INTRODUCTION

This section supports an application for the ISR borrow sites on Crown land. It contains:

- an overview map
- an estimate of personnel requirements
- a summary of the operations
- a description of the potential environmental and resource effects
- construction equipment estimates

The location of the individual sites and alignment of the site access roads are shown in the overview maps, photographs, and site-specific maps in each specific borrow site subject. The terms used in borrow site development activities are described next and are included in the Glossary Section.

CONVENTIONS

Borrow Site Numbering

Borrow site locations within the Northwest Territories are identified using a numeric identifier system. This identification system was established for three borrow resource summary reports prepared for the Department of Indian Affairs and Northern Development (DIAND) from 1978 to 1988 (EBA 1976; Hardy 1978; and EBA 1988). Site location identifiers established between 1978 and 1988 range from 1.000 to 11.000. Locations that have numbers in the 20.000 series, or other numbers such as 303 or GM-4, are from other documents that describe the Mackenzie Valley borrow resources. These documents are located at the University of Calgary's Arctic Institute of North America.

Throughout this application, an entire borrow source is identified with a number such as “2.038”. The proposed borrow site or rock quarry site, or sites, within a borrow source are identified with a number such as 2.038P (one site) or 2.038PA and 2.038PB (two proposed sites in close proximity).

Earth Material Classification

Terms used to classify earth materials are explained in Table 5-1 (DIAND 1986).

Table 5-1: Earth Material Classification

Class 1	Clean, well graded, structurally sound granular material. Suitable for high quality surfacing materials or asphalt and concrete aggregate with minimal processing.
Class 2	Good quality granular material composed of well-graded sands and gravels with limited fines. Suitable for base and surface course aggregates, embankments, or structural fill. Requires processing for concrete aggregate.
Class 3	Fair quality granular material composed of poorly graded sands and gravels with or without silt. Suitable for general fill.
Class 4	Poor quality granular material composed of poorly graded, fine sands with moderate to high silt content. Sometimes contains minor amounts of gravel. Suitable for general fill purposes only.
Class 5	Fair to excellent quality bedrock that is suitable for quarrying and processing into required grades of granular material.
Non-Granular	Non-granular material including fine sands, silts, and cohesive soils. It is unsuitable for most construction purposes, except non-structural fills.

Terminology of Soil Properties and Qualities

Terms used to describe soil properties and qualities are explained in Table 5-2.

Table 5-2: Terminology of Soil Properties and Qualities

Boulders	Particles of rock that will not pass a 300 mm square opening.
Cobbles	Particles of rock that will pass a 300 mm square opening and be retained on a 75 mm sieve.
Gravel	Particles of rock that will pass a 75 mm sieve and be retained on a No. 4 (4.75 mm) sieve.
Coarse Gravel	Particles of rock that will pass a 75 mm sieve and be retained on a 19 mm sieve.
Fine Gravel	Particles of rock that will pass a 19 mm sieve and be retained on No. 4 (4.75 mm) sieve.
Sand	Particles of rock that will pass a No. 4 (4.75 mm) sieve and be retained on a No. 200 (0.075 mm) sieve.
Coarse Sand	Passes a No. 4 (4.75 mm) sieve and is retained on a No. 10 (2.00 mm) sieve.
Medium Sand	Passes a No. 10 (2.00 mm) sieve and is retained on a No. 40 (0.425 mm) sieve.
Fine Sand	Passes a No. 40 (0.425 mm) sieve and is retained on a No. 200 (0.075 mm) sieve.

Table 5-2: Terminology of Soil Properties and Qualities (cont'd)

Silt	Passes a No. 200 (0.075 mm) sieve. A fine-grained soil, or the fine-grained part of a soil, with a plasticity index less than 4.0. It is non-plastic or very slightly plastic and exhibits little or no strength when air dry.
Clay	Passes a No. 200 (0.075 mm) sieve. A fine-grained soil, or the fine-grained part of a soil, with a plasticity index greater than 4.0. It has plasticity within a range of water content values and has considerable strength when air dry.
Peat	Material composed primarily of vegetable tissues in various stages of decomposition, usually with an organic odour, a dark brown to black colour, a spongy consistency, and a texture ranging from fibrous to amorphous.
Organic Silt	A soil that would be classified as silt except that its liquid limit value after oven drying is less than 75% of its liquid limit value before oven drying. It has sufficient organic content to influence the soil properties.
Organic Clay	A soil that would be classified as clay except that its liquid limit value after oven drying is less than 75% of its liquid limit value before oven-drying. It has sufficient organic content to influence the soil properties.

Ice Content Descriptions

Terminology for ice content is shown in Table 5-3 (Van Everdingen 2002).

Table 5-3: Ice Content Descriptions

Excess Ice	The volume of ice in the ground, which exceeds the total pore volume that the ground would have under natural unfrozen conditions.
Ice Content	The amount of ice contained in frozen or partially frozen soil or rock. Ice content is normally expressed in one of two ways: • on a dry-weight basis (gravimetric), as the ratio of the mass of the ice in a sample to the mass of the dry sample, expressed as a percentage, or • on a volume basis (volumetric), as the ratio of the volume of ice in a sample to the volume of the whole sample, expressed as a fraction. The volumetric ice content cannot exceed one, whereas the gravimetric ice content can greatly exceed 100%.
Ice Lenses	A dominantly horizontal, lens-shaped body of ice of any dimension. The term is commonly used for layers of segregated ice. Ice lenses might range in thickness from hairline to more than 10 m. Very thick and extensive ice lenses are better termed massive ice beds.
Ice Wedge	A massive, generally wedge-shaped body with its apex pointing downward, composed of foliated or vertically banded, commonly white, ice. The size of ice wedges varies from less than 10 cm to more than 3.0 m in width at the top, commonly tapering to a feather-edge at a depth of 1.0 m to more than 10 m. Some ice wedges may extend downward as much as 25 m and may have shapes dissimilar to wedges.
Ground Ice	A general term referring to all types of ice contained in freezing and frozen ground.
Massive Ice	A comprehensive term used to describe large masses of ground ice, including iced wedges, pingo ice, buried ice and large ice lenses.

Table 5-3: Ice Content Descriptions (cont'd)

Pore Ice	Ice occurring in the pores of soils and rocks.
Segregated Ice	Ice in discrete layers or ice lenses, formed by ice segregation. It can range in thickness from hairline to more than 10 m. It commonly occurs in alternating layers of ice and soil.
Vein Ice	A comprehensive term for ice of any origin occupying cracks in permafrost. It occurs in various forms, including horizontal layers or lenses, tabular sheets, wedges and reticulate nets.

PERSONNEL (PART 3)

Development activities at a typical borrow site will require clearing vegetation along the winter access road and at the site. The site will also be cleared of overburden, if present, for use in abandonment and reclamation activities. Winter access roads will be built into the site and mobile camps will be established, as required. Operations will involve progressive removal of the borrow material, with the excavated material being transported for further use. Personnel will be required to operate the equipment and provide supervision.

A typical borrow site crew might consist of 12 to 24 people for site development and 10 to 12 people for site operation. A small camp staff of about five people might support each borrow site development crew.

SUMMARY OF OPERATION (PART 5)

The activities in this section are associated with:

- the development and operation of a total of 76.5 km of new 20 m wide access road allowance from the borrow sites to the gathering pipeline rights-of-way, infrastructure sites or pre-existing routes (see access road cross-sections and development activities in Section 3, Overview of Activities)
- further development and operation of three existing borrow pits
- development and operation of one new quarry and four new borrow pits

Figure 5-1 is an overview map showing the location of the borrow sites.

The following subjects contain the locations of the proposed borrow sites, access road alignments, site descriptions, and information on surface and subsurface conditions.

- Subject 5.2 Borrow Site 1.002P, new borrow pit
- Subject 5.3 Borrow Site 2.025P, new borrow pit
- Subject 5.4 Borrow Site 2.028P, existing borrow pit
- Subject 5.5 Borrow Site 2.022P, new borrow pit
- Subject 5.6 Borrow Site 2.020P, new borrow pit

- Subject 5.7 Borrow Site 2.029P, existing borrow pit
- Subject 5.8 Borrow Site 2.029PB, existing borrow pit
- Subject 5.9 Borrow Site 20.038P, new quarry

The potential supply within each borrow site is identified in the site-specific subjects. From sites identified for ISR Crown development, the current estimate of the total supply available is about 14,030,000 m^3. Of this amount, it is estimated 760,000 m^3 of borrow materials will be required from Crown lands in the ISR, including the quantity required by the three anchor field owners. Imperial will be developing some sites on their behalf.

Some of the sites listed in this application might not be developed. As borrow material volumes and the locations in which the material is required are further refined, some sites will likely remain undeveloped.

Preconstruction Activities

Before development at each borrow site begins:

- a preconstruction survey will be conducted to finalize the site-specific pit layout, which will include delineation of the required development areas
- geotechnical evaluations will be conducted to assess the quality, thickness, extent and permafrost properties of the material at the borrow sites

Planned Development Activities

Access Roads

Winter access roads will be required for borrow site development in the ISR. See the access road description and schematic in Section 3. A list of the access roads is shown in Table 5-4. The alignment is shown in the site-specific maps in each borrow site subject.

Figure 5.1 has been moved to reduce file size. To view it, click on the link to the figure in the web page List of Figures for this document.

Table 5-4: Winter Access Roads to Borrow Sites

Access Road Name	Kilometre Post (KP)	Land Use		Estimated Length (km)
		Private Length (km)	Crown Length (km)	
I-B1-W-1.009Pa*	T 1.7	-	21.3	21.3
I-B1-W-1.009Pb*	T 23.4	0.5	22.4	22.9
I-B1-W-1.002P	T 25.2	-	0.6	0.6
I-B2-W-2.022P	T 63.0	-	4.6	4.6
I-B1-W-2.020P	T 66.8	-	2.0	2.0
I-B1-W-2.029P	T 71.3	-	2.9	2.9
I-B1-W-2.029PB	T 73.8	-	1.6	1.6
I-B1-W-2.017P*	T 80.2	12.8	8.9	21.7
I-B2-W-2.025P	P 0.0	-	5.9	5.9
I-B1-W-2.028Pa	P 0.0	-	3.2	3.2
I-B1-W-2.028Pd	P 0.2	-	0.2	0.2
I-B1-W-2.028Pb	P 1.1	-	1.1	1.1
I-B1-W-2.028Pc	P 2.6	-	1.8	1.8
Total Length of Borrow Source Access on ISR Crown Lands:			76.5	
NOTE: *Borrow site is located on private ISR land. A portion of its access is on Crown land, as noted above.				

Mobile Camps

To facilitate early development and operation of the borrow sites, a mobile camp might be used. Mobile camps are described in Section 3.

Borrow Sites

Borrow material deposits and bedrock sources have been identified and will be developed to provide the necessary material for infrastructure and facility sites, slope protection, ditch bedding, pipe padding and select trench backfill for the project.

The development of the proposed borrow sites will include:

- extraction areas
- mobile camps

- stockpile areas
- space to form a final grade
- space for work equipment
- access in and out of the sites

Planning and development of the borrow pits and rock quarries will protect sensitive terrain and other aspects of the environment to the extent practical. In a short-term pit or quarry, all required material will be extracted at one time and stockpiled for future use. In a long-term pit or quarry, material will be extracted section by section, in sequence, so that only one section of the pit is opened at a time and the operation will be controlled. Only a part of each borrow source will be required by the project.

Existing sites will be used wherever practical and pits or quarries will be opened and operated in the appropriate season of the year to reduce potential effects to wildlife and the land surface. Development of the site could take place over a longer or shorter period depending on actual material requirements and project timing.

BORROW SITE DEVELOPMENT

Pit and quarry development will be based on DIAND's *Environmental Guidelines: Pits and Quarries* (DIAND 1982). The overall final pit or quarry development sequence will depend upon site access and site-specific subsurface conditions as well as the overall construction schedule. Where terrain is thermally sensitive, most pit development work is expected to take place during the winter. In areas with stable terrain, significant work might also take place in the summer.

Preparation for Development

Site Clearing

Brush and understory vegetation will be cleared from the initial development area. The brush and the understory (slash) material will either be burned, or chipped, mulched and stored with the coversoil and overburden materials, for later use in reclamation. An undisturbed vegetation buffer, with a minimum width of 30 m, will be maintained around the edge of the overall pit or quarry area and around all waterbodies, where practical. This will assist in mitigating erosion and siltation concerns, as well as providing a visual barrier.

Coversoil and Overburden Stripping and Stockpiling

Organic coversoil and overburden materials will be stripped once the vegetation has been removed, and the stumps and roots grubbed. These materials will be stored with the understory slash, in separate windrows within cleared, but not stripped, areas between the pit and the edge of the vegetated buffer. Coversoil and

overburden from the initial development area will be stockpiled for use in final reclamation.

The same process will be undertaken during quarry development, although part of the overburden materials will be used to construct a processing and stockpiling pad.

Typical Sequence of Borrow Pit Development

Figure 5-2 identifies a typical sequence of development areas within a borrow pit.

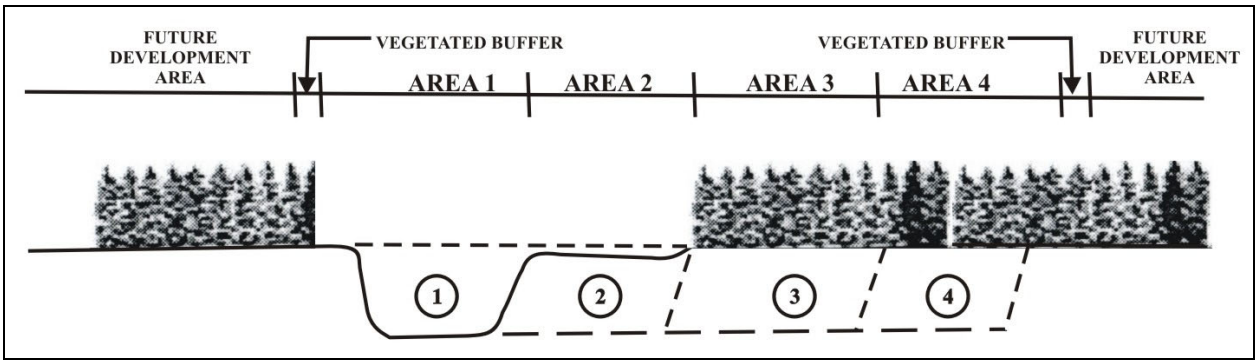

Figure 5-2: Typical Sequence of Borrow Pit Development

For illustrative purposes only, four extraction areas have been shown with pit development, extraction and reclamation taking place in five stages.

During stage one, vegetation is cleared and coversoil and overburden is stripped from areas 1 and 2. Area 1 is developed and borrow material is extracted, transported for use or stockpiled for thawing and drying.

During stage two, vegetation is cleared and coversoil and overburden is stripped from Area 3. Area 2 is developed and borrow material is extracted, transported for use or stockpiled for thawing and drying.

During stage three, vegetation is cleared and coversoil and overburden is stripped from Area 4. Area 3 is developed and borrow material is extracted, transported for use or stockpiled for thawing and drying. Reclamation of Area 1 commences.

During stage four, vegetation is cleared and coversoil and overburden is stripped from Area 4. Area 4 is developed and borrow material is extracted, transported for use or stockpiled for thawing and drying. Reclamation of Area 2 commences.

During stage five, reclamation of areas 3 and 4 commences.

To minimize “double handling” during borrow pit development, newly stripped materials will be used for ongoing reclamation. Once the borrow pit is in

operation, future development areas will be cleared and stripped in advance. This will allow natural thawing of exposed near-surface materials to occur, in the absence of an insulating coversoil layer, before the start of extraction operations.

Typically, frozen borrow pit materials might be stockpiled on site to allow thawing and drainage to take place over the summer season before it is used. If necessary, equipment can be maintained on site through the summer and used to "work" the stockpiles and encourage thawing and drying of the material. If the borrow material is unfrozen or ground ice or moisture content is low and the material is friable, it might be feasible to excavate and transport directly to the project.

Processing

Processing of pit-run material during the winter season will involve crushing and some screening of material for transport and use.

Site Drainage

Positive in-pit drainage will be maintained at all times where practical, through the installation of in-pit ditches. Surface runoff from disturbed pit areas will not be permitted to drain towards surface waterbodies and wetlands.

Typical Sequence of Quarry Development

Quarries will be developed, either by ripping at ground level, or by using a bench-type excavation. Figure 5-3 illustrates a typical bench-type quarry development sequence.

Ultimately, the quarry design includes developing two sequential 5.0 m high benches, with bench access directly off the proposed access road. Bench face angles are designed at 45° with an 8.0 m safety bench being left at the elevation of every second bench. Bench floors will be designed and excavated with minimum 2.0% sideslope to promote positive drainage, where practical.

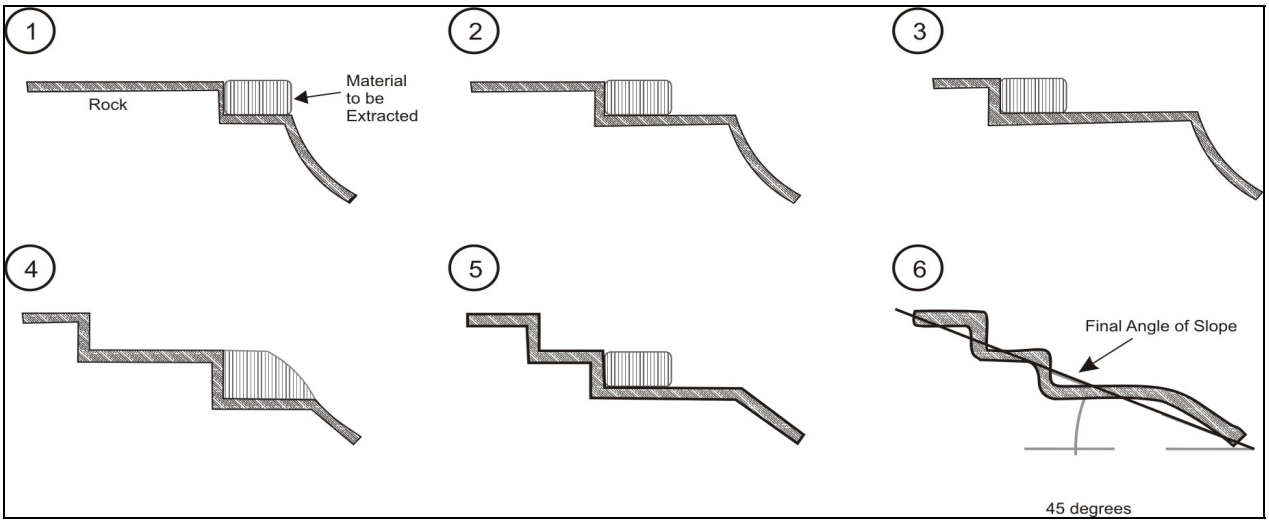

Figure 5-3: Typical Sequence of Quarry Development

Drilling and blasting will be required to break up and loosen the bedrock material before extraction. Either ripping or drilling and blasting, or both, are anticipated to be required to extract the rock. The rock face will be worked inwards and downwards to create benches and faces to given specifications. The final angle of the overall slope will not exceed 45°.

Quarries developed by ripping at ground level will follow the same development sequence as that proposed for borrow pits.

Processing

Processing of the pit-run material will involve sorting, crushing (in some cases), and screening. A processing and stockpiling area will be required where these operations can be carried out. There are no plans to produce concrete at quarry sites. Therefore, washing is not expected to be an element of the process.

Site Drainage

Positive drainage in the quarry will be encouraged by sloping the bench floors to avoid ponding and, if necessary and where practical, through the installation of in-quarry ditches to direct runoff to a fully contained sump. Presently, there are no plans to develop interceptor ditches upslope of quarries, given that quarries are commonly located on ridge-tops with small, associated drainage catchment areas.

ABANDONMENT AND RECLAMATION

Borrow Sites

Where identified as being required by the community, and as documented by separate agreement, borrow sites or winter access roads will be left in place.

Where a site is not required for future use by the local community or project operations, the area will be abandoned and reclaimed once the required borrow material has been extracted. Abandonment and reclamation will be ongoing, while development and extraction continue in other sections.

Site Abandonment

When a borrow pit is temporarily abandoned, slopes adjacent to undeveloped sections of a deposit might be left at a slope no steeper than two horizontal to one vertical (2H:1V). Before total abandonment of a depleted section, final pit slopes will be reduced to a maximum of three horizontal to one vertical (3H:1V). This can be achieved by cutting back the slope, encroaching if necessary into the perimeter coversoil and overburden storage area, or placing overburden material along the toe to reduce the overall slope, or both. The flatter long-term slopes are intended, in conjunction with coversoil and overburden replacement and seeding, to assist in mitigating erosion concerns. Final pit slopes will be contoured to blend in with the adjacent natural terrain.

Site Drainage

Runoff from the site area will not be directed toward the surface waterbodies and wetland areas. Therefore, positive drainage will be maintained at all times, particularly after abandonment, where practical.

Overburden and Coversoil Replacement

Overburden and coversoil materials that were stockpiled in the early stages of borrow pit development will be evenly distributed over the regraded and contoured area. Stockpiled slash and understory debris might also be placed on the pit slopes to assist in mitigating erosion concerns.

Site Revegetation

The replaced coversoil contains seeds and organic material that, along with re-invasion from adjacent undisturbed areas, will promote natural revegetation. This is often a slow process that might be assisted by seeding and fertilizing. Any re-seeding will be done with a native seed mix, consisting of plant species suitable to the ecological zone in which the borrow site is located. If there are seed shortages, non-native species and natural recovery options will be considered.

Quarry Sites

Options for abandonment and reclamation of a depleted bench-type quarry in a northern area are limited. The designed depth of the quarry will be set to ensure that the final excavation will be opened into the surrounding topography. This design constraint was introduced to ensure that positive drainage in the quarry is assured at abandonment.

Site Abandonment

When a quarry is abandoned or depleted, the site will be cleaned up and all equipment and buildings will be removed from the site. All quarry drainage sumps and significant depressions will be backfilled to prevent ponding, where practical.

Site Drainage

Runoff from the site area will not be directed toward surface waterbodies and wetland areas. Therefore, positive drainage will be maintained at all times, particularly after abandonment, where practical.

Overburden and Coversoil Replacement

The overburden that was salvaged during the development phase of quarries will be placed at strategic locations within the re-contoured quarry site.

Site Revegetation

The replaced coversoil contains seeds and organic material that, along with re-invasion from adjacent undisturbed areas, will promote natural revegetation. This is often a slow process that might be assisted by seeding and fertilizing. Any re-seeding will be done with a native seed mix, consisting of plant species suitable to the ecological zone in which the quarry is located. If there are seed shortages, non-native species or natural recovery options will be considered.

SUMMARY OF POTENTIAL ENVIRONMENTAL AND RESOURCE EFFECTS (PART 6)

A summary of the biophysical and human environment setting, potential effects and primary mitigation strategies is provided for the region in Section 8. Specific information for each individual borrow site is included in the site-specific subjects that follow.

EQUIPMENT (PART 10)

Table 5-5 shows an estimate of the equipment that might be required for site development and operations. An exact list and numbers will not be known until immediately before construction.

Table 5-5: Estimate of Site Development and Operations Equipment for Borrow Sites

Type and Approximate Number per Site	Size, Model or Equivalent	Proposed Use
Crew cabs pick-ups – 2	4x4	Transporting crews
Passenger van – 1	12-15 passenger 4x4	Transporting crews
Dump trucks (double axle) 5 – 10	Truck with trailer (12 m^3)	Hauling sand and gravel
Mechanical ditcher – 1	Medium sized excavator (1.9 m^3 bucket)	Excavating and removing earth
Mechanical ditcher – 1	Large sized excavator (3.2 m^3 bucket)	Excavating and removing earth
Bulldozer – 1	Medium sized bulldozer (305 HP)	Excavating and removing earth
Bulldozer – 1	Large sized bulldozer (405 HP)	Excavating and removing earth
Bulldozer – 1	Very large sized bulldozer (570 HP)	Excavating and removing earth
Loader – 1	Medium sized loader (4.2 m^3 bucket loader)	Removing earth
Loader – 1	Large sized loader (5 m^3 loader)	Removing earth
Fuel truck – 1	As required	Fuelling equipment
Sea containers – 2	6 m	Storage
Grader – 1	Medium sized grader (4.3 m blade)	Grading and levelling
Low ground-pressure tracked equipment– 1	As required	Access road freeze down and preparation
Water truck – 1	Tandem axle (16-24 m^3)	Winter access road preparation
Mobile camp – 1	35 person	Site development
Light tower – 2	Assorted sizes	Work area lighting

FUELS (PART 11)

Refueling of construction equipment will be done by fuel trucks supplied from nearby fuel storage depots, or by using on-site fuel tanks provided by construction contractors. The tanks will have an approximate capacity of between 5,000 and 20,000 L.

PERIOD OF OPERATIONS (PART 14)

The sites will be developed and operated between 2006 and 2010 (see Section 3). Some sites might be required during the operations phase of the project.

LOCATION OF ACTIVITIES BY MAP COORDINATES (PART 16)

Map coordinates of borrow site centroids are shown in Table 5-6.

Table 5-6: Map Coordinates of Borrow Site Centroids

Subject	Borrow Site No.	Latitude (DD)	Longitude (DD)	UTM Easting (m)	UTM Northing (m)	UTM Zone
5.2	1.002P	69.2064	-134.5679	517120	7677434	8
5.3	2.025P	69.0244	-133.5087	559571	7657805	8
5.4	2.028P	68.9849	-133.5196	559241	7653392	8
5.5	2.022P	68.9651	-133.9569	541782	7650825	8
5.6	2.020P	68.9280	-134.0475	538218	7646635	8
5.7	2.029P	68.8993	-133.8985	544253	7643530	8
5.8	2.029PB	68.8747	-133.9026	544136	7640781	8
5.9	20.038P	68.4630	-133.3301	568407	7595419	8

FEES (PART 18)

The total land area required for ISR Crown development in this section is 664.2 ha, consisting of 511.2 ha of borrow sites and 153 ha of winter access roads to the borrow sites.

The land requirements are shown in Appendix A.