stockpile
- Rock Stockpile
- Ditch
- Watercourse Diversion
- Flow Direction

0 1.25 2.5 5 7.5 10 Kilometres

NOTES:
- Site Plan from AMEC CAD drawing May 3, 2013, derived from BBA drawing 3098003-003000-41-D20-0001, April 29, 2013
- Stockpile modification provided by BBA, Sept 30, 2013

Datum: NAD83
Projection: UTM Zone 15N

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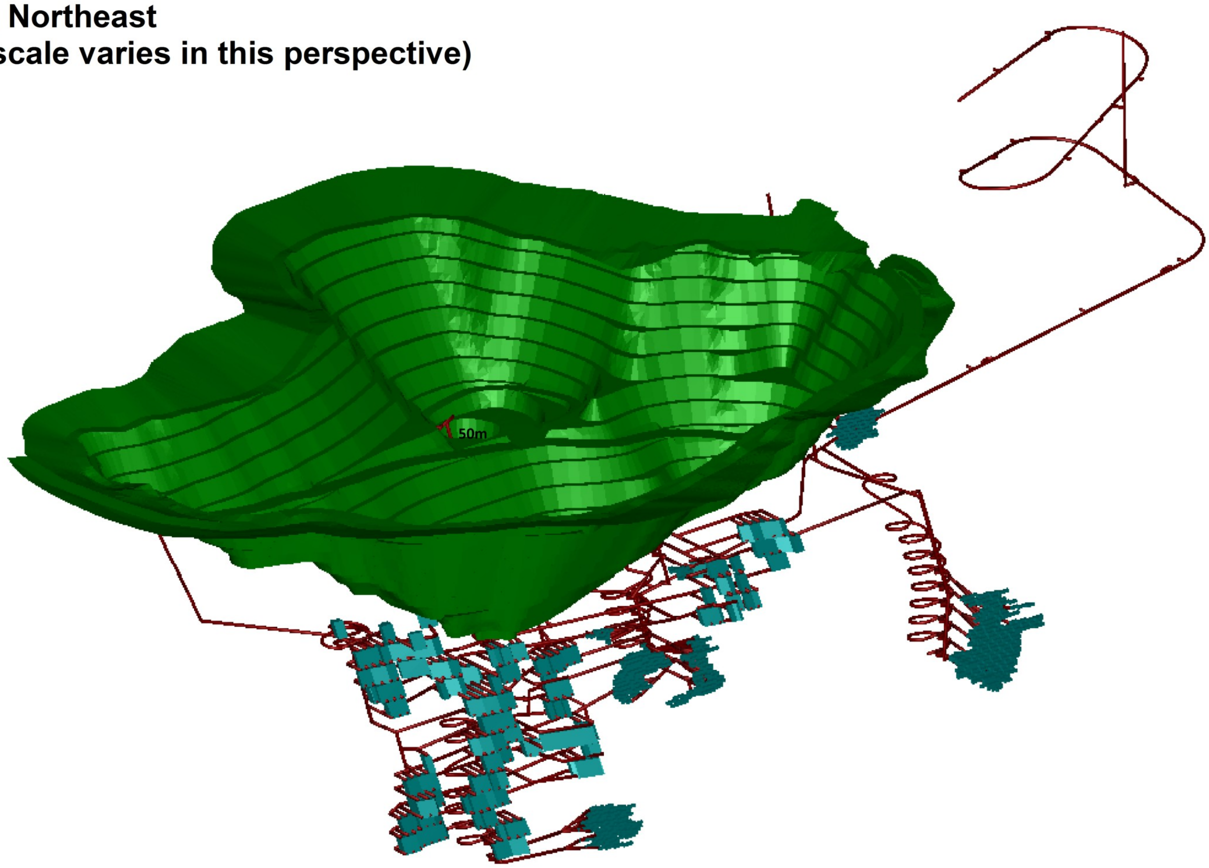
RAINY RIVER PROJECT

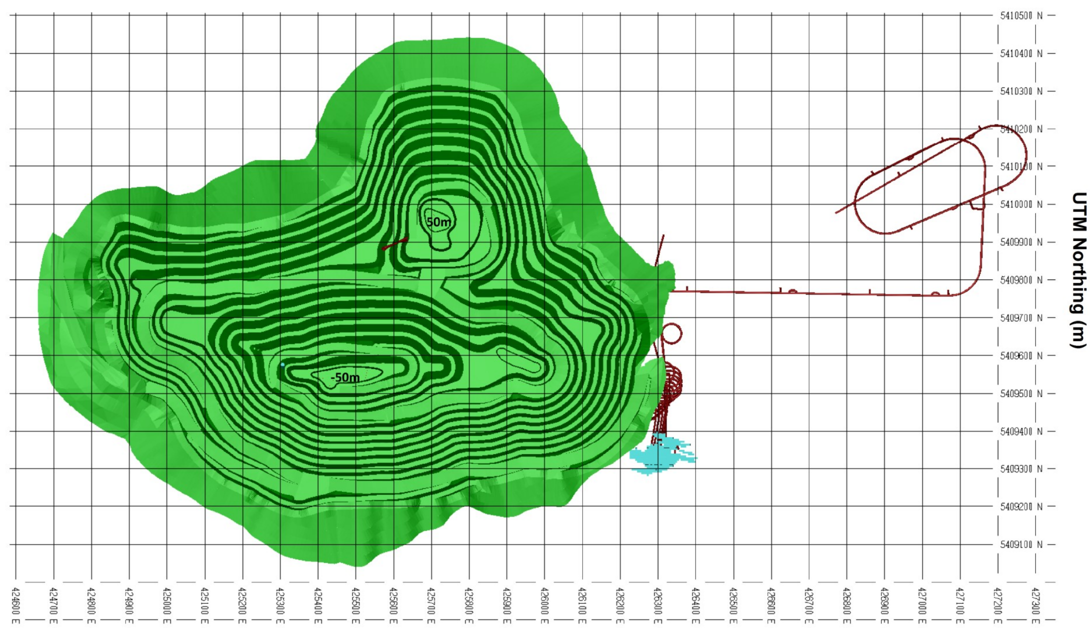
Site Plan
Ultimate Footprint

PROJECT N°: TC111504	FIGURE: 4-1
SCALE: 1:39,500	DATE: October 2013

Three-Dimensional
Looking Northeast
(Linear scale varies in this perspective)



Plan View
(Scale:
0 200 m



NOTES:
- Numbers in open pit renderings show approximate elevation (masl) at those locations.
- Linear measurement scale varies in 3-dimensional perspective renderings.

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RAINY RIVER PROJECT

Open Pit

PROJECT N^{o}: TC111504	**FIGURE: 4-2**
SCALE:	DATE: October 2013

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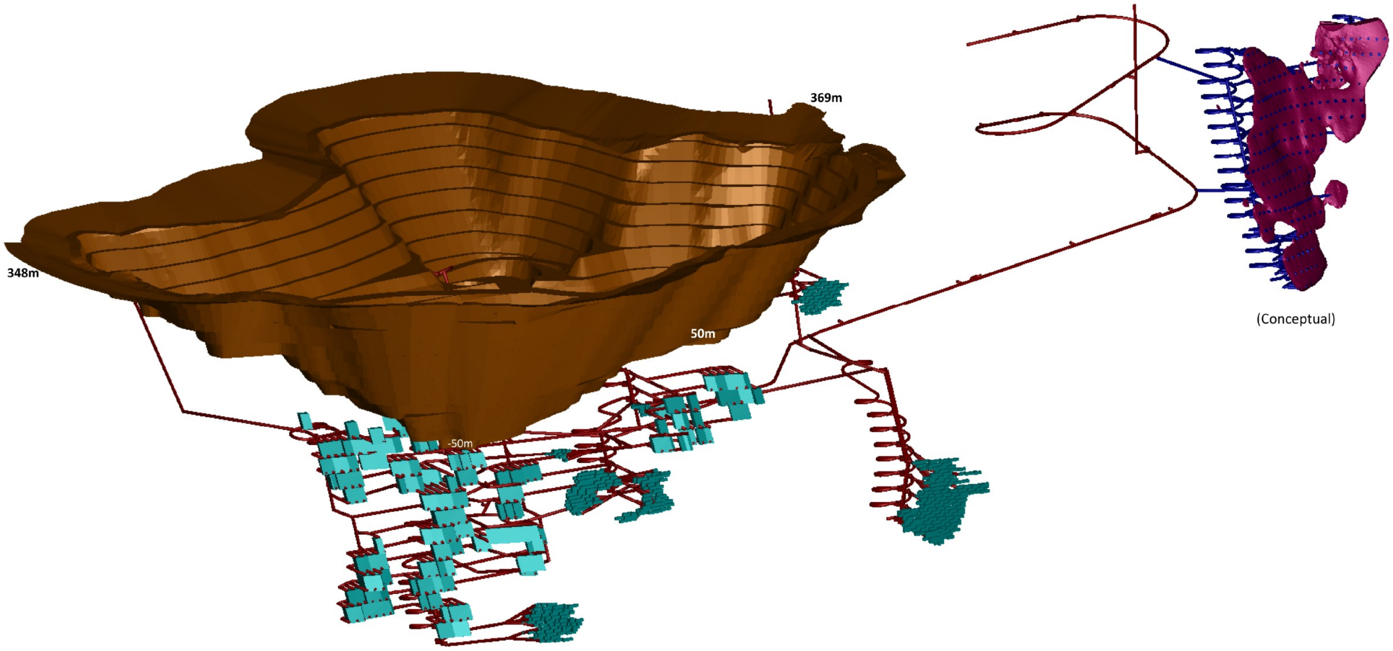
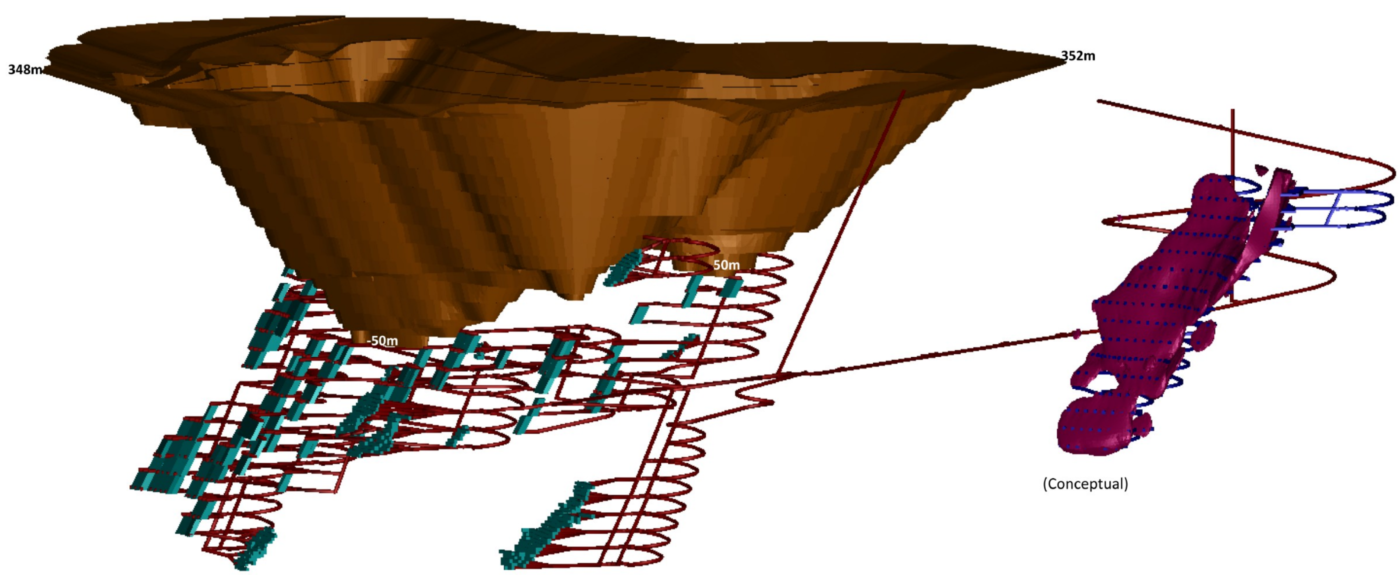
Three-Dimensional
Looking Northeast
(Linear scale varies in this perspective)



Three-Dimensional
Looking Northwest
(Linear scale varies in this perspective)



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NOTES:
- Schematic of underground mine; design in progress
- Numbers in open pit renderings show approximate elevation (masl) at those locations.
- Linear measurement scale varies in 3-dimensional perspective renderings.

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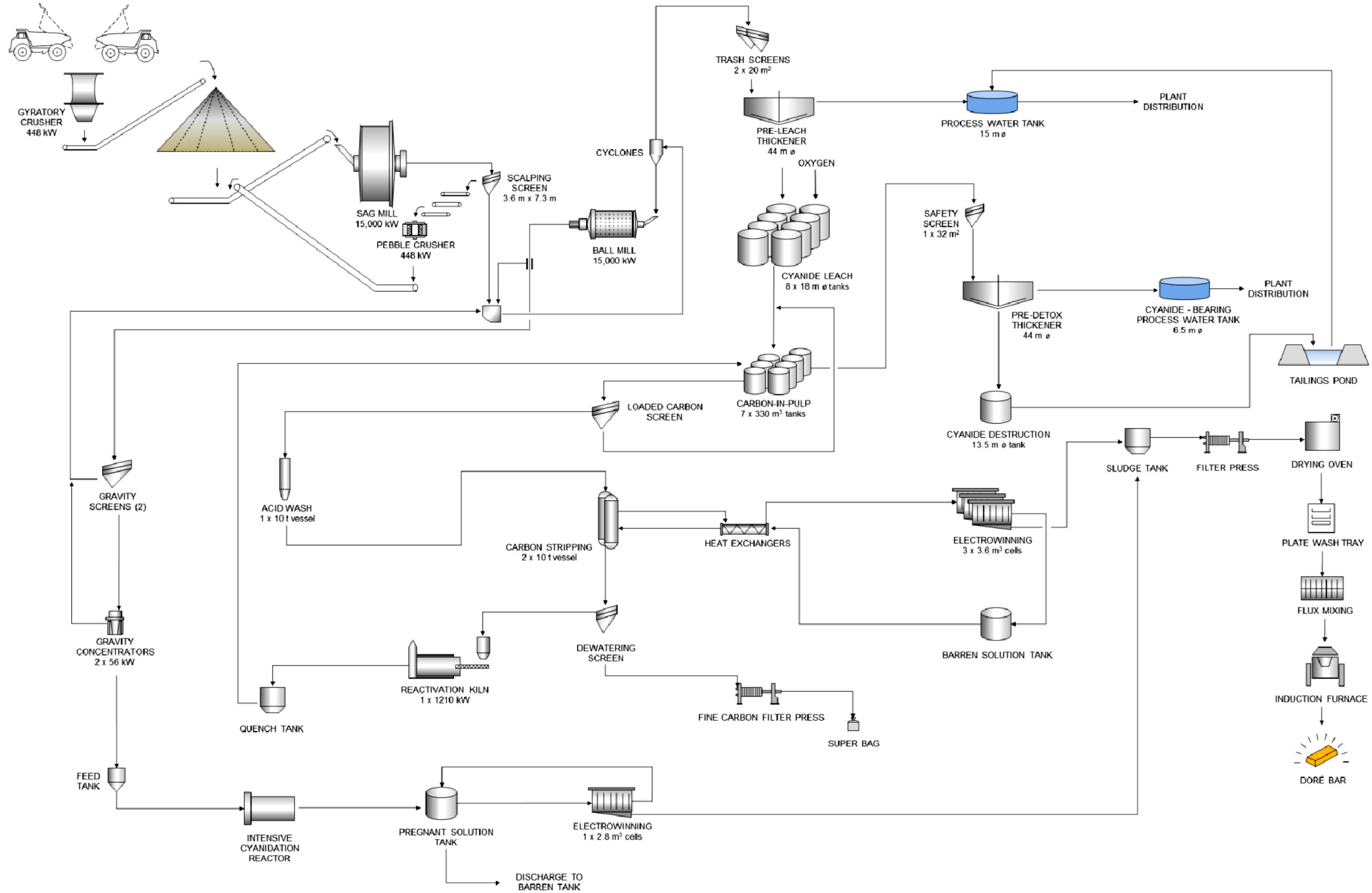
RAINY RIVER PROJECT

Underground Mine

PROJECT N^{o}: TC111504	**FIGURE: 4-3**
SCALE:	DATE: October 2013



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NOTES:
- Processing flowsheet provided by BBA

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RAINY RIVER PROJECT

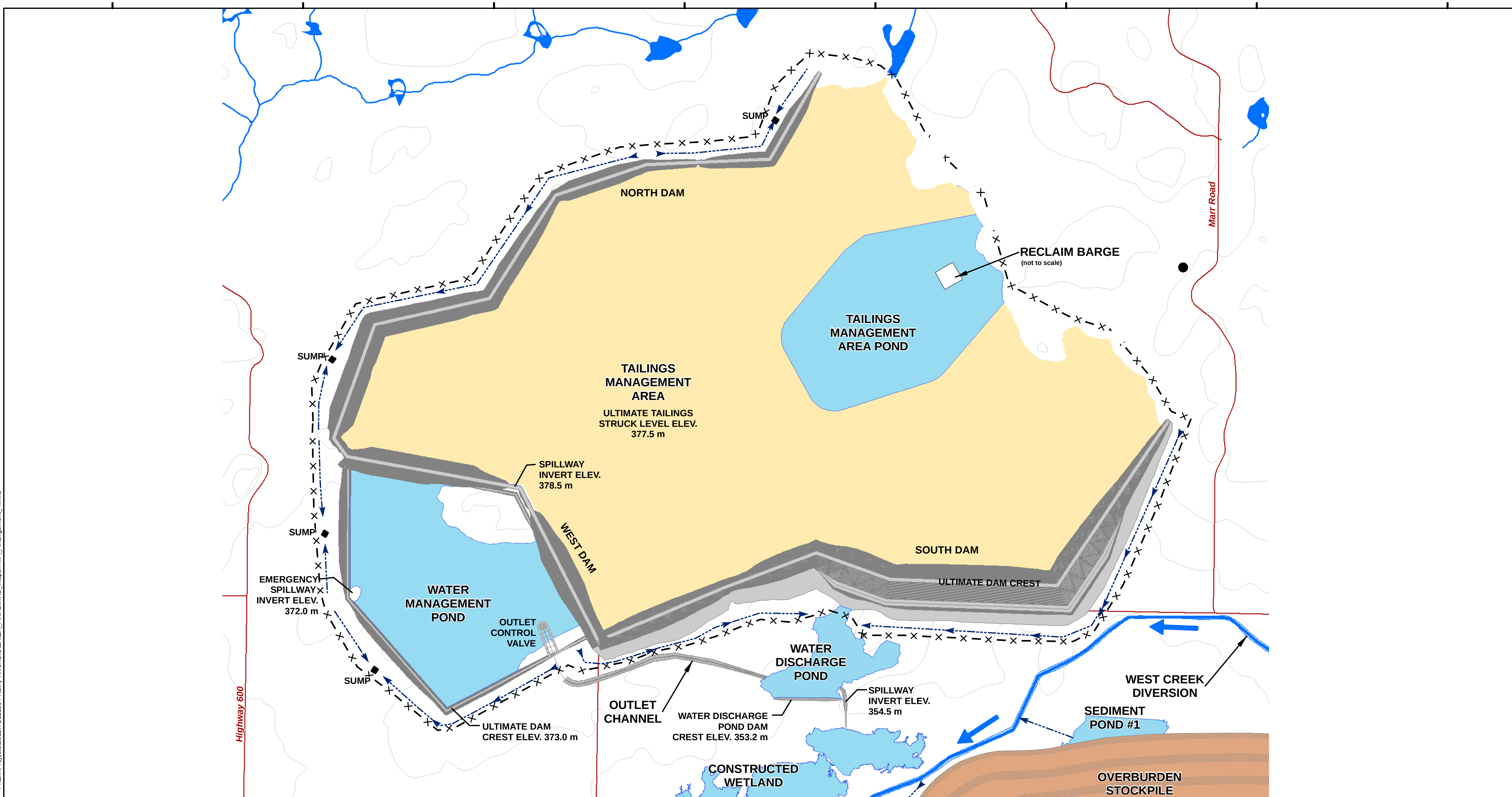
Simplified Processing Flowsheet

PROJECT N°: TC111504

FIGURE: 4-4

SCALE:

DATE: October 2013



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LEGEND

Proposed Site Features

- Deposited Tailings
- Overburden Stockpile
- Pond
- Watercourse Diversion
- Flow Direction
- Ditch
- Fence
- Onsite Landfill Alternative

NOTES:
- Figure shows final arrangement with approximate operations water cover.

Datum: NAD83
Projection: UTM Zone 15N

0 0.5 1 2 3 4 Kilometres

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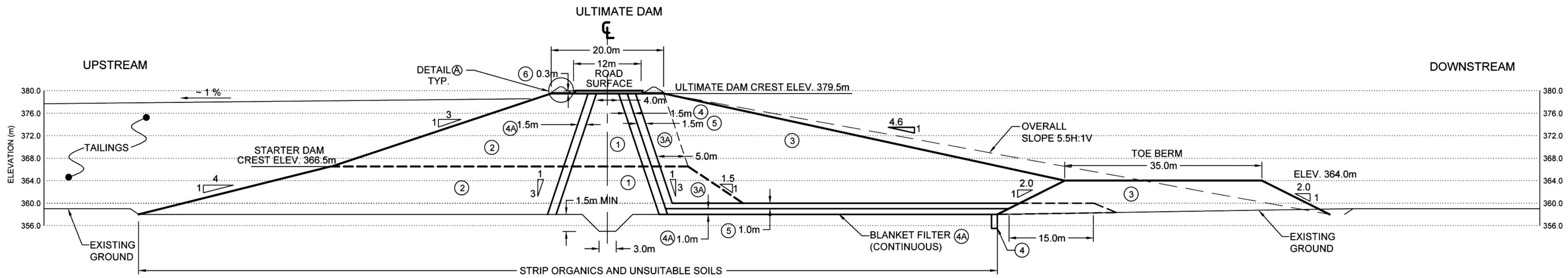
RAINY RIVER PROJECT

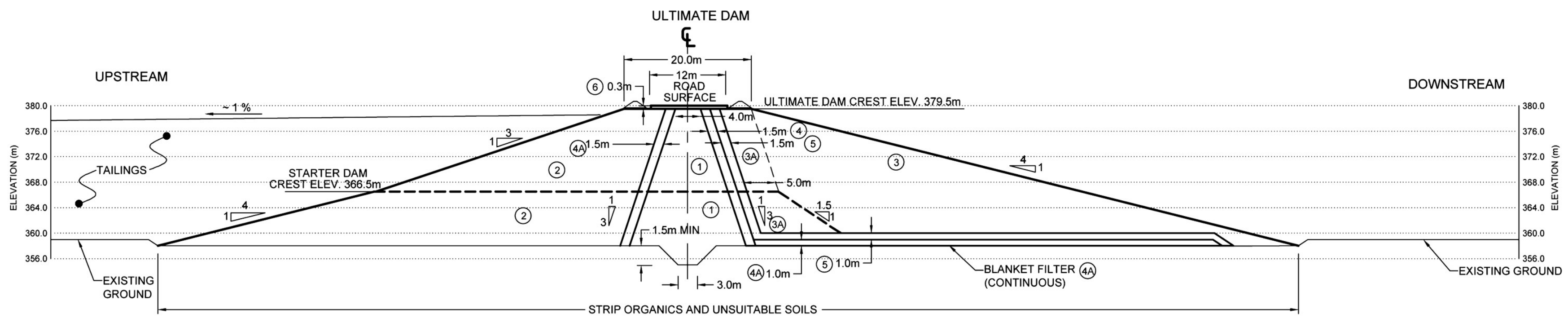
Tailings Management Area Arrangement

PROJECT N°: TC111504	FIGURE: 4-5
SCALE: 1:19,500	DATE: October 2013



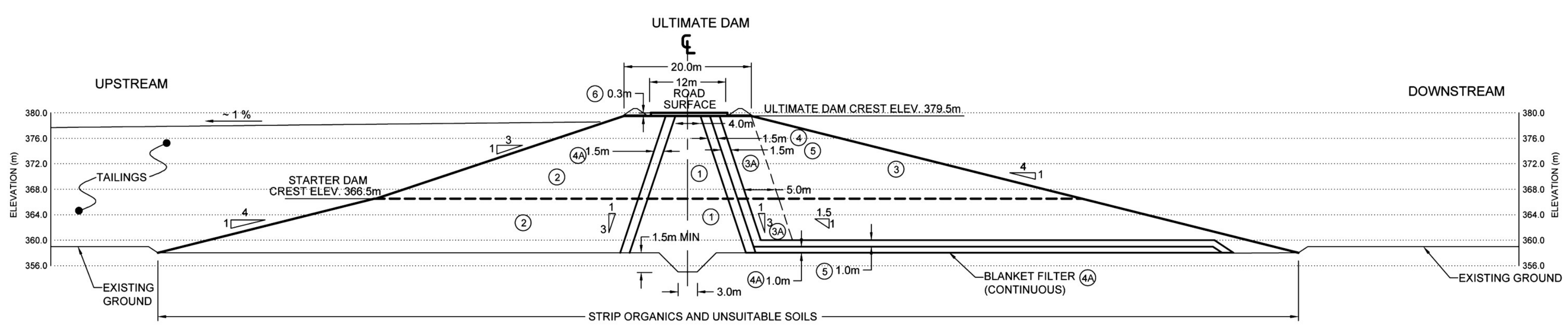
TYPICAL SECTION A-A 105 - SOUTH DAM

1:500 SCALE



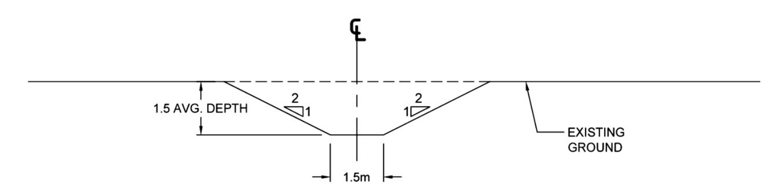
TYPICAL SECTION B-B 105 - NORTH DAM

1:500 SCALE



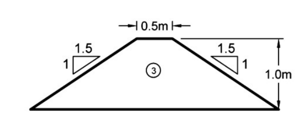
TYPICAL SECTION C-C 105 - WEST DAM

1:500 SCALE



TYPICAL SECTION - SEEPAGE COLLECTION DITCH

1:100 SCALE



DETAIL A SAFETY BERM (TYP.)

1:50 SCALE

DRAFT

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Construction Material

1. CORE - SELECT CLAY
2. UPSTREAM SHELL - RANDOM FILL
3. DOWNSTREAM SHELL - CLEAN MINE ROCK
(3A) DOWNSTREAM SHELL - SELECT-CLEAN MINE ROCK
4. FILTER - SELECT OR PROCESSED SAND
(4A) FINE FILTER - PIT RUN SAND
5. TRANSITION - PROCESSED ROCK
6. ROAD SURFACE - SAND AND GRAVEL
7. UPSTREAM EROSION PROTECTION - COBBLES AND BOULDERS.
8. DOWNSTREAM EROSION PROTECTION - SAND TO COBBLES.
9. BEDDING - COBBLES
10. ARMOUR STONE - BOULDERS

Notes from CAD Drawing:

1. INSTRUMENTATION IS REQUIRED TO ENSURE ADEQUATE DAM PERFORMANCE. THE RATE OF RISE AND/OR SLOPE MAY HAVE TO BE ADJUSTED.

NOTES:
- Cross Sections from CAD drawing October 28, 2013

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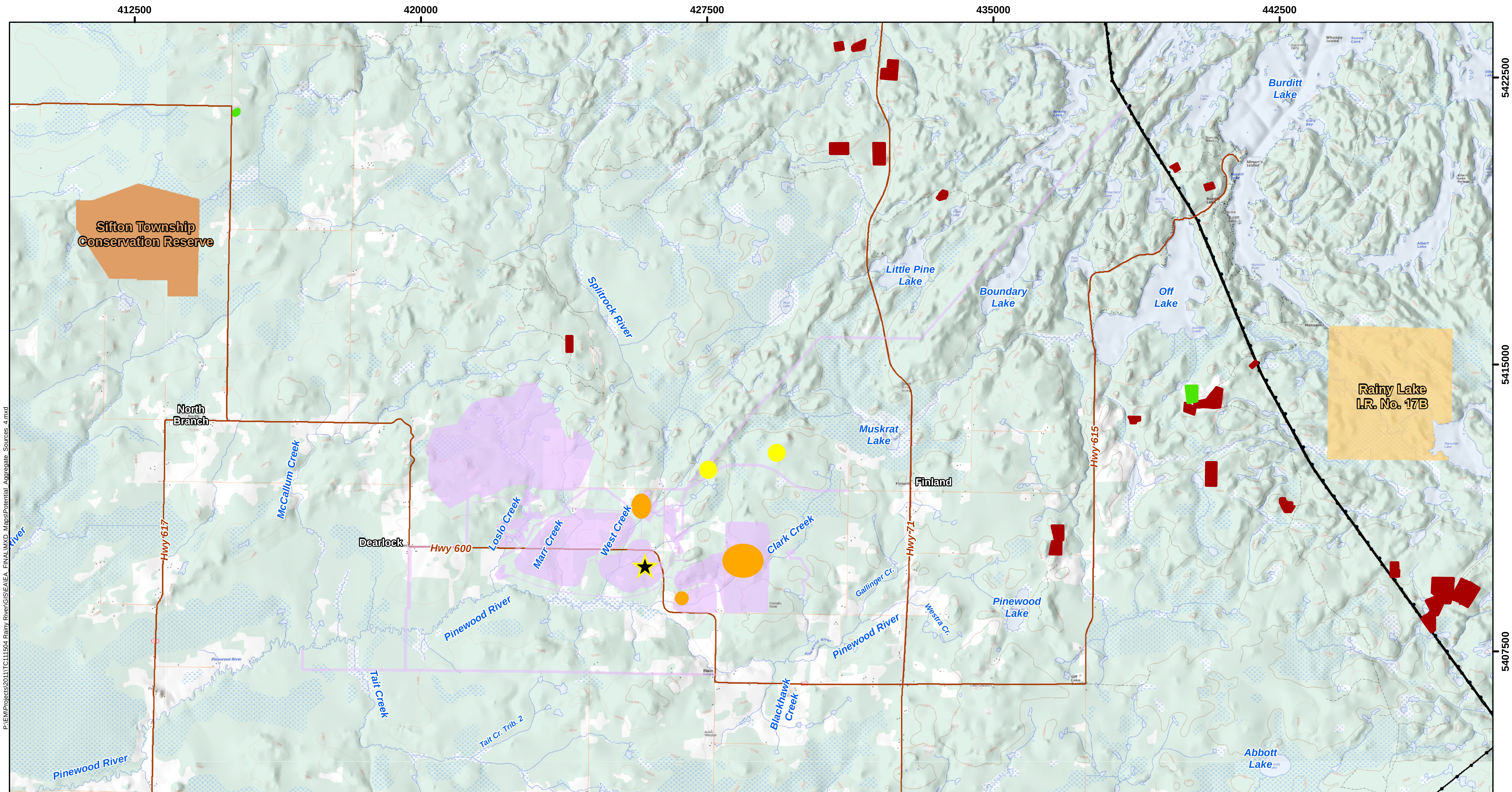
RAINY RIVER PROJECT

Typical Tailings Management Area Dam Cross Sections

PROJECT N°: TC111504	**FIGURE: 4-6**
SCALE:	DATE: October 2013



LEGEND

- RRP Site
- Approximate Principal RRP Facilities
- Regional Road / Highway
- Transmission Line
- First Nation Reserve
- Conservation Reserve (Regulated)
- Provincial Park

Potential Aggregate Source Areas

- Potential Aggregate Sites (Identified by TBT Engineering, 2012)
- Potential Aggregate Sites (Identified by AMEC, 2012)

MNR Authorized Aggregate Areas

- Active Site
- Surrendered Site

NOTES:
- All base data on this map was extacted from Land Information Ontario (MNR), Queen's Printer for Ontario, 2011-2012 and NRCan Toporama 1:50,000 NTS DRG map sheets, 2011
- USA land extracted from ESRI base map service, USGS Topo maps
- MNR Authorized aggregate sites, extracted from Land Information Ontario (MNR), Queen's Printer for Ontario, 2013

Datum: NAD83
Projection: UTM Zone 15N

N W E S

0 2.5 5 10 15 20 25 Kilometres

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RAINY RIVER PROJECT

Potential Aggregate Sources

PROJECT N°: TC111504	FIGURE: 4-7
SCALE: 1:95,000	DATE: October 2013

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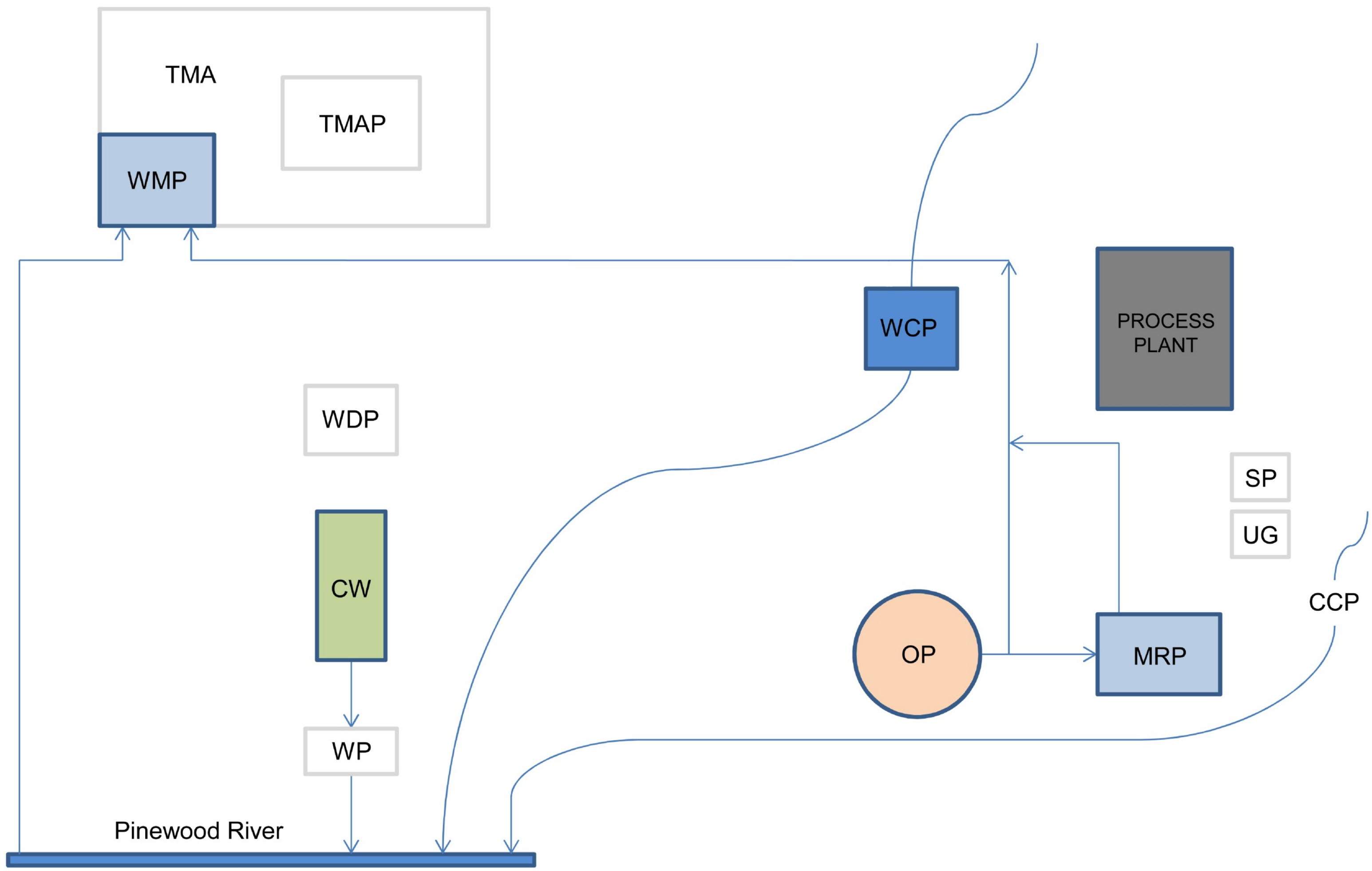

Notes: TMA – Tailings Management Area; WMP – Water Management Pond; TMAP – TMA Pond; WDP – Water Discharge Pond; CW – Constructed wetland; OP – Open Pit; UG – Underground; WP – Wetland Pond; WCP – West Creek Pond / Diversion; MRP – Mine Rock Pond; SP – Stockpile Pond: CCP – Clark Creek Diversion

⟶ Ongoing Flow - - -> Intermittent Flow

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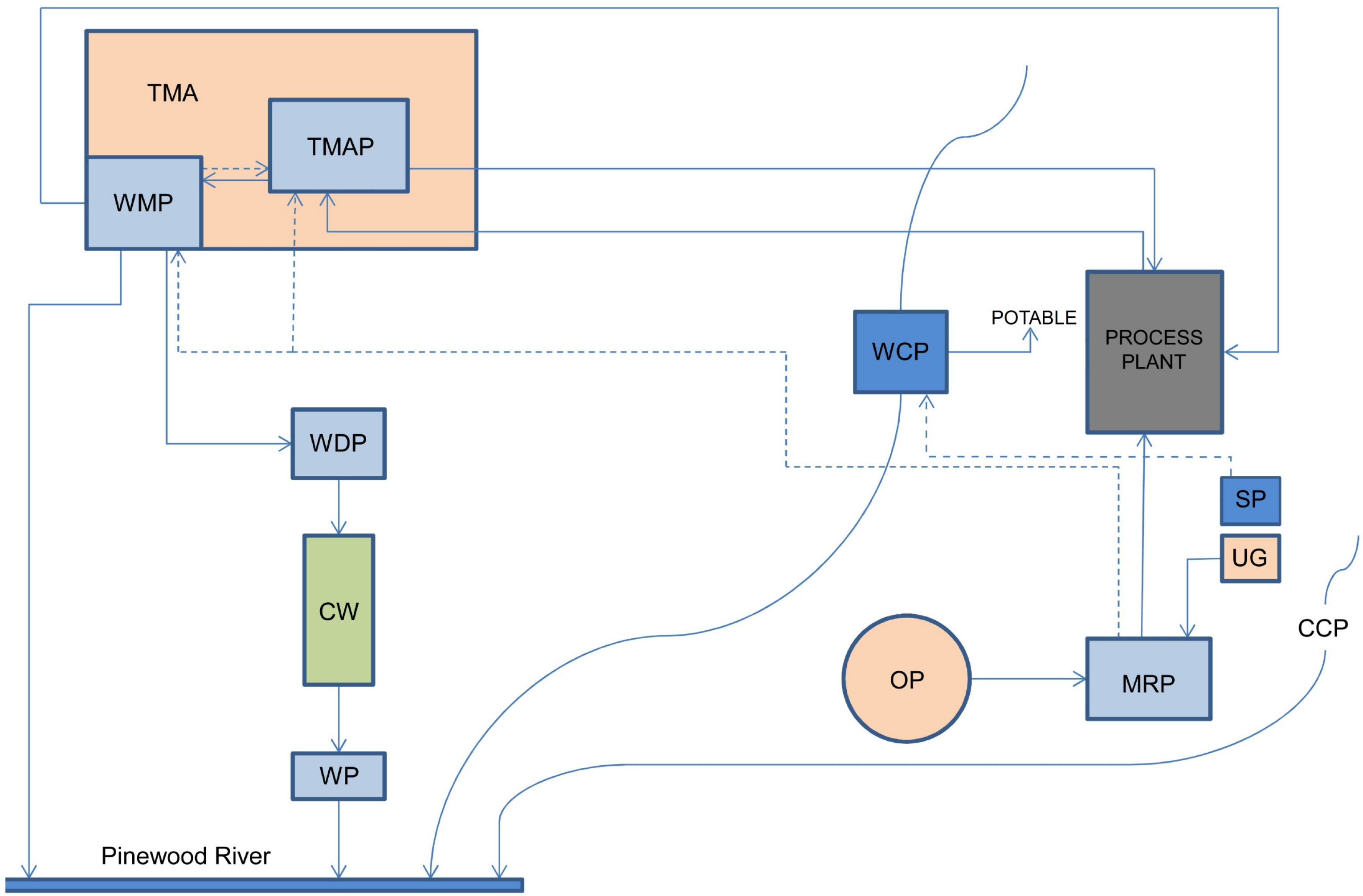
RAINY RIVER PROJECT

Water Management
Start-Up Water Collection

PROJECT N°: TC111504	**FIGURE: 4-8**
SCALE:	DATE: October 2013



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Notes: TMA – Tailings Management Area; WMP – Water Management Pond; TMAP – TMA Pond; WDP – Water Discharge Pond; CW – Constructed wetland; OP – Open Pit; UG – Underground; WP – Wetland Pond; WCP – West Creek Pond / Diversion; MRP – Mine Rock Pond; SP – Stockpile Pond: CCP – Clark Creek Diversion

→ Ongoing Flow - - → Intermittent Flow

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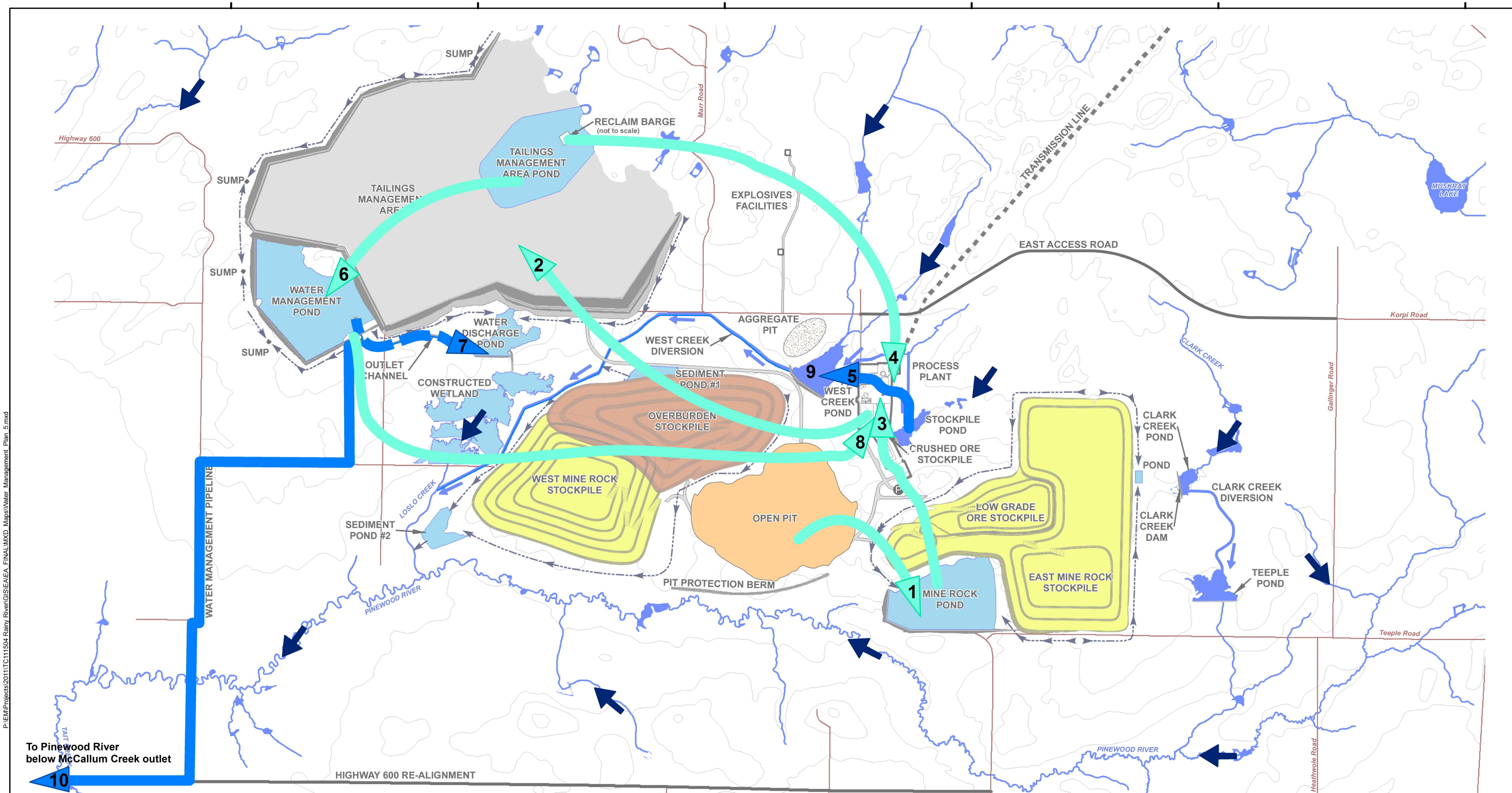
RAINY RIVER PROJECT

Water Management System
Full Operations

PROJECT N°: TC111504	**FIGURE: 4-9**
SCALE:	DATE: October 2013



LEGEND

- Integrated Water Recycle
- Excess Water Discharge
- General Surface Water Flow Direction

ID (on this Figure)	Flow From	Flow To	Method	Purpose	Control Logic
1	Open Pit	Mine Rock Pond	Pumped	Dewatering of the Open Pit	Rate to match inflows (lower bench may flood during storm events).
2	Process Plant	TMA	Pumped	Tailings slurry discharge.	Pumped at fixed rate.
3	Mine Rock Pond	Process Plant	Pumped	Process Plant Make-up.	Fixed rate with on/off float switch at minimum pond level.
4	TMA	Process Plant	Pumped	Process Plant Make-up.	Pumped at fixed rate adjusted according to Mine Rock Pond supply.
5	Stockpile Pond	West Creek Pond	Gravity	Divert clean runoff.	Free draining to match inflow.
6	TMA	Water Management Pond	Pumped	Seasonal transfer. Net annual inflow to the system.	Transfer net annual inflow after effluent is released from the Water Management
7	Water Management Pond	Water Discharge Pond /Constructed Wetland	Gravity	Discharge treated effluent to the Pinewood River via the constructed wetland.	Seasonal discharge to constructed wetland (all months except Feb./March) for added treatment and maintain Pinewood River flows.
8	Water Management Pond	Process Plant	Pumped	Mill process fresh water and make-up requirements	Pumped at variable rates as needed.
9	West Creek Pond	Potable	Pumped	Provide potable water	Pumped at variable rates as needed.
10	Water Management Pond	Pinewood River / McCallum Creek	Pumped	Discharge treated effluent to the Pinewood River.	Discharge treated effluent to the Pinewood River.

NOTES:
- Nominal monthly pump rates indicate on figure are based on average annual conditions.
- Pump rates are provided on table 9

Datum: NAD83
Projection: UTM Zone 15N

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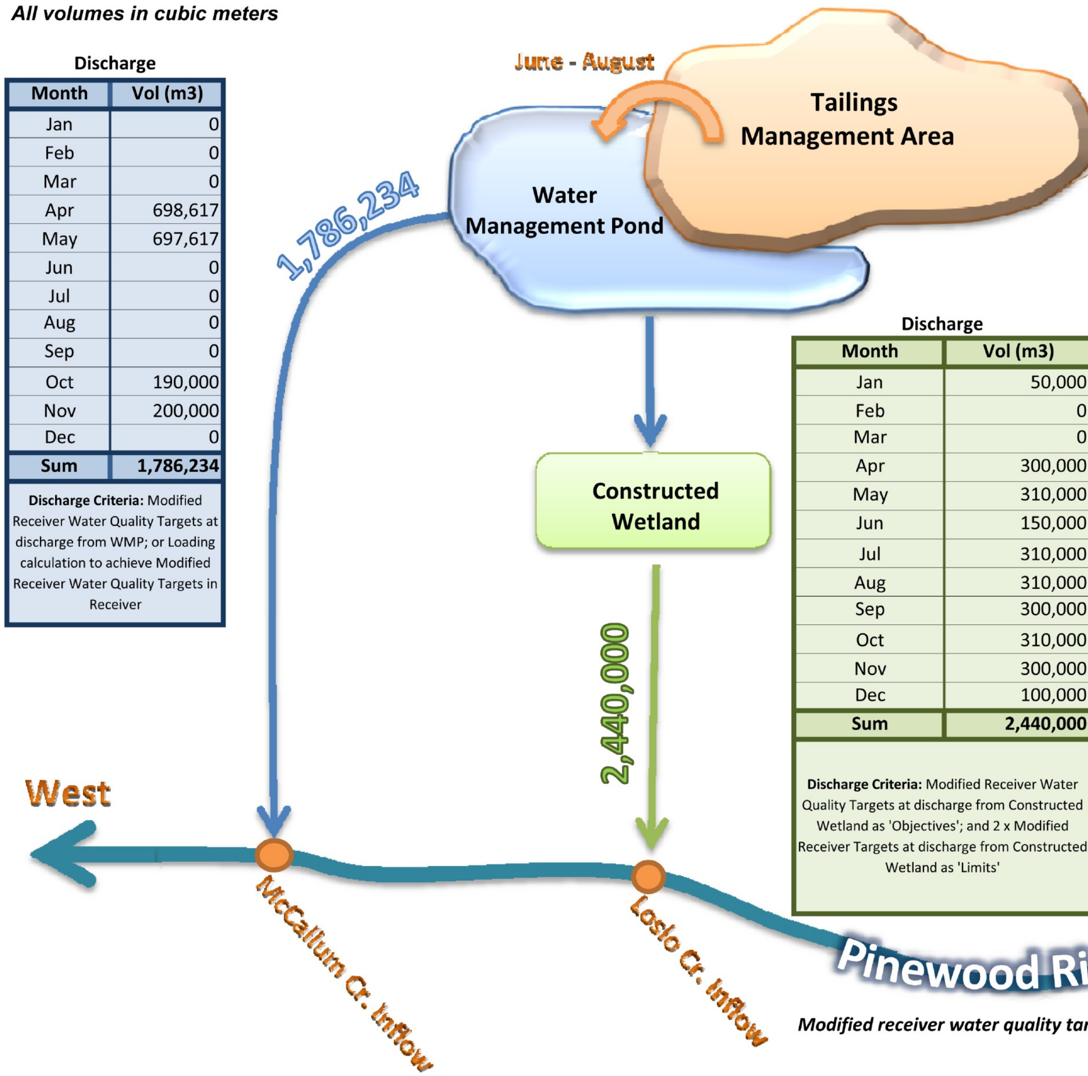
RAINY RIVER PROJECT

Water Management Plan

PROJECT N°: TC111504	FIGURE: 4-10
SCALE: 1:37,500	DATE: October 2013

0 1.25 2.5 5 7.5 10 Kilometres

All volumes in cubic meters



Discharge

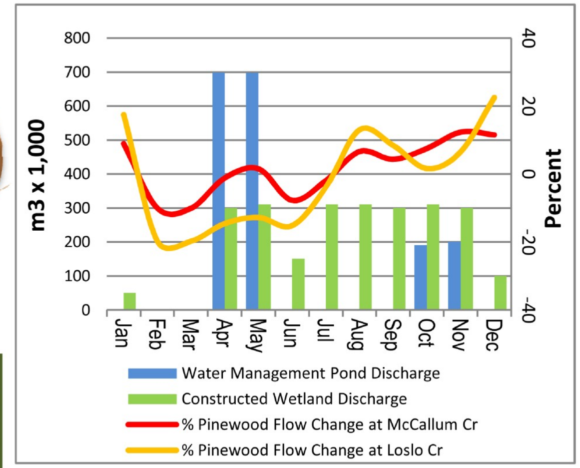
Month	Vol (m3)
Jan	0
Feb	0
Mar	0
Apr	698,617
May	697,617
Jun	0
Jul	0
Aug	0
Sep	0
Oct	190,000
Nov	200,000
Dec	0
Sum	**1,786,234**

Discharge Criteria: Modified Receiver Water Quality Targets at discharge from WMP; or Loading calculation to achieve Modified Receiver Water Quality Targets in Receiver

Discharge

Month	Vol (m3)
Jan	50,000
Feb	0
Mar	0
Apr	300,000
May	310,000
Jun	150,000
Jul	310,000
Aug	310,000
Sep	300,000
Oct	310,000
Nov	300,000
Dec	100,000
Sum	**2,440,000**

Discharge Criteria: Modified Receiver Water Quality Targets at discharge from Constructed Wetland as 'Objectives'; and 2 x Modified Receiver Targets at discharge from Constructed Wetland as 'Limits'



Pinewood Flow Change at McCallum Creek

Month	%
Jan	8.9
Feb	-10.1
Mar	-10.1
Apr	-1.2
May	1.5
Jun	-7.8
Jul	-2
Aug	6.6
Sep	4.3
Oct	7.5
Nov	12.3
Dec	11.5
Average	**0.30**

Pinewood Flow Change at Loslo Creek

Month	%
Jan	17.5
Feb	-19.8
Mar	-19.8
Apr	-14.6
May	-12.8
Jun	-15.2
Jul	-3.9
Aug	13
Sep	8.4
Oct	1.6
Nov	6.5
Dec	22.5
Average	**-8.01**

Modified receiver water quality targets maintained in Pinewood River at all times

NOTES:

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RAINY RIVER PROJECT

Water Management Schematic
Average Annual Balance - Year 15

PROJECT N°: TC111504	**FIGURE: 4-11**
SCALE:	DATE: October 2013

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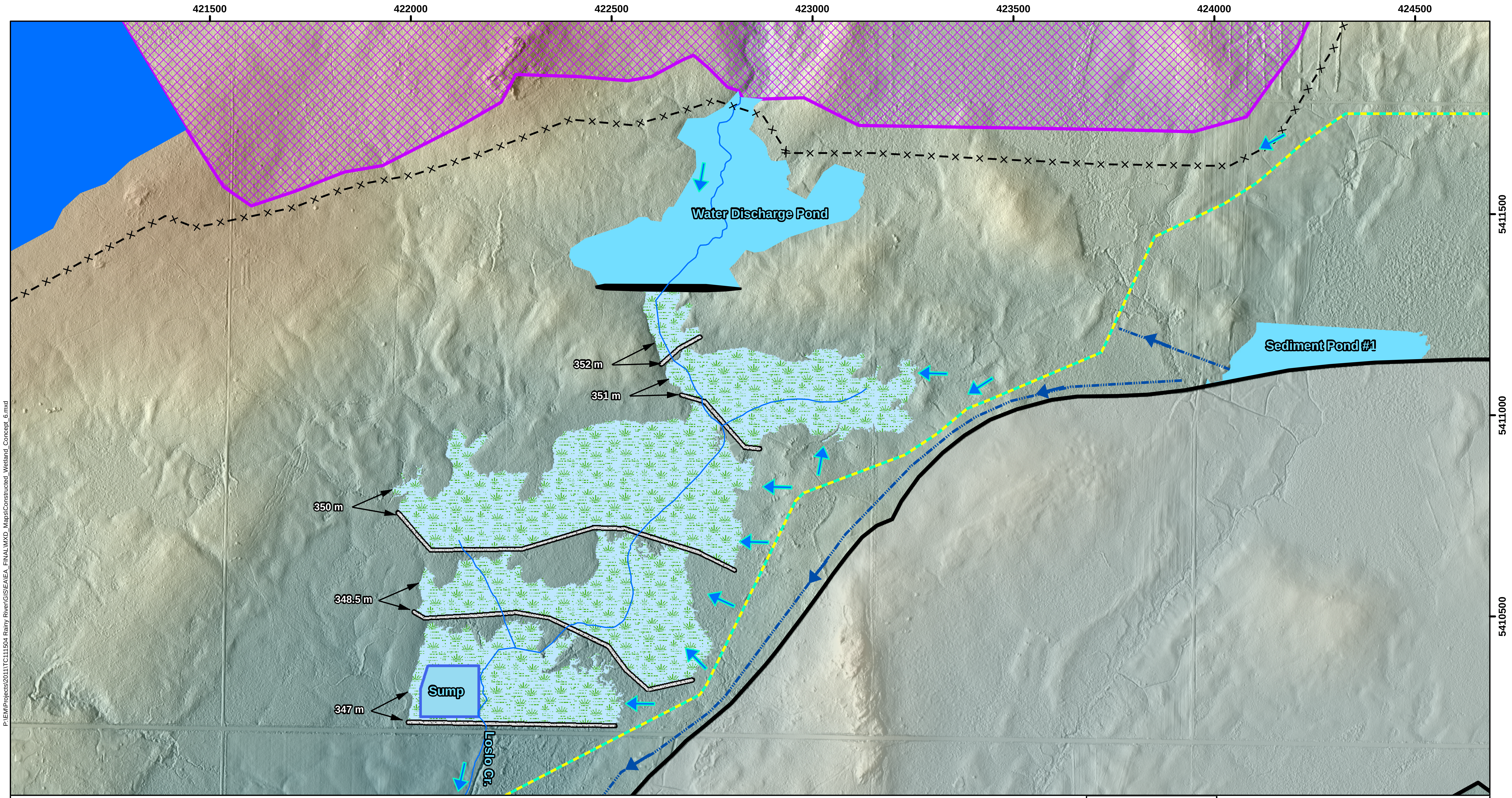

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LEGEND

- West Creek Diversion Route
- Water Discharge Pond Dam
- Pond / Sump
- Rock Groyne / Dam
- Constructed Wetlands (labelled with crest elevation of groyne/dam)
- General Flow Direction
- Runoff and Seepage Collection Ditch
- Water Discharge Pond and Sediment Pond #1
- Water Management Pond
- Tailings Management Area
- Proposed Overburden/NPAG Mine Rock Stockpile
- Fence (approximate location)

Elevation Colour Ramp

High ground

Low ground

NOTES:
-

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

0 0.25 0.5 1 1.5 2 Kilometres

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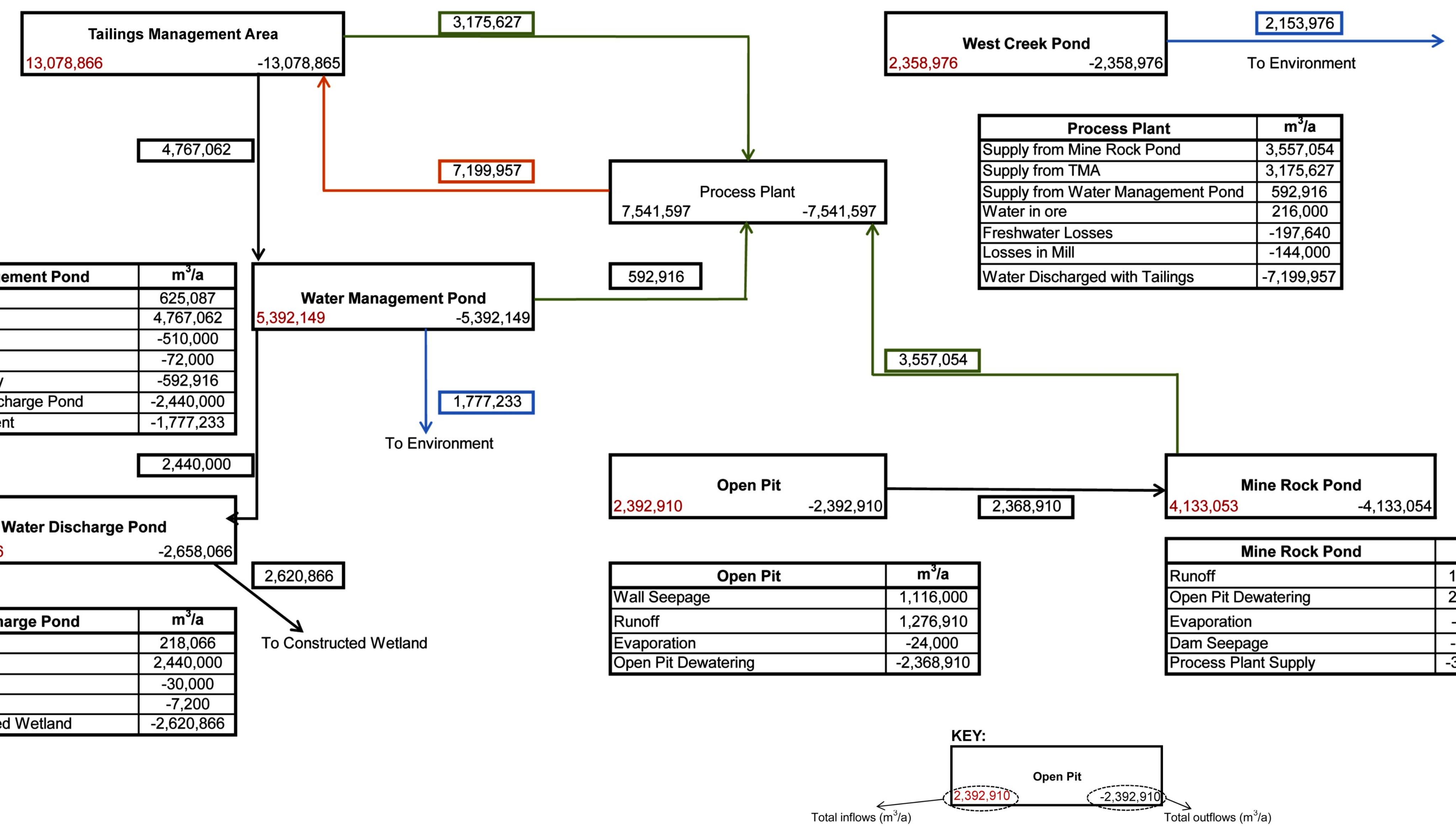
RAINY RIVER PROJECT

Constructed Wetland Concept

PROJECT N°: TC111504	**FIGURE: 4-12**
SCALE: 1:9,000	DATE: October 2013



Tailings Management Area	m^3/a
Water Discharged with Tailings	7,199,957
Runoff	5,878,909
Retained Pore Water	-2,553,176
Evaporation	-2,223,000
Dam Seepage	-360,000
Process Plant Supply	-3,175,627
Decant to Water Management Pond	-4,767,062

West Creek Pond	m^3/a
Runoff	2,358,976
Evaporation	-96,000
Dam Seepage	-36,000
Potable Water	-73,000
Overflow to Environment	-2,153,976

Process Plant	m^3/a
Supply from Mine Rock Pond	3,557,054
Supply from TMA	3,175,627
Supply from Water Management Pond	592,916
Water in ore	216,000
Freshwater Losses	-197,640
Losses in Mill	-144,000
Water Discharged with Tailings	-7,199,957

Water Management Pond	m^3/a
Runoff	625,087
TMA Decant	4,767,062
Evaporation	-510,000
Dam Seepage	-72,000
Process Plant Supply	-592,916
Decant to Water Discharge Pond	-2,440,000
Decant to Environment	-1,777,233

Open Pit	m^3/a
Wall Seepage	1,116,000
Runoff	1,276,910
Evaporation	-24,000
Open Pit Dewatering	-2,368,910

Mine Rock Pond	m^3/a
Runoff	1,764,143
Open Pit Dewatering	2,368,910
Evaporation	-396,000
Dam Seepage	-180,000
Process Plant Supply	-3,557,054

Water Discharge Pond	m^3/a
Runoff	218,066
TMA Decant	2,440,000
Evaporation	-30,000
Dam Seepage	-7,200
Decant to Constructed Wetland	-2,620,866

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LEGEND

Water Transfers

- Flows to the Environment
- Process Plant Supply
- Process Plant Discharge
- Water Transfer

Water Volume

- Flows to the Environment (m^3/a)
- Process Plant Supply (m3/a)
- Process Plant Discharge (m3/a)
- Water Transfer (m^3/a)

NOTES:
- Changes in pond storage (losses and gains) are not accounted for in this schematic

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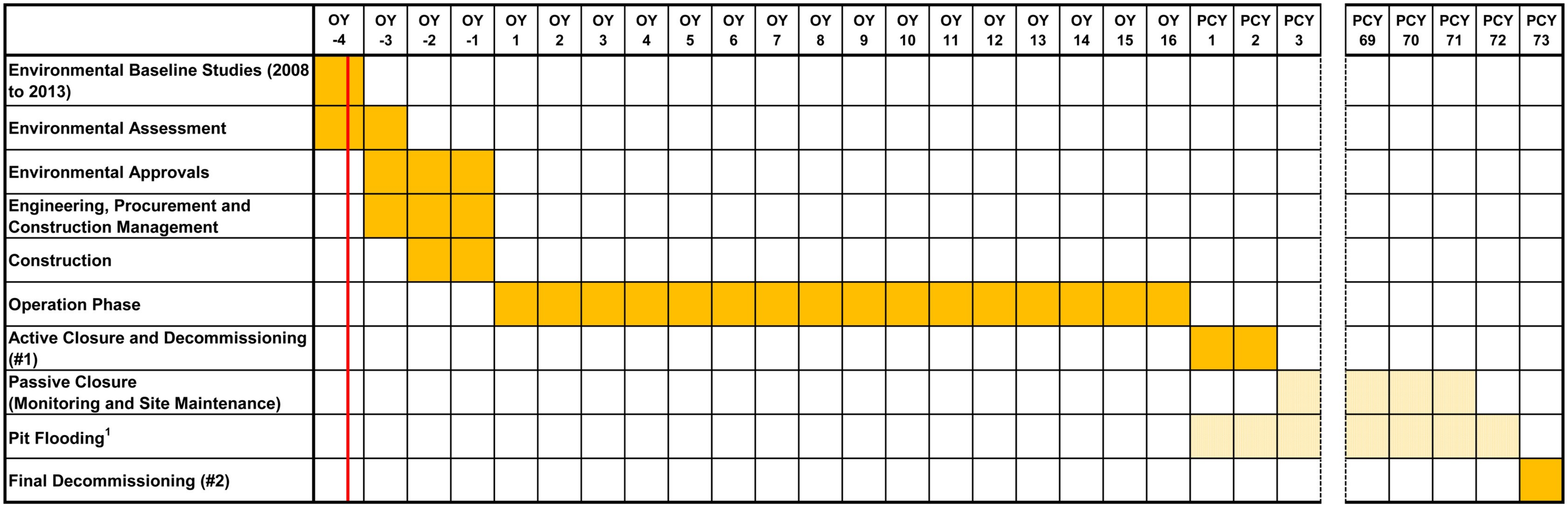
RAINY RIVER PROJECT

Water Balance Operations

PROJECT N°: TC111504 | **FIGURE: 4-13**

SCALE: | DATE: October 2013



LEGEND

OY **Operation Year**
PCY **Post-closure Year**
1 Natural time to flood shown (94 years); enhanced pit flooding with multiple sources may take from 25 to 72 years.

| Current status

NOTES:
-

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RAINY RIVER PROJECT

Project Schedule

PROJECT N°: TC111504 | **FIGURE: 4-14**

SCALE: | DATE: October 2013