SITE C CLEAN ENERGY PROJECT

WEST PINE QUARRY DEVELOPMENT PLAN

Prepared by

Klohn Crippen Berger Ltd. and SNC-Lavalin Inc.

For

BC Hydro

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1. Introduction and Purpose

The construction of the proposed dam and generating station at Site C would require approximately 869,100 m^3 of high quality permanent riprap rock (594,500 m^3 riprap and 274,600 m^3 riprap bedding). Riprap rock would be required from Year 1 until Year 7 of the project construction. A detailed description of the project components and activities is provided in Volume 1 Section 4 Project Description.

Based on the available geotechnical studies, the West Pine Quarry was identified as the closest source of acceptable riprap for the permanent dam site structures for the Project. The West Pine Quarry is located 75 km southwest of Chetwynd along Highway 97. It is approximately 162 km by highway and 149 km by rail from the dam site area. The inset in Figure 1.1~~Figure 1.1.1~~ shows the location of the West Pine Quarry.

The objectives of this plan are to:

1) Facilitate environmental assessment approvals

2) Support permitting requirements

3) Plan for guiding the use of the quarry site during construction and operation

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2. Background

The British Columbia Ministry of Transportation and Infrastructure operates an active quarry on crown land under a map reserve, file number 8005674. In order to expand the quarry, BC Hydro applied for and was granted two map reserves for the purpose of quarrying by the British Columbia Ministry of Forests, Lands and Natural Resources Operations, file numbers 8003167 and 8003168. These quarrying tenures and extent of the proposed expanded West Pine Quarry are shown in Figure 1.1.

As shown in Figure 1.1~~Figure 1.1.1~~ quarrying operations would overlap on Ministry of Transportation and Infrastructure and BC Hydro tenures. The Ministry of Transportation and Infrastructure and BC Hydro have agreed that BC Hydro can develop the lower ridge along the Canadian National Rail line as well as stockpile and load in areas contained within their map reserve tenure. Coordination between the Ministry of Transportation and Infrastructure and BC Hydro regarding quarry development is ongoing.

The West Pine Quarry can be accessed by Highway 97 and Canadian National Rail as both are parallel to the southern boundary of the quarry. There is also a rail siding along the southern boundary of the quarry, as shown in Figure 1.1.

Field investigations and evaluations identified the rock to be a highly metamorphosed limestone with high strength. The limestone unit contained two intersecting joint sets yielding a blocky appearance; dip and dip direction of the joint sets were approximately 70-80°/090° and 30-35°/225°. Joint spacing ranged from 0.3 m to 3.0 m. The average rock density was about 2,700 kg/m³, which is an adequate density value for permanent riprap.

A preliminary and conservative estimate indicates that about 3,000,000 m^3 of riprap could be obtained from the quarry which exceeds the required estimated 869,100 m^3.

For the Project, only the larger riprap product and a smaller amount of riprap bedding would be used. All other rock material would be considered surplus. The surplus material and the remaining intact bedrock, however, would be available for use by Ministry of Transportation and Infrastructure. Storage of the surplus material is an important consideration for Ministry of Transportation and Infrastructure.

Following construction, the West Pine Quarry would continue as an active Ministry of Transportation and Infrastructure quarry.

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The West Pine Quarry may be used as a source of riprap during the operations phase of the Project, if riprap on the dam, generating station or spillway require repairs in the future. Small quantities of riprap for could be purchased from the Ministry of Transportation and Infrastructure. If more material is required in the future than the Ministry of Transportation and Infrastructure could supply under its permits, a separate permit would be obtained by BC Hydro at that time.

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3. Input Information

This Plan has been developed based on the following information:

- Approximately 869,100 m^3 of high quality permanent rock riprap (594,500 m^3) and riprap bedding (274,600 m^3) would be required for the Project
- The diameter of permanent riprap would range between 300 mm and 1,200 mm and riprap bedding would range between 40 mm and 150 mm. Approximately 35% of the riprap would be equal to or larger than 600 mm in size, and the balance 65% would be less than 600 mm
- The yield of useable riprap is estimated to be 30% by weight. Therefore, on average, the total weight of rock excavated would be 3.33 times the weight of riprap required
- Riprap bedding materials would be screened from the coarser surplus material after riprap selection
- Bulking factors (the volume ratio of disturbed material to in-situ material) for rock and overburden are expected to be 1.6 and 1.2 respectively
- Densities are estimated as: 2.70 tonne/m^3 for in-situ rock; 1.9 tonne/m^3 for riprap; 2.20 tonne/m^3 for riprap bedding; and 2.0 tonne/m^3 for surplus material
- Processed riprap and riprap bedding would be hauled either by highway legal haul trucks or by Canadian National Rail. If hauled by rail to the dam site area, riprap and riprap bedding would be unloaded and stockpiled at Septimus Siding. If hauled by trucks, it is expected that 75% of the riprap and riprap bedding would be hauled directly to the structures for placement; the balance would be unloaded and stockpiled at Septimus Siding for future transferring to the structures
- Wastage quantities were calculated based on riprap haul by rail since rail haul would result in additional breakage from increased handling. Material wastage due to stockpiling, handling, over-building and hauling are estimated to be 15%, and 20% for riprap and riprap bedding, respectively

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- Based on field observations, riprap up to 600 mm in diameter is stockpiled and large rock blocks, up to 1,200 mm in diameter, are available in limited supply

- Based on field observations, the thickness of overburden is less than 500 mm deep

- 1,600,000 m^3 of in-situ rock would need to be excavated in order to produce the permanent riprap and riprap bedding for the Project. After selecting and removing riprap rock, the remaining 1,150,000 m^3 of rock material would be stockpiled at West Pine Quarry for future use by others

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4. West Pine Quarry – Operations

4.1 Production and Scheduling Estimates

According to the Project schedule (see Volume 1 Section 4 Project Description), riprap would be placed within the dam site area from Year 1 through Year 7. Table 4.1 summarizes the annual quantities of riprap placed at the dam site.

Table 4.1 Annual riprap placement and production schedule

Description	Unit	Year of Construction								Totals
		Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	
Permanent Riprap and Riprap Bedding Placed at the dam site										
Riprap and Bedding	m^3	42,000	22,000	51,000	117,000	70,000	147,000	419,000	-	869,100
Potential Corresponding Production at West Pine										
Total In-situ Rock	m^3									1,600,000
Total Surplus Rock	m^3									1,150,000

Note: This schedule is based on Project planning at the time of preparation of the Environmental Impact Statement and could change as a result of procurement and project planning advancements.

In order to meet riprap requirements in Year 1, quarry development and riprap and bedding production would begin as soon as the Project receives environmental certification. If it is not possible to produce rock for Year 1, riprap would be purchased either at West Pine from the existing Ministry of Transportation and Infrastructure operation or from another source.

Twenty-six months (10 hours per day, 6 days per week) would be required to produce the total volume of riprap and bedding at West Pine Quarry. This work would not be continuous and it is expected that riprap production would occur mainly in the summer months.

Riprap would be produced to meet the dam, generating station, and spillways construction schedule. Contractor preferences would determine how to produce rock riprap to meet this schedule.

4.2 Quarry Development and Layout

The proposed West Pine Quarry area for the Project is shown in Figure 1.1~~Figure 1.1.1.~~ The major components of the West Pine Quarry include:

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Stockpiles

- Two temporary loading stockpiles for riprap and riprap bedding would be located adjacent to the rail siding prior to loading into rail cars or haul trucks
- Surplus material unsuitable for Project construction would be stockpiled for use by others. Surplus materials may also be disposed of along the excavated benches
- The Ministry of Transportation and Infrastructure would continue quarrying during the Project construction, this stockpile area is reserved for their work

Rock excavation area

- The direction of rock excavation would be from the north-west corner of the existing area along the Canadian National Rail toward the body of the mountain
- The quarrying benches would be 10 m high with an 8 m wide berm
- Rock blasting would be designed to minimize blasting disturbance of the final wall to minimize rock fall

Area for access improvement

- Twenty-eight rail cars would be required to haul riprap daily from the West Pine Quarry to the dam site area during peak periods, requiring 430 m of rail siding. The current rail siding is approximately long enough for loading a 28 car train. However, the siding may be extended within the quarry to increase capacity

Additional on-site structures

- Haul roads would be constructed within the site to suit the 40 tonne rock trucks
- Supporting infrastructure such as office trailers and maintenance areas would also be on site

4.3 Activities of Quarry Operations

The quarry operations at West Pine would include the following activities:

- Build haul roads within the quarry at different elevations leading to the benches to be quarried
- Clear the area to be quarried

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- Grub and strip stumps and topsoil
- Mobilize equipment and setup riprap plant
- Drill and blast
- Excavate, haul, select, and feed rock to grizzly and screening plants
- Hoe ram oversized rock, if any
- Stockpile processed final riprap and bedding material to be hauled to the dam site area
- Stockpile surplus materials
- Load rail cars or trucks
- Reclaim the site at completion

4.4 Equipment for Quarry Operations

The major equipment required for the quarry operations would be as follows with the number of equipment pieces to be determined at a later stage:

- Loaders (to feed riprap plants, stockpile material, load trucks and rail cars)
- Bulldozers (to stockpile materials)
- Rock drills
- Grizzly or riprap plant
- Highway legal haul trucks transferring material within quarry site
- Rail cars and locomotives (rail option) or highway legal rock haul trucks (truck option), to transport riprap rock final products to the dam site
- Water trucks (to control dust as required)
- Personnel site pick-ups (for onsite mobility)
- Service vehicles (mechanic, fuel trucks)

4.5 Quarry Access

Access to West Pine Quarry is currently limited by Ministry of Transportation and Infrastructure. Access would be either closed to the public or controlled during quarrying operations. Safety issues on the site would be related to the increased traffic and blasting within the quarry operation.

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The quarry can be accessed by both Highway 97 and Canadian National Rail. If the riprap and bedding are transported by rail, the material would be loaded at the existing siding on site and transported to the dam site area and unloaded at Septimus Siding. If the riprap and bedding are transported by truck haul, the route would be limited to the public roads from the quarry area to the dam site, namely Highway 97, Jackfish Lake Road, and the Project Access Road.

4.6 Safety and Environmental Management during Operations

The quarry is an existing operation run by Ministry of Transportation and Infrastructure and would be operated in a consistent manner. The quarry operations would follow the Province's Aggregate Management Principles that have been established to ensure that aggregate activities are undertaken in compliance with health and safety standards and environmental protection requirements. The reference documents are:

- Aggregate Operators Best Management Practices Handbook for British Columbia, 2002, Ministry of Energy and Mines (MOEM 2002)
- Health and Safety: A Practical Guide for Aggregate Operations, 2007, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM 2007)

In addition, the quarry operations at West Pine Quarry would:

- Comply with applicable environmental management plans outlined in Volume 5 Section 35 Summary of Environmental Management Plans
- Minimize clearing to the areas to be used for quarrying
- Source blasting materials from specialized suppliers. Blasting activities would be undertaken in accordance with WorksafeBC, the Explosives Act (Canada), the Transportation of Dangerous Goods Regulations (Canada) and the Motor Vehicle Act (BC)
- Install proper lighting facilities as described in the guidelines of the Aggregate Operators Best Management Practices Handbook (MOEM 2002)
- Install office and lab trailers, rest trailers, portable toilets for the operators working at the quarry
- Provide traffic control personnel on Highway 97 to facilitate safe access and egress of trucks, if material would be transported by road

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- Portable toilet facilities within the quarry area and near the Project site offices. These facilities would be maintained as required. If trailer type washroom stations were to be used onsite, the grey water created would be disposed of into a suitable tank and then pumped out and trucked to the municipal treatment location
- A truck wash for noxious weed control

4.7 Site Reclamation and Future Use

West Pine Quarry would continue to operate as a rock quarry under the jurisdiction of the Ministry of Transportation and Infrastructure. At completion of quarrying, slopes would be stabilized and drainage features would be established at the quarries areas. Seeding to control noxious weeds would be done on soil slopes and overburden stockpiles.

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5. References

Province of British Columbia Ministry of Forests, Lands and Natural Resources Operations (August 2011). Notice of Establishment of a Section 16 Map Reserve (Notation of Interest Letters).

Province of British Columbia Ministry of Transportation and Highways (March 2008), RE: West Pine Quarry – Preliminary Rock Slope Design.

Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM). November 2009. Aggregate Management Principles, http://www.empr.gov.bc.ca/Mining/Aggregate/BMP/Pages/default.aspx

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Ministry of Energy and Mines (MOEM), April 2002. Aggregate Operators Best Management Practices Handbook for British Columbia. Volumes 1 (Introduction and Planning) and Volume 2 Best Management Practices, http://www.empr.gov.bc.ca/Mining/Aggregate/BMP/Pages/default.aspx

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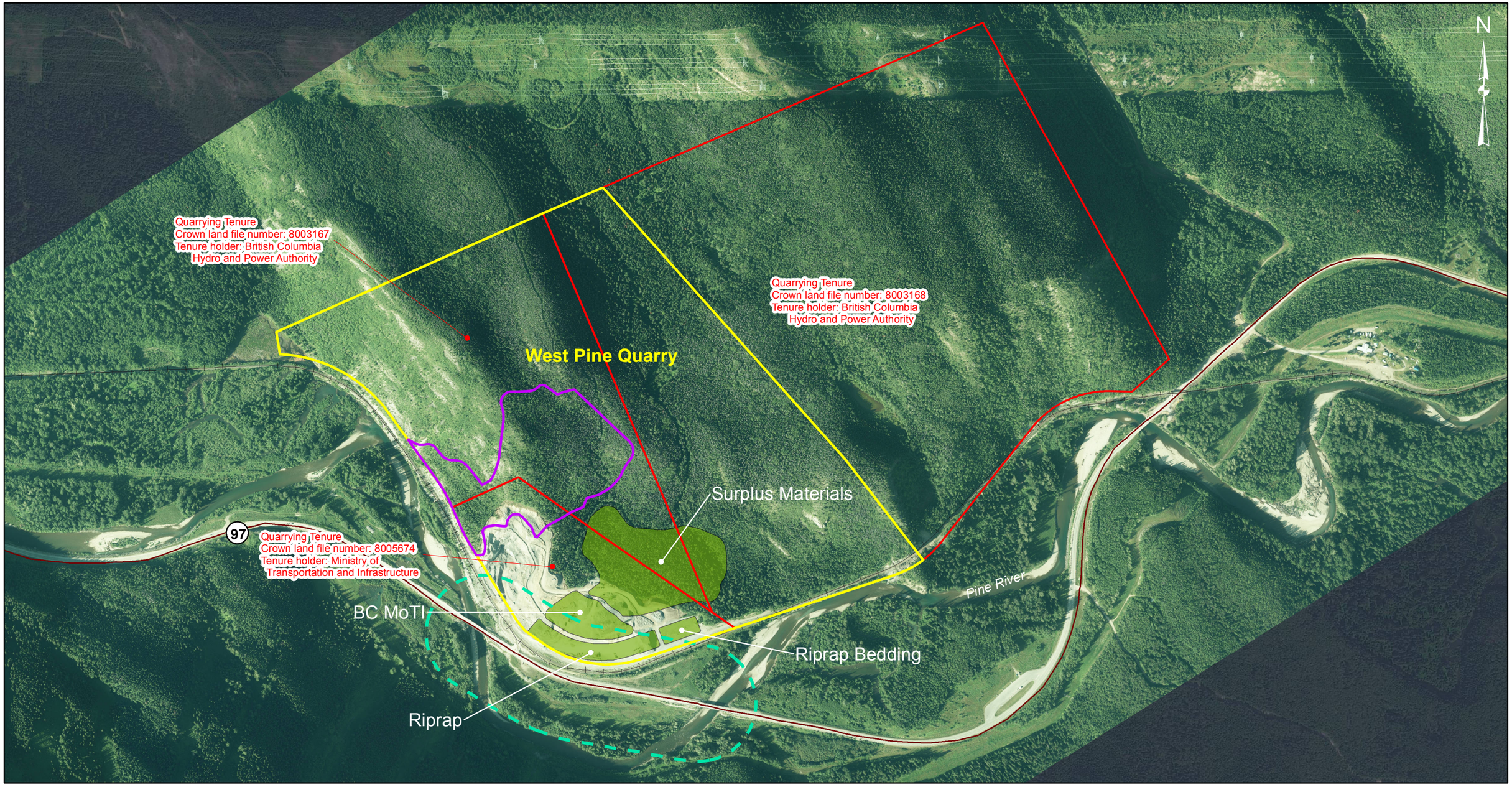

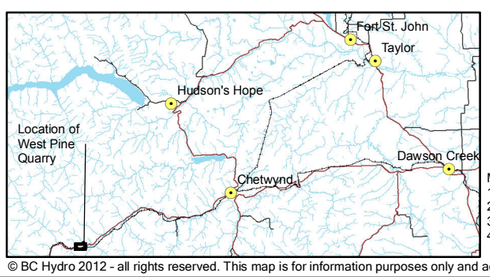

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011; Bing Aerial Maps.

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Legend

- West Pine Quarry
- Main Excavation Area
- Stockpile Area
- Potential Area for Access Improvement
- Tenure - Map Reserve
- Existing Highway
- Existing Railway

1:9,500

0 250 m

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SITE C CLEAN ENERGY PROJECT

Figure 1.1
Proposed development plan of the west pine quarry

Date	Nov. 23, 2012	DWG NO	1016-C14-B6098	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification