7.0 DESCRIPTION OF AND RATIONALE FOR ALTERNATIVES

7.1 Background

The Ontario *Environmental Assessment Act* makes reference to both "alternatives to" a proposed undertaking, and "alternate methods" of carrying out a proposed undertaking.

As part of the development of the Environmental Assessment (EA) process and in compliance with the *Canadian Environmental Assessment Act* 2012 (CEAA 2012) Environmental Impact Statement (EIS) Guidelines and the Provincially-approved Terms of Reference (ToR), IAMGOLD committed to assess alternatives to and for the Côté Gold Project (the Project).

As a matter of general policy and practice, alternatives will only be brought forward into the EA if they are likely to satisfy the following questions (adapted from the Ministry of the Enivornment and Climate Change (MOECC), 2014):

- Do they provide a viable solution to the problem or opportunity to be addressed?
- Are they proven technologies at the scale required?
- Are they technically feasible at the scale required?
- Are they consistent with other relevant planning objectives, policies and decisions?
- Are they consistent with Provincial government priority initiatives (for example, waste diversion, energy efficiency, source water protection, reducing greenhouse gas emissions)?
- Could they affect any sensitive environmental features (for example, provincially significant wetlands, prime agricultural area, endangered species habitat, floodplains, archaeological resources, built heritage)?
- Are they practical, financially realistic and economically viable?
- Are they within the ability of the proponent to implement?
- Can they be implemented within the defined study area?
- Are they appropriate to the proponent doing the study?
- Are they able to meet the purpose of the Ontario *Environmental Assessment Act*?

In addition to the above considerations, an alternative is considered unacceptable if any of the following criteria are met:

- the alternative cannot adequately meet the needs of IAMGOLD;
- the alternative cannot be financially supported by IAMGOLD (causes an unacceptable return on investment). Cost-effectiveness is measured within the context of capital costs, operational costs, maintenance costs, and closure/reclamation costs; and/or

- the alternative would result in substantive and unnecessary disruption to the physical, biological[1] or human environment[2] when compared with other viable alternatives.

7.2 Alternatives Assessment and Evaluation Methodology

7.2.1 Project Alternatives

7.2.1.1 Identification of Alternatives

Alternatives for the Project have been carefully considered, bearing in mind that all mining operations pose some unavoidable on-site safety risks, as do other industrial operations. IAMGOLD is cognizant of this and will place an emphasis on worker health and safety, and training programs.

Alternatives for the Project have been considered with respect to the following Project components:

- mining;
- minewater management;
- mine rock and overburden management (mine rock area, MRA);
- ore processing plant;
- process effluent treatment;
- tailings management facility (TMF);
- water supply;
- water discharge;
- watercourse realignments;
- site infrastructure positioning;
- aggregate supply;
- solid waste management and domestic sewage treatment;
- power supply and routing; and
- mine closure.

7.2.1.2 Alternative Assessment Approach

The assessment approach selected for the Project EA 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

[1] For the purpose of this EA, the natural environment is broken down into physical and biological environment.
[2] For the purpose of this EA, the human environment includes the economic, social, cultural and built environments, as defined in the *Environmental Assessment Act*.

unacceptable for each performance objective). Using this method, with the knowledge that all performance objectives are essential to the decision process, an alternative is rejected if it attains an unacceptable rating for any single performance objective.

This approach has been developed in consultation with the Ontario MOECC and used successfully by AMEC for alternative assessments for a number of other mining project-related EAs in Ontario, which were subsequently approved or are currently within the approvals process by the Ontario Minister of the Environment or Federal Minister of the Environment as applicable. 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.

The evaluation of alternatives was undertaken in consideration of comments received and the results of consultation and discussions with the general public, Aboriginal communities and government reviewers. Information collected during this engagement helped to determine the choice of alternatives considered and the relative importance of the individual performance objectives.

The EA also considered an evaluation of the advantages and disadvantages to the environment of the undertaking and the alternatives methods of the undertaking, as per the Ontario *Environmental Assessment Act*. The methodology is further outlined in the following sections.

7.2.1.3 Performance Objectives

The assessment of alternatives for the Project was carried out at an appropriate level to distinguish the relative merits of the different alternatives methods. A comparative evaluation of feasible alternative methods was conducted. The advantages and disadvantages of each method was assessed within the EA based on a series of performance objectives, evaluation criteria and indicators and to define the preferred alternative, excluding those unique circumstances where this level of comprehensive evaluation is unwarranted.

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

- cost-effectiveness;
- technical applicability and/or system integrity and reliability;
- ability to service the site effectively;
- effects to the physical and biological environments;

- effects to the human environment, including Aboriginal and treaty rights, cultural heritage resources (including archaeological, built heritage and cultural heritage landscape resources) and traditional land use; and
- amenability to reclamation.

For each performance objective a series of evaluation criteria and indicators were selected to better describe and assess each alternative. Consideration was also given to potential benefits in the evaluation of the alternatives.

7.2.1.4 Evaluation Criteria and Indicators

Assessed criteria and indicators under each performance objective for the assessment of alternatives are detailed below, and summarised in the respective tables presented.

Data sources for the assessment of alternatives indicators are provided below:

- baseline studies carried out in the Project area;
- engineering and feasibility studies carried out for the Project;
- municipal, Provincial and Federal guidelines, reports, websites and other sources;
- Statistic Canada Census data;
- property owners, business owners, municipal agencies, tourism associations and other stakeholders; and
- Aboriginal communities.

<u>Cost-Effectiveness</u>

Cost-effectiveness relates to the overall Project costs, including capital, operation, maintenance, and closure/reclamation costs. Each aspect of the Project has cost implications and thus cost-effectiveness is a performance objective common to all aspects. The evaluation criteria and indicators are presented in Table 7-1.

Table 7-1: Cost-Effectiveness Evaluation Criteria and Indicators

Criteria	Indicators for the Assessment of Alternatives
Côté Gold Project financing	• Investor attractiveness or risk
Return on investment (ROI)	• Provides a competitive or acceptable ROI
Financial risk	• Provides, or is associated with, a preferred, manageable or acceptable financial risk

Performance was determined as follows:

- Preferred: Facilitates a competitive return on investment and presents manageable or acceptable financial risk.
- Acceptable: Facilitates an acceptable return on investment and presents manageable or acceptable financial risk.
- Unacceptable: Cannot be financially supported by the Project as it does not facilitate an acceptable return on investment and does not present manageable or acceptable financial risk to the Project.

Technical Applicability and/or System Integrity and Reliability

"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. The evaluation criteria and indicators are presented in Table 7-2.

Table 7-2: Technical Applicability Evaluation Criteria and Indicators

Criteria	Indicators for the Assessment of Alternatives
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 was determined as follows:

- 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.

Ability to Service the Site Effectively

This performance objective is relevant for those aspects of the Project dealing with the provision of consumables or access to the Project site. The reliable (guaranteed) supply of consumables, such as fuel, is critical to the uninterrupted operation of the mine. The evaluation criteria and indicators are presented in Table 7-3.

Table 7-3: Ability to Service the Site Effectively Evaluation Criteria and Indicators

Criteria	Indicators for the Assessment of Alternatives
Service	• Provides a guaranteed supply to the site with manageable potential for supply disruption, and/or contingencies are available
Accessibility	• Accessible land base or infrastructure needed to support component development and operation

Performance was determined as follows:

- 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.

Effects to the Physical and Biological Environments

The “physical and biological environments” 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. The assessment of alternatives within the EA also considered potential positive effects. Potential climate change scenarios were considered, where applicable. The evaluation criteria and indicators are presented in Table 7-4.

Table 7-4: Effects to the Physical and Biological Environments Evaluation Criteria and Indicators

Criteria	Indicators for the Assessment of Alternatives
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 (GHGs)
Effect on fish and aquatic habitat	• Attainment or maintenance of surface water quality guidelines for the protection of aquatic life, or where pre-Project water quality does not meet the Provincial Water Quality Objectives, it shall not be degraded further • Maintenance of flows and water levels in streams and lakes suitable to support aquatic species and habitat • Maintenance of fish population • Maintenance of groundwater flows, levels and quality
Effect on wetlands	• Attainment or maintenance of water quality guidelines for the protection of aquatic life, or where pre-Project water quality does not meet the Provincial Water Quality Objectives, it shall not be degraded further • Area, type and quality (functionality) of wetlands that would be displaced or altered • Maintenance of wetland connectivity

Criteria	Indicators for the Assessment of Alternatives
Effect on terrestrial species and habitat	• Area, type and quality (functionality) of terrestrial habitat that would be displaced or altered • Potential for noise (or other harm and harassment) related disturbance • Maintenance or provision of plant dispersion and wildlife movement corridors • Maintenance of wildlife population
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 noise (or other harm and harassment) related disturbance • Maintenance or provision of wildlife movement corridors

Performance was determined as follows:

- Preferred: Avoids or minimizes adverse effects to the physical and biological environments without additional mitigation and/or results in a positive effect for one or more of the evaluation criteria.
- Acceptable: Avoids or minimizes adverse effects to the physical and biological environments with additional mitigation.
- Unacceptable: Likely to cause significant adverse effects to the physical and biological environments that cannot reasonably be mitigated.

Effects to the Human Environment

The potential for negative human environment effects was evaluated, where appropriate, for alternatives for various aspects of the Project. Human environment criteria include a wide range of community, economic, social, land use, Aboriginal and treaty rights, and cultural heritage indicators as noted in Table 7-5. IAMGOLD acknowledges that there are Provincial Standards and Guidelines for Conservation of Provincial Heritage Properties that could apply, should the Project involve properties that the Government of Ontario owns or controls that have cultural heritage value or interest. The assessment of alternatives within the EA also considered potential positive effects. The evaluation criteria and indicators are presented in Table 7-5.

Table 7-5: Effects to the Human Environment Evaluation Criteria and Indicators

Criteria	Indicators for the Assessment of Alternatives
Effect on local residents and recreational users	• Maintenance of property values • Maintenance or improvement of income opportunities • Maintenance or provision of local access • Attainment of noise by-law guidelines, and /or background sound levels if already above the guidelines • Non-interference with water well supply systems • Non-interference with surface water drinking supply • 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 IAMGOLD control • Maintenance or provision of health services
Effect on local businesses and economy	• Maintenance or improvement of local business and economic opportunities (including commercial bait harvesters and trappers) • Continued access to areas used for natural resource harvesting by tourism operators
Effect on tourism and recreation	• Maintenance or improvement of tourism and recreational opportunities
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 such as Bear Management Areas and Sustainable Forest Management units
Excessive waste materials	• Limiting the generation of unnecessary waste materials • Potential for material to be recycled/reused

Criteria	Indicators for the Assessment of Alternatives
Effect on built heritage and cultural heritage landscapes	• Destruction of any, or part of any, built heritage resources, cultural heritage landscapes, heritage attributes or features • Alteration that is not sympathetic or is incompatible with the historic fabric and appearance of cultural heritage resources • Shadows created that alter the appearance of a built heritage resource, cultural heritage landscape, heritage attribute or change the viability of a natural feature or plantings, such as a garden • Isolation of a built heritage resource or heritage attribute from its surrounding environment, context or a significant relationship • Direct or indirect obstruction of significant views or vistas within, from or of built heritage resources or cultural heritage landscapes • A change in land use such as rezoning a battlefield from open space to residential use, allowing new development or site alteration to fill in the formerly open spaces • Avoidance of damage to built heritage resources or cultural heritage landscapes, or document cultural resources if damage or relocation cannot be reasonably avoided
Effect on archaeological resources	• Land disturbances (such as a change in grade that alters soils and drainage patterns that adversely affect an archaeological resource) • Avoidance of archaeological sites, or mitigation through excavation of the site, if avoidance is not possible, as per the Standards and Guidelines for Consultant Archaeologists (2010), including other forms of mitigation through engagement with Aboriginal communities
Effects on First Nation reserves and communities	• 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 and ceremonial sites	• Avoidance of damage or disturbance to known spiritual and ceremonial sites; or implement other forms protection/preservation supported by Aboriginal communities
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

Performance was determined as follows:

- Preferred: Avoids or minimizes adverse effects to the human environment without additional mitigation and provides positive effects.
- Acceptable: Avoids or minimizes adverse effects to the human environment with additional mitigation.
- Unacceptable: Likely to cause significant adverse human environment effects that cannot reasonably be mitigated.

Amenability to Reclamation

This performance objective relates to the decommissioning or reclamation of the Côté Gold Project and associated infrastructure (if any). The evaluation criteria and indicators are presented in Table 7-6.

Table 7-6: Amenability to Reclamation Evaluation Criteria and Indicators

Criteria	Indicators for the Assessment of Alternatives
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 where pre-Project water quality does not meet the Provincial Water Quality Objectives, it shall not be degraded further • Restoration of passive drainage systems • Provision of habitats for vegetation and wildlife species, including Species at Risk (SAR)
Effect on land use	• Provide opportunities for productive land uses following the completion of mining activities • Provide for an aesthetically pleasing site

Performance was determined as follows:

- Preferred: Causes disturbance to the physical, biological and human environments that requires limited reclamation.
- Acceptable: Causes disturbance to the physical, biological and human environments that requires moderate to extensive reclamation, and/or mitigation meets minimum regulatory requirements where applicable.
- Unacceptable: Mitigation of disturbance to the physical, biological and human environments is not practical or feasible.

7.2.1.5 Method to Identify the Preferred Project Alternative

The alternatives were given a summary evaluation followed by an overall evaluation, which took all indicators, criteria and performance objectives into consideration. Alternatives were classified as unacceptable, acceptable or preferred.

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, as 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.

Additionally, some Project components or activities may best be served by a combination of some or all of the alternatives presented as a progressive strategy. 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 Project site plan presented in this EA takes into account the indicated preferred alternatives, and is shown in Figure 1-2.

7.2.2 Method to Assess Alternatives to the Project

As part of the development of the EA process and in compliance with the Approved ToR and CEAA (2012) EIS Guidelines, IAMGOLD committed to assess alternatives to the Côté Gold Project. Three alternatives to the Project have been identified:

- proceed with the Project planning and development, as identified by IAMGOLD;
- formally delay the Project planning and development until circumstances are more favourable; and
- the “do nothing” alternative (development of the Project is cancelled).

This assessment was carried out to distinguish the relative merits of the different Project alternatives. An analysis of these three alternatives was carried out using the Ontario Ministry of Natural Resources and Forestry (MNRF) Class EA Environmental Screening Criteria (MNR, 2003), and the assessment is presented according to:

- physical and biological environment considerations; and
- human environment considerations.

For each topic, considerations were expressed relative to potential environmental effects, 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 likely 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 significant, and will likely positively affect a large number of people 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, where applicable. 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.

7.3 Project Alternatives – Construction and Operations

7.3.1 Mining

The available alternatives for mining of the Côté Gold orebody are open pit mining; underground mining; and a combination of open pit and underground mining.

7.3.1.1 Open Pit Mining

Open pit mining includes the removal of overburden to reach the orebody, in a stepwise development of concentric levels or benches following the ore deposit. Development of the open pit also includes access roads connecting the various levels or benches within the pit. Extracted material is then transported to nearby stockpiles by haul trucks.

Open pit mining is typically used for:

- large, shallow, low-grade deposits;
- deposits where the ore is distributed more or less evenly over a large, shallow area;
- deposits that are close to the surface or outcrop; and
- deposits where the rock is not suitable for underground mining.

Open pit mining typically generates large quantities of mine rock and stripped overburden, which require disposal.

7.3.1.2 Underground Mining

Underground mining involves accessing the orebody with a combination of vertical shafts, ramps and horizontal drifts. The ore is then brought to surface by means such as conveyor belts, trucks and hoists. This method allows to selectively mine ore and avoid, to the extent possible, the extraction of mine rock.

Underground mining is typically used for:

- deeper-lying deposits;
- high-grade deposits;
- vein or seam-type deposits; and
- settings where land access is limited.

In contrast to open pit mining, there is little overburden stripped (at mine entrances or shafts) and the small amounts of mine rock generated are used to backfill mined out areas where feasible, reducing mine rock disposal requirements on the surface.

7.3.1.3 Underground and Open Pit Combination Mining

A combination of underground and open pit mining is used for deposits where the upper portion of the orebody can be mined by open pit, and higher-grade ore deeper underground is extracted through underground mining, as open pit mining alone becomes uneconomical with increasing depth (greater mine rock and overburden removal).

7.3.1.4 Selected Mining Method

The Project proposes to mine a large low-grade deposit disseminated more or less consistently close to the surface. It is therefore most amenable to a high-tonnage open pit mine. Open pit mining on its own is economically feasible and a proven technology. Using open pit mining for the Project will result in the dewatering of Côté Lake and will require realignment of some of the surrounding surface waters. The use of underground mining would likely reduce these disturbances; however, underground mining is neither economical nor technically suitable under the geological conditions encountered at the Project site.

Other potential effects to the physical, biological and human environments due to open pit mining can be minimized by positioning the mine rock area (MRA) close to the open pit and by developing higher stockpiles, thereby reducing the overall Project site footprint. Open pit mining generates greater air and noise emissions than underground mining, as well as potentially greater effects for fish and aquatic habitats. Measures to mitigate effects, including stockpile positioning, dust suppression methods and others, can minimize or prevent effects. Open pit development of the mine will also result in employment opportunities that will benefit local and regional economies.

Consistent with the approved ToR, the selected alternative for the Project is open pit mining. Other alternatives were not assessed as part of the EA because of the rationale outlined above.

7.3.2 Mine Water Management

In order to limit freshwater requirements, the Côté Gold Project is considering an integrated minewater management approach. With this approach, water from the open pit will be pumped to the mine water pond to feed the ore processing plant.

The minewater management alternatives potentially applicable for the Project include:

- development of a separate minewater treatment and management system; or
- development of an integrated minewater treatment with stockpile catchment TMF operations.

Minewater will be pumped from the open pit using sumps, as well as from the seepage and runoff collection ponds around the MRA and low-grade ore stockpile. Water from the reclaim pond in the TMF and the polishing pond will also be pumped directly to the ore processing plant to provide for make-up processing water requirements, reducing the need for freshwater, to the extent practicable. Surplus water from the mine water pond can be pumped directly to the polishing pond for discharge to the environment.

Minewater from the open pit sump(s) and seepage collection ponds is expected to contain suspended solids from general mining and earthmoving activities, ammonia residuals from ammonia-based explosives, and residual hydrocarbons from heavy equipment operation. Leaching of the exposed bedrock within the open pit and from the various stockpiles may also potentially contribute minor quantities of metals to the minewater. In-pit sump(s) and the seepage collection ponds will provide for preliminary suspended solids removal. Ammonia residuals will be managed at source through best management practices for explosives handling and through extended effluent aging in the mine water pond and/or ultimately the polishing pond, prior to any discharge to the environment.

A key objective of the Project is to recycle as much of the on-site and process water as practicable. Therefore, the alternative to develop a separate minewater treatment and management system was not assessed in the EA and the preferred alternative is to develop an integrated minewater treatment with stockpile catchment and TMF operations.

7.3.3 Mine Rock and Overburden Management

Development of the Project is expected to generate approximately 20 million tonnes (Mt) of overburden and 850 Mt of mine rock. Based on the current design, approximately 40 Mt of mine rock is expected to be used in various Project site construction activities, mainly for TMF dam and road maintenance/construction. The remainder of the overburden and mine rock will be stockpiled for permanent disposal at the site, with a portion of the overburden used for final site reclamation activities. The MRA is currently expected to serve as storage for both mine rock and overburden. As described in Chapter 5, it is currently anticipated that overburden will be stockpiled separately within the MRA to be used erosion protection as needed and for closure activities for the Project.

The available alternative methods for mine rock and overburden storage and management are:

- placing and managing the mine rock and the overburden in areas adjacent or proximal to open pit; or
- establishing a temporary stockpile location, with mine rock and overburden retained in the open pit during operations and/or returned to the open pit at closure.

Establishing a temporary stockpile location for returning the large amounts of overburden and mine rock generated during the construction and operations phases into the open pit upon closure would be cost excessive, thereby rendering the Project uneconomic. This alternative was not assessed in the EA for the MRA, but see Section 7.4.1.3 on the alternative for backfilling the open pit with waste rock upon closure.

A comprehensive assessment of mine rock management alternatives is provided in Appendix U1. IAMGOLD will submit a revised alternatives assessment for the MRA consistent with the alternatives assessment requirements associated with the Federal MMER Schedule II amendment process, and in accordance with the Guidelines for the Assessment of Alternatives for Mine Waste Disposal (Environment Canada, 2011). The principal criteria for selection of MRA locations and design were the following:

- areas within reasonably close proximity to the open pit to minimize the overall Project environmental footprint, to reduce greenhouse emissions and to achieve economic efficiencies of operation;
- limit the number of stockpiles – fewer but larger stockpiles can be managed more efficiently;
- areas with suitable foundation conditions;
- minimize adverse effects on visual aesthetics by limiting stockpile height;
- areas within a safe distance from water bodies, creeks and fish habitats;
- position stockpiles in a manner such that drainage from the stockpiles can be suitably collected and managed in accordance with MMER and Provincial environmental approval requirements;
- minimize potential adverse effects to aquatic and terrestrial habitats, including potential adverse effects to SAR; and
- land tenure and existing/potential land uses, including proximity to existing residences/cottages as potential noise receptors.

Initially, the results of the alternatives assessment had narrowed the MRA locations to three areas to the northeast, southeast and south of the open pit. As part of ongoing engineering design and in response to comments received from stakeholders, it is now planned that only one MRA to the south of the open pit would be developed for the Project (see Figure 1-2). This results in a more cost-efficient operating plan, and reduces potential effects on Mesomikenda Lake and the cottagers that reside near the lake.

7.3.4 Gold Recovery

Various process 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 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, but are currently not developed to an industrial scale due to operational limitations.

As a result, the only potentially applicable, commercially viable methods for recovering gold from the Project 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 can be toxic and its handling requires extreme care to protect both workers and the environment. It is the industry standard for gold processing. Safe procedures for cyanide handling and subsequent detoxification are well established and internationally recognized.

Alternatives potentially available for recovering gold from the ore at the Project are the following:

- whole ore cyanidation;
- gravity recovery;
- flotation concentrate recovery; and
- combination of non-cyanide and cyanide recovery.

An analysis of these alternatives is presented in Table 7-7, and each is discussed in the following sections.

7.3.4.1 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 tanks, 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 use in Canada. Tank leaching is common in Canada and may be better suited to the Canadian climate.

In whole-ore tank leaching, cyanide (CN) dissolves gold (Au) in accordance with the following reaction:

$$4Au + 8\ NaCN + 2\ H_2O + O_2 \rightarrow 4\ Na[Au(CN)_2] + 4\ NaOH$$

Sodium cyanide (NaCN) is stable in solution at pH values above 10. At lower pH values cyanide volatilizes to the atmosphere as cyanide gas (HCN). Lime is used in the leach circuit to maintain an elevated pH. Gold dissolved with cyanide is recovered by adsorption onto activated carbon.

Cyanide is comprised of one carbon (C) atom and one nitrogen (N) atom, 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 (O) in the presence of sunlight (photolysis) through a series of reactions to form carbon monoxide (CO) and nitrous oxide (N_2O).

Cyanide is also easily oxidized (destroyed) by chemical means such as by sulphur dioxide (SO_2) addition to form the much less toxic compound cyanate (CNO). CNO will further degrade in tailings ponds to ammonia (NH_3) and carbon dioxide (CO_2).

The use of cyanide in ore processing is easily managed for worker safety using industry standard methods and protocols, and easily detoxified either within the ore processing plant or through volatilization in tailings ponds.

7.3.4.2 Gravity Recovery

Gold has a very high specific gravity compared to the ore host rock. 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[3] 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.

7.3.4.3 Flotation Concentrate Recovery

Flotation concentrate recovery is a third method of gold recovery. This process involves crushing and grinding the ore to a very fine grind, followed by the use of flotation chemicals and

[3] Natural accumulation of valuable minerals formed by gravity separation during sedimentary processes.

air in a sequence of flotation cells, to preferentially float a gold-bearing sulphide concentrate. In the order of 10% to 15%, 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 on-site or off-site, depending on the availability of external processing sites and costs. Flotation concentrate production with off-site gold recovery is not commonly practiced except occasionally for some small scale operations where other larger nearby ore processing plants are available to receive custom ores and concentrates.

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.

7.3.4.4 Combination of Non-Cyanide and Cyanide Recovery

A combination recovery method is commonly practiced within a single ore processing 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.

7.3.4.5 Selected Gold Recovery Method

Gravity concentration and flotation concentration individually are uneconomic for the Project ore and therefore, are not considered further. The processing alternative of gravity concentration in combination with flotation concentration recovery and cyanidation is not cost competitive, offers no other major advantage to other recovery means and,\ therefore, is also not considered further. It is possible to undertake whole ore cyanidation without gravity concentration but this alternative reduces Project economics, and confers no advantages, environmental or otherwise. This alternative, therefore, is also not considered further. The selected alternative, from an economic point of view, is a combination of non-cyanide and cyanide recovery (gravity concentration coupled with whole ore cyanidation).

From an environmental point of view, gravity separation on its own would be the preferred alternative. However, only a small portion of the gold can be recovered with this method, which would make the Project uneconomical. However, the use of a combination of gravity separation and cyanidation requires the least amount of cyanide compared to the other alternatives (i.e., flotation, cyanidation or a combination thereof). It should be noted that cyanide will be recycled and destroyed prior to release to the TMF.

7.3.5 Process Effluent Treatment

One of the two by-products of gold production is process effluent, which together with the tailings, are conveyed to the TMF. Cyanide will be used to recover gold from the ore. Cyanide levels in process effluent are such that it is required to either treat cyanide-laden process effluent or to store process effluent in the TMF to allow for natural degradation of cyanide.

Process effluent treatment methods potentially applicable to the Project include:

- in-plant cyanide recycling and destruction using the SO_2/Air process;
- process effluent discharge to the TMF with natural degradation for the destruction of cyanide, with supplemental hydrogen peroxide destruction of residual cyanide; and
- process effluent discharge to the TMF with natural degradation for the destruction of cyanide.

Alternative treatment techniques include the use of Caro's acid and the Combinox process. These treatment methods were not assessed as part of the EA as these technologies failed to achieve treatment targets during preliminary testing and are therefore not currently considered appropriate for the Project.

A summary of these alternatives is presented in Table 7-7, and the analysis is presented in Appendix U2.

7.3.5.1 In-plant SO_2/Air Treatment

In-plant sulphur dioxide and air (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. Cyanate formed through this process reacts with water (hydrolyzes) within the TMF to form ammonia and carbon dioxide. The SO_2/Air treatment process is a more costly alternative compared to the other available options, but has the advantage of discharging a low strength cyanide solution to the TMF. 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 TMF. 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 TMF pond further reduces residual cyanide and heavy metal concentrations in the final effluent. This process is most commonly used at locations where surface waters and people would be severely impacted in case of accidental release of tailings.

7.3.5.2 Hydrogen Peroxide Destruction and Natural Degradation

Hydrogen peroxide (H_2O_2) 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 ore processing plant. The result is that hydrogen peroxide is generally used in combination with natural degradation, where the tailings slurry is first discharged to a TMF 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.

Natural degradation has been used successfully at some Ontario gold mines where the process effluent 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. Based on AMEC's experience, the use of natural degradation alone is likely to be viewed by investors as not being the best available technique. Lack of investor confidence can jeopardize overall Project financing and scheduling. This alternative also presents a greater overall environmental risk in the event of any unintended or accidental release. This alternative, therefore, is not considered further in the EA.

7.3.5.3 Preferred Process Effluent Treatment Method

It is currently anticipated that SO_2/Air treatment will be used and it is the preferred option. This alternative presents the greatest advantages, both economically and environmentally, for use at the Project (see Appendix U2).

The SO_2/Air treatment alternative is a cost-effective, well-proven technology and best practice process that is very attractive to investors. Though the SO_2/Air treatment process has higher operational costs, this is partially offset by reduced storage and dam requirements in the TMF. This alternative provides the best and most secure method of effluent treatment to meet applicable effluent quality criteria with low environmental risk. A description of this process is detailed in Chapter 5.

The natural degradation and H_2O_2 treatment alternative has a higher risk in attaining acceptable final effluent and meeting receiving water quality standards compared to the SO_2/Air Treatment alternative. This extends risk in seepage quality and management, with potential effects downstream in the event of TMF dam failure / unintended release. An additional risk exists for wildlife loss due to access to higher residual cyanide concentrations.

7.3.6 Tailings Management

The Project will process an estimated 60,000 t/day of ore. Rejects from this processing (tailings) will comprise the total of this weight, minus recovered gold, which is an estimated 261 Mt of tailings over the expected Project life. The tailings slurry will be treated in the ore processing plant to destroy cyanide and to render any associated dissolved heavy metals into solid phase, before being discharged to a TMF for further effluent treatment (extended aging and natural degradation) and permanent storage of the tailings solids. Once in the TMF, the tailings solids will settle out.

A comprehensive assessment of mineral waste management alternatives is provided in Appendix U3. IAMGOLD will submit a revised alternatives assessment for the TMF consistent with the alternatives assessment requirements associated with the Federal MMER Schedule II amendment process, and in accordance with the Guidelines for the Assessment of Alternatives for Mine Waste Disposal (Environment Canada, 2011).

Tailings management deposition methods potentially applicable to the Project include:

- tailings slurry (~50% solid content);
- thickened tailings (~60% solid content); and
- paste thickened tailings (~68% solid content).

An initial trade-off study was carried out, as described in Appendix U3, which resulted in the selection of tailings slurry deposition as the preferred alternative. The other deposition method alternatives were not assessed for the EA.

The principal criteria for selection of the TMF location include the following:

- select a technically and economically feasible alternative and location;
- use natural topography for containment to minimize the construction of dams;
- provide for all tailings storage in a single location;
- position the TMF so that drainage from the system can be collected and managed in an integrated manner, in accordance with MMER and Provincial environmental approval requirements;
- provide for an optimal operations and reclamation scenario for potential Acid Rock Drainage (ARD) management using passive systems to the extent possible, but with an allowance for contingency chemical treatment if required;
- minimize potential adverse effects to aquatic and terrestrial habitats, including to SAR; and
- land tenure and existing/potential land uses.

The results of the alternatives assessment narrowed the TMF location to the area to the north of the open pit. Optimization of this area was conducted in parallel to the EA process in response to the needs of the Project as well as feedback gathered from local stakeholders. TMF location alternatives were thus not assessed for the EA.

7.3.7 Water Supply

Process water will be derived from open pit dewatering, seepage and runoff collected from the various stockpile areas and water recycled from the TMF reclaim pond and the polishing pond. There are a large number of environmental and economic benefits to recycling of water, rather than utilizing fresh water partly or completely. Nonetheless, a freshwater supply will still be required for potential seasonal water deficits, initial start-up and ongoing ore processing plant needs, as well as potable water uses. This freshwater demand is still being developed as part of the overall site water balance.

Alternatives considered for the Project water supply are the following:

- water directly from the Mesomikenda Lake;
- water from other area watercourses, lakes and ponds; and
- groundwater.

The critical aspects of the Project water supply include:

- developing a sufficient water inventory for ore processing plant start-up; and
- maintaining a sufficient water inventory for the winter period or during potential prolonged summer/fall drought conditions.

A summary of the alternatives is presented in Table 7-7, and the analysis is presented in Appendix U4.

Potable water is also required for the accommodations complex and other facility support. It may be possible to derive all or a portion of the potable water needs from well(s), depending on the selected locations for the construction of camp facilities, and the potential effects of open pit dewatering on possible well locations. Potable water, whether taken from wells or Mesomikenda Lake, will be treated as necessary to ensure drinking water quality standards are met. The options of using groundwater or surface water for potable water needs were assessed in the EA, including the placement of potential wells or surface water sources.

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.

7.3.7.1 Take Water Directly from the Mesomikenda Lake

Mesomikenda Lake is the largest water body in the area and approximately 4.5 km from the proposed ore processing plant location. The availability of water from the Mesomikenda Lake is a function of watershed area and per unit area runoff, taking into account water level management as per the Mattagami Water Conservation Program.

7.3.7.2 Other Area Watercourses, Lakes and Ponds

The only other local surface waters with the capacity to supply the Project water needs and that is reasonably close to the Project site is Bagsverd Lake, with or without supplemental uptake from other smaller water bodies adjacent to the Project site. Bagsverd Lake is located north of the open pit and within 1 km of the proposed ore processing plant location. Other nearby lakes includes the Three Duck Lakes to the east of the open pit, Clam Lake to the west of the open pit and Chester Lake to the south of the open pit. These lakes are comparatively smaller than Bagsverd Lake, and would require more infrastructure to meet water supply needs. Taking water from these lakes, especially during low flow years when it could be required at the Project site, may affect aquatic and fish habitat. Depending on how water is managed at the site, it would be possible to draw water from either Bagsverd Lake or a combination with any of these lakes in the non-winter period only, such that expensive provisions to protect the water pipeline from freezing (insulation and heat-tracing) would not be required.

7.3.7.3 Groundwater

Groundwater wells could be installed at the Project site, though the yield from groundwater is expected to be limited and insufficient to meet Project supply needs. This alternative, therefore, is not considered beyond the possibility of providing short-term or interim water supply for potable water needs.

Groundwater could potentially assist with the provision of early stage, specialized water supply needs such as workforce potable water during the Project construction phase and water for concrete manufacture.

7.3.7.4 Preferred Water Supply Alternative

Water intake from Mesomikenda Lake is the preferred alternative, which would allow for a reliable source of water from the largest water body in the area at a relatively short distance from the ore processing plant, which is the main water consumer.

The estimated total water requirement for the ore processing plant is approximately 56,000 m^3/d, of which approximately 7,200 m^3/d must be freshwater. In addition, it is estimated that an extra 245 m^3/d of freshwater will be required to meet potable water needs and fire prevention. While the proposed integrated water management system will supply water for the Project (by recycling of minewater and seepage from various Project components), freshwater will be required to build an initial water inventory until MMER Schedule 2 listings allow for full site infrastructure development and to support the start of processing. As a contingency, when insufficient site water is available to recycle to the ore processing plant, freshwater will be taken to meet Project water demands.

The design of the Project's water intake will take into consideration that Mesomikenda Lake is a water-level controlled lake, limiting water uptake during low flow periods. It should be noted that the estimated daily freshwater uptake from Mesomikenda Lake will be less than 1% of the average annual streamflow at the Mesomikenda Lake outflow. A hydrological monitoring program will also be implemented for streamflow and water level at key surface water locations across the Project site, the results of which will be used for considerations to ongoing operational activities.

Taking water from area lakes (e.g., Bagsverd Lake) is not considered for reasons relating to cost and ability to service the site, and confers no environmental advantage compared with other alternatives. The use of groundwater is potentially viable for the initial supply of potable water and to support early construction operations on a short-term basis, but otherwise is considered unacceptable as a primary water source due to capacity constraints.

7.3.8 Water Discharge Location

IAMGOLD will manage the site water such that recycling of water is carried out as much as practicable. Nonetheless, it is expected that some discharge to the environment may be necessary, on a seasonal basis.

An analysis of water discharge alternatives is presented in Table 7-7. An analysis of alternatives is presented in Appendix U5.

Excess water collected in the TMF reclaim pond will be discharged to either Mesomikenda Lake or Bagsverd Creek/Neville Lake, after a treatment in the polishing pond and/or secondary treatment, if required. Such discharge will meet applicable Federal and Provincial effluent discharge requirements, and will be protective of receiving water aquatic life.

7.3.8.1 Discharge to Mesomikenda Lake

Mesomikenda Lake is capable of meeting the Project's water discharge needs. Water discharge would be treated if required, restricted and controlled to meet water level controls for Mesomikenda Lake, and it is not expected to have any notable adverse effects. Mesomikenda Lake is at a distance of approximately 1.5 km from the polishing pond. Discharge to Mesomikenda Lake is not expected to have significant effects on receiving waters.

Local cottagers and downstream users may perceive water discharge as an infringement or disturbance and may resist such action, which could translate in EA and permitting delays.

7.3.8.2 Discharge to Bagsverd Creek

Bagsverd Creek is also capable of meeting the Project's water discharge needs at the downstream end, just before the creek enters Neville Lake. Water discharge would also be treated as required and controlled, and it is not expected to have significant adverse effects on receiving waters, and it is expected to have a positive effect by diminishing the overall decrease in discharge at the outlet of Bagsverd Creek, predicted to occur due to the proposed realignment of Bagsverd Creek (see Section 7.3.9). The lower basin of Neville Lake would serve as a mixing zone. The proposed discharge location is approximately 2.3 km from the polishing pond, requiring slightly more infrastructure (lengthier pipeline) to be developed for discharge purposes compared to the alternative location on Mesomikenda Lake (see Figure 1-2). This translates into slightly higher capital cost.

No cottagers live along Bagsverd Creek or Neville Lake and no water users are recorded for these water bodies.

7.3.8.3 Preferred Water Discharge Alternative

The preferred alternative for water discharge is to discharge at the Bagsverd Creek location. Water quality modelling predicts that effects on receiving waters would be slightly lower for this discharge location, compared to the Mesomikenda Lake alternative. The resulting mixing zone in Neville Lake is predicted to be smaller in the Bagsverd Creek discharge scenario, and discharge would diminishing the overall decrease in discharge due to the proposed realignment of Bagsverd Creek. As no cottagers or water users reside along Bagsverd Creek or Neville Lake, potential effects to and perceptions of the human environment may be considerably reduced.

7.3.9 Watercourse Realignments

Watercourse realignments will be necessary to accommodate Project components. Their development and locations are dependent on the location of the Project components, which are in turn subject to availability of land acquired for the Project and topography of the Project area. There are, as a result, comparatively few alternatives for siting the required watercourse realignments, given the preference to limit the overall site footprint as practical. Alternative locations for watercourse realignments were thus not assessed for the EA.

As part of the proposed development of the open pit, Côté Lake will need to be drained. It is expected that portions of Three Duck Lakes, Chester Lake, Clam Lake and the Mollie River system will require dams and watercourse realignments to allow safe development and operation of the open pit and associated infrastructure. It is currently planned that a portion of Bagsverd Creek will also be realigned to allow development of the TMF.

The principal guidelines for selection of the watercourse realignment arrangement were the following:

- select watercourse realignments with the aim of minimizing the overall Project environmental footprint, while at the same time considering economic efficiency of the Project;
- minimize disturbance of the existing water flow regime and existing aquatic habitat, thereby also minimizing disturbance on existing terrestrial flora and fauna;
- plan for and establish fish habitat compensation;
- minimize disturbance of existing land use;

- minimize water transfer amongst existing subwatersheds; and
- ensure safety of personnel in the open pit and any other Project components in close proximity to any future realignments.

A summary of the watercourse realignment alternatives is presented in Table 7-7. These realignments are under investigation and, in discussions with regulators, will be reviewed as engineering studies advance. The design may be optimized as engineering design progresses. This optimization will not include any additional watercourse realignments.

7.3.10 Site Infrastructure

Options for locating the majority of site infrastructure are dictated by the positioning of the open pit, TMF, MRA, geographic constraints (such as avoidance of watercourses as practical) and land ownership. There are, as a result, comparatively few alternatives for the siting of most of the required infrastructure components, given the preference to limit the overall site footprint. Alternative locations for infrastructure locations were thus not assessed in the EA.

The following buildings and yard areas are currently planned for the Project:

- primary crusher, screen, secondary crusher and run-of-mine stockpile, with associated conveying systems;
- ore processing plant;
- maintenance garage, warehouse and administration complex;
- accommodations complex, to be used for both construction and operations phases;
- fuel and lube bay;
- general laydown areas and temporary storage facilities during construction; and
- explosives manufacturing (emulsion plant) and storage facilities.

On-site processing is typical for large scale, low-grade operations such as the Project, as off-site processing is not economical, and could have substantial environmental implications related to ore transport. Off-site processing of ore is not a reasonable alternative given the grade of the ore and that there are no existing gold ore processing facilities proximal to the Project site. Off-site ore processing was therefore not considered in the EA.

The ore processing, maintenance and administrative complexes are proposed to be located in one centralized area northwest of the open pit, positioned far enough away from the open pit perimeter to protect workers and facilities from any potential blast (fly) rock. These facilities will be supported by related transport, piping and power infrastructure as needed. The overall layout has been developed to ensure efficient operating conditions with the least travel distances between the facilities, particularly with respect to ore and mine rock haulage and tailings pumping.

Options for locating the majority of building and infrastructure facilities for the Project are dictated by the positioning of the open pit, the TMF, MRA, and by geographic constraints (foundation conditions in the case of the ore processing plant, and regulated separation distances in the case of explosives facilities). The positioning of connectors (mine site roads, pipelines and the on-site 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 accommodations complex and explosives facility (emulsion plant) are discussed in more detail below.

It is expected that some temporary laydown areas will be required, mostly at the ore processing facility during the construction phase. To minimize transport distances and to facilitate construction efforts, these areas will be sited immediately around the ore processing plant footprint.

It is possible that some tailings dam material will need to be stockpiled for short periods of time. These small and temporary stockpiles are planned to be within the future TMF footprint so as to avoid additional clearing.

7.3.10.1 Accommodations Complex

It is expected that approximately 1,500 construction workers will be accommodated during the construction phase. Options for worker accommodations during the construction phase include an on-site construction camp or off-site residence in one or more of the local communities. If workers were to reside off-site, the primary alternatives for residence would be nearby homes owned by IAMGOLD; or existing residences in Gogama. Other more distant communities do not present a reasonable daily commute. It is possible some combination of these may be used.

Options for operations phase accommodations, as for the construction phase, include off-site and/or on-site residences. The construction phase accommodations complex will be converted to hold an operations workforce of approximately 500 full-time personnel and it is currently not anticipated that additional off-site accommodation would be required during operations.

Throughout the early consultation phases of the Project, it became evident that an on-site accommodations complex was required to minimize effects on housing in the region. Off-site residence was therefore not considered in further detail in the alternatives assessment due to effects on the local communities.

7.3.10.2 Explosives Facility (Emulsion Plant)

Explosives are required for blasting during open pit 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 consumption rate is 0.3 kg/t and a nominal ore and mine rock production rate of up to 60,000 tpd.

Explosives needed for the Project development will be prepared in a dedicated explosive manufacturing facility (emulsion plant). The positioning of the explosives facilities is prescribed by the Quantity Distance Principles User's Manual (Natural Resources Canada, 1995) and is dependent in part on the location of other site facilities. For that reason limited practical alternatives are available. Alternatives for the provision of explosives to site are presented below.

Off-Site

Existing explosives manufacturing facilities are located in Winnipeg, Manitoba and Thunder Bay, Ontario. Given the quantity of explosives required for the Project, the transportation of the explosives required for the Project will increase the truck traffic on existing roads, thereby increasing the risk of traffic accidents and collisions with wildlife and others. The transport of explosives in large quantities is neither practical nor safe in comparison to manufacturing explosives on site from materials that can be readily and individually transported. The cost of transportation makes this alternative uneconomic for the Project. Based on these aspects, the provision of explosives from an off-site manufacturing facility was considered unacceptable and therefore not assessed.

On-Site

It is common practice for mining operations comparable in size to the Project to manufacture explosives on site. 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 as per the Quantity Distance Principles User's Manual. 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 operation;
- distance to traffic routes; and
- SAR sensitivities.

Given the limited options for siting an explosives plant on Project property, the current proposed location of the explosives plant and magazine storage area is planned to be sited north-east of the open pit (see Figure 1-2). This location is well removed from the principal Project work site areas and from external residences for safety purposes, but sufficiently close to the open pit so as not to involve the undue transport of manufactured explosives. This location also ensures non-interference with other Project facilities, traffic or safety of employees and the general public.

7.3.11 Aggregate Supply

It is expected that the majority of aggregate required to develop the Project will be inert mine rock produced incidental to ore extraction. However, experience with other projects in this geographic area has shown that it can be difficult to generate aggregate for concrete and other strictly defined applications. It may therefore be necessary to investigate additional aggregate sources.

Identification of alternative aggregate supply sources assessed in the EA is listed in Table 7-7 and the analysis is presented in Appendix U6:

- overburden/mine rock;
- dedicated on-site aggregate pit(s); and/or
- commercial off-site aggregate pits.

Consideration of these alternative sources will allow for operational flexibility in terms of timing, availability and quality of materials.

7.3.11.1 Overburden / Mine Rock

As mentioned earlier and based on the current design, approximately 40 Mt of mine rock is expected to be used in various forms of Project site construction, mainly for TMF dam and road construction and maintenance. Use of mine rock and overburden as aggregate material reduces waste and disturbance of pristine habitat, while also being cost-effective and close to the components where the material would be used. Potential air emissions would be greatly reduced as blasting forms part of the Project development profile and transport would be limited to the Project site. However, it is anticipated that overburden and mine rock would not be sufficient to meet all construction needs. If sulphide content is high, mine rock may not be suitable for concrete manufacture. Closure for this alternative forms part of the open pit closure profile.

7.3.11.2 Dedicated On-Site Aggregate Pit(s)

There are two approved and permitted aggregate pits within the Project site, and these are shown in the site layout as Aggregate Pits #1 and #3 (see Figure 1-2). These pits are remotely located and in close proximity to the proposed Project components where the material would be required. This alternative has low potential for environmental impacts beyond what is already in effect as part of the aggregate pit(s) operations, and transport would also be limited to the Project site. The resources available at either of these pits are surveyed and estimated to have approximately 500,000 m^3 of quality aggregate. However, additional or more suitable rock for concrete manufacture may still be required from external sources. Closure would be as per the management of others operating the aggregate pit(s) with the potential to generate either terrestrial or aquatic habitat upon closure; though these pits may remain operational independent of the Project's development.

7.3.11.3 Commercial Off-Site Aggregate Pits

Commercial off-site aggregate pits, managed by others, could provide all the construction material needed for Project development. Land Information of Ontario (MNR, 2013) indicates that there are three authorized aggregate sites within 20 km of the Project site (see Section 6.5.1.2). However, this alternative implies reliance on external suppliers and higher costs due to transportation of material to the Project site, as well as dependence on external service providers. Potential effects to the environment could include higher traffic volumes on local roads which in turn may increase the risk of traffic accidents and air emissions. This alternative has no notable advantages for the Project, unless the resource is not available on site.

7.3.11.4 Preferred Aggregate Supply Alternative

It is currently anticipated that the Project will use a combination of alternatives – making use of overburden / mine rock extracted from the open pit development for construction, supplemented by materials as needed from the permitted on-site aggregate pits (see Appendix U6). The combination of these two alternatives will result in the most cost-effective option and is believed to supply all the materials that may be required for construction. This reduces potential effects on the environment by eliminating the need for hauling of material over longer distances and public roads and/or the development of additional pits, as well as reducing produced wastes.

The major disadvantage and limitation to obtaining aggregate materials from an off-site pit is the cost of transporting the material to the Project site and, therefore, it is not considered viable for the Project.

7.3.12 Non-hazardous Solid Waste Management

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

- truck the waste off-site to an existing licensed landfill;
- develop an on-site landfill;
- acquire an off-site landfill; and
- incineration.

A summary of these alternatives is presented in Table 7-7, and the analysis of the alternatives is presented in Appendix U7.

Use of an incinerator was rejected as being too costly and difficult to obtain environmental approvals and, therefore, is not considered in the EA (AMEC, 2013a). Consideration may be given to controlled burning in accordance with environmental regulations/timing, of clean wood and cardboard waste in order to reduce overall waste volumes for landfilling, especially during construction. The remaining alternatives, trucking the waste off-site to an existing licensed landfill and developing an on-site landfill, were assessed in the EA.

7.3.12.1 Truck Waste Off-Site to an Existing Licensed Landfill

Solid waste would be temporarily stored on site and regularly transported by trucks to an off-site licensed facility which has not currently been identified. It is assumed that the selected existing landfill will have capacity for the Project's waste disposal needs, but may require an expansion. This alternative allows for liabilities to be transferred to the landfill facility operator, which would benefit cost-effectiveness. Transport would increase traffic along local roads, thereby increasing the risk of potential collisions and spills, and relies on the provision of services and management by others. Transporting activities could be contracted to a local service provider, but may be too costly due to long distances to be supported by the Project.

7.3.12.2 Develop an On-Site Landfill

A landfill could be developed east of Three Duck Lakes (Middle), south of the proposed location for the explosives plant. Should this alternative be preferred, information obtained is expected to be supportive of any required environmental approvals to develop the facility and related infrastructure, such as access roads. An on-site landfill would be operated and closed by IAMGOLD in accordance with applicable Provincial regulations and guidelines. An on-site landfill would eliminate the need for lengthy transport of wastes. Proper design would reduce, eliminate or mitigate any potential effects to the environment. This alternative requires long-term monitoring and potential closure liabilities, making it less attractive from a cost-effectiveness perspective.

7.3.12.3 Acquire an Off-Site Landfill

IAMGOLD is considering the acquisition of the MNRF Neville Township Landfill, which can be accessed via the Mesomikenda Lake Road approximately 2 km from the Project site.

Based on preliminary studies (AMEC, 2013b), it is likely that this landfill would require expansion to meet the Project's waste disposal needs. The close proximity to the Project site would reduce costs of hauling wastes to the facility and would eliminate the need for the development of access roads. Transportation of wastes could be contracted to local service providers. Information obtained for the Project could partly support environmental approvals, and use of an existing facility reduces the amount of habitat that would be disturbed. The location of this facility provides the best alternative to reduce or eliminate potential effects to area watercourses as the water table is comparatively deeper. IAMGOLD would take over operation and closure of the facility, in accordance with applicable Provincial regulations and guidelines. This alternative also requires long-term monitoring and carries potential closure liabilities. The landfill's location greatly reduces the potential for effects to the environment, particularly groundwater, due to the local topography and geology - down gradient of local flows, shallow overburden layer followed by bedrock, high elevation area with a deep water table (AMEC, 2013b).

IAMGOLD is also considering contracting the use of the landfill, which would then remain under the ownership, care and maintenance of the MNRF. Under this scenario, benefits would be similar to acquiring the landfill, but would require lesser capital as expansion and closure costs would be the MNRF's responsibility. An agreement would be reached between IAMGOLD and MNRF for the operating and maintenance of the facility. This agreement will also accommodate local residences around Mesomikenda Lake to continue to use the MNRF Neville Township Landfill.

7.3.12.4 Preferred Non-Hazardous Solid Waste Management Alternative

The preferred alternative is to acquire and expand the existing MNRF Neville Township Landfill (see Appendix U7). This alternative is somewhat more costly compared to developing an on-site landfill (AMEC, 2013b), but it would allow IAMGOLD to control operational and other aspects of the landfill in an environmentally responsible way, ensuring service availability and capacity for the Project's needs. Close proximity of the facility to the Project site also benefits operational aspects and cost-effectiveness for this alternative, reducing risks due to lengthy transportation needs along public roads. Expansion would not disturb pristine habitat. Should only the use of the landfill be contracted, it would benefit the cost-effectiveness of this alternative, transferring expansion costs and environmental and closure liabilities to the MNRF.

7.3.13 Hazardous Solid Waste Management

Hazardous solid and liquid waste will be hauled off-site by licensed contractors to licensed management facilities. Hydrocarbon contaminated soils could potentially be remediated on site using approved methodologies which have demonstrated effectiveness. Through thorough management and operational practices, IAMGOLD does not anticipate the occurance of hydrocarbon contaminated soils. Should minor contamination of soils occur, IAMGOLD would then assess on a case-by-case basis whether on-site or off-site remediation would represent the most suitable and environmental friendly alternative.

No on-site alternatives (such as development of an on-site hazardous waste landfill) are considered acceptable or meet the IAMGOLD identification criteria for alternatives. Specifically, the potential negative effects on the physical, biological and human environment are considered unacceptable when compared with transporting the material to an existing hazardous waste management facility. As such, development of an on-site hazardous waste management system was not assessed in the EA.

7.3.14 Domestic Sewage Treatment

The alternatives currently being considered for domestic sewage treatment at the Project site include:

- septic tank(s) and tile field(s);
- lagoons;
- package sewage treatment plant; and
- trucking domestic sewage off-site.

A summary of these alternatives is presented in Table 7-7 and the analysis is presented in Appendix U8.

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

In this alternative, sewage is pumped or fed by gravity to buried septic tanks where solids settle and clarified liquid flows from the surface towards buried, permeable pipes (the tile field). The liquid permeates into the soil over a broad area, where bacterial processes bring discharge to safe and permissible levels. Solids settled in the septic tanks are periodically removed. This is a passive treatment system that is cost-effective once installed. However, tile fields function optimally when installed in coarse soil types. The site has shallow soils comprised primarily of till, with a maximum depth to bedrock of approximately 22 m, requiring the importation of appropriate material such as sand for tile field development. Additionally, tile fields and septic tank systems must be sited appropriately to avoid potential effects to area watercourses and groundwater resources.

These systems are best suited to small scale applications, such as rural housing. These systems are also used commercially in rural areas for recreational facilities and small scale mining operations.

7.3.14.2 Lagoons

Lagoons are large aerated basin systems where sewage is accumulated and actively aerated to promote biological oxidation of wastewater. Lagoons are a cost-effective option due to semi-passive treatment once installed, but are subject to odour development and require relatively large areas of land, depending on the loading estimated. Lagoons can range from 1.5 m to 5 m in depth and use motor-driven aerators or submerged air injection diffusers. Systems typically require three to four lagoons, and are widely used by small municipalities. As for tile fields, the development of lagoons would likely require the importation of appropriate material, such as sand, as the site has shallow soils comprised primarily of till.

These systems are better suited to regions where temperatures do not fall below 0°C, in order to promote biological oxidation which increases with rising ambient temperature.

7.3.14.3 Package Sewage Treatment Plant

Package sewage treatment plants are cost-effective, pre-fabricated modular systems, engineered such that the resulting effluent can be released directly to the environment. The remaining sludge is either trucked off-site to a licensed landfill or disposed of in the TMF. The package sewage treatment plant for the Project may either be a rotating biological contactor, a sequencing batch reactor, or a membrane bioreactor.

Rotating biological contactors are mechanical rotating systems that treat wastewater by passing it over a shaft which slowly rotates vertical discs covered by a film of microorganisms. These microorganisms consume organic materials by aerobic digestion. The slow rotation facilitates aeration, optimizing treatment. Accumulated sludge can be periodically trucked off site to a licensed landfill or disposed of in the TMF. This option is one of the most cost-effective for package sewage treatment plants, but requires more frequent removal of sludge.

Sequencing batch reactors come in different configurations, but the basic process is similar. The installation consists of at least two identically equipped tanks with a common inlet, which can be switched between them. The first tank receives sewage for settling and decanting, while the second receives the decant fluids for aeration. At the inlet is a section of the tank known as the bio-selector. This consists of a series of walls or baffles which direct the flow either from side to side of the tank or under and over consecutive baffles. This helps to mix the incoming sewage, beginning the biological digestion process before the decant fluids enter the main part of the second tank. The effluent can be directly discharged to the environment following treatment, while the sludge can be periodically trucked off site to a licensed landfill or disposed of in the TMF.

Membrane bioreactor plants also use both aerobic and anaerobic bacteria action to breakdown organic matter by activated sludge treatment followed by a membrane liquid-solid separation process. The membrane component uses low-pressure microfiltration and ultrafiltration membranes immersed in the aeration tank. These plants permit bioreactor operation for decant fluids with higher suspended solid concentrations. This allows for effective removal of soluble and particulate biodegradable materials at higher loading rates. Sludge retention times are also higher, which ensures complete nitrification of solids even in very cold climates. It is a more costly system to install compared to conventional sewage treatment methods but has proven to be a reliable technology with a small footprint, ultimately producing a high quality effluent that can be discharged directly to the environment, or for recycling of water for other uses.

7.3.14.4 Trucking Domestic Sewage Off-Site

Off-site treatment of sewage during operations would require temporary storage in tanks on-site and regular trucking of raw sewage to a local sewage treatment plant. Trucking activities could be contracted to a local service provider. While this alternative would have the least effects on the environment at the Project site, IAMGOLD would rely on the service of others, while trucking would increase traffic along local roads and associated risks of potential collisions and spills. Though this alternative allows for closure liabilities to be transferred to the facility operator, trucking is a costly alternative making it less attractive from a cost-effectiveness perspective.

7.3.14.5 Preferred Domestic Sewage Treatment Alternative

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 (see Appendix U8). There is considerable experience with the operation of package sewage treatment plants for northern Ontario mine sites as well as other applications.

The package sewage treatment plant alternative provides a compact, cost-competitive, low risk technology without capacity constraints. It represents the smallest footprint and, given the soil and geological conditions at the Project site, installation of a package sewage treatment plant is the most appropriate. The small sites utilized by this alternative would provide terrestrial habitat for vegetation and wildlife species at closure.

7.3.15 Power Supply and Routing

Ensuring a reliable, cost-effective power supply is a critical component for the Côté Gold Project. The majority of the power requirement is for the ore processing plant, with the balance required by the mine itself, along with ancillary needs such as dewatering, administration and other on-site activities. During the initial stages of Project construction, the electrical power demand is expected to be relatively low, less than 5 MW. This power demand would be met through the existing nearby transmission line (1 MW) as well as diesel generators (less than 5 MW). The current schedule anticipates that a 230 kV connection to support operations will be in service for the later stages of construction.

Diesel power is an effective method to support Project construction prior to additional grid power being brought to site and can serve effectively as emergency power for critical site functions. This alternative was brought forward into the EA to be considered for short-term use during the construction phase and subsequent periodic use during the operations phase (and potentially during the closure phase) as needed when grid power is unavailable. On-site diesel-fired power generation to support operations, however, will result in the release of greater amounts of carbon dioxide, NO_x, and particulate emissions than other alternatives and is not considered to be cost effective for normal operations.

Alternative energy sources such as hydroelectric, solar and wind power were considered for primary power generation during operations. The nearest hydroelectric dam is Ontario Power Generation's Wawaitin Generating Station located approximately 90 km north of the Project and the capacity of the facility is too low to meet the Project's power requirements. Without viable energy storage technology, solar and wind generated electricity cannot meet the Project's power requirements on a consistent basis because of the intermittent nature of solar and wind generation. As a result, the use of alternative energy sources as the primary power generation supply has not been assessed in the EA.

A review of transmission infrastructure that could serve the Project during operations has been carried out. A 500 kV Hydro One transmission line is located approximately 90 km east of the Project; however, Hydro One and the Independent Electricity System Operator generally do not allow direct connection to a 500 kV transmission line. In addition to the 500 kV transmission line, there is a 115 kV transmission line located approximately 50 km east of the Project; however, 115 kV will not be sufficient for the Project.

IAMGOLD has thoroughly reviewed whether it is viable or not to run the Project with a 115 kV line. Based on the infrastructure requirements for the Project, a 230 kV transmission line has been deemed necessary, and a 115 kV line is not considered a technically, financially realistic or economically viable solution for IAMGOLD. A 115 kV line could provide a maximum of 70 MW to 80 MW. The current Project design requires 120 MW. In addition, the capacity of a 115 kV line would be at its limit at 70 MW to 80 MW and the stability of the system and capacity to deliver consistent power would be questionable. Also, from an efficiency standpoint, lower voltage lines have greater electrical transmission loss rates and, as such, use of a 115 kV line would waste power and increase power costs. Moreover, with greater power capacity available through a 230 kV line, IAMGOLD will assess the potential for a more power-intensive mining method, such as in-pit crushing and conveying (IPCC). IPCC use, if deemed appropriate, can significantly reduce GHG emissions typically emitted from the truck fleet. The 120 MW estimate does not include the power which would be required to operate IPCC, as IPCC is still being evaluated by the Project team. Also, with the 230 kV line, IAMGOLD would have capacity in the power system to support potential future expansions of the mine and/or local needs; whereas, with a 115 kV line, expansion options would be entirely eliminated or extremely limited.

A 230 kV line is preferred for capacity reasons but also to prevent energy shortfalls. Power during the operations phase of the Project will be supplied by this new 230 kV transmission line connected to the existing Hydro One in Timmins at the Porcupine Substation. Either one of the proposed alternative transmission line alignments (TLAs) would be owned and maintained by IAMGOLD. The two TLA alternatives are described below.

The transmission line will be of standard design, typically using wooden, two-pole H-frame structures. Steel lattice tower structures will be required for angle and dead-end support. Guy wires will be used to support the structures as required, typically in softer soils and at turning points. The transmission line structure itself is not considered in this alternatives assessment.

A summary of these alternative TLAs is presented in Table 7-7, and the analysis is presented in Appendix U9. No further TLAs are currently considered because those alignments would either be longer or create more environmental disturbance compared to the alternatives considered in the EA.

7.3.15.1 Shining Tree Transmission Line Alignment

The Shining Tree TLA's first segment, of approximately 120 km in length, would be located parallel to an existing 115 kV transmission line from Timmins to the Shining Tree Substation. The second segment, with a length of approximately 40 km, would extend from the Shining Tree Substation to the Project site alongside an existing distribution line. The total length of this TLA would be 157 km. The right-of-way (ROW) would be expanded by a total of 45 m alongside the existing ROW, thereby requiring the clearing of approximately 830 ha of land.

This alternative is longer, and long transmission lines typically experience greater electrical transmission losses and have higher capital requirements for construction. This alternative, however, has a low potential for Project delays which may be caused by new claims, land tenure negotiations or environmental permitting. Most of the potential physical and biological environment effects at the Shining Tree TLA would occur during the construction phase and can be mitigated, with little to no effects anticipated for the human environment. Periodical clearing of the ROW would be required during operation to ensure its safe operation, through manual/mechanical means to avoid the use of approved chemicals. Closure alternatives for this TLA include complete removal or potential transfer to a local service provider.

7.3.15.2 Cross-Country Transmission Line Alignment

The Cross-Country TLA has three segments. The first segment would run parallel to the same existing 115 kV transmission line from Timmins for approximately 46 km. A new route would then go through previously undisturbed land south-west toward the Project site for approximately 68 km, closer to Highway 144 and Gogama. The last 6 km follows the same route as for the Shining Tree TLA, totalling 120 km in length. The ROW would be expanded by a total of 45 m alongside the existing ROW of the 115 kV line for the first segment, and by 50 m for the rest of its length, thereby requiring the clearing of approximately 675 ha of land. This proposed route has been sited to facilitate access for maintenance requirements, while locating it in remote areas to minimize potential effects to the environment and any nearby residents.

This alternative is shorter in length compared to the Shining Tree TLA alternative, and has a more direct route to the Project site. Potential physical and biological environment effects would occur during the construction phase. This alternative would disturb more wildlife habitat, but potential effects to the biological environment are largely expected to be similar and, in some cases, less than the Shining Tree TLA alternative due to its shorter length. Because a section would cross through currently pristine habitat, this alternative has a higher risk of Project delays which may be caused by new claims, land tenure negotiations or environmental permitting. Periodical clearing of the ROW would be required during operation to ensure its safe operation, through manual/mechanical means to avoid the use of approved chemicals. Closure alternatives for this TLA include complete removal or potential transfer to a local service provider.

7.3.15.3 Preferred Transmission Line Alignment

The resulting preferred alignment is the Cross-Country TLA, as this TLA is more cost-effective, while producing no, to minimal effects on the physical, biological and human environments with appropriate mitigation measures (see Appendix U9).

The Cross-Country TLA is a more direct and shorter route to the Project site, which greatly reduces costs. Vegetation clearing is greatly reduced with this alternative. The Cross-Country TLA will clear 155 ha less than the Shining Tree TLA, following in parts Highway 144 which will facilitate access. Additionally, because it is a shorter route, electricity transmission losses will be greatly decreased, reducing operational costs.

SAR have been detected in the area through which both TLA alternatives would pass; particularly little brown myotis bats. However, no bat roosting or hibernacula sites or SAR bird nesting sites have been identified along the proposed TLAs (see Chapter 6), except for some eagle nests on the existing transmission line's poles along the joint TLA section for both alternatives and the Shining Tree TLA alternative. As a result there are no major differences in the potential for effects between the TLA alternatives for the biological environment. Habitat changes may affect some species but can benefit others, such as whip-poor-wills and bats which prefer more open areas.

While the Cross-Country TLA alternative has a somewhat higher risk of Project delays due to the potential for new claims, land tenure negotiations and environmental permitting, it is not currently anticipated that this will affect the Project differently than the Shining Tree TLA alternative would with respect to the above issues.

7.4 Project Alternatives - Mine Closure

IAMGOLD is committed to the progressive rehabilitation of the Project site over the life of the Project. During the closure phase, mining is terminated and final reclamation of the site occurs. Closure alternatives and the proposed progressive and final reclamation measures for the site and related infrastructure are assessed.

Alternative closure methods consistent with Provincial regulatory requirements have been considered, in order to prevent or reduce potential effects to the environment. The following components closures were considered:

- open pit mine (natural flooding, enhanced flooding, backfill with mineral waste);
- water management system (leave in place, partial or full removal);
- stockpiles (re-use, stabilization and covering/revegetation, use in backfill, engineered cover);
- TMF (permanent flooding, covering and revegetation);
- buildings (disassembly and removal, re-use of acceptable buildings);
- infrastructure (decontamination and removal, leave in place for future use, reclaim in place); and
- drainage (stabilize and leave in place, removal).

It should be noted that when the Project proceeds to the permitting phase, a detailed, certified Closure Plan (including financial assurance) is required under Ontario Regulation 240/00 of the *Mining Act* which will be submitted by the proponent for review by applicable government agencies and First Nations, and will be reviewed in consultation with the general public. A conceptual closure plan based on the preferred alternatives identified below is detailed in Chapter 5.

7.4.1 Open Pit Closure

The primary intent of reclamation and closure of the open pit is to achieve a physically safe and chemically stable environment. Based on the pre-feasibility level pit design, the open pit will have a total approximate void volume of up to 630 Mm^3 to level with ground surface at cessation of mining, and cover an approximately circular area of an estimated 210 ha (2.1 km^2).

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;
- 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 Provincial Terms of Reference (ToR) identified the following preliminary closure strategies for reclamation of the open pit:

- natural flooding;
- enhanced flooding; and
- backfilling with mineral waste.

Given the estimated final volume of the open pit, either flooding alternative or backfilling will require 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 as the groundwater table is reasonably close to surface. Fencing around the perimeter of the open pit and a barricade at the pit access ramp(s) during or following active mining operations to ensure safety during flooding will be employed in conjunction with the preferred alternative.

A summary of the alternatives is presented in Table 7-7, and the analysis is presented in Appendix U10.

7.4.1.1 Natural Flooding

Natural flooding is defined herein to include flooding of the open pit with water that will drain by gravity and natural infiltration of groundwater 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 runoff and seepage from the immediate open pit catchment area, as well as natural groundwater infiltration and precipitation. It would take approximately 100 or more years for the open pit to flood.

The existing pre-development groundwater table in the open pit area is at or near the 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 would be constructed allowing the flooded pit to drain to Upper Three Duck Lakes.

Water that collects in the open pit is not expected to be affected by acid rock drainage/metal leaching (ARD/ML) developing from the pit walls as no PAG mine rock has been detected during geochemical characterization of open pit materials (see Appendix E). Monitoring may be periodically conducted to ensure that any pit overflow to the environment will be protective of aquatic life. 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 a 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, outflow from the open pit would not be expected to occur for many decades, which would allow more time to optimize pit water chemistry.

The end objective at closure is to produce a surface water overflow from the open pit that will be acceptable for passive discharge, akin to conditions pre-development of the Project, 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. With this in mind, natural flooding would extend long-term management costs, which could lead to uncertainties and may require secure long-term fencing to minimize security risks to wildlife and the general public.

Once the open pit is fully flooded, the newly formed open pit lake would be integrated into the Mollie River watershed. This would be achieved by removal of specific watercourse diversion/impoundment dams constructed as part of the Project development.

7.4.1.2 Enhanced Flooding

Enhanced flooding would reduce the time until the open pit is fully flooded, and is also a regularly used alternative that is cost-effective.

Enhanced flooding would occur in stages – at closure, the open pit would begin flooding once dewatering activities cease. Passive flooding would also resume through infiltration of groundwater and precipitation inputs. Active filling would be employed by pumping runoff from the MRA and/or alternate sources. Additional water sources that could be used to enhance the flooding of the open pit include seasonal freshwater inputs from the nearby watercourses (if deemed acceptable) or recycled water from the TMF reclaim and polishing ponds. Some drainage channels and water management structures constructed for dewatering/diversion purposes could be removed or stabilized to support flooding. During Stage I of post-closure, the open pit would continue to flood. Most watercourse realignments and associated dams would still be in place at this stage. Once the pit is fully flooded, as part of Stage II of post-closure, the newly formed open pit lake will be incorporated into the Mollie River watershed by removal/breaching of dams. As for natural flooding, an outlet will be constructed and the flooded pit will eventually overflow, likely to Upper Three Duck Lakes.

Enhanced flooding could reduce the length of time for the open pit to flood to a level close to the existing water table level of the area; it is anticipated that it would take approximately 50 years to flood the open pit.

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 potential metal leaching/acid rock drainage (ML/ARD) development from exposed pit walls, if potentially acid generating (PAG) rock is present; and
- reduce the time to achieve a stabilized, self-sustaining water management condition.

The principal disadvantage of enhanced flooding of the pit is the reduction(s) in watercourse flows and fish habitat while the pit is being flooded, should water be needed from alternate sources such as nearby watercourses.

7.4.1.3 Backfill the Open Pit with Mineral Waste

Backfilling the open pit with mineral wastes (mine rock and overburden) is preferred if feasible. The advantage of backfilling is that the pit can be filled to the surface in a comparatively short time (less than a decade), and PAG rock, if detected, can be permanently stored (along with a volume of non-acid generating (NAG) mine rock and covered with a thick layer (5 m or more) of clay till). The deposited material would then flood to near surface as the water table rises within the backfilled material to permanently seal the filled open pit and PAG mine rock.

Despite having several environmental advantages, the primary disadvantage and limitation of this alternative is cost. The costs for backfilling the approximately 630 Mm^3 pit will cost in the order of $3B. 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 the *Mining Act* financial assurance requirements, the $3B cost will have to be included as part of the closure bond, prohibitively adding to upfront capital costs for financing. This alternative is thus deemed unacceptable for the Project.

7.4.1.4 Preferred Open Pit Closure Alternative

The preferred alternative is enhanced flooding of the open pit (see Appendix U10). It is a cost-effective alternative that would require less time than natural flooding, and may not require additional inputs from nearby watercourses. This alternative will provide future aquatic habitat and will allow the local watersheds to return to their pre-mining conditions, as much as practicable. As the potential for PAG rock is negligible based on current geochemical characterization of the mine rock (see Appendix E), there is no concern of ML/ARD.

The rate of enhanced flooding would have to be balanced with downstream flow and fish habitat protection needs, particularly if water is taken from nearby watercourses to support enhanced flooding. Capturing some portion of the Mesomikenda Lake flow or other appropriate nearby watercourse on a seasonal basis, and diverting this flow to the open pit may be acceptable. Discussions with regulators and other stakeholders would be required to determine the most appropriate mode of flood optimization, together with any adaptive management strategies.

Natural flooding, while an acceptable alternative would extend long-term management costs. This could potentially raise uncertainties, while extending security risks for wildlife and the general public. Backfilling is a costly alternative which cannot be supported by the Project.

7.4.2 Water Management System Closure

The principal Project site water management system components include pipelines (and associated pump stations and facilities), road culverts, ditching and various ponds. The preferred alternatives are to dismantle and remove all Project-related pipelines and water management structures once they are no longer needed for implementation of the Closure Plan.

Alternatives relating to water management system closure are the following:

- leave in place;
- partial removal; and
- full removal.

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 Project site includes:

- road-side ditching; and
- ditching to meet MMER effluent collection and management requirements (particularly around the main Project components).

A summary of the alternatives is presented in Table 7-7, and the analysis is presented in Appendix U11.

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 would stabilize with vegetation over the course of the mine life, and would not pose a flood risk once the associated road culverts are removed. Backfilling the roadside ditches would therefore serve no purpose and is not proposed. The ditches would be left in place with any associated culverts removed.

Ditching installed to meet MMER effluent collection and management requirements is needed to achieve compliance with the Regulation. Regulation-related ditching would therefore be left in place until such time as it can be demonstrated that MMER monitoring of the involved mine component is no longer required. Once the mine becomes a recognized closed mine, Regulation-related ditching would be stabilized and left in place, the same as for roadside ditching. Backfilling the ditches would serve no purpose and is not proposed.

Various ponds are present at the Project site and include:

- mine water pond;
- seepage collection ponds (MRA, TMF, low-grade ore stockpile);
- TMF reclaim pond; and
- polishing pond.

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

The general preference would be 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 IAMGOLD 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 MMER requirements.

The principal function of the minewater pond during operations will be to provide a freshwater and recycled water source. The mine water pond will be removed as part of closure, but may remain operational during the initial stages of closure to receive runoff and seepage pumped from the MRA, if required for MMER monitoring. The water holding dams of the minewater pond will be breached for closure to prevent retention of water and to eliminate an unnecessary Project liability. The liner will be removed and appropriately disposed of, and the area will be revegetated. The alternative of stabilizing and maintaining the mine water management pond in the long term would serve no purpose, and is therefore not proposed. It should be noted that the minewater pond may not be reclaimed immediately as closure commences. The minewater pond may be retained for some time to allow for the transfer of pumped water from the MRA seepage ponds and TMF reclaim and polishing ponds to support open pit flooding (see Section 7.4.1).

The TMF reclaim and polishing ponds will be closed as part of the TMF closure once they are no longer used to support open pit flooding nor have a water management function (see Section 7.4.4).

The major function of the seepage collection ponds during mine operation will be to help prevent excess runoff from entering the open pit, and to monitor seepage. Seepage collection ponds are planned around major mining components, particularly the MRA, TMF and low-grade ore stockpile. As described above, once mining operations are completed, the intent will be to flood the open pit as quickly as practicable. Maintaining the seepage collection ponds after mining is complete and the open pit is flooded would therefore serve no function. The ponds would then be drained and the dams breached, along with removal of associated infrastructure and stabilization and revegetation of remaining solids. Should the water quality be deemed not suitable for release, pumping to the open pit would continue (or to the TMF in the case of TMF seepage collection ponds) and treatment may be considered, though this is currently not anticipated based on the current geochemistry of the mine rock and tailings.

Project-related pipelines, which form part of the general Project infrastructure, are expected to include:

- tailings discharge pipeline;
- TMF water reclaim pipeline;
- freshwater intake pipeline; and
- other internal site water transfer pipelines.

These are discussed further in Section 7.4.6.

7.4.2.1 Preferred Water Management System Closure Alternative

The overall preferred alternative is to fully remove all components of the water management system (see Appendix U11). However, based on the description of each alternative outlined above, the ultimate approach will be a combination of the alternatives in progression. In other words, stabilize site area ditching and leave it in place, and leave all water holding ponds (minewater, seepage collection, TMF reclaim pond and the polishing pond) in place.

The various ponds, and associated infrastructure, will be kept in place as part of closure activities to flood the open pit and for monitoring purposes. These will be breached/removed and restored during post-closure once the open pit has fully flooded, with the potential exception of the seepage collection ponds around the MRA and TMF, depending on the seepage quality. It is currently anticipated that all ponds will be removed and reclaimed during post-closure.

7.4.3 Mine Rock Area and Stockpiles Closure

Stockpiles that will require closure include the mine rock area (MRA), containing the overburden and mine rock stockpile, and potentially the low-grade ore stockpile.

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; and*
- *improving site drainage to prevent water erosion on rehabilitated areas.*

The Provincial ToR provides for the following preliminary closure strategies for reclamation of the Project 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. A summary of the alternatives is presented in Table 7-7, and an analysis of the alternatives is presented in Appendix U12.

The MRA will contain the overburden and mine rock extracted from open pit development. A total of 850 Mt of mine rock and 20 Mt of overburden are estimated to be extracted. An estimated 40 Mt of mine rock will be used for various Project site construction activities. The remaining 810 Mt will remain in the MRA. The MRA will be to the south-west of the open pit, as shown in the site layout (see Figure 1-2).

The low-grade ore stockpile will contain the low-grade ore extracted from the open pit during the first half of operations. This material is stored in the stockpile north of and adjacent to the open pit (see Figure 1-2), to be processed in the latter third of the mine life. This stockpile is expected to be consumed through processing and will not remain at closure, thus not requiring reclamation beyond revegetating the exposed area. However, should economics be such that the low-grade ore cannot be viably processed, the low-grade ore stockpile will be reclaimed in the same manner as the MRA. The low-grade ore is expected to be NAG, based on preliminary geochemical analyses of open pit materials (see Appendix E).

7.4.3.1 Re-use

It is currently anticipated that a portion of the extracted mine rock would be used for construction, particularly for the development of impoundment dams. It is estimated that 40 Mt of mine rock (NAG) would be used, and some of the overburden would be used for covering and revegetation during closure activities. This would reduce the amount of waste produced and marginally reduce the MRA's footprint.

While this is an acceptable alternative that is cost-effective and reduces potential effects to the environment, it utilizes only a small portion of mineral waste.

7.4.3.2 Stabilize and Cover/Revegetate

The standard approach for mineral waste stockpiles (NAG) is to contour the stockpiles, progressively during operations, or at closure to stabilize them. This is followed by revegetation of the top benches or all of the stockpiles with local native plant species or other acceptable plant species, for aesthetic purposes and to reduce the potential effects of erosion and provide for other uses such as terrestrial habitat. This approach could be applied to the Project MRA as preliminary results indicate that there is a negligible potential for PAG rock at the Project site (see Appendix E).

This is a cost-effective alternative which conveys low environmental risk. Covering and revegetation would provide terrestrial habitat for vegetation and wildlife species.

7.4.3.3 Use in Backfill

Utilization of mineral waste as backfill material would reduce waste generation, volume and the footprint of waste stockpiles. However, only a small quantity of this material can be disposed of in this manner as extensive backfilling costs are unsustainable for the Project (see Section 7.4.1.3).

7.4.3.4 Engineered Cover

Engineered or composite covers are used for mineral waste stockpiles to control ML/ARD development, while providing stockpile stabilization, terrestrial habitat or other functions. These covers are expensive to install, but limit the infiltration of precipitation and oxygen to underlying reactive (PAG) material. Some infiltration still occurs and this alternative requires long-term collection of stockpile seepage and monitoring, with possible treatment requirements.

As preliminary results indicate that there is a negligible potential for PAG rock at the Project site (see Appendix E), this alternative is not attractive from a cost-effectiveness perspective.

7.4.3.5 Preferred MRA and Stockpiles Closure Alternative

The preferred alternative is stabilization and cover/revegetation, combined with re-use of some mine rock (see Appendix U12). An estimated 40 Mt of mine rock extracted from the open pit development would be used during the construction phase, particularly for impoundment structures. Mine rock may also be used for other site construction purposes, such as for the development and maintenance of site roads. This would reduce the amount of mineral wastes produced as well as the MRA and overall Project footprint. The remainder would be stockpiled in the MRA. Additionally, overburden would be used for covering and revegetating purposes during closure. Closure of the MRA is expected to be carried out progressively during operations with finalization at closure. Stockpiles would be progressively contoured during operations for stability. The MRA side benches would be partially covered and revegetated to expedite growth of indigenous plant species and trees upon closure.

These two alternatives are the most cost-effective and have the lowest potential for effects to the environment, while providing for other uses or terrestrial habitat.

While the engineered cover alternative is acceptable, it is rejected as preliminary studies suggest that there is negligible potential for PAG rock at the Project site (see Appendix E) and hence negligible potential for ML/ARD. As covers are expensive and primarily aimed at managing and containing ARD/ML, it is not a cost-effective alternative for the Project.

7.4.4 Tailings Management Facility (TMF) Closure

The TMF will hold the tailings solids and reclaim pond. Adjacent to the TMF will be the polishing pond. The TMF will have the capacity to hold an estimated 261 Mt of tailings which are expected to be NAG, based on preliminary geochemical analysis (see Appendix E).

At the completion of mining the TMF must be closed out in accordance with Ontario Regulation 240/00, amended by 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; and*
> - *applying soils or a gravel barrier.*

The Provincial ToR identified the following closure alternatives for reclamation of the TMF:

- permanent flooding; and
- covering and revegetating.

A summary of these alternatives is presented in Table 7-7, and the analysis is presented in Appendix U13.

7.4.4.1 Permanent Flooding

Flooding the TMF to maintain tailings in a saturated state is a standard and well accepted closure strategy, employed to provide an oxygen barrier to prevent development of ML/ARD for PAG tailings. This alternative is costly, as dams may have to be reinforced and/or raised to support the large volumes of water required to fully flood the tailings beaches. Impounding such a quantity of water would require ongoing maintenance and monitoring of water quality and dam stability. This alternative also carries a higher potential for environmental risk in the event of TMF dam failure/unintended release.

As current indications are that the tailings will be NAG (see Appendix E), based on preliminary geochemical analyses, this alternative is not attractive from both a cost-effectiveness and environmental perspective.

7.4.4.2 Covering and Revegetating

Covering the TMF (fully or partially) with low permeability material and revegetating is also a standard and well-proven technology, effective for both NAG and PAG tailings. In the case of NAG tailings, such as for the Project, the tailings surface can be vegetated directly without the requirement of a layer of topsoil. The tailings beaches would be covered and revegetated with native, or other acceptable, plant species.

This alternative is less costly than permanently flooding the TMF, and has the potential to develop terrestrial habitat, or for the development of new and innovative land uses such as biomass production. In turn, it carries a lower potential for environmental risk as dam failure/unintended release would not occur.

7.4.4.3 Preferred TMF Closure Alternative

The preferred alternative for closure of the TMF is to cover and revegetate it (see Appendix U13). The tailings dams and associated spillway(s) would be stabilized during operations for long-term performance, with periodic inspections by a qualified engineer in accordance with regulatory requirements. Upon closure, tailings beaches would be vegetated directly, while the reclaim pond and the polishing pond may remain for some time for water management and monitoring purposes. Water from the TMF reclaim pond and the polishing pond could be pumped through the reclaim pipeline to support open pit flooding during closure. Once the reclaim pond water reaches an acceptable quality level and open pit flooding has ceased, the two planned spillways for both the reclaim and polishing ponds would be breached to drain them. The remaining area would then be fully vegetated to control the potential effects of erosion and suspended solids loadings to nearby watercourses.

This alternative provides the best security from an environmental perspective, providing terrestrial habitat or potential for other uses, such as biomass production.

7.4.5 Buildings Closure

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

- ore processing plant (including primary crusher and control room);
- explosives facility (emulsion plant);
- accommodations complex;
- maintenance shop, warehouse; and
- truck wash, fuel bay.

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

In accordance with Ontario Regulation 240/00, amended O. Reg. 307/12, and the Code of the Ontario *Mining Act*, buildings must be dismantled and removed. 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.*

It should be noted that off-site transport of buildings, equipment or parts and scrap is feasible only if a market exists to receive these materials. This cannot be guaranteed at the time for closure. Non-hazardous materials can be landfilled on site, with approval, and in accordance with Provincial Environmental Compliance Approvals. Hazardous materials must be trucked to an approved and licensed off-site landfill.

The Provincial ToR provides for the following alternatives for the disposal of buildings and equipment:

- disassembly and removal (according to applicable regulations); and
- re-use of acceptable buildings (and related infrastructure/equipment).

A summary of these alternatives is presented in Table 7-7, and the analysis of the alternatives in Appendix U14.

7.4.5.1 Disassembly and Removal

Disassembly and removal of buildings from the Project site is common practice and must be consistent with the specified future use of the land (O. Reg. 240/00). This alternative requires greater capital in order to meet closure requirements and to develop an on-site demolition landfill. It is expected that information obtained to date and future monitoring data would support permitting requirements for an on-site landfill. The re-sale or recycling of appropriate materials would be considered to reduce closure costs and generated wastes.

Disassembly and full removal of buildings would allow the area to return to unobstructed terrestrial habitat.

7.4.5.2 Re-use of Acceptable Buildings

Some buildings, such as the accommodations complex, may be useful to nearby communities and may be retained through negotiation for alternate future uses, either by IAMGOLD (for example, to accommodate staff required for long-term monitoring purposes), or others such as local communities and/or First Nations.

This alternative would reduce closure costs, while potentially benefitting local communities through future employment opportunities or property value appreciation. Any buildings that are maintained would have to be made safe for public or general use, and associated infrastructure would remain (such as access roads, transmission line, water management features, etc.).

7.4.5.3 Preferred Buildings Closure Alternative

As per regulatory requirements, the preferred alternative is to disassemble and remove all buildings upon closure (see Appendix U14). Hazardous materials would be trucked off site to an approved landfill, and recycling or sale of material for scrap/re-use will be considered. Remaining non-hazardous materials would be landfilled on-site in an approved demolition landfill.

IAMGOLD would negotiate with nearby communities and First Nations in the event that there is interest in re-using any of the Project buildings for alternate future use. In such case, buildings and related infrastructure would be secured for general public use, and closure liabilities would pass on to those who take over use of the building.

7.4.6 Infrastructure Closure

The principal Project site infrastructure include roads, pipelines (including pump houses and related infrastructure), power transmission lines and equipment.

The Project-related access roads are expected to include:

- site haul and access roads; and
- service access roads.

The Project-related pipelines are expected to include:

- tailings discharge and reclaim lines;
- freshwater line; and
- other internal site water transfer lines.

The Project-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 Project site.

Primary equipment will comprise:

- crushers and processing equipment housed at the primary crusher and in the ore processing plant;
- various conveyors, including conveyors linking the primary crusher, coarse ore stockpile transfer house and the ore processing plant;
- mobile heavy equipment (diesel and electric shovels, excavators, bulldozers, haul trucks, loaders, jumbos, bolters, load haul dump (LHD) vehicles, scissor lifts, crane trucks, graders, diamond drills, explosives loaders, etc.);
- pumps / pump stations; and
- other miscellaneous equipment.

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.*
>
> *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.*

Since all the Project pipelines will have functions specific to the Project, these pipelines have no reasonable potential value to other possible future land uses. However, due to the conditions at the Project site and potential requirements for ongoing monitoring and closure activities, or as required in the event that buildings are left for alternate future uses (see Section 7.4.5), other alternatives are also considered.

Alternatives relating to the decommissioning of these items as provided in the Provincial ToR are the following:

- decontamination and removal (in accordance with applicable regulations);
- leave in place for future use; and
- reclaim in place.

A summary of these alternatives is presented in Table 7-7, and the assessment of the alternatives is presented in Appendix U15.

Roads associated with the Project have greater flexibility for potential future uses, and may thus be left in place for future use or reclaimed in place. If buildings are retained for future use, by necessity all applicable access roads would be left in place.

Reclaiming roads in place once they are no longer required for building access and/or maintenance/monitoring requirements is a more cost-effective alternative that would allow the area to be reclaimed as terrestrial habitat.

Pipelines are best decontaminated and fully removed, in accordance with applicable regulations, once they are no longer required for closure activities. Materials would be trucked off site to an approved landfill if required, or else disposed of in an approved on-site demolition landfill. Some pipelines or sections of pipelines, due to site conditions or those installed underground, may be reclaimed in place. Such pipelines would be decontaminated, filled and capped. This is a commonly used practice that can reduce generated wastes.

In the event that buildings are retained for future use, the freshwater pipeline and any associated infrastructure would have to remain in place. Closure responsibilities and liabilities would pass onto whoever takes over the buildings and associated infrastructure.

It is currently anticipated that the 230 kV connecting line to the Provincial grid and the smaller capacity distribution lines for routing power around the Project site will only have value to the Project. As per the Provincial regulation, the transmission line would be decontaminated and removed. If this proves to be the case during closure, certain materials may be suitable for re-use (for example, towers and poles, cables), and these would be sold or transferred to other utility suppliers, as negotiated with others. Other material may be disposed of in an approved on-site demolition landfill.

In the event that buildings are maintained for future use, the transmission line may be left in place to provide power to these buildings, unless other power supply options are deemed appropriate or acceptable. Alternatively, other utility service providers in the area may be willing to take over the 230 kV transmission line, substation and associated distribution lines. In such case, closure responsibilities and liabilities would be passed on to others.

Salvageable machinery, equipment and other materials would be dismantled and taken off site for sale or re-use, if economically feasible. Steel and other inert materials from dismantled equipment may also be disposed of in a dedicated on-site demolition landfill. No equipment containing polychlorinated biphenyl (PCB) will be used at the site.

7.4.6.1 Preferred Infrastructure Closure Alternative

Based on the above, the preferred alternative is to decontaminate and remove all Project-related pipelines, access roads, transmission lines and equipment, once they are decommissioned or no longer needed for Closure Plan implementation, maintenance or monitoring requirements (see Appendix U15). This alternative is not the most cost-effective, but is preferred overall due to its benefits to the environment and in compliance with the Regulation.

However, given closure needs or the potential for future use of Project infrastructure by others, a combination of the proposed alternatives may be implemented. Roads are more likely to be reclaimed in place, as this is a more cost-effective alternative that does not impose notable effects on the environment, while some infrastructure (such as buildings or the transmission line) may be left in place for future use by others or potentially by IAMGOLD to support ongoing closure, maintenance and monitoring activities. It is currently anticipated that all infrastructure will be removed following completion of all closure and post-closure activities.

7.4.7 Drainage Closure

The Project site drainage modifications, as part of the water management system (see Section 7.4.2), include the re-alignment of the Mollie River system, including portions of Upper Three Ducks Lake, Clam Lake and Chester Lake, as well as the realignment of Bagsverd Creek. Alternatives relating to surface drainage restoration at closure, included in the Provincial ToR, are the following:

- stabilize and leave in place; and
- removal (and restoration).

The Mollie River system realignments are necessary to support development of the open pit, MRA and low-grade ore stockpile for the Project. The proposed realignments are aimed at maintaining the existing watershed flowpaths to reduce potential effects on the environment. The Bagsverd Creek realignment is necessary to support the development of the TMF, and likewise is aimed at maintaining the existing natural watershed flowpaths. A summary of these alternatives is presented in Table 7-7, and the analysis of the alternatives is presented in Appendix U16.

7.4.7.1 Stabilize and Leave in Place

Stabilizing and leaving drainage systems in place would be a cost-effective alternative that would not preclude the establishment of passive drainage systems, and sections could provide for alternate fish passage. Watershed drainage would not be expected to differ from the existing condition. This would eliminate the need for additional disturbance to the environment as part of closure activities, but ongoing maintenance and monitoring may be required with this alternative, in accordance with Ontario Regulation 240/00, amended O. Reg. 307/12, and the Code of the Ontario *Mining Act* (Section 66), and in accordance with MMER requirements.

7.4.7.2 Removal

Removal of drainage systems would be a more costly alternative that would also impose some disturbance due to closure activities, but it would allow for natural watershed drainage to be established akin to pre-mining conditions. In this alternative, all impoundment dams would be breached and re-contouring of the land may be required in some sections. Materials would be disposed of in an approved on-site demolition landfill.

7.4.7.3 Preferred Drainage Closure Alternative

Based on the above, the preferred alternative is to stabilize site drainage systems (impoundment dams and watercourse realignments) and leave them in place. It is a cost-effective alternative that would not impose any notable effects to the environment (see Appendix U16).

However, removal of some drainage features and decommissioning of minor watercourse realignments may be required to allow the natural watershed drainage to be re-established akin to pre-mining conditions, and may be necessary to re-incorporate the open pit lake formed at closure (see Section 7.4.1) into the existing water systems. It is currently anticipated that the Bagsverd Creek realignment and the Chester Lake-Clam Lake realignment will be left in place to become part of the water systems in the area, as well as some of the Clam Lake impoundment dams near the open pit lake.

7.5 Alternatives to the Project

An analysis of the alternatives to the Project is presented in Table 7-7. The assessment of alternatives to the Project is presented in Appendix U17. All negative environmental effects associated with the Project were assessed at significance levels of 1 to 3 and are not considered to be significant after mitigation, with the exception of the following which were assessed at a Level 4:

- creation of excessive waste materials;
- adjacent or nearby uses, persons or property.

The following effects were assessed with a 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 Project as planned by IAMGOLD. Proceeding with the Project as planned would also involve highly significant positive effects to the local and regional economies, and to the preservation of community character, especially given the current long-term downturn in the forestry sector, which is of general importance to the area.

Depending on circumstances related to future Project economics and financing, further investigations, environmental approval processes and discussions with First Nations, delaying the Project cannot be ruled out as an alternative. Scheduling delays have the potential to delay the overall Project for a period indefinitely, and would increase overall Project costs. Delaying the Project until circumstances are more favourable is therefore regarded as an acceptable alternative. Delaying the Project for longer timeframes has the potential to seriously affect investor confidence. The "do nothing" alternative is rejected as not fulfilling the Project purpose.

7.5.1 Preferred Alternative to the Project

From an overall perspective, the preferred alternative is to proceed with the Project planning and development as identified by IAMGOLD. This is the only alternative that fulfils the Project purpose, and there are essentially no differences in environmental effects associated with the alternative of proceeding with the Project as planned versus delaying the Project

7.6 Summary of Alternatives

A summary of the proposed alternatives for the Project is provided in the Table 7-7 below.

Table 7-7: Summary of Alternative Methods

Project Element	Alternative	Assessed in the EA?	Rationale
Mining	Open pit mining	Yes	Orebody is a high tonnage, relatively low-grade deposit located near the surface, which is best suited to open pit mining.
	Underground mining	No	Orebody not suitable for underground mining, due to the fact that the gold is finely disseminated and close to the surface.
	Open pit and underground mining	No	Developing a smaller open pit, combined with an underground operation is not suitable due to the fact that the gold is finely disseminated in the orebody. In addition, it is not anticipated that expanding the final pit into an underground operation be economically viable.
Minewater Management	Develop a separate minewater system	No	A key objective of the Project is to recycle as much of the on-site water as practicable. A separate minewater treatment and management system would go against this objective.
	Integrate minewater with TMF operations	Yes	This alternative is best suited for the Project's objective of recycling on-site water.
Mine Rock and Overburden Management	Place and manage the mine rock and the overburden in stockpile adjacent or proximal to open pit	Yes	For large mining projects, minimizing mine rock management cost is a major cost driver;, therefore, it is common to place mine rock and overburden as close to the pit as practicable.
	Establish a temporary stockpile location, with mine rock and overburden retained in the pit during operations and/or returned to pit at closure	No	Moving the large amounts of overburden and mine rock generated during the construction and operations phases again upon closure would be excessively costly, thereby rendering the Project uneconomic.

Project Element	Alternative	Assessed in the EA?	Rationale
Gold Recovery	Non-cyanide recovery	No	No viable industrial scale application alternative available.
	Cyanide recovery methods	No	This method is applied when all gold is extremely fine and cannot be recovered partially by using gravity separation.
	Combination of non-cyanide and cyanide recovery methods	Yes	In this orebody, a portion of the gold can be recovered using gravity separation, such that a smaller fraction will require cyanide leaching, hence the combination of these two methods is the chosen alternative.
Process Effluent Treatment	In-plant cyanide recycling and destruction using the SO_2/Air process	Yes	This process is most commonly used at locations where surface waters and people would be severely impacted in case of accidental releases of tailings.
	Process plant effluent discharge to the TMF with natural degradation for the destruction of cyanide	No	The use of natural degradation presents a greater overall environmental risk.
	Process effluent discharge to the TMF with natural degradation for the destruction of cyanide, with supplemental hydrogen peroxide destruction of residual cyanide	Yes	Hydrogen peroxide treatment will have a lower cost than the SO_2/Air, but may carry environmental risks.
Tailings Management	Tailings slurry (~ 50% solid content)	Yes	This is the most commonly used deposition method in cooler climates and is therefore most suitable for this Project.
	Thickened tailings (~60% solid content)	No	Thickening of tailings is very costly and is generally only carried out in settings with very limited water availability and in dry climates.
	Paste thickened tailings (~68% solid content)	No	
Water Supply	Mesomikenda Lake	Yes	The method of meeting the fresh water needs (that cannot be met by recycling) was considered in the EA.
	Other area watercourse(s), lake(s) and pond(s)	Yes	
	Groundwater well(s)	Yes	

Project Element	Alternative	Assessed in the EA?	Rationale
Water Discharge	Mesomikenda Lake	Yes	Water discharge locations were evaluated based on receiving water hydrological conditions, the water balance and the water quality model.
	Bagsverd Creek	Yes	
Watercourse Realignments	Realignment of Bagsverd Creek around the TMF and realignment of portions of Three Duck Lakes, Chester Lake, Clam Lake and the Mollie River system around the open pit and MRA.	Yes	Watercourse realignments are dependent on the location of Project components and were optimized as further studies were completed. It was designed to minimize impacts to receiving waters and aquatic species.
	Other realignments around Project components	Yes	
Site Infrastructure	Maintenance garage, warehouse and administration complex (various locations)	Yes	As Project design continued, the optimal locations for these components were further reviewed and defined.
	Accommodation complex (various locations)	Yes	
	Fuel and lube bay (various locations)	Yes	
	General laydown areas and temporary storage facilities (various locations)	Yes	
	Explosives manufacturing and storage facilities (various locations)	Yes	
Aggregate Supply	Overburden/mine rock	Yes	As the Project aggregate needs are defined, potential aggregate quantities and sources were identified and assessed in the EA.
	Dedicated on-site aggregate pits	Yes	
	Commercial off-site aggregate pits	Yes	
Non-Hazardous Solid Waste	Truck waste off-site to an existing licensed landfill	Yes	EA considered alternative non-hazardous waste management methods and locations.
	Develop an on-site landfill	Yes	
	Acquire an off-site landfill	Yes	
	Incineration	No	This alternative is not economically viable.
Hazardous Solid Waste	Shipment off-site to an appropriate licensed landfill	Yes	Shipment of hazardous solid waste is generally the preferred alternative for similarly sized projects.
	Development of an on-site hazardous solid waste management system (such as landfill)	No	This alternative's potential effects on the environment are unacceptable and was not considered further.

Project Element	Alternative	Assessed in the EA?	Rationale
Domestic Sewage	Septic tank(s) and tile field(s)	Yes	EA considered proven methods of treating domestic sewage.
	Lagoons	Yes	
	Package sewage treatment plant	Yes	
	Trucking domestic sewage off-site to a licensed treatment plant	Yes	
Power Supply and Routing	On-site diesel generation	No	This alternative has high environmental implications and is not economically viable for the Project.
	Tie in to the 115 kV line near the Project	No	This alternative is not considered based on the power requirements of the Project design.
	230 kV Shining Tree transmission line alignment	Yes	Both alignments were evaluated as part of the EA and ongoing engineering studies.
	230 kV Cross-Country transmission line alignment	Yes	
	Alternative energy sources (hydroelectric, solar, wind)	No	Renewable energy cannot provide consistent uninterrupted power (renewable energy) or do not meet the IAMGOLD criteria regarding environmental protection (dedicated hydroelectric) or technical needs.
Mine Closure – Open pit mine	Natural flooding	Yes	EA considered proven alternatives for the closure of the open pit mine.
	Enhanced flooding	Yes	
	Backfill with mineral waste	Yes	This alternative is not economically viable for the Project
Mine Closure – Water management system	Leave in place	Yes	EA considered proven alternatives for the closure of water management system and the timeframes for the use of all alternatives.
	Partial removal	Yes	
	Full removal	Yes	
Mine Closure – Stockpiles	Re-use	Yes	EA considered proven alternatives for the closure of stockpiles.
	Stabilization and covering/revegetation	Yes	
	Use in backfill	Yes	
	Engineered cover	Yes	
Mine Closure – TMF	Permanent flooding	Yes	EA considered proven alternatives for the closure of the TMF.
	Covering and revegetation	Yes	
Mine Closure-Buildings	Disassembly and removal	Yes	EA considered proven alternatives for the closure of buildings.
	Re-use of acceptable buildings	Yes	

Project Element	Alternative	Assessed in the EA?	Rationale
Mine Closure – Infrastructure	Decontamination and removal	Yes	EA considered proven alternatives for closure of infrastructure.
	Leave in place for future use	Yes	
	Reclaim in place	Yes	
Mine Closure – Drainage	Stabilize and leave in place	Yes	EA considered proven alternatives for closure of drainage.
	Removal	Yes	
Alternatives to the Project	Proceed with the Project in the near term, as planned by IAMGOLD	Yes	EA considered potential alternatives to the Project.
	Delay the Project until circumstances are more favourable	Yes	
	"Do nothing" (development of the Project is cancelled)	Yes	