4. PROJECT ALTERNATIVES

4.1 INTRODUCTION

This chapter presents the processes and criteria that HD Mining International Ltd. (HD Mining) and its consultants have used to select preferred options, and alternative means, of developing the Murray River Coal Project (the Project).

This alternatives assessment for the Project satisfies the requirements of the *Canadian Environmental Assessment Act*, *2012* (CEAA 2012), the Operational Policy Statement Addressing "Purpose of" and "Alternative Means" under CEAA 2012 (CEAA OPS); and the British Columbia (BC) *Environmental Assessment Act* (2003). In addition, alternatives assessment meets the information requirements as outlined in the Canadian Environmental Assessment Agency (CEA Agency) Environmental Impact Statement (EIS) Guidelines for the Murray River Coal Mine Project and the BC Environmental Assessment Office (EAO) Application Information Requirements (AIR).

"Alternative means" of carrying out the Project are defined as the various technically and economically feasible ways that the Project could be implemented. Throughout the design process, HD Mining has made numerous decisions on how to develop and implement the Project throughout the Bulk Sample, Construction, Operation, Decommissioning and Reclamation, and Post Closure based on Project economic, technical, environmental and social criteria. The decision-making process to identify the preferred Project alternative for the following components required by the AIR and EIS Guidelines are reported in this chapter, including:

- from AIR:
  - mining method;
  - site selection;
  - location/design of conveyor system;
  - location/design of rail load-out;
  - backfilling waste rock and/or coal rejects;
  - location/design of coarse coal rejects storage area;
  - power supply; and
  - employment/recruitment.
- and from EIS Guidelines:
  - Siting of project components;
  - Worker accommodations and transportation.
  - Mining method;
  - Coal extraction technologies;
  - Coal processing methodologies;

  - Location and layout of rail load-out facility, mine access roads, bridge crossings, transmission line(s), and pipelines;
  - Mine waste disposal, including rock, contaminated water treatment, sewage treatment
  - Water management plans (including water sources, diversions, pumping, pumping/drawdown/dewatering);
  - Contaminated water treatment methodologies;
  - Energy sources for the mine complex operations including back-up power plant; and
  - Location of infrastructure related to the mine, including the location of surface and underground explosive storage, water treatment plant, and final effluent discharge point.

4.2 METHODS

4.2.1 Decision-making

As recommended by CEAA OPS, four steps should be used to determine the preferred option for each component of the Project:

- Step 1: Identify technically and economically feasible alternative means
- Step 2: List their potential effects on valued components
- Step 3: Select the approach for the analysis of alternative means
- Step 4: Assess the environmental effects of alternative means

This alternatives assessment was conducted using a decision-making framework to systematically evaluate alternatives to determine the best means of undertaking the Project.

4.2.2 Performance Objectives, Criteria and Indicators

To assist with the screening and subsequent assessment of the identified alternatives, performance objectives are used. Performance objectives are meaningful attributes that are essential for the Project success and provide a basis for distinguishing between individual alternatives. The following performance objectives have been used:

- <u>Technical Feasibility</u>

Relates to the appropriateness of an alternative from an engineering or operational perspective and incorporates aspects of known performance, reliability, and operational ease for the Project.

- <u>Cost Implication</u>

  Relates to the overall Project costs including capital, operating and maintenance, and closure/reclamation costs of an alternative. Each aspect of the Project has cost implications and therefore cost implication, or effectiveness, is a performance objective common to all alternatives.

These technical and cost considerations are used to screen the alternatives and identify those that are feasible.

Feasible alternatives, once identified, are screened using the following performance objectives to determine the preferred alternative for the Project.

- Effects to the Natural Environment

  Each alternative under evaluation can have adverse effects on the natural environment and in some cases the effect could be positive. The "natural environment" in this context refers to the air, bedrock, soil/overburden, water (surface and ground) and biological organisms/communities, focusing on valued components (VCs) including:

  – Migratory Birds;
  – Air quality;
  – Geology, landforms and soils (including terrain and wetlands);
  – Rare and Sensitive Ecological Communities;
  – Mammals;
  – Amphibians;
  – Surface water, domestic water and groundwater quality and quantity;
  – Aquatic environment (e.g. aquatic life, fish, fish habitat);
  – Flora at Risk (as defined under and in accordance with the SARA);
  – Fauna at Risk (as defined under and in accordance with the SARA);

- Effects to the Human Environment

  The potential for positive and negative human effects is evaluated where appropriate for the Project alternatives. The human environment includes aspects of the cultural heritage environment as well as Aboriginal and treaty rights. The potential for negative impacts to cultural resources, traditional land use, and Aboriginal and treaty rights (such as reduction of land use by Aboriginal peoples or the quality of resources harvested by Aboriginal peoples) is also evaluated where appropriate. Alternative assessment focuses on valued components (VCs) including:

  – Employment and income;
  – Community Well-being (including education, infrastructure, services);
  – Heritage and archaeological resources;
  – Aboriginal traditional use (current and historic);
  – Land and resource use;
  – Outdoor Recreation (Navigation);
  – Noise and vibration; and
  – Human health.

- Amenability to reclamation

  This objective relates to the decommissioning or reclamation of various aspects at eventual Project closure. It is relevant to those aspects of the Project that alter the landscape (i.e., roads and stockpiles) and/or require dismantling and either removal from site or disposal on site (e.g., buildings).

4.2.3 Alternatives Evaluation and Assessment

4.2.3.1 Screening

Potentially feasible alternative means to develop the Project are identified by first screening preliminary options based on basic technical and economic feasibility criteria in concordance with the CEAA OPS. Options are ranked as **preferred**, **acceptable**, **challenging** or **unacceptable**.

Basic technical feasibility criteria used in the screening includes:

- technology for the option must be proven at the industrial scale;
- technology must meet required industrial and government standards;
- option must be suitable for the Project climate and terrain;
- option must meet health and safety requirements; and
- option must not exceed acceptable risk levels (i.e., such as from geohazards).

Economic feasibility criteria include:

- amenability for financing;
- economic viability based on cost estimates (i.e., of capital or operating expenditures); and
- the level of associated risk.

Where screening led to only one technically and economically feasible option being identified, this option was selected for use by the Project and no further assessment was conducted. Where screening led to more than one option being technically and economically feasible, further assessment was completed.

4.2.3.2 Detailed Assessment of Alternative Means

Where more than one feasible alternative is identified through the screening process, further consideration is given to compare the merits of each alternative in relation to relevant Valued Components that may be adversely (or beneficially) affected. The assessment is carried out at a level sufficient to distinguish the relative merits of the different options based on the consideration of the advantages and disadvantages of each.

It is important to recognize that Project alternatives are inter-connected, and that decisions for one topic cascade down to other topics. There is also a decision-making chronology to Project development that influences the ultimate identification and selection of Project alternatives. This context is brought into the assessment where appropriate.

Based on the descriptors of the advantages and disadvantages of the criteria of each alternative, preferred alternative is identified.

4.3 ALTERNATIVES ASSESSMENT

Alternative means are the various technically and economically feasible options under consideration for HD Mining to develop the Project. Table 4.3-1 lists the major project components and their sub-components developed for screening based on the required components listed in Section 4.1.

Table 4.3-1. Major Project Components and Sub-components Considered for Screening

<table>
<tr><td rowspan="2">Major Considerations</td><td colspan="2">Mining Method</td></tr>
<tr><td colspan="2">Underground Access (Bulk Sample)</td></tr>
<tr><td rowspan="3">Primary Project Components</td><td colspan="2">Product Transport</td></tr>
<tr><td colspan="2">Coal Reject Storage</td></tr>
<tr><td colspan="2">Raw Coal Transport</td></tr>
<tr><td rowspan="14">Secondary Project Components</td><td colspan="2">Project Access and Transport</td></tr>
<tr><td colspan="2">Explosives</td></tr>
<tr><td rowspan="2">Power</td><td>Primary Power Supply</td></tr>
<tr><td>Back-up Power Supply</td></tr>
<tr><td rowspan="2">Coal Processing</td><td>Heating Resources for Coal Drying</td></tr>
<tr><td>Flotation Tailings</td></tr>
<tr><td colspan="2">Ventilation</td></tr>
<tr><td rowspan="4">Water Management</td><td>Water Source</td></tr>
<tr><td>Sewage Effluent Discharge</td></tr>
<tr><td>Contact Water Treatment Method</td></tr>
<tr><td>Treated Water Discharge Location</td></tr>
<tr><td colspan="2">Employment</td></tr>
<tr><td colspan="2">Accommodation</td></tr>
<tr><td colspan="2">Non-Hazardous Solid Waste</td></tr>
</table>

For each Project component, a screening assessment of potential options was completed to scope out the ones that are unfeasible based on technical and economic evaluation criteria. Table 4.3-2 summarizes the screening of the Project component alternatives. The discussion presented in Sections 4.3.1 through 4.3.4 provides the detailed alternatives assessment of each relevant Project component (as determined above).

4.3.1 Mining Method

The first alternative that must be assessed for the Project is mining method, as this drives primary decisions related to site layout, and the major project components that would be required to support the method.

Four mining methods are potentially applicable to the project: open pit mining, room and pillar underground mining, advancing longwall underground mining, and retreating longwall underground mining.

Given the depth of the coal seams, open pit mining is not an economic or technically feasible option. A pit 950 m deep and several kilometers wide would be required, requiring the diversion of Murray River and the removal of existing gas infrastructure. Surface mining was rejected as an alternative.

Three underground mining methods were considered, room and pillar mining, which is the currently the only underground coal mining method practised in Canada, and longwall mining (in both advancing and retreating forms), which has been used in Nova Scotia and Alberta but never in British Columbia.

Room and pillar mining consists of tunnels or rooms driven in a rectilinear grid pattern leaving solid pillars of coal between them to safely support the workings. The size of the pillars required for safety determines the extraction efficiency, which then governs the economics of the operation. Initial estimates of the pillar sizes required for safe room and pillar mining were between 50 and 90 m resulting in extraction ratios of 10 to 20%. The method is restricted to seam gradients of less than about 12°, after which the amount of rock which has to be cut reduces the quality of the run-of-mine product and increases processing costs. Second mining (pillar extraction) at depths of greater than 500 m is almost unheard of internationally and would present significant technical and safety difficulties in thick seams at depths of up to 950 m.

Longwall mining is a fully mechanised method in which coal is cut from the solid between one or more "gateroads" by large milling-type machines, loaded onto an armoured conveyor and subsequently onto rubber conveyors to be hauled from the mine. The working area is protected by massive steel supports which use hydraulic legs with a capacity of several hundred tonnes each to support the roof at the face before it caves into the opening left by the removal of the coal. The method can be used in steep dips (near-vertical coalfaces have been mined by longwall) and at depth (up to about 1500 m).

With the advancing method of longwall mining the tunnels providing access, fresh air and product transport are developed as the face moves. In the retreating system, the gateroads are driven before the face starts. This method is disadvantageous compared to the advancing method as it requires extensive initial capital development. However, the subsequent productivity increases and better safety record have led to the universal adoption of the retreating method of longwall, and this method is the selected alternative for the Project.

Given the mining conditions and the limitations of the other methods, retreat longwall mining was the selected mining method.

Table 4.3-2. Murray River Project Alternative Means Screening Table Based on Basic Technical and Economic Feasibility Criteria

Project Component		Alternatives	Technically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Economically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Screening Result
Mining Method		Open pit	unacceptable	The coal seams are too deep to mine using open pit methods	unacceptable	Project would not be economically feasible with open pit mining	Discard
		Underground method 1: Advancing Longwall Mining	preferred	The depth of the coal seams and the number of seams makes longwall mining the only technically feasible option.	unacceptable	Advancing longwalls are more difficult to maintain safely and output is reduced as the gateroads are formed in line with the coal face.	Discard
		Underground method 2: Retreating Longwall Mining	preferred	The depth of the coal seams and the number of seams makes longwall mining the only technically feasible option	preferred	Economically the best, and certainly the safest underground solution	Select
		Underground method 3: Room and Pillar	challenging	The depth of the coal seams, the number of seams to be worked and the unacceptable hazards ensuing from using this method make it a challenging alternative which would severely reduce the available reserves.	unacceptable	Safety hazards too expensive to mitigate with certainty	Discard
Underground Access (Bulk Sample)		Decline Site and Shaft Site					Previously assessed and permitted as part of Bulk Sample
Primary Project Components	Product Transport	Rail	preferred	BC Provincial rail system provides safe transportation corridors for rail	preferred	Costs associated with hauling coal along existing rail route acceptable and significantly lower than using trucks	Assess Further
		Road	acceptable	BC Provincial highways provide safe transportation corridors for heavy trucks; upgrading of Project roads may be necessary	unacceptable	Costs to haul coal to market unacceptably high compared to rail	Discard
	Coal Reject Storage	Backfill into underground mine	challenging	Backfilling into gobs is technically feasible but very challenging in terms of the infrastructure required to move the material to the required location and insert it efficiently	unacceptable	The economics would render the Project unviable.	Discard
		Disposal into surface coal rejects facilities (CCR piles) at Project site	preferred	Surface CCR disposal is a well-established technology.	preferred	Most economically acceptable method.	Assess Further
		Disposal into surface coal rejects facilities (CCR piles) off-site	acceptable	Surface CCR disposal is a well-established technology.	unacceptable	Haulage costs by truck would be economically unacceptable.	Discard

(continued)

Table 4.3-2. Murray River Project Alternative Means Screening Table Based on Basic Technical and Economic Feasibility Criteria (continued)

Project Component			Alternatives	Technically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Economically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Screening Result
Primary Project Components *(cont'd)*	Raw Coal Transport		Conveyor to Surface and Truck	acceptable	Technically feasible	unacceptable	Haulage costs by truck are significantly higher than by conveyer	Discard
			Overland Conveyor from the underground conveyor	acceptable	Technically feasible	acceptable	Potentially lower cost than a second decline, but decline also required for ventilation and secondary egress route.	Assess Further
			Underground Conveying to CPP Site	preferred	Technically feasible	acceptable	Comparable initial capital costs to other options as declines would be required for the Project anyway; long-term economics for winter operations and reclamation would be lower.	Select
Secondary Project Components	Project Access and Transport		Rail	acceptable	BC Provincial rail system provides safe transportation corridors for rail	unacceptable	Would require the construction of a marshalling yard, which would add unnecessary cost to the Project	Discard
			Road	preferred	BC Provincial highways provide safe transportation corridors for heavy trucks	preferred	Alternative is feasible	Select
	Explosives		On-site storage	acceptable	sufficient storage area is available on-site for explosives manufacture and storage	unacceptable	Given the amount of explosives required for this Project, it is uneconomical to manufacture and store explosives on-site	Discard
			Contractor supply and storage	preferred	Technically feasible option	preferred	Given the small amount of explosives required for this Project, it is more economical to contract this service out	Select
	Power	Primary Power Supply	BC Hydro Transmission Line	preferred	BC Hydro 230 kV electric transmission line passes through the Project coal field and can be tied in for the project power supply.	preferred	Captial costs are minimal as less than 2 km of transmmission line would need to be constructed.	Select
			On-site generation (natural gas, coal, wind, etc)	acceptable	Technically feasible. Gas turbine generators or clean coal burning technologies can provide the required power at voltages and frequencies compatible with Chinese equipment.	unacceptable	Capital costs associated with on-site generation may be excessive.	Discard
		Backup Power Supply	Diesel Generators	preferred	Diesel generators are well-established technology	preferred	Alternative is feasible	Select
			Backup power from a separate grid source	unacceptable	Back-up power from a separate grid source is not available at this remote location	unacceptable	Back-up power from a separate grid source is not available at this remote location	Discard

(continued)

Table 4.3-2. Murray River Project Alternative Means Screening Table Based on Basic Technical and Economic Feasibility Criteria (continued)

Project Component			Alternatives	Technically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Economically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Screening Result
Secondary Project Components *(cont'd)*	Coal Processing	Heating Resources for Coal Processing	Natural gas	preferred	Feasible and available locally.	acceptable	Economically viable given current natural gas prices.	Select
			Coal	unacceptable	Although this technology is well-established, this option presents significant permitting challenges.	preferred	Coal would be sourced at the Project.	Discard
		Flotation Tailings	Deposition as conventional slurry into a tailing storage facility (TSF)	acceptable	Conventional method but results in large ponds requiring long-term maintenance after mine abandonment	challenging	Least short-term cost but long-term implications. Long-term water treatment may also be required.	Discard
			Filter press circuit to dewater tailings and allow storage as dry-stack	preferred	Technological advances in tailings dewatering now allow this as a more expensive, but more environmentally responsible option.	preferred	Initially more expensive than tailings dam construction but reduced long-term liability.	Select
	Ventilation		Location of Secondary Shafts					not assessed at this time.
	Water Management	Water source	Murray River	preferred	Sufficient year-round flow, the best option as a back-up to underground seepage.	preferred	Bank-side pump station the easiest to construct.	Select
			Groundwater Wells	challenging	Unlikely to achieve good recovery in shallow well. Deep well would effectively draw from the Murray River.	acceptable	Well construction costs might be higher than a pump/filter station on the banks of the Murray River.	Discard
			Underground Seepage	preferred	Subject to sufficient flow, the best option.	preferred	Pumping from underground with suitable filtration could be used as greywater for toilets, etc. and for process water.	Select
		Sanitary Water Treated Sewage Effluent Discharge Location	Discharge into Murray River	challenging	Technically feasible but would be more difficult to permit.	acceptable	costs differences associated with these options would be minimal	Discard
			Discharge to Septic Area on site	preferred	Currently in place at the Decline Site. A smaller system would be required at the CPP for process workers and for the shaft site where very few workers would actually work.	acceptable	costs differences associated with these options would be minimal	Select
		Contact Water Treatment (TSS)	Gravity settling	unacceptable	Fine-grained particles unlikely to settle solely by gravity; required pond capacity would not be feasible.	acceptable	Least expensive option if space for large pond was not limiting.	Discard
			Filtration	challenging	Technically feasible but would require many filtration units, and high level of manual operation.	acceptable	Operating cost may be high due to requirement for manual oversight.	Discard
			Flocculent	preferred	Currently in place at the Decline Site for Bulk Sample.	acceptable	Operating cost reasonable, particularly once tied to the electrical grid.	Select

(continued)

Table 4.3-2. Murray River Project Alternative Means Screening Table Based on Basic Technical and Economic Feasibility Criteria (continued)

Project Component			Alternatives	Technically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Economically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Screening Result
Secondary Project Components *(cont'd)*	Water Management *(cont'd)*	Treated Water Discharge	Discharge to local creeks (M19, M19A, M17B)	unacceptable	Inadequate streamflow during winter months to accept anticipated discharge from the Project (10 - 50 L/s).	acceptable	costs differences associated with these options would be minimal	Discard
			Discharge to Murray River	preferred	Murray River has dilution and mixing capacity to accept anticipated discharge rates (10 - 50 L/s)	acceptable	costs differences associated with these options would be minimal	Select
	Employment		Use of Temporary Foreign Workers for underground mining	Acceptable	HD Mining has been able to source experienced TFWs.	Challenging	Temporary foreign workers wage rates are identical to local wage rates, but would incur marginally higher overhead due to travel and housing costs.	Select
			Contract Mining	Acceptable	Canadian mining contractors generally will not consider coal mining and do not have experience with longwall methods. International contractors may not be allowed to work in Canada without immigration challenges.	Challenging	FIFO contractors run at about $25,000 per man per month.	Discard
			Use of Canadian workers for underground mining	Challenging	Local workforce is not currently trained for work in longwall mining. Overall, there are very few Canadian underground coal mine workers available in the workforce.	Preferred	Local or immigrant workers living in Tumbler Ridge are the most economical solution.	Select
	Accommodation		On-site Camp	Acceptable	Technically possible to provide the living and leisure facilities for a large workforce at a single site.	Acceptable	Economically challenging because of the construction issues and travel arrangements required to bring workers to site	Discard
			Housing in Tumbler Ridge	Challenging	Challenging because of the lack of housing when coal prices are good and the ability to build additional units for families.	Preferred	Economic burden of housing falls on workers, not employer, with the downside that if no suitable housing is available, a worker may not accept a position.	Select

(continued)

Table 4.3-2. Murray River Project Alternative Means Screening Table Based on Basic Technical and Economic Feasibility Criteria (completed)

Project Component		Alternatives	Technically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Economically Feasible? (preferred, acceptable, challenging, unacceptable)	Rationale (advantages and disadvantages)	Screening Result
Secondary Project Components *(cont'd)*	Non-Hazardous Waste	On-site landfill	Challenging	Feasible if there is appropriate location on-site to accommodate waste over the Project life, soil to cover waste, and managing the site in winter conditions.	Challenging	Land fill operation is not the main business of the company.	Discard
		Off-site landfill	Preferred	Feasible as this is a standard approach to disposal of waste for mines and there are available landfill sites located in the mine site region.	Preferred	Contract waste disposal haulage and dumping fees	Select
		Incineration, and disposal in off-site existing landfill	Acceptable	Incineration of solid waste is technically feasible for many solid waste products (i.e., food waste). Materials such as plastics and rubber would require special high temperature furnaces which are available at additional cost, otherwise they would need to be land-filled.	Challenging	incineration of solid waste would be prohibitively expensive	Discard

4.3.2 Underground Access (Bulk Sample)

Once the mining method was identified, the next major decision required was to determine how to access the coal resource. All underground mines require a minimum of two means of egress; therefore two points of access needed to be identified.

Accessing mineral at depth is accomplished by using either shafts, or declines, or both. All three options were assessed.

Shafts, vertical or inclined, are more expensive, more dangerous to construct, restrict the size of equipment that can be moved, and do not allow continuous haulage of product to the surface.

A decline is less expensive per metre to build, but necessarily longer to achieve the same depth. A major advantage of a decline is that it allows the installation of a conveyor belt which is the most efficient means of transporting material from underground to the surface from depth at high tonnage rates.

In order to achieve the large production rate anticipated for the Project (6 Mtpa), continuous haulage from underground, ease of access for some very large equipment and considerable quantities of ventilating air are key technical requirements. As part of the exploration program for the Project, the bulk sample permit application included construction of both a decline (Decline Site) and a shaft (Shaft Site). Given the cost to construct access down to the coal seams, these features were designed with future commercial mining in mind. As well as providing safe entrance and exit from the mine, these means of access are sized to allow for ventilation, passage of persons and materials, movement of equipment, and movement of coal from underground to the surface. Key factors that governed their siting included:

- surface space requirements within HD Mining's coal licence;
- drivage/sinking distances (shallower depth to coal reduces capital cost);
- avoiding the Murray River flood plain and the potential for water inrush from the other water courses;
- placing the structures close to, but at the periphery of, the resource so that they would not be affected by subsequent mining beneath them;
- close proximity to roads and utilities (e.g., power, gas, rail).

The selected locations of the Shaft and the Service Decline have already been evaluated and permitted as part of Bulk Sample. Decline construction is currently underway.

The remainder of alternatives discussed below are completed in the context of this previous Project decision.

4.3.3 Primary Project Components

Some of the primary Project components that drove engineering decision making related to definition of the preferred Project included: product transport; coal rejects storage; and raw coal transport. Alternatives for these three topics are discussed in the following sub-sections. Once decisions were made around primary Project components, then evaluation of secondary components were considered (Section 4.3.4).

4.3.3.1 Product Transport

A primary requirement of the Project is for 4.8 million tonnes per year of clean coal product to be transported to seaports on the west coast. Potential options for transport include rail and road transport. The trucking option, while technically feasible, is too expensive in terms of total dollars, dollars per tonne kilometre and upgrading costs to roads and bridges to accept the volume of traffic required for the Project. Rail transportation from a dedicated rail loadout is the same method used by the other mining operations in the area and is the selected alternative for the Project.

A rail load was required that connects to the existing CN Rail line located on the east side of Murray River. Siting and design of a loadout is constrained due to the existing loadouts of Peace River Coal (Trend/Roman), and Teck (Quintette). Three options/configurations were evaluated for HD Mining by Ausenco Sandwell (2012; Figure 4.3-1):

1. conventional loop located north of the existing Peace River Coal loadout;
2. tear-drop loop located north of the existing Peace River Coal loadout; and
3. linear loadout that parallels the existing rail right of way.

Each of these options is considered technically feasible. Economics were not substantially different among the options such that a clear preferred option emerged. Ultimately, all three options could be reasonably developed. However, the linear loadout was selected as the preferred alternative because it has the following advantages:

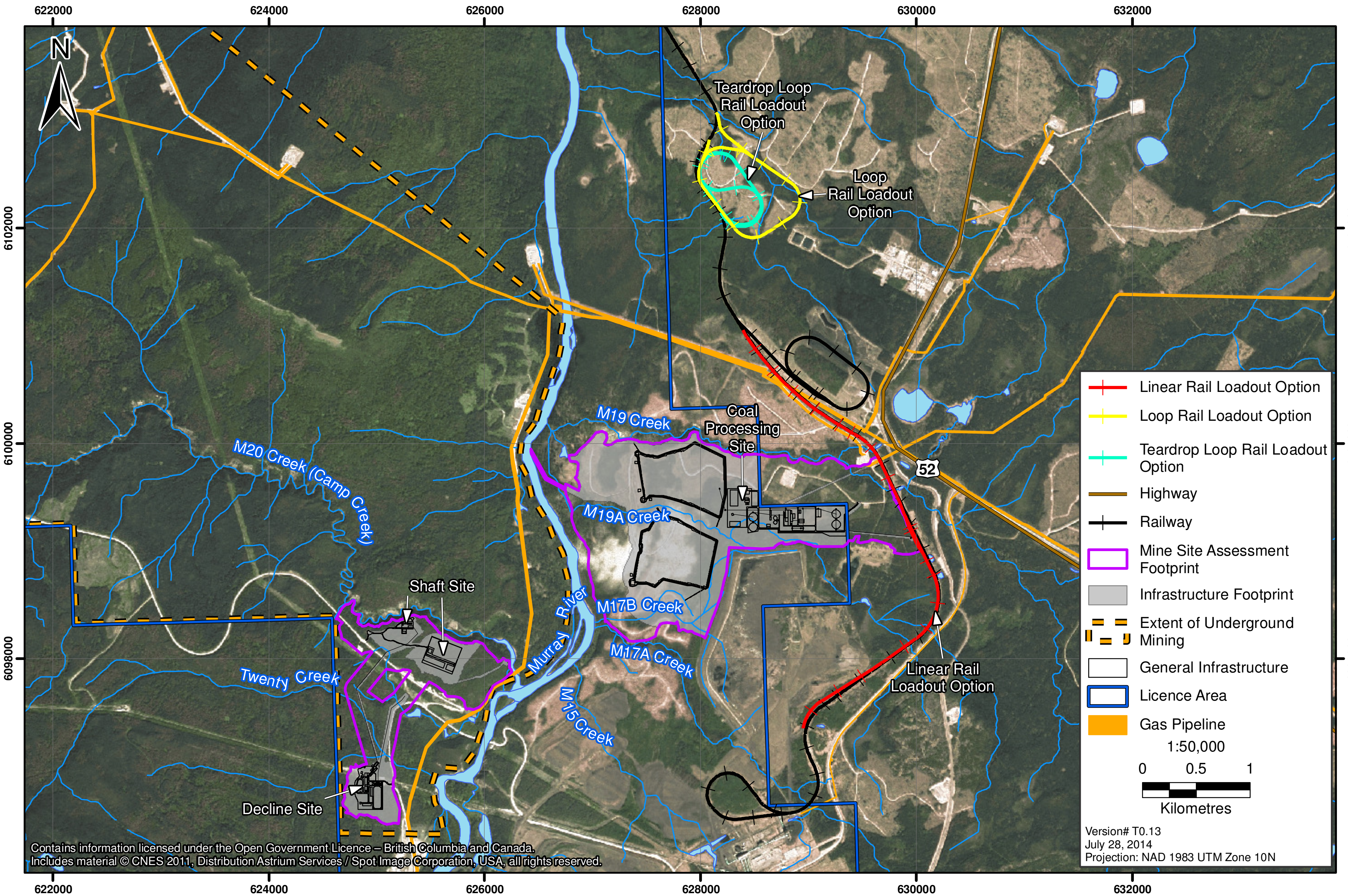
- minimizes new disturbance to vegetation and ecosystems VCs and habitat for wildlife VCs (within existing ROW);
- most efficient loading times;
- preferred loadout method for CN operations;
- stockpiles are located at the plant site rather than at the loadout, which:
  - reduces impact to air quality VCs (fugitive dust) near the rail line
  - concentrates the infrastructure footprint
  - reduces need for duplicate ancillary facilities

4.3.3.2 Coal Reject Storage

Another primary requirement for the Project is adequate space to store the coal rejects that are anticipated to be generated over the mine life.

Figure 4.3-1
Murray River Project Rail Load-out Alternatives

ERM



In order to minimize the requirement for surface storage of materials, the potential for backfilling within the underground mine was considered. Backfilling coarse coal rejects into open areas underground is technically feasible, but very challenging in terms of the infrastructure required to move the material to the required location and insert it efficiently. The only open areas available for backfill would be immediately behind the longwall supports. The process of preparing the material for placement, pumping it and dewatering it once in place, presents severe challenges particularly when multiple seam mining is planned (because mining is going to proceed underneath backfilled areas at a later time). Backfilling is prohibitively expensive and has only been used systematically in state-owned coal mines. The economics would render the Project unviable, and thus it was rejected as an option.

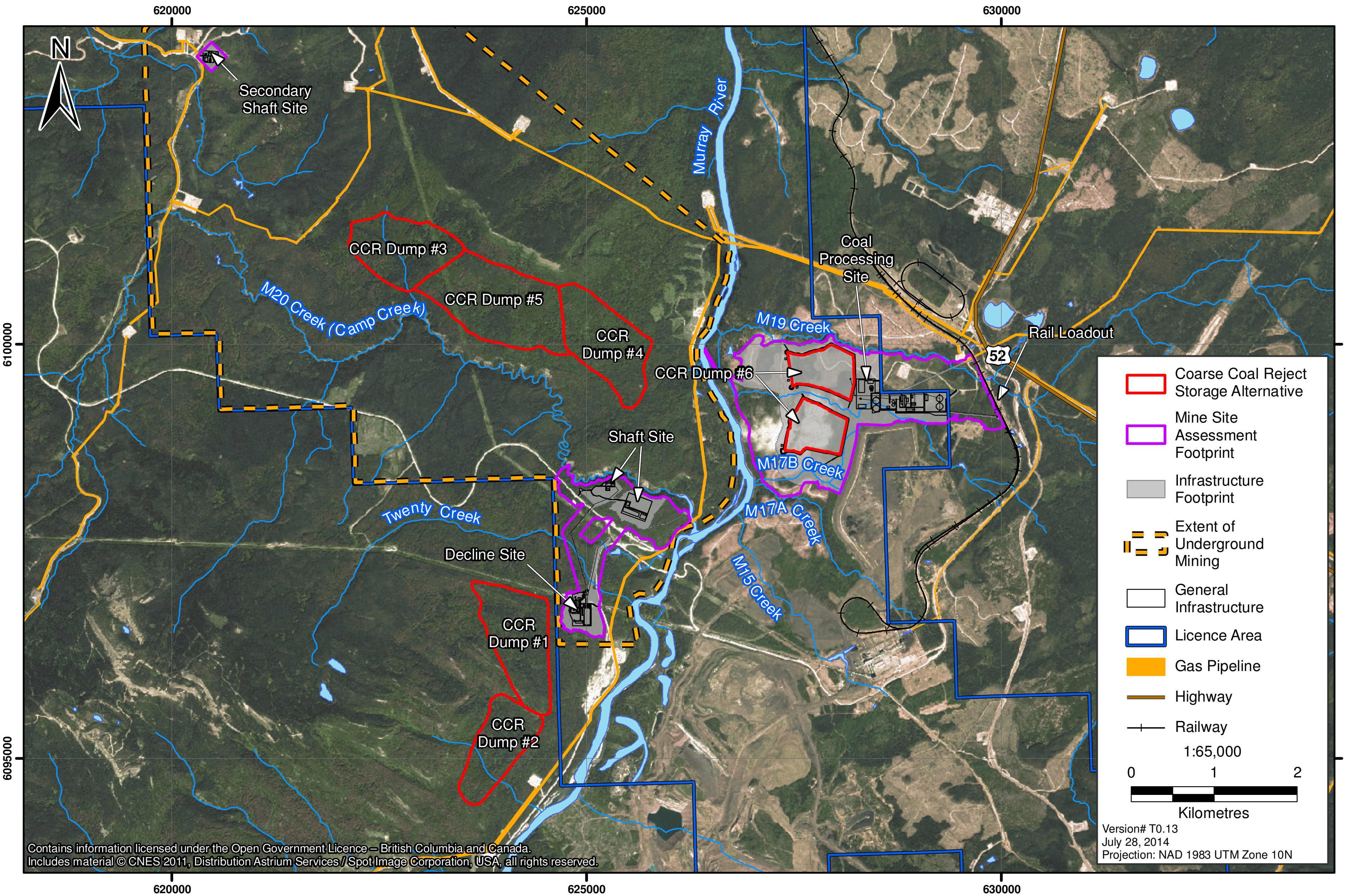
Two surface storage alternatives were considered: on or near the Murray River coal license area (on-site) and at a location away from the coal license area (off-site). While both options are technically feasible, the haulage costs to haul Project waste coal off-site may render the Project unviable, and thus is was rejected as an option.

Based on the need for on-site coal reject storage, mapping was reviewed to identify potential sites, and six options were evaluated (Figure 4.3-2). Each of the options was confirmed to have sufficient space to store the full-mine volume while maintaining reasonable dump heights and slopes (Table 4.3-3).

Table 4.3-3. Summary of Coal Reject Storage Options

Option #	Dump Height (m)	Crest Elevation (masl)	Capacity (Mm^3)	Foundation	Comments
1	110	960	22.5	Till blanket and glacio-fluvial.	Short haul from Decline Site. Can be expanded to the west. Outside HD Mining coal license area.
2	80	900	18.4±	Till with organic cover.	Slightly longer haul that Option 1. Organics to be removed. Can be expanded to west. Outside HD Mining coal license area.
3	130	1175	21.8±	Till blanket.	Requires new road and bridge across M20 Creek and longer haul. Can be expanded to north.
4+5	60 - 120	< 1160	22.5+	Till blanket.	Requires new road and bridge across M20 Creek. Can be expanded to northeast.
6	60	860	17.4	Glaciofluvial and till deposits.	Located on east side of Murray River, near rail loadout. Constrained by Teck Old Tailings pile; M19, M19A, M17B Creeks.

Figure 4.3-2
Coal Reject Storage Location Alternatives



Options 1 and 2 are located adjacent to the Decline Site, and would support a short haul distance (if the coal preparation plant was located at the Decline Site), making them economically attractive options. However, they are both located off HD Mining's existing coal license, so additional license would need to be secured. Relatively large areas of forest clearing would be required for these options (92 ha for Option 1; 68 ha for Option 2). Road building and forest clearing would have resultant effects to wildlife habitat, and could potentially affect rare and endangered species (vegetation and wildlife VCs). In particular, for Option 1, the dump would be located immediately upslope of Project infrastructure at the Decline Site, which would increase risk to facilities in the event of a slope failure (terrain VC).

Options 3, 4, and 5 would require pioneering new access into an area north of M20 Creek, and would require a longer haul from the Decline Site. Relatively large areas of forest clearing would be required, particularly for Option 5 (83 ha for Option 3; 91 ha for Option 4; 134 ha for Option 5). Road building and forest clearing would have resultant effects to wildlife habitat, and could potentially affect rare and endangered species (vegetation and wildlife VCs). These areas are over top of planned mining areas, therefore their design would need to take into account potential effects of subsidence, which is possible, but would increase risk of slope failure (terrain VC).

Option 6 was identified because it is close to the rail loadout facility, and within HD Mining's coal licence area. The topography is relatively gentle, except in the creek gullies that cross the site. It is amenable to siting a coal preparation plant upslope of the coal rejects pile (compared to Option 1), between the pile and the rail loadout. The area has been recently logged; therefore less forest clearing would be required than for Options 1 to 5 and this option would have a lower impact to wildlife habitat (vegetation and wildlife VCs). The site is easily accessed along a decommissioned logging road. The site is also immediately adjacent to Teck's Quintette site. This concentrates new activity in an area that has already experienced disturbance (reducing potential effects to ecosystems and habitat VCs, and reducing likelihood of impacts to recreational and hunting/trapping land uses). M19, M19A and M17B creeks are considered fish bearing; however, there is sufficient space to site the piles while maintaining setback distances from the creeks.

Option 6 was identified as the preferred alternative; however, it would only be feasible if the coal preparation plant was located on the east side of Murray River (rather than at the Decline Site), and if a suitable means of transporting raw coal to the east side of Murray River could be developed.

4.3.3.3 Raw Coal Transport

Raw coal transport to the CPP begins at the coal face where it is loaded onto conveyors which move the coal through the mine, to the surface, and then to the CPP. Potential alternatives considered for the Project were:

1. to haul the coal to the surface at the Decline Site and truck it to the CPP;
2. to haul the coal to the surface at the Decline Site and then to use an overland conveyor to the CPP; or
3. to convey the coal in a second decline constructed from near the base of the shaft under Murray River and directly to the CPP site.

While technically feasible, trucking from the Service Decline over to the CPP presents significant extra cost to the Project, as nearly 450 round trips a day would be required. This haulage volume would involve capital investment in a fleet of trucks and an additional river crossing, ongoing expenditures related to fuel and Project staff, plus additional closure costs related to closing and reclaiming any additional roads and crossings required. This option was discarded from further consideration based on economic considerations.

The Project Description document submitted to CEAA in March 2013 (Rescan, 2013) included a site layout with an overland conveyor to deliver raw coal from the Decline Site across Murray River to a coal preparation plant adjacent to the rail loadout (Figure 4.3-3). This conveyor would be similar to the one that was used by Teck to convey material from the Mesa pit to their processing plant. Although this option is both technically and economically feasible, it would have potential impacts to the shoreline riparian vegetation community, effect wildlife corridors that currently exist along the Murray River valley, and potentially interfere with a known archaeological site along the river bank. The crossing over the Murray River may also increase the regulatory requirements of the Project in relation to navigability of the river and serious harm of fish habitat. As well, the chances for an accidental release of coal into the Murray River would be increased. These effects may be difficult to mitigate during the construction and operation of the Project.

HD Mining also evaluated an option of constructing a second decline with a portal located on the east side of Murray River at the coal preparation plant, angled down to intersect near the base of the Shaft. This option would eliminate the effects to vegetation and ecosystems, wildlife, archaeology and heritage that an overland conveyer would potentially incur, but it would interact with groundwater resources and have potential for in-rush of water. However, at a 16° slope, the decline will be approximately 350 m below ground when it crosses under the river. Mining a tunnel under a river is technically feasible, and, for example, was completed for the Quinsam mine here in BC.

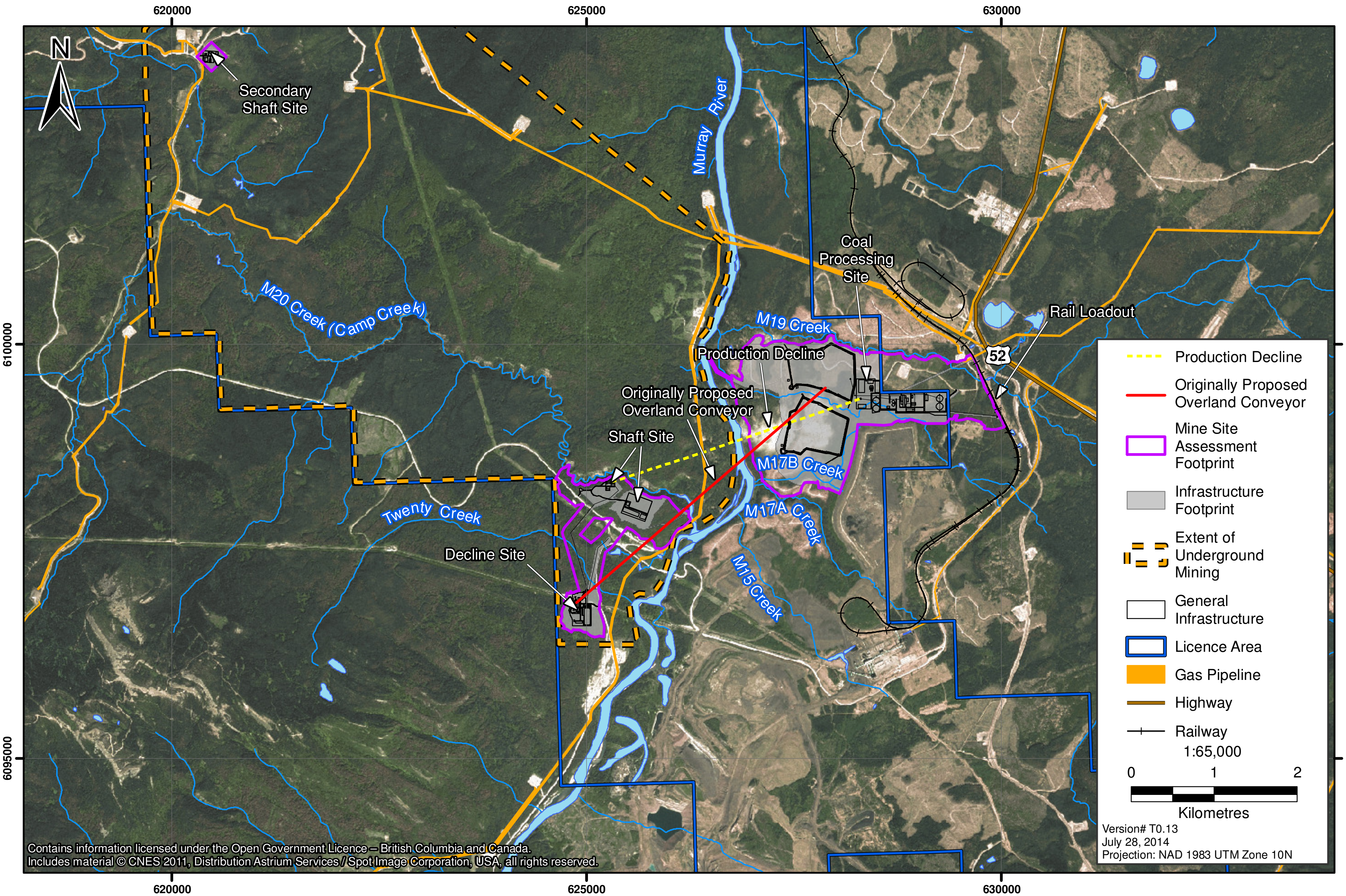
The second decline option is not just an alternative to raw coal transport. It represents a fundamental change to the Project design, because it creates a new access from surface down to the coal. This has important implications for underground mine design in terms of options for secondary egress, ventilation, and movement of personnel/equipment. Overall, there is a substantial cost associated with constructing a second decline; however, this is somewhat offset by other project changes. For example, the second decline means that hoisting is no longer required at the shaft, and as a result, the required diameter of the shaft can be decreased. Ultimately HD Mining determined that the second decline option is economically feasible, and is considered a better and safer mine design. Thus it was selected as the preferred alternative for raw coal transport.

4.3.4 Secondary Project Components

With the preferred primary Project components identified, alternatives to a number of secondary Project components were considered, including:

- project access and transport;
- explosives;
- power;

Figure 4.3-3
Raw Coal Transport Alternatives



- coal processing;
- ventilation;
- water management;
- employment; and
- accommodation.

4.3.4.1 Project Access and Transport

Two methods were considered for transportation of materials, equipment, supplies and personnel to and from the project; rail and road transport. Transportation to the site by rail would involve construction of a marshalling yard at the rail head which would increase the footprint of the infrastructure. All the other mines in the area are served by road transportation (i.e., trucks, flatbeds and light vehicles) and the existing road system can be used for Project traffic as-is (i.e., no upgrades are required).

The selected alternative for the Project is to use road transportation with trucks to deliver materials, equipment and supplies, and to transport personnel to the site.

4.3.4.2 Explosives

Very limited use of explosives is planned for the Project. Most of the mining, including the main tunnel systems, will be within the coal seams, where use of explosives is not necessary. Small amounts of explosives may be required when constructing the Production Decline, excavating rock tunnels, and when mining between coal seams.

Two methods were considered for explosives storage and use: on-site storage; and contractor supply and storage. Both options are technically feasible. However, given the sporadic nature and small amount of explosives required, contractor supply and storage is the most economic option.

When blasting is required, a local blasting company will be contracted to provide the necessary explosives and conduct the blasting. Strict safety procedures will be in place to ensure that areas are clear before any blasting occurs. All blasting will be conducted by qualified persons in a manner consistent with the Health, Safety and Reclamation Code for Mines in British Columbia.

The selected alternative for the Project is to use a contract company to supply explosives when required.

4.3.4.3 Power

<u>Primary Power Supply</u>

Two options were considered for the primary power supply; the BC Hydro provincial Grid or an on-site dedicated power plant.

Both options are technically feasible: the existing BC Hydro 230 kV electrical transmission line passes through the Project coal field, and coal- or natural gas-fuelled generators are well-established technologies. However, the initial capital costs to construct a generator would be uneconomical, and permitting such a plant may be challenging particularly as Hydro power is readily available. The existing BC Hydo grid 230 kV line already serves local mining operations, and it currently has capacity to support the Murray River Project. The line runs across the Murray River licence area.

The selected alternative for the Project is to use the BC Hydro Grid as the primary power supply.

Back-up Power Supply

A back-up power supply is a regulatory requirement for fans and safety systems, and is a best practise requirement to maintain critical equipment in the event of a main supply failure. Two options for back-up power were considered: stand-alone diesel generators and backup power from a separate grid source. Given the relatively remote location of the Project, there is no separate grid source available. Diesel generators are a well-established technology.

The selected alternative for the Project is to use stand-alone diesel generators as back-up power.

4.3.4.4 Coal Processing

Two alternatives with environmental implications that were evaluated for coal processing included:

- heating source for coal drying; and
- flotation tailings handling.

Heating Source for Coal Drying

Although great care is taken to limit the water content of the coarse coal fractions from the process, the finer clean coal streams inevitably entrain more water and must be dried to ensure a product leaving the mine that is within acceptable water content limits.

Coal dryers require an energy source, and the two most efficient candidates are natural gas, which occurs in a number of existing pipelines through the area, and coal, which is the substance being mined. Coal burning dryer plants are built and used, and have the benefit of using the less valuable coal products (middlings/tailings) to produce heat. However, a plant built to burn coal would be challenging to permit in BC due to air quality and greenhouse gas considerations.

A more suitable option is to use locally available natural gas to fire the coal dryer. Greenhouse gas emissions are low compared to using coal and treatment of exhaust is much more straight-forward; thus, permitting would be less challenging.

The selected alternative for the Project is to use natural gas as the fuel source for the coal dryer.

Flotation Tailings

Flotation tailings are one of the by-products of all conventional metallurgical coal plants. Two alternatives are possible for the processing of flotation tailings: disposal of tailings slurry behind a conventional impoundment; or filtration of tailings to allow disposal by dry-stacking.

Historically the only available method of disposal has been to impound the tailings slurry behind impermeable structures (i.e., a tailings storage facility [TSF]) and let the water drain from it, leaving a relatively dry waste material in the impoundment. Tailings storage facilities can become quite large and require long-term maintenance after mine closure. These facilities are typically low cost to operate as no processing of the tailings would occur. However, the long-term economic implications of this disposal methodology, related to the cost of construction, and closure of the TSF, potential water treatment requirements, and long-term maintenance requirements can be very costly.

Technological advances in filtration and drying systems have resulted in methods which are capable of filtering tailings rejects and producing nearly clean water and a solid with about 10% moisture, which is suitable for above-ground dumping in stable waste dumps. This process results in tailings that can be "dry-stacked". In the case of the Project, filtered tailings would be co-mingled with the CCR and stored in a single waste facility. While initial capital costs are greater because of the investment in filtration and drying equipment, the incremental operating and closure costs would be minimized.

The selected alternative for the Project is filtration of flotation tailings for co-disposal with the CCR in a waste dump.

4.3.4.5 Ventilation

The location of the initial ventilation shaft is described above in Section 4.3.2. After several years, underground mining will have progressed to the north-east side of the mine plan (Blocks 3 and 4). As the underground tunnels increase in length it becomes more difficult to push sufficient air through them for safety because the friction between the air and the tunnel walls increases. Pushing more air makes it travel faster which increase the friction, which increases inefficiency (i.e., requires more energy).

Providing additional shafts at the north-east extent of the mine will allow for more efficient ventilation and provision of adequate air quantities to maintain safety. The location of the shaft sites is dictated by the location of the workings, the protection of the shafts from ground movements associated with extraction, sufficient area to develop them and clearance from water courses and other infrastructure such as gas lines and roads. No specific alternatives have been evaluated at this time. The surface footprint required for the Secondary Shafts is small, and it is not expected that alternate locations will substantially impact biophysical VCs (e.g., ecosystems, habitat). The current location has been designed to fit within the mine plan; however, as the shafts are not required until 15 years into the mine life, their location will be regularly re-evaluated over time to ensure they remain relevant to the mine plan, and also to other future developments in the area (e.g., gas lines and roads).

4.3.4.6 Water Management

Water Source

Three water sources were evaluated for the Project: recycled contact water; the Murray River, and groundwater wells. All three sources will be used in various combination for the Project.

A groundwater supply well has been installed at the Decline Site to support Bulk Sample activity. Water from this well may continue to be used to support water demand during Construction, or for the sewage treatment system and the Decline Site. Groundwater wells may be considered for the Coal Processing Site; however, drilling that has been completed during site investigations to date suggests poor recovery.

The CPP has a zero discharge flowsheet, with water being recycled back within the circuit. Ultimately the plant runs a deficit water balance as moisture is lost to evaporation and with the coal product.

The Water Management Plan for the Project has been developed to maximize recycling of contact water within the Project. This includes re-use of groundwater inflows to the underground mine for dust suppression efforts, and preferential use of CCR runoff/seepage collection as make-up water to the CPP.

Even with the above measures, it is expected, particularly during the first half of mine life, that additional water will be required as make-up to the CPP. Demand is dependent on the rate of groundwater inflow to the underground mine, and the contact water supply on surface is seasonally variable. It is predicted that demand will be up to 2,300 m^3/d. With poor recovery expected from groundwater wells at the CPP, the Murray River is the only viable water source that can be relied upon to consistently provide Project demand.

The selected alternative for the Project is to recycle contact water as much as possible, and to use Murray River as the water source with make-up demand is greater than recycling can supply.

Sewage Effluent Discharge

Selecting the sewage treatment methodology and discharge location/type revolves primarily around technical criteria on type and flow levels of sewage requiring treatment, site conditions, and effluent discharge requirements. Economic criteria on capital and operating costs may be a secondary factor. Two locations will require sewage management during the life of the Project: the Decline Site (224 m^3/d), and the Coal Processing Site (56 m^3/d). These systems will be regulated by the Municipal Wastewater Regulation (BC Reg. 87/2012) under the jurisdiction of the *Environmental Management Act* (2003). Type 1 in-ground septic systems are planned, and are expected to be feasible based on soil conditions observed during site investigations to date.

An alternative possibility would be to discharge sewage effluent directly to Murray River; however, the company is not evaluating this as a required option at this time.

The selected alternative for the Project is to in-ground septic systems for sewage management.

<u>Contact Water Treatment Method</u>

Contact water will be collected in ponds at each of the Decline Site, Shaft Site, and Coal Processing Site (CPP Pond). Current water quality predictions (Appendix 8-E) show that treatment for dissolved parameters prior to release is not required, however, contact water will be treated for TSS prior to discharge to ensure permit criteria are met.

Sediment ponds are the simplest form of treatment (passive settling), and where settling time allows, this will be used as the preferred treatment option.

However, sources of TSS (underground inflow, CCR seepage, stockpile runoff) are expected to generate very fine grained sediments that will not settle by gravity without use of settling aids. This is currently the case at the Decline Site, where active flocculent treatment is being used to manage water generated from within the decline.

Filtration has been considered as an alternative treatment method; however, it has been rejected for technical reasons, due to likelihood of clogging, and a requirement for very frequent manual filter changes.

Flocculent treatment systems are well established and cost effective solutions, and thus are the preferred alternative. The system is adaptable to changing conditions. For the Bulk Sample, water is currently being treated with a flocculent called Hydrex; testing has also been successful with a Magnafloc product. However, this has all been in overburden rocks. As the Bulk Sample progresses into the coal seams, further testing will confirm the most appropriate flocculent product and optimal dose rate.

The selected alternative for the Project is to use a flocculent treatment system for managing TSS prior to discharge to the receiving environment.

<u>Treated Water Discharge Location</u>

Two water discharge locations have been sited and permitted associated with Bulk Sample activities:

1. discharge from the Decline Site pond to ground via an exfiltration gallery; and
2. discharge from the Shaft Site pond to M20 Creek.

It is anticipated that these discharge locations will continue to be required during Construction, but that they can be reclaimed early in Operation.

During Operation, water management is focussed at the Coal Processing Site. As described for Water Source alternatives above, efforts to maximize the recycling and re-use of contact water have been built into the Water Management Plan. This will help to minimize the volume of water that requires treatment and discharge. As described in Section 3.6.3.8, it is estimated discharge rates over the mine life will range of between 10 to 55 L/s. The local creeks (M19A, M19, M17B) do not have sufficient natural streamflow during the low flow periods to support discharge of this magnitude. Given that these creeks are fish bearing, it would be difficult to permit discharging to these creeks without requirements for 'offsetting' fish habitat. While technically feasible, this was rejected as it would not be an environmentally, nor economically prudent choice when compared to an option for direct discharge to Murray River (the ultimate receiving environment of discharge to a small creek anyways).

The preferred option is to discharge to Murray River from the right bank, a short distance upstream of M19 Creek. To assess mixing of effluent discharge into Murray River from the Coal Processing Site, a MIKE3 hydrodynamic model was developed (Appendix 8-F). Four potential discharge sites were modelled. Ultimately, even at very low flow conditions, Murray River has adequate dilution and mixing capacity that many potential discharge locations could be reasonably selected. In order to minimize potential effects to the river associated with instream works and the installation of discharge infrastructure, a site was selected where the flow naturally comes to the right bank, even during low flow conditions.

The selected alternative for the Project is to discharge treated water to Murray River.

4.3.4.7 Employment

The alternatives identified to source the Project workforce are: to staff the mine with temporary foreign workers (TFWs) already skilled in the methods and the use of equipment; to use mining contractors; or to employ and train Canadian workers. All three options are technically feasible, but all present significant economic challenges.

HD Mining will be utilizing a mechanized long-wall mining construction method that is not currently used in Canada. There is only one other underground coal mine currently operating in BC, and it utilizes a room-and-pillar method. In eastern Canada the last underground longwall coal mine closed in 2000. Finding a trained workforce for a new underground coal mine employing a technology not seen in Canada for nearly 20 years may not be possible.

Temporary foreign workers are utilized by the natural resource sector where there is a significant shortage of skilled labour. All of the TFW's required for this project would be required to have experience in underground coal mining. Although TFW are paid at rates equivalent to Canadian workers, they are housed, fed and transported between their home base and the work site at the employer's cost.

Although Canada has a number of available mining contractors, none of them have any experience in longwall coal mining and none have expressed an interest in locating employees for such work. Like TFW, these workers must be housed, fed and transported, although their rotations are considerably shorter (in the order of weeks) than current TFW rotations.

Training a new workforce presents considerable challenges, not just for equipment operators but more importantly for the skilled mechanics and electricians who must be trained to recognise and mitigate hazardous conditions of methane and coal dust where they work. TFW are being used during the development of the decline and the collection of the bulk sample, and their continued use alongside Canadian workers undergoing training is planned. HD Mining intends to utilize the services of TFWs for a period of ten years with the target of replacing 10% of the TFW workforce with locally-sourced workers per year. HD Mining is committed to training Canadians for the specialized work in underground mining. Ultimately, all but a few underground workers and professionals will return home when a locally-sourced workforce is trained.

The selected alternative for the Project is to employ TFW's for the underground mine development until a locally trained workforce can be developed.

4.3.4.8 Accommodation

The two alternatives for workforce accommodation considered are an on-site camp and local housing in Tumbler Ridge.

On-site camps are widely used at remote mine sites and experience in northern BC and Alberta has shown that it is technically possible to provide the living and leisure facilities for a large workforce at a single site. The ability of regulated camps to limit access to drugs and alcohol (which can cause safety issues at the workplace) is also an advantage. However, camps are expensive to build and run (contract options are available) and they isolate local communities from the wider economic benefits of the industry. Their environmental footprint is outside of established communities' water, sewage and safety services resources and as such they present a significant drain on the resources of the local area. Camps are essentially temporary structures ideal for short periods of intense construction activity but are not suited for long term (in this case, 30 years or so) habitation without significant repair/overhaul.

Housing of the workforce in Tumbler Ridge, whether in privately built accommodation or company built accommodation for purchase or rent is the preferred option. Company built housing purchased by employees will have a residual value and provide wealth generating opportunities in a long term mining community, although history suggests that such wealth generation is cyclical. Workers do better emotionally and physically if they are at home, and the influx of families as the workforce expands will provide additional economic stimulus to the area. HD Mining has invested $15 million to develop worker housing in Tumbler Ridge, building duplex houses. This is the single largest residential development in the history of Tumbler Ridge

The selective alternative for housing the Project workforce is to accommodate them in Tumbler Ridge.

4.3.4.9 Non-Hazardous Solid Waste

Three alternatives were considered for the disposal of solid, non-hazardous wastes: an on-site landfill, an off-site landfill, and incineration followed by ash disposal in an off-site land fill.

An on-site landfill is feasible if there is an appropriate location on-site to accommodate waste over the Project life. In addition, there must be equipment and management structures available to excavate, fill, maintain and remediate the landfill over its lifetime. In order for this alternative to be acceptable there has to be an appropriate site on the property to place the landfill. The construction and operation of a landfill requires specialized expertise, and this would have to be sourced externally.

Resident expertise already exists at the land fill sites in surrounding areas, and commercial trucking and disposal of Project non-hazardous wastes will add to the local economic benefits

Incineration of solid waste is technically feasible for many solid waste products (i.e., food waste). Materials such as plastics and rubber would require special high temperature furnaces which are available at additional cost, otherwise they would need to be land-filled. Permitting a garbage incinerator would be very challenging.

Off-site commercial land filling of Project non-hazardous wastes is the selected alternative.

4.4 SUMMARY OF ALTERNATIVES ASSESSMENTS

Alternative assessment included a decision-making process that started with screening the alternatives to identify the feasible alternatives based on technological and economic considerations. These feasible alternatives were assessed by balancing the advantages and disadvantages of each using criteria that incorporates VCs for the natural environment, human environment and reclamation.

While a number of alternatives were investigated as part of the options analysis, the current Project configuration minimizes environmental impacts, optimizes construction and operating costs, as well as meeting logistical requirements of operating a mine. This preferred configuration is the basis of the Project Description (Chapter 3) and the subsequent environmental impact assessment.

REFERENCES

2012. *Canadian Environmental Assessment Act, 2012.* SC. C. 19. s. 52

CEAA OPS. *Operational Policy Statement Addressing "Purpose of" and "Alternative Means" under CEAA 2012*. December 2013