# 6.0 EVALUATION OF ALTERNATIVES

## 6.1 Assessment of Project Alternatives

### 6.1.1 Rationale

Rainy River Resources (RRR) is part of New Gold Inc., a publicly traded company that proposes to develop and operate the Rainy River Project (RRP) in order to provide shareholders with a reasonable return on investment. The underlying rationale for the RRP is the strong demand for gold in the global marketplace. With gold prices at sustained high levels, the economics of the RRP are expected to be such that RRR can successfully produce gold and provide shareholders with value.

The RRP is expected to also provide benefit to the local area and region. There is a demonstrated local and regional need in northwestern Ontario for economic development. In the 2006 census, the Rainy River District exhibited a higher unemployment rate than the Province of Ontario as a whole, with some of the highest out-migration rates in Canada. The regional workforce; however, shows a tendency toward occupations related to primary industry and trades, and is well-suited to support the RRP. The RRP is expected to be a positive economic influence on the region providing construction and permanent employment opportunities for a large number of people (Section 7.19).

RRR is an active member of the local community with offices in both Emo and Thunder Bay that offer residents easily accessible locations to learn about the RRP. RRR has engaged the local communities as well as First Nations and Métis community members. Through meetings, site tours and regular communications, RRR strives to ensure engagement with all members of the local communities. Community Town Hall meetings are held regularly to discuss and update the community on the RRP. Key comments received by RRR during consultation and discussions regarding the RRP to date, have consistently been related to employment and training opportunities. The region has experienced recent declines in both employment and population in large part related to the downturn in the forestry industry, and development of the RRP has received very strong Municipal and Provincial government support to date.

### 6.1.2 Methodology

The Ontario *Environmental Assessment Act* makes reference to both "alternatives to" a proposed undertaking, and "alternate methods" of carrying out a proposed undertaking. All of the alternatives considered in the Environmental Assessment (EA) Report meet the Ministry of the Environment (MOE) guidance (MOE 2009d).

During the preparation of the Terms of Reference (ToR) as part of the Provincial Individual EA process, RRR committed to assess alternatives to the RRP utilizing an approach consistent with the methodology recommended in MOE (2009d), including an assessment of alternatives to the RRP. Three alternatives have been identified for the RRP. These are:

- Proceed with the RRP in the near term, as planned to produce gold for sale and provide a return on investment to shareholders of RRR;
- Delay the RRP until circumstances are more favourable; or
- Abandon the RRP.

Tables 6-1 to 6-4 provide an analysis of these three alternatives to the project using criteria developed by the Ministry of Natural Resources (MNR) with regards to the Class EA for MNR Resource Stewardship and Facility Development Projects (MNR 2003). This methodology is consistent with the methodology described in the Provincially-approved Amended ToR for assessing alternatives (Appendix C-1) but less complex. The MNR criteria which are used across Ontario were thought to be more transparent for a general audience understanding of the overall merits of the RRP as a whole. This methodology has the additional benefit that it does not require the reviewer to go to an appendix for further detail.

The MNR commented in its review of the draft EA Report (Version 2) that the assessment methodology for evaluating alternatives to the project did not strictly follow the criteria in the Approved ToR, and requested clarification with respect to the use of criteria developed in the ToR. For this reason (and in addition to the methodology presented in this section for assessing alternatives to the project), a parallel assessment was carried out which strictly follows application of criteria developed in the Provincially-approved Amended ToR (Appendix O, Table O-0). The results of this parallel assessment support the conclusions in Section 6.1.3.

The assessment presented in Tables 6-1 to 6-4 is carried out at a level sufficient to distinguish the relative merits of the different project alternatives. The project alternatives assessment table have been grouped under the following headings:

- Natural environment considerations;
- Land use and resource management considerations;
- Social, cultural, and economic considerations; and
- Aboriginal considerations.

For each topic, considerations were expressed relative to potential environmental effects and associated mitigation measures, and to the significance of the effect after mitigation. Significance was assessed from low to high level using a numerical scale of from 1 to 5 for convenience of expression only.

- **Low (numerical value of 1):** the anticipated future change affects the environmental component in such a way that only a portion of the component is disturbed for a short period of time, or not at all; or in the case of positive socio-economic effects, the effects will be minor and will apply to small numbers of people, often for only a short timeframe. Level 1 effects are considered to be not significant.

- **Medium (numerical value of 3):** the anticipated future change affects the environmental component so as to bring about a disturbance, but does not threaten the integrity, distribution, operation, or abundance of the component. Short term effects associated with construction and the operation of facilities also constitute a medium effect. Alternatively, in the case of positive socio-economic effects, a Level 3 rating is considered to be such that the effect will be likely to meaningfully affect a moderate number of people, for intermediate to longer term timeframes. Level 3 effects are considered to be not significant.

- **High (numerical value of 5):** the anticipated future change affects the environmental component so as to seriously disturb the integrity, distribution, operation, or abundance of the component. Alternatively, in the case of positive socio-economic effects, a Level 5 rating is considered to be highly significant, such that the effect will be likely to positively affect a large number of people, in a meaningful way, for a prolonged period of time.

Numerical values of 2 and 4 are intermediate values. In most instances only negative environmental effects are assessed; however, a "+" sign is attached to the numerical score to indicate a net positive effect. The numerical scores cannot be tallied to develop an overall rating, since the components being assessed are unique and are not of equal importance. The overall selection of a preferred alternative is therefore a reasoned process based on best professional judgment.

### 6.1.3 Assessment Results

All negative environmental effects associated with the RRP as planned, were assessed at significance levels of from 1 to 3 and are not considered to be significant after mitigation (Tables 6-1 to 6-4), with the exception of the following which were assessed at a Level 4:

- Vegetation and habitat;
- Terrestrial wildlife;
- Natural heritage features;
- Creation of excessive waste;
- Views and aesthetics; and
- Adjacent or nearby uses, persons or property.

Proceeding with the RRP as planned would result in highly significant positive effects to the local and regional economies, and help preserve community character despite the current long term forestry sector downturn. The following effects were assessed as positive level of 4 or 5:

- Community character; and
- Local, regional, or Provincial economies or businesses.

The only project alternative that meets the intended project purpose is to proceed with the RRP in the near term, as planned.

Depending on circumstances related to future project economics and financing, further investigations, environmental approval processes and discussions with Aboriginal groups, delaying the project cannot be ruled out. Scheduling delays however, have the potential to delay the overall project for an indefinite period and would increase overall project costs. Delaying the project until circumstances are more favourable is therefore regarded as an acceptable but not a preferred alternative. Delaying the RRP for longer timeframes has the potential to seriously affect investor confidence. The abandon the RRP alternative is rejected as not fulfilling the project purpose.

From an overall perspective, proceed with the RRP in the near term as planned is selected as the preferred alternative, since this is the only alternative that fulfils the project purpose, and as there are essentially no differences in negative environmental effects associated with the alternative of proceeding with the RRP as planned versus delaying the RRP.

## 6.2 Assessment of Alternative Methods Methodology

### 6.2.1 Performance Objectives

The assessment of alternative methods provided herein is carried out at a level sufficient to distinguish the relative merits of the different alternative methods for developing, operating and closing the RRP. The assessment includes consideration of the advantages and disadvantages of each alternative method based on a series of performance objectives, evaluation criteria and indicators, to define a preferred alternative for each of the major project components or activities.

Performance objectives are meaningful attributes that are essential for the RRP success, and provide a basis for distinguishing between individual alternatives. The following performance objectives (or a subset thereof as appropriate for any given alternative) have been used:

- Cost-effectiveness;

- Technical applicability and/or system integrity and reliability;

- Ability to service the site effectively;
- Effects to the natural environment;
- Effects to the human environment, including Aboriginal and treaty rights, cultural heritage resources and traditional land use; and
- Amenability to reclamation.

Where applicable, consideration in the evaluation is given to positive effects to the natural and human environment.

### 6.2.2 Evaluation Criteria and Indicators

Proposed criteria and indicators for assessing performance objectives identified in Section 6.2.1 are detailed below. The application of these criteria and indicators is documented in a tabular format (Appendix O) to allow an assessment of the advantages and disadvantages of each feasible alternative method. Overall summary narratives for each alternative are provided below in Sections 6.3 through 6.18, for each applicable performance objective to determine whether an individual alternative has a preferred, acceptable or unacceptable level of performance.

Criteria and indicators specific to each performance objective are provided in the following tables. One or more indicators are associated with each criterion. Where specific criteria or indicators are not applicable to the assessment of a given alternative, an assessment of not applicable (NA) is provided in the Appendix O assessment tables. Summary criteria for assessing overall preferred, acceptable and unacceptable ratings for the performance objectives are also provided in the tables below.

**Cost-effectiveness**

| Criteria | Indicator |
|---|---|
| RRP financing | Investor attractiveness or risk |
| Return on investment | Provides a competitive or acceptable return on investment |
| Financial risk | Provides, or is associated with, a preferred, manageable or acceptable financial risk |
| **Performance** | |
| Preferred | Facilitates a competitive return on investment |
| Acceptable | Facilitates an acceptable return on investment |
| Unacceptable | Cannot be financially supported by the RRP |

Cost-effectiveness relates to overall RRP costs, including capital, operation, maintenance, and closure / reclamation costs. Each aspect of the RRP has cost implications and thus cost-effectiveness is a performance objective common to all aspects.

**Technical Applicability and/or System Integrity and Reliability**

| **Criteria** | **Indicator** |
|---|---|
| Available technology | Used elsewhere in similar circumstances, and is predictably effective with contingencies if and as required |
| | New technologies supported by pilot plant or strong theoretical investigations or testing, with contingencies if and as required |
| **Performance** | |
| Preferred | Predictably effective with contingencies if the alternative does not perform as expected |
| Acceptable | Appears effective based on theoretical considerations; contingencies are available if the alternative fails to perform as expected |
| Unacceptable | Effectiveness appears dubious or relies on unproven technologies |

Technical applicability and system integrity and reliability are used interchangeably, as appropriate to the issue, to describe the suitability or expected performance of a given alternative.

**Ability to Service the Site Effectively**

| **Criteria** | **Indicator** |
|---|---|
| Service | Provides a guaranteed supply to the site with manageable potential for supply disruption, and/or contingencies available |
| Accessibility | Accessible land base or infrastructure needed to support component development and operation |
| **Performance** | |
| Preferred | Provides a guaranteed access / supply to the site with a low risk of interruption |
| Acceptable | Provides the required access / supply to the site with contingencies in the event of disruptions |
| Unacceptable | Cannot reliably provide sufficient access / supply, or involves an unacceptable level of risk without contingencies |

This performance objective is relevant for those aspects of the RRP dealing with the provision of consumables or access to the RRP site. The reliable (guaranteed) supply of consumables, such as fuel and power, is critical to the uninterrupted operation of the mine. Having access to required lands is also a critical aspect of this performance object, because unlike governments that have the power to expropriate lands, private proponents are unable to compel unwilling landowners to sell their lands; and even if such landowners are willing to sell their lands, the terms of such arrangements may not be reasonable to each party.

**Effects to the Natural Environment**

| Criteria | Indicator |
|---|---|
| Effect on air quality and climate | Attainment or maintenance of air quality point of impingement standards, or scientifically defensible alternatives |
| | Emission rates of greenhouse gases |
| Effect on fish and aquatic habitat | Attainment or maintenance of water quality guidelines for the protection of aquatic life, or scientifically defensible alternatives |
| | Maintenance or provision of fish habitat |
| | Maintenance of water flows or conditions suitable for fish passage |
| | Maintenance of groundwater flows, levels and quality |
| Effect on wetlands | Attainment or maintenance of water quality guidelines for the protection of aquatic life, or scientifically defensible alternatives |
| | Area, type and quality (functionality) of wetlands that would be displaced or altered |
| | Maintenance of wetland connectivity |
| Effect on terrestrial species and habitat | Area, type and quality (functionality) of terrestrial habitat that would be displaced or altered |
| | Potential for sound (or other harm and harassment) related disturbance |
| | Maintenance or provision of plant dispersion and wildlife movement corridors |
| Effect on Species at Risk (SAR) | Sensitivity level of involved species (Endangered, Threatened, Special Concern) |
| | Area, type and quality of SAR territories or habitat that would be displaced |
| | Potential for sound (or other harm and harassment) related disturbance |
| | Maintenance or provision of wildlife movement corridors |
| **Performance** | |
| Preferred | Requires least amount of mitigation to minimize adverse effects to the natural environment and is superior to acceptable alternatives |
| Acceptable | Minimizes adverse effects to the natural environment with mitigation |
| Unacceptable | Likely to cause significant adverse effects to the natural environment that cannot reasonably be mitigated |

The natural environment referred to in this performance objective is a broad term used to describe the air, bedrock, soil / overburden, water (surface and ground) and biological organisms / communities. Where appropriate, the assessment of alternatives relative to natural environment effects considers potentials for positive effects. Potential climate change scenarios are considered, where applicable. For example, could climate change alter the anticipated effects on the natural environment?

**Effects to the Human Environment**

| Criteria | Indicator |
|---|---|
| Effect on local residents | Maintenance of property values |
| | Maintenance or improvement of income opportunities |
| | Maintenance or provision of local access |
| | Attainment of sound by-law guidelines, and /or background sound levels if already above the guidelines |
| | Non-interference with water well supply systems |
| | Potential for general disturbance and adverse affects on aesthetics |
| | Potential for adverse health and safety effects |
| Effect on infrastructure | Maintenance or provision of local and regional access |
| | Maintenance and reliability of power supply systems |
| | Maintenance and reliability of pipeline systems |
| Public health and safety | Attainment or maintenance of air quality point of impingement standards, or scientifically defensible alternatives |
| | Maintenance or attainment of the quality of drinking water supply systems |
| | Managing the potential for adverse electromagnetic exposure |
| | Maintaining safe road traffic conditions that are within the domain of RRR control |
| | Maintenance or provision of health services |
| Effect on local businesses | Maintenance or improvement of business opportunities |
| Effect on tourism and recreation | Maintenance or improvement of tourism and recreational opportunities |
| Effect on agriculture and forestry | Potential loss of lands<br>Potential loss of productivity |
| Regional economy | Maintenance or improvement of the regional economy |
| Effect on government services | Maintenance or improvement on the capacity of existing health, education and family support services |
| Effect on resource management objectives | Consistency with established and planned resource management objectives |
| Excessive waste materials | Limiting the generation of unnecessary waste materials |
| Effect on built heritage and cultural heritage landscapes | Avoidance of damage to built heritage resources, or document heritage values if damage or relocation cannot reasonably be avoided |
| Effects on First Nation reserves, and Aboriginal communities, and Métis | Maintenance or improvement of First Nation reserve and community conditions (subject to the limitations of Company capacity and community members' personal choice) |
| Effect on spiritual, ceremonial, and cultural heritage, and archaeological sites | Avoidance of damage or disturbance to known spiritual, ceremonial, cultural heritage and archaeological sites; or implement other forms protection / preservation supported by local First Nations and Métis |
| Effects on traditional land use | Maintain access to traditional lands for current traditional land uses, except as otherwise agreed to with local First Nations and Métis |
| Effects on Aboriginal and Treaty Rights | Avoid infringement of Aboriginal and Treaty Rights, except as otherwise agreed to with local First Nations and Métis |

| Criteria | Indicator |
|---|---|
| **Performance** | |
| Preferred | Requires least amount of mitigation to minimize adverse effects to the human environment, is superior to acceptable alternatives and provides positive effects |
| Acceptable | Minimizes adverse effects to the human environment with mitigation |
| Unacceptable | Likely to cause significant adverse human environment effects that cannot reasonably be mitigated |

The potential for negative human environment effects, such as the reduction of land use, is evaluated where appropriate for the alternatives for the various aspects of the RRP. The human environment is defined herein to also include aspects of the cultural heritage environment as well as Aboriginal and treaty rights. The potential for negative effects to cultural heritage resources, traditional land use, and Aboriginal and treaty rights, such as the reduction of land use by Aboriginal peoples, or the quality of resources harvested by Aboriginal peoples, is evaluated where appropriate for the alternatives for the various aspects of the RRP. RRR acknowledges that there are Provincial Standards and Guidelines for Conservation of Provincial Heritage Properties that could apply. The assessment of alternatives within the EA also considers potential positive effects.

**Amenability to Reclamation**

| Criteria | Indicator |
|---|---|
| Effect on public safety and security | Avoidance of safety and security risks to the general public |
| Effect on environmental health and sustainability | Attainment or maintenance of air quality point of impingement standards, or scientifically defensible alternatives |
| | Attainment or maintenance of water quality guidelines for the protection of aquatic life, or scientifically defensible alternatives |
| | Restoration of passive drainage systems |
| | Provision of habitats for vegetation and wildlife species, including SAR |
| Effect on land use | Provide opportunities for productive land uses following the completion of mining activities |
| | Provide for an aesthetically pleasing site |
| **Performance** | |
| Preferred | Causes disturbance to the natural environment that requires limited reclamation |
| Acceptable | Causes disturbance to the natural environment that requires moderate to extensive reclamation |
| Unacceptable | Mitigation of disturbance to the natural environment is not practical or feasible |

This performance objective relates to the decommissioning or reclamation of the RRP and associated infrastructure (if any). The consideration of alternatives methods for closure is more complex than for other alternatives, because there are a number of subcomponents that require consideration.

### 6.2.3 Identification of the Preferred Alternative

The alternatives are given an overall or summary evaluation, taking all of the performance objectives into consideration. There are two general approaches to summary evaluations in EA processes. One approach is to give numerical values to individual performance objectives (or equivalents), based on application of the appropriate criteria and indicators, and then to sum these values to arrive at an overall index. This approach typically requires some form of weighting to take into account the varying importance of the different performance objectives. Weighting factors have to be carefully justified and are thus are often open to interpretation. In addition, the numerical approach may result in two or more very different alternatives that have the same, or very similar, overall index values; when intuitively it is clear that one alternative better meets environmental, and health and safety requirements; and is technically superior to the other. Numerical evaluations may also not be as readily transparent during public review and consultation processes.

The second approach, and the one used herein for the RRP EA and defined in the Provincially-approved Amended ToR, is to rely on a comparative evaluation of the overall advantages and disadvantages of a method as demonstrated through the performance descriptions (that is whether an alternative is preferred, acceptable or unacceptable for each performance objective). Using this method, and with the knowledge that all performance objectives are essential to the acceptability of any given alternative; an alternative is rejected if it attains an unacceptable rating for any single performance objective.

This approach with minor variations, has been used successfully by AMEC for alternative assessments for a number of other mining project-related EAs in Ontario, that were subsequently approved by the Ontario Minister of the Environment or Federal Minister of the Environment as applicable. These include:

- Aquarius Project (Federal EA pursuant to the *Canadian Environmental Assessment Act*);

- Victor (Diamond) Project (Federal EA pursuant to the *Canadian Environmental Assessment Act*); and

- Detour Lake Project (Federal EA pursuant to the *Canadian Environmental Assessment Act*; two Provincial Individual EAs pursuant to the Ontario *Environmental Assessment Act*, and one Class EA pursuant to the Ontario *Environmental Assessment Act*).

This methodology has also been utilized for a number of other mining-related undertakings which were subject to a proponent-driven Class EA process under the Ontario *Environmental Assessment Act* related to the Electricity Projects Regulation, that were reviewed by Federal and Provincial government agencies, other stakeholders and Aboriginal groups at the time. This is also the methodology described during RRP open houses held in 2012.

The alternative which receives the greatest number of preferred ratings is not necessarily the best, or most preferred, overall alternative. The relative importance of the individual performance objectives needs to be considered as well. It may be that one or two performance objectives are more important and override all other objectives, so long as a minimum rating of acceptable is attained for the less important objectives and the relative importance assigned to performance objectives is supported by Provincial and Federal regulatory agencies. The final evaluation of alternatives is therefore a reasoned process, in which the basis for the final selection of alternatives is easily understood at all levels.

The final evaluation of alternatives will be undertaken in consideration of comments received, and discussions held, with the general public, local landowners, Aboriginal communities and government reviewers. Information received through this process will help to confirm the choice of alternatives considered and the relative importance of the individual performance objectives.

#### 6.2.4 Alternative Methods for Carrying Out the Undertaking

Alternatives presented and assessed in Sections 6.3 through 6.18 of the EA Report have been selected for assessment only if they are technically feasible, and satisfy the RRR requirements for employee, local residents and Aboriginal health and safety, and environmental protection. All mining operations pose some unavoidable onsite safety risks, as do other industrial operations. RRR is cognizant of this and will place an emphasis on worker health and safety, and training programs.

Alternative methods of carrying out the RRP have been considered with respect to the following elements:

- Mining;
- Minewater management;
- Mine rock and overburden management;
- Processing;
- Process plant effluent treatment;
- Tailings management;
- Buildings, facilities and areas;
- Aggregates;
- Water supply;
- Site water management;
- Solid waste management;
- Domestic sewage treatment;
- Highway 600 re-alignment;
- Power supply;

- Transmission line routing; and
- Reclamation and closure.

A preliminary screening was completed of potential alternatives for those aspects above and other related to mining development and operation (AMEC 2013a; Appendix C-1). This screening considered such aspects as: technical applicability, ability to service the site effectively, potential negative environmental effects on the natural and human environment, cost-effectiveness and amenability to reclamation. This preliminary screening was expanded upon and is reflected in the descriptions of alternatives that follow and the identification of a preferred alternative.

There is the potential that other economic alternatives may arise through ongoing engineering studies, or the EA process and related consultation and engagement activities.

## 6.3 Mining

### 6.3.1 Alternatives

The choice of a mining method (or methods) is a function of: the geometry and character of the ore body in relation to the surrounding geology and terrain, ore grade and costs relative to resource value (reflective of commodity pricing), available technologies, and environmental sensitivities.

The RRP deposit occurs within a large mineralized system containing a world class resource of gold and silver. The near surface resource can be mined by an open pit mine and contains 113 Mt of proven and probable reserves grading 0.97 g/t gold for 3.5 Moz of contained gold. In addition to the ore reserves, the open pit will move 80 Mt of overburden and 350 Mt of mine rock over a 12 year period to expose the ore for mining and processing. A portion of the open pit reserve, 43 Mt, will be lower grade ore that is stockpiled during operations for processing in later years. At a deeper level, reserves totalling 3.1 Mt grading 5.07 g/t gold for an additional 0.5 million ounces of gold are accessible by a ramp from surface.

The available alternatives for mining of the RRP ore body are:

- Open pit mining;
- Underground mining; and
- Combination of open pit and underground mining.

**Open Pit Mining**

Open pit mining requires the removal of surface materials to expose the ore body, followed by the stepwise development of concentric levels (benches) into the deposit, with an inclined roadway connecting the various mining levels. Open pit mining methods are well suited to:

- Shallow ore deposits that are exposed at surface, or are near surface covered by comparatively shallow overburden;
- Large deposits that have a more uniformly distributed resource or scattered, often randomly distributed pockets, that are not readily traceable by underground mining methods; and
- High tonnage, low grade deposits which are uneconomic using underground mining techniques.

In contrast to underground mining techniques, open pit mining typically generates large quantities of mine rock and stripped overburden that require disposal.

**Underground Mining**

Underground mining requires the development of a shaft or ramp to access the underground workings. Shaft access mining requires the construction of a vertical, underground passage (shaft) from surface to the targeted depth. Horizontal tunnels (drifts) are driven from the shaft, at strategic levels to access the ore body. Mining takes place off these drifts by drilling and blasting, and ore is transported to surface using a hoist. This type of mining is best suited to deeper, often smaller, ore bodies, which are easily traceable underground.

Ramp access mining is a second type of underground mining suited to higher grade, frequently smaller deposits, and involves the use of an inclined tunnel or ramp from surface to access the ore. Drifts are driven off from the ramp into the ore body at strategic levels. Ramp mining is more suited to shallower deposits compared with shaft mining, because of the cycle time it takes to truck ore and mine rock up the ramp to surface.

Where the ore is near surface and/or is not covered by host rock, underground mining must leave a substantial portion of the ore body in place (a crown pillar[1]) to maintain ground stability. Underground mining techniques typically produce comparatively limited quantities of mine rock (mined rock requiring disposal which is not ore), because mining is targeted specifically to well-defined ore zones.

[1] Crown pillar: a thickness of competent rock that must be left in place between the surface and the underground mine workings for safety reasons

**Combination of Open Pit and Underground Mining**

Where ore bodies are complex, a combination of open pit and underground mining is often used to extract the ore, with open pit mining being used to recover ore closer to surface, and underground mining being used to mine higher grade, more concentrated ore zones either adjacent and connected to the open pit, or deeper than the open pit.

### 6.3.2 Performance Objectives and Evaluation

Performance objectives used in the evaluation of mining method alternatives were the following:

- Cost-effectiveness;
- Technical applicability;
- Minimize effects to the natural environment;
- Minimize effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives in tabular form is presented in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

While a portion of the RRP deposit is suitable for development by underground mining methods; overall the ore body is too disseminated and of too low a grade to facilitate mining by underground methods alone. Similarly, while the major portion of the ore body is mineable using open pit methods, underground mining is better suited to accessing deeper, higher grade portions of the ore body. Open pit mining on its own is economically feasible, but does not allow for optimal mining of the ore body. Based on results of the Feasibility Study (BBA 2013) the optimal mining scenario is a combination of open pit and underground mining methods, with the bulk of the deposit (estimated at approximately 94% by tonnage, and 78% by gold content) to be mined using open pit operations, and the remainder to be mined by underground operations (ramp access).

Underground mining on its own is uneconomic and therefore unacceptable from a cost-effectiveness perspective. Open pit mining on its own is economic, but does not allow optimal exploitation of the resource, and is therefore rated as acceptable. The preferred mining method is a combination of open pit and underground ramp mining. There are a number of Ontario mines where both open pit and underground mining has occurred, including: the Dome Mine (Goldcorp), Hemlo Mine (Barrick Gold) and Lac Des Isles (North American Palladium).

**Technical Applicability**

Open pit and underground mining methods are both well proven technologies for hard rock gold mining. For RRP, underground mining methods alone are not suited to mining the ore body, because the resource is too low in grade and disseminated to support this mining technique. Open pit mining on its own is a feasible mining method, but is not optimal. A combination of open pit and underground mining is the optimal method for maximizing ore recovery.

**Effects to the Natural Environment**

Underground mining methods generate far less surface disturbance compared with open pit mining, and would yield far smaller quantities of waste overburden and mine rock, and are therefore preferred where the deposit is amenable to underground mining. Terrestrial habitat disturbances associated with open pit mining would include the 168 ha pit area, together with an approximately 774 ha combined area required for overburden and mine rock stockpile storage.

Open pit development would also require diversion of West Creek, and the overprinting of Marr Creek and portions of Clark Creek (Teeple Drain) with overburden and mine rock. In addition, approximately 40% of the generated mine rock is predicted to be potentially acid generating (PAG) per AMEC (2013h; Appendix G). PAG materials will need to be managed over the short term and longer-term after mine closure to prevent potential adverse environmental impacts to the natural environment.

Effects to the natural environment can be minimized by positioning overburden and mine rock stockpiles as close to the open pit as practical, and by developing higher stockpiles, thereby reducing the overall footprint. Potential acid rock drainage (ARD) concerns can be mitigated through segregation of the majority of the PAG mine rock by encapsulation to limit the potential for ARD development, and where necessary to capture and manage any drainage as described in Section 4.8. The anticipated affect on aquatic resources in overprinted creek systems can be mitigated through habitat compensation as described in Section 7.5.

Underground mining methods are therefore rated as preferred from a natural environment perspective, and combined open pit / underground mining and open pit mining are rated as acceptable.

**Minimize Effects to the Human Environment**

Open pit mining generates considerably more overburden and mine rock, and associated air and sound emissions compared with underground mining. The intrusive effects of open pit mining on local residents are therefore much more substantive. Measures available to mitigate air and sound emission effects include: stockpile positioning, water sprays and other methods for dust suppression, choice and positioning of heavy equipment, operations scheduling (daytime and night time operations), use of sound barriers and setbacks, and potentially other measures. Open pit mining also has a greater potential to affect fish and wildlife resources, as described above compared with underground mining.

Open pit mining, or open pit mining in combination with underground mining are the only economically viable methods for developing the RRP. Hence, use of either of these methods will result in employment and business opportunities that will benefit both the local and regional economies, whereas underground mining will not generate such benefits. The different mining methods are not expected to have any significant effect on health-related emissions, physical or cultural resources, or historical, archaeological, palaeontological or architectural features.

All alternatives are rated as acceptable from a socio-economic perspective, taking into account the positive and negative aspects of each alternative, and the varying perspectives that might be held on this topic.

**Amenability to Reclamation**

The underground mining methods are preferred from a reclamation perspective, as neither alternative has an appreciable effect on the surface environment that will require reclamation. The open pit will be reclaimed as a pit lake, and the overburden and mine rock stockpiles will be vegetated and returned to productive habitat on closure. As a portion of the stockpiled mine rock is predicted to be PAG, this portion of the mine rock will need to be managed in the long term after closure to prevent adverse environmental impacts to the natural environment including downstream receiving waters. Open pit mining is rated as acceptable with appropriate mitigation related to ARD. Mitigation measures are available and practical.

### 6.3.3 Summary Evaluation

Open pit mining of the low grade, high tonnage deposit supplemented with underground mining of high grade zones is the most cost-effective and technically viable alternative for the RRP, being rated as preferred in two performance categories and acceptable in the remaining three categories. Underground mining is acceptable when associated with open pit mining as a primary method; but underground mining on its own is not financially or technically viable and is rated as unacceptable. Open pit mining on its own is technically and financially viable, but is not optimal from either environmental or financial perspectives, and is rated as acceptable, achieving acceptable ratings in all five performance categories.

With the determination of the preferred means of mining, the method of ore (and mineral waste) transport can be assessed. The alternatives available for this type and scale of mining operation are truck transport and conveyor. The primary advantage of truck transport is flexibility and ability to transport within a less restrictive route as compared to conveyors, particularly over a relatively short distance. Conveyors require crushing at source in order to transport the rock and are restrictive in terms of routing, with often more maintenance needs if the routing has a large number of transfer / turning locations.

The choice of means of ore and mineral waste (overburden and mine rock) conveyance is essentially constrained by the design of the mine and the location of facilities (process plant and mineral waste stockpiles) that they are intended to service. For the RRP where PAG and non-potentially acid generating (NPAG) mine rock are proposed to be segregated within the mine, the number of conveyors required to access individual stockpiles by ore / mineral waste type, makes use of conveyors unattractive when a haul truck fleet and road access would be required to transport overburden. The overburden is too wet to be transported effectively by any means but truck haulage. Alternatives to ore and mineral waste conveyance are therefore not considered further.

### 6.4 Minewater Management

#### 6.4.1 Alternatives

Minewater that collects in the open pit and underground mine will contain suspended solids generated from blasting, and drilling and heavy equipment operation; trace metals such as copper associated mainly with suspended solids; ammonia residuals from the use of ammonia-based blasting agents; and potentially residual hydrocarbons from occasional hydraulic oil and fuel leaks from heavy equipment. This minewater will need to be collected and treated before it can be released to the environment. Minewater is typically collected in mine sumps (shallow excavations in the pit floor) to allow effective pumping and handling. Minewater is also an important component of the overall RRP site water balance, as described in Sections 4.5 and 4.12.3 (and Appendix W-1).

The most frequent minewater treatment methods include use of sumps (in pit or underground) to remove bulk suspended solids and residual hydrocarbons, followed by settling in surface ponds to remove suspended solids. Additional technologies such as silt curtains and flocculant can be used in association with sumps or ponds to assist the suspended solids settling process, especially where retention times are more limited (such as less than 10 days). Residual ammonia is most commonly managed by controlling ammonia at source through the selection and management of explosives use, and subsequently through natural degradation in extended aging ponds. Through natural degradation, ammonia is lost from the system through uptake as a nutrient by bacteria and algae and through volatilization to the atmosphere. Extended aging for ammonia removal typically takes several weeks during warm water conditions when growing conditions for bacteria and algae, and conditions for volatilization are optimal (Section 4.12).

The minewater management alternatives considered for the RRP after collection are therefore:

- Integrate minewater with tailings management area operations either directly or through process plant operations; or
- Develop a separate, dedicated minewater treatment and management system.

**Integrate Minewater Treatment with Site Water Management**

The RRP will require a number of site runoff and dedicated water management ponds (Figure 4-10). All of these ponds are required for site effluent and water supply management independent of minewater management needs (Section 4.12). As a result, it is possible to integrate minewater management with the proposed water management system without the need to construct additional treatment ponds.

Under an integrated approach, minewater will be pumped from the minewater collection sump(s) in the open pit and underground mine to the mine rock pond. Water from the mine rock including the integrated minewater will be used for processing. Tailings slurry resulting from the processing of ore will be directed to the cyanide destruction circuit for treatment before being piped to the tailings management area. Excess water in the mine rock pond not needed for processing, will be transferred to either the water management pond or tailings management area pond. As such, minewater will be discharged to the tailings management area either directly or by way of the process plant operations, and there will be no direct release of minewater to the environment.

The integrated site water management system will provide sufficient retention time for the settlement of suspended solids and any associated heavy metals, as well as for ammonia degradation / volatilization. Minewater will be mixed with all other water within the tailings management area with clarified excess waters discharged to the environment on meeting applicable regulatory requirements, as required to balance the overall system water inventory. Discharge to the environment is expected to occur principally during the fall and spring, and more sparingly at other times (Section 4.12).

The integrated site water management system requires a number of large ponds to ensure adequate water availability for processing at all times, and does not require any modification to contain and treat minewater. Minewater will be re-used in order to minimize the need for additional fresh water supply. There is also the potential to manage a portion of the minewater separately within the tailings management area (and hence still as part of the integrated site water management system) as a contingency as described in Section 4.12, if required to ensure that regulatory requirements can be met for discharge.

**Separate Minewater Pond System**

The other alternative identified is to construct a separate minewater pond system capable of providing extended open air aging for ammonia degradation / volatilization, and for suspended solids and residual hydrocarbon removal. The dedicated pond will discharge directly to the environment on meeting all regulatory requirements.

### 6.4.2 Performance Objectives and Evaluation

Performance objectives applicable to minewater management are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

The only additional costs associated with the integrated minewater management alternative will be for the pumping systems and pipelines required to transfer minewater to the mine rock pond; or to the tailings management area directly. Development of a separate minewater pond system will also require pumping systems and pipelines to collect and transfer water, including the ability to recycle minewater to the process plant. The dedicated ponds and infrastructure will result in substantive extra costs, in the order of several million dollars, without providing any improvement in minewater treatment or the quality of excess water. Use of the integrated minewater management alternative therefore confers a substantial cost advantage over the development and use of a separate minewater treatment pond system, without conferring any environmental limitation as per Appendix O and is preferred. The substantive costs associated with development and use of a separate minewater pond system cannot be justified, and the alternative is rated as unacceptable for cost-effectiveness.

**Technical Applicability and/or System Integrity and Reliability**

Both minewater management alternatives will be equally functional and reliable in terms of technical applicability and system reliability, and are both therefore rated as preferred for this attribute.

**Ability to Service the Site Effectively**

The only criterion applicable to this performance objective is accessibility (Appendix O). Use of the integrated minewater management alternative reduces land requirements, which generally require purchase from private land owners. Alternatives that reduce land requirements are therefore preferred. The integrated minewater management alternative requires less land and is therefore preferred. Use of a separate minewater pond system is rated as acceptable (Appendix O).

**Minimize Effects to the Natural Environment**

There is no difference in the quality of the excess water requiring discharge from the two systems assuming both systems were designed for equivalent retention time. Use of the integrated site water management system for minewater management avoids the need to construct a separate minewater treatment pond system which will unnecessarily expand the overall RRP footprint. Therefore, from a natural environment perspective the integrated system is preferred (Appendix O). Use of a separate minewater pond system is regarded as acceptable.

**Amenability to Reclamation**

The integrated site water management system will require reclamation at mine closure, irrespective of whether or not it is used for minewater management. Development of a separate minewater treatment pond system will add unnecessarily to mine reclamation requirements without providing any tangible overall benefit to the RRP. Use of an integrated site water management system for minewater management is preferred from the perspective of reclamation.

### 6.4.3 Summary Evaluation

The integrated site water management system will be fully capable of providing capacity for effective minewater treatment, irrespective of whether or not it receives minewater. Development of a separate minewater treatment pond system will add considerable and unnecessary costs to the RRP with no tangible technical or performance benefit. In addition, development of a separate minewater treatment pond system will substantively and unnecessarily increase the overall mine footprint, resulting in an unnecessary increased environmental effect for no measurable benefit. Use of the integrated site water management system for minewater treatment is therefore the preferred alternative. The alternative of constructing and operating a separate minewater system will pose an unnecessary environmental and cost burden to the RRP for no tangible benefit and is rated as unacceptable.

## 6.5 Mine Rock and Overburden Management

### 6.5.1 Alternatives

The RRP will generate an estimated 70 to 80 Mt of overburden and 350 to 400 Mt of mine rock over the life of the mine. Almost all of these waste materials will be generated by open pit mining. A significant portion of the mine rock (estimated at approximately 40%) is expected to be PAG and will have to be managed for ARD during operations and following mine closure. There is no single location on the RRP site where all mineral wastes can be reasonably managed. It is therefore proposed to place these materials in two separate locations, with one location being primarily for PAG materials and low grade ore, and the other being primarily for overburden and NPAG mine rock.

The most critical aspects to consider when selecting a suitable location(s) for mineral waste disposal are the following:

- Haul distance from the open pit;
- Property ownership;
- Distance to nearest receptors for sound control;
- Potential for runoff and seepage control;
- Effects on sensitive wildlife, particularly SAR;
- Effects on waters frequented by fish; and
- Effects on local access routes.

Haulage distance and associated cost is critical because of the very large quantity of mineral waste involved. Loading and dumping of materials is a base cost common to all alternatives, but there is also an added haulage cost per t/km distance. Even small haulage distance differentials can therefore amount to substantive cost differentials between alternatives. It is therefore critical that selected stockpile sites be located in close proximity to the open pit.

Property ownership is another critical consideration. RRR must hold surface rights (or options to obtain surface rights) for any selected sites. If the rights are not held or cannot reasonably be acquired for an alternative, then RRR will be unable to secure and utilize the location.

Distance to offsite receptors for sound control is also important. The hauling, dumping and management of stockpiled mineral materials with heavy equipment (principally haul trucks and bulldozers) is a significant source of sound emissions. These operations are carried out on the same frequency as the mining operation (24 hours per day, 7 days per week). Heavy equipment sound can project over distances in excess of 1 km, and are additive to other RRP sound sources such as drills and excavators used in the open pit. The MOE has strict guidelines for permissible sound levels at area receptors (permanent and temporary residents, and institutional facilities). For rural settings the guideline limits are 45 dBA during the day and 40 dBA at night. Meeting these values in a setting where there are a number of outlying residences is challenging. Where it cannot be demonstrated that sound guidelines can be met, the alternative will not be able to be approved.

A fourth critical aspect is potential for runoff and seepage control during operations and following closure. This is especially the case for PAG mine rock. Runoff and seepage from mineral waste stockpiles must be collected and managed in accordance with Metal Mining Effluent Regulation requirements, and site-specific Provincial environmental approvals. Sites which cannot reasonably be integrated into a site-wide water management system are less attractive.

Among the more important environmental aspects to consider aside from the general displacement of habitat, are potential effects on SAR and effects on aquatic habitat. A number of SAR wildlife species have been identified in the natural environment local study area (NLSA; Section 5.10.6), with whip-poor-will being the most sensitive and critical species as identified by the MNR. Bobolink and Barn Swallow are also Threatened SAR that could be affected. Fisheries and Oceans Canada (DFO) and Environment Canada (EC) also strongly encourage the protection of aquatic habitats that support fish, including minnow species, and strongly recommend that proponents make best efforts to develop mineral waste stockpiles which do not overprint waters frequented by fish. Where such avoidance is not reasonably practicable, listing of the affected waterbodies is required on Schedule 2 of the Metal Mining Effluent Regulation. This is a time consuming process and requires a prescribed method of alternatives assessment that goes beyond the assessment presented in this section. A copy of this alternatives assessment is provided as Appendix P (AMEC 2013k).

The final critical aspect to consider is effect on local infrastructure and most notably access for local residents. Where stockpile locations will block existing access, reasonable alternatives must be available to develop alternative access routes for local residents and services that do not inconvenience people or generate a safety risk.

The approved ToR provides for the following alternatives for the storage and management mine rock that cannot be re-used in construction:

- Place and manage the mine rock a stockpile adjacent or proximal to open pit;
- Develop an alternative mine rock storage and management plan; or
- Establish a temporary stockpile location, with mine rock retained in the open pit during operations and/or returned to the open pit at closure.

The available alternatives presented in the Provincially-approved Amended ToR for overburden storage and management for material that cannot be re-used in construction are:

- Place and manage the overburden adjacent to open pit;
- Develop an alternative overburden storage and management plan; and
- Establish a temporary stockpile location, with overburden retained in the open pit during operations and/or returned to the open pit at closure.

It is not feasible to retain overburden within the open pit during operations as such action would interfere with and essentially preclude mining operations. The overburden needs to be removed to access the ore. Temporarily stockpiling overburden and then placing the overburden back in the open pit is possible, but replacing any appreciable volume of materials back in the open pit at closure is cost prohibitive and is not considered herein. For further details on this aspect, see Section 6.18.1.

During the latter stages of open pit mining, it may be possible to retain some portion of the generated mine rock in mined out areas at the bottom of the pit, if these are available. The quantities of such material that can reasonably be retained in the pit will be comparatively small, and any such actions are better regarded as an optimization potential, rather than an alternative disposal method. The current design includes retention of approximately 30 Mt of NPAG mine rock in the open pit. The potential for placing mine rock back in the open pit at closure is also addressed in Section 6.18.1.

For the purposes of this assessment, it is assumed that two separate stockpile locations will be selected, and that each location should be capable of containing at least 200 Mt of mineral waste. One location will be primarily for PAG mine rock and ore, and the other for overburden and NPAG mine rock.

Following an initial screening of preliminary stockpile alternatives (Appendix P), five alternative stockpile locations were selected for detailed evaluation:

- Alternative A (Northwest Alternative) located to the immediate southwest of the proposed tailings management area;
- Alternative B (South Alternative) located directly south of the proposed open pit and south of the Pinewood River;
- Alternative C (Clark Creek Basin) located immediately east of the open pit;
- Alternative D (Northeast Alternative) located north of and slightly overlapping with Alternative C; and
- Alternative E (West Alternative) located immediately west of the open pit.

Alternative locations are shown in Figure 6-1.

Metal Mining Effluent Regulation Schedule 2 requirements necessitate that there be consideration of at least one stockpile alternative that does not overprint waters frequented by fish including minnow species, and where the use of waters can be seasonal. Alternatives A, B and D do not overprint waters frequented by fish.

**Alternative A (Northwest Alternative)**

Alternative A was selected as one of three sites that do not overprint aquatic habitat. The alternative is centred on the area immediately north of Dearlock and overprints the north-south portion of Highway 600, west of the RRP mine site. Alternative A encompasses a footprint of 717 ha. RRR has acquired surface rights or has options to acquire surface rights, to a substantive portion but not all of the Alternative A footprint.

**Alternative B (South Alternative)**

Alternative B was selected as a second site that does not overprint aquatic habitat. The alternative is centred on the area immediately west of the Black Hawk corner and overprints portions of Tait Road. This is the only alternative located on the south side of the Pinewood River. Alternative B has a footprint of 594 ha. The topography of this alternative is elevated in the central region which partially constrains its capacity. RRR has acquired surface rights or has options to acquire surface rights to a portion of the Alternative B footprint.

**Alternative C (Lower Clark Creek Basin)**

Alternative C (the Lower Clark Creek Basin) is positioned immediately east of the open pit. The alternative overprints a portion of lower Clark Creek and a local road (Clark Road). The lower portion of Clark Creek is a Municipal drain (Teeple Drain). Diversion of the upper portion of Clark Creek away from the stockpile and connecting south to a small Pinewood River tributary is required with this alternative. Alternative C encompasses a footprint of 375 ha and takes advantage of low valley topography, which facilitates efficient runoff and seepage collection. RRR has acquired surface rights or has options to acquire surface rights, to all of the Alternative C footprint.

**Alternative D (Northeast Alternative)**

Alternative D is positioned immediately north of Alternative C and does not overprint waters frequented by fish. This alternative is located further away from the open pit compared with Alternative C, and is located on a topographic high which constrains its capacity (as with all upland sites). This alternative blocks the proposed East Access Road which is intended to provide alternative access to local traffic using the Marr Road, as the current access to Marr Road will be severed by the open pit and process plant site development. Alternative D has a footprint of 612 ha. Its position at the top of the watershed divide will make runoff and seepage collection more difficult, as drainage is to four separate creek systems, one of which is outside of the Pinewood River watershed. RRR has acquired surface rights or has options to acquire surface rights to only portions of the Alternative D footprint.

**Alternative E (West Alternative)**

The west alternative is positioned immediately west of the open pit and is better suited to the stockpiling of overburden, as the main pit ramp will be located on the east side of the open pit nearest to the process plant. Alternative E encompasses a footprint of 399 ha and is entirely located on lands to which RRR has acquired surface rights or has options to acquire surface rights. The terrain associated with this alternative is relatively flat and it overlays the smallest of the local tributary creeks in the RRP site area, the lower reach of the Marr Creek / Cowser Drain.

### 6.5.2 Performance Objectives and Evaluation

Performance objectives applicable to overburden and mine rock storage alternatives are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

Cost-effectiveness is primarily a function of haul distance and risks relating to EA approval and other permits and approvals. Greater haul distances may also result in additional capital costs for haul trucks to ensure cycle times are maintained. The centroid of Alternative A is located approximately 9 km from the open pit, and is approximately 6.5 km further from the open pit compared with the closest available alternative. Transporting 200 Mt an extra 6.5 km would add approximately $78M to the overall project costs. Such a cost differential is not economically supportable. This alternative is therefore considered uneconomic.

Alternative B is located approximately 3.5 km from the open pit, and will therefore incur a cost differential relative to the closest alternative of approximately $12M over the mine life. Added to this cost would be the substantive costs of approximately $5M to construct a haul road crossing over the Pinewood River. This alternative does not involve the overprinting of waters frequented by fish, the stockpile location is too close to Black Hawk to allow compliance with MOE sound guidelines under any possible operating scenario, This alternative is consequently not able to be approved, and therefore will not receive financial backing by potential investors.

Alternatives C and E are both located in immediate proximity to the open pit, and therefore have the shortest haul distances and overall costs. Both alternatives also overprint waters frequented by fish, and will therefore require Metal Mining Effluent Regulation Schedule 2 listing to support full development. Such listing is time consuming, but sufficient portions of these stockpile areas are removed from waters that their use will not jeopardize the overall RRP schedule, and therefore would not entail a financial risk (assuming that a Schedule 2 listing can ultimately be obtained).

The centroid of Alternative D is located approximately 3.8 km from the open pit, such that use of this alternative will add approximately $16M in additional costs to the overall project. This cost differential is too high to be reasonably supportable. There will also be costs for additional property acquisition and the provision of access to Marr Road.

Based on the above, Alternatives C and E are preferred from a cost and project financing perspective, with Alternative C being most suited to mine rock stockpiling and Alternative E most suited to overburden stockpiling, because of their positions relative to the pit ramp. Alternatives A, B and D are rejected because of excessive costs and in the case of Alternative B also because of non-compliance with MOE sound emission requirements which will preclude project financing.

**Technical Applicability and/or System Integrity and Reliability**

All of the alternatives can be constructed technically, but Alternatives B, C and D are preferred on the basis of more favourable foundation conditions. Alternatives A and E are constructible but will likely require flatter slopes and more careful monitoring, and are regarded as being acceptable.

**Ability to Service the Site Effectively**

The ability to service the site effectively is a function of haulage distance; avoiding delays through the EA and associated permitting processes, and land acquisition and/or availability. As described above in association with costs and scheduling risks, increased haulage distance means that a larger truck fleet would be required to transport and dispose of the same quantity of material, as truck cycle times would increase.

Alternative A is the furthest removed from the open pit, and would therefore be the most difficult site from a haulage serving perspective. Alternatives B and D are also further removed from the open pit compared with Alternatives C and E.

From a permitting perspective, Alternatives C and E both overprint waters frequented by fish and would therefore require Metal Mining Effluent Regulation Schedule 2 listing. As long as Schedule 2 listings can be obtained within approximately ten months following completion of the Federal and Provincial EAs, this timeline would not interfere with RRP scheduling and operations. The Major Project Management Office agreement for the RRP has the completion of the Schedule 2 Amendment within eight months of a posting of the Minister of the Environment's Decision Statement on the Canadian Environmental Assessment Registry Internet Site (and potentially could be reduced by three months).

Alternatives C and E are both located on lands to which RRR has acquired surface rights, or has options to acquire surface rights. Alternatives A. B and D would all require further land acquisition, as RRR holds title, or options, to only portions of lands contained within the footprints of these three alternatives.

Taking all servicing aspects into consideration, Alternatives C and E are preferred, and Alternatives B and D are considered acceptable. Alternative A is rated as unacceptable because of excessive haul distance, which will require a much larger truck fleet, which will in turn aggravate sound and greenhouse gas emissions and other project aspects that could potentially affect mine site operational efficiencies.

**Effects to the Natural Environment**

This performance objective is associated with a large number of criteria and associated indicators. The principal differentiators between the alternatives relating to natural environment effects are those relating to greenhouse gas emissions, the overprinting of aquatic habitat and associated wetlands, and effects to SAR. Other considerations relate to the ability to meet air quality point of impingement standards and overall site water management.

Development of Alternative A will not overprint aquatic habitat or wetlands, and will have limited effect on SAR species. The major disadvantage with this alternative will be increased greenhouse gas emissions related to greater transport distance. Additional lands will also have to be acquired to meet air quality point of impingement standards.

Development of Alternative B will also not result in the overprinting of aquatic habitat or wetlands, and will have a limited effect on SAR species. There will be a small increase in greenhouse gas emissions with this option compared with alternatives located closer to the open pit. Alternative B will also require a haul road bridge crossing over the Pinewood River. Runoff and seepage from the Alternative B stockpile will be more difficult to integrate with other site water management operations because of its location on the opposite site of the Pinewood River. Additional lands will also need to be acquired to meet air quality point of impingement standards.

Alternatives C and E are closest to the open pit and will therefore generate the least quantity of greenhouse gases. Point of impingement air quality standards can also be met with either of these two alternatives without the need to acquire additional lands. The major limitations associated with these alternatives are that they overprint creek habitat. Development of Alternative C will also displace two known whip-poor-will territories, and six Bobolink territories (as approximately known). Whip-poor-will tend to be associated with forest edge habitats which can occur due to natural or anthropogenic influences. Bobolink are associated with agricultural grasslands (hayfields and range land). For comparison, Alternatives A and B will each displace one known whip-poor-will territory, and Alternatives D and E will not displace any known whip-poor-will territories.

Development of Alternative D will not overprint aquatic habitat or wetlands and will have limited, if any, effect on SAR species. There will be a small increase in greenhouse gas emissions with this alternative compared with alternatives closer to the open pit.

Overall, Alternatives B and D are rated as preferred for effects to the natural environment and Alternatives A, C and E are rated as acceptable.

**Minimize Effects to the Human Environment**

This performance objective is also associated with a large number of criteria (and associated indicators), among the more notable of which are: effects on local residents and especially sound effects, effects on local infrastructure / access roads, effects on local and regional employment and business opportunities and the regional economy, and effects on Aboriginal communities and members.

The primary limitation associated with the Alternative A is excessive haul distance, which will make the RRP uneconomic; hence employment, training and business opportunities that will otherwise derive from the RRP will not occur. In addition, development of the Alternative A will not allow compliance to be achieved with MOE sound guidelines at adjacent residences immediately south (Dearlock) and north of the site. Hence this alternative is not able to be approved unless RRR were to acquire these properties. At least one owner has indicated an unwillingness to sell. Use of Alternative A will also require the re-routing of Highway 600 a greater distance than otherwise proposed for the RRP development. This alternative is therefore unacceptable for a human environment perspective.

Alternative B is rejected from a human environment effects perspective, irrespective of any other attributes related to the human environment, because development of this alternative will not allow compliance with MOE sound guidelines to be achieved at Black Hawk area receptors. It will therefore not be possible to obtain approvals for this alternative unless the community of Black Hawk was purchased by RRR which is not practical. Alternative B is therefore rated unacceptable for the performance objective.

Alternatives C and E are both cost-effective and will support the RRP development, and associated employment and business opportunities. The potential for conflicts with local residents is limited with both alternatives, provided that stringent measures are implemented to control sound emissions. Modelling shows that with application of these and similar measures, MOE sound guidelines can be met. Alternatives C and E are therefore rated as preferred for the human environment performance objective.

Alternative D requires a longer haul distance and a higher stockpile. Alternative D is not as cost-effective as Alternatives C and E, and hence will not support RRP development and associated employment and business opportunities. Establishment of an alternative routing for the planned East Access Road can likely be addressed, but terrain and land ownership constraints may make this challenging. The potential for conflicts with local residents is limited, provided that stringent measures are implemented to control sound emissions. This alternative is rated as being unacceptable for the human environment performance objective.

Further details are presented in Appendix O.

**Amenability to Reclamation**

The critical aspect of amenability to reclamation for all alternatives is the long term management of stockpile ARD potentials, and the ability to develop a site-wide integrated water management plan both during operations and at closure. Considerable efforts have been made during development of the RRP site plan, to develop a site-wide water management strategy that will allow residual PAG stockpile drainage to be directed to the open pit at closure. This strategy will allow use of the pit lake for water management (Section 4.19). Alternative A is too far removed from the open pit to allow passive drainage to the pit. Alternative B is also not suitably located for this function as it is positioned on the opposite side of the Pinewood River. Both alternatives are therefore rejected for this performance objective.

Alternatives C and E are both located immediately adjacent to the open pit and can therefore readily be incorporated into a pit-centred, site-wide water management system at closure. These alternatives are therefore rated as preferred. Major portions, but not all of the drainage and seepage from Alternative D can be directed to the open pit at closure. Drainage outside of the Pinewood River will have to be pumped to the pit. This alternative is rated as acceptable.

### 6.5.3 Summary Evaluation

From an overall perspective, Alternatives C and E are rated as preferred for all performance objectives with the exception of effects to the natural environment which are assessed as acceptable, mainly because both alternatives overprint portions of small creek systems. Alternative C is most appropriate for PAG mine rock and low grade ore stockpiling and Alternative E is most appropriate for stockpiling overburden and NPAG mine rock primarily because of positioning related to the pit ramp. Alternative A is rejected as being cost prohibitive and because of disturbance effects to local residents (primarily sound effects). Alternative B is rejected outright because of an inability to comply with MOE sound guidelines at Black Hawk area receptors. This alternative is consequently not able to be approved. Alternative D is rejected because of costs, inability to service the site effectively, and because of access and closure limitations.

## 6.6 Processing

### 6.6.1 Alternatives

Various methods are theoretically available for liberating gold from gold-bearing ores, but only a limited number of alternatives are viable and proven at a commercial scale. Methods such as mercury amalgamation, aqua regia gold dissolution and ammonium thiosulphate (or thiosulfate) dissolution are not considered viable alternatives. The historic use of mercury amalgamation has caused serious environmental pollution concerns in some gold mining camps and is no longer used in the modern industry. Aqua regia is a mixture of concentrated hydrochloric and nitric acids which is commonly used in small scale operations for recovering gold from scrap metal and other such sources, but it is not a commercially viable method for recovering gold from large scale gold ore processing facilities. Thiosulphate-based gold recovery technologies are being investigated for gold ore processing; however, to date this and related technologies are not suitable, as per the following:

Marsden and House (2006):

> *Despite showing considerable promise, the development of an effective thiosulfate-based process remains elusive because of the high reagent consumption and costs (due to thiosulfate oxidation) and difficulties with metal recovery from the leach solution.*

Hilson and Monhemius (2006):

> *It is concluded that, in spite of the vociferous opposition to the use of cyanide in the gold mining industry by sections of the environmental movement, unless further research and development makes one or more of the alternative lixiviants [thiourea, thiosulphate, etc.] economically competitive, it will continue to be the only practical leach reagent in large-scale gold extraction processes.*

Other process modifiers are applicable to refractory ores, gold ores where a substantive portion of the gold is structurally bound to sulphides. By themselves, modifiers are not a complete process. These process modifiers include roasting, pressure oxidation and bioleach processes, all of which are designed to oxidize the sulphide matrices to liberate the attached gold to support further processing. The RRP ore is not refractory and therefore does not require the use of refractory gold process modifiers.

As a result, the only potentially applicable, commercially viable methods for recovering gold from RRP ores are cyanidation, gravity concentration and flotation concentration. Cyanide is one of the few chemicals that will dissolve gold from gold ores at commercial scale. Cyanide is combined with alkaline earth metals, typically sodium, potassium or calcium, with sodium cyanide being the typical reagent. Cyanide is toxic and its handling requires extreme care to protect both workers and the environment. Cyanide use is the industry standard for gold processing and safe procedures for cyanide handling and subsequent detoxification are well established.

Alternatives considered for RRP ore processing are the following:

- Whole ore cyanidation;
- Gravity recovery;
- Flotation concentrate recovery; and
- Combination of non-cyanide and cyanide recovery.

**Whole Ore Cyanidation**

Whole ore cyanidation refers to the process whereby the ore is crushed and ground prior to being leached with cyanide. Cyanide leaching can occur in vats, or it can be applied to crushed, stockpiled ore placed on large outdoor leach pads referred to as heap leaching. Heap leaching is almost always practiced in warmer climates such as in Nevada, and particularly for some ore types where gold is concentrated on surface fracture planes. This process has received limited, primarily experimental use in Canada and is not suited to cold climate environments. Vat leaching is common in Canada, is both better suited to the Canadian climate and also easier to manage from an environmental perspective.

In whole ore vat leaching, cyanide dissolves gold in accordance with the following reaction:

$$4Au^{o} + 8\ NaCN + 2\ H_2O = O_2 \rightarrow 4\ Na[Au(CN)_2] = 4\ NaOH$$

Sodium cyanide is stable in solution at pH values above 10. At lower pH values cyanide will begin to volatize to the atmosphere as cyanide gas. Lime is used in the leach circuit to maintain an elevated pH. Gold dissolved with cyanide is recovered by adsorption onto activated carbon. Process details for the RRP are described in Section 4.7.

Cyanide (CN) is comprised of one carbon (C) atom and one nitrogen (N) atom, and is inherently unstable (except at high pH) and is easily destroyed. For example, if cyanide solutions are discharged to tailings ponds, cyanide will volatilize to the atmosphere as low concentration cyanide gas (HCN). Once it enters the atmosphere, HCN will react with hydroxyl ($OH^-$) radicals and oxygen in the presence of sunlight (photolysis) through a series of reactions, to form carbon monoxide and nitrous oxide (Lary 2004). Cyanide is also easily oxidized (destroyed) by chemical means such as by sulphur dioxide addition to form the much less toxic compound cyanate (CNO). This is the process proposed for the RRP (Section 4.7). CNO will further degrade in tailings ponds to ammonia and carbon dioxide. The use of cyanide in ore processing is rigorously managed for worker safety using industry standard methods and protocols, and easily detoxified either within the process plant or through volatilization in tailings ponds, both as proposed for the RRP (Section 6.7).

**Gravity Recovery**

Gold has a very high specific gravity of 19.3 compared to the ore host rock which has a specific gravity of about 2.8. This gravity differential can be used to separate free gold from the host rock. To separate the free gold the ore is first crushed and ground to free up the gold particles. The ground ore in a water slurry is then passed over shaking tables or similar apparatus to concentrate the gold particles through gravity separation. Gravity separation is a common gold recovery method, and for some placer deposits can be used as the sole method for gold recovery. For more conventional hard rock gold mining, gravity separation is typically only capable of recovering a portion of the gold hosted in the ore. For the RRP, metallurgical testing has indicated that approximately 20 to 30% of the available gold can be recovered by gravity separation but even this material will need to undergo cyanidation of the gravity concentrate to form product.

**Flotation Concentrate Recovery**

Flotation concentrate recovery is a third method of gold recovery. This process involves crushing and grinding the ore to a very find grind (finer than that used for gravity concentration or whole ore cyanidation), followed by the use of flotation chemicals and air in a sequence of water vats, to preferentially float a gold-bearing sulphide concentrate. An amount in the order of 10 to 15% of the ore feed will typically be recovered as a gold-bearing flotation concentrate. Cyanidation is then required to separate the gold from the concentrate. Cyanidation can be accomplished onsite or offsite, depending on the availability of external processing sites and costs. Flotation concentrate production with offsite gold recovery is not commonly practiced except occasionally for some small scale operations where other larger nearby mills are available to receive custom ores and concentrates. AMEC is only aware of one such small scale operation in Ontario; the Aquarius Mine in Timmins which operated for a brief period during the late 1980s and early 1990s.

Power demands are high with the flotation concentration process, because of the need to achieve very fine grinds necessary for efficient flotation. The total amount of cyanide used to leach the flotation concentrate is often not that different from the total amount of cyanide needed to leach whole ore. In some cases the total amount of cyanide needed to leach the flotation concentration can be greater than that required to leach whole ore as is the case for the RRP.

An advantage of flotation concentration is that two types of tailings are produced: sulphide tailings and non-sulphide tailings. Where the whole ore is PAG, only the flotation concentrate portion of the tailings (which concentrates the sulphide minerals) will be PAG. The generation of PAG and NPAG tailings streams can facilitate a greater range of tailings management options for closure.

**Combination of Non-cyanide and Cyanide Recovery**

Combinations of recovery methods are commonly practiced within a single process plant in the mining industry. For example, gravity concentration is frequently coupled with cyanidation of all remaining ore and of the gravity concentrate itself. For simplicity, this process is herein referred to as gravity concentration coupled with whole ore cyanidation, since virtually all components of the ore feed and including the gravity concentrate are subject to cyanidation. Gravity concentration may also be used with flotation concentrate recovery followed by cyanidation of the concentrates. Extensive metallurgical testing is carried out to determine the best combination of methods that will achieve optimal recovery and costs. As gravity concentration is a comparatively low cost operation, it is almost always used in combination with whole ore cyanidation or flotation concentration, to improve overall gold recovery. Flotation concentration is essential for the processing of refractory ores, but its use with other ore types depends on the specific ore characteristics as to whether or not flotation concentration in combination with cyanidation will improve recovery economics.

### 6.6.2 Performance Objectives and Evaluation

Performance objectives applicable to ore processing alternatives are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives in tabular form is presented in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

Gravity concentration on its own will only allow for the recovery of approximately 20 to 30% of the gold hosted in the RRP ore, and is consequently uneconomic. Such recovery could not support RRP mining and development costs. Project specific test work has shown that gravity concentration in combination with flotation concentration recovery and cyanidation of the concentrates (gravity and flotation concentrates) will achieve an approximate 87.5% gold recovery. Test work of gravity concentration coupled with whole ore cyanidation yielded improved overall gold recoveries (92%) and lower overall production costs. The net life of mine cost differential between gravity concentration, in combination with flotation concentration recovery and cyanidation, and gravity concentration and whole ore cyanidation is approximately $300 million.

Use of the gravity concentration in combination with flotation concentration recovery and cyanidation alternative will confer some cost savings relative to final closure because of the separation of PAG and NPAG tailings; but any such saving will be a small fraction of approximately $300 million processing cost differential.

Gravity concentration and flotation concentration individually are uneconomic and are rated as unacceptable. The preferred alternative is a combination of non-cyanide and cyanide recovery (gravity concentration coupled with whole ore cyanidation). The other combined processing alternative of gravity concentration in combination with flotation concentration recovery and cyanidation is not cost competitive, offers no other major advantage that cannot be more effectively offset by other means, and is therefore also rated as unacceptable. It is possible to undertake whole ore cyanidation without gravity concentration but this alternative reduces project economics, and confers no advantage, environmental or otherwise. This alternative is therefore also rated as unacceptable from a cost perspective.

**Technical Applicability and/or System Integrity and Reliability**

All of the gold recovery methods described above and assessed in greater detail in Appendix O are technically sound and reliable methods, but gravity concentration and flotation concentration on their own cannot yield the required gold recoveries, and are considered unacceptable unless used in combination with cyanidation. Whole ore cyanidation and cyanidation in combination with gravity concentration and/or flotation concentration are preferred technologies.

**Effects to the Natural Environment**

Excess water will be treated to levels consistent with receiving water protection of aquatic life guidelines or scientifically defensible alternatives, irrespective of the ore processing alternative. Concentrations of parameters in ponds will also be maintained below wildlife toxicity thresholds, in addition to the tailings management area being fenced to prevent wildlife and human access. In the case of cyanidation, in-plant $SO_2$/Air treatment will be used to destroy cyanide before discharging the tailings slurry to the tailings management area. If required, additional effluent treatment could be used to control concentrations of neutral soluble metals that might be released from deposited tailings, notably zinc and cadmium. The potential for neutral soluble metal release from deposited tailings is common to all processing alternatives and is not influenced by cyanide use.

All ore processing alternatives are therefore rated as preferred for effects to the natural environment.

**Minimize Effects to the Human Environment**

Excess water will be treated to levels consistent with receiving water protection of aquatic life guidelines or scientifically defensible alternatives, irrespective of the ore processing alternative. Tailings pond waters and tailings seepage waters will meet all applicable health-related standards, irrespective of whether or not cyanide is used in ore processing. Tailings pond waters will be protective of wildlife. As such there will be no adverse effects to human health or to fish and wildlife resources, irrespective of the ore processing alternative.

**Amenability to Reclamation**

The primary consideration for reclamation related to ore processing is tailings management area reclamation. With the use of the cyanidation process, the treatment of tailings for cyanide destruction in the process plant will reduce cyanide and associated dissolved metals to low levels prior to discharge to the tailings management area. Therefore neither cyanide nor dissolved metals will pose a concern after operations with that process. With use of either gravity concentration or flotation concentration alone, cyanide and associated dissolved metals are not present in the tailings slurry and therefore have no relevance to closure.

The more important considerations in regards to closure are ARD and neutral metal leaching potentials. Neither of which are directly related to the use or non-use of cyanide. The ARD and neutral metal leaching potentials will be affected by the use of flotation concentration, as the process concentrates the sulphide minerals and any associated heavy metals in the smaller volume (10 to 15% by mass) flotation concentrate tailings. Generating a smaller volume of potentially ARD and metal leaching tailings will make this material easier to manage for reclamation purposes. Other suitable measures are however, available to manage tailings which have not been concentrated.

All alternative processing methods lend themselves to reclamation. The flotation concentrate alternative, presents closure opportunities which are preferable to those associated with other alternatives, and this alternative when used in combination with cyanidation is preferred. The other alternatives are rated acceptable.

### 6.6.3 Summary Evaluation

The preferred alternative is a combination of non-cyanide and cyanide recovery; namely gravity concentration coupled with whole ore cyanidation. The other combined processing alternative of gravity concentration, flotation concentration recovery and cyanidation, is not cost competitive, offers no other major advantage that cannot be more effectively offset by other means, and is therefore rated as unacceptable. Whole ore cyanidation can be completed without gravity concentration, but this alternative reduces project economics, without conferring any environmental or other advantage, and is therefore also rated as unacceptable. All processing alternatives can be suitably managed to protect the natural and human environments against risk.

## 6.7 Process Plant Effluent Management

### 6.7.1 Alternatives

Cyanide will be used in the RRP process plant for gold dissolution and recovery per standard industry practice (Sections 4.7 and 6.5). The effluent generated by this process will contain both free cyanide (cyanide that is not complexed with any other elements or compounds) and cyanide complexed with heavy metals (metallo-cyanide complexes), and will require treatment prior to release to the environment. Cyanide and metallo-cyanide complexes are inherently unstable and will degrade to simpler components under appropriate conditions. Rates of cyanide degradation can be forced or greatly accelerated by chemical oxidation and other means.

Tailings slurry from the process plant effluent will be directed to the tailings management area, where water will collect in the tailings pond for further treatment (aging). The majority of the water will be recycled back to the process plant. Excess water release to the environment will occur from the water management pond either directly to the Pinewood River by a pipeline discharge, and/or through a constructed wetland, depending on volume, season and condition (Section 4.12). The timing and rates of release of excess water to the environment will be a function of water quality and receiver assimilative capacity. Attaining low concentrations of cyanide and heavy metals is an integral part of the overall site water management function. In general, it is expected that excess water release to the environment will occur mainly during the fall and spring to take advantage of natural aging processes in the tailings pond and to maximize receiver assimilative capacity.

Proven alternative technologies considered for process plant effluent treatment include:

- In-plant cyanide destruction and heavy metal precipitation using the $SO_2$/Air treatment process, followed by natural degradation in the tailings management area;
- Process plant tailings slurry discharge to the tailings management area with use of natural degradation in the tailings management area pond as the sole means of cyanide destruction and heavy metal precipitation; and
- Process plant tailings slurry discharge to the tailings management area with use of natural degradation for the destruction of cyanide and the precipitation of heavy metals, coupled with hydrogen peroxide destruction of residual cyanide.

Other cyanide destruction and recovery technologies are also available, but the above methods are the most commonly used, are well proven at a commercial scale and are most applicable to the RRP.

**In-plant $SO_2$/Air Treatment Coupled with Natural Degradation**

In-plant $SO_2$/Air treatment involves the destruction of cyanide and metallo-cyanide complexes through oxidative processes, with cyanide being converted to cyanate, and metals liberated through cyanide oxidation being subsequently precipitated as insoluble metal hydroxides (Section 4.7). Cyanate formed through this process reacts with water (hydrolyzes) within the tailings pond to form ammonia and carbon dioxide. The $SO_2$/Air treatment process is a more costly alternative compared to the other options considered herein, but has the advantage of discharging a low strength cyanide solution to the tailings management area. Post-treatment total cyanide values in the order of 1 mg/L are attainable with this technology. The $SO_2$/Air treatment system has the additional advantage of being able to treat slurries, as opposed to just clear solutions. Metal hydroxide precipitates formed during the treatment process thereby have the opportunity to adsorb onto tailings solids, which improves their settling performance in the tailings management area. This adsorption process typically results in lower metals concentrations in the final effluent compared with that achieved using other treatment technologies considered herein. Post treatment effluent aging in the tailings management area pond further reduces residual cyanide and heavy metal concentrations in the final effluent.

**Natural Degradation**

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 cyanide and metallo-cyanide complexes will naturally break down to simpler compounds without the use of chemical reagents. The principal cyanide loss mechanism in natural degradation is volatilization of hydrogen cyanide gas to the atmosphere. Once hydrogen cyanide enters the atmosphere, it reacts with hydroxyl radicals and oxygen in the presence of sunlight (photolysis) through a series of reactions to form carbon monoxide and nitrous oxide (Lary 2004). Cyanide concentrations in the atmosphere generated by this process are too low to pose an environmental or heath risk. The removal of hydrogen cyanide from the system through volatilization causes a shift in metallo-cyanide complex equilibrium, liberating the metal ions previously bound to cyanide. The liberated metal ions in the tailings pond are then free to react with hydroxyl ions to form insoluble metal hydroxide precipitates, or to otherwise adsorb onto suspended or precipitated solids.

Natural degradation has been used successfully some Ontario gold mines where the process plant discharge is particularly suited to this treatment technology due to low concentrations of associated metals and especially nickel; and where sufficient effluent retention capacity is available for extended effluent aging and batch discharging. This includes at the Barrick Gold Holt-McDermott Mine located near Kirkland Lake.

**Natural Degradation Followed by Hydrogen Peroxide Oxidation**

Hydrogen peroxide oxidation treatment is similar in concept to $SO_2$/Air cyanide oxidation, except that hydrogen peroxide is used as the oxidizing agent to convert cyanide to cyanate. The hydrogen peroxide process can also be used to breakdown metallo-cyanide complexes, similar to the $SO_2$/Air process.

The hydrogen peroxide process has been shown to work well on clear solutions, but is generally much less effective on effluent tailings slurries discharged directly from the process plant. The result is that hydrogen peroxide is generally used in combination with natural degradation, where the tailings slurry is first discharged to a tailings management area and after the slurry solids have settled, the remaining clear solution is treated with hydrogen peroxide, often with a loss of a significant portion of the available cyanide through natural degradation during the intervening period. Weak acid dissociable metallo-cyanides are also removed with use of hydrogen peroxide.

### 6.7.2 Performance Objectives and Evaluation

Performance objectives applicable to process plant effluent treatment are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

Of the three treatment alternatives considered, the $SO_2$/Air treatment process on tailings slurry carries the highest operating costs. This is because cyanide and metallo-cyanide metal complex concentrations are greatest at the process plant, therefore requiring increased reagent use for cyanide destruction and heavy metal precipitation. This reagent cost differential is at least partially offset by reduced tailings dam storage requirements compared with that required to support the other two alternatives. Additional dam storage will be required for the other option due to the need for larger ponds and additional retention time. Equally or more important from a cost perspective, is consideration project financing and risk. Investors are increasingly risk averse particularly when it comes to environmental and approvals scheduling risk, and are therefore more inclined to support projects which employ progressive technologies which lower overall environmental risk so long as these technologies are financially viable. From a financial risk perspective, destroying cyanide in the process plant before discharge to the tailings management area presents the lowest overall environmental risk and is therefore the most attractive alternative to investors.

Natural degradation is the least costly treatment technology in terms of reagent costs, but typically requires increased effluent retention time for effective effluent treatment, which results in increased tailings dam costs. Seepage management costs are also higher with this alternative. Based on AMEC's experience, the use of natural degradation alone is also likely to be viewed by investors as not being a best available technology and therefore presenting a greater overall environmental risk. Lack of investor confidence can jeopardize overall project financing and scheduling.

Hydrogen peroxide treatment will be intermediate in costs between $SO_2$/Air and natural degradation effluent treatment, and would still carry environmental risks that may prove unattractive to investors.

Therefore, from an overall cost perspective, the $SO_2$/Air treatment process followed by extended effluent aging in the tailings management area and elevated levels of water recycling, is regarded as the preferred alternative, with the hydrogen peroxide treatment alternative being regarded as acceptable. Natural degradation on its own is unacceptable because of increase tailings management area capacity needs, and investor confidence risk.

**Technical Applicability and/or System Integrity and Reliability**

Each of the treatment technologies considered herein has the potential to break down cyanide and metallo-cyanide complexes and to precipitate heavy metals out of solution. The main technical considerations are: cyanide and heavy metal concentrations in the tailings pond, cyanide and dissolved metal concentrations in the tailings pore water, and excess water quality.

The only way to ensure low cyanide and metallo-cyanide complex concentrations in the tailings management area is to destroy these compounds in the process plant before they are discharged to the tailings management area. The $SO_2$/Air treatment process will achieve this result. In-plant treatment using the $SO_2$/Air treatment process will also minimize cyanide and dissolved metals concentrations in the tailings pore water, thereby improving tailings management area seepage quality. Use of the $SO_2$/Air treatment process is also expected to contribute to an overall superior final effluent quality compared with use of the other technologies considered. This is particularly important given that the Pinewood River is a comparatively small receiver, with restricted treated effluent assimilative capacity. In-plant cyanide destruction also provides the best protection against effects of a possible tailings dam failure, despite the very low probability of any such failure. The $SO_2$/Air treatment technology is therefore rated as preferred.

The other technologies are capable of destroying cyanide complexes, but carry more risk, particularly natural degradation when used on its own. Natural degradation coupled with the use of hydrogen peroxide treatment is rated as acceptable because it is capable of generating a superior effluent compared with natural degradation on its own, but still carries with it greater risk and liability associated with tailings pond and tailings pore water cyanide concentrations. Natural degradation used on its own is rated as unacceptable.

**Effects to the Natural Environment**

In-plant cyanide destruction using the $SO_2$/Air cyanide treatment technology is the best means of protecting the environment under all possible circumstances (wildlife protection from exposure to tailings ponds, improved seepage quality and improved final effluent quality) and is preferred. Natural degradation coupled with the use of hydrogen peroxide treatment is rated as acceptable, and use of natural degradation used on its own is rated as unacceptable (Appendix O).

**Effects to the Human Environment**

In-plant cyanide destruction using the $SO_2$/Air alternative is the best means of protecting receiving water fisheries resources and for minimizing adverse downstream effects in the event of a tailings dam failure; the probability of such an event being extremely low. Aboriginal people and local residents are anticipated to feel more comfortable with the $SO_2$/Air treatment alternative because it carries less environmental risk, including potential concerns about wildlife exposure to tailings pond water (tailings management area will be fenced), cyanide volatilization to the atmosphere, and tailings management area seepage quality and local well water use.

From a human use perspective the $SO_2$/Air treatment alternative is rated as preferred, and the other two alternatives are rated as acceptable.

**Amenability to Reclamation**

Use of in-plant cyanide destruction using the $SO_2$/Air cyanide oxidation technology will prevent the accumulation of cyanide and metallo-cyanide complexes in the tailings pore water, negating the need for long term seepage collection and water management for these compounds at closure. This technology is therefore rated as preferred. The other two technology alternatives are rated as acceptable.

### 6.7.3 Summary Evaluation

The preferred alternative is use of in-plant $SO_2$/Air treatment to reduce cyanide and associated heavy metals to low levels coming out of the process plant, followed by natural degradation (as a polishing step) to achieve further final effluent improvement. Use of this technology was considered superior for all performance objectives. Natural degradation on its own was rated as unacceptable for cost-effectiveness, technical applicability and/or system integrity and reliability, and effects to the natural environment, and was therefore given an overall unacceptable rating. The use of natural degradation coupled with hydrogen peroxide was rated as acceptable.

## 6.8 Tailings Management

### 6.8.1 Alternatives

The RRP will process an estimated 110 to 120 Mt of ore over the life of the mine. Rejects from this processing (tailings) will comprise the total of this weight, minus recovered gold and silver. The tailings slurry will be treated in the process plant to destroy cyanide and to render any associated dissolved heavy metals into solid phase, before being discharged to a fenced tailings management area for further effluent treatment (extended aging) and permanent storage of the tailings solids. Once in the tailings management area, the tailings solids will settle out a solids density of approximately 1.4 $t/m^3$, translating to a tailings solids volume of 83 $Mm^3$. These numbers are subject to change as the ore resource estimate evolves.

Test work has shown that the tailings have a neutralization potential ratio (NPR) of less than 1, and are therefore PAG (Section 5.5). The lag time to tailings ARD development is expected to be in the order of 25 years, such that tailings discharged to the tailings management area can remain safely exposed for a reasonable period, before having to be covered with fresh tailings to limit longer-term exposure to oxygen. At closure the final layer of tailings will be secured against long term oxygen exposure.

The tailings management area therefore has several functions, namely:

- Short and long term storage of tailings solids;
- Treatment and management of effluent, including provision for recycle of excess water to the process plant;
- Control ARD potentials; and
- Provision of plant and wildlife habitat at closure.

The standard method of tailings disposal for northern Ontario mining operations is permanent surface impoundment (tailings management area) surrounding as necessary within tailings dams to ensure containment. Tailings discharged to a tailings management area can be discharged at conventional densities in the range of 40 to 55% solids by weight; or they can be discharged as thickened tailings with solids contents upwards to 70% or more by weight. Thickened tailings deposition is used where there is an advantage to developing a steeper tailings beach, such as against a natural slope draining towards a downstream tailings dam. In such an instance, more tailings can be stored with less dam volume, as opposed to developing a flatter deposited tailings profile. The optimal strategy for PAG tailings is to deposit the tailings at a low gradient such that they can be more easily permanently water-covered at closure, to restrict oxygen exposure to the tailings preventing the development of ARD. The RRP tailings are PAG and the preferred strategy is to deposit the tailings at low gradient so that they can be flooded at closure. Thickening the tailings have additional costs, will be counterproductive for final closure and is not considered further.

Other possible tailings deposition strategies include utilizing the tailings underground as part of a paste backfill, or filtering the tailings within the process plant and trucking the tailings to a stockpile for permanent storage. The moisture content of filtered tailings is generally reduced to about 20% water by weight.

Underground disposal of tailings in paste backfill is helpful if such backfill is needed for underground structural support or if there is a comparatively small volume of ARD tailings that can be rendered non-reactive by placing them in an underground environment. Paste backfill is not proposed as a method of providing underground support at the RRP, and the volume of the underground workings will be too small to contain a meaningful quantity of tailings. Paste backfilling with tailings is therefore not proposed for the RRP and is not considered further.

The development and management of filtered tailings is a very expensive operation due to the power requirements. Use of filtered tailings are normally confined to use in hot, dry climates or to arctic environments where the water reclaimed from the tailings filter presses is needed because of a severe shortage of process water available in the natural environment. In hot, dry climates considerable volumes of water can be lost to evaporation with conventional tailings slurry disposal in tailings management areas. Filtering the tailings in the process plant avoids such losses. Similarly in arctic environments, a substantial portion of the free water discharged to a conventional tailings management area can be permanently locked up as ice, and therefore rendered unavailable for water recycle. Neither of these conditions apply to the RRP and the filtered tailings deposition option is not considered further.

The only viable tailings management alternative is disposal of non-thickened tailings to a conventional tailings management area. Conventional tailings management areas are constructed surface impoundments, contained by both natural topography (preferred) and tailings dams designed to contain both the tailings solids and the tailings liquid effluent. Even though the tailings at the RRP are treated in the process plant for cyanide destruction and heavy metal precipitation, additional effluent treatment benefits are achieved through further effluent aging in tailings ponds as described in Sections 4.12 and 6.7.

Tailings dams can be constructed with a variety of materials, with the most cost-effective strategy being to construct the dams with mineral wastes generated from mining, as opposed to developing separate aggregate pits or quarries. For open pit operations there is normally an abundant quantity of waste material (overburden and mine rock) from which the dams can be designed to be constructed. In the case of mine rock, it is important to generally use NPAG mine rock for the construction (PAG mine rock may be used in certain circumstances where it will not be exposed). For the RRP, the open pit is covered overburden of 25 to 45 m thickness of mainly clay and clay till. This material needs to be stripped from the open pit to expose the ore body and is therefore readily available as construction material. Much of the mine rock is NPAG especially within the upper southern portion of the open pit area is also available for tailings dam construction.

It is desirable to select a tailings management area site with as much natural containment as reasonably practicable to optimize tailings dam construction timing and costs, and to achieve maximum long term stability. This strategy frequently results in a trade off between cost effectiveness and long term dam stability, as compared to the protection of aquatic resources since low-lying areas in northern Ontario invariably host aquatic habitats that support fisheries resources. The overprinting of fish bearing waterbodies with mineral wastes including tailings is generally discouraged by the Metal Mining Effluent Regulation, and the use of such waters requires a Schedule 2 listing under the Regulation, which can be onerous and time consuming to obtain. Where a reasonable case can be made for developing a tailings management area that overprints fish bearing waters (defined as waters frequented by fish in the Regulation), such development is permissible with appropriate justification. A copy of the prescribed method of alternatives assessment needed to support a listing on Schedule 2 of the Metal Mining Effluent Regulation is provided as Appendix P (AMEC 2013k).

The approved ToR provides for the following tailings management area alternatives.

- Selection of a site immediately northwest of the open pit; and

- Selection of another, possibly more remote tailings site (and potentially on lands held by others).

Metal Mining Effluent Regulation Schedule 2 requirements necessitate the consideration of a broader range of tailings disposal alternatives, including various means of tailings disposal (such as thickened tailings, filtered tailings, use of tailings as backfill as described above), as well as consideration of the tailings management area that do not overprint waters frequented by fish, where fish are any type of fish including minnow species and where the use of waters can be seasonal.

In developing a set of tailings management area alternatives for detailed consideration, a number of preliminary options were considered. From these preliminary options, four alternatives were selected for assessment herein:

- Alternative A: Northwest Alternative;
- Alternative B: Loslo Creek Basin Alternative;

- Alternative C: Clark Creek Basin Alternative; and
- Alternative D: South Alternative.

Alternatives A and D do not overprint waters frequented by fish. The other two alternatives both overprint small creek systems. Descriptions of the four alternatives are presented below.

**Alternative A (Northwest Alternative)**

Alternative A was selected as one of two tailings management area sites that do not overprint aquatic habitat. The alternative is centred on the area immediately north of Dearlock (Figure 6-2) and overprints a north-south portion of Highway 600, west of the RRP mine site. Alternative A encompasses a footprint of 803 ha, and will require an approximate dam volume of 18.7 $Mm^3$ to contain 116 Mt of tailings plus provision for adequate freeboard. The maximum dam height associated with this alternative would be approximately 28 m. This alternative takes advantage of high ground along its north border, and is suited to the development of internal dams for separate water ponding and excess water management. RRR has acquired surface rights or has options to acquire surface rights, to a substantive portion of the Alternative A footprint.

**Alterative B (Loslo Creek Basin)**

Alternative B located in the Loslo Creek Basin, is positioned northwest of the open pit, and is located in closer proximity to the process plant site compared with Alternative A. Alternative B does not overprint any existing access roads or residences, but it does overprint the headwaters of Loslo Creek and Marr Creek. The alternative has a footprint of 912 ha and will require an approximate dam volume of 14.1 $Mm^3$ to contain 116 Mt of tailings. The maximum dam height associated with this alternative will be approximately 24 m. Similar to Alternative A, this alternative also takes advantage of high ground along its north border, and is suited to the development of internal dams for separate water ponding. The lower portion of Loslo Creek (Cowser Drain) is also well suited to the development of a constructed wetland that can be used to improve overall final effluent quality. RRR has acquired surface rights or has options to acquire surface rights, to the entire Alternative B footprint.

**Alternative C (Clark Creek Basin)**

Alternative C (the Clark Creek Basin) is positioned east of the open pit in very close proximity to the process plant complex. The alternative overprints Clark Creek, one local road (Clark Road), and a couple of residences, the title to which has already been acquired by RRR. Alternative C has a footprint of 858 ha, and will require an approximate dam volume of 25.9 $Mm^3$ to contain 116 Mt of tailings. The maximum dam height associated with this alternative will be approximately 41 m. Alternative C takes partial advantage of low valley topography provided by the Clark Creek basin. The site does not lend itself particularly well to the development of more than one internal pond for water management. RRR has acquired surface rights or has options to acquire surface rights, to portions of the Alternative C footprint.

**Alternative D (South Alternative)**

Alternative D was selected as a second site that does not overprint aquatic habitat. The alternative is centred on the area immediately west of the Black Hawk corner and overprints portions of Tait Road. This is the only alternative located on the south side of the Pinewood River. Use of this tailings alternative will therefore require a tailings line across the river. Alternative D covers an area of 594 ha, and will require an approximate dam volume of 32.7 $Mm^3$ to contain 116 Mt of tailings. The maximum dam height associated with this alternative will be approximately 28 m. Unlike the other three alternatives described above, Alternative D is unable to take advantage of any appreciable natural high ground, and will therefore require a complete ring dam. The topography of this alternative is also elevated in the central region, which constrains capacity. RRR has acquired surface rights or has options to acquire surface rights, to a small portion of the Alternative D footprint.

### 6.8.2 Performance Objectives and Evaluation

Performance objectives applicable to the tailings management area alternatives are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

Cost-effectiveness is a function of tailings storage to tailings dam fill ratios, and any associated risks having the potential to either delay construction, or result in a tailings management area arrangement that is difficult to obtain approval.

Tailings storage to dam fill ratios for Alternatives A, B, C and D are respectively 4.4:1, 5.8:1, 3.2:1 and 2.5:1. These ratios result in increased dam cost differentials of approximately $46M, $118M and $186M for Alternatives A, C and D respectively, compared with Alternative B. These costs do not include other costs which may be associated with the different alternatives such as provision for alternative access and land acquisition costs. A further important consideration is potential for expansion. Alternatives C and D are near their practical capacity limit and will be challenged to accommodate increased ore reserves should these be defined.

Associated risks that may potentially delay construction of a tailings management area alternative include: property acquisition, requirements for Metal Mining Effluent Regulation Schedule 2 listing and obtaining Provincial approvals. RRR holds title (or options) to all lands required for the development of Alternative B, and most of the lands required to develop Alternatives A and C. A lesser portion of the lands required to develop Alternative D is currently held (or optioned) by RRR. Whether or not the additional lands required to develop Alternatives A, C and D can reasonably be acquired is uncertain.

Metal Mining Effluent Regulation Schedule 2 listing requirements apply to tailings alternatives that overprint waters frequented by fish and *Fisheries Act* authorizations are also expected to be required. This requirement would apply to Alternatives B and C, but not to Alternatives A and D. The timing to obtain a Schedule 2 listing is not certain, but EC have indicated that approximately eight months to complete following Ministerial sign-off of the Federal EA. This schedule is adequate to accommodate the construction schedule for Alternative A because the water management pond required to accumulate an initial water inventory for process plant start for Alternative A can be developed within the southwest corner of the basin where there are no waters frequented by fish. Alternative C; however, contains no such area, and as such there is no area within the footprint of Alternative C that can be developed in advance of Schedule 2 listing for water inventory storage. This limitation will delay the RRP for a period of about eight months. Any such delay will be excessively costly and may jeopardize financing.

The major Provincial permits required for tailings management area construction and operation are an Environmental Compliance Approval from the MOE to manage and discharge industrial effluent, and a *Lakes and Rivers Improvement Act* approval to construct the tailings dams (Section 14, Table 14-2). The Pinewood River will be the final effluent receiving water. This receiver has limited assimilative capacity because it is a comparatively small system, perched within thick clay / clay till substrates and therefore has limited base flow. Even with the proposed treatment of the tailings slurry in the process plant to destroy cyanide and render heavy metals in solid phase for subsequent precipitation within the tailings management area, extended effluent retention will be required within the tailings management area to manage residual ammonia from blasting, cyanide breakdown products and other parameters; and to buffer effluent discharges in years when the assimilative capacity of the receiver is low. Alternatives A and B are well suited to providing such effluent storage potential. Alternative C is much more constrained in this function, and Alternative D faces very serious effluent retention potentials, and may therefore not be able to be approved.

The proximity of Alternatives A and D to the Dearlock and Black Hawk corners respectively, may also result in difficulties for obtaining environmental approvals. Alternative A also overprints Highway 600, which will require additional re-alignment at an approximate cost of about $8M.

The preferred alternative from a cost and scheduling perspective is Alternative B (located in the headwaters of the Loslo Creek Basin). This alternative has the most favourable tailings storage to dam fill ratio, is located entirely on lands held (or optioned) by RRR, is best able to accommodate anticipated Provincial environmental approval considerations, and can function with Metal Mining Effluent Regulation Schedule 2 listing requirements while maintaining the RRP construction and development schedule. Alternative A is unacceptable because of an unfavourable tailings storage to dam fill ratio, uncertainty over land title and proximity to Dearlock. The overall cost differential between Alternatives A and B, taking into account all factors (dam costs, highway re-alignment, additional land acquisition, and longer tailings lines) is in the order of $60M. Alternative C has even less favourable tailings storage to dam fill ratios, uncertainty over land title, effluent retention limitations and will have schedule delays due to the requirements to obtain Metal Mining Effluent Regulation Schedule 2 prior to water storage. This alternative is also consequently unacceptable from a cost and scheduling perspective. Alternative D has the most serious limitations of all alternatives, having extremely unfavourable tailings storage to dam fill ratios, the greatest limitations on capacity, probable difficulties with obtaining Provincial environmental approvals due to limited ability to store effluent and is in very close proximity to Black Hawk which is likely to raise public opposition. This alternative is also unacceptable from a cost and scheduling perspective.

**Technical Applicability and/or System Integrity and Reliability**

Alternatives C and D will require substantively higher average dam heights compared with Alternatives A and B, and are therefore less favoured from a technical applicability, and system integrity and reliability perspective. Alternatives A and B are rated as preferred for this performance objective, and Alternatives C and D rated as acceptable.

**Ability to Service the Site Effectively**

The ability to service the site effectively is a function of: avoiding delays through the EA and environmental approvals processes including potential delays relating to land acquisition, and the ability to generate an effluent capable of protecting the receiving water (the Pinewood River) and remaining in compliance with the Provincial approval once issued. Alternative B has the least risk associated with overall scheduling and is the most likely to generate excess water of a quality capable of suitably protecting the receiving water. There is some potential for schedule delay if the Metal Mining Effluent Regulation Schedule 2 listing for this alternative is delayed beyond the tentative timeline suggest by EC to date. Alternative B is therefore rated as acceptable for this performance objective and not preferred.

The other three alternatives are all rated as unacceptable for this performance objective, principally because they all face a strong potential for EA or environmental approval delays. The ability of Alternative D to achieve the required final effluent quality to adequately protect the receiving water is highly questionable, because of effluent retention capacity constraints. Alternative D also has severe tailings storage capacity constraints.

**Effects to the Natural Environment**

Effects to the natural environment considered a number of aspects as detailed in Appendix O. Among the more notable were: effects on fish and aquatic habitat, maintenance of provision of fish habitat, effects on wetlands and effects on Threatened SAR (notably Eastern Whip-poor-will).

Alternative A avoids effects on fish and fish habitat, is capable of generating a high quality effluent that will be fully protective of the receiving water, avoids effects to wetlands, and overlaps with only two isolated, individual SAR territories (one known whip-poor-will territory and one known Bobolink territory). This alternative was consequently rated as preferred for this performance objective.

Alternative B will displace the headwaters of Loslo Creek and Marr Creek and their associated beaver meadow wetlands, but has the greatest potential of the four alternatives for generating a high quality final effluent that will be fully protective of Pinewood River flows and water quality. Loslo Creek and Marr Creek are small systems that provide habitat for minnow species and are not suited to larger game fish such as Northern Pike (which were also not found in these systems during baseline studies). These systems frequently exhibit zero flow conditions during the summer and winter. The Alternative B footprint has been optimized through discussion with MNR to avoid overlap with all known whip-poor-will territories, but the alternative does overlap with a number of agricultural fields which contain Bobolink territories. Alternative B is rated as acceptable for this performance objective.

Alternative C was rated as unacceptable for this performance objective because it is questionable as to whether or not this alternative is capable of providing the extended effluent residence time necessary to achieve a final quality capable of fully protecting the Pinewood River. Alternative C also overprints Clark Creek and its associated beaver meadow wetlands, and a number of known whip-poor-will territories.

Alternative D is attractive in that it does not overprint aquatic habitat, wetlands or known Threatened SAR territories. This alternative is however, severely constrained in its potential to provide extended effluent retention, and is therefore unlikely to be able to generate a final effluent quality that would be protective of the receiving water. This alternative was therefore rated as unacceptable, irrespective of its performance regarding other criteria and indicators related to this performance objective.

**Minimize Effects to the Human Environment**

This performance objective is also associated with a large number of criteria and associated indicators. Among the more notable criteria are: effects on local residents; effects on local infrastructure (access roads); effects on local and regional, employment and business opportunities and the regional economy; and effects on Aboriginal communities and members.

Alternative A is considered unacceptable because it has an approximate $60M cost differential compared with Alternative B which does not support project development; hence the employment, training and business opportunities associated with the RRP will not be gained. The local area and region are facing challenging economic times because of the downturn in the forestry and tourism sectors. Economic benefits that will derive from the RRP are therefore much anticipated by a majority of local and regional, residents and business, by several area First Nations, and by the local municipalities. Further complications associated with Alternative A are its close proximity to Dearlock and the need to relocate Highway 600. Alternative A was rated as unacceptable for this performance objective.

Alternative B is the most favourable of the available alternatives from a human environment / socio-economic perspective. This alternative is the most economically viable of the tailings management area alternatives and carries the lowest overall project risk. It is therefore supportive of development of the RRP, and associated employment, training and business opportunities that will derive from the RRP. Alternative B is well removed from area residents and will have no adverse effect on local infrastructure. This alternative is therefore rated as preferred from the socio-economic perspective.

Alternative C is unacceptable from a cost perspective and therefore suffers from the same limitations as Alternative A with respect to overall project viability and the provision of employment, training and business opportunities. Metal Mining Effluent Regulation Schedule 2 limitations are also such that development of this alternative will delay the project for several months. This will have significant repercussions on project financing and on overall project viability. Alternative C is therefore rated as unacceptable for this performance objective.

Alternative D has severe cost and capacity constraints, is unlikely to be able to be approved (ability to demonstrate an acceptable final effluent quality) and is located on lands that will likely be difficult to obtain. This alternative will therefore not support development of the RRP; hence the employment, training and business opportunities potentially associated with the project will be received. Alternative D is also located in close proximity to Black Hawk, and is expected to be opposed by local residents, given the availability of other alternatives. For these and other reasons Alternative D is not supportable from a socio-economic perspective and is rated as unacceptable.

**Amenability to Reclamation**

The critical aspect of amenability to reclamation for all of the tailings management area alternatives is the long term management of tailings ARD potentials, as the tailings are PAG. The preferred strategy for managing tailings ARD potentials is to provide a permanent water cover at closure to limit oxygen contact with the tailings solids. If a complete water cover cannot be provided, then the alternative is to provide a water cover / low permeability cover, or low permeability cover alone. Covers are more expensive and are less effective for controlling oxygen exposure. Alternatives A and B lend themselves to development of a complete or partial water cover at closure and are rated as preferred. Alternatives C and D (and particularly D) are less suited to development of a water cover and will require more extensive soil covers, and are therefore rated as acceptable for this performance objective.

### 6.8.3 Summary Evaluation

Alternative B was selected primarily on the basis of costs and socio-economic factors, much of which are also related to cost and the ability of the RRP to move forward to create economic opportunities for the local area and the region. Alternative B (Loslo Creek Basin alternative) was rated as preferred from an overall perspective, achieving preferred ratings in four of the six performance categories and acceptable ratings in the remaining two categories.

Alternative B was rated as acceptable for environmental effects but Alternative A was rated as preferred from an environmental perspective. There is however, an expected difficulty in obtaining environmental approvals for Alternative A related to possible noise and perceived dust issues for adjacent residents in Dearlock. This could complicate obtaining a Provincial Environmental Compliance Approval (Air) and affect approval timelines. Approval complications may also arise over an additional re-alignment of Highway 600 required for Alternative A, when other reasonable alternatives requiring lesser re-alignments are available. In public meetings local citizens have stressed the importance of maintaining local access.

Alternatives A, C and D all received unacceptable ratings in three or more categories and were therefore rated as unacceptable overall.

## 6.9 Buildings, Facilities and Areas

Buildings, facilities and areas are herein defined to include:

- Process plant, primary crusher and coarse ore transfer house;
- Ancillary buildings (truck shop, warehouse, offices, etc.);
- Mine site roads and pipelines;
- Fuel storage and fuelling facilities;

- Explosives manufacturing facility and explosives magazines; and
- Electrical substation, diesel generators and onsite distribution system.

The process plant, primary crusher, coarse ore transfer house, ancillary buildings and electrical substation (and generators) are collectively referred to herein as the process plant complex. The fuel storage and fuelling station will also be contained within this complex.

Options for locating the majority of building and infrastructure facilities for the RRP are dictated by the positioning of the open pit, the tailings management area, mine rock and overburden stockpiles, and by geographic constraints (foundation conditions in the case of the process plant complex, and regulated separation distances in the case of explosives facilities). This section only considers alternatives to siting the process plant complex and explosives facilities. The positioning of connectors (mine site roads, pipelines and the onsite electrical distribution system) is essentially constrained by the location of facilities that they are intended to service. Alternatives to connector locations are therefore not considered.

The Project Description and the Provincially-approved Amended ToR provided for development of a permanent accommodations complex. An accommodations complex is not currently proposed as the operations workforce is expected to reside offsite in residential private housing. Alternatives for siting a permanent accommodations complex are therefore not considered.

### 6.9.1 Process Plant Complex

#### 6.9.1.1 Alternatives

Selection of a suitable process plant site for the RRP is constrained by the following factors:

- Proximity to the open pit for ease and economics of ore transport;
- Setback from open pit for blast fly rock protection;
- Foundation conditions; bedrock near surface for key facilities;
- Property boundaries and proximity to offsite receptors (local residences); and
- SAR sensitivities.

The optimal location for process plant facilities is as close to the open pit as practical, provided that competent bedrock is at or near surface to present a suitable foundation condition, and provided that there is a suitable setback of at least 500 m from the pit to minimize risk from blast fly rock. The process plant complex also needs to be sited on lands to which RRR has ownership, or which can reasonably be acquired, and which are sufficiently removed from offsite receptors for the control of offsite sound and air quality emission effects. Effects to SAR, notably Eastern Whip-poor-will, are also an important consideration.

There are no suitable bedrock outcrop (or subcrop) zones within close proximity to the north, west or south sides of the open pit. The closest such bedrock zones consist of small, isolated bedrock outcrop areas located approximately 1,200 m to the south-southeast and south-southwest of the open pit on the opposite side of the Pinewood River. These locations are too far from the pit, will require haul road crossings over the Pinewood River and will result in site drainage complications. Efforts are being made to keep all mine site facilities on the north side of the Pinewood River to assist with development of an integrated site-wide water management system and to help maintain a compact site footprint. Efforts are also being made to position facilities as far away from the rural centre of Black Hawk located to the south of the RRP site as reasonably practical to minimize potential sound effects to residents of this corner. Positioning the process plant complex on either of the small rock outcrop areas to the south of the open pit will not allow compliance to be achieved with MOE sound guidelines at Black Hawk residences.

Positioning the process plant complex on the east side of the open pit is therefore the only reasonable alternative, although it does require the re-routing of a minor drainage to West Creek.

The primary crusher is ideally positioned in an area of deep overburden immediately adjacent to a bedrock outcrop or subcrop zone. The coarse ore transfer house and plant site require bedrock foundations at or very near surface. These three features are also ideally positioned approximately 300 to 500 m from one another to allow for conveyor connections with suitable grade differentials. The currently proposed process plant complex sited to the immediate northeast of the open pit fits all of these requirements, and also positions the process plant complex well away from Black Hawk for better control of sound emissions.

The primary crusher is positioned approximately 600 m northeast of the open pit on the north side of a pronounced rock outcrop. The outcrop zone will host the ore feed stockpile. The deeper overburden zone adjacent to the north side of the rock outcrop is ideal for developing the primary crusher foundation and the conveyor pathway exiting from the crusher base. The crusher will be developed below grade and requires an excavation depth of approximately 15 m to develop the crusher foundation. A below grade location for the crusher is necessary to receive run of mine ore that will be dumped from surface into an underground hopper feeding the crusher. Overburden depths to bedrock bordering the north side of the rock outcrop average approximately 16 to 17 m, which is optimal.

Crushed ore from the primary crusher will be directed by conveyor to the crushed ore stockpile. This facility is ideally situated on bedrock or where bedrock is very close to surface, for concrete foundation development. Bedrock exposure is present at this site.

Crushed ore from the stockpile will be fed to the plant site. It is critical that the process plant foundations be developed on bedrock, to withstand vibration pressures from the secondary crushers and large rotating mills. The process plant site is positioned on a bedrock outcrop zone with scattered thin overburden to a maximum depth of about 2 m.

**Options for Shifting the Process Plant Location to Avoid Interference with Whip-poor-will**

The proposed process plant complex location intersects a known concentration area of whip-poor-will breeding territories, centred on Roen Road (Figure 6-3; Appendices K-1, K-2 and K-3). Shifting the process plant complex further to the west will not be helpful in avoiding whip-poor-will territories as there is an equal or greater concentration of whip-poor-will territories to the immediate west of the proposed process plant site complex. Shifting the process plant complex further to the west is also not be feasible from a process plant foundation perspective as there are no suitable bedrock outcrop / subcrop zones in this area. Geotechnical drilling in this area shows an overburden thickness in the order of 10 m just west of the plant site. Shifting the process plant complex further to the west will also place it within the blast fly rock risk zone.

Shifting the process plant complex to the immediate east will avoid known whip-poor-will territories, but areas to the immediate east of the plant site exhibit deeper overburden in the order of 6 to 8 m, which is not suitable for plant site foundations. There is a rock outcrop zone located about 500 m to the east of the proposed plant site, but this outcrop zone is on the property boundary with Bayfield Ventures Corp. RRR does not have surface rights to the Bayfield Ventures claims, and any process plant development in this area may potentially interfere with the ability of Bayfield Ventures to continue to explore and develop this property. The rock outcrop zone to the east has not been surveyed for whip-poor-will due access challenges, but habitats in this area are nearly identical to those of the proposed process plant site area. Consequently there is a reasonable probability that whip-poor-will may also occupy this location.

Shifting the process plant complex further north will also not be helpful from a whip-poor-will perspective, as there are a number of whip-poor-will territories to the immediate north of the proposed process plant location. Shifting the process plant complex to the north will also move the complex further away from the open pit, thereby increasing ore transport costs.

There is extensive rock outcropping slightly further to the south, in the area more directly east of the open pit, which can provide suitable foundations for a process plant site. RRR was only very recently able to acquire surface rights to this property (January 2013), and Bayfield Ventures still holds the mineral rights to this area. Without assurance that surface rights to this area can be obtained, it was not feasible for RRR to undertake the geotechnical and engineering studies necessary for process plant complex design in this area. More importantly, there is a known mid-depth ore zone on the Bayfield Ventures property. Blasting associated with development of this ore zone, were it to occur, will take place directly under the mill which is not be acceptable, as even slight offsets in foundation integrity can markedly affect mill tolerances. There is also a known whip-poor-will territory in this area which will be displaced by shifting the process plant complex further south. Finally, shifting the process plant complex to the south will aggravate sound emission effects to the residents of Black Hawk.

Consequently, there is no reasonable alternative position for the process plant complex that will allow avoidance of known whip-poor-will breeding territories. A SAR Net Benefit permit for displacement and disturbance to whip-poor-will will therefore be required for development of the process plant site and other RRP facilities. Discussions have been underway with the MNR in support of this aspect since late 2011.

#### 6.9.1.2 Performance Objectives and Evaluation

Based on process plant complex siting constraints defined above, there is no reasonable alternative to positioning of the process plant complex. The preferred options for the process plant complex and explosives facility are included in Appendix O for completeness.

#### 6.9.1.3 Summary Evaluation

The currently proposed site for the process plant complex is the only site which meets all of the site selection criteria, and there are no other reasonable alternative sites. The site positioned northeast of the open pit is therefore the preferred site. Other ancillary facilities, and the electrical substation, would be positioned as part of the process plant complex site.

### 6.9.2 Explosives Facility

#### 6.9.2.1 Alternatives

Explosives are required for blasting during open pit and underground operations, and potentially a limited quantity during the construction phase. Mining operations require a relatively large quantity of explosives on an ongoing basis throughout the life of the mine. The current projected explosives use is up to 48 tpd, based on an explosives consumption rate of 0.32 kg/t and a nominal ore and mine rock production rate of up to 150,000 tpd.

The siting of explosives facilities is prescribed by the Quantity Distance Principles User's Manual (NRCan 1995) and is dependent in part on the location of other site facilities. Alternatives for the provision of explosives to site are presented below.

**Offsite**

Existing explosives manufacturing facilities are located in Winnipeg, Manitoba and Thunder Bay, Ontario. Given the quantity of explosives required for the RRP, the transportation of the explosives required for the RRP will increase the truck traffic on the existing roads, therefore increasing the risk of traffic accidents and collisions with wildlife. In addition, the transport of explosives in large quantities is neither practical nor safe in comparison to manufacturing explosives onsite, from materials readily transportable individually. The cost of transportation will make this alternative uneconomic for the RRP. Based on these aspects, the provision of explosives from an offsite manufacturing facility was considered unacceptable and was therefore not considered further.

**Onsite**

It is common practice for mining operations the size of the RRP to manufacture explosives onsite. Similar to other site infrastructure, the location of the explosives manufacturing plant and the associated magazine storage facility is selected based on the location of other mine components. The location of the explosives plant and magazine is based on the following criteria:

- Safe operational setbacks in accordance with provisions of the Quantity Distance Principles User's Manual;
- Distance to the open pit and underground operation;
- Distance to traffic routes; and
- SAR sensitivities.

The current proposed location of the explosives plant and magazine storage area is due east of the tailings management area (Figure 4-1). This location is well removed from the principal RRP work site areas and from external residences for safety purposes, but sufficiently close to the open pit and underground workings so as not to involve the undue transport of manufactured product. The proposed location also avoids interference with known whip-poor-will territories.

The only available alternative for siting the explosives manufacturing facilities is a location west of the overburden stockpile. This location is almost twice as far from the open pit and is located within approximately 2 km of Dearlock, and is considered unacceptable.

#### 6.9.2.2 Performance Objectives and Evaluation

Based on explosives facility siting constraints defined above, there is no reasonable alternative to positioning of the facility. A detailed tabular assessment of alternatives utilizing methodologies, criteria and indicators developed in Section 6.2 is therefore not provided.

#### 6.9.2.3 Summary Evaluation

The preferred alternative for the provision of explosives is to have an onsite manufacturing plant and associated magazine area, with such facility to be located east of the tailings management area to ensure non-interference with other RRP facilities and traffic, and the safety of the general public.

## 6.10 Aggregates

### 6.10.1 Alternatives

Aggregates are required for concrete manufacture, tailings management area dam filter zones, road construction, development of laydown areas and other incidental needs. Aggregate materials required for these needs will consist of sand, gravel and crushed rock. The bulk of the tailings management area dams will be constructed with clay till derived from pit stripping overburden wastes, and for the purpose of this EA is not regarded as aggregate.

Aggregate materials (sand, gravel and crushed rock) can be obtained from NPAG mine rock, mine site area aggregate pits and quarries, and/or from offsite sources. Specific potential aggregate sources were not defined in the Provincially-approved Amended ToR, other than to state that the majority of aggregate required to develop the RRP will derive from NPAG mine rock, and other potential sources, possibly including commercial sources. As with some other alternatives assessed in this EA, the various potential alternative aggregate sources are not mutually exclusive, but instead can be complementary.

Major project aggregate needs are currently estimated as follows:

- Concrete manufacture: 56,000 t;
- Tailings management area and other dam filter zones and shell facings: 3,100,000 t;
- Highway 600 re-alignment: 280,000 t; and
- East Access Road: 80,000 t.

For tailings management area and other dam construction needs, the total quantity needed for initial construction is estimated at 1,350,000 t of aggregate.

**NPAG Mine Rock**

Where quarried rock is required for aggregate (either as granular or rock fill) the material of choice would be NPAG mine rock as this material will be removed and available in any event as part of mining operations. It is consequently more cost effective and environmentally responsible to use this material for construction, rather than to develop alternative quarry sites. Current mining plans provide for the removal of 2.4 Mt of NPAG rock during 2014 and 9.5 Mt during 2015. These quantities are more than adequate for the RRP construction aggregate needs. There may also be some functions where PAG rock is suitable for rock fill such as for the construction of internal haul roads within the overburden stockpile, but such uses are anticipated to be limited.

### Quarry Sources on RRP Lands

There are a number of rock outcrops on the main RRP property, east of the proposed open pit area and within the footprint of the proposed east mine rock stockpile that could be developed as local quarry sites to support mine site construction, such as the provision of granular material for concrete manufacture. Concrete has particular needs in terms of aggregate composition that may not be met by local NPAG.

There are also a small number of rock outcrop areas on lands to which RRR holds both mineral and surface rights or options for such rights, that could potentially be developed as local quarry sources for construction of the Highway 600 re-alignment and the East Access Road. Use of local quarry sources can significantly reduce traffic.

There are also extensive rock outcrops immediately east of the proposed tailings management area on lands for which RRR holds mining and surface rights, and which are accessible by Roen Road and Marr Road.

### Sand and Gravel Sources on RRP Lands

RRR currently holds title to a former Ministry of Transportation (MTO) sand and gravel pit located immediately north of the proposed open pit (Figure 4-1) within the identified whip-poor-will habitat area. It is expected that the RRR aggregate pit could potentially supply a substantial portion of aggregate materials required for concrete manufacture and early phase tailings management area dam filter zone construction, and possibly also for some road construction. The exact type and quantity of materials potentially available from this pit is still under investigation.

### Off Property Quarry Sources

There are extensive rock outcrop areas to the immediate north of the RRP lands, and elsewhere that could potentially be used to develop quarry sources for the RRP. There are no local commercial quarries.

### Off Property Sand and Gravel Sources

There are a number of off property sand and gravel sources and existing aggregate pits that could potentially supply aggregate to the RRP. The most accessible of these are a series of pits adjacent to Highway 71, located about 11 to 14 km north and northeast of the RRP; and a site located approximately 11 km directly east of the RRP (Figure 4-7).

### 6.10.2 Performance Objectives and Evaluation

Performance objectives applicable to aggregate source alternatives are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators developed in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

NPAG mine rock will be available as a mining waste suitable for most of the project's quarried rock needs. Re-use of this waste material is an industry standard and will avoid the need for additional quarry sites, except possibly for some types of concrete manufacture where local quarried rock may be more suitable. Separate locally quarried rock may be better suited for some types of concrete manufacture, and can potentially be taken from sites that will later be overprinted by mineral waste stockpiles, and therefore not contribute to an expanded mine footprint. Locally quarried rock is also better suited to construction of the Highway 600 re-alignment and the East Access Road because of closer proximity to the point of end use.

The primary disadvantage of the existing RRR aggregate pit is that known whip-poor-will territories overlap with the aggregate pit. A SAR Net Benefit permit will therefore be required, but will be required in any case for this area because of the proximity to other RRP infrastructure. Use of the existing aggregate pit is therefore not expected to add to RRP approval requirements, or affect Project timelines and investor confidence.

There are no apparent advantages to either of the offsite aggregate (quarry or sand and gravel) alternatives, excluding consideration of local quarries to support Highway 600 re-alignment and the East Access Road construction. Costs of offsite aggregate supplied will be higher because of longer haul distances, and there is greater potential for public concern resulting from use of public roads for haulage including considerable additional traffic, and hence a greater potential for approval delays.

Use of NPAG mine rock, quarry sources on the RRP lands and the existing RRR aggregate pit are all rated as preferred alternatives, with each having specific advantages for certain uses.

The two offsite alternatives are not preferred but may be acceptable, because of costs linked to longer haul distances and greater potential for public concern.

**Technical Applicability and/or System Integrity and Reliability**

All alternatives are comparable with regard to this performance objective, and all are rated as preferred.

**Ability to Service the Site Effectively**

The critical parameter associated with this performance objective is land tenure. The first three alternatives are all located or can be located, on lands to which RRR holds mining and surface rights, or on lands for which RRR holds options to obtain such rights. Potential offsite sources associated with the last two alternatives may or may not be potentially available, or may require contracts with existing pit and quarry operators to obtain the required resources. The first three alternatives are therefore rated as preferred, and the other two alternatives are rated as acceptable.

**Effects to the Natural Environment**

Use of the NPAG mine rock alternative will result in minor additional and temporary / intermittent air emissions associated with crushing (as needed). Otherwise this alternative will have no adverse environmental effects, and its use would have a small positive effect on reducing the total quantity of mine rock left on the site at closure, compared with bringing additional materials from outside sources. For quarry sources on RRP lands, the use of such resources will be most effective for construction of the Highway 600 re-alignment and the East Access Road because of shorter haul distances, and consequently reduced traffic and greenhouse gas emissions. Use of these sites would be short term and they will reclaimed progressively once no longer required.

For the RRR aggregate pit alternative, some additional disturbance would occur to whip-poor-will habitat, requiring a SAR permit. This permit will be part of a more comprehensive RRP site SAR Net Benefit permit.

Air emissions with the two offsite alternatives will be minor and of a temporary / intermittent nature, but there will be increased greenhouse gas emissions associated with longer haul distance. Minor habitat disturbance will be readily reclaimed.

Therefore from a natural environment perspective, the NPAG mine rock and quarry source on RRP land alternatives are rated as preferred, and the remaining three alternatives are rated as acceptable.

**Minimize Effects to the Human Environment**

The principal differentiating factor relating to effects to the human environment is the use of public roads for haulage associated with the aggregate property alternatives. There may be some public concern related to such use, when there are other available onsite alternatives, even if traffic levels remain below the road design capacity. A potential positive aspect to the use of offsite aggregate sources is the potential employment and business opportunities to offsite suppliers. The first three alternatives are therefore rated as preferred, and the other two alternatives are rated as acceptable.

**Amenability to Reclamation**

There are no substantive differences between any of the alternatives in terms of their amenability to reclamation. All alternatives are rated as preferred for this alternative.

### 6.10.3 Summary Evaluation

The NPAG mine rock alternative is rated as preferred for the production of aggregate for RRP site use because NPAG material will already be available as a mining waste product, within the appropriate timeframe (as long as it meets technical requirements). The only limitation to the use of this alternative is that crushing will be required which is an additional cost, and that the quality of NPAG rock may not be suitable for some types of concrete manufacture where there are strict tolerance limits. Other dedicated quarry sources on RRP lands are preferred for construction of the Highway 600 re-alignment and the East Access Road because of shorter haul distances, and potentially for some concrete manufacture where NPAG rock may not be suitable.

The only known commercial grade sand and gravel source within the general RRP site footprint area is the existing RRR aggregate pit. Volumes and types of material potentially available from this pit are still under investigation. The only disadvantage to the use of this aggregate source is that it overlaps with a small cluster of known whip-poor-will territories. Whip-poor-will is a SAR which is of particular interest including to the MNR (Section 5.10.6). For only this reason, the existing RRR sand and gravel pit was rated as acceptable rather than preferred. In this context it is noteworthy that a whip-poor-will SAR Net Benefit permit will be required for the RRP in any event, because the RRR aggregate pit is only one of several site facilities that will affect this species.

The two offsite alternatives are acceptable and not preferred, principally because of higher costs associated with transportation distances, and because of increased potential disturbance to local residents associated with additional trucking on local roads. On further investigation they may be found to be preferred from a technical perspective.

## 6.11 Water Supply

### 6.11.1 Alternatives

The annual average process plant water requirement will be 20,000 $m^3$/d (Section 4.7). An additional approximately 400 $m^3$/d of water will be lost through process plant evaporative processes. Of this approximate 20,400 $m^3$/d water consumption rate, a calculated 7,092 $m^3$/d (2,588,580 $m^3$/a) will be permanently stored within the tailings void space and will be lost from the integrated water management system. The remaining, nominal 13,308 $m^3$/d will be returned to the tailings management area as part of the site water inventory. In addition to process plant requirements, an estimated 260,000 $m^3$/a of water will be required for dust suppression, together with approximately 55,000 $m^3$/a for potable water needs. The total RRP water consumption rate is therefore calculated at approximately 3,000,000 $m^3$/a.

Project-generated water additions to the system will include minewater estimated at approximately 1,241,000 $m^3$/a (3,400 $m^3$/d) once steady state is reached in approximate Year 2 of operations and increased runoff associated with site development landform changes, estimated at approximately 1,890,000 $m^3$/a over the base case at full development (Year 15). Runoff values are for a developed catchment area of 21 $km^2$. The runoff coefficient increase corresponds to an average annual value of 0.41 for the fully developed condition compared with 0.028 for the predevelopment condition.

The annual water balance is summarized in Table 6-5 for the full development, mean annual average runoff condition. Values shown in Table 6-5 do not allow for the building of an initial water inventory in preparation for process plant start-up operations. The net calculated discharge of 4,231,000 $m^3$/a under these conditions exceeds the predevelopment runoff value of 4,095,000 $m^3$/a that would otherwise be generated by the 21 $km^2$ site catchment, resulting in a net positive flow contribution to the Pinewood River of approximately 136,000 $m^3$/a. Excess water not needed to balance the RRP water inventory will be discharged to the environment (Section 4.12).

The critical aspects of RRP water supply will be:

- Developing a sufficient water inventory for process plant start-up in 2016;
- Maintaining a sufficient water inventory entering the winter months that will provide an uninterrupted water supply source for process plant operations during this period; and
- Providing for process plant operations during extended drought periods.

Site water balance calculations show that a minimum water inventory of not less than 5 $Mm^3$ of water is required entering into the winter months to ensure an adequate water supply for process plant operations. This will vary somewhat depending on how the system is operated, including pond areas, losses to ice cover and the tailings deposition arrangement. The critical aspect will be ensuring sufficient water availability for the first winter (December 2016), assuming a mid-2016 process plant start-up date.

The RRP will be operated with extensive water recycling. Recycled water will make up virtually all of the water used in the process plant after start-up. The site water management system has been designed as an integrated system with process plant water deriving from a combination of tailings management area reclaim water (including water reclaimed from the water management pond), mine rock stockpile drainage water, and minewater pumped from open pit and underground (Section 4.12). This will limit water supply needs and associated environmental effects.

Alternatives considered for the RRP water supply are the following:

- Take water directly from the Pinewood River;
- Capture site drainage water (site runoff);
- Take water from other area watercourses, lakes and ponds; and
- Groundwater.

The quantity of water required from any of these sources will be minimized to the extent practicable by recycling from the integrated water management system including utilizing site contact water (precipitation and runoff that contacts site facilities and therefore requires collection and management).

**Take Water Directly from the Pinewood River**

The availability of water from the Pinewood River is a function of watershed area and per unit area runoff. Therefore to maximize the water taking potential and to minimize water taking effects, the water taking point should be positioned as far downstream on the river as reasonably practicable. Such a location will be downstream of the McCallum Creek outlet to the Pinewood River as this location will capture inflows to the river from both the Tait Creek and McCallum Creek catchments. The watershed area at that location on the Pinewood River is approximately 207 $km^2$ (Figure 5-6). The entire Pinewood River has a watershed area of 575.5 $km^2$. Annual runoff values calculated for the Pinewood River are 195 mm for the average annual condition, 66 mm for the 5th percentile annual condition, and 394 mm for the 95th percentile condition (Section 5.6).

To supply the average annual water needs of the RRP (approximately 3,000,000 $m^3$), an estimated 7.4% of the annual river flow, at McCallum Creek, will be required for the average annual 195 mm runoff condition; 22.0% for 5th percentile, 66 mm annual runoff condition; and

3.7% for the 95th percentile, 394 mm annual runoff condition. The Pinewood River downstream of McCallum Creek is therefore capable of supplying RRP water supply needs.

**Capture Site Drainage Water (Site Runoff)**

Proposed site facilities overlap with a number of small site watersheds, including Clark Creek / Teeple Drain (mine rock stockpile); West Creek (open pit and plant site); Marr Creek (overburden stockpile); and Loslo Creek / Cowser Drain (tailings management area, water discharge pond and the constructed wetland). Contact water from these catchments will need to be collected and treated, prior to release to the environment irrespective of RRP water needs. Together the portions of these small watersheds that will need to be managed comprise an area of approximately 21 $km^2$. All of these site watersheds drain to the Pinewood River.

Under natural conditions, a 21 $km^2$ watershed is capable of generating annual flows of approximately 4,095,000 $m^3$, 1,386,000 $m^3$ and 8,274,000 $m^3$ for the 195 mm, 66 mm and 394 mm runoff conditions, respectively. Calculated flow contributions from average and high runoff years exceed site water demands. The flow contribution from a 5th percentile, 66 mm runoff year, will be less than the site annual water demand, but could easily be accommodated through longer term water inventory averaging. However, as the site is developed, per unit area runoff contributions will gradually increase as described above, leading to increased site water yields. To optimize water supply from site area catchments, it will be necessary and advantageous from the environmental perspective to divert non-contact portions of the site catchment area away from runoff collection systems; namely portions of Clark Creek and West Creek systems. Such diversions generate a minimum site catchment area of approximately 21 $km^2$.

If average or above average annual runoff conditions were encountered during 2015 and 2016 leading to process plant start-up and the first winter of operations, then the 21 $km^2$ site catchment area would be more than capable of providing the required start-up water inventory. There would in fact be a water surplus under these conditions and for long term average runoff conditions. If, however, two 5th percentile low runoff years were to be encountered sequentially in 2015 and 2016, then the entire runoff volume from the 21 $km^2$ catchment would not be sufficient to generate the required start-up water inventory of not less than 5 $Mm^3$ to support process plant operations through the winter of 2016 / 2017. The probability of encountering two 5th percentile low runoff years in a row is low but could occur.

A critical consideration relating to the site runoff capture alternative is timing. Many of the site catchments required for the implementation of this alternative will require Metal Mining Effluent Regulation Schedule 2 listing to construct the catchment impoundments. Such listings are unlikely to be available until 2015.

**Other Area Watercourses, Lakes and Ponds**

The only other local surface waters with the capacity to supply RRP water needs reasonably proximal to the RRP site are Off Lake and Burditt Lake, both located to the northeast of the mine site. Off Lake is located approximately 12.5 km (20 km by road) northeast of the proposed plant site. Off Lake has a surface area of approximately 4.8 $km^2$ and a watershed area of 117 $km^2$. Burditt Lake is located slightly further to the northeast (about 5 km further by road from Off Lake), and has a surface area of 14.6 $km^2$ and a watershed area of approximately 437 $km^2$. Little Pine Lake and Boundary Lake are slightly closer, but these are smaller lakes with proportionately smaller watersheds. There are a comparatively large number of cottages and other recreational facilities located on Burditt and Off Lakes. Taking water from these lakes, especially during low flow years when it could be required at the RRP site, may therefore generate concern amongst local residents.

**Groundwater**

Groundwater well yields in the RRP site area are limited, but it may be possible to install a series of wells that could provide a combined yield of up to approximately 300 $m^3$/d, until such time as pit dewatering disrupted the groundwater source. A maximum 300 $m^3$/d water source is inadequate for meeting overall project water supply needs, but this water source could potentially assist with the provision of early stage, specialized water supply needs such as workforce potable water during the RRP construction phase and water for concrete manufacture.

**Combination of Water Taking Sources**

Opportunities exist for combined water supply sourcing, especially given potential timing constraints on the site drainage capture alternative, due to Metal Mining Effluent Regulation Schedule 2 listing requirements.

### 6.11.2 Performance Objectives and Evaluation

Performance objectives applicable to process plant make-up water supply alternatives are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

The capture and management of site area contact water (runoff) is required for tailings management area development, and to meet Federal (Metal Mining Effluent Regulation) and Provincial effluent management requirements. As a result, there would be no appreciable added cost to the RRP to capture and recycle process water from site area catchments to meet water supply requirements. Relying on site drainage runoff capture in the short term; however, is potentially problematic due to anticipated timing constraints related to Metal Mining Effluent Regulation Schedule 2 listing requirements, and potentially if extremely low runoff years were to be encountered during this period.

Developing a water intake on the Pinewood River just downstream of the McCallum Creek outlet has a cost, but the majority of the approximately 8 km pipeline route to this location is proposed in any event for final effluent discharge to maximize receiver assimilative capacity. Access costs are therefore already largely accounted for by other related infrastructure. The costs of installing additional pipelines and a pumping station will therefore be fairly modest.

Developing a pipeline to Off Lake or Burditt Lake will be more expensive than developing a pipeline to the Pinewood River downstream of the McCallum Creek outlet, particularly in regard to gaining pipeline access from local landowners if needed. Access to both locations would require an approximately 20 to 25 km pipeline to be constructed, preferentially along existing road alignments. The greater cost concern with the area lakes alternative is the potential for EA and permitting delays because of possible cottage and resort interests (Appendix O). Project delays are expensive and the added risk of any such delay, or associated EA and permitting uncertainty, may dissuade investors.

The preferred alternative from a cost and scheduling perspective is the capture of site drainage for ongoing steady state operations, together with the shorter term taking of water from the Pinewood River to build an initial water inventory to support process plant start-up requirements. Much of the infrastructure required for the capture and management of site runoff will be required in any event for site development and effluent management. Use of the Pinewood River as a temporary water source is needed to accommodate timing limitations related to Metal Mining Effluent Regulation Schedule 2 listing requirements which are expected to constrain the construction of some site facilities. Groundwater has the potential to help meet early construction needs. Taking water from area lakes is unacceptable because of longer pipeline requirements, and more importantly the potential for regulatory delays and added costs.

**Technical Applicability and/or System Integrity and Reliability**

All of the water supply alternatives considered herein are predictably effective and are commonly used in the industry, and are rated as preferred.

**Ability to Service the Site Effectively**

Site drainage water quantities are more than sufficient to meet RRP water demands once facilities are fully constructed, and when used in combination with extensive water recycle and development of a large tailings management area pond to offset dry years. The capture of site runoff is required in any event for site development and effluent management, so it makes sense to utilize this same water for ore processing and other site needs. Development of new sources which will only add to annualized average water surpluses and the need to release additional excess water to the receiver. Use of site drainage water is therefore the preferred alternative from the perspective of ability to service the site effectively.

The only major limitation to the site drainage capture alternative is timing constraints related to listing of a facility on Schedule 2 of the Metal Mining Effluent Regulation. An interim water supply alternative is therefore required to build a water inventory to support process plant start up. In the absence of an interim water source, site operations would likely be delayed by a year. Taking water from the Pinewood River is the preferred interim water source. Area lakes (Off and Burditt Lakes) are fully capable of providing for RRP water needs. Potential regulatory complications associated with the area lakes alternative make it questionable as to whether or not this alternative could supply water to the site in the short term, and this alternative is rejected. Groundwater supplies alone are inadequate for site water supply needs and can only function in a short term limited capacity.

**Effects to the Natural Environment**

Use of the site runoff capture and Pinewood River alternatives will confine the RRP footprint to the Pinewood River watershed. Use of the area lakes alternative (Off Lake or Burditt Lake) will unnecessarily extend the footprint to other watersheds beyond the Pinewood River.

A number of minor local site area watersheds (Clark Creek / Teeple Drain, Marr Creek and Loslo Creek / Cowser Drain) will be substantially overprinted as a result of mine infrastructure development (tailings management area and mineral stockpiles). West Creek will be retained in an altered state because of the need to divert this creek around the open pit. Additional adverse environmental effects to these systems as a result of runoff capture will therefore not occur, except to West Creek where a portion of the annual runoff will be taken to provide for potable and specialized water needs (Section 4.12). Capturing site runoff water will; however, have an effect on the Pinewood River as these catchments comprise part of the Pinewood River watershed.

Average annualized watershed losses to the Pinewood River due to RRP water supply demands (losses to tailings voids, process plant evaporative losses, dust suppression water) will be approximately 3,000,000 $m^3$/a. This loss will be substantively offset by minewater production and increased runoff enhancement resulting from site development (more developed areas will shed precipitation more effectively compared with native ground conditions) (Table 6-6).

While site development and operation will result in the above annualized changes to Pinewood River flows, the temporal distribution of treated effluent flow release to the Pinewood River will be governed in part by water quality treatment needs, and in part by the objective of maintaining or enhancing low flow conditions in the river for fish habitat protection. More specifically, it is envisioned that the bulk of the treated excess water released to the Pinewood River will occur during the months of April, May, October and November, with lesser releases occurring during June through September, and in December (and potentially early January). Major flow releases (April, May, October and November) will occur by pipeline to the Pinewood River downstream of the McCallum Creek outlet, unless water quality was sufficiently good to allow discharge at the Loslo Creek outlet to the Pinewood River (Appendix W-1).

The Pinewood River assimilative capacity is greater downstream of the McCallum Creek outlet (effective watershed area 186 $km^2$) compared with the Loslo Creek outlet (effective watershed area 85 $km^2$). The dominant treated effluent release will occur at the Loslo Creek area through the constructed wetland treatment system. The constructed wetland treatment system is expected to be able to handle flows up to about 10,000 $m^3$/d. The objective of this flow release will be to maintain flow conditions in the river to support fish habitat and fish movement. Further details on operation of effluent treatment works and associated effects on the Pinewood River are described in Section 7.6.

The net effect of the water taking associated with the site runoff capture alternative will be to maintain flow losses in the Pinewood River to within a modest percentage of natural flows under all flow conditions (as measured at the Loslo Creek outlet point), and to within a much smaller percentage loss further downstream (Table 6-7; Section 7.6). For the mean flow condition, the annualized flow loss calculated for the Pinewood River at the Loslo Creek outlet is approximately 8.01%. This value was calculated based on the percentage of the watershed from which site effluent will be captured and managed (21 $km^2$, or 19.8%), minus the effect of water flow returned to the Pinewood River through the wetland treatment system (2,440,000 $m^3$/a). Under drier conditions, the annual average flow loss at this point will be less than for the mean annual natural flow condition, except for the very early operation, because the annual release of treated effluent through the wetland will remain relatively higher from year to year, thereby generating a proportionally greater flow contribution to the river in low flow years (Table 6-7; Appendix W-1). Conversely, in high flow years the effect of effluent release through the wetland will be proportionately less. The net effect will be to better maintain Pinewood River low flows during low flow conditions (Section 7.6).

Taking water directly from the Pinewood River (downstream of the McCallum Creek outlet) will be additive to the capture of water from the local smaller creek catchments described above, in the sense that all such water takings will ultimately be from the Pinewood River system. Additive water taking directly from the Pinewood River will therefore further accentuate flow reductions in the Pinewood River and will not be necessary to maintain the RRP system water balance once a suitable tailings management area water inventory is developed. In essence taking more water from the Pinewood River will add excess water to the system inventory that will need to be discharged as treated effluent, given that the capture of water from the local watersheds is required for water quality management in any event. Taking water from the Pinewood River therefore offers no advantage over the site drainage capture alternative from an environmental perspective, during the period of ongoing mine operations.

The only time when taking water directly from the Pinewood River is advantageous from an environmental and project scheduling perspective, is to develop an initial water inventory to support process plant start-up (Section 4.12). Water takings for this purpose will be restricted to not more than 20% of the spring flow and to not more than 15% of river flows during the remaining open water period as measured just downstream of the Loslo Creek outlet (Section 4.12). There will be no direct water taking from the Pinewood River during the winter months. Available water volumes from the Pinewood River under average and varying low flow conditions are shown in Table 6-8.

Providing for RRP water needs by capturing water from site area drainages (Clark Creek / Teeple Drain, West Creek, Marr Creek and Loslo Creek / Cowser Drain watersheds) and from the Pinewood River, either directly or indirectly, will result in the disruption or loss of fish habitat associated with these systems. Such disruption or loss will require fish habitat compensation in accordance with DFO no net loss fish habitat policies (Sections 7.5 and 7.6).

Taking water from area lakes (Off Lake and/or Burditt Lakes) will satisfy the RRP water requirements, but as with the Pinewood River water supply alternative described above, there will be no material advantage to such takings from an environmental perspective as the capture of water from local site drainages is required for water quality management in any event. Adding additional water to the system from these external sources will therefore simply add to the inventory of site water that will need to be released as treated effluent. The construction of infrastructure to take water from these further removed sources will therefore add to the RRP environmental footprint without conferring a material advantage and therefore cannot be justified from an environmental perspective.

Taking water from site area drainages and/or the Pinewood River in preparation for process plant start-up is the preferred alternative from an environmental perspective. Taking water from area lakes is rated unacceptable. The taking of water from groundwater sources is effectively non-applicable.

**Minimize Effects to the Human Environment**

The taking of water from site area catchments, directly from the Pinewood River, or a combination of the two, will affect Pinewood River flows as described above. There is consequently a small potential to reduce water availability to downstream users during the period of early operations. Currently, no such users are known to RRR. Taking water from area catchments and/or directly from the Pinewood River at the rates proposed will not be expected to adversely affect the navigability of the Pinewood River, as upstream areas above McCallum Creek are effectively only navigable by light weight vessels, such as canoes because of the frequency of beaver dams; and because downstream areas will be only be minimally affected (Section 7.6). Fishing for Northern Pike in the Pinewood River is not expected to be affected by the anticipated short term localized flow reductions, as only limited adverse effects to Pike spawning and recruitment will be expected and then only low flow years. Proposed habitat compensation measures will offset any such effects (Section 7.6).

Adverse human environment effects associated with taking water from area lakes (Off Lake or Burditt Lake) will be mainly associated with road travel interference during installation of the water pipelines. Once the pipelines were installed, the only other possible adverse effect to other users will be the perception of water taking for users of Off Lake or Burditt Lake and possible sound emissions from a diesel pump station. Sound emissions could be mitigated through shielding. Taking water from area lakes has a high potential for project delays, and therefore an adverse effect (delay) on employment and business opportunities related to the RRP.

**Amenability to Reclamation**

All of the alternative measures considered herein lend themselves to easy reclamation. Slightly greater efforts will be required to reclaim the pipelines to area lakes. From a project perspective, all alternatives are rated as preferred, since reclamation efforts in all instances will be regarded as requiring limited reclamation.

### 6.11.3 Summary Evaluation

The preferred water supply alternative is capture of runoff from site area watersheds in combination with supplementation by direct water taking from the Pinewood River to build an initial water inventory to support the start of processing. The capture of runoff from the majority of site area catchments is required in any event for tailings management area construction and for mineral stockpile runoff management, such that the added costs and environmental effects of using this water for processing are minimal. Taking water directly from the Pinewood River is preferred for assistance in developing an initial water inventory until Metal Mining Effluent Regulation Schedule 2 listings allow for full site infrastructure development. Taking water from area lakes (Off Lake and/or Burditt Lake) is considered unacceptable for reasons relating to cost, ability to service the site and human environment effects, and confers no environmental advantage compared with other alternatives. The use of groundwater is recommended for the initial supply of potable water and to support early construction operations, but is otherwise consider unacceptable as a primary water source due to severe capacity constraints.

## 6.12 Site Water Management

Site water management is a function of the site layout and other specific water management activities related to mining, mine rock and overburden stockpile placement, process plant effluent, tailings management and water supply. The primary objectives of the water management system are to generate a reliable water source for process plant operations, and to optimize the quality and quantity of site effluent released to the environment so as to meet applicable regulatory requirements and guidelines. An integrated and adaptable water management system is required to achieve these objectives in a sustained and responsive manner. Given this context, there are no site water management alternatives in the general sense of alternatives assessed elsewhere in this document. Rather, an integrated and flexible water management system has been developed to meet the RRP and environmental needs, as described in Section 4.12. This system will be further optimized during site operations.

## 6.13 Solid Waste Management

### 6.13.1 Alternatives

#### Hazardous Solid Waste

Hazardous solid waste will be shipped off site to a licensed landfill or other facility approved to receive such wastes. Hydrocarbon affected soils could potentially be remediated on site using approved methodologies which have demonstrated effectiveness. This will be assessed during future engineering investigations. Both of these alternatives will be described in the EA.

No onsite alternatives (such as development of an onsite hazardous waste landfill) are considered acceptable to RRR and meet the RRR identification criteria for alternatives. Specifically, the potential negative effects on the natural and human environment are considered unacceptable when compared with transporting the material to an existing hazardous waste management facility, particularly given the relatively low quantity expected to be generated. As such, development of an onsite hazardous waste management system is not considered further. It is also very unlikely that such a site could be approved for the RRP given the severe constraints for these types of facilities.

#### Non-Hazardous Solid Waste

Non-hazardous solid waste includes the day-to-day waste that will be disposed of during the project construction, operations and closure phases, but excludes demolition wastes associated with mine closure.

Alternatives considered for the management of non-hazardous solid wastes include:

- Truck waste offsite to a Township of Chapple landfill;
- Truck waste offsite to another alternate existing licensed landfill; or
- Develop an onsite landfill.

Use of an incinerator was not considered as the alternative is too costly and this alternative produces air emissions which could be difficult to mitigate, reducing the likelihood of meeting the air quality environmental compliance criteria.

**Truck Waste Offsite to the Township of Chapple Landfill**

Solid wastes from the exploration program are currently trucked offsite to a Township of Chapple landfill. 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 already receives industrial waste, to accommodate the construction and operation phase wastes from the RRP under existing approvals, while still maintaining availability for other users for nearly twenty years based on current usage rates.

For this alternative, the solid waste will be trucked from the site to the Township of Chapple Shenston landfill which is located approximately 21 km (by road) south-southwest of the RRP site. The transportation of the waste will likely be contracted to a local business. Operation and closure of the landfill will be carried out by the current landfill operator using fees generated from tipping charges.

**Truck Waste Offsite to another Existing Landfill**

Similar to the Township of Chapple alternative, the solid waste will be transported by trucks to another offsite licensed facility which has not currently been identified. It is assumed that this existing landfill will likely not have capacity for the RRP waste disposal needs and will therefore require an expansion.

**Develop an Onsite Landfill**

A landfill could be developed north of the tailings management area, such that runoff and leachate from the facility would drain to the tailings management area. Existing information is expected to be supportive of progressing environmental approvals should the alternative of developing an onsite landfill site be preferred which is not currently expected. An onsite landfill will be operated and closed by RRR in accordance with applicable Provincial regulations and guidelines.

### 6.13.2 Performance Objectives and Evaluation

Performance objectives applicable to non-hazardous solid waste disposal are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize the results of the detailed assessment.

**Cost-effectiveness**

The design, development and cost of an onsite landfill facility along with the requirement for long term monitoring and potential closure liabilities make this alternative less attractive from a cost-effectiveness and liability perspective.

Both offsite facilities will be more advantageous from a cost-effectiveness and liability perspective, by allowing the post-closure monitoring and closure liabilities to be passed on to the landfill facility operator. Given the existing relationship with the Township of Chapple landfill, this alternative is preferred. RRR will accept its share of any long term liabilities associated with offsite facilities through contractual arrangements with the site operators.

**Technical Applicability and/or System Integrity and Reliability**

All three alternatives use similar technologies. Alternatively, it is likely that the offsite options have a recycling option, which will not exist at the onsite landfill. Therefore, both offsite landfill alternatives are preferred over the onsite landfill alternative.

**Ability to Service the Site Effectively**

All three alternatives can service the site effectively. The main potential risk for the offsite alternatives is for a strike of the transportation company or the landfill facility operator, which will create a temporary disruption in service.

Depending on the onsite landfill location, additional roads or road upgrades may be required in order to provide adequate access to and from the landfill facility.

Taking these factors into consideration, the onsite landfill facility will be preferred as it mitigates potential risks of service disruption.

**Effects to the Natural Environment**

Wastes will be landfilled irrespective of the landfill location. Disposal of solid wastes within an existing landfill will be the preferred solution from the perspective that it will likely require less land area and will be less intrusive overall, compared with developing a new site.

Relative to offsite disposal alternatives, the onsite landfill will be preferred as air emissions and greenhouse gas emissions from fuel consumption to transport the wastes to Township of Chapple landfill (or other off site landfill) although limited, can be avoided. All three alternatives are deemed as equally acceptable.

**Effects to the Human Environment**

Based on the assessment completed by an independent consultant (Smart 2013a,b) and described in Section 4.14, there is sufficient capacity at the Shenston Township of Chapple landfill, such that no adverse effects are predicted on the serviceability of existing landfills to other users. It is likely that the offsite alternatives will allow for more opportunities for local businesses to offer their services and create a positive economic effect.

**Amenability to Reclamation**

From a closure perspective, offsite disposal to a licensed landfill is the preferred alternative, since this will not involve further project site closure liabilities or considerations. These liabilities are considered in the cost-effectiveness section.

From a broader closure perspective, irrespective of location (since closure and long term monitoring of landfills is required irrespective of whether or not they are linked to mine sites or mine site activities), use or expansion of an existing landfill site will be preferred, as opposed to development of a new site.

### 6.13.3 Summary Evaluation

The preferred alternative is to use the existing Township of Chapple Shenston landfill. This alternative is more economic, will continue an existing relationship with the Township of Chapple, will not infringe on other users of offsite landfills and will be environmentally responsive.

## 6.14 Domestic Sewage Management

### 6.14.1 Alternatives

There are no plans to establish either a construction camp or a permanent camp, to support the RRP. There will; however, be a need to manage and treat domestic sewage from the onsite workforce, during both the construction and operation phase of the RRP, as well as during the active phase of decommissioning. While there are no plans for a general construction camp, it is possible that some contractors may wish to house at least a portion of their construction workforce at site for brief periods of time. Consequently, domestic sewage treatment facilities will be required for a maximum of 500 onsite workers.

The alternatives considered for domestic sewage treatment at the RRP site include:

- Septic tank(s) and tile field(s);
- Package sewage treatment plant; and
- Offsite treatment.

**Septic Tank(s) and Tile Field(s)**

The septic tank(s) and tile field(s) system alternative consists of buried holding tanks into which sewage is pumped (or fed by gravity) allowing solids to settle. Clarified liquid then flows to a set of buried permeable pipes (the tile field) enabling the liquid to permeate into the soil over a broad area. Bacterial processes within the ground surrounding the tile field act to breakdown elements in the liquid to safe levels. Sewage solids are periodically removed from the septic tank(s). Tile fields are optimally developed in coarse soils such as sandy loams. Where clay and clay-till soils area present (such as the RRP site) and the system is expected to be subject to heavy loadings, it is preferable to construct tile fields with imported sandy materials. Sufficient setbacks must be in place to avoid potential damage to area watercourses and potable groundwater sources. Septic tank and tile field systems are generally used for smaller scale applications such as rural housing or remote applications, but may also be used at commercial scales in rural settings for facilities such as motels, schools, campgrounds, logging camps, and small scale mining operations.

**Package Sewage Treatment Plant**

The package sewage treatment plant consists of a pre-engineered and pre-fabricated modular system to treat wastewater. The design is such that the final effluent of this treatment can be released directly to the environment. The second product is a sludge which is often disposed of in the tailings management area or trucked to a landfill. The package sewage treatment plant may be a rotating biological contactor, sequencing batch reactor, or membrane bioreactor. Each of these is briefly described below.

Rotating biological contactors consist of a series of vertical discs connected to a shaft which rotates the discs through a bath of wastewater. The discs develop a microorganism organic film which acts to remove (consume) organic materials through aerobic digestion. The slow rotation of the discs alternately contacts the biomass microorganism film with the wastewater and the air, enhancing bacterial action.

Sequencing batch reactor systems involve the use of two identically equipped tanks serviced by a common inlet, with one tank actively receiving sewage influent while the other is idle. Treatment involves five steps: fill, react, settle, decant and idle. Aeration to support aerobic bacterial action occurs in the first two stages; whereas anaerobic and aerobic bacteria both function in the settling stage. Sludge is removed to a digester for further treatment.

Membrane bioreactor plants also use both aerobic and anaerobic bacteria action to breakdown organic matter. After these steps, the treated effluent is passed through a set of membrane filters to remove suspended solids and other materials. Sludge is periodically removed to a digester.

**Offsite Treatment**

Offsite treatment of sewage during operation will require storage in tanks onsite and trucking of raw sewage to a local sewage treatment plant by a third party. This alternative is also considered to be an option.

### 6.14.2 Performance Objectives and Evaluation

Performance objectives applicable to domestic sewage treatment are:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects to the natural environment; and
- Effects to the human environment.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize the results of the detailed assessment.

**Cost-effectiveness**

Passive treatment system, septic tanks and tile fields are the most cost-effective of the three proposed alternatives in terms of both initial capital outlay, consisting of the tank(s), tiles, and construction costs, and subsequent operating costs which are generally limited to the costs to have the tank(s) pumped and inspected periodically. It will be necessary to acquire adequate fill material for site preparation based on the ground conditions at the RRP site which may be costly.

The package sewage treatment plant is considered to be acceptable in terms of cost-effectiveness. Given the ground conditions at the site, this alternative is preferred as there are essentially no risks associated with it.

As with the septic tank / tile field option, offsite treatment has comparatively low capital costs related to holding tank purchase and installation. The operating costs for haulage and treatment will be expected to exceed the operating costs of the package systems.

**Technical Applicability and/or System Integrity and Reliability**

The package sewage treatment system alternative uses proven technologies, is commonly used at mine sites, is reliable, and is therefore rated as a preferred technology.

Passive septic fields are a technically acceptable method of treating domestic sewage; however, their applicability to the RRP is limited due to the poorly-drained soil conditions in the RRP area, requiring constructed tile fields with imported fill; and because septic tile systems are generally better suited to smaller scale uses. Use of a septic tile system is therefore considered to be an acceptable, but not preferred, alternative.

Offsite treatment is also a technically acceptable alternative, as the sewage waste will be transported to a currently-operating facility designed for this purpose. However, this option relies on suitable capacity at the receiving facility, and reaching and maintaining an agreement for receipt of domestic sewage waste from the RRP.

**Ability to Service the Site Effectively**

The package sewage treatment plant and the septic tank and tile field alternatives have the advantage that both will be operated by RRR without reliance on outside facilities. The ability of a septic tile field to service the anticipated RRP workforce; however, is more constrained as this technology is better suited to smaller scale operations. Offsite transportation and treatment of the sewage will require third-party involvement, and a consequent potential for service disruption that may not be able to be controlled or mitigated by RRR.

The package sewage treatment plant alternative is therefore rated as preferred. The other two alternatives are rated as acceptable.

**Effects to the Natural Environment**

The package sewage treatment plant alternative, if designed and operated adequately, is not expected to result in adverse environmental effects, as the discharge to the environment is expected to meet MOE effluent limits. There is considerable experience with the operation of package sewage treatment plants for northern Ontario mine sites as well as other applications.

Site area soils consist mainly of clay and clay till, and are therefore not well-suited to the development of a septic tile field. Without adequate site preparation, adverse environmental effects to soil and groundwater could potentially ensue. If the ground conditions are adequate, no adverse environmental effects are expected with this alternative, therefore it is still considered a preferred option with the understanding that the tile field will have to be constructed with imported coarse fill.

Offsite treatment is rated as acceptable, since there will be increased emissions related to transport, and the additional handling and transport increases the potential for a spill which can result in the discharge of raw, untreated sewage directly to the environment.

**Effects to the Human Environment**

It is expected that both the package sewage treatment plant and the septic tank with tile field alternatives will not generate adverse effects on the human environment. The transportation of sewage to the offsite treatment plant will likely be handled by a contactor and therefore may generate a local business opportunity.

### 6.14.3 Summary Evaluation

The preferred alternative is to use a package sewage treatment plant, whether it is a rotating biological contactor, a sequencing batch reactor or a membrane bioreactor, as these systems provide the best quality effluent and greatest reliability, despite somewhat increased capital and operating costs.

## 6.15 Highway 600 Re-alignment

### 6.15.1 Alternatives

The RRP open pit will overprint the existing gravel-surfaced, two-lane Highway 600. RRR will need to re-align a portion of Highway 600 to maintain local access along Highway 600, and to enable traffic to avoid the RRP site. It is acknowledged that there are environmental impacts associated with the development and operation of new road corridors, including: road-related mortality of wildlife, barriers to dispersal and gene flow in populations; and it may support colonization of invasive species, particularly plants.

Preliminary discussions were held with the Township of Chapple, MTO and local residents to get their input on the different Highway 600 re-alignment alternatives because of the importance of local traffic routing. A Feasibility Study of Highway 600 rerouting alternatives was also carried out by TBT Engineering (2012) to assist with the evolution of alternatives, including costing, together with MTO and the Township of Chapple.

The generalized alternatives are to re-align Highway 600 to the: southwest of the RRP site, through the site avoiding key infrastructure; and to the north of the site. Rerouting through the site will not address potential land use conflicts and safety concerns, and has not been carried forward in the alternatives assessment. The northern route will require a longer road across less developed terrain and will disrupt local traffic patterns. A northern route was therefore not considered further (MTO 2012a; Township of Chapple 2012b). The Township of Chapple indicated a preference for Alternative C.

Re-alignment to the southwest of the RRP site was determined to be acceptable, with both the MTO and the Township of Chapple having preference for this option. Four southwest routing alternatives were considered and have been carried forward in the alternatives assessment, namely alternative routings A, B, C and D (Figure 6-4). All four alternatives involve the expanded use and upgrading of Tait Road, connecting to existing Highway 600 south of the existing Highway 600 Pinewood River crossing. The Pine River Road or Loslo Road north of the Pinewood River would also require upgrading.

**Alternative A**

Alternative A extends from the western terminus of Tait Road, directly west for a distance of approximately 2.75 km along the Township road allowance, before heading northwest and across the Pinewood River to reconnect with Highway 600 north of the Pinewood River, by way of Pine River Road. Pine River Road will be upgraded for highway traffic. Alternative A requires 5.3 km of new road.

**Alternative B**

Alternative B extends from the western terminus of Tait Road and follows an existing, irregular trail generally to the west-northwest and across the Pinewood River prior to connecting with Pine River Road. As with Alternative A, the Pine River Road will be upgraded for highway traffic. Alternative B requires 5.1 km of new road.

**Alternative C**

Alternative C extends west from the western terminus of Tait Road in part along an existing trail, to a point directly south of the Pine River Road. The road turns directly north from this point and passing across the Pinewood River until it connects with Pine River Road. Pine River Road will require upgrading for highway traffic. Alternative C is positioned the furthest from the site, and is the route with the fewest number of turns, with 6.4 km of new road. The Reeve and Council for the Township of Chapple have expressed that Alternative C is their preferred route.

**Alternative D**

Alternative D extends north from the west terminus of Tait Road and follows existing trails to the Pinewood River, crossing the Pinewood River and connecting to the southern terminus of Loslo Road. Loslo Road will be upgraded for highway traffic. Alternative D involves the least length of new road (4.3 km).

### 6.15.2 Performance Objectives and Evaluation

Performance objectives applicable to the Highway 600 re-alignment are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment; and
- Effects to the human environment.

Amenability to reclamation is not assessed because the re-aligned Highway 600 will be transferred permanently to the Province following construction and MTO final approval. This assumes as proposed, that the highway re-alignment is constructed to MTO standards and requirements.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

The primary costs with the Highway 600 re-alignment alternatives are upgrading existing municipal roads, construction of new road and watercourse crossings. The range of costs for the four alternatives varies from $11.1M for Alternative D to $14.4M for Alternative C. The differences are comparatively small within the context of overall project costs. Of greater cost significance is investor attractiveness and risk. Alternative C is supported by the Township and by MTO which removes risk, and therefore affords greater attractiveness to investors. Alternative C is therefore rated as preferred for cost and the other alternatives are rated as acceptable.

**Technical Applicability and/or System Integrity and Reliability**

Roads and road re-alignments are commonly used throughout Ontario and can be built to handle natural events such as design floods, and can be designed to facilitate safe use. Additional turns in a highway can increase the chance of an accident. Alternative A has three turns and a couple gentle curves. Alternative B has three turns and a couple of gentle curves. Alternative C has two turns. Alternative D has six turns and a gentle curve. Alternative C is rated as preferred as it has best sightlines and the fewest turns which can potentially contribute to safety concerns. Turns and bends are common in highways and the highway can still be built with a sufficient safety factor and Alternatives A, B and D are rated as being acceptable.

**Ability to Service the Site Effectively**

All four alternatives are able to re-align Highway 600 away from the RRP site. Alternatives A, B and C also keep traffic sufficiently far from site such that there is room for western and southern expansion of mine infrastructure if required. Currently there are no such plans for expansion. Alternatives A, B and C are all rated as preferred and Alternatives D is rated as acceptable.

**Effects to the Natural Environment**

With respect to air quality and greenhouse gas emissions, emissions are related to fuel combustion which is a factor of road length, and braking and accelerating requirements. Air quality can also depend on dust emissions which are dependent on weather and road design / maintenance. All the re-alignment alternatives are preferable to, or similar to the existing Highway 600 route as the alternatives are approximately the same length or shorter than the current route and require less fuel combustion for travel. Alternatives A and B are the shortest of the routes. Alternative C is the only route longer than the existing route, but has the least number of turns and no bends.

Alternatives A, B, C each require crossing only of the Pinewood River, while Alternative D also requires crossing of a minor tributary to the Pinewood River. Alternatives A, C and D are proposed to cross at Habitat Type 1 (narrower floodplain with moderate entrenchment and forested riparian vegetation extending close to the channel edge), while Alternative B crosses at Habitat Type 2 (similar to Habitat Type 1 but with a slightly wider floodplain). As a result, these alternatives are approximately comparable, although Alternative D requires an additional watercourse crossing.

Each of the alternatives will overprint a wetland(s). Alternative C requires new roads along wetland (primarily coniferous swamp) for most of its new road alignment. Roughly half of the new road associated with Alternatives A and B occurs over wetland (primarily coniferous swamp). Only a small fraction of the new road for Alternative D will overprint wetland.

From a terrestrial habitat perspective, the alternatives will overprint a mix of aspen-birch hardwood and coniferous swamp, with other land covers making up a much lesser portion of the alignments. Each alternative could partially fragment existing habitat and create new edge effects.

SAR that have been observed along the existing Highway 600 alignment include Eastern Whip-poor-will, Bobolink, Barn Swallow and Golden-winged Warbler. The only SAR that were identified to the south of Pinewood River along any of the proposed re-alignments were whip-poor-will and Golden-winged Warbler. Whip-poor-will were observed at the western terminus of existing Tait Road, together with one observation at the Alternative C route crossing of the Pinewood River. This latter observation is considered a spurious observation, and is not regarded as a whip-poor-will territory in the sense of a defended breeding territory. The western terminus of Tait Road already exists and is common to all four alternatives.

Overall, effects to the natural environment associated with the four re-alignment alternatives are similar for each alternative, and are considered typical for two-lane gravel highways in northwestern Ontario, and can be somewhat mitigated. Therefore, each of the alternatives is rated as acceptable.

**Effects to the Human Environment**

Impacts to local residents are expected to be generally similar for each of the four alternatives. Property values may be impacted along Tait Road because of increased traffic and sound, while accessibility is improved. All alternatives will change the cultural heritage roadscape.

Local infrastructure will be improved with all of the alternatives as the re-alignment will be constructed to modern MTO highway standards, which may exceed requirements that the current highway was originally designed to meet. There is anecdotal evidence that the current Highway 600 may be flooded in the spring.

From a health and safety perspective, additional turns in a highway can also increase the chances of an accident, depending on design parameters and sight line clearances. Alternative A has three turns and a couple of gentle curves. Alternative B has three turns and a couple of gentle curves. Alternative C has one turn. Alternative D has six turns and a gentle curve.

From positive impact to the human environment perspective, all alternatives are approximately equally effective in generating employment and business opportunities related to clearing and construction of the re-alignment.

It is noteworthy that Alternative C is the preferred route of the Reeve and Council of the Township of Chapple.

Overall, most negative impacts to the human environment are similar between the alternatives and can be mitigated. The Township of Chapple has expressed preference for Alternative C, which is rated as the preferred option. Alternatives A, B and D are rated acceptable.

**Amenability to Reclamation**

The road re-alignment will be transferred to Provincial control, following construction and MTO inspection. There are no plans to reclaim the Highway 600 re-alignment following completion of the RRP and the road re-alignment options have not been assessed for amenability to reclamation.

### 6.15.3 Summary Evaluation

From an economic perspective, each alternative is similar in cost-effectiveness, with the notable exception that selection of Alternative C would be most attractive to investors, as this alternative is supported by the Township, and therefore carries the least risk from an EA and permitting perspective. From a technical applicability and ability to service the site, Alternative C is preferred because it is the safest of the four alternatives as it has the fewest number of turns and bends. From a natural environment perspective, all alternatives will have some impacts that require mitigation and all are rated acceptable. From a human environment perspective, most negative impacts can be mitigated, but Alternative C is preferred as it is the preferred option of the Township. Overall, Alternative C is selected as the preferred alternative, primarily because it follows existing road allowances and is supported and preferred by the Township, and because it has fewest numbers of bends and turns.

## 6.16 Site Access and Transport Routes

The existing road network (apart from Highway 600) ends at the intersection at Gallinger Road and Korpi Road, approximately 2 km northeast of the RRP site. As a result of the re-alignment of Highway 600, a new means of access must be provided to the limited number of properties located on Marr Road north of the RRP site (Section 4.15). Once Highway 600 is re-aligned, the properties otherwise will be isolated.

A study was conducted by TBT Engineering to assess the best means of connection for these properties (TBT 2012). As only a relatively short road connection is needed to the Gallinger Road / Korpi Road intersection, limited alternative routes were possible which would not cause unnecessary environmental impacts. The most direct route (traversing west - east) crosses low-lying terrain, particularly in the western area where a number of small ponds and creeks are present. For that reason, a somewhat longer (400 m) route was selected which avoids most of the low lying and wet terrain (Figures ES-1, 4.1).

The new East Access Road will connect the Marr Road properties to Highway 71 by means of Korpi Road, an existing municipal road (Figure 4-1). Korpi Road west of Highway 71 is approximately 1.6 km in length to Highway 71, and runs due west - east, with very good sightlines.

As the required East Access Road will be located to the north of the RRP, it offers a more direct route for vehicular traffic and goods shipment to the RRP industrial facilities (process plant, maintenance facility and explosives facility). For this reason, the East Access Road is proposed to also serve as the main access to the RRP site from Highway 71. This will reduce the overall distance RRP-related vehicular traffic will travel on existing local roads.

The approximately 1.6 km of Korpi Road between Gallinger Road and Highway 71 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.

Based on the above, the preferred alternative is to develop the East Access Road to provide access to the Marr Road properties, and also provide a direct access route to the RRP site form Highway 71. All other alternatives that meet the need to provide access to the Marr Road properties and/or access to the RRP site will be of considerably greater length and as a result, have greater environmental impacts. For that reason, no further assessment has been provided.

## 6.17 Power Supply

### 6.17.1 Alternatives

The RRP will require approximately 2 to 3 MW of power during the construction phase, rising to 5 MW prior to commissioning of the process plant. 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 requiring approximately 25 MW of the total power draw. The local electrical grid is not capable of supplying sufficient power to meet power demands in the late construction phase and in the operation phase.

Energy saving equipment and processes will be used where practical to save on energy costs; however, conservation cannot materially change the energy requirements for the RRP and a new power source is required. Power can be provided from 230 kV transmission line which supplies hydroelectric power to the region or through RRR owned generating equipment.

The nearest 230 kV transmission line is located approximately 16 km northeast of the process plant. A connecting 230 kV transmission line could provide sufficient power to the RRP and is assessed as a power supply alternative.

Self generated power could include diesel generators or alternative energy sources such as hydroelectric, solar and wind. Diesel generators are a proven technology for the mining industry and are carried forward in the alternatives assessment. Alternative energy sources; however, cannot provide consistent uninterrupted power (wind and solar) and the nearest site with significant hydroelectric potential is Rainy River. This is an international waterway and is located further away from the RRP than the existing 230 kV line. Alternative energy generated by RRR is not a viable alternative and is not assessed herein.

The power supply alternatives considered for the RRP are therefore:

- Construct a 230 kV transmission line to the regional electrical grid; or
- Install diesel-fired generators on the RRP site.

**Construct a 230 kV Transmission Line to the Existing Grid**

Power in the region is predominantly generated at hydroelectric stations, with surplus capacity capable of supplying the RRP. The nearest 230 kV transmission line links Kenora to Fort Frances and is located approximately 16 km northeast of the process plant.

Several routes for constructing a 230 kV transmission line to the existing grid were considered including: cross-country routes, routes that follow existing road systems and more direct routes. Transmission line routes are assessed in Section 6-12. The preferred transmission line route is a cross-country route that follows ridges to the northeast of the plant site and is used in the power supply comparison.

The 230 kV transmission line will extend 16.6 km to the northeast and connect to the Hydro One Networks transmission line between Beadle Lake and Panorama Lake. The route is located primarily on high ground, with the exception of an approximately 2 km segment where it extends east through a low-lying area and a less than 1 km segment near Beadle Lake. The route avoids populated areas, with a highway crossing at the Trans-Canada Highway (Highway 71) and two other minor road crossings. The only significant watercourse crossing is the outlet of Beadle Lake.

**Diesel-fired Generators**

The other alternative identified is to install a series of diesel-fired generators capable of supplying sufficient power for the sole use of the RRP site and construct a fuel tank farm to store the required fuel. Diesel-fired generators typically have self contained double-walled fuel tanks for immediate fuel storage and are equipped with appropriate measures to prevent and monitor tank ruptures or overflows. At the scale required, generators would be supplied by a local day tank connected by a fuel line to a fuel tank farm.

### 6.17.2 Performance Objectives and Evaluation

Performance objectives applicable to the power supply alternatives are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

The primary capital costs for the diesel-fired generators include construction of a fuel tank in a bermed and lined facility, and the generators. Capital costs for the 230 kV transmission line include clearing of the transmission line right of way (ROW) and construction of the transmission line. Purchase or rental of private properties is not significant for the preferred route. From the capital cost perspective, diesel-fired generators have an advantage.

Operating costs for the diesel-fired generators include diesel fuel consumption, fuel delivery and generator maintenance. Operational costs for the transmission line are generally limited to periodic ROW maintenance costs and the cost of electricity. Overall the transmission line has much lower operating costs than the diesel fired generators for this scale of operation.

Closure costs for diesel-fired generators include removal of generators (likely for re-sale) and dismantling of fuel tanks. Closure costs for the transmission line will include removal of the transmission line if ownership is not transferred.

For financial risk, electricity costs from a transmission line have an added advantage of being relatively stable in price, while diesel fuel requires futures or is subject to volatility in world fuel prices.

Overall, the substantive costs associated with the operation of diesel-fired generators for production cannot be justified (57 MW of generating capacity will require fuel consumption at a rate of approximately 350,000 L/d, based on a consumption rate of 265 L/MWh). The diesel generation alternative is rated as unacceptable for cost-effectiveness. The transmission line is rated as preferred.

**Technical Applicability and/or System Integrity and Reliability**

Transmission lines are typically used to power mine sites in Canada when a transmission line with sufficient capacity is present within a reasonable distance. Diesel-fired generators are typically used in smaller, high grade mine sites that are remote and located a long distance from the nearest transmission line or where capacity is not available on the local electrical grid.

Both transmission lines and diesel fired generators are proven technologies for mine sites.

The transmission line is the preferred option because a transmission line with sufficient capacity exists at a distance of approximately 16 km from the RRP site. Diesel-fired generators are rated as acceptable from a technical applicability perspective.

**Ability to Service the Site Effectively**

The transmission line option is subject to potential disruptions such as blackouts that can occur with the Provincial electrical grid. These disruptions can be caused by natural occurrences such as storm events or by decisions from the power generating authority that are outside of RRR control. Contingency back-up generators will be available for emergency power. Diesel-fired generators are less susceptible to disturbances from natural occurrences.

From an accessibility perspective, the transmission line is contingent on land purchase / rental agreements where the ROW crosses private lands and from land use approvals from relevant government agencies on Crown lands. The majority of the transmission line is on lands already held by RRR. The diesel-fired generator option is not subject to accessibility constraints.

Considering both service and accessibility criteria, the transmission line is rated as acceptable and the diesel-fired generators are preferred.

**Effects to the Natural Environment**

Diesel-fired generators will have an impact on air quality through the combustion of diesel fuel and shipment of fuel to site. Emissions will include sound, greenhouse gasses (primarily carbon dioxide) and potentially sulphur oxides, nitrogen oxides, carbon monoxide and fine particulate matter. Air quality impacts for the transmission line will be limited to heavy equipment operation during the construction phase, and to a lesser extent emissions associated with that portion of grid power generated by fossil fuel combustion.

Neither option will have a major impact on fish and aquatic habitat, provided that appropriate measures are taken to manage the risk of fuel spills with the use of diesel power; and the potential for sediment release during transmission line construction (for example using the standard practice of leaving root masses in place).

No significant impacts to wetlands are anticipated by either option, as long as the transmission line construction occurs during frozen conditions.

Terrestrial habitat impacts will be limited to the immediate footprint of the generators and fuel tank for the diesel-fired generators. The transmission line will require clearing of the ROW, which will result in the loss of terrestrial habitat, potentially with forest habitat being replaced by meadow / shrubland. The transmission line could fragment existing forests while creating an edge effect and may create a new corridor for wildlife movement along the transmission line ROW.

SAR impacts for the diesel-fired generators could potentially include minor overprinting of SAR habitat (Eastern Whip-poor-will and Bobolink) which is prevalent at the RRP site. SAR impacts along the transmission line ROW could potentially be beneficial through the development of forest edge habitat suitable for whip-poor-will.

Overall, most detrimental impacts to the natural environment can be mitigated, and each alternative is considered acceptable.

**Effects to the Human Environment**

The most substantive effect of diesel-fired generator operation will be increased fuel transport on local roads, together with minor increases in sound and air emissions. The transmission line will be routed away from local residents as much as practical.

Both alternatives will positively contribute to the regional economy as contractors will be required to construct either option. The diesel-fired generators have the added advantage of requiring a regular fuel distributor and transportation company to provide large quantities of fuel to the site.

Overall, the transmission line is preferred as it will positively impact the local economy and most negative impacts are avoided. Diesel-fired generators are considered acceptable because of economic benefits and as negative impacts can be mitigated.

**Amenability to Reclamation**

On closure the diesel-fired generators will need to be removed along with fuel tanks. Any hydrocarbon affected soils associated with this alternative will be remediated as per regulatory requirements at the time. The transmission line will be removed and the ROW reclaimed through natural vegetation regrowth. Any air quality effects associated with on-site diesel generation will be negated upon cessation of power generation.

### 6.17.3 Summary Evaluation

Use of diesel-fired power generation is not supportable on economic, environmental and socio-economic grounds. From an economic perspective, the diesel-fired generator requires large operating costs associated with the fuel transport and consumption that cannot be justified for the RRP. The transmission line alternative offers more affordable hydroelectric power from the Provincial grid. The major environmental limitation to the use of on-site diesel generation is increased fuel consumption and associated unnecessary increased emission of greenhouse gases. Potential adverse effects to the human environment include increased fuel transport on local roads, and increased air emissions associated with the diesel generation alternative. Both alternatives are technically able to supply power to the site and are amenable to reclamation. Overall, a 230 kV transmission line connection to the existing electrical grid is selected as the preferred option.

## 6.18 Transmission Line Routing

### 6.18.1 Alternatives

The nearest transmission line capable of meeting the RRP electrical needs is a 230 kV transmission line that links Kenora to Fort Frances. At its nearest position, the 230 kV Hydro One Networks transmission line is approximately 16 km northeast of the plant site. A ROW will need to be cleared and a connector 230 kV transmission line constructed between the plant site and the existing Hydro One Networks line to use power from this line. Periodic clearing of the ROW will be required during operation to ensure its safe operation (maintaining clearance for conductors). Mechanical / manual clearing is proposed rather than use of approved chemicals.

The transmission line will be of standard design, typically using wooden, two-pole H-frame structures, with three-pole structures at angles. Guy wires will be used to support the structures as required, typically in softer soils and at turning points. Steel tower structures will be required in order to cross and connect to the existing 230 kV line from the east side (a 115 kV transmission line is present on the west side of the main 230 kV line). The transmission line structure itself is not considered in this alternatives assessment. Four transmission line routing alternatives were considered (Figure 6-5):

- Alternative A: construct along high ground to the northeast of the site;
- Alternative B: shortest direct route to the Hydro One Networks transmission line;
- Alternative C: similar to the shortest direct route but maintains a setback from nearby residences; and
- Alternative D: construct along the existing road network.

Each of the routes traverse a somewhat similar terrain, except for Alternative A that travels across a ridge for the eastern portion. The elevation varies for each alternative (Figure 6-5) as follows:

- Alternative A: minimum elevation 366 masl; maximum elevation 429 masl;
- Alternative B: minimum elevation 362 masl; maximum elevation 402 masl;
- Alternative C: minimum elevation 361 masl; maximum elevation 403 masl; and
- Alternative D: minimum elevation 356 masl; maximum elevation 398 masl.

None of the alternatives are proposed to cross significant watercourses / waterbodies:

- Alternative A: crosses one minor watercourse (outlet of Beadle Lake);
- Alternative B: crosses four minor watercourses;
- Alternative C: crosses three minor watercourses; and
- Alternative D: crosses seven minor watercourses.

The forest / wetland composition of the four alternatives is shown on Figure 6-6 and detailed in Table 6-9.

**Alternative A – Northeastern Route**

Alternative A is generally to the northeast and has a total length of 16.6 km. This alternative is generally routed along sparsely vegetated high ground and rocky ridges, occasionally crossing lowland terrain and one river between ridges. Alternative A is intended to minimize impacts to the human environment by avoiding residences.

**Alternative B – Direct Route**

The direct, cross country route is a 15.7 km route that runs east-northeast to connect with the Hydro One Networks transmission line. Alternative B passes to the immediate north of the community of Finland, and is generally located through forested areas. This ROW route minimizes the transmission line length, thereby reducing the impacted area and having a lower construction costs.

**Alternative C – East Route**

The east route is a 16 km ROW that generally follows a similar route as the direct route (Alternative B). The primary difference between Alternatives B and C is that the East Route maintains a larger separation distance from residences / buildings. The east route initially proceeds to the northeast prior to turning due east for approximately half the route distance.

**Alternative D – Along Existing Roads**

Alternative D is the longest route at 19.2 km and follows along existing roads where possible, for ease of access for construction and maintenance. This results in reduced tree clearing requirements.

### 6.18.2 Performance Objectives and Evaluation

Performance objectives applicable to the transmission line routing are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Ability to service the site effectively;
- Effects (adverse) to the natural environment;
- Effects to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

The primary costs associated with transmission line routing alternatives are land acquisition, ROW clearing and transmission line construction.

Alternative A is positioned on private lands to which RRR holds surface rights, or has options to acquire surface rights (or easements), or is on Crown land. Costs for land acquisition have therefore already been accounted for, and uncertainties related to land acquisition have been removed, which improves overall investor confidence and decreases risk. Clearing costs associated with Alternative A are also reduced because of the prevalence of sparsely vegetated upland areas; however, access will be higher compared with other alternatives.

Alternatives B and C are the shortest routes and will have reduced transmission line construction costs; however, clearing costs associated with these alternatives will be higher as these ROWs are primarily forested. The more important cost consideration associated with Alternatives B and C (and D) is land acquisition costs, and uncertainty around whether or not current land owners will be willing to sell, or make easement rights available, to RRR.

Alternative D will have reduced clearing and access costs, but is the longest route. It also has the greatest number of turning points compared with other options, and is therefore the most costly to construct. Alternative D will also have the greatest land purchase / rental cost requirements as it passes through more private land holdings. Perhaps more important are concerns over the willingness of local landowners to sell, or rent, lands to RRR for construction of a high voltage transmission line that would run close to their residences. This aspect alone raises considerable uncertainty to investor confidence.

Overall, the main driver on costs is the ability to acquire lands and to avoid potential landowner conflicts and concerns, all of which affect investor confidence and RRP scheduling. Alternative A is located on lands to which RRR has or can reasonably attain access, and is well removed from residences / buildings. This alternative is consequently rated as preferred from a cost and investor risk perspective. Alternatives B and C are of similar length and constructability compared with Alternative A, but will each require substantive additional land purchase or easements, and are rated as acceptable, assuming that such lands can be reasonably attained. Alternative D is slightly longer than the other alternatives and follows a winding path for several kilometres, but has good access for construction. Transmission lines are designed to follow straight routes in order to improve cost-effectiveness. They can theoretically be designed to follow curving roads through reduced distance between poles and increased use of triple pole and guy supports, or they can be constructed to cross the road at several points so as to maintain a straighter alignment. Either of these approaches will increase the cost substantively. Road crossings should in general be minimized due to safety concerns. The ability of RRR to acquire lands for construction of a 230 kV transmission line proximal to existing residents for Alternative D is highly questionable and this alternative is rated as unacceptable.

#### Technical Applicability and/or System Integrity and Reliability

Alternatives A, B and C have transmission lines with 3, 2 and no turning points respectively, each with one river crossing (and several creek crossings for Alternatives B and C). Each of the options is similar to other 230 kV transmission lines constructed elsewhere in Ontario. Alternative D includes 3 major turning points and then winds alongside Manomin Road for several kilometres. Alternatives A, B and C are rated as preferred and Alternative D is rated as acceptable.

#### Ability to Service the Site Effectively

All four alternatives are able to effectively provide power to the RRP, although Alternative D has the potential to interfere with future infrastructure placement to the immediate east of the process plant.

From an accessibility perspective, the transmission line is contingent on land purchase / rental agreements where the ROW crosses private lands and for land use approvals from relevant government agencies on Crown lands. Alternative A is located on lands to which RRR has, or can reasonably attain, access, and maintains the greatest distance from residences. Land accessibility for constructing Alternatives B and C is less certain, but such lands have a reasonable of being attainable. The acquisition of lands for construction of Alternative D is likely to be problematic, as the required lands will require current landowners to either leave their place of residence; or to lease lands in close proximity to their residences for construction of a transmission line.

Alternatives A, B and C will be primarily dependent on a winter access road for construction. Alternative D has an advantage of being accessible year round through the regional road network.

Considering both service and accessibility criteria, Alternative A is preferred because RRR already has, or can reasonably attain, access to the required lands. Alternatives B and C have a reasonable potential for access and are rated as acceptable. Alternative D is likely to present serious access limitations and is rated as unacceptable.

**Effects to the Natural Environment**

There are no major differences between the routing alternatives with respect to air quality, greenhouse gas emissions, water quality and fish habitat. Impacts to wetlands can be mitigated by construction during frozen conditions. Adverse impacts to SAR will likely be greatest for Alternatives B and C as these routings pass through more heavily forested environments, compared with Alternatives A and D.

The primary impacts to the natural environment from the transmission line routing alternatives are related to forest clearing, creation of new wildlife corridors and alteration of habitat. The vegetation community types within a 1 km wide corridor centred on the transmission line routes are relatively similar between the four alternatives (Table 6-9, Figure 6-5). Alternatives A, B and C will all create a new corridor habitat through forests, and may cause forest fragmentation and edge effects along the ROW. These alternatives are rated acceptable. Alternative D will not create any appreciable new edge effects or cause fragmentation, as it is positioned along existing roads and is rated as preferred.

**Effects to the Human Environment**

Each transmission line alternative has the potential to impact local residents. Alternative A will have the least negative impacts associated with sound during construction, aesthetics and property values because it is the more remote option. Alternative D will have the greatest impact to local residents as it will be highly visible for its entire length, and will cross several properties and driveways. Alternatives B and C are anticipated to represent an intermediary condition.

As there is no expectation for a future use for the transmission line connector, no long term infrastructure benefits will result. Alternative D has the disadvantage of potentially hindering any potential road expansion while the transmission line is in place and operating.

The transmission line will generate electromagnetic fields. Electromagnetic field exposure from transmission lines is common, and many transmission lines traverse populated urban areas. General public concern and uncertainty around this issue (Moulder 2006) may prove problematic for Alternative D. Alternative A is located the greatest distance away from residences. Alternatives B and C are generally located away from households, with Alternative B approaching closer than Alternative C.

All alternatives will provide opportunities for local and regional businesses as contractors would be required to clear the ROW and to construct the transmission line.

Overall, Alternative A is rated preferred because it has the least potential for adverse human environment effects. Alternatives B and C are rated as acceptable. Alternative D is rated as being unacceptable, principally because of aesthetic considerations and because of potential for concerns over possible health effects.

**Amenability to Reclamation**

Each of the alternatives could be transferred to Hydro One Networks upon closure to reinforce the Provincial electrical grid, although it is not expected. All four alternatives are equal in amenability to reclamation and are rated as preferred.

### 6.18.3 Summary Evaluation

From an overall perspective, Alternative A is preferred as land access for this alternative is already available to RRR, or can reasonably be obtained in the case of those portions of the ROW positioned on Crown lands; and because there is less potential for conflicts or concerns from local residents, as this routing is the most removed from local residences. Alternative A was rated as preferred in five categories and acceptable in the remaining category.

Alternatives B and C are broadly comparable in their evaluations, each being rated as preferred in two categories, and acceptable for all remaining categories. The primarily limitations to Alternatives B and C are uncertainties regarding land availability, and potential public concern due to proximity to residences along a portion of the route.

Alternative D has the advantage of year round access for construction, and a reduced potential for disturbance to the natural environment as this alternative follows along existing roadways. Alternative D is however, located in very close proximity to a number of residences and consequently is aesthetically less preferred and has a greater potential for concerns over health aspects related to electromagnetic fields, and as such is unlikely to receive public support. This potential for adverse public reaction is also important to investor confidence, and hence financing and scheduling for the RRP. Alternative D is therefore rated as unacceptable.

## 6.19 Reclamation and Closure

### 6.19.1 Open Pit

#### 6.19.1.1 Alternatives

The primary intent of reclamation and closure of the open pit is to achieve a physically safe and chemically stable environment. Based on the Feasibility level pit design, the open pit will have a total void volume of approximately 210 $Mm^3$ to level with ground surface at cessation of mining. The open pit must be closed out in accordance with the Mine Reclamation Code of Ontario (the Code) pursuant to the Ontario *Mining Act*. Section 21 of the Code provides for the following strategies for reclamation and closure of open pits in order of preference:

- Backfilling (with mineral waste; preferred if feasible);
- Flooding (if fully justified);
- Sloping (if flooding or backfilling are not appropriate);
- Boulder fencing or berming (if all of the above are impractical); and
- Chain link fencing (if none of the above is practicable).

The Code also recognizes that different open pit closure strategies may be appropriate at different stages of closure. For example, boulder fence protection may be an appropriate measure until a pit is fully backfilled or flooded.

The Provincially-approved Amended ToR identified the following preliminary closure strategies for reclamation of the open pit:

- Natural flooding;
- Enhanced flooding; and
- Backfilling with mineral waste.

Given the project volume of the open pit, flooding or backfilling will require from several years to several decades depending on the selected closure approach and its application. Installation of fencing alone as a permanent measure is not considered as the open pit will flood naturally once pumping ceases and the groundwater table is reasonably close to surface.

Proven alternative technologies considered for open pit closure are the following:

- Natural flooding;
- Enhanced flooding;
- Partially backfill with tailings; and
- Backfill with mine rock and overburden.

**Natural Flooding**

Natural flooding is defined herein to include flooding of the open pit with water that will drain by gravity to the open pit without pumping from external sources or adjustment of the operational water management practices (such as re-direction of creek flows). This will include as a minimum runoff and seepage from the immediate open pit catchment area. It will take an estimated approximate 97 years for the open pit to flood and stabilize at the natural water table level elevation with only these water inputs along with direct precipitation. The water table will reach the top of the bedrock in approximately 68 years (Appendix E, Attachment 1).

The existing predevelopment groundwater table in the open pit area is at or near surface, so it is expected that once fully flooded, the water level in the open pit will be close to the existing ground level. As such, an outlet will be constructed and the flooded pit will eventually overflow to the Pinewood River. The open pit will continue to be dewatered and will not be allowed to flood until underground mining is complete, unless stable bulkheads can be developed to hydraulically separate the open pit from the underground workings. Any such bulkheads will have to be designed to accommodate developing water heads in the flooding pit and as such, is not a preferred approach.

Water that collects in the open pit is expected to be affected by ARD developed from the pit walls and PAG mine rock contained in the east mine rock stockpile. As a result, the quality of this water will have to be managed to ensure that any pit overflow to the environment will be protective of aquatic life in the Pinewood River, the nearest receiver. Experience with other similar, deep pit lakes has shown that once fully flooded, these pit lakes tend to develop a stable chemocline at a depth of about 30 m below surface (Fisher and Lawrence 2006; Gammons and Duaime 2006; Sanchez Espana 2008). A chemocline is relatively sharp transition in pit water quality that occurs as a result of water density gradients and oxygen concentrations. Waters below the chemocline typically show elevated concentrations of parameters such as sulphate, ammonia and metals sensitive to low oxygen concentrations (such as iron and manganese).

Oxygenated waters above the chemocline generally contain low concentrations of these parameters. Various technologies are currently available for enhancing the quality of pit lake surface waters, such as lime addition to precipitate metals (Neil et al. 2009), and growth stimulation of selected bacteria and algae to sequester metals from the upper portion of the water column and to precipitate these to depth (McCullough 2008; Geller et al. 2009). With the natural flooding scenario, there will be no outflow from the open pit for many decades, which will allow more time to optimize pit water chemistry, potentially including the application of technologies not yet available. Should there be a requirement, water within the open pit could be treated either *in situ* or by means of a water treatment plant to ensure protection of receiving waters with either natural or enhanced flooding scenarios.

The end objective at closure is to produce a surface water overflow from the open pit that will be acceptable for passive discharge to the Pinewood River, with as little active management as feasible. Until such time as the open pit is fully flooded, perimeter fencing (boulder fence, berm or chain link fence) will be required to prevent inadvertent access to the pit.

**Enhanced Flooding**

Enhanced flooding will accelerate the pit flooding and reduce the time until flooded. Additional water sources that could be used to enhance the natural flooding of the open pit include the tailings management area, stockpile drainages and natural watercourses (West Creek, together with a portion of Pinewood River flows). Enhanced flooding could reduce the length of time for the open pit to flood to the top of bedrock to as little as a few decades depending on the level of water taking from surrounding watercourses deemed acceptable. With moderately enhanced flooding is anticipated to take approximately 54 years to flood to the top of bedrock and 73 years to surface (Appendix E, Attachment 1).

The primary advantages of enhanced flooding are to:

- Reduce the risk to the general public from inadvertent access / trespass and resultant injury;
- Reduce the time available for ARD development from exposed pit walls; and
- Reduce the time to achieve a stabilized, self-sustaining water management condition.

Principal disadvantages of enhanced flooding of the pit include:

- Reduction(s) in watercourse flows and fish habitat while the pit is being flooded (West Creek, runoff to the Pinewood River and direct water taking from the Pinewood River); and
- The need to stabilize water quality in the pit more quickly than for natural flooding, in preparation for pit overflow to the Pinewood River.

**Partially Backfill the Open Pit with Tailings**

Mining of the open pit is expected to be completed in year 10 of operations, followed by an additional approximately five years of underground mining. During this latter period, stockpiled ore from the open pit as well as ore extracted directly from underground will be processed, resulting in approximately 26 $Mm^3$ of tailings solids requiring storage. The tailings during this period could be stored in the open pit rather than in the tailings management area, provided that the underground workings could be effectively sealed, such that there was no chance of inadvertent flooding of the underground workings. A water cover will be retained over the tailings.

The primary advantages of this alternative are to:

- Accelerate the rate of flooding of the open pit, although not substantially;
- Provide complete water cover / flooding of the tailings;
- Reduce the capacity requirements for the tailings management area and
- Allow earlier reclamation of the tailings management area, rather than waiting until the completion of operations.

There will also be power savings by pumping tailings from the process plant to the open pit, rather than pumping upgradient through a longer tailings pipeline to the tailings management area.

The critical aspect of this alternative which remains to be verified is the ability to safely separate the open pit from the underground workings at reasonable cost. There is an inherent sensitivity to flooding an open pit while a connected underground mine is actively being worked. Bulkheads may be used to separate the open pit from the underground and may be either natural (leaving a crown pillar of ore in place) or of engineered concrete. The feasibility of developing such bulkheads is a function of the mine design, geology and economics. For the RRP, a sizable crown pillar of ore in the order of 30 to 40 m thick might be required at any location where the underground workings approach the open pit wall to ensure a safe separation. Use of concrete is less likely to be preferred from the technical perspective as the mining process by its nature of explosives use, will fracture the surrounding rock. If there is any chance that the flooded pit with deposited tailings could break into the underground workings, this alternative will have to be rejected for safety reasons. Such an event could reasonably translate to a loss of life for the underground miners.

As this alternative relates to reclamation and closure, it could be retained as an alternative to be considered as a future optimization potential, if the alternative can be proven safe and economic at a later date.

**Backfill the Open Pit with Mine Rock and Overburden**

Backfilling the open pit with mineral wastes is preferred if feasible. The advantage of backfilling is that the pit can be filled to surface in a comparatively short time (less than a decade), and that PAG mine rock can be permanently stored under water once flooded. It is estimated that the total volume of PAG rock will be in the order of 125 $Mm^3$ (assuming total mine rock production of about 350 Mt and that broken rock has a density of about 2 $t/m^3$). This rock can be placed in the open pit along with a volume of NPAG mine rock and covered with a thick layer (5 m or more) of clay till. The deposited material will then flood to near surface as the water table rises within the backfilled material to permanently seal the PAG mine rock.

The primary disadvantage and limitation of this alternative is cost. The costs for backfilling the 200 $Mm^3$ pit will cost in the order of $1B. This cost is extremely prohibitive which is why the backfilling of large, single open pits generally does not occur. Backfilling is more prevalent at mining projects where multiple pits are present and the double-handling of mineral waste can be avoided. Moreover, in accordance with *Mining Act* financial assurance requirements, the $1B cost will have to be included as part of the closure bond, prohibitively adding to upfront capital costs for financing.

#### 6.19.1.2 Performance Objectives and Evaluation

Performance objectives applicable to open pit reclamation and closure are the following:

- Cost-effectiveness;
- Technical applicability;
- Minimize effects (adverse) to the natural environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

Natural flooding will extend site management and related costs to an unnecessarily long timeframe, which will increase overall project costs. Enhanced flooding of the open pit in as little time as reasonably practical while taking into consideration other factors as discussed below, will reduce the long term site management costs.

Partial backfilling of the open pit with tailings along with enhanced flooding is the most attractive alternative from the perspective of investment and overall financially viability. This alternative will not reduce long term site management costs, result in substantial savings in tailings management and will allow the tailings management area to be reclaimed during the operation phase. The critical aspect of this alternative which remains to be verified is the ability to safely separate the open pit from the underground workings at reasonable cost, to ensure that there is no potential for catastrophic flooding of the underground workings under any scenario.

The cost of backfilling the open pit with mineral wastes is estimated at approximately $1B and cannot be supported by the RRP. Therefore from an overall cost-effectiveness perspective, enhanced flooding and partially backfilling of the open pit with tailings, coupled with enhanced flooding, are the preferred alternatives, provided that security of the underground workings can guaranteed in the case of backfilling with tailings. Natural flooding is rated as acceptable and backfilling the open pit with mineral wastes is rated as unacceptable.

**Technical Applicability**

Each of the technologies considered herein is standard practice in the industry and can be implemented with predictable success, with the exception of tailings disposal in an open pit connected to active underground workings. The partial backfilling with tailings in the open pit during underground mining operations remains to be fully evaluated as technically viable. All of the alternatives are therefore rated as preferred for this performance objective, with the above noted caveat.

**Effects to the Natural Environment**

Allowing the open pit to flood naturally and at a slower rate will provide for longer term effluent containment without release. This will allow more time to stabilize pit water quality and if needed, more time to potentially implement new technologies that are currently not practical, are unproven, or are unknown. Flooding the pit more slowly will also divert less runoff away from area watercourses, thereby more effectively maintaining fish habitat. The disadvantages associated with this alternative are the exposure of the pit walls to oxidation for a longer period of time and a longer timeline to establish passive site drainage for the open pit.

Flooding the pit more quickly (enhanced flooding) will accelerate the timeline to establish passive site drainage from all parts of the site and will reduce the period of pit wall exposure to oxidation; but this approach will likely have adverse effects on downstream flows and fish habitat. There will also be less time to take advantage of potentially available new technologies.

The principal advantage of discharging and storing tailings to the open pit during the final years of operation will be to accelerate reclamation of the tailings management area. This will allow for a more rapid stabilization of passive tailings management area drainage and establishment of terrestrial habitat around the tailings management area perimeter.

Placing all of the PAG mine rock back in the open pit and covering this PAG rock with NPAG mine rock and a clay till (overburden) cap, will remove any long term ARD potential once the system stabilizes. Backfilling the pit with rock and overburden will also allow for the re-establishment of terrestrial habitats in the pit area to support wildlife. From an environmental perspective, this is the overall preferred alternative. The other three alternatives are all rated as acceptable for effects to the natural environment, recognizing that optimization of the pit flooding rate will be required to achieve a balance between the rate of pit flooding and non-interference with downstream water flows and fish habitat.

**Amenability to Reclamation**

All aspects relevant to amenability to reclamation are discussed in the preceding sections. Backfilling with mine rock and overburden is the preferred alternative. All of the other alternatives are rated as acceptable, recognizing that optimization will be required with the flooding alternatives.

#### 6.19.1.3 Summary Evaluation

The preferred alternatives are enhanced flooding and partially backfilling the open pit with tailings (coupled with enhanced flooding), provided that security of the underground workings can be guaranteed. In either case the rate of enhanced flooding will have to be balanced with downstream flow and fish habitat protection needs. For example, it may not be desirable to fully divert the re-aligned West Creek into the open pit at closure, as a means of accelerating pit flooding. Similarly, once the tailings management area has been reclaimed and tailings management area runoff has been stabilized to the point where it is acceptable for direct discharge to the Pinewood River without the need for any further treatment or management, it may be best from a downstream flow and fish habitat protection perspective to allow this flow to report to the Pinewood River and not to the open pit. Capturing some portion of the Pinewood River flow on a seasonal basis and diverting this flow to the open pit may be acceptable. Discussions with the regulators and other stakeholders will be required to determine the most appropriate mode of flood optimization, together with any adaptive management strategies.

Natural flooding is regarded as an acceptable alternative. Backfilling the open pit with mineral wastes is unacceptable despite the noted environmental advantages, as the cost of this action cannot be supported by the RRP.

### 6.19.2 Underground Mine

#### 6.19.2.1 Alternatives

Approximately 3.1 Mt of ore and 1.5 Mt of mine rock will be removed from the underground mine (BBA 2013a). At the completion of mining the underground workings must be closed out in accordance Ontario Regulation 240/00, Amended O. Reg. 307/12. Subsection 24(2) of the Regulation specifies the following in relation to the closure of underground workings:

> *All … mine openings to surface that create a mine hazard shall be stabilized and secured*; and
>
> *All surface and subsurface mine workings shall be assessed by a qualified professional engineer to determine their stability, and any surface areas disturbed or likely to be disturbed by such workings shall be stabilized.*

Securing underground openings is typically achieved using reinforced concrete caps for shafts and vent raises, or other measures such as backfilling underground portals, as specified in the Code. If underground workings near surface are determined through engineering assessment to present a possible stability hazard such as possible future collapse of a crown pillar, the underground workings in question must be mitigated in accordance with the engineering assessment. Typically such remediation will involve backfilling underground stopes below the crown pillar with mine rock or other fill materials.

The Code also recognizes that different underground closure strategies may be appropriate at different stages of closure; for example, the use of fence protection as an interim measure.

The Provincially-approved Amended ToR provides for the following preliminary closure strategies for reclamation of the underground workings:

- Natural flooding;
- Enhanced flooding; and
- Backfilling with mineral waste.

As with securing of the open pit, the primary intent of underground closure is to achieve a physically safe and chemically stable environment.

In the case of backfilling, backfilling of the underground workings as a general closure strategy is considered separate from any site specific backfilling that might be needed to stabilize near surface workings, such as crown pillars that may pose a safety hazard.

**Natural Flooding**

Natural flooding will involve allowing the underground workings to flood on their own, without water being actively pumped to the underground. Under a natural flooding scenario, deeper portions of the underground workings will be expected to flood within a few years, but upper portions of the underground workings will not become fully flooded until the open pit is flooded, as the water table within the underground workings will ultimately be controlled by the water table in the adjacent and overlying open pit. Flooding the open pit could take up to approximately 97 years (Section 6.18.1; Attachment 1 in Appendix E).

**Enhanced Flooding**

Enhanced flooding will reduce the length of time until the underground workings are flooded. Enhanced flooding could reduce the overall underground (and open pit) flooding time to as little as a few decades (Section 6.18.1; Attachment 1 in Appendix E). Additional water sources that can be used to flood the underground (and open pit) comprise all areas of site development including the tailings management area, stockpile drainages and West Creek, together with a portion of the Pinewood River flows.

The principal advantage of flooding the underground more aggressively will be to reduce the time available for ARD development from exposed underground working faces. Principal disadvantages associated with flooding the underground (and pit) more aggressively include: reductions in watercourse flows and fish habitat while the mine workings are flooding. Further details are provided in Appendix E (Attachment 1). With the natural flooding scenario, described above, there will be no outflow from the underground workings (and the open pit) for several decades, as groundwater and localized surface runoff will flow towards the workings.

If the underground workings were to be sealed off from the open pit, for any reason, as part of active mining, then the underground workings could be actively flooded much more quickly.

**Backfill with Mineral Wastes**

A substantive portion, but not all, of the underground workings will be filled with crushed mine rock backfill during mining operations. Backfilling during mining is required to provide structural stability. Without the use of backfill, it will not be feasible to effectively mine the entire underground ore body with planned mining methods.

#### 6.19.2.2 Performance Objectives and Evaluation

Performance objectives applicable to underground mine closure are the following:

- Cost-effectiveness;
- Technical applicability;
- Minimize effects (adverse) to the natural environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

Allowing the underground workings to flood passively is standard industry practice, has no added costs and does not confer any undue liabilities or risks. Enhanced flooding of the underground workings will only be effective if secured bulkheads were established to hydraulically isolate the underground workings from the open pit; otherwise any water added to the underground workings will simply equilibrate with the open pit water level. Additional costs will be incurred to construct the bulkheads and to pump water to the underground, with little benefit. Partial backfilling of the underground workings with mine rock is required in any event to support mining. Complete backfilling of the underground workings with crushed mine rock is not financially viable and will serve no water quality control purpose, as the void spaces within the mine rock backfill will not flood until the water level rises in the open pit.

Natural flooding is therefore the preferred alternative. Enhanced flooding is considered acceptable. Complete backfilling is not proposed and is considered unacceptable.

**Technical Applicability**

Natural and enhanced flooding are both technically feasible. Natural flooding is a common practice within the industry. Both are rated as preferred for this performance objective. Partial backfilling of the underground workings with crushed mine rock will occur during operations, as described above, but it will be technically difficult to backfill the entire underground workings. This alternative is rated as unacceptable.

**Effects to the Natural Environment**

The total volume of the underground workings is expected to be in the order of 1.8 $Mm^3$, which represents less than 1% of the projected open pit volume. The underground workings will be connected to the open pit unless bulkheads are put in place to hydraulically isolate the underground workings from the open pit. Whether or not the underground workings flood naturally or in an enhanced manner, or are backfilled, will have little effect on overall water management at the site during mine closure; and hence little effect on site effluent discharge quality, receiving water quality or receiver fish habitat.

All alternatives are rated as preferred for this performance objective.

**Amenability to Reclamation**

Whether or not, the underground workings are flooded passively or in an enhanced manner or are backfilled, will have a negligible effect on site environmental conditions following closure.

All alternatives are rated as preferred for this performance objective.

#### 6.19.2.3 Summary Evaluation

Natural flooding of the underground workings is the preferred alternative based principally on costs. Enhanced flooding is rated as acceptable. Complete backfilling of the underground workings will be technically difficult, costly and will serve no purpose.

### 6.19.3 Stockpiles

#### 6.19.3.1 Alternatives

There are four primary stockpiles associated with the RRP:

- West mine rock stockpile;
- East mine rock stockpile;
- Overburden stockpile; and
- Low grade ore stockpile (Section 4.6).

The mine rock stockpiles and overburden stockpile will be present at the cessation of mining and processing operations at the RRP, although a substantive volume will be re-used for construction, development and reclamation purposes.

The low grade ore stockpile will contain that portion of the low grade ore generated from the open pit during the first approximately 10 years of mining that is not directly processed. It will be processed during the latter third of the mine life along with ore generated from the underground mine. There is no intent for the low grade ore stockpile to remain at closure. If the economics are such that the low grade ore cannot be viably processed, the low grade ore stockpile will be reclaimed in a manner consistent with the east mine rock stockpile, unless it can be demonstrated to be NPAG.

At the completion of mining the mineral waste stockpiles must be closed out in accordance with Ontario Regulation 240/00, amended O. Reg. 307/12, and the Code of the Ontario *Mining Act*. Section 24(2) of Regulation states the following:

> *All tailings, rock piles, overburden piles and stockpiles shall be rehabilitated or treated to ensure permanent physical stability and effluent quality.*

Section 59 (2) of the Code states the following:

> *In order to ensure the chemical and physical stability of the ML or ARD generating materials and that the quality of the environment is protected, the management plan [for waste rock stockpiles] shall consider, where appropriate,*
>
> - *The design and construction of covers and diversion works; and*
> - *The use of passive and active treatment systems.*

Section 71 of the *Code* states the following:

> *When revegetating waste rock storage areas … or other steeply sloped features, the following specific measures shall be considered, where appropriate:*
>
> - *Contouring to mimic local topography and blend into surrounding landscape.*
> - *The application of soil to a depth sufficient to maintain root growth and nutrient requirements.*
> - *The incorporation of organic materials, mulches and fertilizers based upon soil assessment.*
> - *The scarification or ripping of flat surfaces which may have been compacted by heavy equipment.*
> - *Improving site drainage to prevent water erosion on rehabilitated areas.*

The Provincially-approved Amended ToR provides for the following preliminary closure strategies for reclamation of the RRP overburden and mine rock stockpiles:

- Re-use during construction;
- Stabilize and cover / revegetate;
- Use in backfill; and
- Engineered cover.

These alternatives are not necessarily mutually exclusive and are frequently used in combination with one another.

**Re-use**

An estimated 16 Mt of overburden and mine rock will be needed for site construction works, with the majority of this material being required for the construction of tailings dams and other RRP impoundment structures. An additional volume of overburden will be required for site reclamation. There are more than sufficient mineral wastes generated from the development of the open pit to provide the required materials.

**Stabilize and Cover / Revegetate**

For overburden and NPAG mine rock stockpiles, the standard reclamation approach is to contour the stockpiles either progressively during operation or at closure, and then to develop a stabilizing vegetative cover that will ultimately provide for other uses such as wildlife habitat. For the west mine rock stockpile, a layer of overburden will typically be applied over all or part of the stockpile, potentially organics or topsoil to assist with plant growth. Seed will be applied to initiate a ground cover, along with tree seedlings and shrub plantings, as appropriate to support wildlife.

**Use in Backfill**

Underground mining typically requires a quantity of backfill to fill underground voids after the ore has been removed to provide structural stability, which then allows the mining of adjacent areas. Without the use of backfill, it will not be feasible to effectively mine the underground RRP ore body with planned mining methods. Crushed rock fill is a common backfill material, although other materials are possible. Rock backfill material can consist of NPAG or NPAG materials and will be available over the entire underground mine life.

**Engineered Cover**

Engineered or composite covers may be used on mine rock stockpiles to control ARD development, as well as to provide for overall stockpile stability and wildlife habitat or other functions. The purpose of the engineered cover for ARD management is to limit precipitation and oxygen contact with the underlying reactive (PAG) material. Details of the engineered cover proposed for the RRP PAG stockpile are provided in Appendix E. Even with use of a well engineered cover, there will still be some precipitation infiltration into the stockpile that will discharge from the toe of the stockpile as seepage. This seepage will have to be collected and managed for potential ARD elements. The quantity and quality of this seepage will; however, be vastly improved compared with that derived from use of a simple overburden cover.

#### 6.19.3.2 Performance Objectives and Evaluation

Performance objectives applicable to overburden and mine rock stockpile closure are the following:

- Cost-effectiveness;
- Technical applicability;
- Ability to service the site effectively;
- Minimize effects (adverse) to the natural environment;
- Minimize effects (adverse) to the human environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

The most cost-effective management approach for overburden and mine rock resulting from the mine development is to utilize these materials for site construction, in underground mine backfill to the extent required to support mine operations and in reclamation, and then to contour and cover any remaining stockpiled material. Where such mineral wastes are needed and can be utilized, it is the most cost-effective to re-use these materials rather than to extract aggregate from another source. There are no plans to use stockpiled mineral wastes for open pit backfill (Section 6.18.1).

In regards to reclamation, the most cost-effective alternative is to develop a simple cover over both the west and east mine rock stockpiles. Development of a simple cover for reclamation of the east mine rock stockpile could potentially be more costly in the longer term, if ARD conditions were to develop. This could also present a risk for obtaining environmental approvals and negatively affect investor confidence.

Alternatives are therefore preferred from the cost perspective for selective uses as follows:

- Re-use during construction to the extent feasible based on site demand;
- Stabilize and cover / revegetate for overburden and west mine rock stockpiles only;
- Use in backfill for underground mining only; and
- Engineered cover for the east mine rock stockpile and any remaining ore stockpiles.

**Technical Applicability**

In regards to technical applicability, overburden and NPAG mine rock are preferentially used for construction. Mine rock (NPAG or PAG) is preferentially used for underground mine backfill and are preferred alternatives to the extent that materials are required. Simple covers are preferred for reclamation of NPAG rock stockpiles together with revegetation. Overburden stockpiles generally require revegetation. Engineered covers are being used increasingly in the industry to better control ARD development, and are preferred for PAG mine rock and for any low grade ore that might be left on surface at closure.

All alternatives are therefore preferred for selective uses from the technical perspective as follows:

- Re-use during construction to the extent feasible based on site demand;
- Stabilize and cover / revegetate for overburden and west mine rock stockpiles only;
- Use in backfill for underground mining only; and
- Engineered cover for east mine rock and any remaining ore stockpiles.

**Ability to Service the Site Effectively**

Overburden and NPAG mine rock are proposed to be used preferentially for site construction rather than development of separate aggregate pits and quarries where materials are of equivalent utility. PAG mine rock may be acceptable for selected construction functions where there is limited risk of long term exposure to oxygen, such as internal access roads within the developing overburden stockpile. Mine rock is commonly used for underground backfill, and will be readily available when needed. Re-use during construction and use in backfill, are therefore preferred for the respective and limited uses discussed above. The ability to service the site effectively performance objective is not applicable to the alternatives of stabilize and cover / revegetate and engineered cover.

**Effects to the Natural Environment**

Utilization of a portion of mine mineral wastes for construction will reduce the volume and footprint of mineral waste stockpiles, and will reduce potential disturbance associated with obtaining construction materials from other sources. However, as noted above, only a small portion of mineral wastes can be disposed of in this manner. Utilization of a portion of mine mineral wastes for underground backfill will also reduce the volume and footprint of mineral waste stockpiles, and will reduce potential disturbance associated with obtaining backfill from other sources. Only a very small portion of the mineral wastes can be disposed of in this manner.

The bulk of the RRP mineral wastes must be reclaimed per Provincial mine closure planning requirements. Stabilize and cover / revegetate, and engineered cover will limit the release of suspended solids loadings to receiving waters and provide habitat for plant and animal species including SAR species. Use of an engineered cover will also inhibit ARD development and any associated metal loadings to receiving waters.

All alternatives are preferred from the perspective of natural environment effects for selective uses as follows:

- Re-use during construction to the extent feasible based on site demand;
- Stabilize and cover / revegetate for overburden and west mine rock stockpiles only;
- Use in backfill for underground mining only; and
- Engineered cover for the east mine rock stockpile and any remaining ore stockpiles.

**Effects to the Human Environment**

The use mine mineral wastes for construction and underground mine backfill will contribute to a reduction in overall mineral wastes that will otherwise need to be stockpiled on surface.

Revegetation of mineral waste stockpiles at closure will improve area aesthetics, and potentially contribute to local hunting and other outdoor recreational opportunities. Use of an engineered cover to better control ARD development from PAG rock will help to maintain receiving water quality and associated aquatic resources.

All alternatives are preferred from the perspective of human environment effects for selective uses as follows:

- Re-use during construction to the extent feasible based on site demand;
- Stabilize and cover / revegetate for overburden and west mine rock stockpiles only;
- Use in backfill for underground mining only; and
- Engineered cover for the east mine rock stockpile and any remaining ore stockpiles.

**Amenability to Reclamation**

All alternatives are preferred from the perspective of reclamation for selective uses as follows:

- Re-use during construction to the extent feasible based on site demand;
- Stabilize and cover / revegetate for overburden and west mine rock stockpiles only;
- Use in backfill for underground mining only; and
- Engineered cover for the east mine rock stockpile and any remaining ore stockpiles.

#### 6.19.3.3 Summary Evaluation

The alternatives considered herein are complementary to one another, and all alternatives are preferred for selective uses as per the following summaries.

**Re-use during Construction and Use in Backfilling Operations**

An estimated 16 Mt of overburden and NPAG rock will be required for tailings dam and other related construction, together with an estimated approximately 1.5 $Mm^3$ of mine rock for underground mine backfill (subject to final design). Additional mine rock is also likely to be used for other site construction purposes such as for the development and maintenance of site roads. Therefore an estimated 5 to 10% of projected mineral wastes will be used to meet construction and underground backfill needs.

**Stabilize and Cover / Revegetate and Engineered Cover**

For overburden and west mine rock stockpiles, the preferred reclamation approach is to stabilize the slopes of the stockpiles, and to cover mine rock with overburden in order to develop a self-sustaining vegetative cover. The preferred alternative for east mine rock stockpile (and unprocessed ore stockpile on surface at closure, if any) is to develop an engineered cover to better manage the potential for ARD development.

### 6.19.4 Tailings Management Area

#### 6.19.4.1 Alternatives

During the operation phase, the tailings management area will consist of a larger tailings solids repository and an associated internal tailings pond. At closure, the tailings management area is expected to contain an estimated 115 Mt of tailings solids, which will take the form of a wide perimeter beach of exposed tailings, occupying approximately 90% of the basin footprint, together with a smaller central tailings pond occupying approximately 10% of the basin. As the tailings solids are PAG, they must be isolated from exposure to oxygen at closure to prevent ARD development. Oxygen exclusion can be achieved through development of an approximately 2 m or greater water cover, or by means of an approximately 2 m or greater low-permeability overburden (or other) cover. Either alternative will keep the tailings solids saturated, restricting oxygen transport within the tailings pore spaces, and will act as a diffusion barrier restricting oxygen in the atmosphere from contacting the tailings surface.

The tailings dams and associated spillway(s) will be stabilized during operations for long term performance, with periodic inspections by a qualified engineer in accordance with regulatory requirements.

At the completion of mining the tailings management area must be closed out in accordance with Ontario Regulation 240/00, amended O. Reg. 307/12, and the Code. Section 24(2) of Regulation states the following:

> *All tailings, rock piles, overburden piles and stockpiles shall be rehabilitated or treated to ensure permanent physical stability and effluent quality.*

Sections 35 and 36 of the Code state:

> *The objective of this Part of the Code is to ensure the long term physical stability of tailings dams and other containment structures.*
>
> *The procedures and requirements set out in the Dam Safety Guidelines published by the Canadian Dam Safety Association shall be given due regard by all persons engaged in the design, construction, maintenance and decommissioning of tailings dams and other containment structures.*

Section 72 of the Code states:

*When revegetating tailings surfaces, the following reclamation measures shall be considered, where appropriate:*

- *Contouring to provide accessibility and good surface drainage while controlling surface erosion.*

- *Removing any crests prone to wind erosion or creating/planting live wind breaks.*

- *The scarification or ripping of crusted surfaces.*

- *The incorporation of organic materials and mulches.*

- *Correcting the pH and adding fertilizer based upon soil assessment and vegetation requirements.*

- *Applying soils or a gravel barrier.*

The Provincially-approved Amended ToR provides for the following closure strategies for reclamation of the tailings management area:

- Stabilize and permanent flooding;
- Cover with mineral wastes and revegetate;
- Stabilize and permanent flooding / cover with overburden and revegetate; and
- Cover with modified mineral waste and revegetate.

These various closure strategy alternatives are not necessarily mutually exclusive, and are frequently applied in combination with one another.

**Stabilize and Permanent Flooding**

The intent of flooding PAG tailings is to restrict oxygen contact with the tailings, thereby preventing the development ARD. ARD occurs when oxygen in combination with moisture reacts with sulphide materials present in the tailings to generate sulphuric acid which then acts to leach any metals present in the tailings. The water cover acts as an oxygen diffusion barrier between the overlying atmosphere and the underlying tailings. Some oxygen will be transferred from the atmosphere through the water cover to the flooded tailings solids surface, but quantities will be limited provided that the water cover is of sufficient depth. Industry experience has shown that a water cover of approximately 2 m or greater will provide an effective oxygen diffusion barrier. The second function of the water cover is to ensure that the underlying tailings remain saturated. Saturation restricts oxygen diffusion within the tailings pore spaces. The water cover should be of sufficient depth that it does not diminish to excessively low levels during periods of prolonged drought (or this effect is otherwise mitigated).

The major limitation to using water covers as the sole means of oxygen restriction is that this strategy requires the impoundment of considerable volumes of water in order to flood all exposed tailings beaches. In the case of the RRP, it is expected that the tailings beaches will form at an approximate slope angle of 1%. Therefore with exposed beach lengths in the order of 1 km at closure, the tailings basin pond level will have to be raised by about 12 m from the operating level condition to flood all exposed beaches. This results in a considerable volume of water being impounded in perpetuity, and will pose a long term dam stability risk, particularly if ponded water is against the tailings dams.

**Stabilize and Cover with Mineral Wastes and Revegetate**

Low permeability overburden covers also provide an effective oxygen barrier. The cover needs to be thick enough and of appropriate material, such that they do not form deep desiccation cracks that will allow oxygen transport.

The principal limitations for developing a complete overburden cover are costs and the geometric limitations presented by the tailings surface. Covering a tailings surface of approximately 8 $km^2$ to a depth of 2 m will therefore cost an estimated $80M, excluding costs for revegetation. The tailings surface geometry will also pose a concern. In order to drain the tailings pond which will be near the centre of the facility during operations, a substantial wedge of tailings will have to be removed in order to establish a drainage way / spillway.

**Stabilize and Permanent Flooding / Cover with Overburden and Revegetate**

This alternative is a combination of the two alternatives described above, whereby a central portion of the tailings surface will have enhanced flooding at closure by raising the operating pond surface; but the pond surface will not be raised to the extent that ponded water will contact the perimeter dams. Instead a perimeter zone of exposed tailings beach will be maintained, to keep the central pond away from the dams. This zone of exposed tailings beach and a contingency area where the water cover might not be retained during drought conditions will be covered with a low permeability layer of overburden. A drainage way / spillway will connect the central pond with the tailings management area perimeter as described for the complete cover scenario above, but the cut through the tailings solids in this case will be much smaller.

**Cover with Modified Mineral Waste and Revegetate**

This alternative involves placement of a depyritized tailings cover over the tailings surface. To produce depyritized tailings which are NPAG, a flotation circuit will be added to the milling process to remove the sulphide fraction of the tailings solids as a sulphide concentrate (typically about 10 to 15% of the tailings mass). The smaller quantity sulphide concentrate can be buried in the tailings management area, while the remaining 85 to 90% of the tailings which are non-reactive, could be placed as a chemically stable, NPAG cover over the PAG tailings produced during the majority of operations. The depyritized tailings cover will form an oxygen barrier similar to that described for the low permeability overburden cover. It will take approximately 3 years of processing to develop a cover of suitable thickness and uniformity. A soil cover will still be required on top of the depyritized tailings to support plant growth.

Developing a flotation circuit to generate a depyritized tailings cover for closure, that will still require an overlying soil cover for plant growth is not considered economic, or otherwise competitive with the alternatives described above, and is not considered further.

#### 6.19.4.2 Performance Objectives and Evaluation

Performance objectives applicable to reclamation and closure of the tailings management area are the following:

- Cost-effectiveness;
- Technical applicability and/or system integrity and reliability;
- Minimize effects (adverse) to the natural environment; and
- Amenability to reclamation.

A detailed assessment of the alternatives is presented in tabular form in Appendix O, utilizing methodologies, criteria and indicators described in Section 6.2. The following sections summarize results of the detailed assessment.

**Cost-effectiveness**

The most cost-effective approach to tailings management area closure will be to provide a water cover, as the perimeter tailings dams will already have been constructed to a height near to that required to support such a cover during mine operations (an additional approximately 12 m height is required). Developing a 2 m average thickness overburden cover over the entire tailings surface will cost an estimated $80M. The RRP cannot support such a cost, particularly as all or most of this cost will have to be posted early on as part of the Closure Plan financial assurance. Development of a complete overburden cover is therefore uneconomic, and is unacceptable. There is a potential concern with the long term risk of maintaining a complete water cover that also makes this alternative unacceptable from project financing / risk perspective, in addition to the extra costs of raising the dams. The preferred alternative is therefore a blending of the two alternatives, whereby a substantial portion of the tailings surface will be flooded at closure, supported by perimeter covered tailings beach around the tailings management area periphery to keep the central tailings pond away from the perimeter dams in the long term.

**Technical Applicability and/or System Integrity and Reliability**

Each of the alternatives is predictably effective in the ability to control ARD potentials, but provision of a complete water cover is rated as acceptable because there is greater risk associated with maintaining a large volume of ponded water against the tailings dams in perpetuity. The other two alternatives (low permeability cover and combined overburden / water cover) are rated as preferred for this performance objective.

**Effects to the Natural Environment**

All alternatives are capable of preventing the development of ARD and of protecting downstream wetlands and receiving waters. The principal limitation to use of the water cover alternative on its own is that it will not generate terrestrial habitat that will be capable of supporting plant and wildlife species. In contrast, the full overburden / soil cover alternative will generate an extensive area of terrestrial habitat (approximately 8 $km^2$), once the tailings management area is fully restored, that will be capable of supporting plant and wildlife species. The mixed cover alternative (pond and perimeter overburden zone) will be capable of supporting terrestrial and wetland plant and wildlife species. The full water cover alternative is rated as acceptable, and the remaining two alternatives (low permeability cover and combined overburden / water cover) are rated as preferred.

**Amenability to Reclamation**

All alternatives proposed are capable of preventing the development of ARD and protecting downstream wetlands and receiving waters. The principal limitation to the complete water cover alternative is that it will not generate terrestrial habitat that will be capable of supporting plant and wildlife species and that it presents a greater long term potential risk. This alternative is rated as acceptable.

Development of a low permeability cover and combined overburden / water cover pose less long term potential risk because there will be no ponded water against the tailings dams and provide habitats that will support plant and wildlife species, potentially including SAR. Both of these alternatives are rated as preferred for this performance objective.

### 6.19.4.3 Summary Evaluation

Establishment of a complete water cover alternative will be effective for ARD control and is the most cost effective alternative. This alternative carries an inherent long term potential risk because the ponding of water against the tailings dams is not preferred with respect to geotechnical stability, and unlike the other two alternatives will not provide any appreciable terrestrial or wetland habitat at closure. This alternative was consequently considered unacceptable overall. The complete overburden cover will also be effective for ARD control, will provide terrestrial habitat and will be associated with low risk; but this alternative will be prohibitively expensive, and is therefore also unacceptable. The combined alternative consisting of an enlarged central ponded area, surrounded by a perimeter zone of tailings covered with overburden, provides the best balance of environmental protection, cost and risk, and is therefore the preferred alternative.

### 6.19.5 Buildings and Equipment

Principal buildings and related structures on the RRP site will include the following:

- Ore process plant;
- Primary crusher;
- Coarse ore stockpile transfer house;
- Administration building;
- Mine office and dry;
- Maintenance shop, warehouse;
- Truck wash; and
- 230 kV substation.

There will also be other minor buildings associated with the explosive manufacturing facility, security and pump houses.

Primary equipment will comprise:

- Crushers and processing equipment housed at the primary crusher and in the process plant;
- Various conveyors, including linking the primary crusher, coarse ore stockpile transfer house and the ore process plant;
- Mobile heavy equipment (diesel and electric shovels, excavators, bulldozers, haul trucks, loaders, jumbos, bolter, load haul dump (LHD) vehicles, scissor lifts, crane trucks, grader, diamond drill, explosives loader, etc.);
- Pumps / pump stations;
- Underground ventilation equipment;
- Electrical equipment associated with the substation and other facilities; and
- Other miscellaneous equipment.

The Provincially-approved Amended ToR provides for the following preliminary alternatives for the disposal of buildings and equipment:

- Destruction, removal and/or disposal according to applicable regulations; and
- Re-use of acceptable buildings and equipment.

Subsection 24(2) of O. Reg. 307/12 of the Ontario *Mining Act* states the following:

> *All buildings, power transmission lines, pipelines, waterlines, railways, airstrips and other structures shall be dismantled and removed from the site to an extent that is consistent with the specified future use of the land.*
>
> *All machinery, equipment and storage tanks shall be removed from the site to an extent that is consistent with the specified future use of the land.*

It is generally interpreted that buildings and equipment, or parts thereof, that are not suitable for re-sale or re-use offsite, or for sale as scrap, can be permanently stored in an approved landfill on the mine site, in accordance with a site-specific Provincial approval (Environmental Compliance Approval). Hazardous materials such as gear boxes containing petroleum products must be shipped to a licenced landfill capable of receiving such materials.

The two alternatives listed above are not mutually exclusive in that the offsite shipment of buildings and equipment or parts thereof, or scrap derived from such materials, is feasible only where markets for such materials are available. There is no guarantee that such a market will be available at the time of closure. Where markets for such materials are not available, and where these materials are non-hazardous, such materials will be landfilled onsite. Given this context, there are no building and equipment removal / disposal alternatives in the general sense of alternatives assessed elsewhere in this document. Rather, a blend of both alternatives will be implemented in accordance with available market conditions at the time of mine closure and applicable regulatory requirements.

The development of detailed tabular evaluations of performance objectives, criteria and indicators (per Appendix O), is therefore not appropriate to this set of alternatives, and has not been carried out.

### 6.19.6 Infrastructure

#### 6.19.6.1 Alternatives

The principal RRP site infrastructure components include roads, pipelines (and associated pump stations and facilities) and transmission / power distribution lines. Alternatives relating to the decommissioning of these items as provided in the Provincially-approved Amended ToR are the following:

- Decommission and remove and dispose of wastes in accordance with applicable regulations;

- Leave in place for future use; and

- Reclaim in place.

RRP-related roads are expected to include:

- Re-aligned Highway 600;
- East Access Road;
- Site haul roads; and
- Site service roads.

RRP-related pipelines are expected to include:

- Tailings discharge and reclaim lines;
- Final effluent discharge water line(s); and
- Other internal site water transfer lines.

RRP-related transmission lines are expected to include:

- 230 kV connecting line to the Provincial grid; and
- Smaller capacity distribution lines for routing power around the RRP site.

At the completion of mining site infrastructure must be closed out in accordance Ontario Regulation 240/00, as amended by O. Reg. 307/12. Subsection 24(2) of the Regulation specifies the following in relation to roads, pipelines and transmission lines:

> *All buildings, power transmission lines, pipelines, waterlines, railways, airstrips and other structures shall be dismantled and removed from the site to an extent that is consistent with the specified future use of the land.*
>
> *All transportation corridors shall be closed off and revegetated to an extent that is consistent with the specified future use of the land.*

Since all RRP pipelines will have functions specific to the RRP, these pipelines have no reasonable potential value to other possible future land uses. The only alternative consistent with the Regulation is therefore to remove and dispose of the pipelines (in an onsite demolition landfill) once the pipelines are no longer required for site reclamation activities. Leaving the pipelines in place for future use, and/or reclaiming the pipelines in place, are not viable alternatives and are not considered further.

Similarly, it is expected that the 230 kV connecting line to the Provincial grid; and the smaller capacity distribution lines for routing power around the RRP site, will only have value to the RRP. In such an instance, the only alternative consistent with the Regulation is to dismantle the transmission / distribution lines and towers, cut the poles at the ground surface, and dispose of the materials in an onsite demolition landfill once power is no longer required for site reclamation activities. Preferentially, the poles and conductor will be re-used or recycled if possible. Substations will also require dismantling with associated materials either re-used or recycled if possible, or landfilled onsite. Leaving the 230 kV transmission line in place for future use and/or reclaiming the power infrastructure in place, are not viable alternatives and are not considered further. If a user was identified in the future that is willing to take over the 230 kV transmission line, substation and associated site distribution lines, the favoured alternative of decommissioning and disposal will need to be revisited.

The intent is that the re-aligned Highway 600 will become a permanent part of the regional road network. Reclamation is not proposed. Removal and disposal, or reclaiming in place are not viable alternatives and are not considered further.

The East Access Road will remain in place to access the RRP site as well as the limited number of properties on Marr Road. These roadways will become permanent and will be left in place for future use. Removal and disposal, or reclaiming in place are not viable alternatives and are not considered further.

Site haul roads and site service roads have a greater flexibility for potential future potential uses, and could therefore be either left in place for future use, or reclaimed in place. These roads are proposed to be reclaimed in place once they are no longer required to site maintenance and monitoring. The option of leaving the roads in place for use by others could be revisited at a later date.

#### 6.19.6.2 Performance Objectives and Evaluation

Based on discussion of the alternatives presented above, there are no real alternatives to dismantling and removing project-related pipelines and transmission lines once they are no longer needed. Similarly there are no alternatives other than to retain the function of the re-aligned Highway 600 and the new East Access Road. The only viable alternative consistent with the Regulation is to reclaim the site haul and service roads in place once they are no longer needed for Closure Plan implementation or site maintenance and monitoring.

The development of detailed tabular evaluations of performance objectives, criteria and indicators, as per Appendix O, is therefore not appropriate to this set of alternatives, and has not been completed.

#### 6.19.6.3 Summary Evaluation

Based on the above, the preferred alternatives are to dismantle and removing all project-related pipelines and transmission lines once they are no longer needed for Closure Plan implementation; to retain permanent use of the re-aligned Highway 600 and the new East Access Road; and to reclaim mine site area roads in place.

### 6.19.7 Drainage

#### 6.19.7.1 Alternatives

RRP site drainage modifications include the installation of road culverts, ditching, various ponds, and the re-alignment of West Creek and Clark Creek. Alternatives relating to surface drainage restoration at closure, included in the Provincially-approved Amended ToR, are the following:

- Stabilize and leave in place; and
- Removal and restoration.

Culverts will be used to support site road development as required for cross-drainage control. Culverts will be left in place until the roads they service are no longer required and will be removed thereafter.

Ditching at the RRP site includes:

- Road-side ditching; and
- Ditching to meeting Metal Mining Effluent Regulation effluent collection and management requirements.

Various ponds are present at the RRP site and include:

- Water management pond;
- Mine rock pond;
- Stockpile pond;
- West Creek pond;
- Water discharge pond and associated constructed wetland complex; and
- Terminal collection ponds associated with Metal Mining Effluent Regulation ditching.

Subsections 71(1), (5) and (7) of the Code state the following relative to site preparation and drainage control for final closure, respectively:

- *Contouring to mimic local topography and blend into the surrounding landscape.*

- *Improving site drainage to prevent water erosion on rehabilitated areas.*

- *Contouring and sloping of impoundment areas must be integrated with engineering design.*

The general preference is to remove drainage features, and to contour and restore the associated lands wherever possible, unless the drainage features in question are integral to overall site water management following closure. Otherwise it will be the responsibility of the proponent to continue to monitor the function and stability of any such drainage features in accordance with Section 66 of the Code, and in accordance with Metal Mining Effluent Regulation requirements.

**Ditching**

The alternatives for road-side ditching are to stabilize and leave the ditches in place, or to backfill the ditches once the roadways in question are no longer needed. Roadside ditches will stabilize with vegetation over the course of the mine life, and will not pose a flood risk once the associated road culverts are removed. Backfilling the roadside ditches will therefore serve no purpose and is not proposed. The ditches will be left in place with any associated culverts removed.

Metal Mining Effluent Regulation ditching is needed to achieve compliance with the Regulation. Regulation-related ditching will therefore be left in place until such time as it can be demonstrated that Metal Mining Effluent Regulation monitoring of the involved mine component is no longer required. Once the mine becomes a recognized closed mine, regulation-related ditching will be stabilized and left in place, the same as for roadside ditching. Backfilling the Metal Mining Effluent Regulation ditches will serve no purpose and is not proposed.

**Ponds**

The water management pond will no longer be required once the tailings management area is fully reclaimed and is capable of generating a runoff of acceptable water quality, or it is directed to the open pit to assist with pit flooding. At such time maintaining water holding dams will create an unnecessary RRP liability. The water management pond dams will therefore be breached to prevent retention of water. Upstream dam faces that become exposed will be revegetated. The alternative of stabilizing and maintaining the water management pond in the long term will serve no purpose, and is not proposed.

The water discharge pond dam will be similarly breached once it no longer has a water management function.

The berms used to develop the constructed wetland will however, be left in place as this system will be designed to operate passively, and will have stabilized as a wetland complex during operations. The alternative of removing these berms at closure could prove problematic, as any such action could cause a sudden release of wetland sediments and associated metals to the Pinewood River.

The major function of the stockpile pond during mine operation will be to help prevent excess runoff from entering the open pit. As described above, once mining operations are completed, the intent will be to flood the pit as quickly as practicable. Maintaining the stockpile pond after mining is completed will therefore serve no function. The stockpile pond dam will be breached and the associated runoff directed to the pit. The alternative of maintaining the pond is rejected.

The principal function of the West Creek pond during operations will be to provide a freshwater source. The West Creek pond is also expected to comprise part of the RRP fish habitat compensation package. Once processing ceases, the West Creek pond will no longer have a water supply function, but it will still have a fish habitat compensation function and it will be retained as fish habitat.

The function of the mine rock pond is more complex. During operations, this pond will collect runoff and seepage from the east mine rock stockpile, as well as from open pit and underground dewatering. The accumulated water will be the primary water source for processing, with any excess water to be pumped to the tailings management area. At closure, the only water reporting to the mine rock pond will be runoff and seepage from the east mine rock stockpile which will then be directed to the open pit to help flood the pit, and to help manage site runoff and seepage. At closure there will likely still be some value in maintaining the mine rock pond, but the quantity of ponded water could be considerably reduced. The preferred alternative is to lower the dam, and stabilize in place.

Terminal ponds associated with Metal Mining Effluent Regulation ditching will be maintained until such time as the site or if applicable, individual site components become a recognized closed mine. At such a time, any applicable pond impoundment structures will be breached and the residual pond sites will be stabilized and restored.

**Re-aligned West Creek and Clark Creek**

West Creek and Clark Creek will be re-aligned as part of mine development to avoid direct drainage to the open pit and through the east mine rock stockpile, respectively. Over the course of mine development the re-aligned creek will become stabilized. The re-aligned creeks may also become part of the RRP fish habitat compensation works, and as such the intent at closure will be to leave the re-aligned creeks in place. Restoration of the original creek alignments is therefore not proposed.

#### 6.19.7.2 Performance Objectives and Evaluation

For ditching, the alternatives are to stabilize and leave in place, or to remove and restore. Removal will entail backfilling the ditches which will serve no purpose. Gradients at the RRP are sufficiently flat, such that there is no realistic potential for erosional scour of ditches. Providing a detailed review of the alternatives is therefore not warranted. The ditches will therefore mostly be left in place, with any associated culverts removed.

For the majority of the site ponds, the water holding function will no longer be required following closure. The exceptions are the West Creek pond and mine rock pond as described above. Since maintaining water impoundments unnecessarily will serve no function and will pose an environmental liability, a detailed evaluation of the alternatives is not required. Impoundments associated with all such ponds will be breached and the impoundment sites will be restored.

In regards to the West Creek and Clark Creek re-alignments the re-aligned creek will be left in place. There are no other reasonable alternatives.

The development of detailed tabular evaluations of performance objectives, criteria and indicators (per Appendix O), is therefore not appropriate to this set of alternatives, and has not been carried out.

#### 6.19.7.3 Summary Evaluation

Based on the above, the preferred alternatives are generally to stabilize site area ditching and leave it in place; breach (remove) all water holding ponds and restored the pond sites, with the exception of the West Creek pond and mine rock pond as described above; and to leave the re-aligned West Creek and Clark Creek in place.

**Table 6-1: Natural Environment Considerations**

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Air quality and sound | Environmental effects | • Will generate dust, emissions from fuel combustion and processing (including greenhouse gases), vibration and sound | Same as for Alternative 1 | None |
| | Potential for mitigation | • Spray water or approved dust suppressants along site roads, and progressive reclamation for dust control<br>• Use of transmission line power, proper vehicle maintenance and emission control equipment to reduce air pollutants (including greenhouse gasses)<br>• Sound will be mitigated through enclosing equipment, proper equipment maintenance and stockpile and facility placement (process plant will be surrounded by high ground and other infrastructure) | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| SAR | Environmental effects | • Direct loss of habitat, and general disturbance to SAR including Eastern Whip-poor-will and Bobolink | Same as for Alternative 1 | None |
| | Potential for mitigation | • Maintain as compact a site as practical<br>• Avoidance of SAR habitat as practical<br>• Additional Eastern Whip-poor-will and Bobolink habitat will be created as part of the Provincial SAR permitting process | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| Earth or life science features | Environmental effects | • Ridges of high ground to the northeast of the RRP site are relatively undeveloped and will be the site of a transmission line | Same as for Alternative 1 | None |
| | Potential for mitigation | • Maintain as narrow of a transmission line ROW as practical and utilize existing access for construction as possible | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| Fish, aquatic resources and habitats | Environmental effects | • Treated effluent will be discharged to the Pinewood River as required<br>• Overprinting of minor creeks and drainages associated with tailings management area, stockpiles, open pit and process plant development<br>• Potential flow reductions in local creeks and the Pinewood River system associated with open pit dewatering | Same as for Alternative 1 | None |

| Environmental Component | Information Requirements | Alternative 1 Proceed with RRP as Planned | Alternative 2 RRP Delayed | Alternative 3 Abandon the RRP |
|---|---|---|---|---|
| | Potential for mitigation | • In plant cyanide destruction and heavy metal precipitation using $SO_2$/Air process, followed by natural degradation of effluent prior to release to environment, combined with seepage collection<br>• Use of sumps and settling ponds for sediment control<br>• Segregation of PAG and NPAG materials to manage ARD<br>• Fish habitat compensation where appropriate<br>• High rate of water recycle for the process plant will reduce water takings from Pinewood River and locals creeks | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| Land subject to hazards | Environmental effects | • No such lands have been identified | Same as for Alternative 1 | None |
| | Potential for mitigation | Not Applicable | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 1 | Level 1 | Not Applicable |
| Recovery of a species under special management | Environmental effects | • See SAR above | Same as for Alternative 1 | None |
| | Potential for mitigation | • See SAR above, Eastern Whip-poor-will does not have a recovery plan, Bobolink has a draft recovery plan | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| Terrestrial wildlife | Environmental effects | • Project development will displace local terrestrial habitat and associated wildlife<br>• Potential for general disturbance caused by sound and vibration emissions<br>• Potential for vehicular collisions | Same as for Alternative 1 | None |
| | Potential for mitigation | • Mitigation measures as described above (e.g., manage air emissions, develop compact site and progressively reclaim the site) | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 4 | Level 4 | Not Applicable |
| Vegetation and habitat | Environmental effects | • Project development will displace local terrestrial habitat and associated plant species<br>• Transmission line ROW will require clearing of wooded areas | Same as for Alternative 1 | None |
| | Potential for mitigation | • Mitigations as described above (including manage air emissions, develop compact site, progressive reclamation)<br>• Transmission line ROW width will be limited to the extent practical<br>• Complete mitigation is not possible because the open pit and fish habitat compensation will result in a net loss of terrestrial habitat. | Same as for Alternative 1 | Not applicable |
| | Significance | Level 4 | Level 4 | Not Applicable |
| Permafrost | Environmental effects | Not applicable | Not Applicable | Not Applicable |
| | Potential for mitigation | Not Applicable | Not Applicable | Not Applicable |
| | Significance | Not Applicable | Not Applicable | Not Applicable |

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Soils and sediment quality | Environmental effects | • Potential for soil damage in the area of PAG material storage<br>• Potential for minor areas of soil damage associated with potential hydrocarbon and other spills | Same as for Alternative 1 | None |
| | Potential for mitigation | • PAG and NPAG materials to be segregated for optimal long term management<br>• Procedures and infrastructure to be put in place to reduce the potential for hydrocarbon and other spills, and to clean up any spills that do occur on a regular basis | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 1 | Level 1 | Not Applicable |
| Drainage or flooding | Environmental effects | • RRP infrastructure located on Pinewood River floodplain<br>• West Creek flows over the open pit<br>• The east mine rock stockpile containing PAG material will overprint Clark Creek<br>• Other site infrastructure could interfere with local surface drainage<br>• Highway 600 watercourse crossings may be degraded by increased traffic<br>• Site water management will be complex | Same as for Alternative 1 | None |
| | Potential for mitigation | • Flood control berm along the south of the overburden / west mine rock stockpile and open pit to prevent flooding of site infrastructure<br>• West Creek (including Cowser Drain) and Clark Creek (including Teeple Drain) will be diverted to avoid RRP facilities<br>• Minor drainage improvements around the mine site, including culvert replacement and repairs along Highway 600, to better protect infrastructure and local roads<br>• Constructed wetland and other ponds will be created to optimize site water management<br>• High rate of water recycle for the process plant will reduce the amount of water taking from Pinewood River and local creeks | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| Sedimentation or erosion | Environmental effects | • Potential sediment release from mineral stockpiles and exposed lands | Same as for Alternative 1 | None |
| | Potential for mitigation | • Perimeter ditching and runoff collection ponds around site infrastructure | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 1 | Level 1 | Not Applicable |

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Release of excess parameters | Environmental effects | • Treated effluent will be discharged to the environment<br>• Sediment management ponds will discharge to nearby watercourses if water quality criteria are met<br>• Potential for localized spills from industrial operations | Same as for Alternative 1 | None |
| | Potential for mitigation | • In-plant cyanide destruction and heavy metal precipitation using $SO_2$/Air process, followed by natural degradation of effluent prior to release to environment, combined with seepage collection<br>• Use of sumps and settling ponds for sediment control<br>• Segregation of PAG and NPAG materials to manage ARD<br>• High rate of water recycle for the process plant will reduce water discharge to the environment<br>• Procedures and infrastructure to be put in place to reduce the potential for hydrocarbon and other spills, and to clean up any spills that do occur on a regular basis | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 2 | Level 2 | Not Applicable |
| Natural heritage features | Environmental effects | • No natural heritage features, beyond those discussed above | Same as for Alternative 1 | None |
| | Potential for mitigation | • No additional mitigation measures beyond those discussed above | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 4 | Level 4 | Not Applicable |

**Table 6-2: Land Use and Resource Management Considerations**

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Access to inaccessible areas | Environmental effects | • Project development will provide improved access along the transmission line ROW | Same as for Alternative 1 | The do nothing alternative will provide no positive enhancement for other resource management projects |
| | Potential for mitigation | • Although access along the cleared ROW may be beneficial for hunters, anglers and recreational vehicles, access will be restricted as practical | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 1(+) | Level 1(+) | Not Applicable |
| Obstruct navigation | Environmental effects | • The re-alignment of Highway 600 will involve construction of a new crossing over 8 km downstream of the existing crossing | Same as for Alternative 1 | None |
| | Potential for mitigation | • Crossing will be designed to meet regulatory navigable waters requirements | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 2 | Level 2 | Not Applicable |
| Other resource management projects | Environmental effects | • Provision of 230 kV power to the immediate local area could help encourage other resource projects | Same as for Alternative 1 | The do nothing alternative will provide no positive enhancement for other resource management projects |
| | Potential for mitigation | • Potential to transfer transmission line to Hydro One Networks at RRP closure if appropriate | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 2(+) | Level 2(+) | Not Applicable |
| Traffic patterns and infrastructure | Environmental effects | • Increased use of Highway 600 and the Trans-Canada Highway (Highway 71 and Highway 11), particularly during construction period<br>• Potential increased use of the Canadian National Railway, with access to Emo, particularly during construction period<br>• Re-alignment of Highway 600 to avoid RRP infrastructure | Same as for Alternative 1 | None |
| | Potential for mitigation | • Adhere to speed limits<br>• Highway 600 re-alignment will comply with MTO highway safety requirements, improve public safety along re-alignment, and follow preferred routing of the municipality<br>• Strongly encourage project employees and contractors to adhere | Same as for Alternative 1 | Not Applicable |

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| | | to local speed limits<br>• Bus employees to site from collection point(s) if appropriate | | |
| | Significance | Level 1(+) | Level 1(+) | Not Applicable |
| Recreational importance | Environmental effects | • Potential for sound disturbance to local hunting activities<br>• RRP currently restricts access on its lands, and will continue to do so, for hunting, fishing and bait fishing | Same as for Alternative 1 | None |
| | Potential for mitigation | • Maintain as compact of a site as practical<br>• Other emission treatment systems indirectly support recreation by maintaining appropriate air, sound and water discharges | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 1 | Level 1 | Not Applicable |
| Create excessive waste materials | Environmental effects | • Large quantities of tailings and mineral waste stockpiles will be developed<br>• Potential to construct domestic material and demolition material landfills for non-hazardous solid wastes | Same as for Alternative 1 | None |
| | Potential for mitigation | • Open pit volume will be limited to the extent practical<br>• Tailings management area will be reclaimed with a water and vegetative cover at mine closure<br>• Mineral stockpiles will be reclaimed to productive wildlife habitat at mine closure if practical<br>• Landfill(s) will reclaimed according to regulatory requirements | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 4 | Level 4 | Not Applicable |
| Commit a significant amount of non-renewable resources (e.g., aggregates) | Environmental effects | • Aggregates (sand and gravel) will be required for site development and ongoing tailings management area construction<br>• Local aggregate sources are available, but require further definition<br>• Areas of limited agriculture (cattle and fodder cropping), abandoned farmland and forest will be replaced with mine infrastructure | Same as for Alternative 1 | None |
| | Potential for mitigation | • Re-use of mine waste as practical<br>• Maintain as compact of a site footprint as practical<br>• Aggregate searches by RRR could identify and delineate aggregate resources, that could potentially be made available to others | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Sound levels | Environmental effects | • Nearby residents will experience increased sound levels from RRP construction, operations and closure, including increased traffic along Highway 600 and the Trans-Canada highway | Same as for Alternative 1 | None |
| | Potential for mitigation | • Sound will be mitigated through enclosing equipment, proper equipment maintenance and stockpile and facility placement (process plant will be surrounded by high ground and other infrastructure) | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| Views and aesthetics | Environmental effects | • Mineral stockpiles (tailings management area, mine rock and overburden stockpiles developed, along with open pit, and other mine aspects)<br>• Stockpiles will be visible from a distance and will change landscape<br>• Transmission line will be visible along ridges and road crossings | Same as for Alternative 1 | None |
| | Potential for mitigation | • Site to be progressively reclaimed as possible<br>• Final closure will improve aesthetics of stockpiles<br>• Tailings surface will be submerged with a water cover and vegetation | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 4 | Level 4 | Not Applicable |
| Precondition or justification for another project | Environmental effects | Not Applicable | Same as for Alternative 1 | Not Applicable |
| | Potential for mitigation | Not Applicable | Same as for Alternative 1 | Not Applicable |
| | Significance | Not Applicable | Not Applicable | Not Applicable |
| Adjacent or nearby uses, persons or property | Environmental effects | • Local study area is a low density rural area<br>• Other nearby land is used for limited agriculture (focused on cattle and fodder cropping) and logging activities<br>• Will maintain a compact footprint; however, infrastructure placement limited to properties that RRR can purchase<br>• Limitation to local hunters, fishermen, and recreational vehicle users around the general mine site area | Same as for Alternative 1 | None |
| | Potential for mitigation | • Maintain a compact mine site<br>• Maintenance of road access to all local residents at all times<br>• Any merchantable timber cut as a result of mine site development will be made available to the local forestry licence holder | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 4 | Level 4 | Not Applicable |

**Table 6-3: Social, Cultural and Economic Considerations**

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Cultural heritage resources | Environmental effects | • Eight pre-contact sites associated with the Paleo-Indian period and four pioneer settlement sites have been identified in the local study area | Same as for Alternative 1 | None |
| | Potential for mitigation | • Archaeological sites discovered during baseline studies are protected through the Ontario *Heritage Act*<br>• Additional archaeological studies to be conducted<br>• Procedures and programs will be put in place to identify and respond to cultural heritage resources in the event that any such resources are inadvertently uncovered during mine site construction | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 3 | Level 3 | Not Applicable |
| Displace people, businesses, institutions or facilities | Environmental effects | • RRP occurs over private and occupied land and will displace local residents | Same as for Alternative 1 | None |
| | Potential for mitigation | • Maintain as compact of a project footprint as possible<br>• Provide financially generous offers on land needed for the RRP | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 4 | Level 4 | Not Applicable |
| Community character | Environmental effects | • Development of the RRP will help to maintain the character of the local resource based community by helping to sustain employment and businesses | Same as for Alternative 1 | The do nothing alternative will provide no positive enhancement to local communities |
| | Potential for mitigation | • Maximize local economic benefits | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 5(+) | Level 5(+) | Not Applicable |
| Increase demands on government services | Environmental effects | • EA and permit applications will temporarily increase workloads for government departments (primarily MNR, MOE, MNDM, MTO, Major Projects Management Office, CEA Agency, EC, DFO and NRCan)<br>• Potential for increased demands on municipal services,<br>• Project negotiations, TK/TLU studies, and environmental reviews will increase demands on Aboriginal government functions | Same as for Alternative 1 | None |
| | Potential for mitigation | • Alert the various governments to Project timelines so they can plan for increased work loads | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 2 | Level 2 | Not Applicable |

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Public health and safety | Environmental effects | • Possible release of excess parameters in discharged effluents<br>• Possible release of excess parameters as a result of spills<br>• Potential for traffic accidents | Same as for Alternative 1 | None |
| | Potential for mitigation | • On site effluent treatment and water management systems<br>• Spill contingency and clean-up plans and protocols<br>• Safe driving training programs, and adherence to speed limits<br>• Highway 600 re-alignment will comply with MTO highway safety requirements, improve public safety along re-alignment, and follow preferred routing of the municipality<br>• Bussing of employees from collection point(s) to site if applicable | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 2 | Level 2 | Not Applicable |
| Local, regional, or Provincial economies or businesses | Environmental effects | • Development of the RRP will provide direct business opportunities primarily to local and regional business to construct RRP components, supply needed materials and provide services for employees<br>• The RRP will make a significant contribution to the local and regional economy | Same as for Alternative 1 | The do nothing alternative will provide no positive enhancement to local communities |
| | Potential for mitigation | • Maximize economic benefits | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 5(+) | Level 5(+) | Not Applicable |
| Tourism values | Environmental effects | • Adverse effects to tourism expected to be minor<br>• Boost to local and regional economy may extend to tourism sector | Same as for Alternative 1 | The do nothing alternative will provide no positive enhancement to local communities |
| | Potential for mitigation | • Maximize economic benefits | Same as for Alternative 1 | Not Applicable |
| | Significance | Level 2 (+) | Level 2(+) | Not Applicable |

**Table 6-4: Aboriginal Considerations**

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| First Nation Reserves or communities | Environmental effects | • Development of the RRP will provide employment, training and business opportunities to numbers of Aboriginal persons living on First Nation Reserves/communities, together with other tangible economic benefits, such that the net effect is expected to be positive (excluding any person choice issues) | Same as for Alternative 1 | The do nothing alternative will provide no positive enhancement to local communities |
| | Potential for mitigation | • Efforts are being made, and will be made through Impact Benefit (or similar) agreements to optimize economic benefits to local Aboriginal peoples | Same as for Alternative 1 | None |
| | Significance | Level 3(+) | Level 3(+) | Not Applicable |
| Spiritual, ceremonial or cultural sites | Environmental effects | • Eight Paleo-Indian archaeological sites have been identified in the local study area during baseline studies (Woodland Heritage Services 2013) | Same as for Alternative 1 | None |
| | Potential for mitigation | • Procedures have been, and are being, set in place to involve local Aboriginal groups in the RRP on an ongoing basis to ensure that spiritual, ceremonial and cultural sites are not disturbed<br>• TK and TLU information collection from regional First Nations is ongoing<br>• Additional archaeological baseline studies to be conducted<br>• All TK, TLU and archaeological information will be available prior to major construction activities. If any sites are identified in future, disturbance to such sites will be avoided. | Same as for Alternative 1 | None |
| | Significance | Level 1 | Level 1 | Not Applicable |
| Traditional land or resources used for harvesting activities | Environmental effects | • None known | Same as for Alternative 1 | None |
| | Potential for mitigation | • Any adverse effects to traditional pursuits involving RRP site area lands will be compensated through Impact Benefit (or similar) agreements | Same as for Alternative 1 | None |
| | Significance | Level 1 (after compensation) | Level 1 (after compensation) | Not Applicable |

| Environmental Component | Information Requirements | Alternative 1<br>Proceed with RRP as Planned | Alternative 2<br>RRP Delayed | Alternative 3<br>Abandon the RRP |
|---|---|---|---|---|
| Aboriginal values | Environmental effects | • RRR is working with local Aboriginal peoples to ascertain Aboriginal values relating to cultural heritage and land use aspects. Thus far eight archaeological sites have been identified from the Paleo-Indian period that are associated with glacial lake features | Same as for Alternative 1 | None |
| | Potential for mitigation | • Pre-contact archaeological sites discovered during baseline studies are protected through the Ontario *Heritage Act*<br>• Procedures have been, and are being, set in place to involve local Aboriginal groups in the RRP on an ongoing basis to ensure that cultural heritage values are protected, and that any adverse effects to traditional pursuits involving RRP site area lands will be compensated through Impact Benefit (or similar) agreements | Same as for Alternative 1 | None |
| | Significance | Level 1 (after compensation) | Level 1 (after compensation) | Not Applicable |
| Lands subject to land claims | Environmental effects | To RRR knowledge no First Nations have an active land claim in the local area. | Same as for Alternative 1 | None |
| | Potential for mitigation | Not Applicable (RRR has no authority to negotiate or participate in land claims negotiations) | Not Applicable | Not Applicable |
| | Significance | Not Applicable | Not Applicable | Not Applicable |

**Table 6-5: Average Annualized Site Water Balance at Full Development for a 21 km$^2$ Catchment**

| Water Source or Sink | Volume ($m^3$/a) |
|---|---|
| Predevelopment average annual runoff (+) | 4,095,000 |
| Enhanced runoff resulting from site development (+) | 1,890,000 |
| Minewater addition (+) | 1,241,000 |
| Water lost to tailings voids (-) | 2,590,000 |
| Water lost to process plant evaporation (-) | 146,000 |
| Water for dust suppression (-) | 260,000 |
| Net annual discharge (+) | 4,231,000 |

**Table 6-6: Water Additions Related to Site Development for a 21 km$^2$ Catchment**

| Mine Development Stage | Water Additions Related to Site Development | | | Net Change in Pinewood River Flow ($m^3$/a) |
|---|---|---|---|---|
| | Minewater ($m^3$/a) | Enhanced Runoff Above Background ($m^3$/a) | Minewater plus Enhanced Runoff ($m^3$/a) | |
| Early Development (Year 2) | 1,241,000 | 378,000 | 1,619,000 | -1,376,000 |
| Mid Development (Year 7) | 1,241,000 | 1,323,000 | 2,564,000 | -431,000 |
| Full Development (Year 15) | 1,241,000 | 1,890,000 | 3,131,000 | +136,000 |

Note: The net change in Pinewood River flow is a function of net additions provided in the table, less the approximately 2,995,000 $m^3$/a water loss due to RRP water demands

**Table 6-7: Expected Annualized Percentage Change in Pinewood River Flows Resulting from Project Development under Varying Flow and Timeline Conditions**

| Location | Watershed Area ($km^2$) | Mean Flow (195 mm/a) | | | 5th Percentile Low Flow (66 mm/a) | | | 95th Percentile High Flow (394 mm/a) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Year 2 | Year 7 | Year 15 | Year 2 | Year 7 | Year 15 | Year 2 | Year 7 | Year 15 |
| Pinewood River at Cowser Drain (Loslo Creek) Outlet | 106.2 | -8.01 | -8.01 | -8.01 | -9.93 | -3.26 | 4.59 | -13.97 | -13.97 | -13.97 |
| Pinewood River at McCallum Creek Outlet | 207.1 | -3.45 | -1.08 | 0.30 | -5.09 | -1.67 | 2.35 | -4.62 | -2.89 | -2.25 |

Notes: Mean, 5th Percentile and 95th Percentile conditions correspond to mean, extreme low and extreme high natural flow conditions. Flow reductions for the Pinewood River at the Loslo Creek outlet assume a preference for effluent discharge through the wetland, to a nominal limit of 10,000 $m^3$/d, regardless of background flow conditions. All final effluent from the water management pond, not discharged through the wetland, would be discharged via pipeline to the Pinewood River downstream of McCallum Creek (see Section 7.6 for details).

**Table 6-8: Water Availability from the Pinewood River downstream of the McCallum Creek Outlet**

| Condition | Water Availability per Month ($m^3$) | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | |
| Mean | 2,233,431 | 1,716,127 | 1,259,682 | 570,612 | 277,102 | 312,013 | 424,367 | 333,989 | 7,127,323 |
| 5th Percentile | 751,305 | 577,289 | 423,745 | 191,949 | 93,215 | 104,958 | 142,753 | 112,351 | 2,397,565 |
| 10th Percentile | 927,733 | 712,853 | 523,252 | 237,024 | 115,104 | 129,606 | 176,276 | 138,734 | 2,960,580 |
| 25th Percentile | 1,305,698 | 1,003,274 | 736,429 | 333,589 | 161,998 | 182,408 | 248,092 | 195,255 | 4,166,743 |

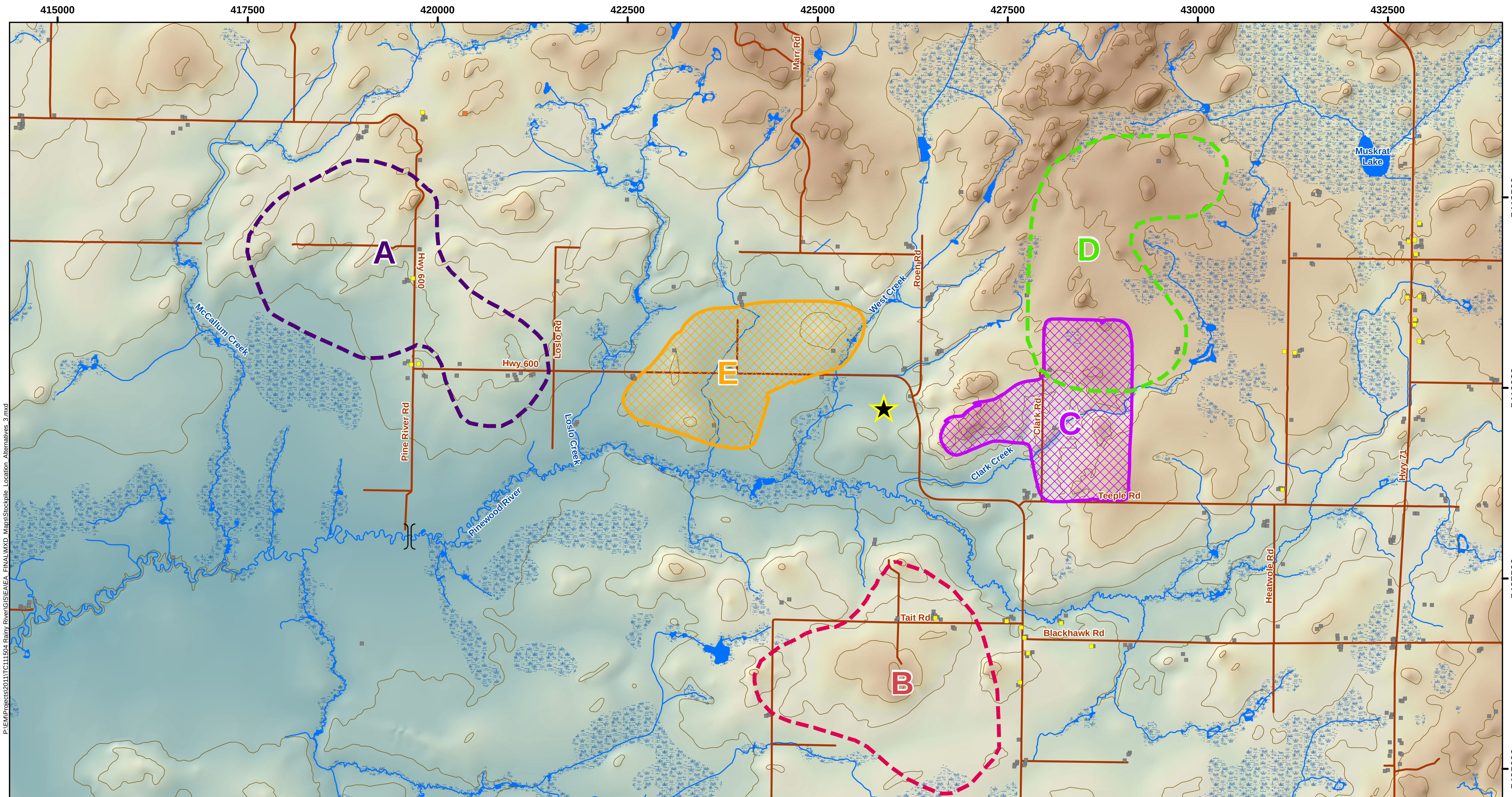
Note: Tabled values represent a 20% taking of the spring flow (April to June) and a 15% taking for other months; no winter (December to March) water taking is proposed. Percentile values are calculated as annualized and not monthly percentiles.

**Table 6-9: ELC Vegetation Communities within a 1 km Corridor of Transmission Line Routing Alternatives**

| Broad Vegetation Community | Northwest Ontario Ecosite Code | Ontario Boreal ELC Ecosite Code | ELC Ecosite Community Name | Transmission Line Alternative (corridor habitat area in hectares) | | | |
|---|---|---|---|---|---|---|---|
| | | | | A | B | C | D |
| Hardwood Forest | ES19 | B055 | Dry to Fresh, Coarse: Aspen – Birch Hardwood | 820.5 | 484.6 | 456.6 | 362.2 |
| | ES28 | B104 | Fresh, Silty to Fine Loamy: Aspen – Birch Hardwood | 9.1 | 7.3 | 5.4 | 0 |
| | ES29 | B088 | Fresh, Clayey: Aspen – Birch Hardwood | 658.6 | 1413.5 | 1473.4 | 2003.4 |
| | ES30 | B089, B105 | Black Ash Hardwood: Fresh, Silty Clayey Soil | 47.1 | 34.8 | 26.2 | 36.7 |
| | ES33 | B119 | Moist, Fine: Aspen – Birch Hardwood | 16.0 | 53.4 | 45.2 | 33.8 |
| | | | Total Hardwood Forest | 1551.3 | 1993.6 | 2006.8 | 2436.1 |
| Coniferous Swamp | ES35 | B127 | Organic Poor Conifer Swamp | 44.0 | 44.5 | 32.2 | 66.3 |
| | ES36 | B128 | Organic Intermediate Conifer Swamp | 129.4 | 39.1 | 19.0 | 39.2 |
| | ES37 | B129 | Organic Rich Conifer Swamp | 93.6 | 85.7 | 120.4 | 65.0 |
| | ES38 | B130 | Intolerant Hardwood Swamp | 73.2 | 91.1 | 104.3 | 74.3 |
| | | | Total Coniferous Swamp | 340.2 | 260.4 | 275.9 | 244.8 |
| Coniferous Forest | ES11 | B011 | Very Shallow, Dry to Fresh: Red Pine – White Pine Conifer | 231.2 | 5.0 | 9.0 | 8.0 |
| | ES12 | B012 | Very Shallow, Dry to Fresh: Pine – Black Spruce Conifer | 334.1 | 44.3 | 59.1 | 65.9 |
| | ES13 | B034 | Dry, Sandy: Jack Pine – Black Spruce Dominated | 3.5 | 0 | 0 | 0 |
| | ES14 | B035 | Dry, Sandy: Pine – Black Spruce Conifer | 0 | 27.6 | 27.6 | 11.9 |
| | ES16 | B040 | Dry, Sandy: Red Pine – White Pine Dominated | 44.9 | 52.3 | 52.3 | 52.5 |
| | ES17 | B115 | Fine, Moist: Cedar (Hemlock) Conifer | 30.3 | 0 | 0 | 0 |
| | ES18 | B054 | Dry to Fresh, Coarse: Red Pine – White Pine Mixed Wood | 111.7 | 0 | 0 | 0 |
| | ES20 | B049 | Dry to Fresh, Coarse: Jack Pine – Black Spruce Dominated | 54.1 | 167.4 | 167.4 | 161.9 |
| | ES21 | B052 | Dry to Fresh, Coarse: Spruce – Fir Conifer | 110.3 | 25.1 | 25.1 | 23.5 |
| | ES26 | B083 | Fresh, Clayey: Black Spruce - Pine Conifer | 14.2 | 10.3 | 4.1 | 9.3 |
| | ES31 | B114 | Moist, Fine: Black Spruce – Pine Conifer | 3.9 | 27.7 | 27.7 | 32.3 |
| | ES32 | B116 | Fir-Spruce Mixedwood: Moist, Silty-Clayey Soil | 8.9 | 24.6 | 28.5 | 34.8 |
| | | | Total Coniferous Forest | 947.1 | 384.3 | 400.8 | 400.1 |
| Marsh | ES46 | B142 | Mineral Meadow Marsh | 99.4 | 102.0 | 102.6 | 157.8 |
| | | B144 | Organic Meadow Marsh | 7.7 | 13.2 | 6.4 | 35.5 |
| | ES47 | B149 | Organic Shallow Marsh | 8.5 | 6.5 | 6.5 | 9.3 |
| | ES48 | B148 | Mineral Shallow Marsh | 0 | 7.0 | 6.8 | 7.6 |
| | ES49 | B150, B152 | Open Water Marsh: Floating-Leaved; Open Water Marsh: Organic | 0 | 5.2 | 5.2 | 5.2 |
| | | | Total Marsh | 115.6 | 133.9 | 127.5 | 215.4 |
| Thicket Swamp | ES44 | B134 | Mineral Thicket Swamp | 21.6 | 40.3 | 48.8 | 66.4 |
| | | B135 | Organic Thicket Swamp | 25.7 | 60.4 | 49.6 | 77.5 |

| Broad Vegetation Community | Northwest Ontario Ecosite Code | Ontario Boreal ELC Ecosite Code | ELC Ecosite Community Name | Transmission Line Alternative (corridor habitat area in hectares) | | | |
|---|---|---|---|---|---|---|---|
| | | | | A | B | C | D |
| Fen | ES40 | B136 | Sparse Treed Fen | 43.5 | 31.7 | 26.4 | 29.3 |
| | ES41 | B139 | Poor Fen | 0.1 | 17.1 | 20.1 | 10.2 |
| | ES42 | B140 | Open Moderately Rich Fen: Ericaceous Shrub / Sedge: Organic Soil | 9.1 | 7.3 | 5.4 | 0 |
| | ES45 | B147 | Shrub Shore Fen | 27.6 | 45.5 | 89.4 | 11.6 |
| | | | Total Fen | 80.3 | 101.6 | 141.3 | 51.1 |
| Rock and Mineral Barren | ES7 | B164 | Rock Barren | 7.7 | 3.0 | 5.3 | 11.0 |
| | ES9 | B007 | Active Mineral Barren | 0 | 10.9 | 10.9 | 11.3 |
| Agricultural Land | -- | Agriculture | Agriculture | 39.0 | 106.6 | 79.9 | 146.7 |
| Cultural Meadow | ** | CUM | Cultural Meadow | 40.6 | 112.3 | 112.5 | 98.0 |
| Open Water | -- | Open Water | Open Water | 249.9 | 42.8 | 48.3 | 96.8 |
| Total Area | | | | 3451.5 | 3242.8 | 3302.5 | 3855.1 |

Note: ELC Ecological land classification




P:\EM\Projects\2011\TC111504 Rainy River\GIS\EA\EA_FINAL\MXD_Maps\Stockpile_Location_Alternatives_3.mxd

**LEGEND**

- RRP Site
- Residence-House
- Lodging Cabin-Occasional Use
- Building - Unknown Use
- Roads
- Contours, 10 m interval (LIO-MNR)
- Watercourses
- Low-lying Area

Elevation Colour Ramp
- High ground
- Low ground

- Stockpile Alternative A (approx. 714 ha)
- Stockpile Alternative B (approx. 594 ha)
- Stockpile Alternative C (Proposed) (approx. 362 ha)
- Stockpile Alternative D (approx. 612 ha)
- Stockpile Alternative E (Proposed) (approx. 373 ha)

0 1.5 3 6 9 12 Kilometres

Notes:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR Queen's Printer for Ontario, 2011-2012
- Background topographic and elevation data extracted from MNR Land Information Ontario, Queen's Printer for Ontario, 2011-2012

Datum: NAD83
Projection: UTM Zone 15N

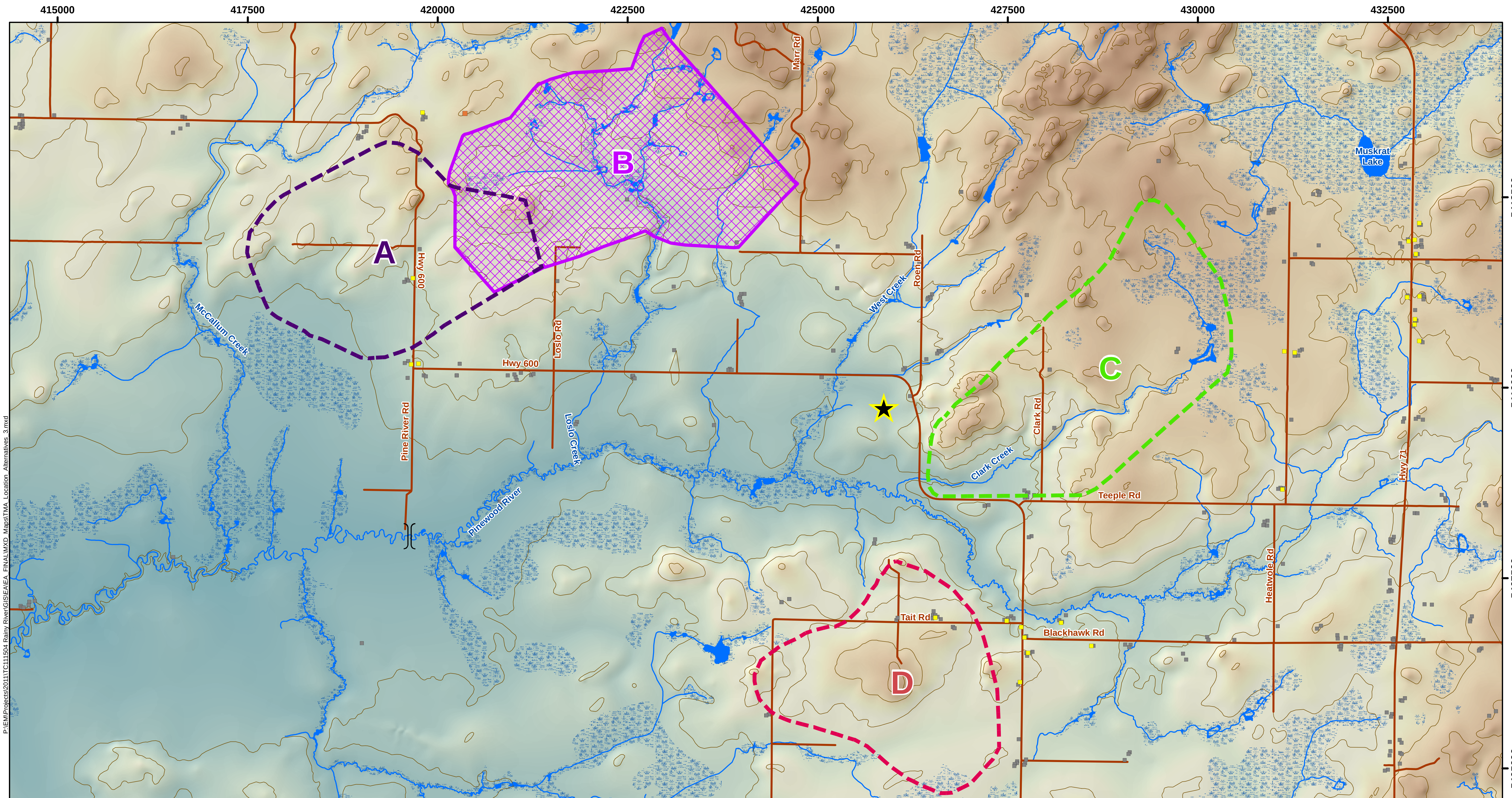
N W E S

newgold Rainy River Project amec

**RAINY RIVER PROJECT**

**Stockpile Location Alternatives**

| | |
|---|---|
| PROJECT N$^o$: TC111504 | **FIGURE: 6-1** |
| SCALE: 1:48,000 | DATE: October 2013 |




**LEGEND**

- ★ RRP Site
- Residence-House
- Lodging Cabin-Occasional Use
- Building - Unknown Use
- Roads
- Contours, 10 m interval (LIO-MNR)
- Watercourses
- Low-lying Area

**Elevation Colour Ramp**

- High ground
- Low ground

- TMA Alternative A (approx. 717 ha)
- TMA Alternative B (Proposed) (approx. 912 ha)
- TMA Alternative C (approx. 858 ha)
- TMA Alternative D (approx. 594 ha)

0 1.5 3 6 9 12 Kilometres

Notes:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR Queen's Printer for Ontario, 2011-2012
- Background topographic and elevation data extracted from MNR Land Information Ontario, Queen's Printer for Ontario, 2011-2012

Datum: NAD83
Projection: UTM Zone 15N

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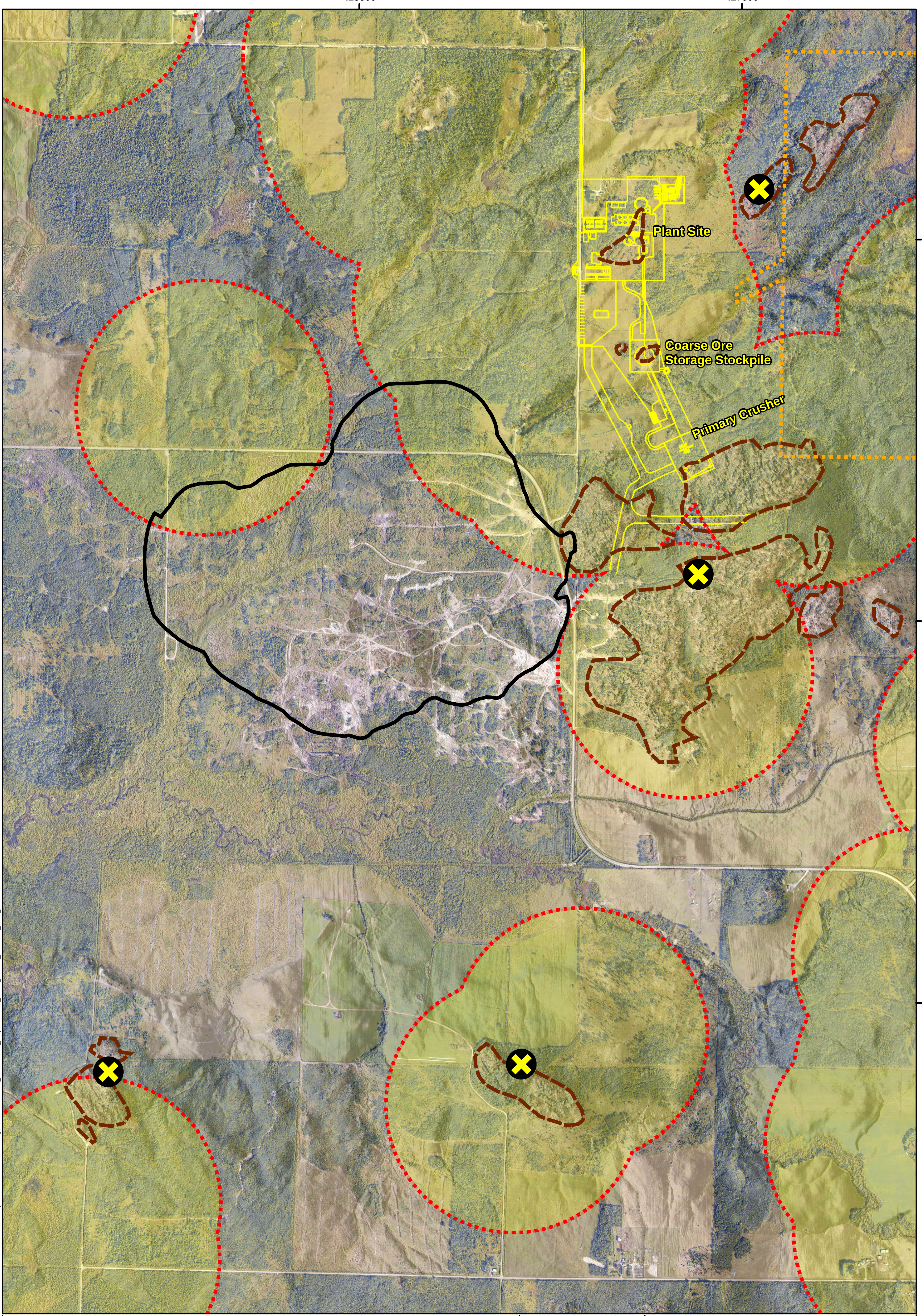
**RAINY RIVER PROJECT**

**Tailings Management Area Location Alternatives**

| | |
|---|---|
| PROJECT N°: TC111504 | FIGURE: 6-2 |
| SCALE: 1:48,000 | DATE: October 2013 |

P:\EM\Projects\2011\TC111504 Rainy River\GIS\EA\EA_FINAL\MXD_Maps\TMA_Location_Alternatives_3.mxd




P:\EM\Projects\2011\TC111504 Rainy River\GIS\EA\EA_FINAL\MXD_Maps\General_WPW_Around_PlantSite_Area_3.mxd

**LEGEND**

- Open Pit Extent
- Process Plant Site Facilities
- Bayfield Property Boundary
- Rock Outcrop
- General Area where Whip-poor-will Observations have been made
- Other Considered Process Plant Site Locations

NOTES:
- Exact Whip-poor-will observation locations are not shown per MNR request

Datum: NAD83
Projection: UTM Zone 15N

0 0.25 0.5 1 1.5 2 Kilometres

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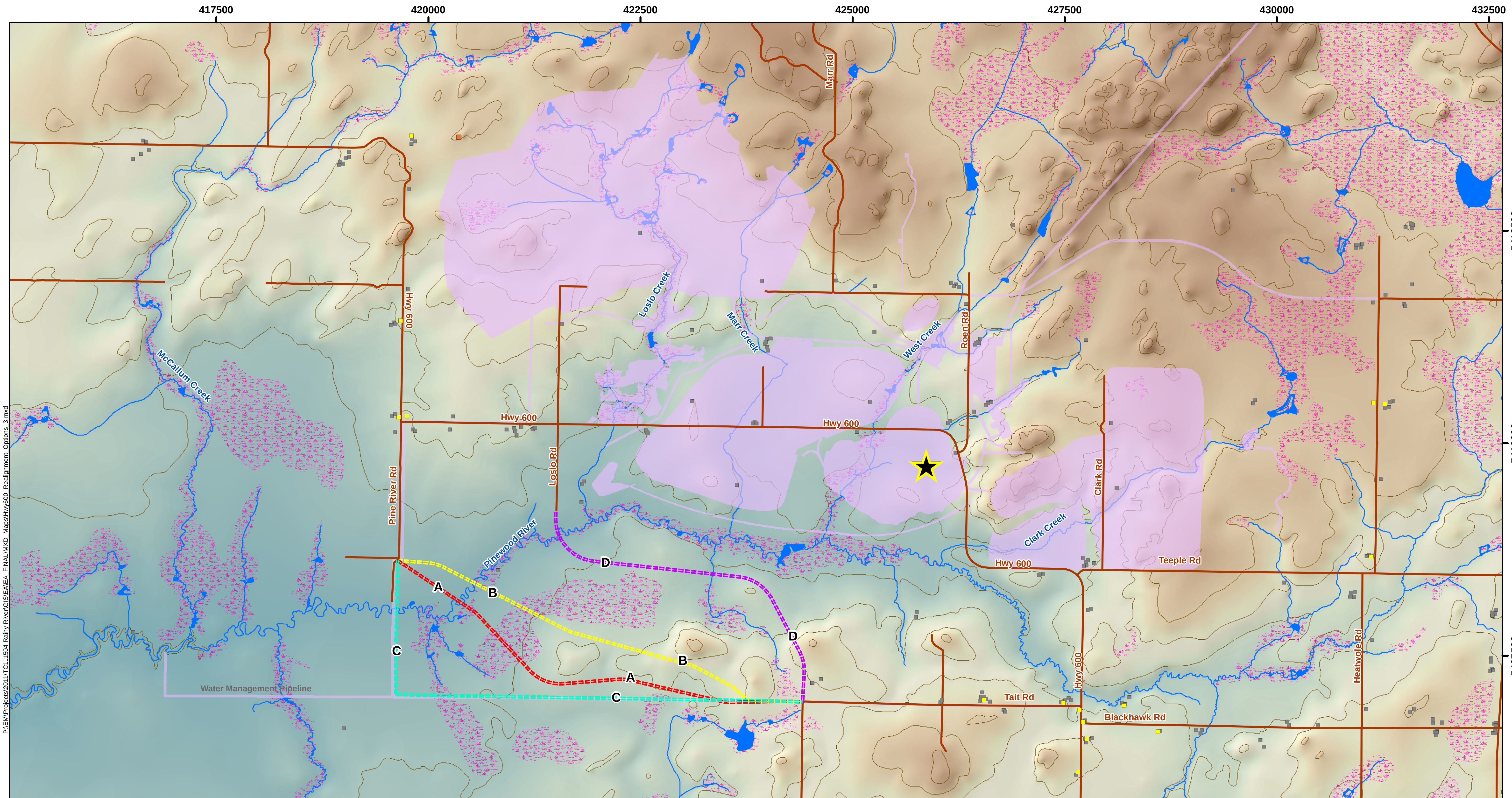
**RAINY RIVER PROJECT**

**Whip-poor-will at Process Plant and Other Considered Process Plant Sites**

| | |
|---|---|
| PROJECT N°: TC111504 | **FIGURE: 6-3** |
| SCALE: 1:14,000 | DATE: October 2013 |




## LEGEND

- RRP Site
- Approximate Principal RRP Facilities
- Residence-House
- Lodging Cabin-Occasional Use
- Building - Unknown Use
- Roads
- Watercourses
- Contours, 10 m interval (LIO-MNR)
- Low-lying Area

**Elevation Colour Ramp**

- High ground
- Low ground

**Preliminary Highway 600 Realignment Alternatives**

- Alternative A (approx. 5.3 km)
- Alternative B (approx. 5.1 km)
- Alternative C (approx. 6.4 km) (Proposed)
- Alternative D (approx. 4.3 km)

Notes:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR Queen's Printer for Ontario, 2011-2012
- Background topographic and elevation data extracted from MNR Land Information Ontario, Queen's Printer for Ontario, 2011-2012

Datum: NAD83
Projection: UTM Zone 15N

0 1 2 4 6 8 10 Kilometres

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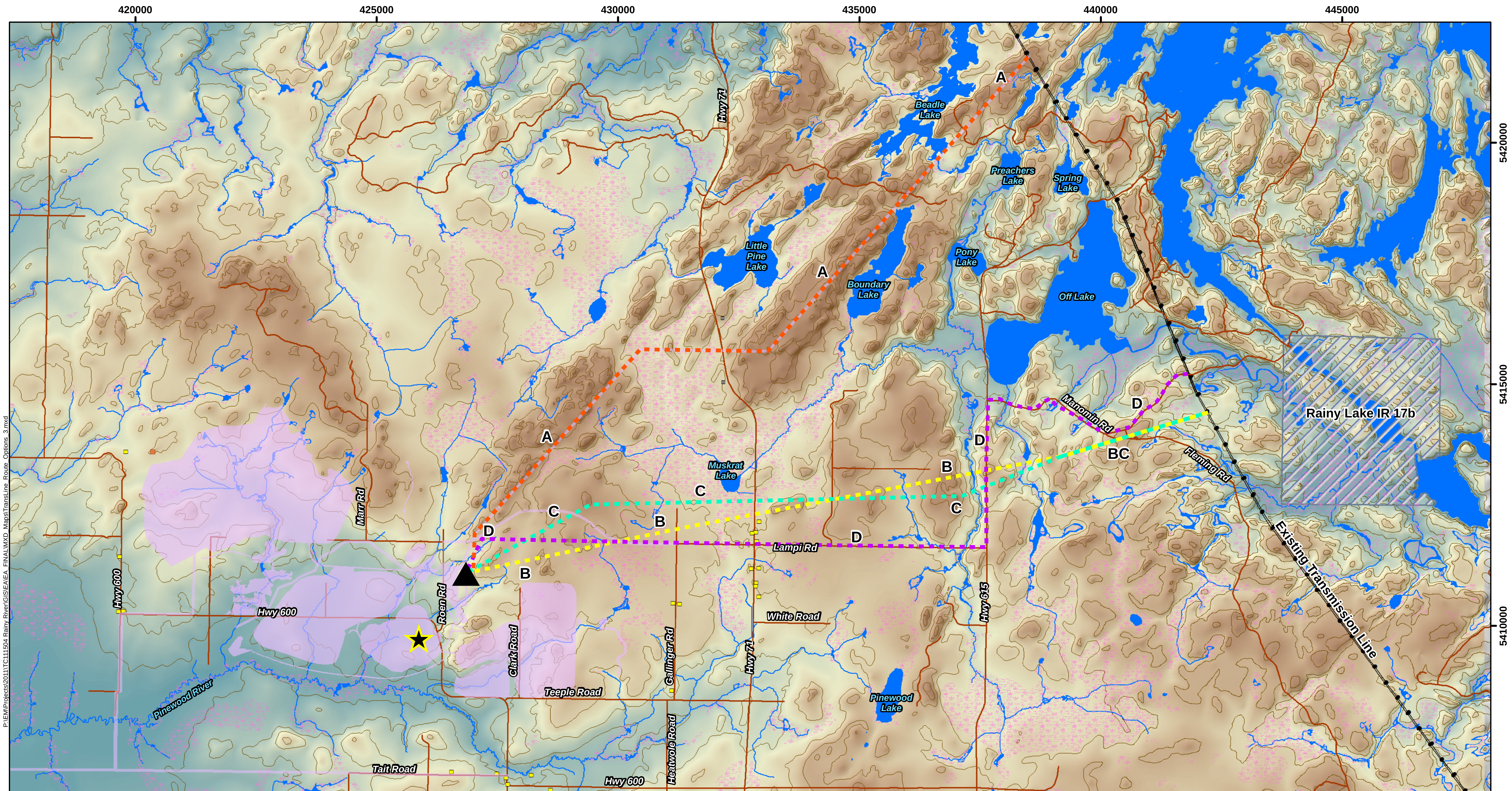
**RAINY RIVER PROJECT**

**Highway 600**
**Re-alignment Alternatives**

| PROJECT Nº: TC111504 | FIGURE: 6-4 |
|---|---|
| SCALE: 1:43,000 | DATE: October 2013 |




**LEGEND**

- RRP Site
- Approximate Principal RRP Facilities
- Approximate Processing Plant Location
- Residence-House
- Lodging Cabin-Occasional Use
- Building - Unknown Use
- Roads
- Existing Transmission Line
- Low-lying Area
- First Nation Land
- Contours, 10 m interval (LIO-MNR)

**Elevation Colour Ramp**

- High ground
- Low ground

**Transmission Line: Preliminary Alternative Routes**

- Alternative A (approx. 16.6 km) (Proposed)
- Alternative B (approx. 15.7 km)
- Alternative C (approx. 16 km)
- Alternative D (approx. 19.2 km)

Notes:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR Queen's Printer for Ontario, 2011-2012
- Background topographic and elevation data extracted from MNR Land Information Ontario, Queen's Printer for Ontario, 2011-2012

Datum: NAD83
Projection: UTM Zone 15N

0 2.5 5 10 15 20 Kilometres

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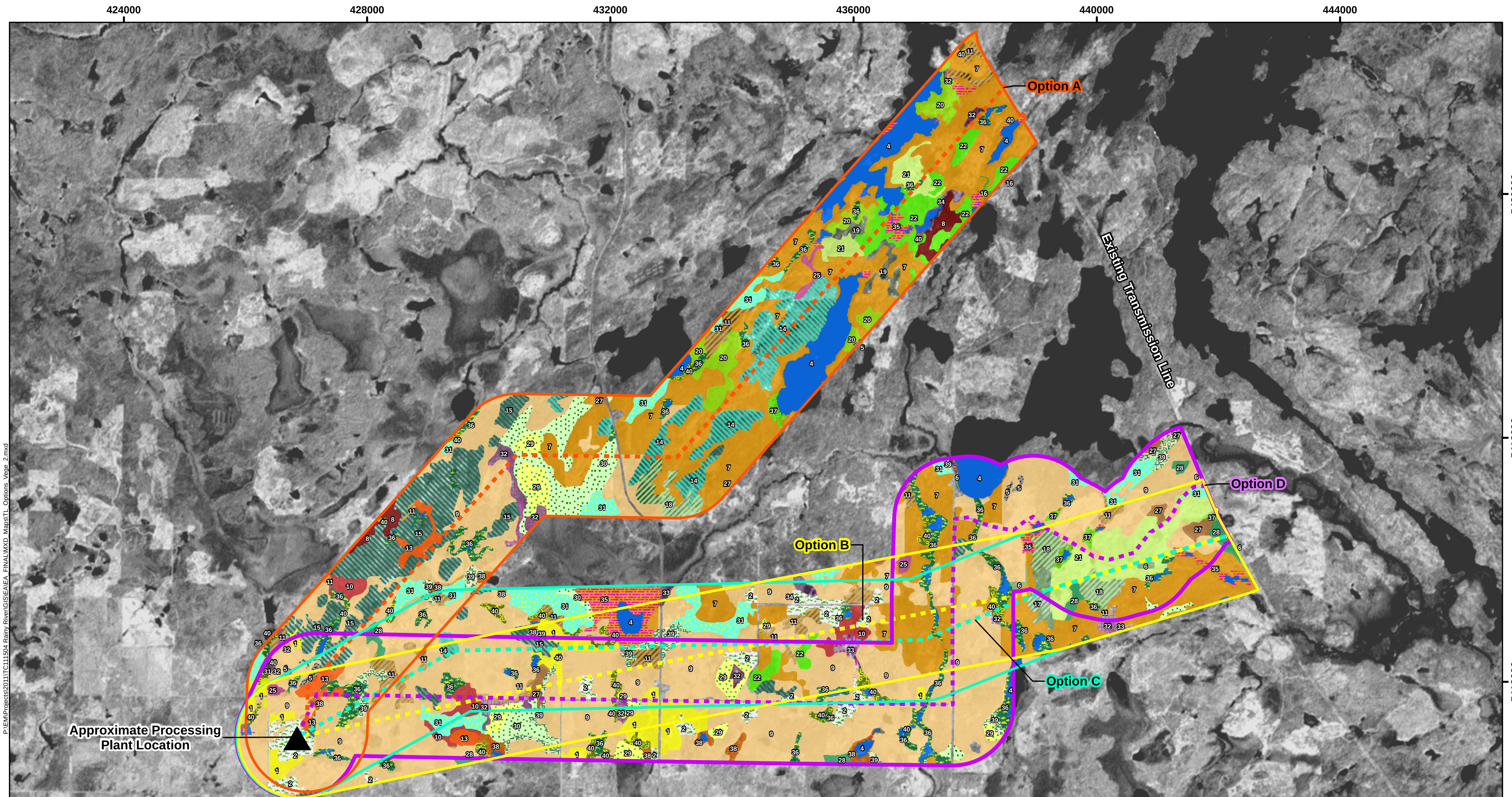
**RAINY RIVER PROJECT**

**Transmission Line Route Alternatives**

| | |
|---|---|
| PROJECT N°: TC111504 | FIGURE: 6-5 |
| SCALE: 1:75,000 | DATE: October 2013 |




## LEGEND

### Ecological Land Classifications

- (1) Agriculture
- (2) Cultural Meadow (CUM)
- (4) Open Water

**Rock and Mineral Barren**

- (5) Rock Barren (B164)
- (6) Active Mineral Barren (B007)

**Hardwood Forest**

- (7) Dry to Fresh, Coarse: Aspen – Birch Hardwood (B055)
- (8) Fresh, Silty to Fine Loamy: Aspen – Birch Hardwood (B104)
- (9) Fresh, Clayey: Aspen – Birch Hardwood (B088)
- (10) Moist, Fine: Aspen – Birch Hardwood (B119)
- (11) Intolerant Hardwood Swamp (B130)
- (13) Fresh, Clayey : Elm - Ash Hardwood (B089)

**Coniferous Forest**

- (14) Very Shallow, Dry to Fresh: Red Pine – White Pine Conifer (B011)
- (15) Very Shallow, Dry to Fresh: Pine – Black Spruce Conifer (B012)
- (16) Dry, Sandy: Jack Pine – Black Spruce Dominated (B034)
- (17) Dry, Sandy: Pine – Black Spruce Conifer (B035)
- (18) Dry, Sandy: Red Pine – White Pine Dominated (B040)
- (19) Moist, Fine: Cedar (Hemlock) Conifer (B115)
- (20) Dry to Fresh, Coarse: Red Pine – White Pine Mixed Wood (B054)
- (21) Dry to Fresh, Coarse: Jack Pine – Black Spruce Dominated (B049)
- (22) Dry to Fresh, Coarse: Spruce – Fir Conifer (B052)
- (25) Fresh, Clayey: Black Spruce – Pine Conifer (B083)
- (27) Moist, Fine: Black Spruce – Pine Conifer (B114)
- (28) Moist, Fine: Spruce – Fir Conifer (B116)

**Coniferous Swamp**

- (29) Organic Poor Conifer Swamp (B127)
- (30) Organic Intermediate Conifer Swamp (B128)
- (31) Organic Rich Conifer Swamp (B129)

**Fen**

- (32) Sparse Treed Fen (B136)
- (33) Poor Fen (B139)
- (34) Open Moderately Rich Fen (B140)
- (35) Shrub Shore Fen (B147)

**Meadow and Shallow Marsh**

- (36) Mineral Meadow Marsh (B142)
- (37) Organic Shallow Marsh (B149)
- (38) Organic Meadow Marsh (B144)

**Thicket Swamp**

- (39) Organic Thicket Swamp (B135)
- (40) Mineral Thicket Swamp (B134)

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR
- Ontario base data extracted from Land Information Ontario (MNR) data warehouse, Queen's Printer for Ontario, 2011-2012
- Watershed delineations are approximate and are derived from MNR Ontario
- Most ecosite data provided by MNR, some ecosite data derived from FRI data provided by MNR.
- Base map data from Geogratis NRCan Toporama DRG 1:50,000 NTS sheets
- ELC data derived from ecosite classifications

Datum: NAD83
Projection: UTM Zone 15N

N W E S

0 1.5 3 6 9 12 15 Kilometres

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**RAINY RIVER PROJECT**

**Vegetation Cover Types along Transmission Line Route Alternatives**

| | |
|---|---|
| PROJECT N$^{o}$: TC111504 | FIGURE: 6-6 |
| SCALE: 1:60,000 | DATE: October 2013 |