4. PROJECT DESIGN AND ALTERNATIVES ASSESSMENT

4.1 INTRODUCTION

This chapter describes the methodology and criteria that Harper Creek Mining Corporation (HCMC) and its consultants have used to select preferred options from a variety of alternative means for developing the proposed Harper Creek Project (the Project). The alternatives assessment identifies both potential alternatives to the Project (i.e., functionally different ways to meet the Project need and achieve the Project purpose) and alternative means of carrying out the Project (e.g., by changing locations of mine components and facilities, processing methods, storage and transportation options, access corridors, accommodations, and waste rock and tailings management). As described in the Operational Policy Statement *Addressing "Need for," "Purpose of," "Alternatives to," and "Alternative Means" under the Canadian Environmental Assessment Act* (CEA Agency 2007), "alternative means" are the various technically and economically feasible ways to implement a project.

This evaluation of the alternative means for undertaking the proposed Project satisfies the Application Information Requirements (AIR) for the Project (BC EAO 2011a). Section 14.3 of the AIR states that "Alternatives to" the proposed Project will be identified and evaluated based on environmental, engineering, and socio-economic considerations. In addition, alternative means of carrying out the Project will be identified and evaluated based on the same criteria. Preferred alternatives must include a rationale for their selection. The alternative means assessment may include, but will not necessarily be limited to, the following (BC EAO 2011a):

- location of various mine components/facilities (e.g., tailings management facility (TMF), waste rock storage, etc.);
- processing methods;
- concentrate movement, storage, and transportation;
- access corridors;
- employee accommodations (e.g., on site versus off site); and
- waste rock and tailings management, including management of metal leaching/acid rock drainage (ML/ARD).

Where an alternative has the potential to affect an environmentally or socio-economically sensitive area or receptor, the alternative's potential effect to that area or receptor is discussed.

No comments specifically related to this alternatives assessment, or alternative Project options that should be considered, have been received to-date by HCMC from Aboriginal groups.

4.2 METHODOLOGY

HCMC has selected an approach for the alternatives assessment of the Project that evaluates alternatives by a reasoned process in which the basis for the final selection of alternatives is easily understood at all levels. The approach considers alternatives that are not only technically and economically feasible but would also satisfy HCMC's requirements for environmental and socio-economic acceptability.

Each alternative was evaluated according to pre-established performance objectives which are meaningful attributes that HCMC considers essential for Project success and align with Canadian Environmental Assessment Agency (CEA Agency) criteria and the AIR. The performance objectives include the following considerations:

- technical feasibility; and
- economic viability.

If an alternative is deemed to not be technically feasible or economically viable then that alternative is not considered to be a reasonable alternative for the Project and is not considered further in this assessment. If more than one alternative remains after this initial ranking, then the following additional performance objectives are applied to each remaining alternative:

- environmental acceptability; and
- socio-economic acceptability.

There are three rankings for each of the four performance objectives defined above: Preferred, Acceptable, or Unacceptable (Table 4.2-1). Definitions for each ranking are based on both the short- to medium-term effects of each alternative through the Project's Construction and Operations phases, as well as the long-term effects of the Project's Closure and Post-Closure phases.

An alternative is rejected if it attains an unacceptable rating for any single performance objective. Also, the alternative that receives the greatest number of preferred ratings is not necessarily the best or most preferred alternative. The relative importance of individual performance objectives needs to be considered as well. One or two performance objectives may be considered to be more important and override all other objectives, so long as a minimum rating of acceptability is attained for the less important performance objective.

In selecting the appropriate methodology for the proposed Project alternatives assessment, HCMC considered the *Guidelines for the Assessment of Alternatives for Mine Waste Disposal* (Environment Canada 2013). Environment Canada specifies that:

> *This document is intended to provide guidance in addressing the requirement of a proposed project to prepare alternatives assessment to inform both the environmental assessment (including public/Aboriginal consultation) and the Metal Mining Effluent Regulations (MMER; SOR/2002-222) regulatory process, including the preparation of a Regulatory Impact Analysis Statement.*

Table 4.2–1. Alternatives Assessment - Performance Objectives and Ratings

Technical Feasibility	
Criteria	Applicability, system integrity and reliability as appropriate to the given issue, to describe the suitability or expected technical performance of a given alternative
Considerations	Potential for increased capacity (e.g., likelihood of additional future development)
	Transportation (e.g., from the Project Site to the TMF)
	Flexibility with regard to technical, operation, and environmental uncertainties
	Proposed technologies and the advantages and disadvantages of the technologies considered (e.g., proven technology used elsewhere or new)
	Technical feasibility and risks (e.g., unforeseen geotechnical condition may require design modification)
	Availability of construction material and volume requirements
	Post-Closure risks and uncertainties (e.g., requirements for perpetual treatment or maintenance)
Performance	
Preferred	Predictably effective with contingencies if the alternative does not perform as expected
Acceptable	Appears effective based on modelling/theoretical results; contingencies are available if the alternative fails to perform as expected
Challenging	Appears marginally effective based on modelling/theoretical results, contingencies may not be available if the alternative fails to perform as expected
Unacceptable	Effectiveness appears dubious or relies on unproven technologies
Economic Viability	
Criteria	Project financing
	Return on investment
	Financial risk
Considerations	Capital, Operating, Decommissioning and Closure and Post-Closure costs (e.g., treatment if required, fish habitat offsetting and monitoring costs)
	Economic benefits and risks
	Regulatory review and construction timeline costs
Performance	
Preferred	Facilitates a competitive return on investment
Acceptable	Facilitates an acceptable return on investment
Challenging	May or may not facilitate an acceptable return on investment
Unacceptable	Cannot be financially supported by the Project
Environmental Acceptability	
Criteria	Overall environmental effects of the Project
	Ability to mitigate effects
	Amenability to reclamation
Considerations	Overall affected land footprint size of (e.g., dams, saddle dikes), and access road
	Issues related to water quality, atmospheric, hydrology, hydrogeology, and storage

(continued)

Table 4.2–1. Alternatives Assessment - Performance Objectives and Ratings (completed)

Environmental Acceptability (*cont'd*)	
Considerations (*cont'd*)	Considerations related to climate change adaptation (e.g., changes in water management or stability of foundations in permafrost)
	Effects to valued components (e.g., fish and their habitats, aquatic/terrestrial plants and animal species and their habitat, species at risk and their habitats)
	Amenability to reclamation (e.g., probability of achieving long-term reclamation goals)
Performance	
Preferred	Minimizes adverse effects on the environment without mitigation
Acceptable	Minimizes adverse effects on the environment with mitigation
Challenging	May cause substantial or irreversible adverse effects on the environment that may be difficult to reasonably mitigate.
Unacceptable	Likely to cause substantial or irreversible adverse effects on the environment that cannot reasonably be mitigated
Socio-economic Acceptability	
Criteria	Positive or negative changes on socio-economic factors
Considerations	Overall perceived consequences, benefits and relative preferences from community members, First Nations, local governments (e.g., contracting opportunities, building community capacity)
	Preservation of archaeological/cultural sites
	Potential effects on asserted Aboriginal rights
	Maintenance of traditional lifestyle or spiritual well-being
	Aesthetics
	Uses such as recreation, tourism, industrial
	Safety considerations
Performance	
Preferred	Minimizes negative effects on the socio-economic environment without mitigation and provides positive benefits
Acceptable	Minimizes negative effects on the socio-economic environment with mitigation
Challenging	May cause substantial negative effects on the socio-economic environment that may be difficult to reasonably mitigate.
Unacceptable	Likely to cause substantial negative socio-economic effects that cannot reasonably be mitigated

It is important to note that the TMF for the proposed Project will be situated on a plateau that does not contain a natural fish-bearing waterbody and therefore the proposed Project does not require a MMER Schedule 2 regulatory amendment. Regardless, Environment Canada's guidelines regarding the consideration of technical feasibility, economic viability, environmental acceptability, and socio-economic acceptability and the characterization of alternatives under these accounts were taken into consideration when establishing the performance objectives for the methodology used for the Project alternatives assessment.

4.3 ALTERNATIVES TO THE PROJECT

4.3.1 Introduction

This section of the Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS) discusses the alternatives to the proposed Project and provides an overall examination of whether to proceed with the Project, delay it, or abandon it. The CEA Agency recommends the following approach for addressing "alternatives to" a project:

- "alternatives to" a project should be established in relation to the project need and purpose and from the perspective of the proponent; and
- analysis of "alternatives to" a project should serve to validate that the preferred alternative is a reasonable approach to meeting the need and purpose of the project and is consistent with the aims of the *Canadian Environmental Assessment Act* (1992).

The purposes and needs for the proposed Project are three-fold:

1. Help meet the current and forecasted global demand for copper, gold, and silver.
2. Provide employment and business opportunities in an area of British Columbia (BC) that is adjusting from the decline of the local forestry sector.
3. Provide income to local, regional, provincial, and federal governments through various levels of taxation.

4.3.2 Alternative Scenarios

Unlike other types of projects for which a number of alternatives to the project might be available, such as the development of transportation systems, mines such as the proposed Project are unique because ore bodies have a fixed location, and the only way to proceed with a mining venture is to mine the ore body in place. The size of the Project, including the ore reserve and mill throughput, has been optimized for economic return. As with other relatively low-grade deposits, project economics are sensitive to the size of the Project. Reducing the size of the proposed Project affects economic return quickly and would make the Project less robust to metal price fluctuations. Moreover, the basic elements of design for environmental protection and worker and community health and safety do not change substantially with changes in the mine size. Therefore, variations in mine size were not evaluated as project alternatives because it is not possible to achieve the minimal rating of acceptable in the economic performance objective. Consequently, the only alternatives to the proposed Project, as a whole, are the following:

- Alternative 1: Proceed with the proposed Project in the near-term, as planned.
- Alternative 2: Delay the proposed Project.
- Alternative 3: Abandon the proposed Project, the "no development scenario."

4.3.3 Assessment

Of the four performance objectives, the following three apply to the evaluation of alternatives to the proposed Project:

- economic viability;
- environmental acceptability; and
- socio-economic acceptability.

The performance objective of technical feasibility does not apply to the evaluation of alternatives to the Project, as a whole, because the expected technical performances of all alternatives are equal. The Project will only be built if it is technically feasible to do so.

4.3.3.1 Performance Objective – Economic Viability

The proposed Project will create short-term employment during the Construction phase and will create additional permanent positions during the Operations phase. A discussion of the Project costs and benefits are presented in Section 1.9 of the Application/EIS.

In terms of economic viability, proceeding with the proposed Project in the near-term as planned provides a competitive return on investment and is the preferred alternative. Delaying the Project would only be an acceptable alternative if future economic conditions could be reliably predicted to be more favourable. However future economic conditions are difficult to predict, increasing the economic risks of delay for the Project. HCMC completed a feasibility study for the proposed Project in July 2014 (Merit 2014) which took into consideration the regulatory review and construction timeline costs based on developing the Project as planned in the near term. In addition, mining is a capital intensive industry and relatively predictable short-term metal prices are critical to recover capital investments during the early "pay-back" period and to determine the overall feasibility of the Project. The feasibility study anticipated that the Project will produce copper concentrate that will most likely be sold to markets throughout the Pacific Rim countries. Metal (copper, gold, and silver) prices are currently relatively high and inflation is low. The following base case metal prices were used in the feasibility study to evaluate the overall feasibility of the Project:

- copper: US $3.00/lb;
- gold: US $1,250/troy oz.; and
- silver: US $20/troy oz.

There is no assurance that future economic conditions would equally or more strongly support a decision to proceed with the proposed Project than currently exists under the above base case metal prices for copper, gold, and silver, so the alternative of delaying the Project does not meet the minimal acceptable criterion for economic viability.

Abandoning the proposed Project or the "no development scenario" is also an unacceptable alternative as it does not meet the Project goals of providing a competitive return on investment or helping to meet the current and forecasted demand for copper, gold, and silver.

4.3.3.2 Performance Objective – Environmental Acceptability

The performance objectives for all three alternatives were considered at a minimum to be acceptable. Land disturbance that will result from proceeding with the proposed Project cannot be completely avoided but will be minimized to the extent practical by proactive project design, including, but not limited to, designing a compact site arrangement, and conducting progressive reclamation to the extent practical during Construction and Operations (i.e., prior to decommissioning and Closure). As an example, the Project is thought likely to result in minor fish habitat losses in T Creek and P Creek due to flow reductions. These losses may be ameliorated through the implementation of proposed mitigation measures and fish habitat offsetting activities. Hence, alternatives that proceed or delay the Project could be, at the very least, acceptable. Similarly, the "no development scenario" could result in an acceptable outcome as there would be no changes to the current fish habitats. However, the objective in fish habitat offsetting activities is to create fish habitat equivalent to the fish habitat that is lost. If mitigation activities, including the creation, maintenance, and greater protection of the current fish habitats, were to result in more habitats, then delaying or proceeding with the Project would be the preferred options.

4.3.3.3 Performance Objective – Socio-economic Acceptability

In terms of socio-economic acceptability, proceeding with the proposed Project in the near term as planned is the preferred alternative. HCMC anticipates that, in the near term, a large number of skilled workers can be found locally and regionally for the Project. The positive socio-economic effects from proceeding with the Project are anticipated to outweigh any negative short-term socio-economic effects that may occur. A detailed assessment of potential socio-economic effects of the Project is presented in Chapter 17 of the Application/EIS. The alternative of delaying the Project may also be perceived as having the potential to be acceptable socio-economically because it would eventually provide employment opportunities for local communities; however, the positive effects on employment may be less certain than those anticipated under the planned Project schedule because future economic risk is difficult to predict and may affect the economic viability of the Project. Given the potential for future economic risk leading to increased uncertainty regarding the socio-economic benefits of the Project, delaying the proposed Project is an unacceptable alternative. Abandoning the Project altogether under the "no development scenario" is an unacceptable alternative socio-economically, because none of the predicted benefits would be realized.

4.3.4 Conclusion

Overall, abandoning the proposed Project would fail to fulfill the need and purpose of the Project by foregoing employment opportunities for local communities, and potential tax revenues to the local, regional, provincial, and federal governments. As such, the "no development scenario" is considered an unacceptable alternative and as described in the methodology for the alternatives assessment, a rating of unacceptable for any performance objective requires rejection of the alternative. Delaying the proposed Project is also an unacceptable alternative because of the risks associated with the uncertainty of future Project economics. Therefore, proceeding with the proposed Project in the near term as planned is the preferred alternative, being rated as preferred in two categories and acceptable in the remaining category. A summary evaluation of the three alternatives to the proposed Project is provided in Table 4.3-1.

Table 4.3-1. Summary Evaluation – Alternatives to the Project

Performance Objectives	Alternatives to the Harper Creek Project		
	Proceed with the Project in the Near Term, as Planned	Delay the Project	Abandon the Project
Economic Viability	The Project has demonstrated feasibility and facilitates a competitive return on investment with current base metal prices being relatively high and inflation low. Project is anticipated to create short-term and permanent positions during Construction and Operations.	Does not meet the Project goal of a competitive return on investment. Economic risks are uncertain in the future and long-term metal prices are unpredictable.	Does not meet the Project goal of a competitive return on investment.
	Preferred	*Unacceptable*	*Unacceptable*
Environmental Acceptability	Minimizes negative effects on the environment with mitigation and monitoring.	Minimizes negative effects on the environment with mitigation and monitoring.	No development would result in no environmental impact.
	Acceptable	*Acceptable*	*Preferred*
Socio-economic Acceptability	Provides substantial positive benefits including employment opportunities for local communities, and potential tax and royalty revenues. Negative effects are minor and will be addressed with appropriate mitigation measures.	Positive benefits and negative effects are delayed. Existing (negative and positive) socio-economic conditions would continue until Project development.	Existing (negative and positive) socio-economic conditions would continue.
	Preferred	*Acceptable*	*Acceptable*
Summary Ratings	**Preferred**	**Unacceptable**	**Unacceptable**

4.4 Alternative Means of Carrying out the Project

4.4.1 Introduction

The objective of this assessment is to ensure that specific components of the Project are developed in an economically, technically, and environmentally sound manner. The alternative that best satisfies these objectives, and that has the fewest adverse effects on the socio-economic setting is the preferred option.

A list of alternatives was prepared, which included those that were reasonable, conceivable, and realistic within the context of developing a mine comparable to the purpose and needs of the proposed Project as described in Section 1.4 of the Application/EIS. The level of detail for the alternative identification stage was generally conceptual; however, candidate alternatives were developed to a point where meaningful evaluations could be made. Section 14.3 of the AIR lists the Project components for which alternative means must be considered (BC EAO 2011a). The assessment of alternative means of carrying out specific Project components included the following:

- Mining Method (Section 4.4.2);
- Tailing Management (Section 4.4.3);
- Alternative Power Sources (Section 4.4.4);
- Ore Processing Methods (Section 4.4.5);
- Transportation and Storage of Copper Concentrate (Section 4.4.6);
- Access Corridors (Section 4.4.7);
- Employee Accommodations (Section 4.4.8); and
- Waste Rock Management (Section 4.4.9).

An assessment of the treatment of contact water was requested by the Project's AIR (BC EAO 2011b). However, no contact water treatment per se is planned for the management of water for this Project and an alternatives assessment is thus not performed for this mine component.

4.4.2 Mining Method

4.4.2.1 Purpose and Background

The mining method chosen for a project affects several other aspects of mine development such as production rates, development schedules, and waste rock volume. The two main methods for recovering ore from hard rock mines are open pit and underground mining. Both methods use drilling, blasting, and heavy equipment, but have different technical and economic considerations.

Open-pit mining is the industry standard practice for large tonnage metal mining in BC, particularly for low-grade ore deposits similar to the Harper Creek deposit. The decision to undertake underground mining instead of open-pit mining is constrained by technical and economic considerations based on the deposit position, type, and ore grade. These factors influence the potential production rates that can be achieved, and ultimately determine the feasibility of underground mining.

4.4.2.2 Alternative Scenarios/Methods

Open-pit mining is ideal for extraction of ore bodies that extend from the surface to considerable depths and have substantial horizontal dimensions with relatively little overburden. The method is flexible, allowing for large variations in production schedules at relatively short notice, and can be highly mechanized. Given favourable stripping ratios and climatic conditions, open-pit mining produces ore at a fraction of the cost of underground mining. Open-pit mines are developed by excavating rock along a series of regularly spaced horizontal lifts/benches, starting with overburden, to access ore. The amount of overburden accounts for the higher amount of waste rock produced by this method in comparison to underground mining.

Underground mining is generally more selective, producing less waste rock than open-pit mining, and poses fewer surface risks, such as avalanches. However, underground mining is also associated with lower production rates, greater equipment needs; and additional expenditures for air ventilation and ground support. Therefore, underground mining has higher overall operating costs than open-pit mining.

There are several types of bulk underground mining methods, including block caving, panel caving, and sublevel caving. Block caving is a bulk underground mining method used for massive low-grade ore bodies that are steeply dipping and have high friability. Other underground caving methods are panel caving and sublevel caving, which are less suitable for large low-grade ore bodies.

The large tonnages and relatively low grades of the Harper Creek deposit dictate that low-cost bulk mining methods must be used in order to profitably extract the copper and gold mineralization. Block caving is a bulk underground mining method used for massive low-grade ore bodies that are steeply dipping and have high friability. Block caving, or variation of, would be the most effective and appropriate underground mining method to consider as an alternative to open pit methods for the Project. If suitable, block caving would significantly reduce the pit limits involved in the open pit alternative, leading to less surface disturbance and waste rock production than open-pit mining.

A final alternative would involve a combination of open-pit mining and bulk underground mining which would also allow the pit limits involved in the open pit alternative, to be reduced and potentially reduce capital associated with underground mining.

Three mining method alternatives for the Project are considered:

- Alternative 1: open-pit mining only;
- Alternative 2: block caving mining only;
- Alternative 3: a combination of open pit and block caving.

4.4.2.3 Assessment

Performance Objective – Technical Feasibility

The main technical aspects that influence the decision to use underground versus open-pit mining methods include surface topography, depth to the top and bottom of the ore zone, plunge and dip of the deposit, ground conditions surrounding the ore zone, present and future production requirements, and equipment fleet and ventilation requirements (Association for Mineral Exploration British Columbia 2009).

In general, due to simpler engineering requirements, open-pit mining is technically preferred over block caving. It is also easier to accommodate scheduling changes with open-pit mining rather than block caving. However, more waste rock will require handling and storage for open-pit mining.

The nature of the Harper Creek ore body is not amenable to block caving as it is has a larger horizontal spread than vertical, as illustrated in Figures 15-5 and 15-6 of the feasibility study for the Project (Merit 2014), and this alternative is excluded on technical considerations. For the same reason, a combination of open pit and block caving is also not considered to be technically feasible for the Project.

For open-pit mining, there is sufficient room on site to safely store waste rock and there are no technical limitations to this mining method.

Performance Objective – Economic Feasibility

In general, open-pit mining reduces costs compared to underground mining. Although open-pit mining would incur costs due to increased waste handling and storage, open-pit mining requires fewer specialized personnel and less specialized equipment and infrastructure. Therefore, open-pit mining is the preferred method.

Due to the low concentration of metals in the Project's ore body, block caving may render the Project uneconomical. Due to this risk, block caving is considered unacceptable from an economic feasibility perspective and is not considered further in this analysis. For the same reason, a combination of open pit and block caving is also unacceptable from an economic perspective.

4.4.2.4 Conclusion

Since it is the only alternative considered that is technically and economically feasible for the Project, open-pit mining is the selected mining method (see Table 4.4-9).

4.4.3 Tailings Management

4.4.3.1 Purpose and Background

Identifying suitable tailings storage methodologies and locations for the Project required consideration of key factors such as economic and technical feasibility specific to the Project Site conditions and the tailings produced. The ability to co-store tailings and waste rock is also desired, as potentially acid-generating (PAG) waste rock is envisaged to be stored subaqueously in the TMF (see Section 4.4.9).

Storage locations were also evaluated while considering habitat disturbance and loss, preventing and minimizing water quality impacts, minimizing transport distances, and finding a sufficiently large area to contain the tailings. For the Project, a TMF is required with sufficient capacity to contain approximately 585 million tonnes (Mt) of tailings and the co-store (to minimize oxidation) of up to 237 Mt of PAG waste rock, together with an anticipated surplus water volume of up to 180 Mm^3. It is envisaged that the balance of the tailings from low grade ore processed in Years 24 to 28 of the life of the mine will be deposited into the open pit.

4.4.3.2 Alternative Scenarios/Methods

There are three alternative TMF storage options for tailings:

1. Dry stacking: tailings are dewatered with vacuum or pressure filters and placed in a storage area using trucks or conveyers; the tailings are generally dry enough to be self-supporting.
2. Paste tailings: tailings are partially dewatered to produce a thick slurry, which can then be pumped; the tailings are not self-supporting and storage of tailings requires impoundment infrastructure (dams).

3. Conventional tailings slurry: tailings are stored subaqueously behind impoundments (dams).

Dry stacking of tailings involves dewatering tailings with vacuum or pressure filters and placing the dry tailings in a storage area using trucks or conveyers. This tailings storage method is beneficial in areas where water conservation is critical (Engels 2012) and has been used for low-tonnage mines, typically in areas of flat topography and dry climate. In general, the method relies on the tailings being dry in order to be self-supporting. The Project's mountainous topography would not lend itself to self-supporting dry stacking and the tailings would most likely require containment structures. The operation of a dry stack facility for a project of this nature is unprecedented, and the construction and operation of a plant to dewater the tailings, as well as the acquisition of trucks or conveyers to transport the dry tailings, would render the Project uneconomical. As well, it would not be possible to subaqueously store the life-of-mine PAG waste rock due to the low water content of the tailings. For these reasons, dry stacking tailings is not considered a technically or economically viable tailings storage option and is not considered further in this assessment.

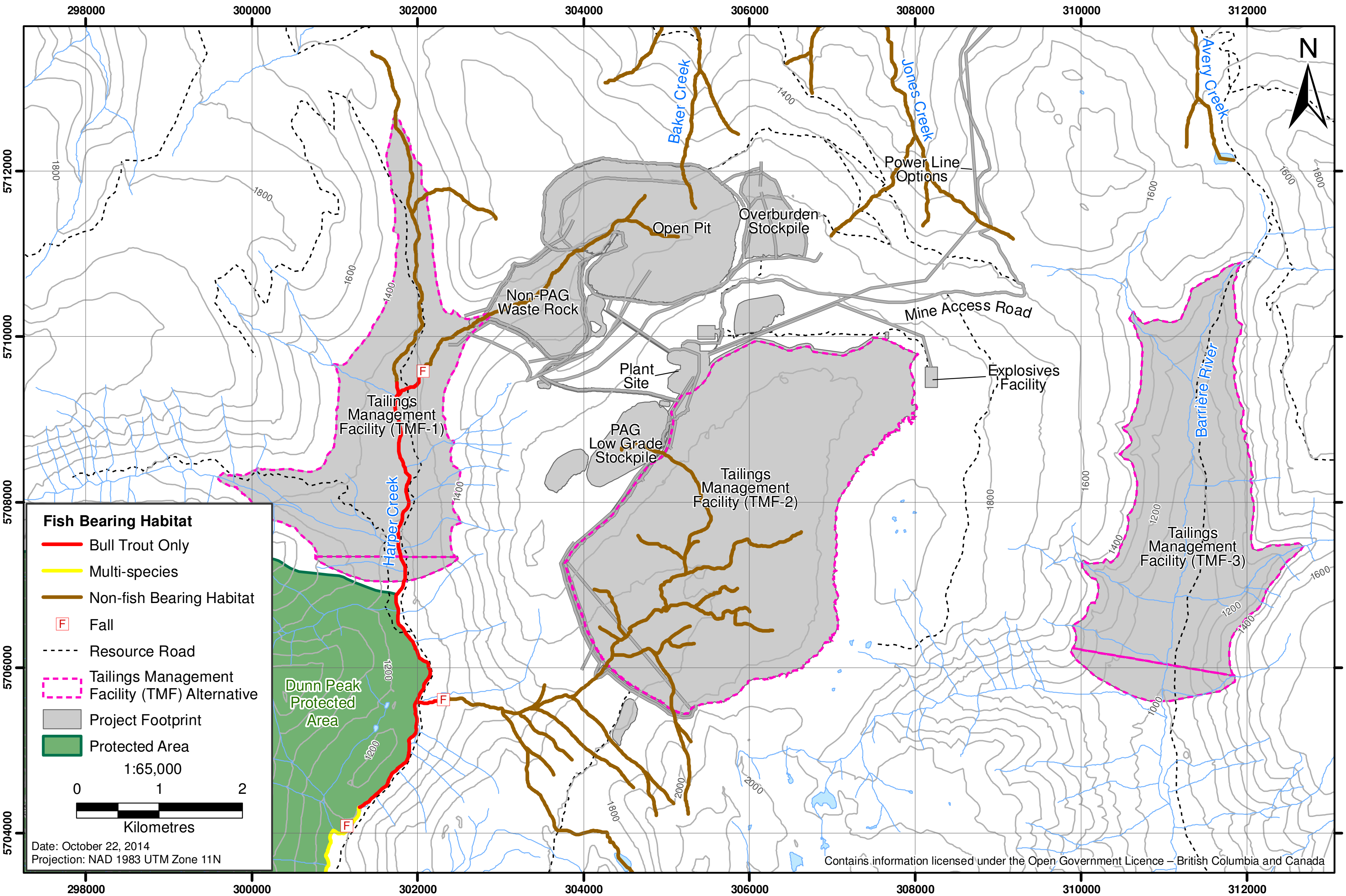
Paste tailings are produced by partial dewatering of the tailings to produce a thick slurry of toothpaste consistency, which can then be transported by pipeline. Paste tailings are commonly used for underground mines as backfill support. The use of paste tailings for surface storage is not common (Engels 2014). Paste tailings are not self-supporting and an impoundment would be required. The storage of paste tailings would involve the construction of a paste plant which would utilize a dewatering filter press system for a portion of the tailings and a high capacity thickener for the remainder. The cost of constructing and operating a plant would be very high, and together with the operating pumping costs, would most likely render the Project uneconomical. No precedent exists for such a large scale paste tailings project. As well, it may not be possible to subaqueously store the life-of-mine PAG waste rock due to the reduced volume and water content of tailings produced through the paste process. For these reasons, paste tailing is not considered a technically or economically viable tailing storage option and is not considered further in this assessment (see Table 4.4-9).

Conventional subaqueous (saturated) tailings storage involves the construction and operation of containment structures (dams) to impound the tailings. Tailings are not dewatered, but are piped and deposited directly in the impoundment. This is the most common tailings storage methodology in similar climates and topographies (e.g., Highland Valley Copper Mine, Gibraltar mine). Several areas exist close to the open pit that would be suitable for the development of a conventional subaqueous tailings impoundment. The volume of saturated tailings and the proposed impoundments is such that all life-of-mine PAG waste rock would be stored subaqueously in the impoundment (see Section 4.4.9). Three impoundment locations are proposed for further consideration (Figure 4.4-1):

- Alternative 1: TMF-1 located within the Upper Harper Creek valley at P Creek, west of the pit;
- Alternative 2: TMF-2 located in the upper reaches of T Creek, a tributary to Harper Creek, and at the upper reaches of the Harper Creek catchment area, south of the pit;
- Alternative 3: TMF-3 located within the Upper Barrière River Valley, east of the pit.

Figure 4.4-1

Harper Creek Project: Tailings Management Facility Alternative Locations



4.4.3.3 Assessment

Performance Objective – Technical Feasibility

In comparing the alternative locations for the TMF, important technical and functional requirements for the preferred alternative included:

- permanent, secure, and total confinement of all solid waste materials within an engineered facility that can securely contain a total of 585 Mt of tailings, 237 Mt of PAG waste rock, and have sufficient containment of decanted water for re-use in the milling process;
- full and secure storage of site contact water in the TMF following process start-up until the end of mining operations;
- water management efforts, including the collection and diversion of water from upstream of the TMF, open pit, and plant site areas during Operations to the maximum practical extent;
- staged development of the TMF over the life of the Project;
- favourable closure characteristics; and
- capacity for expansion.

Water management was a key consideration associated with technical feasibility for the TMF. The size of the diverted catchment area for each alternative TMF location provides an indication of the potential complexity of the associated water management structures and TMF. Both TMF-1 and TMF-3 would require a very large diverted catchment area which is typically associated with increased technical challenges. These challenges include higher inflows of water, which result in a larger annual water surplus that requires larger diversion and storage structures. For these reasons, TMF-1 and TMF-3 are rated as acceptable alternatives, whereas TMF-2 is the preferred alternative because it is located on a plateau at the upper reaches of its catchment area, which reduces the need for water management structures such as diversion channels.

The preferred TMF location should have favourable closure characteristics such as a short distance from the TMF to the pit. The linear distance from the centre of the open pit to the centre of each respective TMF is as follows: TMF-1, 3.86 kilometres (km); TMF-2, 3.74 km; and TMF-3, 7.30 km. The short distance of TMF-2 from the pit allows it to be easily integrated with pit closure following completion of active mining operations. Closure can be accelerated by pumping the TMF supernatant pond to the open pit to increase pit filling and to offset tailings deposition and precipitation inflow to the TMF.

Waste rock will be stored within the catchment area of the TMF, with a portion of the waste being submerged. The shallow, flat nature of the impoundment valley for TMF-2 results in high storage efficiency and allows for the option of co-storage of PAG waste rock, making it the preferred location.

As well as posing challenges for subaqueous PAG waste rock storage, the steeper topography of TMF-1 and TMF-3 also poses a technical challenge with respect to the construction and operation of surface water diversions.

Performance Objective – Economic Viability

The capital costs for the alternative TMF locations were largely influenced by the considerations related to technical feasibility. As discussed earlier, the size of the diverted catchment area typically indicates the potential complexity and cost of the TMF and associated water management structures. Costs include construction capital and operating costs such as pumping and storage costs associated with tailings and PAG waste rock. For TMF-1 and TMF-3 the construction costs for the diversion channels (including energy dissipater and sediment trap structures) would be high given the large size of the diverted catchment area and steep topography. The anticipated operating costs for TMF-1 and TMF-2 were considered acceptable alternatives because the TMFs are relatively close to the Project Site, lowering the cost to transport waste rock from the mine plant to the TMF. TMF-3 is the furthest from the Project Site, increasing the operating cost associated with transport of waste rock from the mine plant to TMF-3 and rendering the Project uneconomic at current commodity prices. For this reason, TMF-3 is considered to be an unacceptable alternative with respect to economic viability; and is not considered further in this analysis

Performance Objective – Environmental Acceptability

In terms of environmental acceptability, TMF-2 at T Creek is the preferred alternative because it would have fewer negative environment effects than TMF-1. TMF-2 is not located on fish habitat, due to natural fish barriers occurring on T Creek, whereas TMF-1 would have direct negative effects to Bull Trout (*Salvelinus confluentus*) habitat in Harper Creek (Figure 4.4-1).

TMF-1 has a larger diverted catchment area and impoundment surface area than TMF-2, resulting in increased potential for water management issues because of surplus water. Rainfall and groundwater or ditch leakage from the diversion systems would contribute major water inputs and result in a substantial water surplus on an annual basis for TMF-1. Even though the area of disturbance for TMF-1 is relatively compact, it would require additional mitigation measures, such as larger diversion structures, for proper water management. For these reasons, TMF 1 is rated as an acceptable alternative. TMF-2 is the preferred alternative because it has the smallest area of disturbance of the three alternatives examined and is the only TMF not located on fish habitat.

Performance Objective – Socio-economic Acceptability

Substantial socio-economic effects (positive or negative) are not envisioned for any of the TMF alternatives; all alternative TMF locations are rated as acceptable in terms of socio-economic acceptability.

4.4.3.4 Conclusion

Overall, TMF-2 is the preferred alternative for the TMF location for the following reasons:

- it represents the lowest total cost for the TMF;
- there is low complexity of associated water management structures;
- its close proximity to the open pit and plant allows for economical haulage of waste rock for subaqueous storage;
- compact mine footprint maximizes operational flexibility and reduces environmental effects;

- it is not situated on fish habitat; and
- closure concepts are simpler than for the other alternatives.

HCMC believes that it is feasible and reasonable to manage all potential environmental and socio-economic effects associated with this alternative. A summary evaluation of the three alternative TMF locations is provided in Table 4.4-1.

Table 4.4-1. Summary Evaluation of Alternative Tailings Management Facility Locations

Assessment Criteria	Tailings Management		
	TMF-1 (Located within the Upper Harper Creek Valley at P Creek, West of the Open Pit)	**TMF-2 (Located in the Upper Reaches of T Creek and at the Upper Reaches of the Harper Creek Catchment Area, South of the Open Pit)**	**TMF-3 (Located within the Upper Barrière River Valley, East of the Open Pit)**
Technical feasibility	Large diverted catchment area indicates high complexity of associated water management structures and TMF.	Smallest diverted catchment area and expansion potential.	Large diverted catchment area indicates high complexity of associated water management structures and TMF.
	Acceptable	*Preferred*	*Acceptable*
Economic viability	Relatively close to the Project Site for a reasonably compact Project Site, decreasing the cost to transport waste rock from the mine plant to the TMF. Steeper terrain complicates waste rock placement.	Relatively close to the Project Site for a reasonably compact Project Site, decreasing the cost to transport waste rock from the mine plant to the TMF.	Greatest distance from the Project Site, increasing the cost associated with transporting waste rock from the mine plant, making the Project economically not viable.
	Acceptable	*Preferred*	*Unacceptable*
Environmental acceptability	Situated on fish habitat of P Creek and would have a direct impact on fish and fish habitat. Relatively large catchment area with increased water management risks.	Close to the Project Site and a compact mine design with the smallest Project footprint. Not situated on fish habitat due to natural fish barriers on T Creek, and most amenable to reclamation given proximity to pit.	Environmental acceptability was not considered as the option was excluded from further consideration based on economic considerations.
	Acceptable	*Preferred*	*N/A*
Socio-economic acceptability	Relatively equivalent to the other alternatives. Could be perceived as unacceptable because it is situated on fish habitat.	Relatively equivalent to the other alternatives. Could be perceived as preferred because it is not situated on fish habitat.	Socio-economic acceptability was not considered as the option was excluded from further consideration based on economic considerations.
	Acceptable	*Acceptable*	*N/A*
Summary Ranking	**Acceptable**	**Preferred**	**Unacceptable**

4.4.4 Power Supply

4.4.4.1 Purpose and Background

The proposed Project requires a consistent and reliable source of power of about 82 megawatts (MW) on average during the Operations phase. According to the proposed Project feasibility study (Merit 2014), the largest proportion (59%) of energy would be consumed in the grinding circuit. The annual power consumption presented in Table 4.4-2 is based on the mine operating continuously all day and every day and with electrical power at an availability of 92% (Merit 2014).

Table 4.4-2. Energy Requirements for the Harper Creek Project

Energy Requirements	Connected Load (kW)	Maximum Demand (kW)	Average Demand (kW)	Annual Consumption (MW h/a)
Total	116,510	103,534	82,304	663,302

Source: (Merit 2014)
Note: kW = kilowatt

4.4.4.2 Alternative Scenarios/Methods

HCMC examined a range of power supply alternatives to identify the preferred option for the Project. Three alternatives were reviewed as potential power supply options for the Project:

- Alternative 1: long-term use of diesel generators at the Project Site;
- Alternative 2: liquefied natural gas (LNG) trucked to the Project Site as fuel for a gas turbine generator;
- Alternative 3: electrical transmission line connection via a power line from the Project Site to the BC Hydro switchyard at Vavenby.

Diesel generators are a combination of a diesel engine with an electrical generator to generate electrical energy. Typically, diesel generators are used for mining operations in remote areas where connection to the power grid is not feasible, or as an emergency power supply if the power grid fails. Diesel generators are also used for applications such as peak-lopping, grid support, and export to the power grid. Diesel fuel consumption is a major portion of the operating cost for power supply applications. Specific consumption varies, but a diesel generator generally consumes between 0.28 and 0.4 litres of diesel fuel per kilowatt hour (Diesel Service & Supply 2013). Based on these average diesel fuel consumption rates and the anticipated annual energy requirement of the proposed Project (Merit 2014), the Project would require 1.85×10^8 to 2.64×10^8 litres of diesel fuel per year for the alternative to supply power by diesel generators.

LNG is a potential power supply option for supplying fuel to the proposed Project Site for on-site electrical generation. LNG can be stored and transported by trucks in double-walled cryogenic containers (storage at very low temperature) from a LNG plant to the Project Site where it is vaporized to natural gas as needed for electrical power generation. The typical costs associated with using LNG for power generation includes the cost of the gas turbine generator, construction of an appropriate cryogenic LNG storage and vaporization facility at the Project Site, construction of a truck off-loading station, and the transport distance from the LNG plant to the mine. LNG-related logistical and cost issues associated with securing LNG and using it for electrical power generation can make this power supply option uneconomical.

In the feasibility study for the Project (Merit 2014), reference is made to the need for additional power in the North Thompson Valley region having been identified by BC Hydro. Three possible options to strengthen electricity supply have been investigated by BC Hydro in the past which would bolster either the Vavenby or Clearwater substations. Regardless of the outcome of the BC Hydro project, it is assumed that a new 230 kilovolt (kV) transmission line will be constructed to the Vavenby area by BC Hydro. With this proposed transmission upgrade project by BC Hydro in place, power to the proposed Project could be supplied from a new switchyard that would be constructed by BC Hydro adjacent to their existing transmission line corridor right-of-way near Vavenby. HCMC would construct the 138 kV site power line from the BC Hydro switchyard to the Project Site.

4.4.4.3 Assessment

Performance Objective – Technical Feasibility

The long-term use of diesel generators as the primary power source for the proposed Project is considered to be unacceptable from a technical feasibility perspective. The projected power requirement of the proposed Project could be met by diesel generators, though this would require a very large volume of diesel fuel to be transported and stored on site, resulting in substantial increases in traffic movement and storage and handling infrastructure. The traffic management considerations and need for additional infrastructure makes this option technically challenging.

An LNG-powered gas turbine for on-site electrical power generation is considered to be an unacceptable alternative in terms of technical feasibility because securing and transporting LNG to the proposed Project is challenging. Existing LNG plants in BC are located in the Fort Nelson area and in the city of Delta, some distance from the proposed Project Site. As of August 2014, there are 19 proposed LNG export projects between Alberta and BC (Pipeline News North 2014). Several of these projects have been granted an export licence by the National Energy Board, but in all cases the LNG is destined for either the US or Asia; none of the LNG is intended to supply mining operations in BC (Pipeline News North 2014). Thus, securing a reliable supply of LNG to meet the Project's needs over the life-of-mine is not deemed to be assured, and this alternative is excluded from further evaluation due to technical considerations.

An overhead high-voltage electrical transmission line is the preferred alternative in terms of technical feasibility because it is a well-established and reliable technology. Prior to BC Hydro's transmission line upgrade to the North Thompson area, the contingency is to utilize four diesel generators of 2-MW capacity each and install a temporary 25-kV power line during the Construction phase of the Project. The temporary diesel generators and power line can be installed prior to the availability of an enhanced power supply from BC Hydro and the construction of the 138-kV site power line to the Vavenby switchyard. The temporary diesel generators are sufficient to power one of the pit drills and a shovel that will be used during pre-stripping operations to move material for use as construction materials for haul roads and the starter tailings dam. Two of the temporary diesel generators can remain on site as standby emergency generators during the life of the Project.

Performance Objective – Economic Viability

The operating cost to use diesel generators as the primary power source for the proposed Project is considered to be unacceptable. As described above, diesel fuel consumption is a major portion of diesel generator operating cost for power supply applications. Given the projected annual energy requirements of the proposed Project and the resulting large volume of diesel fuel that would be required, HCMC has determined that long-term use of diesel generators is not a viable option due to the cost of fuel and the cost of storing large amounts of fuel on site. Thus, this option is excluded from further consideration.

Similarly, the long-term use of LNG as a primary power source for the proposed Project is also considered to be unacceptable from an economic viability perspective. Sourcing LNG and the costs related to maintaining cryogenic conditions during its storage and handling would make the proposed Project economically unviable. This alternative is also excluded from further consideration due to these economic considerations.

An overhead high-voltage electrical transmission line is the preferred alternative to provide long-term power to the proposed Project from an economic perspective. The capital and operating cost to establish a connection with the BC Hydro grid can be supported financially by the Project, even with the contingency to use diesel generators during the Construction phase when BC Hydro power is not available. An overhead power line is both economically and technically feasible and is the only power alternative to meet the technical and economic criteria. This alternative is the selected alternative for the Project (see Table 4.4-9).

4.4.4.4 Site Power Line Route Alternatives

Correspondingly, two alternatives were assessed for the site power line route from the rail load-out switchyard, across the North Thompson River to the Project:

- Alternative 1: crosses the North Thompson River west of Avery Creek to the HCMC property (referred to as Power Line Option 1; Figure 4.4-2);
- Alternative 2: crosses Avery Creek and the North Thompson River east of Avery Creek to the Canfor mill property (referred to as Power Line Option 2; Figure 4.4-2).

This subsection of the Application/EIS will discuss the alternatives for the Project–owned 138-kV power line that will connect the Project Site to the proposed BC Hydro switchyard near Vavenby on the north side of the Southern Yellowhead Highway (Highway 5).

Assessment

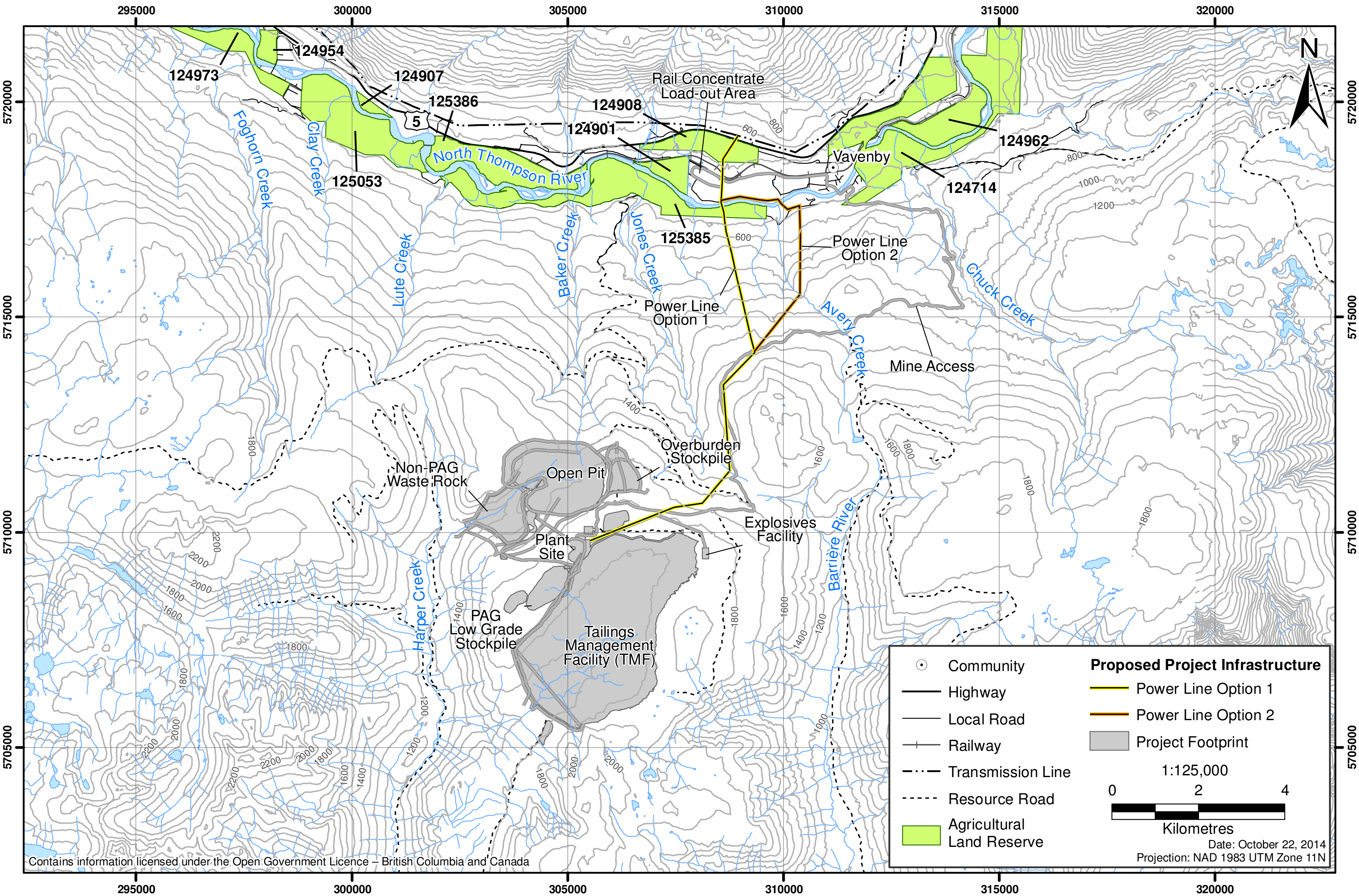
Performance Objective – Technical Feasibility

Substantial technical challenges are not envisioned for either alternative, and both alternatives are rated as acceptable in terms of technical feasibility. Following comparable routes, both site power lines have similar technical requirements:

- from the Vavenby Substation, the power lines will need to cross the North Thompson River to reach the Project's main substation located adjacent to the plant site;

Figure 4.4-2

Harper Creek Project: Power Line Route Alternatives



- The overhead power line will be constructed using wooden poles in a configuration that will be a combination of single pole towers and H-frame structures; and
- The average power demand of the Project is approximately 82 MW.

Prior to construction, a power line engineering firm will be contracted to establish the precise alignment and design for the Project power line that would be secure from geohazard risks, and minimize potential negative environmental effects.

Performance Objective – Economic Viability

A key economic consideration for the power line alignment is the availability of road access to minimize construction and maintenance costs. Ideally, an access road and power line can share rights of way for at least part of the route. For the Project, the cost to construct either power line alignment is similar given that they follow comparable routes. Power Line Option 1 is the preferred alternative because it is marginally more direct and shorter than Power Line Option 2. Power Line Option 2 is rated as an acceptable alternative because it is achievable, although slightly longer and less direct than Power Line Option 1. Since it will have more bend-points, Power Line Option 2 will be more expensive to build and maintain.

As both power line routing options are technically and economically feasible, the environmental and socio-economic acceptability of each option was considered.

Performance Objective – Environmental Acceptability

Neither positive nor negative environmental effects are envisioned for the two proposed alternatives; both site power line alternatives are rated as satisfactory in terms of environmental acceptability because they follow comparable alignments. Both power line rights-of-way will be required to be cleared of trees that might interfere with the conductors and will require roughly equal levels of disturbance. However, Power Line Option 2 would cross the Avery Creek drainage line, which may have additional environmental implications.

Performance Objective – Socio-economic Acceptability

One socio-economic consideration for the site power line alignment is the current usage of the land that will be crossed by the proposed right-of-way. Power Line Option 1 would be sited on existing agricultural lands within Agricultural Land Reserve (ALR) zoning on the south side of the North Thompson River. Conversely, Power Line Option 2 avoids lands within the ALR on the south side of the North Thompson River (Figure 4.4-2), but would be more visible from Vavenby, potentially affecting social acceptance of the Project. The common portion of the two power line alternative routes crosses the ALR on the south side of Highway 5.

4.4.4.5 Conclusion

Power Line Option 1 has a shorter, more direct alignment, and would require less right-of-way clearing than the Power Line Option 2 alignment. Power Line Option 1 is economically preferred over Power Line Option 2 due to its shorter and more direct alignment. Overall, the HCMC's preferred site power line alignment is the western of the two, namely Power Line Option 1, which is the most direct and economical route with the greatest environmental acceptability (Table 4.4-3).

Table 4.4-3. Summary Evaluation of Alternative Power Line Options

Assessment Criteria	Power Line	
	Option 1: West Site Power Line	Option 2: East Site Power Line
Technical feasibility	Appears effective based on anticipated results. Marginally shorter and more direct.	Appears effective based on anticipated results. Route is longer and less direct.
	Preferred	*Acceptable*
Economic viability	Facilitates a competitive return on investment. Marginally shorter and more direct alignment than the east site option.	Facilitates an acceptable return on investment. Marginally longer alignment and less direct alignment than the west site option.
	Preferred	*Acceptable*
Environmental acceptability	Minimizes negative effects on the natural environment with mitigation. Marginally shorter and more direct.	Minimizes negative effects on the natural environment with mitigation but crosses Avery Creek.
	Preferred	*Acceptable*
Socio-economic acceptability	Minimizes negative effects on the socio-economic environment with mitigation.	Minimizes negative effects on the socio-economic environment without mitigation. The alignment would avoid an existing ALR on the south side of the North Thompson River but would be more visible from Vavenby.
	Acceptable	*Preferred*
Summary Ranking	**Preferred**	**Acceptable**

However, both the power line alignment alternatives meet the minimum required ratings for all performance objectives. Consequently, the pending finalization of right-of-way arrangements should not pose a constraint on the installation of the power line.

4.4.5 Ore Processing Methods – Ore Comminution

4.4.5.1 Purpose and Background

Ore comminution at hard rock mines involves the breaking down and pulverizing of ore to prepare it for treatment processes to recover precious metals. The plant throughput for the Project will be approximately 70,000 tonnes per day (tpd), or 25 Mt tonnes per annum (tpa), for the duration of the Operations phase. Grinding is required for ore comminution and, because of the large volume of ore involved in the Project, will require large inputs of energy.

4.4.5.2 Alternative Scenarios/Methods

Two ore comminution methods are possible for the Project:

- semi-autogenous grinding (SAG) followed by ball mill grinding; and
- high-pressure grinding rolls (HPGR) followed by ball mill grinding.

Autogenous mills are so-called because of the self-grinding of the ore. A rotating drum throws larger rocks of ore in a cascading motion, which causes impact breakage of larger rocks and compressive grinding of finer particles. SAG mills function similarly to autogenous mills, except with the addition of grinding balls or pebbles to aid in grinding. Grinding by a SAG mill would be followed up with further particle size reduction using a ball mill. A small portion of the mill feed, approximately 6% would require regrinding

HPGR mills consist of two rollers with the same dimensions, which are rotating against each other with the same circumferential speed. The special feeding of bulk material through a hopper leads to a material bed between the two rollers. The bearing units of one roller can move linearly, and they are pressed against the material bed by springs or hydraulic cylinders. Extreme pressure causes the particles inside of the compacted material bed to fracture into finer particles, and also cause microfracturing at the grain-size level. Compared to SAG mills, HPGRs achieve approximately 30% lower specific energy consumption (Wang 2013). However, HPGR rollers, particularly the liners, are more susceptible to wear than SAG mills, as the HPGR relies on the pressure generated between the rollers to crush rocks, and SAG mills are more reliant on the weight of falling rock for crushing. Grinding by the HPGR would be followed up with further particle size reduction using a ball mill. A small portion of the mill feed, approximately 6% would require regrinding.

4.4.5.3 Assessment

<u>Performance Objective – Technical Feasibility</u>

The SAG/ball mill is technically the preferred comminution technology, as it is a common industry standard and is less sensitive to ore hardness.

The HPGR/ball mill is less acceptable from a technical perspective. The Project's ore has a relatively low metric Bond Work index (13.2), making it more amenable to SAG, and a modest/high abrasion index (~0.35 on the most significant ore types; Merit 2014), would result in increased liner wear and increased maintenance costs. The HPGR mill may also not be able to meet the Project's required throughput and target grind size. Thus, the HPGR/ball mill technology is not technically feasible, and is excluded from further consideration.

<u>Performance Objective – Economic Feasibility</u>

The SAG/ball mill technology is economically acceptable for the Project. While maintenance costs would be lower than for the HPGR mill, as equipment would not need to be replaced as frequently, the operating energy costs for SAG mills are significantly higher than for HPGR mills.

The HPGR/ball mill technology is economically acceptable for the Project. While maintenance costs would be higher than for the SAG mill, the operating energy costs would be significantly lower.

4.4.5.4 Conclusion

Since it is the only alternative considered that is technically feasible, the SAG/ball mill is the selected ore comminution technology (see Table 4.4-9).

4.4.6 Storage and Transportation of Copper Concentrate

4.4.6.1 Purpose and Background

As described in Section 5.8.3 of Chapter 5, Project Description, the copper concentrate produced by the proposed Project is likely destined for overseas markets via Port Metro Vancouver. The estimated concentrate production for the life of the operation is 6.5 Mt, requiring 20 truckloads per day, each carrying approximately 40 tonnes of concentrate.

4.4.6.2 Alternative Scenarios/Methods

HCMC has considered two alternatives for transporting and storing copper concentrate to Port Metro Vancouver (Figure 4.4-3):

- Alternative 1: direct transport by trucks. Truck copper concentrate from the Project Site by major highways (using Highway 5 and Highway 1) to Port Metro Vancouver, an approximate road distance of 520 km;
- Alternative 2: transport by a combination of truck and train. Truck copper concentrate approximately 24 km from the Project Site via the Project access road to a nearby rail load-out facility adjacent to an existing Canadian National Railway rail line where it will be handled (interim storage and reclaim) and railed by train to Port Metro Vancouver, an approximate rail distance of 526 km (Merit 2014).

4.4.6.3 Assessment

Performance Objective – Technical Feasibility

Substantial technical challenges are not envisioned with either alternative, and both transportation methods are rated as acceptable in terms of technical feasibility. Highway 5 and the Canadian National Rail transcontinental main line both pass approximately 8 km north of the proposed Project Site. Thus, from a technical perspective, both alternative methods of transporting copper concentrate are equally operationally feasible.

In November 2011, HCMC acquired the abandoned sawmill property formerly owned by Weyerhaeuser Company Limited, located 2.5 km west of Vavenby. The land acquisition included the rail siding, buildings, offices, and statutory rights of way. HCMC intends to build a rail load-out facility for the proposed Project on the privately owned property which is currently zoned general industrial. The property is accessed via McCorvie Road, an existing paved road suitable for the intended truck traffic. Additionally, the property is situated close to both power and water which can be easily accessed.

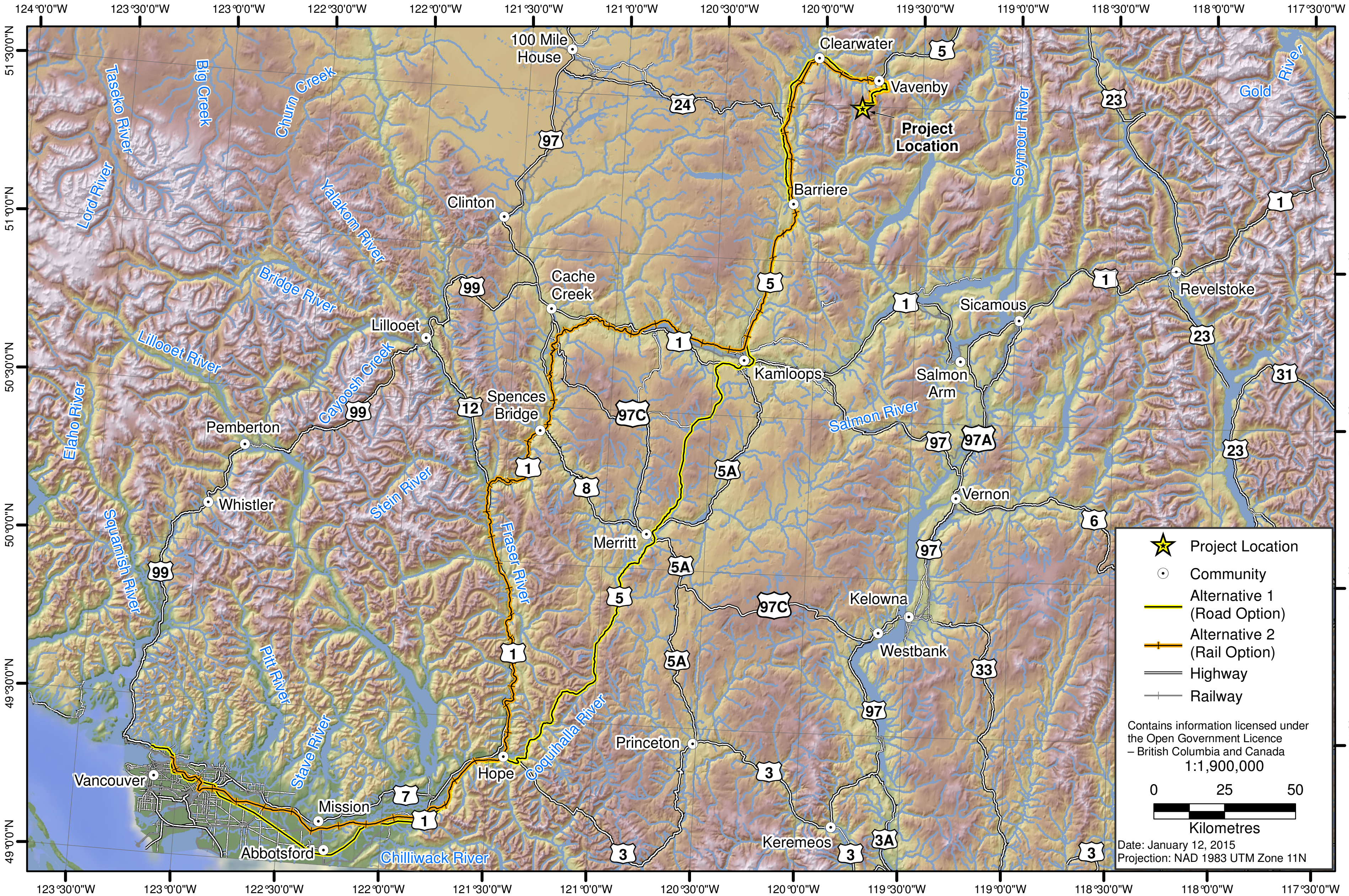
Performance Objective – Economic Viability

The cost of copper concentrate transport and storage by truck and rail to Port Metro Vancouver was estimated in the Project feasibility study to cost per wet metric tonne (wmt; Merit 2014):

- truck transport (site to Vavenby): $13.77/wmt;

Figure 4.4-3

Harper Creek Project: Concentrate Transportation Alternatives



- rail handling and transport: $26.99/wmt; and
- port storage and handling: $27.00/wmt.

Transportation by truck then rail to Port Metro Vancouver is the preferred alternative with respect to economic viability. The rail load-out is located within an existing privately owned industrial property approximately 25 km by road from the Project. The relatively short distance from the plant site to the rail load-out facility decreases the overall cost to transport the copper concentrate by minimizing the use of truck haulage.

The fuel cost of transporting copper concentrate by truck to Port Metro Vancouver is approximately twice that of rail alone (Rocky Mountain Institute 2014). It is assumed that the cost for port storage and handling are approximately the same as for transportation by truck and rail. Transportation by truck to Port Metro Vancouver is rated as an unacceptable alternative in terms of economic viability.

<u>Performance Objective – Environmental Acceptability</u>

Greenhouse gas emissions would be reduced if the copper concentrate was transported by rail to Port Metro Vancouver instead of by truck. Transportation by rail would involve truck transport of copper concentrate approximately 24 km from the plant to the rail load-out facility, whereas transportation by truck only would require hauling for a minimum distance of 500 km. The rail load-out facility is within an existing industrial property; therefore, environmental effects associated with construction would be limited. Truck transportation for the entire distance to Port Metro Vancouver may result in increased vehicle collisions with wildlife because of the greater haul distances.

In summary, transportation by truck to Port Metro Vancouver is considered to be an acceptable alternative from an environmental perspective, but is less preferred than rail. As such, trucking copper concentrate from the proposed Project Site to a rail load-out area and transporting it by train to Port Metro Vancouver is rated as the preferred alternative with respect to environmental acceptability.

<u>Performance Objective – Socio-economic Acceptability</u>

The development of a rail load-out facility at an existing industrial site near the community of Vavenby would not pose a socio-economic concern, and may increase employment opportunities in the community. Nor is it a concern from a land-use or archaeological perspective because the land is a brownfield site. Both transportation options will use established highway and rail networks that are accessible just north of the proposed Project Site. Additional trucks transporting copper concentrate via Highway 5 could have a negative effect on existing traffic and increase the risk of motor vehicle accidents; however, it could also increase employment opportunities for truck drivers and hauling companies. Based mainly on safety considerations, transportation of copper concentrate by truck to Port Metro Vancouver is an acceptable alternative and transportation by truck and rail is the preferred alternative.

4.4.6.4 Conclusion

Both alternatives are equally technically feasible and meet the minimum requirements for all performance objectives; however, the alternative to transport copper concentrate by the combination of truck and rail to Port Metro Vancouver is the preferred alternative. A summary evaluation of the performance objectives and criteria used for assessing the alternative transportation methods is provided in Table 4.4-4.

Table 4.4-4. Alternative Transportation Methods for Copper Concentrate

Assessment Criteria	Transportation Methods for Copper Concentrate: Transport by Truck via Major Highways (using Highway 5 and Highway 1) to Port Metro Vancouver	Transportation Methods for Copper Concentrate: Transport by a Combination of Trucks and Trains. Truck via Local Forest Service Roads to a Rail Load-out Facility near an Existing Canadian National Rail Line and Transport by Train to Port Metro Vancouver
Technical feasibility	Highway 5 is close to the Project.	The Canadian National Rail transcontinental main line is close to the Project.
	Acceptable	*Acceptable*
Economic viability	The cost of transporting copper concentrate by truck alone to Port Metro Vancouver is expected to be prohibitively high.	The cost of transporting copper concentrate by a combination of truck and rail to Port Metro Vancouver is expected to be less than by truck alone.
	Unacceptable	*Preferred*
Environmental acceptability	Potential for increased vehicle collisions with wildlife.	Greenhouse gas emissions would be less by the combination of truck and rail.
	Acceptable	*Preferred*
Socio-economic acceptability	Potential for benefits to local communities from jobs driving and servicing vehicles. Potential for increased vehicle collisions from trucks with other users. Potential for negative effect on existing traffic and increased risk of motor vehicle accidents.	Potential for benefits to local communities from potential jobs at the rail load-out facility near Vavenby.
	Acceptable	*Preferred*
Summary Ranking	**Unacceptable**	**Preferred**

4.4.7 Access Corridor

4.4.7.1 Purpose and Background

Current road access to the Project Site from Kamloops is via Highway 5 to Birch Island, then across the North Thompson River and eastward along the Birch Island-Lost Creek Road (BILCR) for approximately 6 km to the Jones Creek Forest Service Road (FSR) intersection. The Jones Creek FSR provides excellent access to the Project Site. The BILCR continues eastward from the Jones Creek FSR intersection for 5.5 km to the town of Vavenby, located on the north side of the North Thompson River with access to Highway 5.

Upgrades to existing FSRs will be required for construction and operating access to the Project Site and two route alternatives were identified and assessed, as discussed further in Section 4.4.7.2 below.

Information from the *Harper Creek Project: Traffic Impact Assessment* (McElhanney Consulting Services Ltd. 2014) was used to support the alternatives assessment of the access corridors for the Project. The traffic impact assessment was prepared with the following objectives:

- to identify potential impacts due to traffic generated by the operation of the proposed Project on the local highway network and local roads in Vavenby;
- to quantify anticipated delays to traffic that could result from the development of the Project;
- to identify opportunities to minimize potential adverse effects, especially in areas that are determined to be possible "bottlenecks" in terms of capacity or risk;
- to perform a haul-route assessment on the paved infrastructure from the mine to the rail load-out facility; and
- to identify improvements that could be made to the existing road network to improve performance and safety.

4.4.7.2 Alternative Scenarios/Methods

Two routes were assessed as alternatives for access corridors to the proposed Project from the rail load-out facility (Figure 4.4-4):

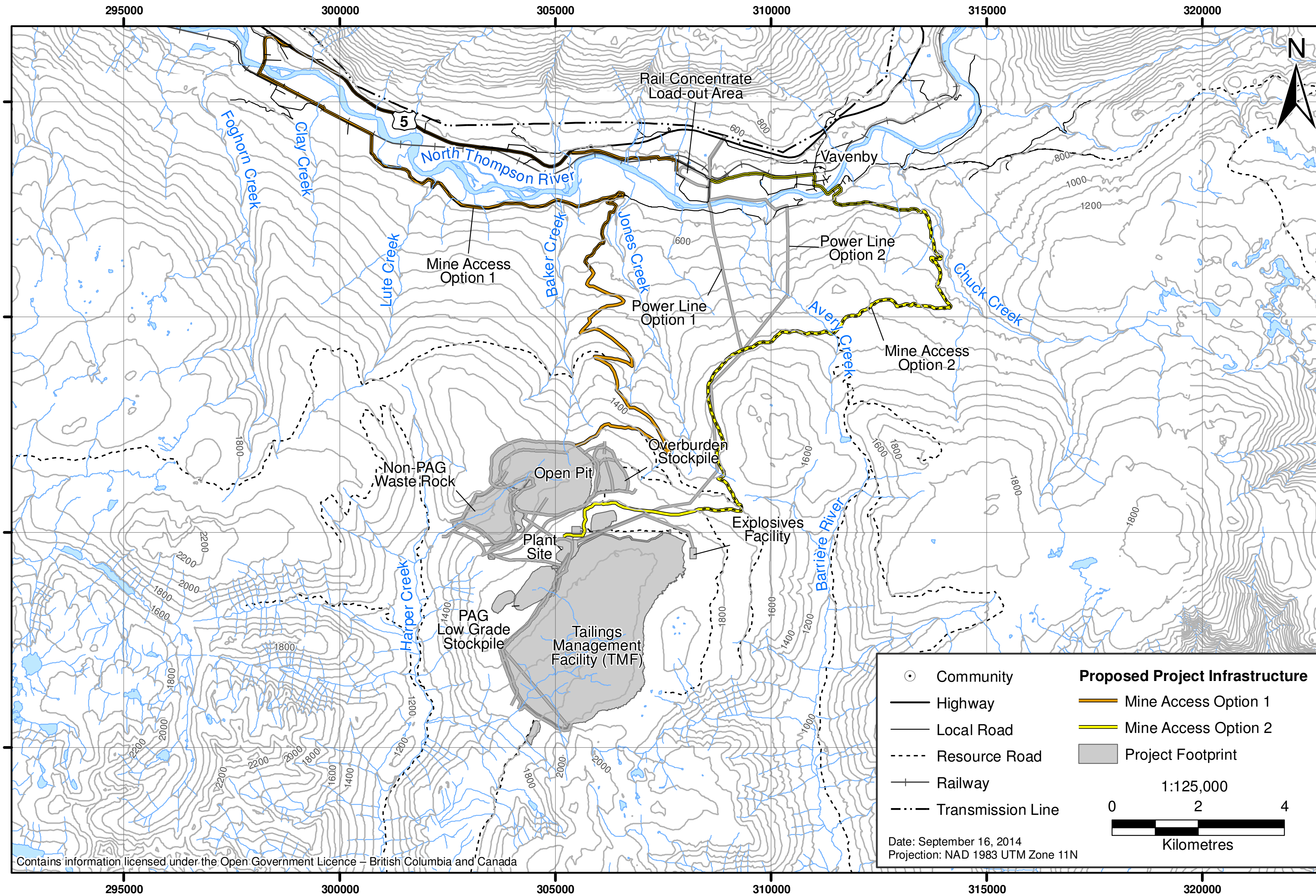
- Alternative 1: west then south. KP Road, Birch Island Bridge, BILCR, Jones Creek FSR;
- Alternative 2: east then south. McCorvie Road, Vavenby Bridge Road, Vavenby Bridge, BILCR, Vavenby Mountain FSR, Saskum Plateau FSR, Vavenby-Saskum FSR, and 2 km of new road.

The proposed Project will make use of existing FSRs, paved roads, and bridges in either access corridor alternatives. Starting from the rail load-out facility, there are three segments to the route in order to access the Project Site, as listed and described in Table 4.4-5.

Table 4.4-5. Route Alternatives and Segment Descriptions

Segments	Alternative 1: West then South from the Rail Load-out Facility (Access to West Side of Harper Creek Project)	Alternative 2: East then South from the Rail Load-out Facility (Access to East Side of Harper Creek Project)
Leaving the rail load-out facility there are two options: heading west (KP Road) or heading east (McCorvie Road to Vavenby Bridge Road)	KP Road	McCorvie Road to Vavenby Bridge Road
Crossing the North Thompson River there are two options: Birch Island Bridge or Vavenby Bridge	Birch Island Bridge	Vavenby Bridge
Immediate access to the Project Site from two directions: BILCR to Jones Creek FSR or Vavenby Mountain FSR to Saskum Plateau FSR and Vavenby-Saskum FSR	BILCR to Jones Creek FSR	Vavenby Mountain FSR to Saskum Plateau FSR and Vavenby-Saskum FSR

Figure 4.4-4
Harper Creek Project: Access Route Alternatives



4.4.7.3 Assessment

<u>Performance Objective – Technical Feasibility</u>

Gaining adequate access to the Project Site is a typical technical challenge associated with mining developments in BC. During the peak of operations for the Project, a total of 171 two-way trips per day on average are projected to be generated to the Project Site (McElhanney Consulting Services Ltd. 2014). Approximately two-thirds of the total projected traffic load associated with the Project as a whole will be light passenger vehicles generated by staff travelling to and from home to the parking area at the rail load-out facility in Vavenby, from where they will be bussed to site, after or before shift change, and will not be using the access route to the Project Site. The remaining one-third of traffic is to support mine operations and includes transportation of copper concentrate from the Project Site to the rail load-out facility and transportation of supplies and personnel to the Project Site.

The proposed Project is ideally situated within close proximity to existing FSRs, paved roads, suitable bridges, and existing major highways. In terms of technical feasibility, both alternatives are predicted to be effective for the anticipated Project traffic uses and volumes. The existing road structure is capable of accommodating regular construction traffic as well as trucks transporting goods, concentrate, and staff travelling to and from work during Operations.

Oversize loads that will be necessary during the Construction phase will access the mine via the BILCR due to load constraints on the use of Vavenby Bridge. For both alternatives, the existing FSRs will need to be upgraded to provide site access. Roads will be widened where necessary and alignments improved where necessary. Detailed road improvements will be discussed during the Project's permitting phase.

<u>Performance Objective – Economic Viability</u>

In terms of economic viability, Alternative 2 is preferred because the total distance from the rail load-out facility to the Project Site is approximately 25 km. The total distance of Alternative 1 is approximately 50 km, which is considered economically unacceptable for transportation from Vavenby.

4.4.7.4 Conclusion

Alternative 2 is rated as the preferred alternative access corridor for Project access from Vavenby given that it is expected to fulfill the transportation requirements of the proposed Project for the majority of the Project life (Table 4.4-6). Although Alternative 2 is preferred, it is anticipated that during Construction, heavy and oversized loads from Highway 5 will need to access the Project Site via the Birch Island Bridge (i.e., Alternative 1) because of the limitations of the Vavenby Bridge mentioned previously. Alternative 1 is generally considered to be an unacceptable alternative in terms of socio-economic acceptability during the Project's Operations phase.

Table 4.4-6. Access Corridor Alternatives

Assessment Criteria	Access Corridors	
	Alternative 1: West then South. KP Road, Birch Island Bridge, BILCR, Jones Creek FSR	Alternative 2: East then South. McCorvie Road, Vavenby Bridge, Vavenby Mountain FSR, Saskum Plateau FSR
Technical feasibility	Access corridor is technically feasible for the passage of most traffic.	Access corridor is technically feasible, but may require some upgrades.
	Acceptable	*Acceptable*
Economic viability	Longest distance (approximately 50 km) to transport copper concentrate from the Project Site to the rail load-out facility, higher transportation cost makes this alternative unacceptable. Upgrade to Jones Creek/BILCR intersection. Shorter distance for staff and materials travelling to and from Kamloops.	Facilitates a competitive return on investment. Shortest distance (approximately 25 km) to transport copper concentrate from the Project Site to the rail load-out facility, lower transportation cost. Longer distance for staff and materials travelling to and from Kamloops.
	Unacceptable	*Preferred*
Summary Rating	**Unacceptable**	**Preferred***

Note:
During Construction, it is anticipated that heavy and oversized loads will travel to the Project Site from Highway 5 south via the Birch Island Bridge, given the limitations on the use of the Vavenby Bridge.

4.4.8 Employee Accommodation

4.4.8.1 Purpose and Background

During the Construction phase of the Project, it is estimated that 600 construction persons will be required at the peak of activities, which occurs in the second construction season when work is focused on the civil, mechanical, and electrical work. In the ninth year of the Operations phase, employment is estimated to peak at 466 positions. Employment opportunities would clearly be an important economic benefit derived from the proposed Project and the provision of accommodation or appropriate facilities for workers is a necessary subject of assessment.

The potential for increased demand for housing in the region is addressed in Chapter 17, Socio-economic Effects Assessment. It is against this background that the approach adopted by HCMC for worker accommodation has been determined. During the Construction phase workers would be housed in a temporary camp on site, while Operations phase workers would reside privately within daily commuting distance from the Project. It should also be recognized that the construction of new housing stock is underway in the region and that the proposed Project is likely a motivating factor for such development.

4.4.8.2 Alternative Scenarios/Methods

To substantiate the approach adopted by HCMC, an evaluation of the on-site and off-site scenarios during both Construction and Operations phases of the Project was undertaken, according to their technical feasibility and economic viability (Table 4.4-7). These must be seen in the context of the approach adopted by HCMC described in the previous paragraph.

Table 4.4-7. Employee Accommodation Alternatives

Assessment Criteria	Employee Accommodation	
	On Site	Off Site
Technical feasibility: Construction phase	Commercially available construction camp units.	Transportation and logistical constraints could affect efficiencies.
	Preferred	*Acceptable*
Economic viability: Construction phase	Acceptable Project cost.	Would undermine Project's viability in terms of return on investment and lost opportunity cost.
	Acceptable	*Unacceptable*
Construction Summary Rating	**Preferred**	**Unacceptable**
Technical feasibility: Operations phase	No specific technical constraints to on-site accommodation.	Optimized resource use and efficiency.
	Acceptable	*Preferred*
Economic viability: Operations phase	Would undermine Project's viability in terms of return on investment and lost opportunity cost.	Minimal Project cost while benefitting the local economy.
	Unacceptable	*Preferred*
Operations Summary Rating	**Unacceptable**	**Preferred**

4.4.8.3 Assessment

Construction Phase

On-site accommodation during the Construction phase would require appropriate facilities to be installed for the envisaged number of workers. This would require temporary accommodation that could be removed in a cost-efficient manner. Modular accommodation units to make up the construction camp can be supplied commercially, meaning that their technical feasibility is proven. As for the economic viability of an on-site temporary construction camp, it would be an acceptable project cost.

An off-site temporary construction camp would be technically feasible but would pose constraints in terms of transportation and optimum efficiency of the construction teams. Note that accommodating temporary construction workers privately in nearby communities has not been evaluated since it is known that temporary housing facilities at sufficient capacity are not available.

Off-site accommodation in a temporary camp during the Construction phase would assume that a suitable area of land could be leased or purchased. While the cost and availability of such an area of land is unknown, it would be an additional cost that would undermine the economic viability of the Project in terms of return on investment and lost opportunity cost.

Operations Phase

Given the smaller number of employees and continual plant operation required during the Operations phase, and the more permanent nature of the employment conditions, the proximity of the proposed Project to available housing to accommodate employees in nearby communities becomes an important factor. There is little benefit in on-site accommodation in this case, unlike mines located in more remote areas. However, there would be no technical constraints to on-site housing for Operations phase employees.

The majority of employees are anticipated to commute daily from nearby communities to the rail load-out facility located on the former Weyerhaeuser Mill site, and from there be bussed to the Project Site. From a technical perspective, such optimization on transport equipment and infrastructure is preferable in terms of resource use and efficiency.

In much the same way that an off-site construction camp would be economically unviable, an on-site Operations phase accommodation facility would be similarly unviable due to return on investment and opportunity cost benefits being undermined. On the other hand, employees maintaining private accommodation within the communities in proximity to the Project would be economically viable for not only the proponent but also in terms of the economic sustainability of the region.

4.4.8.4 Conclusion

The assessment of employee accommodation alternatives indicates that the on-site temporary Construction phase camp is preferable to locating such a camp off-site, for reasons of economic viability. As far as the Operations phase is concerned, the off-site alternative of employees maintaining private accommodation within neighbouring communities is the preference, for reasons of optimized resource use and efficiency, as well as economic benefits for the community and the Project.

4.4.9 Waste Rock Management

4.4.9.1 Purpose and Background

Determining the location and method of waste rock storage is one of the key decisions for metal mines. Waste rock at the Project will consist of overburden and other materials (i.e., soil and fine sand to large boulders) excavated in order to create foundation pads for surface facilities as well as rock excavated from the pit, haul roads, and other infrastructure. Waste rock can be barren of precious metals or have concentrations below cut-off grades; consequently, what is originally classified as waste may change over a project lifetime based on changed metal prices.

Studies to date suggest that waste rock from the open pit is a combination of PAG and non-PAG waste rock (SRK Consulting (Canada) Inc. 2012). A more detailed summary of the ML/ARD assessment is provided in Section 6.3 of the Application/EIS. It is estimated that 542 Mt of waste rock, which includes 265 Mt of non-PAG waste, 237 Mt of PAG waste rock, and 39 Mt of overburden, will be mined from the Project over the life of the mine. The waste rock would be produced mainly from the open pit with lesser volumes from potential road construction and upgrades, and diversion channel construction.

4.4.9.2 Alternative Scenarios/Methods

In developing the preferred waste rock management strategy for PAG and non-PAG waste rock, as described above, HCMC reviewed the following four alternative waste rock management strategies:

- Alternative 1: dry storage of PAG and non-PAG waste rock in an onland dump;
- Alternative 2: backfilling of waste rock in open pit;
- Alternative 3: subaqueous storage of PAG and non-PAG waste rock in the TMF;
- Alternative 4: subaqueous storage of PAG in the TMF and non-PAG waste rock onland adjacent to the open pit in a waste rock dump.

4.4.9.3 Assessment

<u>Performance Objective – Technical Feasibility</u>

Storage of both PAG and non-PAG waste rock onland in surface waste rock stockpiles adjacent to the open pit was not considered amenable to detailed consideration as an alternative because it would leave PAG waste rock exposed to air and water where it could over time generate ML/ARD into the receiving environment. This option would likely require long-term water collection and treatment facilities, and would provide significant permitting challenges.

Backfilling the life-of-mine waste rock into the open pit was not considered amenable to detailed consideration as an alternative because the open pit will not be available for backfilling over the life of the mine due to active mining operations. However, backfilling the tailings associated with the low-grade ore stockpile into the pit is considered technically feasible, as the open pit would be exhausted at that point and active mining would have ceased. This option would have the benefit of reducing the size of the TMF.

In terms of technical feasibility, storage of all PAG and non-PAG waste rock under water requires the development of a substantially larger impoundment area to contain the volume of waste rock anticipated. Additional technical considerations for a larger TMF include an increase in the height of the dam necessary to create the impoundment, and the volume of appropriate dam construction materials. From a technical feasibility perspective this is potentially acceptable, although considerable detailed geotechnical engineering and design work beyond the conceptual level required for the alternatives assessment would be required in order to demonstrate its feasibility. Additional detailed geotechnical engineering and design work for this alternative was not conducted based on the fact that this alternative is considered to be unacceptable from an economic viability perspective.

The success of storing PAG waste rock under water in the TMF and non-PAG waste rock above ground in surface stockpiles requires operational segregation of PAG and non-PAG waste rock. Test work and modelling has shown this can be achieved with suitable waste management planning and materials handling procedures to be implemented during the operation of the Project. The required impoundment area for this would be smaller than would be required for the alternative where all waste rock is disposed of in the TMF, with similar but lesser technical challenges. For these reasons, this alternative is rated as the preferred alternative from the perspective of technical feasibility.

Performance Objective – Economic Viability

In terms of economic viability, the most cost effective storage option for waste rock is to place it as close as possible to the source, which is the open pit. This approach minimizes road construction and truck hauling costs associated with moving the waste rock to its final storage destination. However, permanent storage of PAG waste rock in an onland dump may require very long-term water treatment which would add significant capital and operation expenses to the Project, which may make the Project uneconomical. The permanent onland storage of all PAG waste rock is considered to be unacceptable from an economic perspective and is not considered further in this assessment.

The second alternative considered, the storage of all PAG waste rock in the pit, was not evaluated from an economics perspective because it is not technically feasible.

The third alternative, the storage of all life-of-mine waste rock subaqueously in the TMF, is considered unacceptable from an economic perspective. This waste rock management method would incur additional cost associated with the longer haul distance to place all waste rock from the open pit into the TMF, as well as the higher containment dam and more complex water management structures that would be required. This option is not considered further in this assessment.

The fourth alternative, the subaqueous storage of PAG in the TMF and non-PAG waste rock onland adjacent to the open pit in a waste rock storage stockpile, is the preferred alternative because it provides the more cost-effective solution to handle and stockpile the non-PAG waste rock as close as possible to the source. This option is also less constricted by topography than Alternative 2. As a result, from an economic viability perspective, subaqueous storage of PAG in the TMF and non-PAG waste rock onland is considered to be an acceptable alternative and can be financially supported by the Project.

4.4.9.4 Conclusion

The selected alternative for the management of waste rock from the proposed Project is to store all PAG waste rock under water in the TMF and non-PAG waste rock above ground in surface waste rock stockpiles near the pit during the active mining operations. The TMF is designed to provide storage for approximately 585 Mt of tailings and for the co-storage of up to 237 Mt of PAG waste rock (see Section 5.8.2.2 of the Project Description chapter in this Application/EIS). The overall site capacity is capable of expansion by approximately 30% should future expansion be required during or after the life of the Project. Once active mining operations have ceased during Year 23 and the open pit is available for storage, the pit will then be backfilled with tailings associated with processing the low-grade ore.

HCMC will implement measures to ensure the proper segregation and storage of PAG waste rock. It is envisaged that 110 Mt of non-PAG waste rock would be used for the construction of the TMF embankment and opportunities for additional construction-based uses of non-PAG waste rock will be investigated as the proposed Project develops. A summary evaluation of the performance objectives and criteria used for assessing the alternative options for waste rock management is provided in Table 4.4-8.

Table 4.4-8. Waste Rock Management Alternatives

Assessment Criteria	Waste Rock Management Alternatives			
	Alternative 1: Storage of PAG and Non-PAG Waste Rock in an Onland Dump	**Alternative 2: Backfilling of Waste Rock in Open Pit**	**Alternative 3: Subaqueous Storage of PAG and Non-PAG Waste Rock in the TMF**	**Alternative 4: Subaqueous Storage of PAG in the TMF and Non-PAG Waste Rock Onland Adjacent to the Open Pit in a Waste Rock Dump**
Technical feasibility	Not feasible to leave PAG waste rock exposed to air and water since it would over time generate ML/ARD into the receiving environment. Not considered further.	Not possible to store life-of-mine waste rock in open pit due to active mining.	Would require the development of a larger impoundment area with higher impoundment dam and additional water management structures for co-storage of both PAG and non-PAG waste rock.	Operational segregation of PAG and non-PAG waste rock can be achieved with suitable waste management planning and materials handling procedures. Would require a smaller TMF than Alternative 3.
	Unacceptable	*Unacceptable*	*Acceptable*	*Preferred*
Economic Viability	This option minimizes road construction and truck hauling costs associated with moving the non-PAG waste rock to its final storage destination. Probable long-term water treatment may render Project uneconomical.	Economics of storing life-of-mine waste rock in pit were not examined due to technical impracticality.	This option has increased costs associated with hauling non-PAG waste rock to the TMF, constructing a higher dam for the impoundment area and more complex water management structures that cannot be financially supported by the Project.	Operational segregation of PAG and non-PAG waste rock can be achieved with suitable waste management planning and materials handling procedures. This option minimizes infrastructure costs and can be financially supported by the Project.
	Unacceptable	*N/A*	*Unacceptable*	*Acceptable*
Summary Rating	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Preferred**

4.4.10 Summary of Alternative Means of Carrying out the Project

This chapter has described the decision-making rationale behind the Project components identified for assessment. It has been undertaken in a transparent manner that demonstrates that the decision-making rationale behind the selected alternative for each component assessed has been conducted in a systematic, reasonable, and defensible way that balances technical and economic Project criteria with minimizing potential adverse effects on surrounding environmental and human systems.

In summary, it is envisaged that the Project will comprise an open-pit mine using a SAG mill comminution process, with conventional wet tailings storage in an optimized catchment area that will also accommodate PAG waste rock subaqueously. The concentrate produced will be transported by road truck a short distance to a rail load-out facility from where it will be transported further by rail to Port Metro Vancouver. Road access to the Project will be via an upgraded existing FSR network. Power supply will be by means of diesel generators supplemented by limited grid supply during the Construction phase and full grid supply during the Operations phase. Employees will be accommodated on-site during the Construction phase and off-site during the Operations phase.

Table 4.4-9 presents a summary of the assessment carried out for the alternative means of undertaking the Project.

Table 4.4-9. Harper Creek Project Alternative Means Screening Table Based on Technical and Economic Performance Objectives

Project Component	Alternatives	Technically Feasible? *(Preferred, Acceptable, Challenging, Unacceptable)*	Rationale	Economically Feasible? *(Preferred, Acceptable, Challenging, Unacceptable)*	Rationale	Screening Result
Mining Method (Section 4.4.2)	Open pit	Preferred	Open-pit mining is a the most common mining method for copper-gold mines	Preferred	Most cost-efficient method	Select
	Underground – block caving	Unacceptable	The nature of the Project's ore body is not compatible with underground mining	Unacceptable	The nature of the Project's ore body, large tonnage and low grade, makes underground mining not economically viable	Discard
	Combination of open pit and underground (block caving) mining	Unacceptable	The nature of the Project's ore body is not compatible with any form of underground mining, even in combination with open-pit mining	Unacceptable	The nature of the Project's ore body, large tonnage and low grade, makes underground mining not economically viable, even in combination with open-pit mining	Discard
Tailings Management (Section 4.4.3)	Dry stack	Unacceptable	Project's climate and terrain are not suitable for dry stack technology; subaqueous co-storage of PAG waste rock is not possible	Challenging	The cost of drying tailings may make the Project uneconomical	Discard
	Paste tailing	Unacceptable	Subaqueous co-storage of PAG waste rock may not be possible	Challenging	The cost of drying tailings may make the Project uneconomical	Discard
	Conventional storage: TMF-1	Acceptable	Large diverted catchment area indicates high complexity of associated water management structures	Unacceptable (due to environmental constraint)	Relatively close to the Project Site, minimizing any haulage or pipeline costs; steeper terrain complicates waste rock placement and consequent increased cost (note that rejection is due to affected fish habitat described in Section 4.4.3.3)	Discard
	Conventional storage: TMF-2	Preferred	Smallest diverted catchment area and expansion potential	Preferred	Relatively close to the Project Site, minimizing any haulage or pipeline costs	Select
	Conventional storage: TMF-3	Acceptable	Large diverted catchment area indicates high complexity of associated water management structures	Unacceptable	Greatest distance from the Project Site, increasing the cost associated with transporting waste rock from the mine plant, making the Project economically not viable	Discard
Power Supply (Section 4.4.4)	Diesel generators	Challenging	Very large volumes of diesel fuel would be required to be transported and stored on site	Unacceptable	High operating costs associated with transporting and storing diesel fuel would make the Project not economically viable	Discard
	LNG generator	Unacceptable	Securing and transporting large volumes of LNG to the Project Site would not be possible	Unacceptable	High operating costs associated with transporting LNG fuel, and storage and vapourizing LNG to natural gas would make the Project not economically viable	Discard
	Power Line Option 1 – West	Preferred	Marginally shorter and more direct than east option	Preferred	Lower costs associated with shorter and more direct route	Select
	Power Line Option 2 – East	Acceptable	Marginally longer and less direct than west option	Acceptable	Higher costs associated with longer and less direct route	Pending finalization of right-of-way arrangements
Ore Processing – Ore Comminution (Section 4.45)	HPGR	Unacceptable	Ore characteristics incompatible with HPGR mills	Acceptable	HPGR mills often have lower operating costs due to lower power requirements	Discard
	SAG	Preferred	Well-established technology; technology is less sensitive to hard and abrasive ores	Acceptable	Lower maintenance costs than HPGR mills (although operating costs higher) means SAG mill economically acceptable	Select
Storage and Transportation of Copper Concentrate (Section 4.4.6)	Trucks	Acceptable	Highway 5 is close (about 24 km) to the Project	Unacceptable	The cost of transporting copper concentrate by truck alone to Port Metro Vancouver is expected to be prohibitively high.	Discard
	Trucks and train	Preferred	The Canadian National Railway transcontinental main line is close (about 25 km) to the Project	Preferred	The cost of transporting copper concentrate by truck and train is expected to be lower than by truck	Select

(continued)

Table 4.4-9. Harper Creek Project Alternative Means Screening Table based on Technical and Economic Performance Objectives (completed)

Project Component	Alternatives	Technically Feasible? *(Preferred, Acceptable, Challenging, Unacceptable)*	Rationale	Economically Feasible? *(Preferred, Acceptable, Challenging, Unacceptable)*	Rationale	Screening Result
Access Corridor (Section 4.4.7)	West then south. KP Road, Birch Island Bridge, BILCR, Jones Creek FSR	Acceptable	Access corridor is technically feasible for the passage of most traffic	Unacceptable	Longest distance (about 50 km) to transport copper concentrate from the Project Site to the rail load-out facility; higher transportation cost makes this alternative unacceptable	Discard
	East then south. McCorvie Road, Vavenby Bridge Road, Vavenby Bridge, BILCR, Vavenby Mountain FSR, Saskum Plateau FSR, Vavenby-Saskum FSR, and 2 km of new road	Acceptable	Access corridor is technically feasible, but may require some upgrades	Preferred	Facilitates a competitive return on investment. Shortest distance (about 25 km) to transport copper concentrate from the Project Site to the rail load-out facility; lower transportation cost	Select
Employee Accommodations – Construction (Section 4.4.8)	Housed on site	Preferred		Acceptable	Construction of on-site housing would be less expensive than housing staff off-site as housing could be constructed as part of the mine lease; staff could be transported to and from the Project Site on a shift rotation basis	Select
	Housed off site	Unacceptable	Insufficient available housing within a reasonable driving distance	Challenging	Construction of off-site housing would be more expensive than housing staff on-site, as due to a shortage of available local housing, land would have to be purchased, housing constructed, and staff would have to be transported to and from the Project Site on a daily basis	Discard
Employee Accommodations – Operations (Section 4.4.8)	Housed on site	Acceptable	No specific technical constraints to on-site accommodation	Unacceptable	Would undermine Project's viability in terms of return on investment and lost opportunity cost	Discard
	Housed off site	Preferred	Optimized resource use and efficiency	Preferred	Minimal Project cost while benefitting the local economy	Select
Waste Rock Management (Section 4.4.9)	Alternative 1: Onland PAG and non-PAG waste rock stockpile	Acceptable	Onland waste rock stockpiles are a well-established technology; long-term water treatment is possible although challenging	Unacceptable	Long-term water treatment may be required, which may render the Project uneconomical	Discard
	Alternative 2: Backfilling of waste rock in open pit	Unacceptable	Not possible to store life-of-mine waste rock in open pit due to active mining	N/A	Economics of storing life-of-mine waste rock in pit were not examined due to technical impracticality	Discard
	Alternative 3: Co-storage of PAG and non-PAG waste rock in TMF	Challenging	Subaqueous storage of waste rock is a well-established technology; there may be insufficient storage space in the TMF to safely store life-of-mine tailing and waste rock	Unacceptable	Alternative is unacceptable from an economical perspective	Discard
	Alternative 4: Co-storage of PAG waste rock in TMF, onland non-PAG waste rock stockpile	Preferred	Onland waste rock stockpiles are a well-established technology; as all PAG waste rock would be stored subaqueously, long-term water treatment would not be necessary	Acceptable	Alternative is acceptable from an economical perspective	Select

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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