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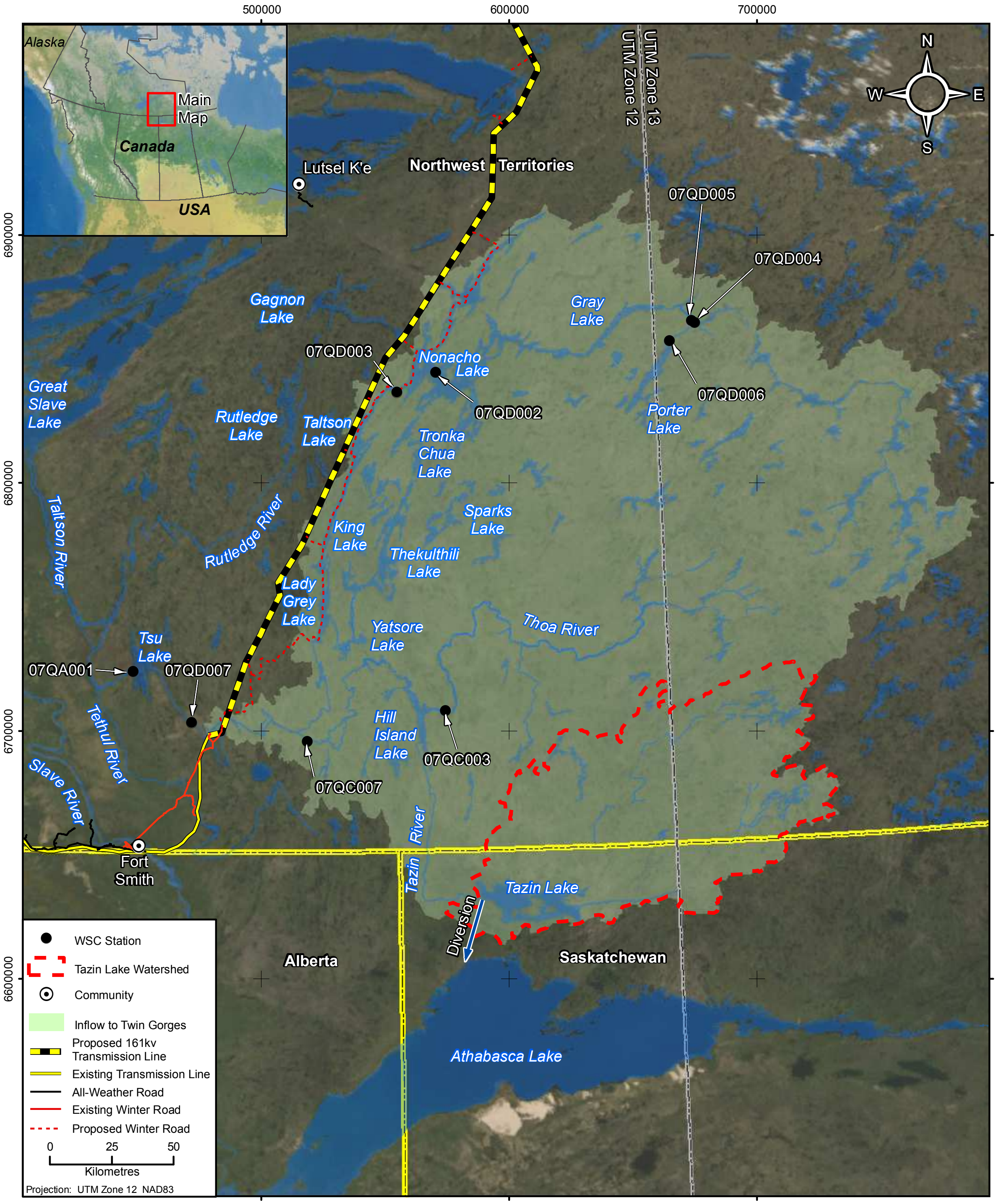
6A Acid Base Accounting Testing Report (Klohn Crippen Berger)

6. DEVELOPMENT DESCRIPTION

6.1 TALTSON RIVER BASIN & EXISTING TWIN GORGES POWER DEVELOPMENT

6.1.1 Development Location

The Taltson River basin is a relatively large drainage area of approximately 60,000 km^2 located between Lake Athabaska and Great Slave Lake and west of the Thelon River drainage basin. The basin comprises a relatively complex system of interconnected lakes, draining generally southwest from the higher elevation Canadian Shield area and then northwards along, and eventually into, the Slave River lowland zones. The river enters Great Slave Lake on its southern shore at the western end of the Simpson Island chain. Two main tributaries form the lower Taltson River on which the existing generation facility was developed – the mainstem Taltson River and the Tazin River. The basin is shown in Figure 6.1.1. The characteristics of the basin are described in more detail in Section 6.1.3.



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Taltson River Drainage Basin**	**Figure 6.1.1**

6.1.2 Development History

Along with a number of other rivers in the region, the Taltson River was investigated for power development potential on a number of occasions in the past, and became the focus of the Northern Canada Power Commission (NCPC) in the early 1960s as a means to support the operation of the proposed Pine Point Mine near Fort Resolution. In 1952 a flow-gauging station was installed on the river immediately below Tsu Lake, although data collection was not consistent. Following that, in 1962, the water level gauging was installed on Nonacho Lake, a large lake in the upper Taltson River mainstem.

The existing power generation facility was constructed in 1964 to 1965 at what was a natural falls on the river, known as Twin Gorges, located approximately 60 km northeast of Fort Smith and 30 km upstream of Tsu Lake on the Taltson River. The facility was sized to match the anticipated mine and a small amount of customer load, and was not developed to maximize either the available head or the available flow from the site. The Taltson Twin Gorges facility delivered energy to the mine through a 115 kV single-circuit transmission line that connects the existing plant and the former mine site area through Fort Smith. The original facilities are shown in Figure 6.1.2 and Plates 6.1.1, 6.1.2, and 6.1.3.

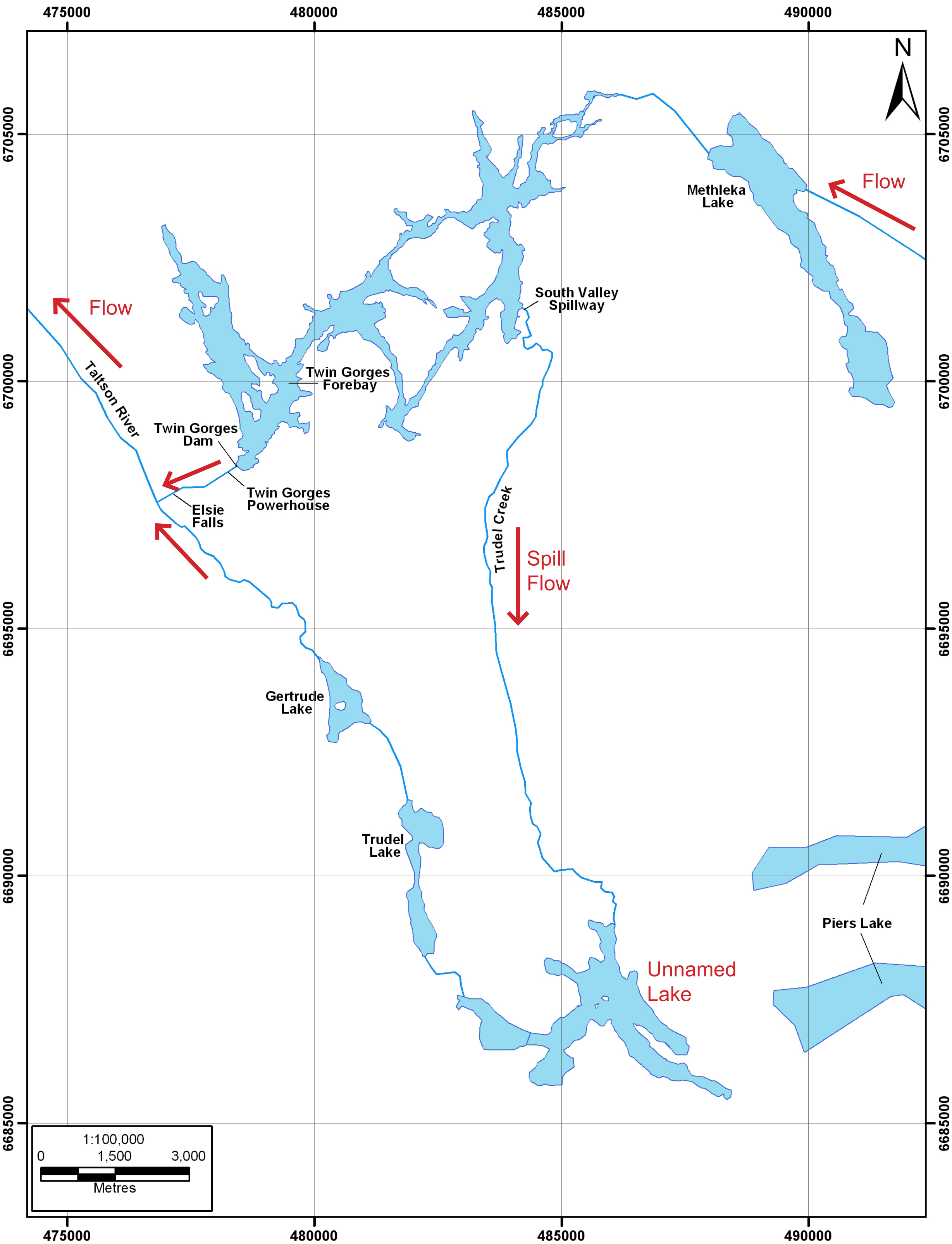
As is typical of mine processing, the power was required on a continuous basis, and the facility was required to run at near capacity output (18 MW) year-round once the mine was in full operation. To support winter generation when natural river flows sometimes tended to decrease below winter generation requirements, a rock dam, gated undersluice, and overflow spillway were constructed at the outlet of Nonacho Lake in 1968. These structures are approximately 150 km northeast (approximately 210 river km upstream) of Twin Gorges (Figure 6.1.1). This simple structure helped regulate the flows from Nonacho Lake into the Taltson River system by allowing storage to occur in the summer and additional releases to be made above the natural flow in the winter.

The Twin Gorges dam that impounds water in the Forebay (upstream of the dam) was developed without a spillway. A concrete weir was constructed across a natural saddle between the original Taltson River and a smaller valley, Trudel Creek, approximately 7 km east of the dam. Excess flows not used for generation were, and continue to be, spilled from the Forebay into Trudel Creek. The structure is called the South Valley Spillway (SVS). Trudel Creek reconnects with the Taltson River at the bottom of Elsie Falls. The arrangement is shown in Figure 6.1.3

The Pine Point Mine operated for approximately 20 years, but was permanently closed and the site reclaimed in 1986. More recently, Hay River and other communities were connected to the existing system through additional lower-voltage transmission lines. Since 1986, with only the residential and commercial customers as load, the plant has operated at only 40% to 60% capacity and uses only about 25% of the available river flows at the Twin Gorges site.

The electrical load growth in the region currently supplied by Twin Gorges has been and continues to be minimal. Historic load growth across the three communities serviced by the plant has averaged less than 2% per annum. It is possible that the regulated customer base load could increase with pipeline-related business in Hay River, or with the re-commencement of mining activity near Pine Point. Specific terms for division of available power between the regulated-base customers and the diamond mines from an expansion project at Twin Gorges are anticipated and included in related business agreements not part of this document.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Existing Taltson Twin Gorges Hydroelectric Facility Infrastructure	Figure 6.1.2



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	South Valley Spillway and Trudel Creek	Figure 6.1.3

Plate 6.1.1 — Nonacho Lake Spillway and Rockfill Dam

Plate 6.1.2 — Twin Gorges Plant

Plate 6.1.3 — South Valley Spillway

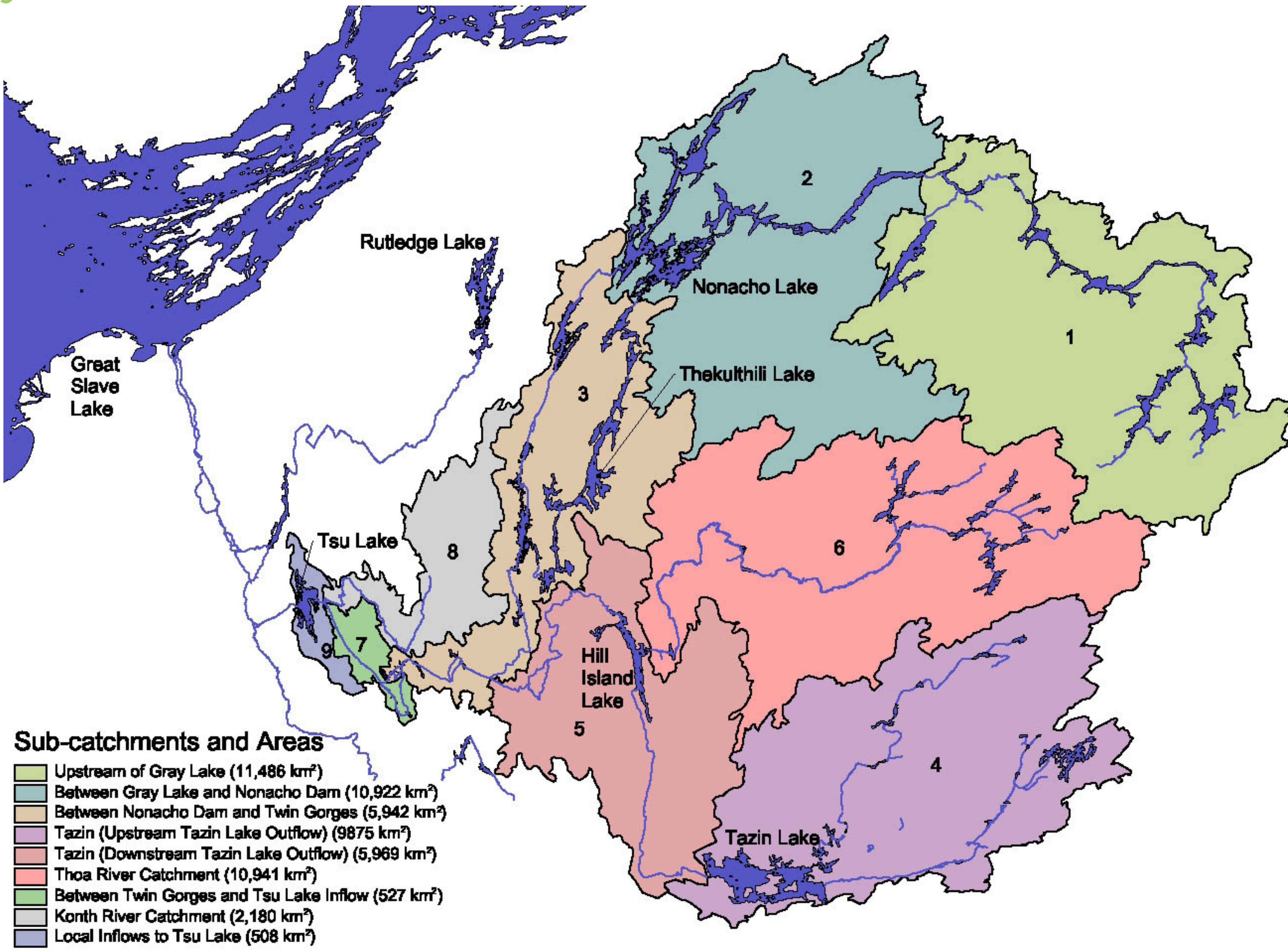
6.1.3 Current Basin Characteristics

The Taltson River watershed drains over 58,000 km^2 upstream of Tsu Lake, and has a mean annual discharge, over the available period of gauging record, of approximately 200 m^3/s near the Twin Gorges site. The watershed area has been divided into major sub-drainages, identified in Table 6.1.1 and shown in Figure 6.1.4. The headwaters of the mainstem river begin in a series of lakes that drain north and west into Gray Lake, now an arm of Nonacho Lake. The Tazin River, a main tributary, drains a large region south of the Taltson River near the Saskatchewan border. The general characteristics of each basin are provided below.

Table 6.1.1 — Areas and Percent Totals of the Nine Major Sub-drainages in the Taltson Watershed

ID	Catchment	Area (km^2)	Percent of Total
1	Catchment upstream of Gray Lake	11,486	23.5
2	Catchment between Gray Lake and Nonacho dam	10,922	22.3
3	Catchment between Nonacho dam and Twin Gorges Forebay	5,942	12.1
4	Tazin River Catchment (upstream of Tazin Lake outflow)[1]	494	1.0
5	Tazin River Catchment (downstream of Tazin Lake outflow)	5,969	12.2
6	Thoa River Catchment	10,941	22.3
7	Local inflows between Twin Gorges and Tsu Lake inflow	527	1.1
8	Konth River Catchment	2,180	4.5
9	Local inflows to Tsu Lake	508	1.0
	Total Catchment (upstream of Tsu Lake - Net)	**48,969**	**100.0**

[1] Tazin River Catchment (upstream of Tazin Lake outflow) has an actual catchment area of 9,875 square kilometres; however, approximately 90-95% of the flow from Tazin Lake is diverted south to the Charlotte River (95% assumed for this calculation). Therefore, an 'effective' catchment area of 494 square kilometres is being used.



TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	Taltson Basin Watershed Showing Main Sub-Catchments	Figure 6.1.4

6.1.3.1 TALTSON UPPER MAINSTEM AND NONACHO LAKE SYSTEM

The Taltson River mainstem rises in the Thelon/Taltson boundary in a series of lakes in the eastern side of the drainage basin. This system flows generally northwest nearly 170 km before reaching Gray Lake at the eastern end of Nonacho Lake, the largest lake in the basin system. Gray Lake is likely to have been separated from Nonacho Lake by a small elevation difference prior to the raising of Nonacho Lake in 1968, but is now considered an arm of Nonacho Lake. Nonacho Lake proper has two uncontrolled outlets: the Taltson River and a natural saddle called the Tronka Chua Gap; and one controlled outlet, the undersluices in the rock dam. Flows over the Tronka Chua Gap occur as a result of the raise in lake elevation from the dam.

6.1.3.2 TRONKA CHUA GAP TO LADY GREY LAKE

Discharge from the Tronka Chua Gap flows though a series of moderate-size lakes including Tronka Chua, Thekulthili and Yatsore Lakes before turning northward and flowing into Lady Grey Lake and rejoining the Taltson River.

6.1.3.3 TALTSON RIVER BELOW NONACHO LAKE

Discharges from the undersluices and the spillway (and dam leakage) enter the Taltson River immediately below Nonacho Lake. The Taltson River flows southwest from this point through a complex series of slow-moving, low gradient river-reaches divided by a series of large lakes, short rapids and waterfalls. Plate 6.1.4 provides a typical view of the Taltson River in this reach. Flow dynamics through the system are controlled by lake storage and flow restrictions (i.e., hydraulic control points) at rapids and lake outflow points.

Plate 6.1.4 — Taltson River Downstream of Nonacho Lake

Downstream of Lady Grey Lake, where the Tronka Chua system re-enters the Taltson River passes through several smaller lakes as it flows the remaining 110 km to the Twin Gorges Forebay. The Tazin River joins the Taltson River within this reach.

6.1.3.4 TAZIN RIVER SYSTEM

The Tazin River rises in the southeast corner of the drainage basin, flowing generally south and then west through northern Saskatchewan before entering Tazin Lake. Flow out of Tazin Lake northwards towards the Taltson mainstem is controlled by a rock and timber dam, which was originally constructed to divert water into the Charlot River system to operate hydroelectric projects to supply power to the mine at Uranium City, Saskatchewan. That mine has now been closed, but the three generation plants constructed on this short river reach have now been interconnected to the Saskatchewan power grid, and the Tazin Lake water continues to be diverted. It is understood that approximately 90 to 95% of the flow from Tazin Lake is diverted south to the Charlot River, with minor spill from the lake into the upper Tazin River occurring during normal freshet and for two to three following months. The diversion effectively removes approximately 9,400 km^2 of area from the Taltson Basin, or about 17% of the total potential drainage area at Twin Gorges. Except during more extreme water years, discharge into the Taltson River basin from the Tazin River system is therefore limited to the portion of the watershed downstream of Tazin Lake, including the Thoa River.

The Tazin River system below Tazin Lake is shown in Plate 6.1.5.

Plate 6.1.5 — Tazin River below Tazin Lake: October, 2008

6.1.3.5 TALTSON RIVER LOWER REACHES

Water can leave the Twin Gorges Forebay either through the existing Twin Gorges generating station, or over the South Valley Spillway, some 7 km east of the generating station. Water passing through the existing generating station flows over Elsie Falls and continues through the Taltson River to Tsu Lake. Flow routed over the South Valley Spillway is diverted through Trudel Creek and flows 33 km in a broad loop to the south before returning to join the Taltson River at the outlet of Elsie Falls. The system is shown in Figure 6.1.3.

Downstream of the Twin Gorges facility, the Taltson River enters the Slave Lowland area and flows a farther 33 km from Elsie Falls to Tsu Lake. In this reach, it passes over a number of rapids, through a narrow gorge (Nende Chute), and into Tsu Lake. Tsu Lake receives additional runoff from the Konth River, which drains from the northeast. Downstream of Tsu Lake, the Taltson flows a farther 132 km at low gradient to Great Slave Lake, with tributary flows from Rutledge River/Deskenatlata Lake joining the river within this reach.

6.1.3.6 TRUDEL CREEK

Prior to the construction of the dam and South Valley Spillway at the Twin Gorges in 1965, Trudel Creek was normally a small meandering stream interconnecting the three lakes in this reach; during periods of higher flows it sometimes connected to the Taltson River mainstem through the natural saddle. Since the use of Trudel Creek as the spillway route, additional high flows have been routed into this drainage. In the period when the mine was operating, 1965 to 1986, and in particular subsequent to the construction of the Nonacho Lake dam in 1968, spill flows were likely minimized, and flows over the South Valley Spillway relatively more intermittent. Since the Pine Point Mine closed in 1986 and power generation was reduced, the flow through the plant has decreased, control at Nonacho Lake has been less structured, and approximately 75% of the annual flow is spilled over the spillway into Trudel Creek. A typical ongoing spill scenario at the South Valley Spillway is shown in Plate 6.1.3. Trudel Creek has therefore had several distinct flow regimes prior to and since the Twin Gorges Project was constructed.

6.1.4 Existing Power Facility

The components of the existing Twin Gorges generation plant and associated facilities, along with their original development dates, are as follows:

- Twin Gorges site access (winter road and airstrip) (1964);
- Twin Gorges dam, intake, penstock, surge tank, powerhouse and generation equipment (1964/65);
- South Valley Spillway (1965);
- Nonacho Lake dam, control gates and spillway structure (1968);
- 115 kV transmission line to Fort Smith and Fort Resolution (1966); and
- alterations since original construction (1974-75) – now decommissioned.

A short description of each of these important components is provided below.

6.1.4.1 GENERAL

6.1.4.2 ACCESS TO THE TALTSON TWIN GORGES SITE

The existing Taltson Twin Gorges facility was constructed via the development of two main access components:

- a winter road from Fort Smith overland through a series of interconnected lowlands and lakes from the Slave River to Gertrude Lake, and
- a gravel airstrip located on a large esker approximately 5 km from the Twin Gorges site, immediately above Gertrude Lake. The winter road and airstrip were linked to the generation site through approximately 6 km of all-weather road.

The winter road has been largely abandoned for over 15 years and the road right-of-way has been extensively altered by beaver and muskrat lodges. The current condition allows only snow machine use in the winter.

The 1130 m long airstrip continues to be a main source of access for the delivery of materials and equipment necessary for operation of the plant. The airstrip is fully maintained and is open year round. The airstrip can support landing of quite large aircraft (Hercules) but only unloaded takeoff weights for the larger aircraft. In addition to the airstrip, the Taltson Twin Gorges Forebay is used for float plane landings, and a small dock is available for personnel changes and small equipment delivery immediately upstream of the dam.

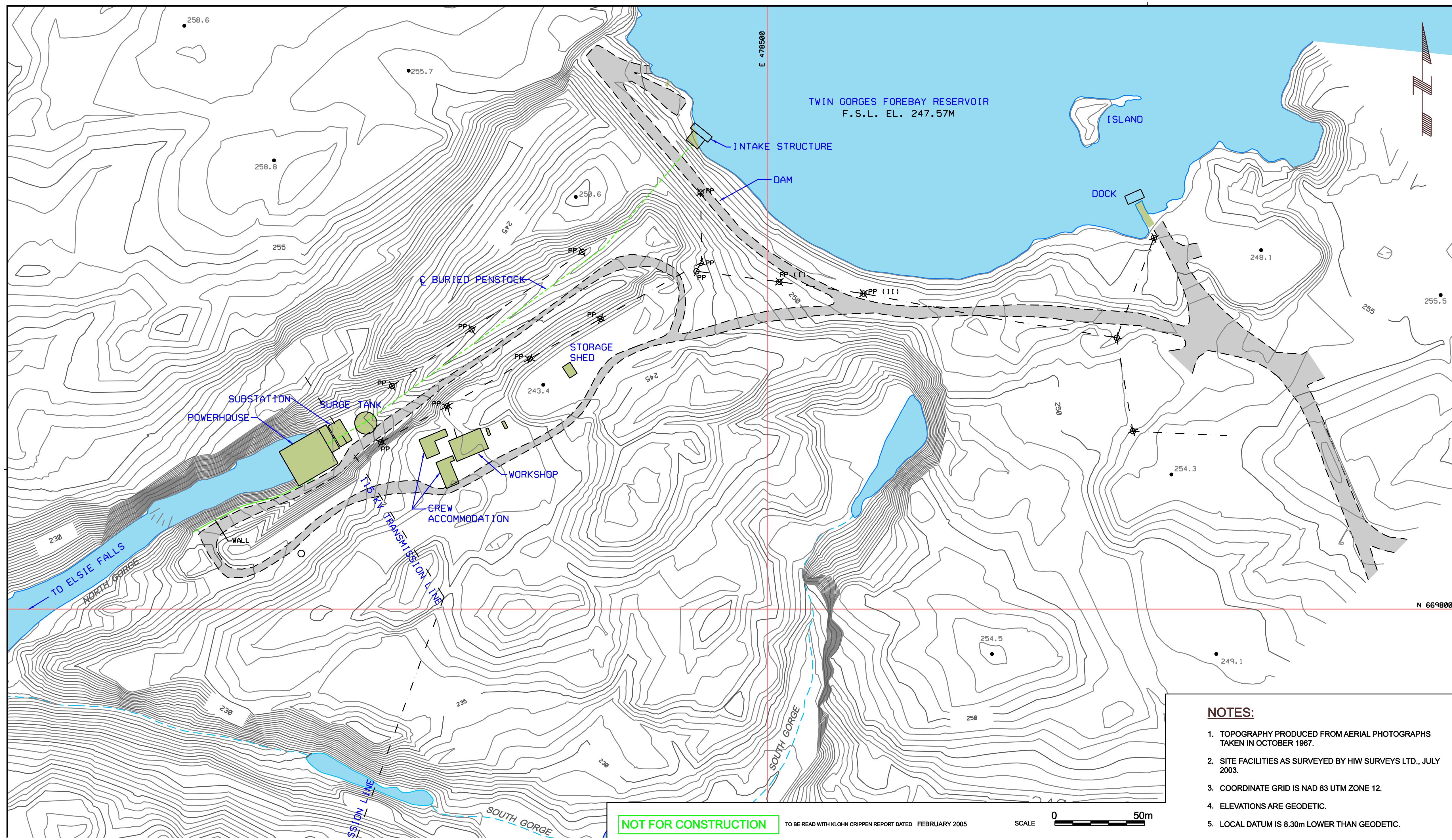
6.1.4.3 TALTSON TWIN GORGES GENERATING STATION

The existing Taltson Twin Gorges facility was planned and constructed by the Northern Canada Power Commission and commissioned in 1965 to supply the Pine Point Mine with electrical power. The facility was transferred to NTPC in 1988. The generation facility comprises the following main components:

- 25 m high zoned earth and rockfill dam across the two gorges in the Taltson River at the Twin Gorges site;
- gated concrete intake structure on the Twin Gorges Dam, right abutment area;
- 375 m long buried steel penstock (4.9 m diameter) to a surge tank;
- steel surge tower, insulated riser and 12 m diameter tank;
- single 18 MW vertical axis Francis turbine and 19.6 MVA generator;
- concrete/steel superstructure powerhouse with bridge crane and control room; and
- step-up substation (6.9/115 kV) and switchyard.

A layout of the facility at Twin Gorges is shown in Figure 6.1.5 and Plate 6.1.6 and Plate 6.1.7.

The facility was constructed to conservative design parameters and has generally been maintained and operated within the design range throughout its life. Annual inspections are undertaken on the water conveyance and generation systems, and dam safety reviews are undertaken periodically. A condition assessment of the facility was completed in 2003, a synopsis of which is presented in Section 6.1.4.8.



TALTSON
Hydroelectric Expansion Project

Developer's Assessment Report
2009

Twin Gorges Generating Station Facility Layout

Figure
6.1.5

Plate 6.1.6 — Twin Gorges Forebay with Taltson River in Background

Plate 6.1.7 — Twin Gorges Plant from Downstream

6.1.4.4 SOUTH VALLEY SPILLWAY

No spillway or release structure other than the generation plant intake was developed in the existing dam or dam abutments. Instead, concrete spillway structures were developed across a moderately narrow saddle feature in the southern side of the Forebay 7 km east of the dam, as shown in Figure 6.1.3, and Plate 6.1.3. At high Forebay levels, this structure connects the Taltson River mainstem with the upper headwaters of a smaller drainage, known as Trudel Creek (Figure 6.1.3, Plate 6.1.8, Plate 6.1.9, and Plate 6.1.10). Trudel Creek runs over a distance of 33 km from the South Valley Spillway to a confluence with the Taltson River immediately below Elsie Falls, itself immediately downstream of the discharge point of the Twin Gorges generation plant.

The Taltson Twin Gorges dam raised the water level an estimated 22 m above the original riverbed elevation at the dam axis. However, it is understood that the natural Twin Gorges feature caused a large backwater effect in this area of the river during summer freshet or flood events prior to the construction of the dam. The height and extent of this original backwater is not known. Current evidence suggests that Trudel Creek received intermittent flows from the mainstem Taltson River during periods of high flow, likely through this area, prior to the development of the Twin Gorges facility.

The structure geometry and discharge characteristics of the South Valley Spillway are complicated in that several flow paths develop as the Twin Gorges Forebay level rises. Up to three main discharge sections normally occur during the summer freshet. Two of these flow paths are controlled by concrete weir structures, while one is an uncontrolled creek. An approximate rating curve has been established for the SVS based on the subtraction of known plant discharge from the flow gauge readings at the Water Survey Canada (WSC) site on the Taltson River between Tsu Lake and Elsie Falls.

Plate 6.1.8 — Trudel Creek: Headwaters at South Valley Spillway

Plate 6.1.9 — Trudel Creek: Low Gradient Zone in Upper Valley

Plate 6.1.10 — Trudel Creek: Higher Gradient Zone

6.1.4.5 NONACHO LAKE STRUCTURE AND TRONKA CHUA GAP

The Nonacho Lake control structure and adjacent spillway channel were constructed in 1968 at the location of the natural outlet from Nonacho Lake to the Taltson River. A rockfill dam with three gated timber sluice passages was installed in the outlet channel itself, and a rock-cut spillway developed immediately adjacent to the dam.

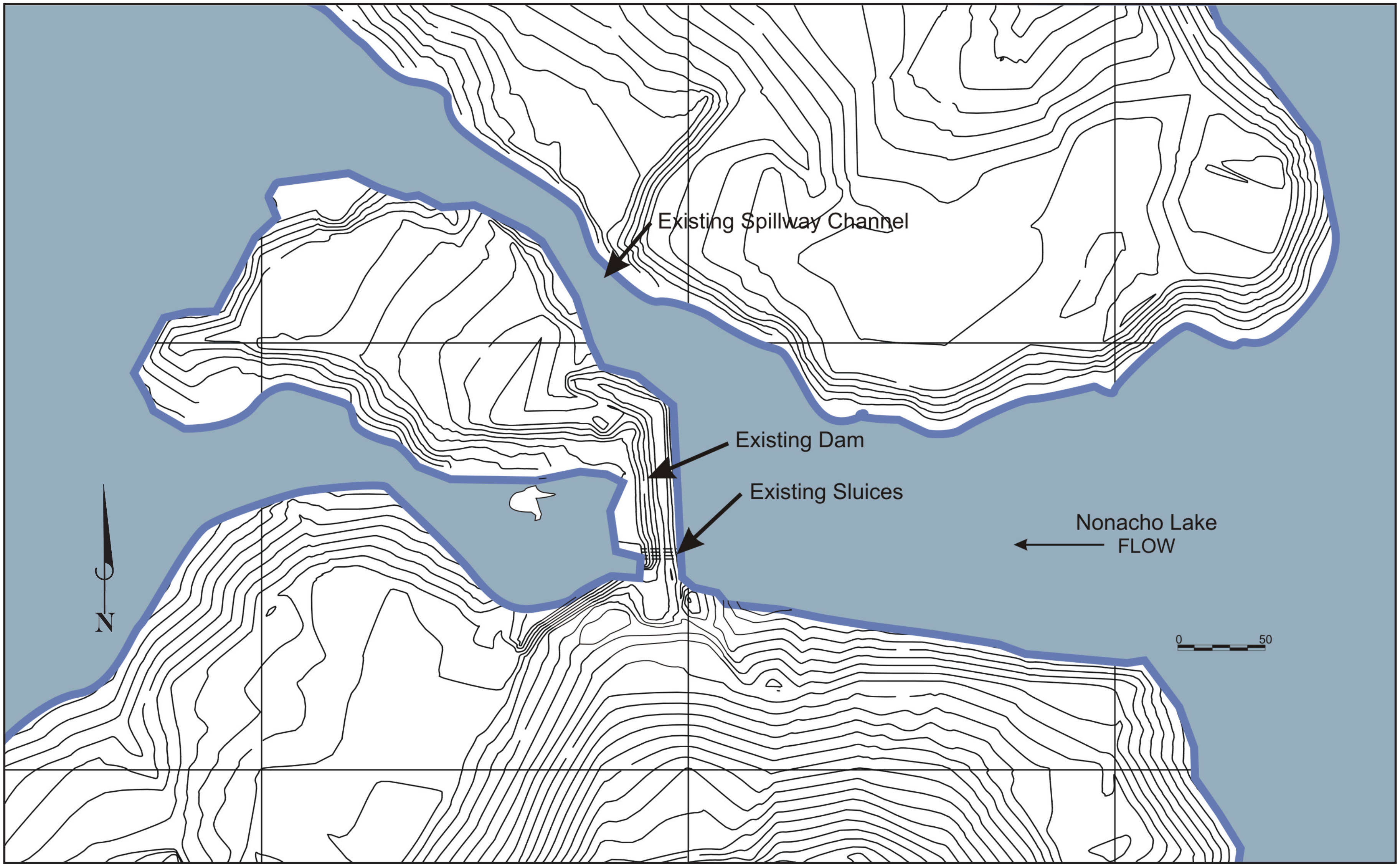
These facilities raised the average lake level by approximately 2 m, and provided a limited capacity to regulate flows to the Twin Gorges plant by storing water in the lake during the high flow period of summer/early fall. The specific components are as follows:

- a 10 m high, 60 m long rockfill dam across the natural Nonacho Lake outlet,
- a 65 m wide rock cut spillway adjacent to dam, and
- three manually-operated sluice gates (6 ft x 6 ft) in timber sluice passages in the rock fill dam.

The rock channel spillway was blasted immediately adjacent to the dam, and served as the main source of dam materials. For construction, necessary equipment, materials and personnel were landed on an ice airstrip on the lake, and a large portion of the work was completed in one winter season. There is no road to the Nonacho Lake infrastructure, and access to the dam and gates was and remains limited to helicopter or float plane. No power is available at the site. The structures are shown in Figure 6.1.6 and on Plate 6.1.11.

The only inhabitants on Nonacho Lake are the Carter family, who operate a fishing lodge seasonally (July to September) on the lake 10 km up-lake from the control structure. The fishing lodge beachfront can be affected by lake levels above about 324.0 masl.

The rise of lake levels introduced by the Nonacho dam causes regular overtopping and release of water through a natural low point between Nonacho Lake and Tronka Chua Lake. This control feature is known as the Tronka Chua Gap (Plate 6.1.12). The spill through the Tronka Chua Gap varies from zero for lake elevations equivalent to the main rock cut spillway crest level (322.6 masl) to over 70 m^3/s at the higher lake levels that typically occur during mid-summer. While the release through Tronka Chua is uncontrolled, this water ultimately flows to the Taltson River through Lady Grey Lake upstream of the Twin Gorges generating facility, and can be fully used in generation at the facility.



TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	Nonacho Lake Control Structure	FIGURE 6.1.6

Plate 6.1.11 — Nonacho Lake Control Structure from Upstream

Plate 6.1.12 — Tronka Chua Gap

6.1.4.6 TALTSON TWIN GORGES TRANSMISSION LINE INFRASTRUCTURE

As part of the original installation, a 115 kV transmission line was constructed overland to Fort Smith and through to Pine Point (170 km total length) and is shown in Figure 6.1.7. Typical line structures are illustrated in Plate 6.1.13 and Plate 6.1.14. After the closure of the Pine Point Mine in 1986, the Taltson Twin Gorges facility was connected to Fort Resolution, and then to Hay River via a 72 kV line spur, and to Fort Fitzgerald. Combined, these communities typically use approximately 8 MW during the summer and 13 MW peak during the winter months, or in the range of 45% to 65% of the generation capability of the original 18 MW plant.

Plate 6.1.13 — Existing Twin Gorges Transmission Line: Example of River Crossing

Plate 6.1.14 — Existing NWT Transmission Line: Example of Line Corridor

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TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Existing 115kV Transmission Line from Twin Gorges to Pine Point	Figure 6.1.7

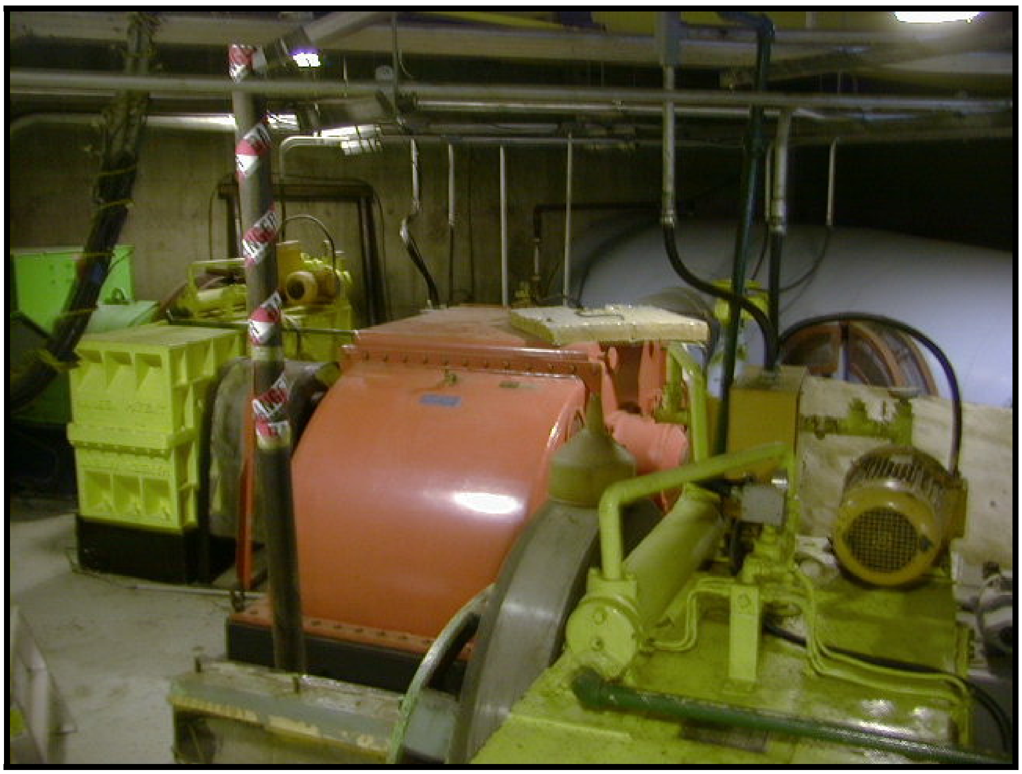
N:\Active\GIS\2008\07-1328-0013 Taltson\Mapping\MXD\DAR_Figures/YK_133 Southern Sector Pine Point

6.1.4.7 ALTERATIONS AT TWIN GORGES SINCE ORIGINAL CONSTRUCTION

In 1975, in response to growth in the electrical demand at the Pine Point Mine, a 4 MW expansion of the generation at Twin Gorges was introduced, comprising the following components:

- a branch bifurcation was introduced into the original steel penstock just upstream of the surge tower;
- a 90 m long, 2.13 m diameter steel pipe and associated anchor blocks were buried in the original access road to the generator floor level of the existing plant;
- the original draft tube gate gantries and hoisting equipment were removed, and steel and concrete floor constructed over the back of the existing powerhouse;
- four 0.75 MW Ossberger cross-flow turbines, associated inlet valves, horizontal shaft generators, and control equipment were installed on the deck (Plate 6.1.15); and
- a 4.16/115 kV three-phase step-up transformer was installed in the existing switchyard and connected to the 115 kV line.

Plate 6.1.15 — Ossberger Turbines at Twin Gorges Plant



The Ossberger turbines supplied peaking power on a continuous basis from their installation in 1975 until the closure of the mine in 1986. A number of the Ossberger units continued to be operated for several more years after mine closure; however, these units are now considered non-serviceable and have been abandoned. The removal of the draft tube gates from the original plant has continued to cause significant inconvenience in inspection and maintenance procedures for the plant.

The branch pipeline to the Ossberger units was removed and the bifurcation in the main penstock permanently plugged with a steel bulkhead in 2004. The access to the plant was restored to the original arrangement. However, the Ossberger deck and machine house remains, as no heavy lifting equipment is available on the site to dismantle these structures. The original draft tube gates, which still exist on site, have not been re-installed.

6.1.4.8 Condition Assessment of Existing Facility

Study work completed during the Expansion Project conceptual phase in 2003 included a condition assessment of the existing generation facility to identify any refurbishment costs and activities that would need to be incorporated into the overall development plan to ensure continued and reliable generation from the existing Taltson Twin Gorges facility. Although the Nonacho dam passed the dam safety inspection conducted in fall 2006, the 2003 condition assessment is considered relevant to the Expansion Project description, and a synopsis is provided below.

6.1.4.8.1 Twin Gorges Generating Station

Although nearly 40 years old, the Twin Gorges generating plant continues to be the primary source of power for Fort Smith, Fort Resolution, Fort Fitzgerald and Hay River. The facility, therefore, remains a key component of NTPC generation assets. Operators are continually stationed at the facility, which is managed through NTPC's regional office at Fort Smith and the head office/engineering office in Hay River. The facility is typically shut down for about one week for a thorough inspection during September each year. These inspections normally cover the penstock, spiral case, runner and associated components of the plant. In accordance with regulatory requirements, formal dam safety inspections occur on the water-retaining and control structures. In 2002, a structural review was undertaken of the powerhouse and associated components, with no major issues identified. Regular maintenance and inspection activities for the transmission line sections owned by NTPC include flying the line, replacement of cracked conductors, brushing of the line ROW and checking of guy tensions.

In general, the demand on the plant is relatively light and it would be classified as having a high reliability in its current operating regime. The transmission line itself is highly reliable.

As part of the Year 2003 Snap Lake Power Supply study program, a portion of which was to consider a life extension of the existing plant, a preliminary condition assessment of the plant was completed in conjunction with two scheduled plant shutdowns. The assessment considered the current condition of the plant and likely upgrades and major maintenance items required for a resumption of generation at design capacity (18 MW), and a life extension of the existing plant (design life anticipated to be a minimum of 40 more years).

Key findings of these recent inspections and other external assessments are summarized in Table 6.1.2:

Table 6.1.2 — Condition Assessment of Existing Plant

Existing Component	Inspection
Main Dam Structures	Stable, continues monitoring required.
Intake Structures	Good condition, some stop-log seal maintenance recommended (completed as of 2007).
Penstock	Internal corrosion products beginning to become pronounced in certain areas of the penstock – recommended thorough sandblast cleaning and application of coatings as part of life extension program.
Prime Machinery	Continued maintenance and upgrades as required.
Generator	Likely to require rewinding as part of life extension program, but currently in reasonable condition. (Major generator re-wedge occurred in 2004).
Surge Riser, Tower and Tank	Not inspected – recommended for thorough inspection.
Branch Penstock	Significant corrosion due to stagnant water – recommended isolation of the Branch Y within five years (as noted, the branch penstock was removed in 2004).
Ossberger Units	Recommended removal and re-instatement of original draft tube gates and hoisting equipment as part of life extension.
Powerhouse General/Structural	Some relatively minor maintenance recommended, including additional ventilation to avoid generator heat trips (ongoing, 2008).
Substation and Switchyard	Not inspected in detail. Transformers may require upgrade/repair through a life extension program. No possibility of expansion of existing switchyard, and a new substation would be required for any expansion.

6.1.4.8.2 Nonacho Lake Control Structure

A condition assessment of the existing structure at Nonacho Lake was planned as part of the Year 2003 Snap Lake Power Supply study program. The assessment was specifically aimed at establishing the condition of the timber sluice passages through the dam. However, at the time of the inspection in early August 2003, combined high leakage flows through the timber structures, the rockfill dam, and in particular the central sluice gate, which cannot be fully closed, prevented access downstream of any of the gates.

The following are observations resulting from the assessment.

- Dam leakage was observed to be in the range of 7 m^3/s to 10 m^3/s and perhaps higher, and may be increasing from historic observations.
- The sluice gates cannot be completely closed, indicating damage to guides or sluiceway, or debris caught in the sluiceway.
- There are no provisions for isolation of the gates or passages by stop-log or other isolation system, therefore inspection or maintenance on the guides and passages is not possible.

- There is a substantial amount of logs and other woody debris in the intake area of the sluice passages.
- The timber structures have operated in a high-energy environment for 36 years (now 40), and it would be expected that they are nearing the end of their service life.
- The rock cut spillway appears in fully satisfactory condition.

6.1.4.8.3 South Valley Spillway

The spillway was not inspected during this program as continued flows make inspection extremely difficult with inherent safety concern. Inspection is recommended at some point in the future when flows can be decreased to make access safe.

6.1.4.8.4 Condition Assessment Conclusions

The conclusions from the preliminary condition assessment of the existing facility suggest that an operational life extension of the existing Twin Gorges facility for up to another 40 years of operation is feasible. Key life extension upgrades recommended as part of the Taltson Hydroelectric Expansion Project are as follows:

- remove Ossberger units and reconstruct the gantry and draft tube gates on the existing powerhouse,
- clean and coat the internal surface of the main penstock,
- rehabilitate/replace the Nonacho Lake release structure, and
- other upgrades as identified in a complete plant inspection.

The Taltson Hydroelectric Expansion Project cost model currently includes a capital cost allowance for an upgrade of the existing Twin Gorges facility and the complete re-development of the Nonacho Lake control structure, in line with the recommendations noted above.

6.1.4.9 Taltson Twin Gorges Current Operation

Since the closure of the Pine Point Mine in 1986, the annual generation at Twin Gorges typically ranges from 7.5 MW in the summer/early fall to a peak of 13 MW in the winter, with an energy delivery to the communities of approximately 65 GWh/year. This represents approximately 40 to 65% of the potential capacity of the plant, and use of only 42% of the potential annual energy available, assuming sufficient flows are available year-round for the 18 MW installed capacity. While several dry periods did in fact occur during the period of mine operation where power flow was reduced, no such periods have occurred for over 20 years.

Currently, little requirement exists for regulated releases from Nonacho Lake to support generation at these lower levels, and gate adjustments at the Nonacho dam are made typically two or three times per year, mainly to control maximum lake elevations for the fishing lodge. The increased flow from Nonacho Lake, combined with the unregulated discharge from the Tazin River system, generally result in substantial excess water in the Twin Gorges Forebay. This water has been spilled into Trudel Creek more or less continually since 1986.

6.2 PROJECT DESIGN EVOLUTION – GENERATION AND LAKE CONTROL FACILITIES

6.2.1 General Approach

As a significant hydroelectric generation expansion facility in a large and complex watershed, the absolute key component in the design development and impact assessment has been to realize a firm understanding of the basin hydrology as it pertains to feasible water management, extreme event prediction and routing, generation plant sizing, predicted generation characteristics, and most recently, the study of operational impacts. This has been a main focus of study work since the inception of the project concept in 2003. A synopsis of the process undertaken to-date is provided in the following sections.

Some general characteristics of the Taltson River watershed were provided in Section 6.1.3, and provide some idea of the size and complexity of the watershed. Despite the existence of an operating plant within the basin, and what appear to be a reasonable distribution of WSC gauging stations (Figure 6.1.1) only a limited amount of data is in fact available for the assessment of key design parameters for a significant expansion proposal. Building from the available data, the feasibility design has therefore relied on the development of a number of numerical models of the hydrological characteristics and behaviour of the basin. The phases of work undertaken to support the current project design have included the following key steps:

1. Collection and collation of all relevant meteorological and hydrological data for the watershed to obtain a baseline hydrological database,
2. Development of a numerical hydrological model of the basin based on the available data and a limited amount of field observation at key points in the basin,
3. Concept design of new control structure at Nonacho Lake to optimize storage and routing of assumed inflow dataset,
4. Concept design of the new generation facility to be located at Twin Gorges,
5. Site capacity assessment based on the flow database routed through the new control structure and the existing and new generation facility to assess generation reliability for various expansion scenarios, and
6. Comparison of expected load demand from the mine customers to the feasible generation capacity range, and specification of installed capacity to match the demand requirements, while meeting all energy delivery reliability requirements for the existing load base.

These steps have been undertaken, beginning with the 2003 study, to supply the Snap Lake Mine with hydroelectric power from a smaller expansion of the existing site. A brief discussion of these steps is presented below.

6.2.2 Taltson Watershed Hydrological Database

A major component in the evolution of the project design has been the development of the hydrological database of the basin to assess critical design requirements, to size components, and to assess generation reliability for various installed capacity plants and more extreme hydrological events such as multi-year dry periods.

Typically, two approaches are used in the development of a database for a watershed such as Taltson: the synthesis of a set of flow records from a precipitation and watershed model (climate-based approach), or the pro-ration/allocation of a set of measured flow records to the various sub-basins through a set of basin characteristic assumptions. As at least some longer-term flow data is available for the watershed, and virtually no meteorological data exists for most of the basin, the hydrological database has been developed from existing flow records and operational data from the existing plant.

Water Survey Canada (WSC) has historically operated a total of eight gauging stations within the Taltson River system. Only two of these have remained active – Nonacho Lake (water level) and the Taltson River (flow) downstream of Elsie Falls – and only two have long-term records (Nonacho Lake and at the outlet of Tsu Lake) suitable for design assessment.

Table 6.2.1 lists the gauge sites and available data sets. Locations of the WSC gauges are shown in Figure 6.1.1. In June 2007, WSC was contracted to re-install the level gauge at Taltson River upstream of Porter Lake outflow (07QD004) and install a new station on the lowest reach of the Tazin River above the Taltson mainstem (07QC007).

As a result of the existing power development and the historic modes of operation, the general analysis of hydrometric data from the Taltson River Basin is usually divided into three time periods:

- 1943 (when data first became available) to 1968, when Taltson Twin Gorges was operating and Nonacho Lake dams were constructed, altering natural flows downstream of Nonacho Lake and in Trudel Creek;
- 1968 to 1986, when Taltson Twin Gorges was operating at capacity and providing power to the Pine Point Mine; and
- 1987 to present, after the closure of the Pine Point Mine, when power demands from Taltson Twin Gorges were significantly lessened.

Table 6.2.1 — Water Survey Canada Flow Gauges on the Taltson River System

Station ID	Latitude Longitude	Description of Location	Period of Record	Comments
07QA001	60°28′1″ N 111°30′46″ W	At outlet of Tsu Lake	1952-1997	No data available 1955 to 1961.
07QC003	60°30′18″ N 109°38′56″ W	Near inlet to Hill Island Lake	1968-1995	On Thoa River upstream of Hill Island Lake and Tazin River.
07QD002	61°43′50″ N 109°40′15″ W	Nonacho Lake near Łutsel K'e (Snowdrift)	1962-present	Water level gauge only.

Station ID	Latitude Longitude	Description of Location	Period of Record	Comments
07QD003	61°39′36″ N 109°58′7″ W	Near outlet of Nonacho Lake	1975-1977	WSC considers records to be poor. Flows are typically greater than those calculated as outflows from Nonacho Lake from rating equations.
07QD004	61°52′32″ N 107°40′12″ W	Taltson River above Porter Lake Outflow	1977-1990 2007 -	WSC considers records to be good.
07QD005	61°53′0″ N 107°41′50″ W	Porter Lake Outflow above Taltson River	1971-1981	Intermittent measurements on tributary to Taltson River.
07QD006	61°48′57″ N 107°52′11″ W	Porter Lake outflow	1983-1990	Tributary to Taltson River.
07QD007	60°28′1″ N 111°30′46″ W	Taltson River below hydro dam	1994-present	Reliable data and current data collection.
07QC007	60°24′31″ N 111°39′52″ W	Tazin River above Taltson River confluence	2007 - ongoing	Early phases of data development, data considered reasonable.

The longest running flow gauge data for the Taltson watershed is at the outlet of Tsu Lake (WSC 07QA001), which was installed well before construction of the existing Twin Gorges plant but was not regularly maintained as a data collection site until 1962. As this measurement gauge is relatively close to the Twin Gorges site (from a watershed area perspective), the Tsu Lake outflow gauge data has been used as the starting point for the creation of the baseline flow dataset. The Tsu Lake gauge was replaced by WSC in 1994 with the currently operated gauge downstream of Elsie Falls (07QD007), with some overlap in records allowing comparison. As these records show good comparative consistency, the new gauge data has been used in conjunction with the Tsu Lake record, with the 45-year period 1962 to 2007 (water year basis) used for the baseline hydrological data set.

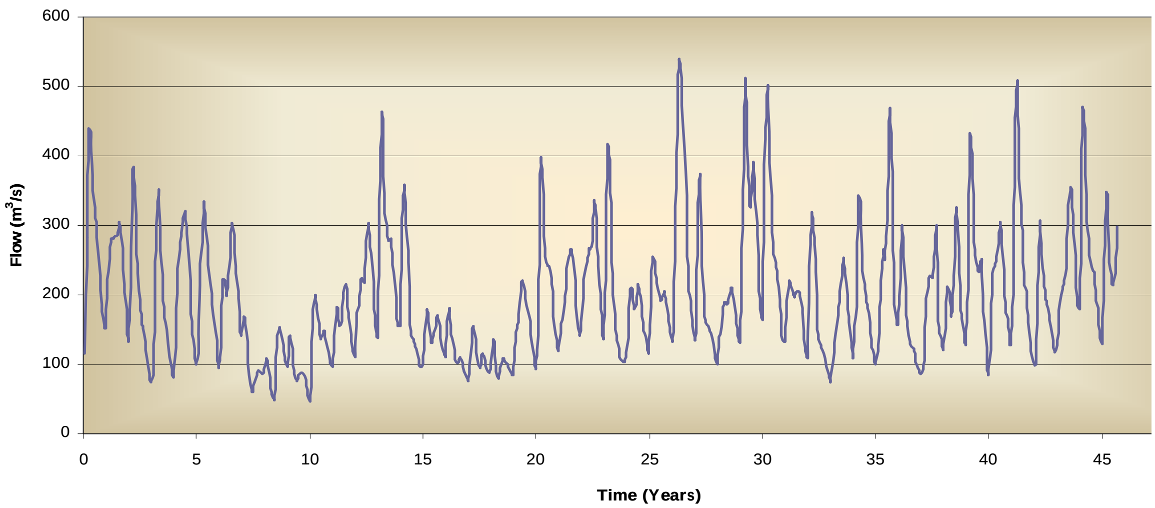
The availability of a 45-year set of WSC average daily flow records close to Twin Gorges is considered an excellent hydrological record to build from for the Expansion Project generation assessment and preliminary design. The monthly average data set from the Tsu Lake and contiguous Taltson River gauge sites is shown in Table 6.2.2 and Figure 6.2.1.

Table 6.2.2 — Average Monthly Flow (m^3/s) Data Set: 1962 to 2007

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1962					115	282	440	433	363	318	297	265	
1963	228.0	186.0	151.0	151.0	210.0	252.0	281.0	281.0	284.0	287.0	306.0	299.0	**243.0**
1964	255.0	215.0	169.0	137.0	242.0	370.0	385.0	293.0	231.0	185.0	163.0	151.0	**233.0**
1965	132.0	109.0	85.9	73.6	89.8	11.0	280.0	351.0	281.0	213.0	175.0	150.0	**162.6**
1966	129.0	111.0	92.3	82.6	141.0	221.0	276.0	289.0	305.0	321.0	288.0	244.0	**208.3**
1967	197.0	152.0	122.0	100.0	125.0	226.0	289.0	335.0	307.0	260.0	228.0	202.0	**211.9**
1968	170.0	144.0	124.0	95.6	139.0	223.0	219.0	199.0	218.0	265.0	304.0	278.0	**198.2**
1969	241.0	195.0	161.0	141.0	169.0	168.0	120.0	85.3	60.5	63.3	74.6	85.1	**130.3**
1970	92.2	88.1	85.5	87.2	109.0	106.0	73.8	59.6	49.5	84.0	135.0	153.0	**93.6**
1971	145.0	128.0	110.0	97.3	131.0	141.0	114.0	86.6	75.5	83.7	85.7	87.8	**107.1**
1972	86.3	77.2	59.3	48.0	95.3	168.0	200.0	179.0	153.0	137.0	148.0	146.0	**124.8**
1973	132.0	117.0	106.0	96.5	127.0	182.0	178.0	155.0	162.0	203.0	215.0	196.0	**155.8**
1974	167.0	143.0	122.0	112.0	166.0	192.0	220.0	224.0	218.0	265.0	304.0	278.0	**200.9**
1975	239.0	199.0	162.0	140.0	293.0	458.0	415.0	328.0	294.0	278.0	281.0	251.0	**278.2**
1976	214.0	181.0	155.0	156.0	287.0	359.0	318.0	247.0	181.0	142.0	137.0	129.0	**208.8**
1977	114.0	102.0	95.9	99.8	131.0	179.0	170.0	131.0	133.0	142.0	161.0	171.0	**135.8**
1978	149.0	128.0	116.0	110.0	151.0	181.0	148.0	129.0	114.0	103.0	103.0	110.0	**128.5**
1979	101.0	89.2	81.4	76.5	85.8	143.0	155.0	129.0	107.0	95.0	108.0	116.0	**107.2**
1980	105.0	92.7	87.7	92.9	136.0	132.0	90.3	79.8	90.3	109.0	108.0	103.0	**102.2**
1981	100.0	92.8	86.3	83.7	146.0	155.0	160.0	217.0	220.0	205.0	185.0	170.0	**151.7**
1982	154.0	131.0	110.0	95.3	166.0	322.0	398.0	323.0	255.0	241.0	242.0	225.0	**221.9**
1983	187.0	155.0	134.0	119.0	153.0	163.0	190.0	227.0	246.0	262.0	265.0	238.0	**194.9**
1984	202.0	167.0	142.0	149.0	208.0	232.0	248.0	267.0	265.0	278.0	336.0	296.0	**232.5**
1985	241.0	190.0	157.0	138.0	257.0	413.0	379.0	283.0	215.0	162.0	142.0	117.0	**224.5**
1986	107.0	103.0	105.0	110.0	150.0	208.0	209.0	180.0	191.0	215.0	209.0	185.0	**164.3**
1987	153.0	140.0	127.0	118.0	204.0	253.0	245.0	217.0	202.0	192.0	193.0	205.0	**187.4**
1988	189.0	171.0	153.0	132.0	174.0	282.0	470.0	539.0	499.0	443.0	379.0	303.0	**311.2**
1989	211.9	190.9	163.9	135.2	167.0	309.0	374.0	266.0	185.0	161.0	156.0	150.0	**205.8**
1990	144.0	129.0	113.0	99.8	133.0	153.0	173.0	189.0	187.0	188.0	211.0	211.0	**160.9**
1991	194.0	171.0	146.0	132.0	221.0	426.0	512.0	441.0	337.0	326.0	391.0	353.0	**304.2**
1992	287.0	230.0	187.0	165.0	350.0	480.0	501.0	413.0	323.0	266.0	247.0	230.0	**306.6**
1993	193.0	154.0	134.0	132.0	180.0	221.0	217.0	200.0	197.0	203.0	206.0	203.0	**186.7**
1994	175.0	148.0	125.0	110.0	212.0	318.0	307.0	233.0	170.0	136.0	127.0	120.0	**181.8**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1995	109.0	96.5	85.0	74.3	91.3	118.0	144.0	171.0	196.0	237.0	253.0	231.0	**150.5**
1996	199.2	160.4	130.4	108.8	145.1	201.9	341.6	328.5	247.6	208.6	193.5	186.7	**204.4**
1997	159.7	129.6	113.4	100.5	128.4	164.5	205.5	265.1	252.2	330.0	408.5	467.6	**227.1**
1998	339.0	200.1	158.1	156.2	246.1	299.3	272.6	190.5	155.3	133.6	125.5	122.0	**199.9**
1999	109.0	99.3	91.7	85.9	92.7	125.0	182.7	218.9	227.6	224.0	239.9	298.8	**166.3**
2000	185.2	147.9	135.7	123.3	163.5	210.2	199.0	168.2	181.0	277.6	326.6	248.4	**197.2**
2001	186.6	172.6	137.4	129.4	242.5	427.9	386.9	303.6	256.7	240.3	233.5	249.3	**247.2**
2002	188.5	143.3	106.6	86.7	137.2	230.3	241.5	248.0	282.2	304.6	285.5	220.5	**206.2**
2003	181.0	160.0	131.0	128.0	234.0	423.0	509.0	389.0	313.0	274.0	220.0	200.0	**263.5**
2004	160.0	131.0	110.0	99.0	106.0	182.0	305.0	258.0	219.0	199.0	189.0	170.0	**177.3**
2005	156.0	134.0	118.0	127.0	163.0	189.0	209.0	216.0	249.0	315.0	356.0	341.0	**214.4**
2006	304.0	241.0	186.0	179.0	330.0	468.0	420.0	323.0	271.0	249.0	235.0	231.0	**286.4**
2007	198.0	175.0	141.0	131.0	219.0	346.0	331.0	257.0	225.0	213.0	242.0	299.0	**231.4**
Avg.	**175.8**	**147.1**	**124.7**	**114.3**	**173.1**	**246.0**	**271.8**	**246.7**	**221.6**	**218.2**	**218.9**	**210.6**	**196.4**

Figure 6.2.1 — Average Monthly Flow (m^3/s) Data Set: 1962 to 2007 Near Twin Gorges



The flow recorded downstream of Twin Gorges and forming the baseline data set necessarily includes the net contribution from all of the sub-basins upstream of the gauge site. In fact, the division of flows between the Taltson River mainstem at Nonacho Lake and that entering from the Tazin River system is critical to the facility design, as only the Nonacho Lake inflows are regulated. This issue has been studied on a number of occasions in the past, but no final conclusion has been made on this flow division, and historic gauging information does not provide any definitive assessment. To alleviate this issue, a new flow gauge was installed in the lowest reach of the Tazin River in June, 2007, and this data is currently being assessed and integrated into the hydrological model assumptions. On the basis of sub-basin area, it would be expected that approximately 50% of the flow at Twin Gorges would come through Nonacho Lake. In the current hydrological model, a range of flow division from 45 to 55% of the total flow below Twin Gorges can be defined for the Nonacho Lake inflow on an annual water balance basis.

Once the flow division noted above is established, the baseline data set for all of the modelling is then the inflow to Nonacho Lake, where the flow releases are regulated, and the balancing flows set from the Tazin River and other more minor downstream catchments, which remain unregulated.

6.2.3 Concept Level Design

In conjunction with the development of the hydrological database, the concept designs for the Nonacho Lake control structure and the generation plant were developed. At Nonacho Lake, the concept designs capture key elements of the structures and functions necessary to provide enhanced water management at the site. At Twin Gorges, the concept designs incorporate the generation characteristics available at the Twin Gorges site for a modern plant and generic layout. These concept designs then allow initial project cost/benefit assessment, and sensitivity analysis for various operational and hydrological scenarios. The actual assessment is performed with the generation model, which uses the historic hydrological database running through the proposed new structures and operating logic.

6.2.4 Generation Model

The generation model uses the data sets described above in combination with the concept design of the control and generation facility, and any known and quantifiable large scale characteristics of the Taltson watershed above Twin Gorges that affect flow release and flow routing. Inherent in this assessment is the use of historic data to represent a future flow sequence for design assessment and to forecast operational decision-making. At present, no other reliable means exists to develop a realistic database for potential future natural flow sequences.

To date, the generation model has been developed to incorporate and assess the impact of the following key basin and Expansion Project characteristics:

Nonacho Lake

- inflows to Nonacho Lake from data set – variable from 45% to 55% of total,
- natural regulation and routing through Nonacho Lake (storage curve),
- unregulated release through Tronka Chua Gap into Tronka Chua Lake system as a function of lake level,
- unregulated release over the outlet spillway as a function of lake level and spillway sill level,
- impact of raising spillway sill level,
- release requirements (and limits) through the new control structure based on forecast demand at Twin Gorges and gate discharge curves, and
- adoption of rule curves and operating criteria consistent with the existing Water License, including a minimum release from Nonacho Lake and minimum water level criterion in the lake.

Twin Gorges Facility

- generation flow available at Forebay from all upstream contributions,
- disposition of flows through the two plants (expansion plant first on, last off),
- detailed generation characteristics of new and existing plants,
- minimum release requirements into Trudel Creek,
- unregulated spill from Twin Gorges Forebay to Trudel Creek,
- energy generation of both plants,
- plant generation reliability, and
- specific assessment of system performance for abnormal dry flow sequences (several of these appear in the period of record).

As the daily variances in Taltson River flows are quite low, a monthly time step is used in the generation model. The model uses a number of rule curves and targets for water levels and minimum releases in accordance with the current Water Licence requirements for both the Nonacho Lake and Twin Gorges dams. These water level targets trigger constraints and actions within the model to limit lake and Forebay level and flow excursions to defined limits, and simulate expected operating criteria for the Expansion Project.

The detailed assessment of project performance using the generation model is detailed in Section 6.7. As noted, the model is working from historic data, and can simulate only the manner in which the new Project would be optimized and operated for such a historic flow sequence. In reality, the actual set of flows to be encountered after construction would be quite different, and may have led to a slightly different conclusion on project design. The design must therefore be developed with a conservative viewpoint, and allow as much flexibility in operations as possible to account for hydrological and operations requirements variability. The final design development stage would allow further opportunity to fine-tune the Project characteristics as presented herein.

6.2.5 Site Capacity Assessment and Plant Sizing

The generation model provides a means of assessment of a range of design parameters and installed plant capacities (sizes) from the basic hydrological perspective. The initial studies on site capacity (2003) concluded that the Twin Gorges site could support a total capacity in the range of 45 MW to 55 MW, with annual generation output reliability consistent with typical commercial requirements for baseload stations (capacity factor above about 90%). This capacity assessment includes the 18 MW capacity of the existing Twin Gorges plant.

On the basis of the initial site capacity assessment, the feasibility design of a 36 MW, two unit expansion plant was developed for the Twin Gorges site, along with a control structure at Nonacho Lake targeted for water management specific to support the 36 MW expansion with the 18 MW existing plant (total capacity of 54 MW). The design development in turn leads to fine tuning of the generation model to reflect more specific design details, such as number of units and expected efficiencies. As well, transmission design advanced during this period, and specific information on anticipated line losses and performance requirements information became available.

Since the initial concept studies and feasibility design development, further assessments based on a longer period of hydrological record, and a wider range of criteria and incremental benefit/cost analysis have been undertaken and continue. As well, load demand from the customer base appears to be growing. The plant sizing analysis is presented in Chapter 8 – Alternatives as a portion of the Alternatives assessment for the Project. In summary, these more recent assessments indicate that an expansion plant larger than 36 MW is likely economically beneficial and would provide a better resource utilization of the basin within the existing development framework of Nonacho Lake and Twin Gorges.

6.2.6 Taltson River Basin Model

The generation model discussed above considers only the points in the basin specifically associated with inflow/outflow control or generation, basically Nonacho Lake and Twin Gorges. To help quantify the operational effects of the new Project on the basin characteristics as a whole, another numerical model has been under development since 2006, the Taltson Basin Flow Model. While ultimately it is anticipated that this model would become quite sophisticated and embody most of the operating strategy for the Project, the specific purpose of the model at this stage is to assess larger-scale changes in timing and characteristics of flow conditions, and lake and river levels throughout the basin sub-sectors that would be influenced by the construction and operation of the Expansion Project. In turn, these results would be used to determine the specific environmental impacts associated with the Project. While not specifically feeding back into the project design evolution, any significant negative impacts associated with the Project and predicted by the Basin Model are used to assess possible mitigation measures, generally related to operational scenarios. The Basin Model is also a key component in the definition of an optimized Project sizing, and forms a key component in the overall Alternatives assessment of Chapter 8. The Basin Model is described in detail in Chapter 9 – Existing Environment.

6.3 PROJECT DESIGN EVOLUTION – TRANSMISSION AND SUBSTATION FACILITIES

6.3.1 General Approach

The transmission and substation design evolution has built from the original work undertaken in the 2003 study phase to supply the Snap Lake Mine with power from Twin Gorges. While that work initially concluded that an East Arm route would be the most viable, some study work was conducted on marine crossing scenarios in the vicinity of the Simpson Islands (Mariport Group 2003).

This work was extended in 2004 study programs to define technical requirements and initial routing to supply all of the proposed and operating diamond mine sites. System studies for line voltage stability, conductor size optimization, voltage level, tower type and configuration, substation equipment requirements, and other key attributes of the line were established at this early phase (IHI 2003, 2005, 2006) and have been recently reviewed in view of updated mine energy and capacity requirements. Construction methodology has been completely reviewed in the more recent work with significant efforts made on establishing modes of access and construction (Teshmont Consultants 2008).

Further detailed line routing assessment has most recently been undertaken to respond to the requirements set by the Developer's Assessment Report Terms of Reference. The work has also included optimization and mitigation study of the preferred routes. These routing studies and findings are fully detailed in Chapter 8, Alternatives.

6.4 PROJECT DESCRIPTION – PREFERRED EXPANSION PROJECT CONCEPT

The preferred concept for the Taltson Hydroelectric Expansion Project has evolved from the basic design processes noted above, the continuing economic viability assessments, updating of hydrological and environmental constraints/requirements, and the formal alternatives assessments discussed in Chapter 8 - Alternatives. The key permanent components of the proposed Project are as follows:

- new two-unit generation plant located on north side of existing plant and connecting the existing Forebay to the Taltson River downstream of Elsie Falls through an open canal, two penstocks, powerhouse and tailrace canal;
- new gated control structure at Nonacho Lake, repair of rock fill dam, and decommissioning of existing gates;
- addition of a minimum flow release facility through the South Valley Spillway to allow continuous regulated releases into Trudel Creek;
- addition of a by-pass spillway with release capability of up to 30 m^3/s on the left bank of the dam and releasing to the South Gorge above Elsie Falls;
- development of an integrated switchyard for existing 115 kV and new 161 kV lines at Twin Gorges;
- 161 kV transmission line running from Twin Gorges around the East Arm of Great Slave Lake to a branch point at Gahcho Kué mine site, with a westward spur to Snap Lake mine site, and northward extension to Ekati and Diavik mine sites;
- electrical substations at each of the four mine sites; and
- life extension of existing plant through a number of upgrades and maintenance processes.

In addition to the permanent components, temporary infrastructure would be required for construction of the facilities. This infrastructure would generally be removed or decommissioned at the completion of construction.

These components are described in further detail in following sections.

6.4.1 Generation Facility – North Gorge Site

The generation facility associated with the Taltson Hydroelectric Expansion Project is located at the Twin Gorges site, slightly north of the existing plant. A general arrangement of the facility is shown in Figure 6.4.1 and Figure 6.4.2. The water conveyance canal to the new powerhouse enters the Forebay near the right abutment of the existing dam and upstream of an old river channel now blocked by the dam, known as the North Gorge. This development scenario has therefore been called the North Gorge site. An entirely different development water conveyance scenario was also considered, and is discussed in Chapter 8, but found to be less attractive than the North Gorge site.

The water conveyance canal from the Forebay runs a total distance of 1,250 m to a gated concrete intake structure. The canal would be excavated in sound rock, and would be primarily unlined. The concrete intake structure directs the flows into twin steel penstocks that would be buried. The penstocks deliver flow to the two turbines through a steel manifold located in the powerhouse. The powerhouse would be excavated into rock, but would be housed in a surface building (not underground). Once through the turbines, the water rejoins the Taltson River through a rock tailrace canal. A cross-section of the water conveyance and plant is shown in Figure 6.4.2. This arrangement represents the shortest water conveyance distance for a feasible connection of the existing Forebay and the Taltson River downstream of Elsie Falls. The existing plant has a much shorter water conveyance system, but uses only the head available from the dam to the former base of the Twin Gorge rapids, and does not capture the significant elevation drop of Elsie Falls.

Access to the new facility would be via the existing dam and new access roads to the canal termination/intake and the powerhouse sites. A 1.5 km section of 161 kV transmission line would connect the new plant substation to the main switchyard to be located next to the existing generating plant.

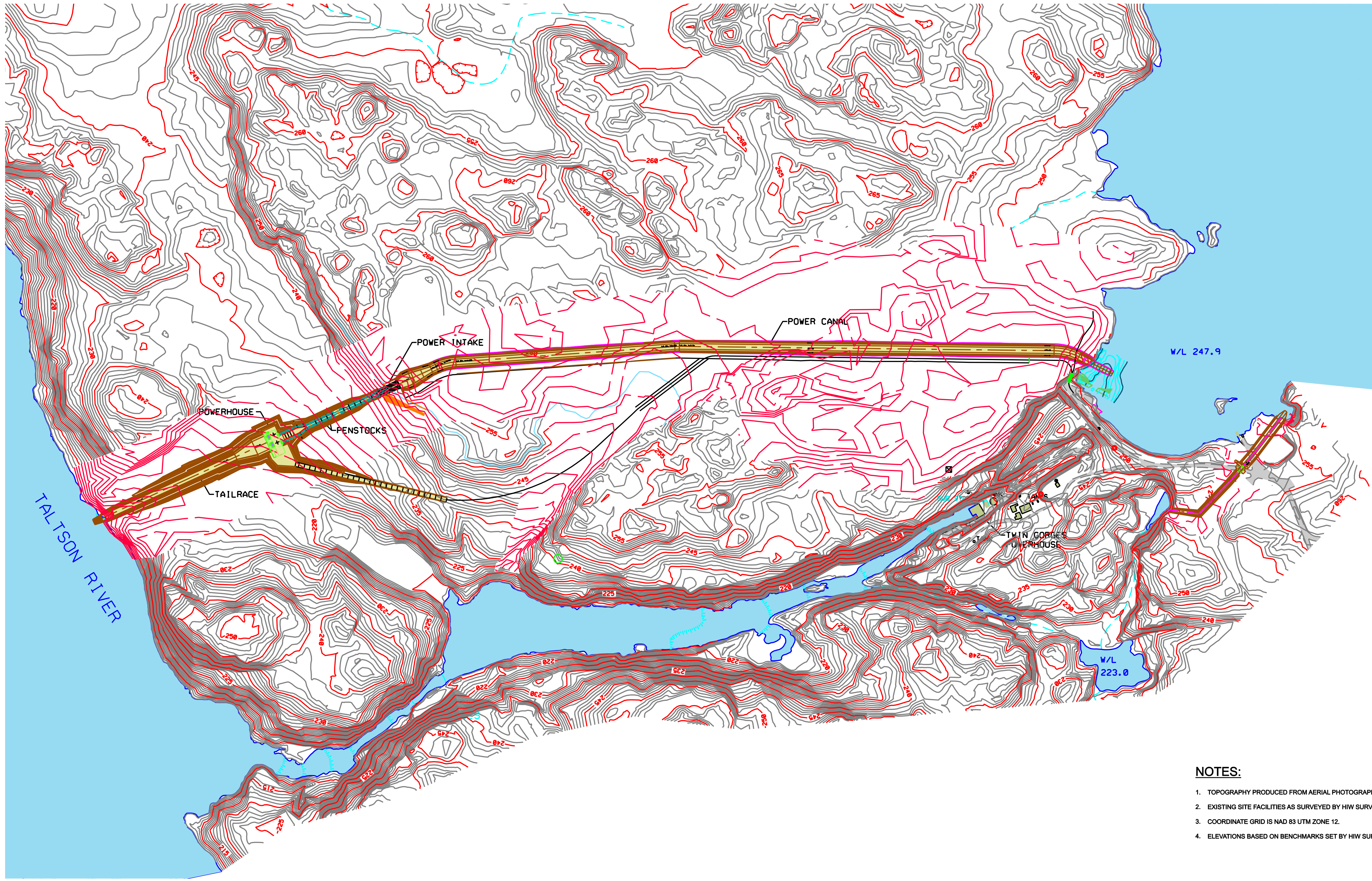
The new powerhouse would house two or possibly three vertical-shaft Francis or Kaplan turbines and associated synchronous generators. The total installed capacity would be rated between 36 MW and 56 MW. With the existing facility running at full capacity, the total output of the Taltson Expansion Project would therefore be in the range of 54 MW to 74 MW. Basic characteristics of the Project are summarized in Table 6.4.1.

The total plant flow for the Expansion Project operating at capacity is the sum of the two plant flows, or approximately 180 m^3/s for the 54 MW total plant size, and 240 m^3/s for the 74 MW total plant size. These design flows span the mean annual discharge of the Taltson River at Twin Gorges, estimated at 196 m^3/s over the period of record 1962 to 2007. As discussed in following sections, when lower flows are available, the Project would be operated such that the new plant is given water preferentially over the existing plant. The rationale is that the new plant would generate over 45% more energy from the same water in the Forebay than the existing plant, due to the increased operating head and higher efficiencies available from the newer generation equipment.

Table 6.4.1 — Generation Project Characteristics for 36 MW and 56 MW Expansion Plant Sizes

Characteristic / Option	North Gorge (New 36 MW Plant)	North Gorge (New 56 MW Plant)	Twin Gorges Plant (Existing)
Water conveyance length: Power Canal Penstock Tailrace Canal	1,830 m 1,250 m 240 m 340 m	As per 36 MW	400 m - 375 m 25 m
Gross Head	41.0 m	41.0 m	29.0 m
Design Flow	107.5 m^3/s	165 m^3/s	74 m^3/s
Installed Capacity	36 MW	56 MW	18 MW
Number of Units	2	2 or 3	1
Machine Efficiency	94%	94%	89% (estimate)
Plant Capacity Factor over Record	98%	86%	83%[1] 58%
Average Annual Energy (Gross)	309 GWh	424 GWh	131/92 GWh
Construction Period/Refurbishment	27 months from a December start	27 months from a December start	6 months

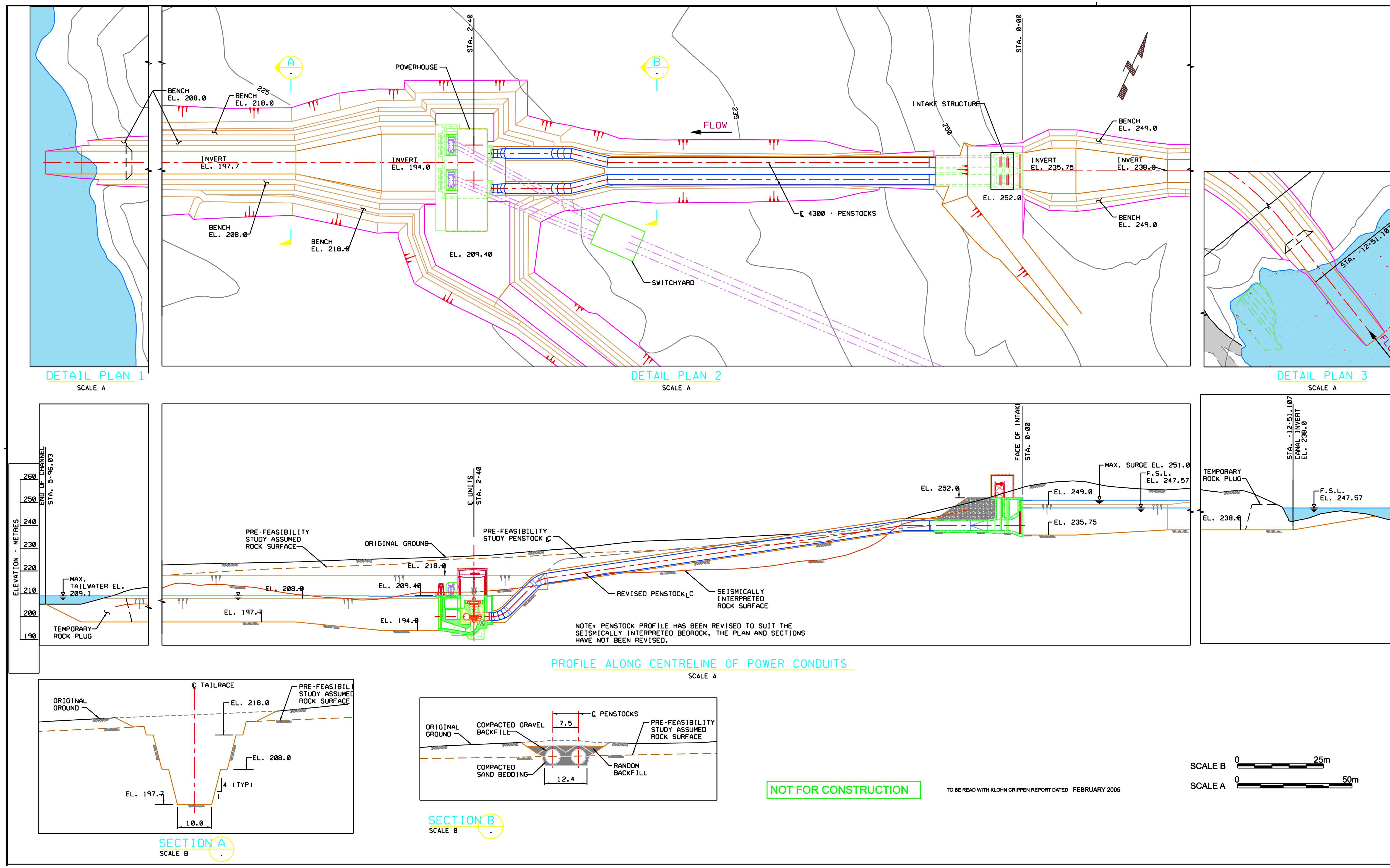
[1] Output of existing plant is a function of Expansion Plant size – both results are shown.



NOTES:

1. TOPOGRAPHY PRODUCED FROM AERIAL PHOTOGRAPHS TAKEN IN OCTOBER 1967.
2. EXISTING SITE FACILITIES AS SURVEYED BY HIW SURVEYS LTD., JULY 2003.
3. COORDINATE GRID IS NAD 83 UTM ZONE 12.
4. ELEVATIONS BASED ON BENCHMARKS SET BY HIW SURVEYS IN 2003.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	General Arrangement - North Gorge Option	Figure 6.4.1



TALTSON
HYDROELECTRIC EXPANSION PROJECT

Developer's Assessment Report
2009

Cross Section of Water Conveyance Canal and Plant

Figure
6.4.2

A construction schedule has been developed for the Project, assuming that a construction contract could be in place for a December, Year 1 mobilization to site (assumed 2010/2012). The December mobilization would maximize the use of the winter road for the first year of the construction, with this access availability a key consideration in overall development logistics. With this assumption, the schedule indicates commercial operation of the first unit in January, Year 3, and the other units in March, Year 3, for a total construction period of approximately 27 months for the plant expansion at Twin Gorges.

6.4.2 Nonacho Lake Control Structures

The existing Nonacho Lake control structures comprise the rockfill dam and its three timber-lined sluice passages, and the adjacent rock channel spillway, both located at the natural outlet of Nonacho Lake. The dam has a significant leakage issue, and the sluice gates have reached the end of their serviceable life. As the Taltson Expansion Project would require a much larger release from the lake than is currently possible through the timber sluiceway gates, a new control structure has been developed to replace the existing sluice gates. The general layout of the proposed new Nonacho Lake structure is shown in Figure 6.4.3, Figure 6.4.4 and in Plate 6.4.1. The new structure would comprise the following key components:

- a short intake canal in rock from the lake at a point upstream of the left abutment of the existing dam;
- a concrete structure housing four gated sluice passages capable of releasing 120 m^3/s at a relatively low lake level (near the current minimum of 321.7 masl), and up to approximately 160 m^3/s at higher lake levels (above 324.0 masl);
- a rock cut canal downstream of the gates to the existing release channel downstream of the dam;
- a micro-hydro generation plant to supply sufficient power for heating of the gates, equipment operations, lighting and control/communications,
- a backup diesel generator and associated equipment; and
- a spillway raise of approximately 0.5 m through installation of a concrete sill across the rock entry sill on the existing rock channel spillway.

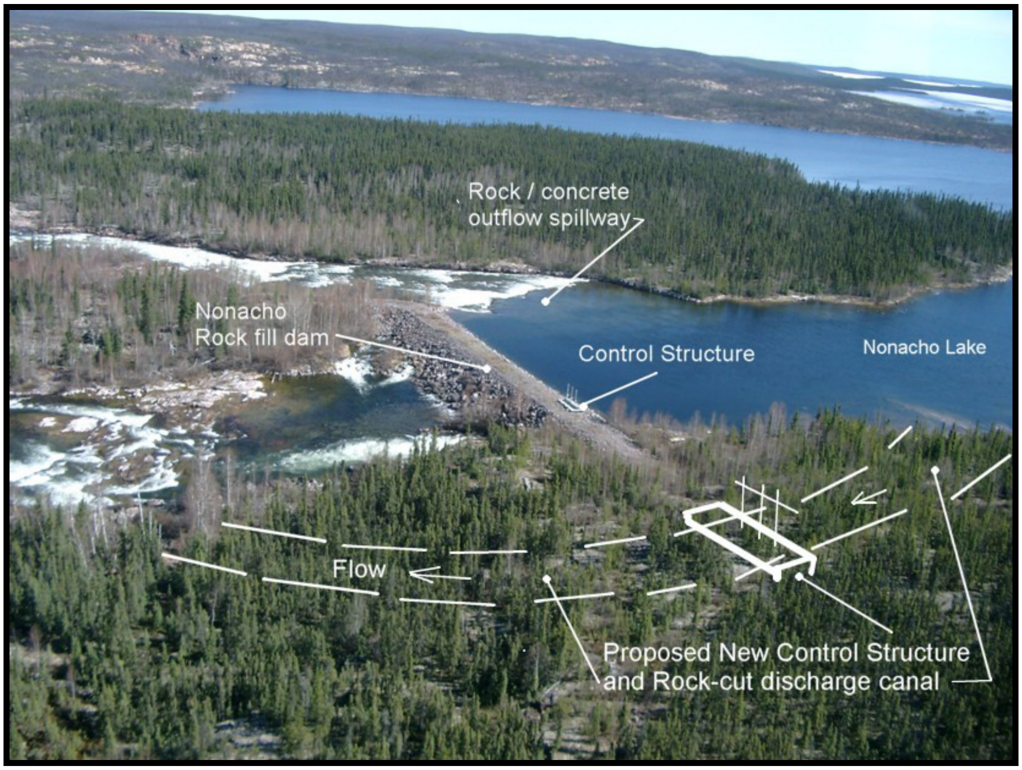
The general characteristics of the new control structure are summarized in Table 6.4.2.

Materials from the canal and gateworks structure excavation would be used for both a new upstream blanket and a raise of the existing dam to decrease the leakage through the structure and provide additional freeboard. The existing gates would be permanently closed, and the sluices filled with both fine and coarser materials, and grouted if required. Sufficient material would be placed in front of the sluice area such that the continued degradation of the timber structures in the existing structure would not affect the dam performance.

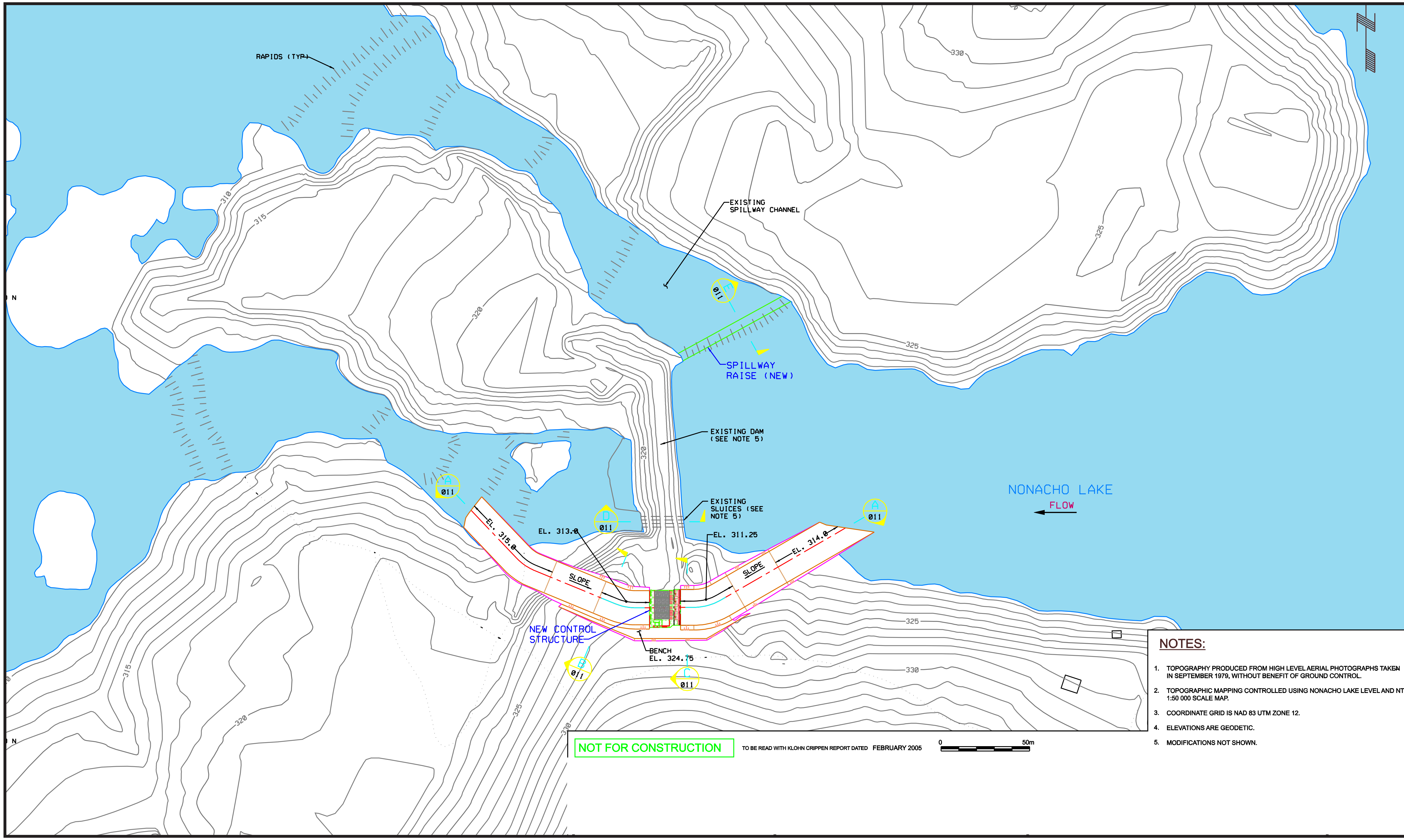
Table 6.4.2 — Nonacho Lake Control Structure Summary

Characteristic	Control Structure
Water conveyance length: Entrance Canal Tailrace Canal	220 m 100 m 120 m
Design Flow	120.0 – 170.0 m^3/s
Construction Period	15 months from a December start

Plate 6.4.1 — Nonacho Lake Structure



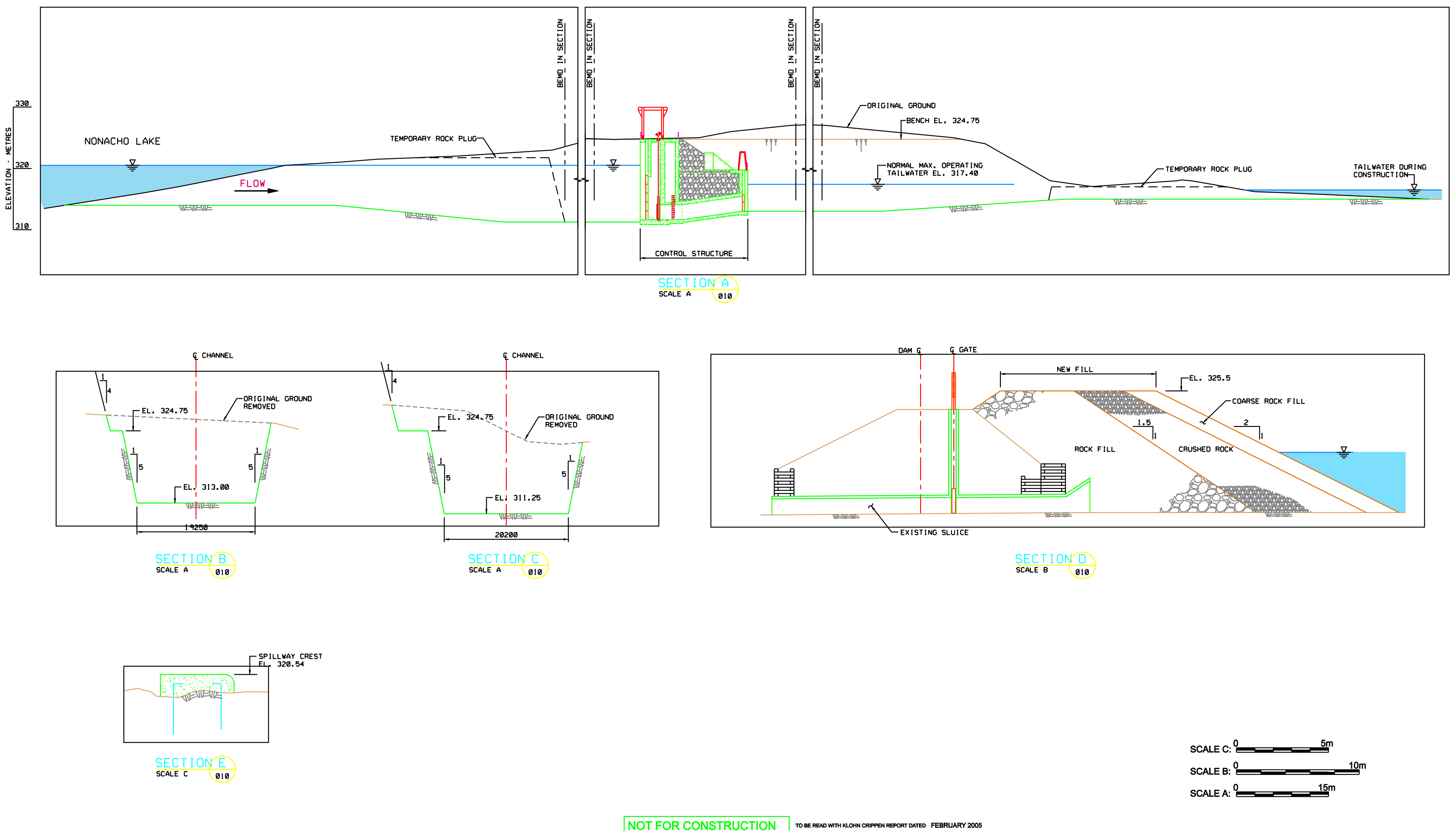
Dezé energy



NOTES:

1. TOPOGRAPHY PRODUCED FROM HIGH LEVEL AERIAL PHOTOGRAPHS TAKEN IN SEPTEMBER 1979, WITHOUT BENEFIT OF GROUND CONTROL.
2. TOPOGRAPHIC MAPPING CONTROLLED USING NONACHO LAKE LEVEL AND NTS 1:50 000 SCALE MAP.
3. COORDINATE GRID IS NAD 83 UTM ZONE 12.
4. ELEVATIONS ARE GEODETIC.
5. MODIFICATIONS NOT SHOWN.

TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	Nonacho Lake Control Structure Site Plan	Figure 6.4.3



TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	Nonacho Lake Control Structure - Cross Section	Figure 6.4.4

The current Water Licence for the existing Taltson Twin Gorges facility includes the Nonacho Lake structure and operation, and stipulates the minimum operating water level in the lake (321.7 masl in revised datum) and a minimum release of 14 m^3/s below the dam/spillway. Anticipating that these requirements would remain in any new arrangement, they have been retained as a part of the design development and included in the hydrological model. As the removal or rehabilitation of the Nonacho Lake control structure is likely to be required in a life extension and eventual re-licensing of the existing generation facility at Twin Gorges, the construction of the new structure within the Expansion Project is of significant benefit to the existing customers of NTPC.

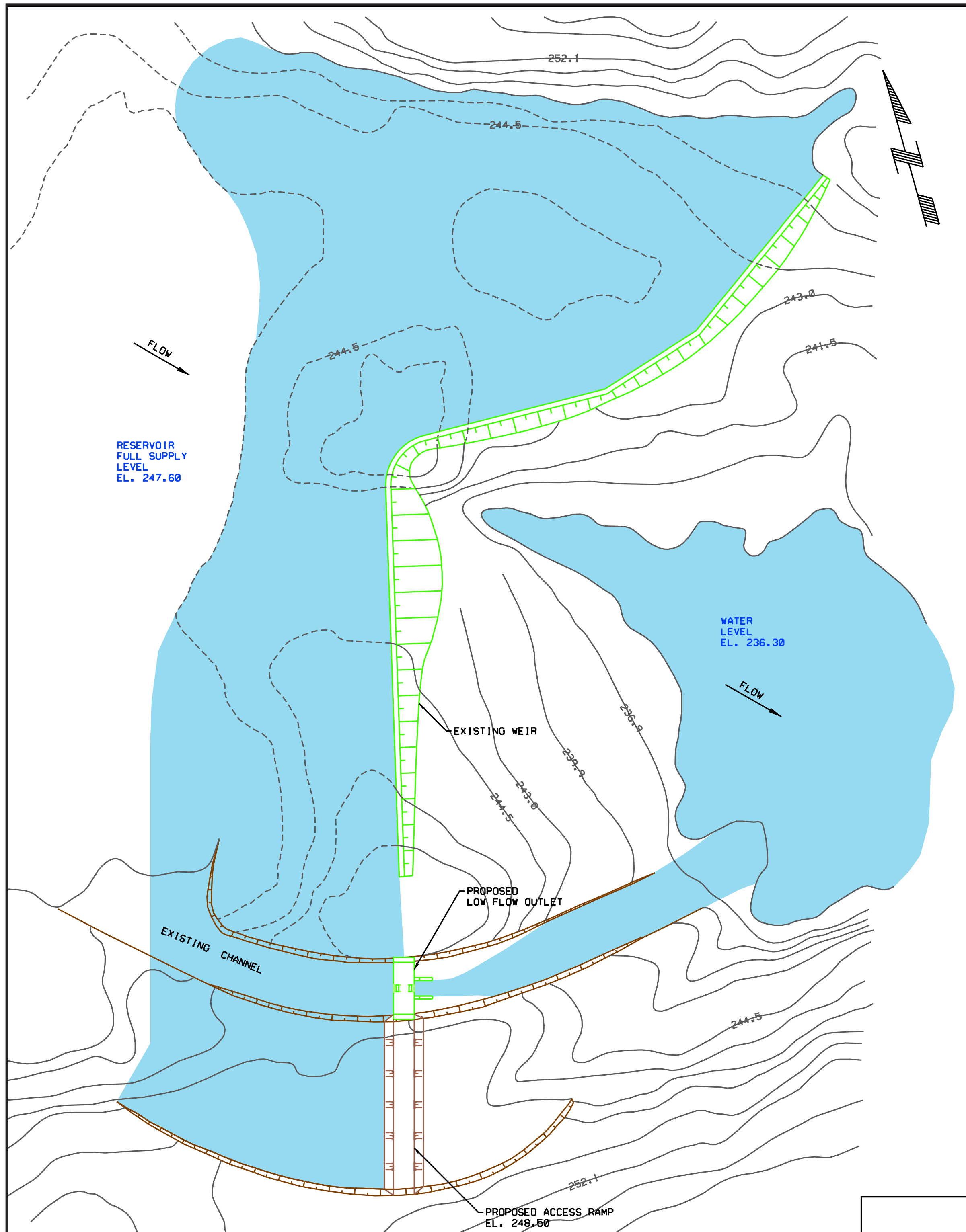
A construction schedule has been prepared on the basis of the preliminary design as discussed above. Assuming a late autumn construction award, early winter mobilization, and the existence of the winter road developed for the transmission line construction in close proximity to the new lake outlet structure, the schedule indicates construction duration of approximately 15 months. This duration would fit well into the overall Project construction duration anticipated to be approximately 30 months, but is not completely critical to the commencement of initial Expansion Project operations.

No construction of facilities or changes to flows are currently envisaged to the natural flows leaving Nonacho Lake through the Tronka Chua Gap. These flows, which can be significant in the freshet when lake levels are high, flow through the parallel Tronka Chua and Thekulthili Lake system, and re-enter the mainstem Taltson River at Lady Grey Lake, approximately 110 km upstream of Twin Gorges. The hydrological model includes these unregulated flow releases.

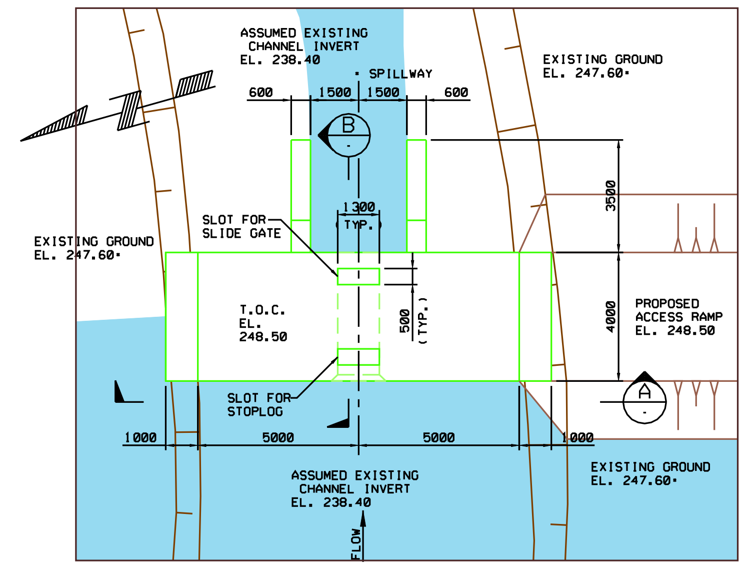
6.4.3 South Valley Spillway and Minimum Flow Release Structure

The existing Forebay formed by the Taltson Twin Gorges dam and the associated South Valley Spillway into Trudel Creek would not be altered in any significant way within the Taltson Hydroelectric Expansion Project, other than to incorporate a minimum flow release structure. The Project operating Forebay level would be kept within historical operational ranges, and typically just slightly below the spillway crest (248.1 masl). Forebay level excursions would be forecast to decrease with the Expansion Project, as the new regulating structure on Nonacho Lake would provide increased control of flow releases into the upper Taltson River, and the expanded plants would use significantly more flow.

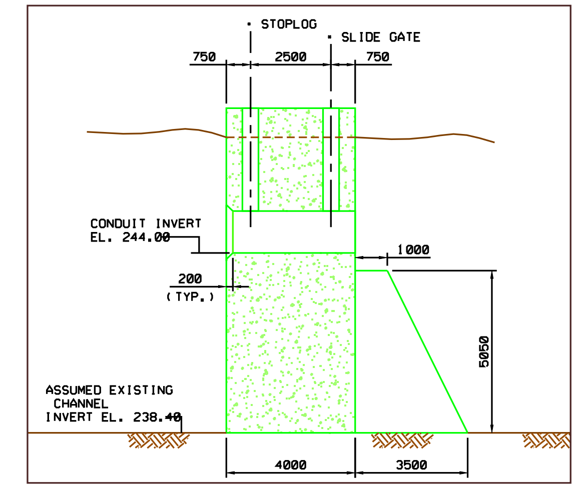
The minimum release structure would be a gated concrete release facility located on the right bank of the main weir of the South Valley Spillway. The release facility would be designed with full redundancy, with two gates each capable of releasing more than the required minimum discharge at an established minimum Forebay level (247.5 masl). Currently, the minimum release flow is set to 4 m^3/s. The general layout of the SVS and the proposed new minimum release structure is shown in Figure 6.4.5.



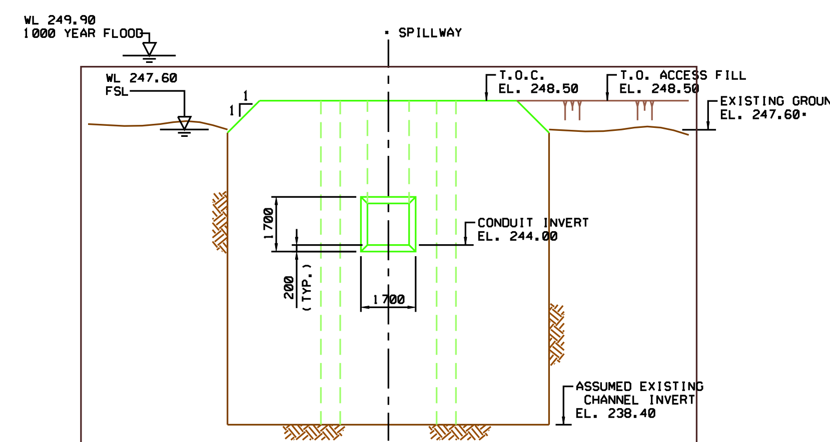
PLAN - SOUTH VALLEY SPILLWAY
SCALE 1:500



PLAN - SOUTH VALLEY
LOW FLOW OUTLET
SCALE 1:100



SECTION B
1:100



SECTION A
1:100

NOT FOR CONSTRUCTION

NOTES:

1. PLAN DIGITIZED FROM HISTORICAL DRAWING.

TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	South Valley Spillway Minimum Release Facility	FIGURE 6.4.5

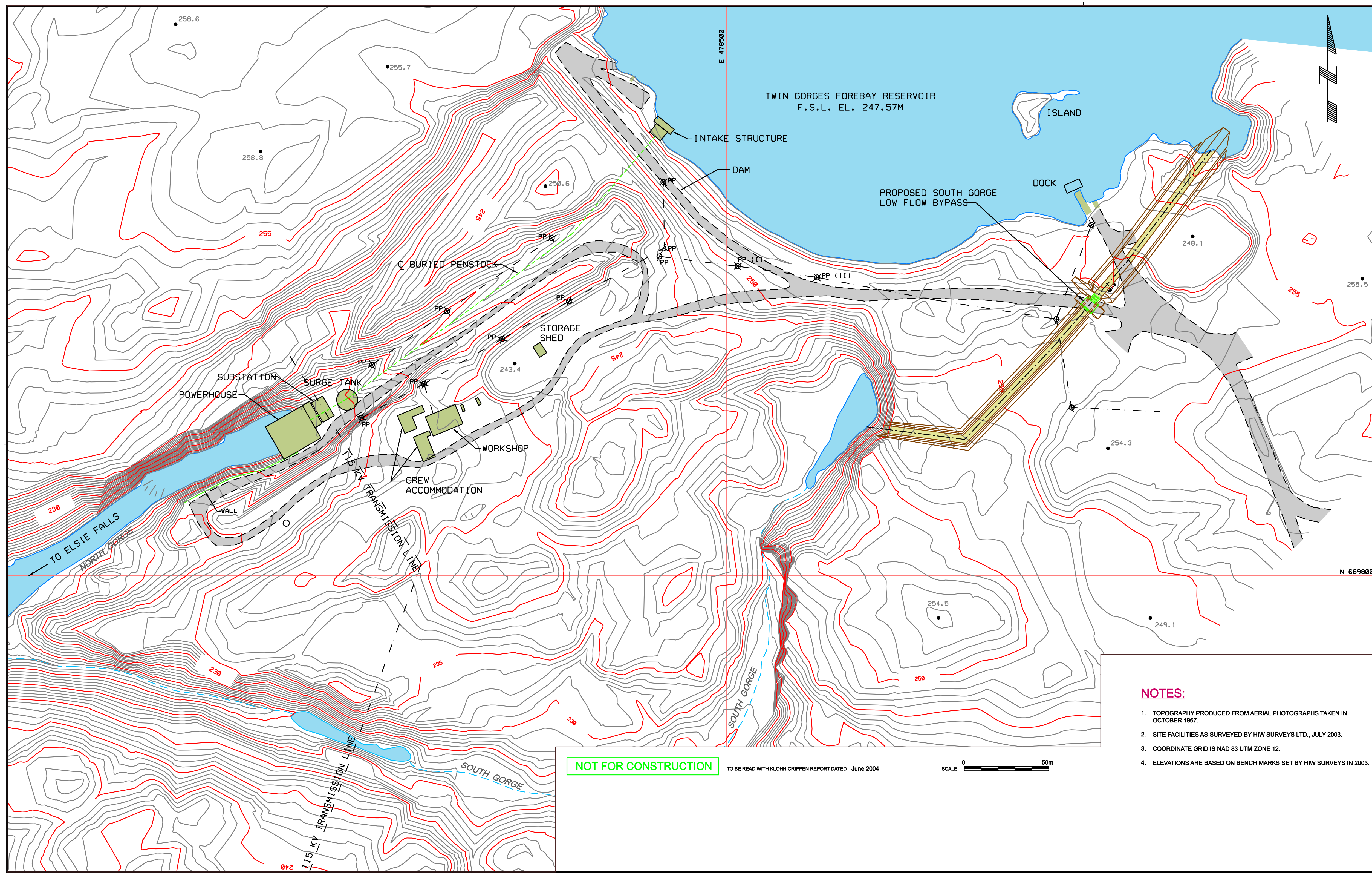
6.4.4 South Gorge By-pass Spillway

The existing 2007 Water License (#N1L4-0154) for the Taltson Twin Gorges generating station requires that a minimum flow of 28 m^3/s be maintained in the Taltson River below Elsie Falls.

Currently, this requirement does not affect plant operations or shutdowns unduly, as a much larger flow is typically spilling into the Trudel Creek system and keeping flows high in the Taltson River in the reach below Elsie Falls irrespective of plant discharge. In the Expansion Project, spill flows into Trudel would need to be closely regulated and normally would not exceed the minimum agreed discharge, which is expected to be significantly lower than 28 m^3/s. Higher flows would occur during freshet. Except in high freshet conditions, flow in the Taltson River below the plants would therefore become highly dependent on the discharge from the existing and new generation plants. In the event of a complete plant outage of any significant duration, flows below the plants might not meet the currently specified minimum.

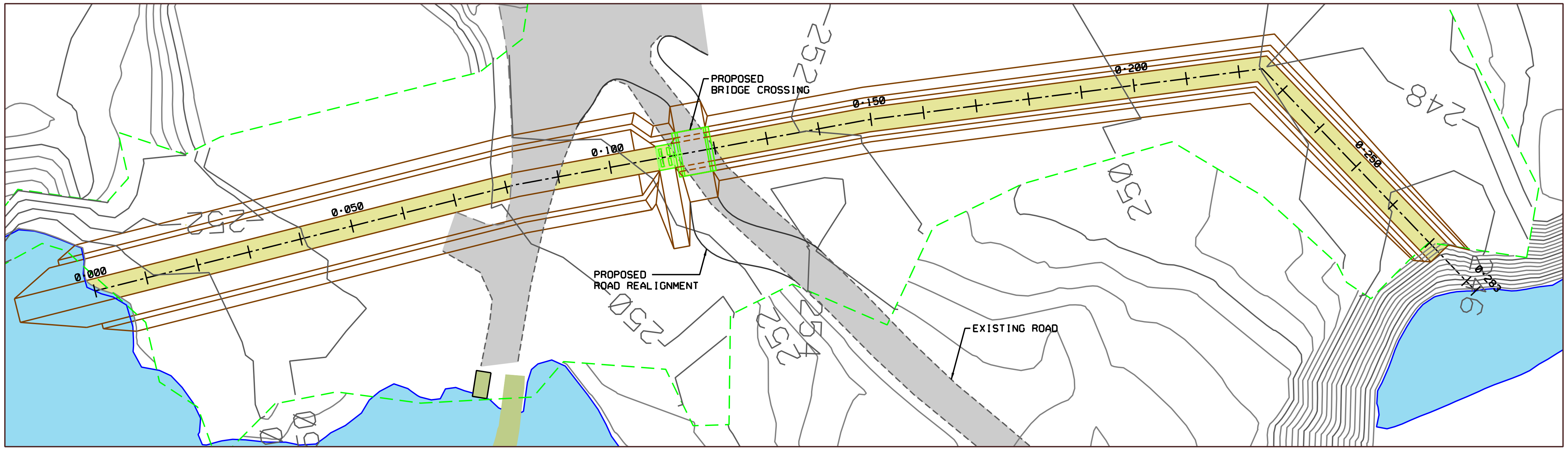
To sustain the minimum flows below the plants in the new operating regime, a by-pass spillway would be constructed around the left abutment of the dam, and discharge into the South Gorge, one of the original river channels of the Twin Gorges site. The general arrangement of this by-pass is shown in Figure 6.4.6 and Figure 6.4.7. The by-pass would be a gated structure designed to release up to 30 m^3/s at normal Forebay operating level, and be synchronized to the new and existing plants such that the gates are opened immediately if both plants have an outage. The gates would discharge into a 200 m long rock-cut canal, and enter the South Gorge at a point downstream of the dam such that no adverse backwater erosion would occur on the dam. A bridge over the canal would provide access to the main site. The gates would be heated such that operation during any season is possible.

As discussed further in Section 6.6, the by-pass spillway would also be utilized during a start-up from an outage to reduce the ramping flows downstream of the plant. In this case, the gates would be closed and a short time later be replaced with flows through the plant.

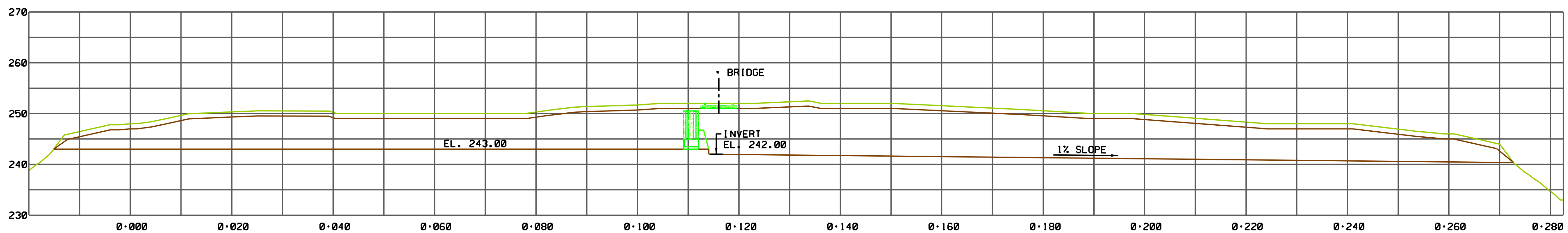


TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	South Gorge Bypass Spillway	Figure 6.4.6

Dezé energy



PLAN - SOUTH GORGE
BYPASS CHANNEL
SCALE 1:500



PROFILE - SOUTH GORGE
BYPASS CHANNEL
SCALE 1:500

TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	South Gorge Bypass Spillway: Plan and Profile	Figure 6.4.7

6.4.5 Main Switchyard at Twin Gorges

The Taltson Hydroelectric Expansion Project would electrically integrate the existing plant and the new generation facility at Twin Gorges such that power generated from either facility can flow to any of the connected loads. This switchyard would therefore replace the existing plant substation, and supply the existing 115 kV line to Fort Smith and the new 161 kV line to the mines. A very minor re-routing of the existing line would be required in the vicinity of the existing plant to reach the new switchyard. The general arrangement of the facilities is shown on Figure 6.4.1.

The integration of the existing and new plants would provide significantly enhanced reliability of generation into the existing 115 kV line and very likely allow elimination of the annual service interruption for maintenance of the existing Twin Gorges plant when diesel generation is required in Fort Smith. The diesel plant would continue to be required for backup support.

6.4.6 New Transmission Line

6.4.6.1 General Characteristics

To supply the power from Twin Gorges to the mine sites, a new 161 kV and 69 kV transmission system would be constructed running from the Twin Gorges switchyard site northeast around the East Arm of Great Slave Lake to a branch point at Gahcho Kué mine site, with a westward spur to Snap Lake mine site, and a northwards extension to the Ekati mine site and a short spur to the Diavik mine site. The branch lines would be 69 kV lines interconnecting substations at Gahcho Kué and Snap Lake mine sites, and between Diavik and Ekati mine sites. A summary of the transmission line characteristics is provided in Table 6.4.3.

Table 6.4.3 — Summary of Transmission Line Characteristics

Characteristic / Option	Transmission Line
Line Sector at 161 kV	
Twin Gorges – Gahcho Kué	388 km
Gahcho Kué – Ekati	183 km
Line Sectors at 69 kV	
Gahcho Kué – Snap Lake	94 km
Ekati – Diavik	33 km
Total of 161 kV	571 km
Total of 69 kV	127 km
Total Line Length	698 km
Design Capacity of 161 kV Line	> 100 MW
Maximum Expected Load from Mine Customers	~60 MW
Conductor Size	715 mcm
Number of Circuits	Single Circuit
Type of Tower (161 kV)	Guyed Steel Pole or Lattice Tower
Type of Tower (69 kV)	Guyed Steel Pole or Lattice Tower

Characteristic / Option	Transmission Line
Communications System	As required, likely Power Line Carrier
Total number of towers	2400 (approx)
Right of Way Tenure Width Requirement	30 m
Construction Period	31 months from an October start

The new transmission line would be constructed on a cleared right-of-way where necessary, up to approximately 30 m in width, with allowable maximum brush height of approximately 3 m in sections that do not require land-based conductor stringing and do not present a fire hazard. The towers would be either lattice steel or pole-type structures, supported on a central foundation pin and using four guy wires running from near the cross-arm structure to anchor points in opposing directions from the tower. The lattice concept structure is virtually identical to those used on the existing 115 kV line to Fort Smith and Pine Point, which have provided excellent service and reliability. A typical 161 kV transmission structure is shown in Figure 6.4.8 and a 69 kV structure in Figure 6.4.9.

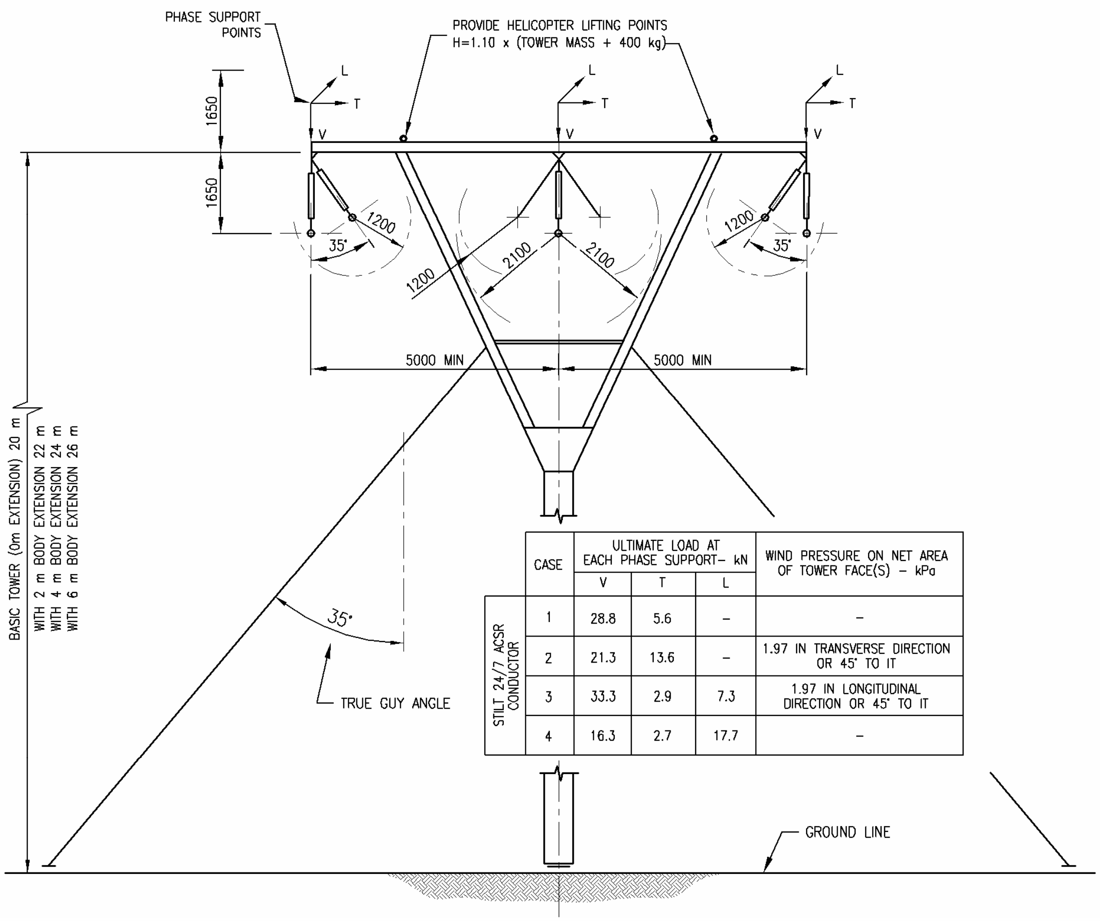
The average spacing of the towers would be approximately 350 m for the 161 kV line, and slightly less for the 69 kV line, however, these spacings would vary depending on the terrain. Typically, towers would be founded on rock outcrops, and guy anchors would be simple grouted anchor bolts. Tower height would depend on terrain and line requirements at the particular station, but would be approximately 22 to 25 m. The single circuit line would include three conductors. These conductors are non-insulated, spiral wound aluminum strand over a central steel cable. The conductors would be "sagged" to meet standard electrical clearance requirements above ground, and would present no shock hazard to humans or wildlife on the ground.

An Electromagnetic Field Affect study has been completed for the line (Teshmont Consultants 2008), which considers audible noise, radio interference, and electric field and magnetic flux density magnitudes. These assessments are compared to industry standards and/or regulations. For the specified right-of-way width and conductor clearances, all of the parameters are well within recognized limits.

The transmission line technical design optimizes the cost of the conductor versus the line loss, which normally decreases as the conductor gets larger in diameter and hence more expensive. As line losses represent very high monetary value for this Project, the cost optimization has resulted in a line capacity much higher than the anticipated maximum generation potential and customer load projected for the Taltson Hydroelectric Expansion Project.

TALTSON EXPANSION PROJECT 161 kV TRANSMISSION LINE
TYPE 'A' 0–3 DEGREE TOWER

PHYSICAL CHARACTERISTICS OF CONDUCTOR	"STILT" 715.5 kcmil, 24/7 ACSR
CONDUCTOR	26.31 mm DIAMETER
RATED TENSILE STRENGTH	113.4 kN
MAXIMUM TENSION WITH 19 mm ICE, 0 WIND @ −25°C	66.7 kN
UNIT MASS OF BARE CONDUCTOR	1.371 kg/m
UNIT MASS OF CONDUCTOR WITH 19 mm ICE	3.850 kg/m
UNIT MASS OF CONDUCTOR WITH 12.7 mm ICE	2.792 kg/m
287 Pa WIND ON CONDUCTOR PLUS 12.7 mm ICE	1.514 kg/m
287 Pa WIND ON BARE CONDUCTOR	0.770 kg/m
WEIGHT SPAN	450 m
WIND SPAN	410 m
LINE ANGLE	3°



	CASE	ULTIMATE LOAD AT EACH PHASE SUPPORT– kN V	T	L	WIND PRESSURE ON NET AREA OF TOWER FACE(S) – kPa
STILT 24/7 ACSR CONDUCTOR	1	28.8	5.6	–	–
	2	21.3	13.6	–	1.97 IN TRANSVERSE DIRECTION OR 45° TO IT
	3	33.3	2.9	7.3	1.97 IN LONGITUDINAL DIRECTION OR 45° TO IT
	4	16.3	2.7	17.7	–

NOTES:

1. THE VERTICAL, TRANSVERSE AND LONGITUDINAL CONDUCTOR LOAD IN CASES 1, 2 & 3 ARE TO BE APPLIED AT ANY ONE, ANY TWO OR ALL THREE PHASE SUPPORT POINTS.
2. THE VERTICAL, TRANSVERSE AND LONGITUDINAL CONDUCTOR LOADS IN CASE 4 ARE TO BE APPLIED AT ANY ONE OR ANY TWO PHASE SUPPORT POINTS. WITH THE LOADS OF CASE 1 ON THE REMAINING PHASE SUPPORT POINT(S).
3. THE LOADS OF ALL LOAD CASES MUST BE MULTIPLIED BY 1.2 FOR FOOTING DESIGN.
4. THE SLOPE OF CONDUCTOR TO THE HORIZONTAL WILL BE −5 AND +25 DEGREES.
5. MINIMUM CLEARANCE FROM CENTER LINE OF CONDUCTOR TO THE EDGE OF TOWER STEEL IS 1200 mm FOR VERTICAL STRING INSULATORS.
6. TRANSVERSE AND LONGITUDINAL LOAD SHALL BE CONSIDERED TO ACT IN EITHER THE POSITIVE OR NEGATIVE DIRECTION.
7. TOWER CONFIGURATION SHOWN IS TO ILLUSTRATE REQUIRED DIMENSIONS ONLY.
8. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

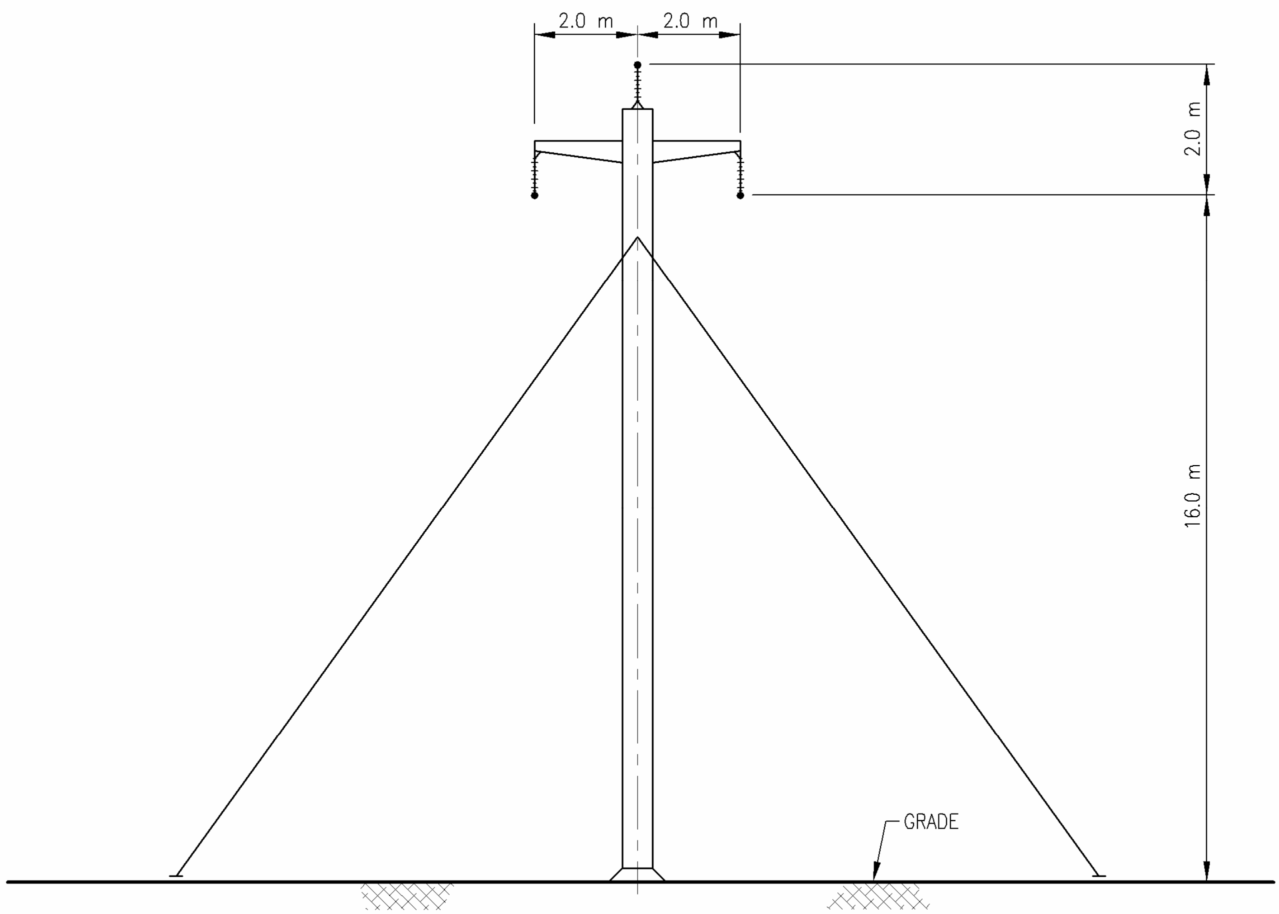
TALTSON
HYDROELECTRIC EXPANSION PROJECT

Developer's Assessment Report 2009

Typical 161kV Transmission Structure Twin Gorges to Ekati

FIGURE 6.4.8

REV. #	DESCRIPTION	DATE	BY
A	FEASIBILITY STUDY	MAY/06	M.R.



AVERAGE SPAN 250.0 m
APPROXIMATE MASS = 900 kg
CONDUCTOR "OSTRICH" 26/7 ACSR

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	Typical 69 kV Transmission Structure Ekati to Diavik Route	Figure 6.4.9

6.4.6.2 TRANSMISSION LINE SECTOR ROUTING DESCRIPTION

The transmission line route is shown in Figure 6.4.10. A table of key Point of Intersections (PIs) along the route is provided in Table 6.4.4. The transmission line route can be described as having a number of sectors, wherein a sector is characterized by the terrain and particularly the access provisions influencing the construction approach for the line. Five sectors are used to define the line: Southern, East Great Slave Lake, Northern Section, Gahcho Kué–Snap Lake, and Ekati–Diavik (see also Section 6.5 and Figures 6.5.3 to 6.5.5).

With reference to Figure 6.4.10, the Southern section starts at Twin Gorges, and extends to the crossing of the Snowdrift River, a total length of approximately 250 km, all at 161 kV. This section is entirely within the treeline, and would require full right-of-way clearing except in areas of past burn. Terrain in this section is undulating rock ridges with many lakes and a few wetlands. The line route generally stays next to lakes on the rock terraces and ridges. The line generally parallels the Taltson River system and Nonacho Lake, which would allow winter road development for construction access to the actual line routing. A number of camp and staging areas would be required along this section of line during construction – these are described further in Section 6.5. Line construction would be done using a mix of aerial and land-based methods in this section.

The East Great Slave Lake sector of the line commences at the Snowdrift River, where the line turns northward towards Charlton Bay. Inland along the south side of the bay, the line continues approximately 104 km, over Glacier Creek (Pike’s Portage) and the Lockhart River to treeline, on the route to Gahcho Kué. Limited access is considered feasible into this remote and high-relief area, and the line would be constructed by aerial methods, using two camp/staging areas located close to the shore of Great Slave Lake, with materials supplied by barge. This sector comprises relatively rugged terrain, including the Macdonald Bluff and the Lockhart River crossing. The ground conditions are primarily rock.

The Northern sector of the line commences at treeline 50 km south of Gahcho Kué, and runs through that mine site and northward to the Ekati Mine site, a sector length of approximately 218 km, all at 161 kV. This sector would not require clearing, and would be constructed primarily through the use of winter access tracks along the line route, supplied by staging areas at the mine sites and several intermediate points. This terrain is low relief, but poses more difficult foundation conditions due to the large-scale presence of broken rock, wetlands, and some zones of permafrost.

The spur sectors - Gahcho Kué to Snap Lake at 69 kV or 161 kV, and Ekati to Diavik at 69 kV, are similar to the northern sector in terrain type and construction approach. Construction of the Gahcho Kué to Snap Lake section would be by winter track developed along the route, with two intermediate staging areas, both accessible from extension of the existing ice roads. The Ekati to Diavik section would be constructed along the existing all-weather road towards Misery Pit, with a short overland section running southward to Diavik built by winter track along the line. No intermediate staging would be required in this sector.

TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Proposed Transmission Line Route**	**Figure 6.4.10**

N:\Active\GIS\2008\07-1328-0013 Taltson\Mapping\MXD\DAR_Figures/YK_139 East Route

Table 6.4.4 — Table of Points of Intersection of East Arm Transmission Line Final Baseline Route PI Points: Twin Gorges to Ekati

PI	Easting (m)	Northing (m)	Length (m)	Chainage (km)
1	478,500	6,699,200		
2	484,000	6,698,750	5,518	6
3	493,800	6,727,800	30,658	36
4	499,500	6,738,800	12,389	49
5	507,500	6,754,800	17,889	66
6	506,800	6,759,800	5,049	72
7	516,250	6,774,800	17,729	89
8	550,110	6,850,410	82,845	172
9	557,750	6,859,500	11,874	184
10	593,000	6,915,000	65,748	250
11	593,808	6,940,803	25,816	276
12	602,826	6,949,411	12,467	288
13	611,570	6,966,560	19,250	307
14	611,300	6,967,999	1,464	309
15	610,750	6,968,700	891	310
16	598,800	6,991,500	25,742	335
17	600,000	7,019,000	27,526	363
18	591,600	7,035,400	18,426	381
19	590,000	7,035,400	1,600	383
20	591,200	7,037,750	2,639	386
21	590,260	7,038,600	1,267	387
22	583,500	7,053,800	16,635	403
23	565,500	7,075,700	28,348	432
24	560,825	7,083,000	8,669	440
25	560,869	7,085,393	2,393	443
26	561,560	7,097,623	12,250	455
27	562,336	7,099,115	1,682	457
28	563,342	7,105,224	6,191	463
29	562,792	7,112,710	7,506	470
30	563,789	7,115,693	3,145	474
31	561,528	7,123,571	8,196	482
32	561,890	7,128,400	4,843	487

PI	Easting (m)	Northing (m)	Length (m)	Chainage (km)
33	556,500	7,128,900	5,413	492
34	556,750	7,135,500	6,605	499
35	557,600	7,137,600	2,266	501
36	556,839	7,140,392	2,894	504
37	557,308	7,144,448	4,083	508
38	554,778	7,148,696	4,944	513
39	556,105	7,157,003	8,412	521
40	553,920	7,161,750	5,226	526
41	550,000	7,165,825	5,654	532
42	545,612	7,174,370	9,606	542
43	541,229	7,177,807	5,570	547
44	534,965	7,180,000	6,637	554
45	522,500	7,178,200	12,594	567
46	520,900	7,176,500	2,335	569

Final Baseline Route PI Points: Ekati to Diavik

PI #	Easting (m)	Northing (m)	Length (m)	Chainage (km)
46	520,900	7,176,500		
47	526,200	7,172,500	6,640	7
48	531,800	7,160,999	12,792	19
49	531,000	7,159,200	1,969	21
50	529,000	7,155,400	4,294	26
51	532,200	7,153,500	3,722	29
52	532,600	7,151,000	2,532	32

Final Baseline Route PI Points: Gahcho Kué to Snap Lake

PI #	Easting (m)	Northing (m)	Length (m)	Chainage (km)
21	590,260	7,038,600		
53	587,920	7,038,000	2,416	2
54	583,540	7,036,830	4,534	7
55	576,320	7,040,150	7,947	15
56	574,825	7,041,380	1,936	17
57	572,130	7,042,750	3,023	20
58	571,340	7,043,330	980	21
59	568,400	7,044,200	3,066	24

PI	Easting (m)	Northing (m)	Length (m)	Chainage (km)
60	544,800	7,049,100	24,103	48
61	534,400	7,045,599	10,973	59
62	531,000	7,043,600	3,944	63
63	524,600	7,044,200	6,428	69
64	522,500	7,042,600	2,640	72
65	511,200	7,044,800	11,512	84
66	511,000	7,045,600	825	84
67	509,100	7,047,500	2,687	87
68	507,100	7,049,600	2,900	90
69	506,400	7,051,800	2,309	92

6.4.7 Substations

New substations would be required at each of the four mine sites, with a typical footprint of 30 m x 35 m. Substations would contain termination structures for the incoming lines and outgoing lines, voltage step-down transformers, circuit breakers, isolation devices, and protection and metering equipment. A small heated building would typically house protection and control equipment in each substation. The transmission line voltage (161 kV or 69 kV) would be stepped down to the operating voltage of the existing mine site substations, typically 4.16 kV, and intertied to the existing diesel generation busline. Revenue metering equipment ahead of the bus would accurately measure electrical power and energy usage of the mines. Satellite communications would be in place between the substations and the Twin Gorges plants to monitor conditions and telemetry key information. Power Line Carrier line systems may be employed for synchronization and control communications.

It is envisaged that substations would be developed adjacent or in close proximity to the existing main mine site diesel generation plants, and would therefore be on mine property.

6.4.8 Existing Plant Life Extension

A number of upgrades and modifications would be required as part of the life extension to be completed at the existing Taltson Twin Gorges generating plant, this work forming a key component of the Expansion Project. The following works are anticipated:

- removal of Ossberger generating equipment and associated building from the downstream area of the powerhouse (possibly completed by NTPC within capital allowances);
- restoration of the original or a new draft tube gate and hoisting system.
- coating of the interior of the penstock;
- electrical upgrades, possibly including a generator rewind;
- upgrades to most ancillary systems to support full output; and

- decommissioning of existing substation, and integration of plant to new switchyard and plant control system.

This work would require a significant plant outage and complete dewatering for a period of approximately six months. Currently, this work is envisaged to be undertaken during the construction phase of the new plant, but may be deferred until the new plant is complete, depending on the timing of customer load demand. The existing customer base would require support by diesel generation in Fort Smith and Hay River during this plant upgrade period if it occurs prior to completion of the Expansion Project.

6.5 CONSTRUCTION

6.5.1 Limitations of Description

The Taltson Hydroelectric Expansion Project is a major project to be developed in largely remote areas, and therefore would require for construction a very high level of logistical planning and control. At the feasibility and preliminary design stages, to which the project definition has been undertaken as of this submission, the construction logistics for each major component have been developed to a level for which a reasonable certainty in feasibility and schedule has been defined for a defined overall construction approach. This work has involved the participation of qualified contracting companies and independent experts for a number of the key Project components.

The actual contractors undertaking the project development have not been chosen. The types of contracts to be used for the work have also not been finalized. As with any major development, it must be recognized that there would be several construction approaches possible, depending on the construction contractor's particular expertise, environmental constraints, the timing of construction award, the availability of labour and materials, and the formatting of the various construction contracts, among others. The construction contractor that would ultimately be engaged would have the appropriate experience and capabilities to undertake this Project, but may have a preferred methodology that may bring benefits to the Project. Similar to other large and complex projects, the changes and benefits that may ultimately accrue from detailed planning and final design cannot be fully surmised at this stage of project development.

The construction approaches described below have been developed from specific consideration of the site and feasibility level design by experienced consultants in the field of hydropower and transmission line development. Ultimately, the exact location of all of the temporary construction facilities may need to be altered from this description to some degree to account for actual site conditions, scheduling, or other reasons beyond the ability of the developer's team to foresee at this time. The Developer assumes that some flexibility would exist within the framework of the regulatory process and permitting in moving through to the final design definition of both permanent and temporary works of the Project, which may differ slightly from those described herein.

6.5.2 Site Access for Construction

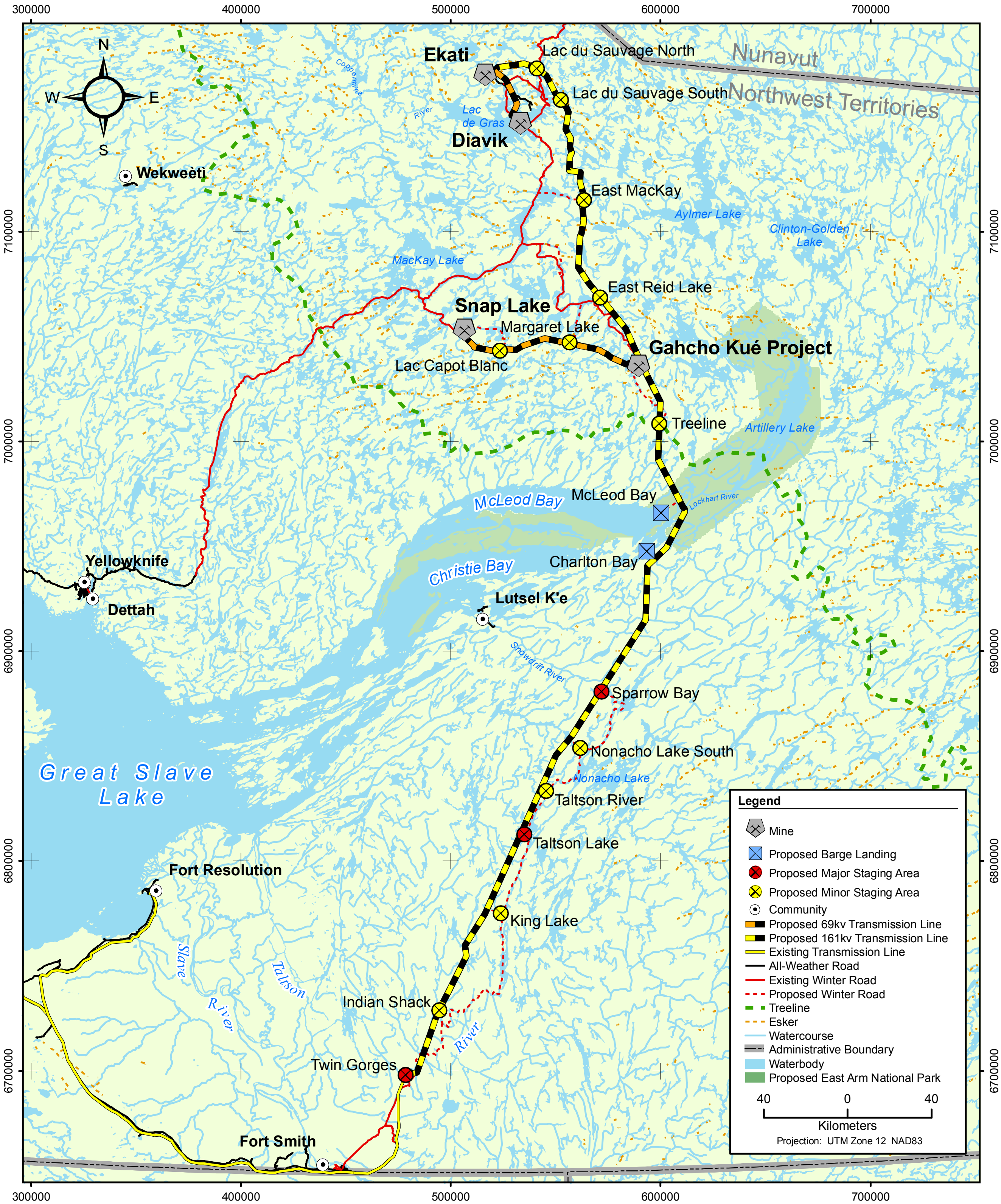
6.5.2.1 General Approaches

Site access presents a unique challenge in the construction of the Expansion Project. A significant effort has therefore been undertaken to develop the site access concepts that would allow a feasible cost and schedule to be maintained. As noted in Section 6.4, the overall Expansion Project site can be characterized into large geographic sectors that would have quite different access provisions. In the southern sector, all materials required for construction of the new plant, the Nonacho control structure, and the entire southern sector of the transmission line would need to be routed through Twin Gorges from Fort Smith. This would require an extensive and reliable winter road development and maintenance during the winters of the construction period. A well-developed winter road from Fort Smith to Twin Gorges would be required, suitable for large and heavy loads. Beyond Twin Gorges, a lower-capacity winter road mainline, spur sections to numerous staging areas, and track extensions would be required to deliver materials from Twin Gorges to the staging areas and then typically from these overland to the line alignment itself. The winter mainline would terminate near the Nonacho Lake dam, with lower-capacity ice road spurs to the two staging areas northeast of the dam. The existing airstrip at Twin Gorges as well as float/ski planes would also be key components of the overall access provisions for this sector for smaller deliveries and for crew rotations.

Nearer the East Arm, access by barge is considered feasible and material delivery is proposed to be staged from two barge landing sites: one in Charlton Bay, and one in McLeod Bay. Little, if any, winter road would be used in this sector. Float plane access would be used for light loads and personnel moves.

Above treeline, which occurs just south of Gahcho Kué, spurs from existing ice road corridors to main staging areas becomes feasible for winter material delivery. Track delivery along the line would also be used where terrain and conditions permit. The existing mine sites would become critical centres for major staging and camp facilities, and the airstrips at those mines would be used for lighter delivery and personnel moves.

The access provisions anticipated for the Expansion Project are shown in overview in Figure 6.5.1. The specific access anticipated for each key component or transmission line sector is discussed in more detail in following sections.



TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report 2009**	**Transmission Line Route and Construction Access**	**Figure 6.5.1**

6.5.2.2 CONSTRUCTION ACCESS FOR TWIN GORGES SITE

The Taltson Twin Gorges facility was constructed in 1964-1966 and included the development of a 60 km winter road from Fort Smith, which crossed the Slave River immediately downstream of the community and ran through lowlands over several small lakes to Gertrude Lake on Trudel Creek. From this point, an all-weather road was constructed to the Twin Gorges site. The winter road route is still visible, although it has not been used for operational activities at the site for many years. The all weather road portion is still reasonably serviceable.

The winter road to Twin Gorges has not been used for approximately 17 years, and has not been maintained for a similar period. However, current investigations indicate that re-opening of the former winter road corridor to Twin Gorges would provide a fully adequate winter road for all anticipated haul requirements. Preparatory work required for re-opening of this road would include re-clearing of the right-of-way, regrading of road sections into and out of the Slave River, and upgrading of the all-weather road section from Gertrude Lake to the Twin Gorges airstrip. The alignment of the original winter road as proposed to be re-opened is shown on Figure 6.5.1 and Figure 6.5.2.

The existing 1,100 m long gravel airstrip at Twin Gorges would continue to be used for relatively light materials delivery and for personnel moves at the Twin Gorges site. Some upgrading of existing all-weather connector roads at Twin Gorges would likely be required to accommodate the heavy haul traffic required in this area.

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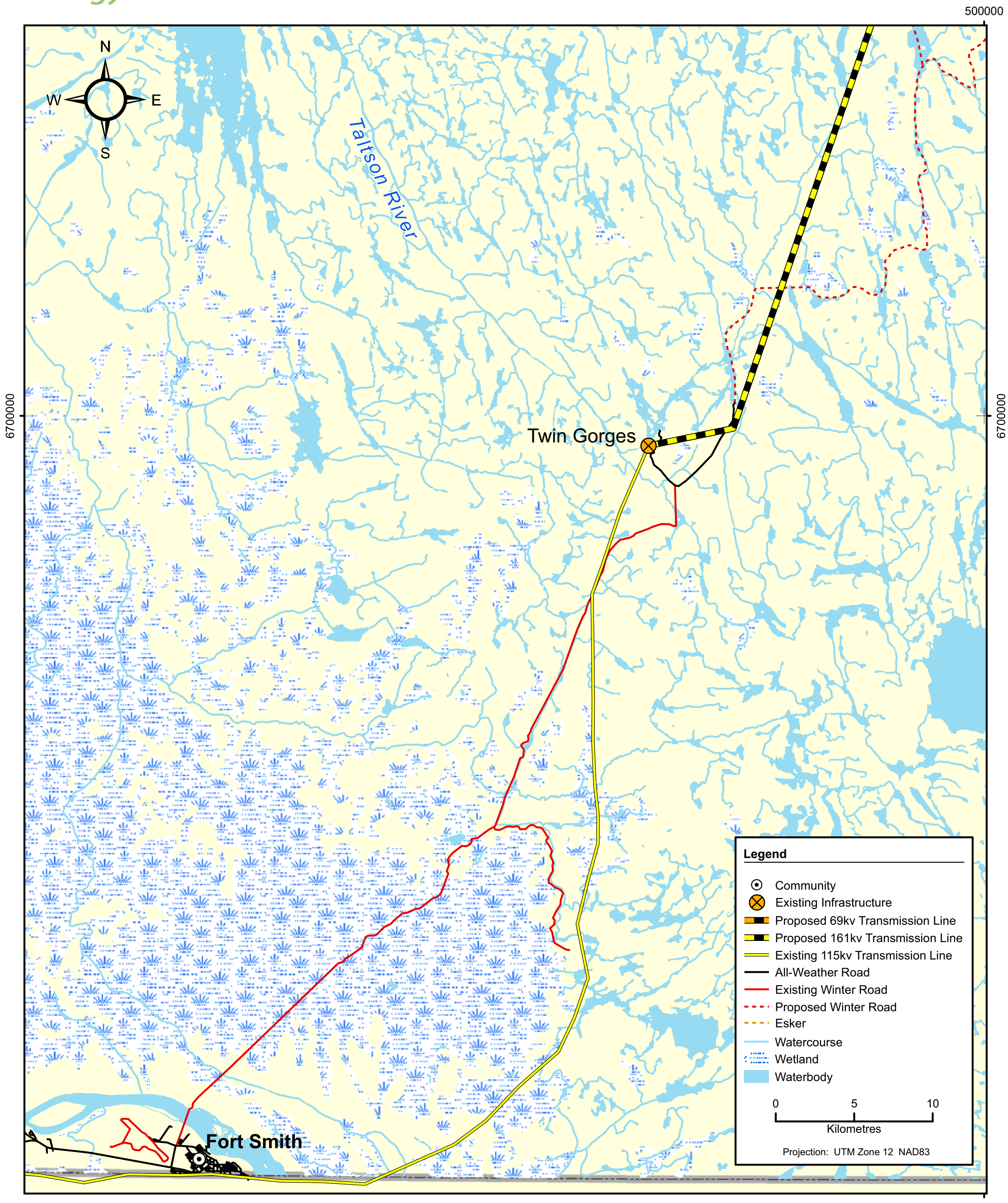


TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Fort Smith to Twin Gorges Winter Road Alignment	Figure 6.5.2

Golder Associates Ltd. YK_142

6.5.2.3 CONSTRUCTION ACCESS FOR SOUTHERN SECTOR TRANSMISSION LINE AND NONACHO LAKE CONTROL STRUCTURE

The Southern sector of the transmission line extends from Twin Gorges 249 km to the crossing of the Snowdrift River. Developing reliable access for construction of the southern line sector and for the new control structure at Nonacho Lake present the most difficult construction logistics for the Project. The terrain is relatively rugged, distances large, and the area has not had winter road development previously.

Proposed winter road and staging facilities for this key sector are shown in Figure 6.5.3. Typical terrain (sections over land) is shown in Plates 6.5.2, 6.5.3 and 6.5.4. All materials would be initially staged to Twin Gorges on the heavy haul road. Depending on the type of materials and condition of the winter road beyond Twin Gorges, loads would be re-assembled at the Twin Gorges staging area. In the initial 75 km from Twin Gorges to Lady Grey Lake, the winter road mainline would be developed overland through an interconnected series of lakes, lowlands and low passes. Some excavation of rock and grading is anticipated to be required on this alignment. In overland sections with soils, clearing of trees would be required along the right-of-way.

Plate 6.5.1 — Typical Winter Road Corridor from Fort Smith to Twin Gorges

Plate 6.5.2 — Typical Forested Terrain on Proposed Winter Route in Area of Methleka Lake (Southern Sector)

Plate 6.5.3 — Typical Forest and Rock Terrain on Proposed Winter Route in Area of Nonacho Lake (Southern Sector)

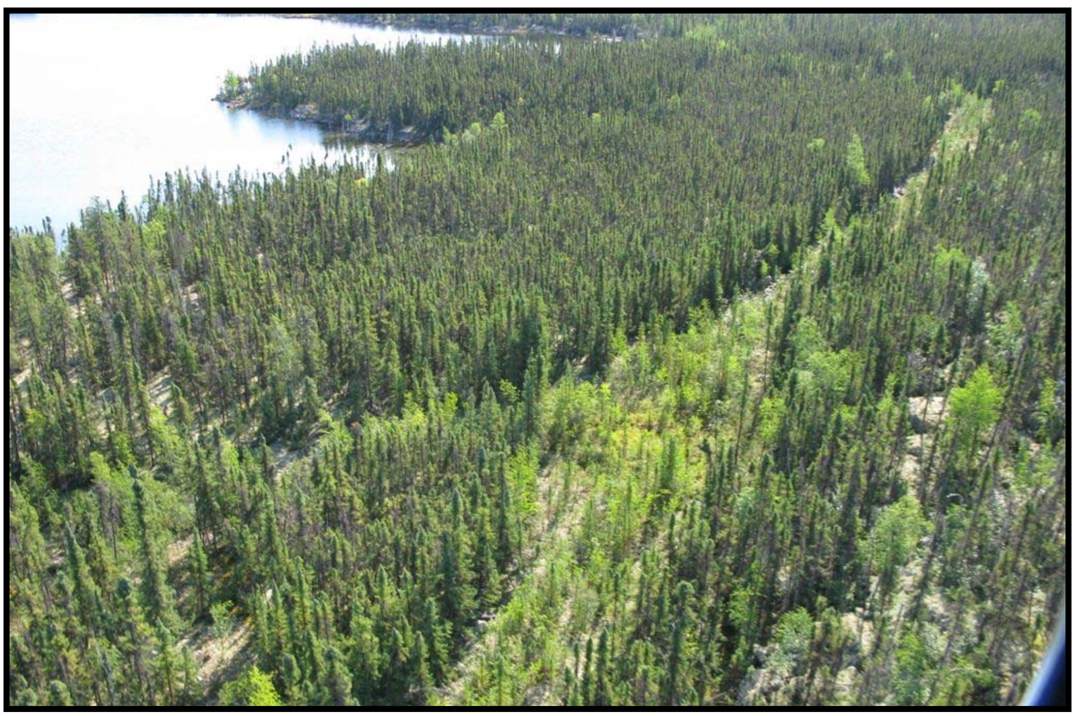
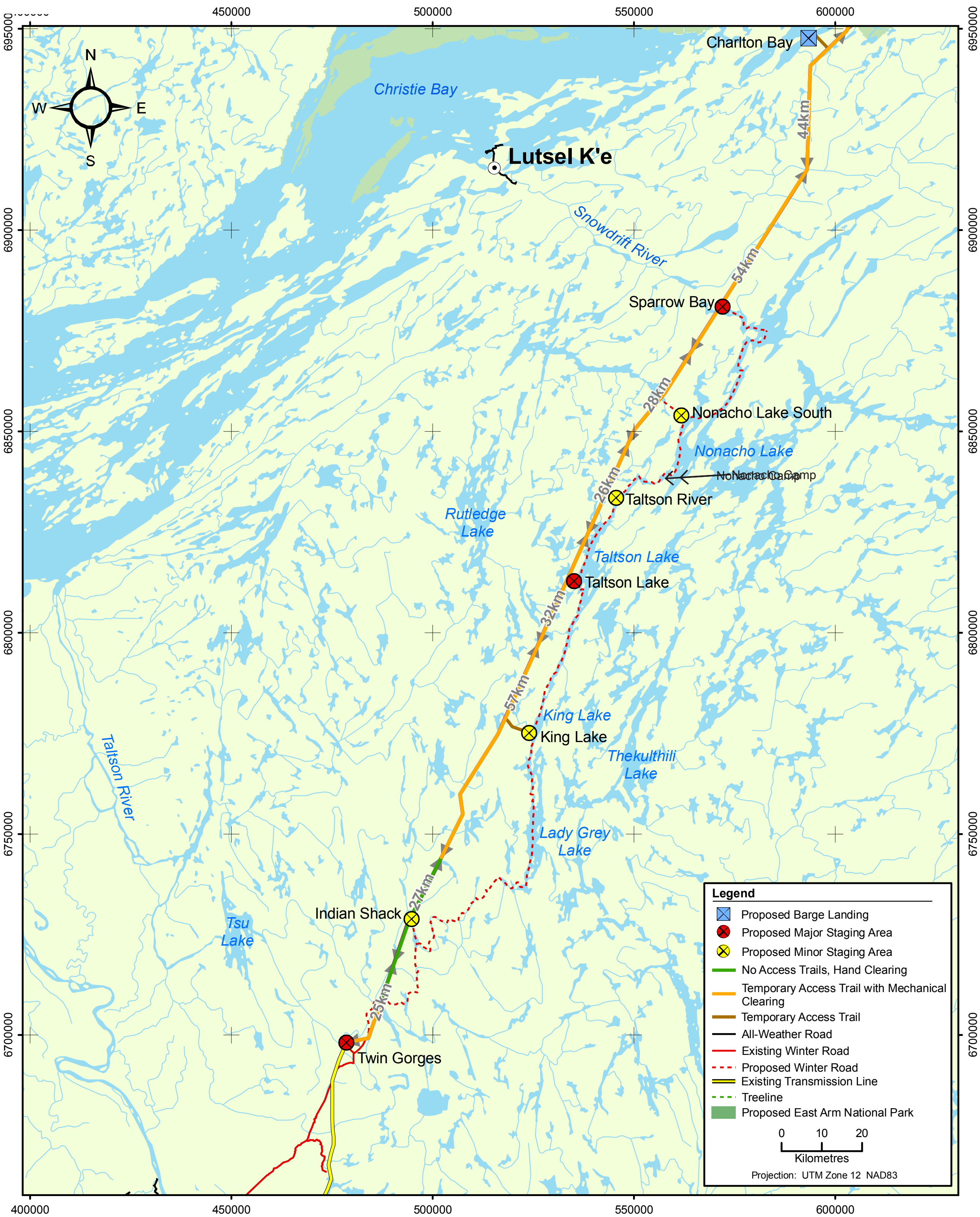


Plate 6.5.4 — Typical Wetland Terrain on Proposed Winter Route in Area Between Twin Gorges and Lady Grey Lake (Southern Sector)

From the southern end of Lady Grey Lake, the winter road mainline would be constructed primarily as an ice road, with three significant overland portage sections anticipated to be required near the south end of Lady Grey Lake, at King Lake, and from the Taltson River to Nonacho Lake. Some clearing and grading is expected to be required at these portages to support heavy load hauls.

Beyond Twin Gorges, six staging areas would be used for winter material delivery for the transmission line, and a main laydown area developed for the Nonacho Lake control facility (Figure 6.5.3). Access to the staging areas generally requires a short ice road spur from the mainline winter road. Staging areas themselves would be 2-3 hectares in extent, and require clearing and limited grading for small camp establishment. Ice monitoring work is continuing on the proposed ice road route along this sector to further assess feasibility and refine the routing.



TALTSON
HYDROELECTRIC EXPANSION PROJECT

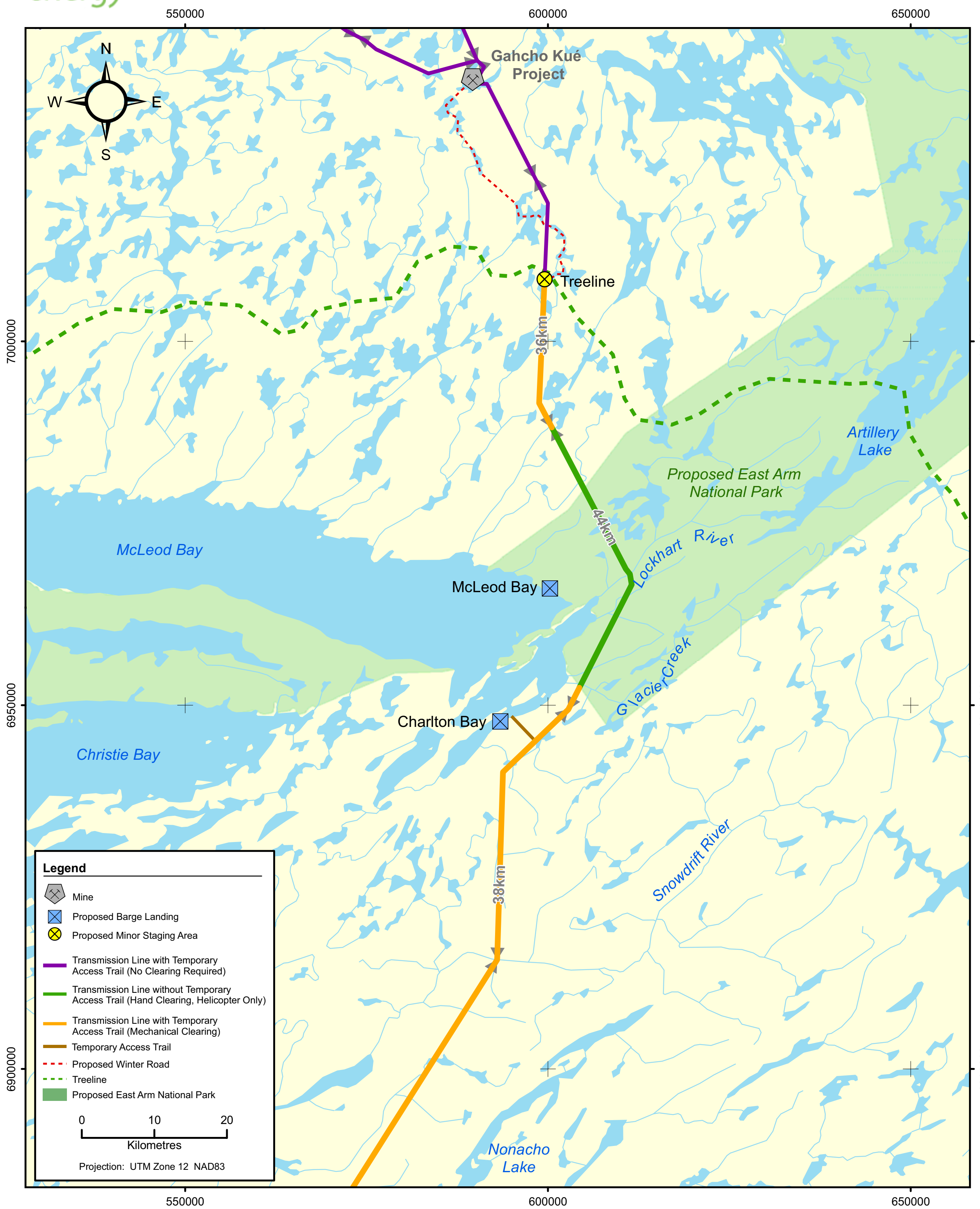
Developer's Assessment Report 2009

Access and Staging Areas: Southern Sector

Figure 6.5.3

6.5.2.4 CONSTRUCTION ACCESS FOR EAST GREAT SLAVE LAKE SECTOR OF TRANSMISSION LINE

The East Great Slave Lake sector of the transmission line extends 104 km from the crossing of the Snowdrift River, along the southern shore of the East Arm of Great Slave Lake, crossing the Lockhart River, and northwards to the treeline. The access and staging provisions are shown in Figure 6.5.4. Access for construction of this sector would be by summer barge delivery of camp and materials to two staging areas close to the shore of the lake, one in Charlton Bay on the south shore, and one slightly north of Fort Reliance on the east shore of McLeod Bay. The two staging areas would require development of a short all-weather road access from the barge landing sites on the beach approximately 500 m inland to a level terrace-type site. The road and staging area would require clearing. An access road would be built from the Charlton Bay staging area to the line corridor, and along the corridor as terrain would permit. Helicopter construction methodology would be used for all tower-setting and other work not amenable to road access along the line. No roads would be built out of the McLeod Bay staging area.



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Access and Staging in the East Arm Sector**	**Figure 6.5.4**

N:\Active\GIS\2008\07-1328-0013 Taltson\Mapping\MXD\Construction_Methods\GM_201_East LAke Section Const.

6.5.2.5 CONSTRUCTION ACCESS FOR NORTHERN SECTOR OF TRANSMISSION LINE

The northern sector of the transmission line extends 218 km from treeline south of Gahcho Kué northward to Ekati. Construction access to this sector would be via existing ice road corridors to the mine sites, with ice road spurs developed on several of the major lakes for winter delivery of materials to four staging areas between Gahcho Kué and Ekati. Access provisions and staging areas in this sector are shown in Figure 6.5.5. Short overland tracks would be required to move the materials from the lake shore to the actual staging locations located next to the right-of-way. Materials would also be delivered along winter tracks developed on the line right-of-way southward and northward from Gahcho Kué. Staging areas are to be approximately 2 ha in size in this area.

It is acknowledged that significant additional one-time transport requirements would be required for delivery of materials over the privately-operated ice road for the construction of the transmission line in the northern sector. The coordination of the delivery process with existing users of the winter road would be a key logistics item included in the scope of work of the line contractor. The tonnage estimate for delivery on the Tibbitt to Contwoyto winter road for construction of the northern line sector is provided in Section 6.5.4.3.

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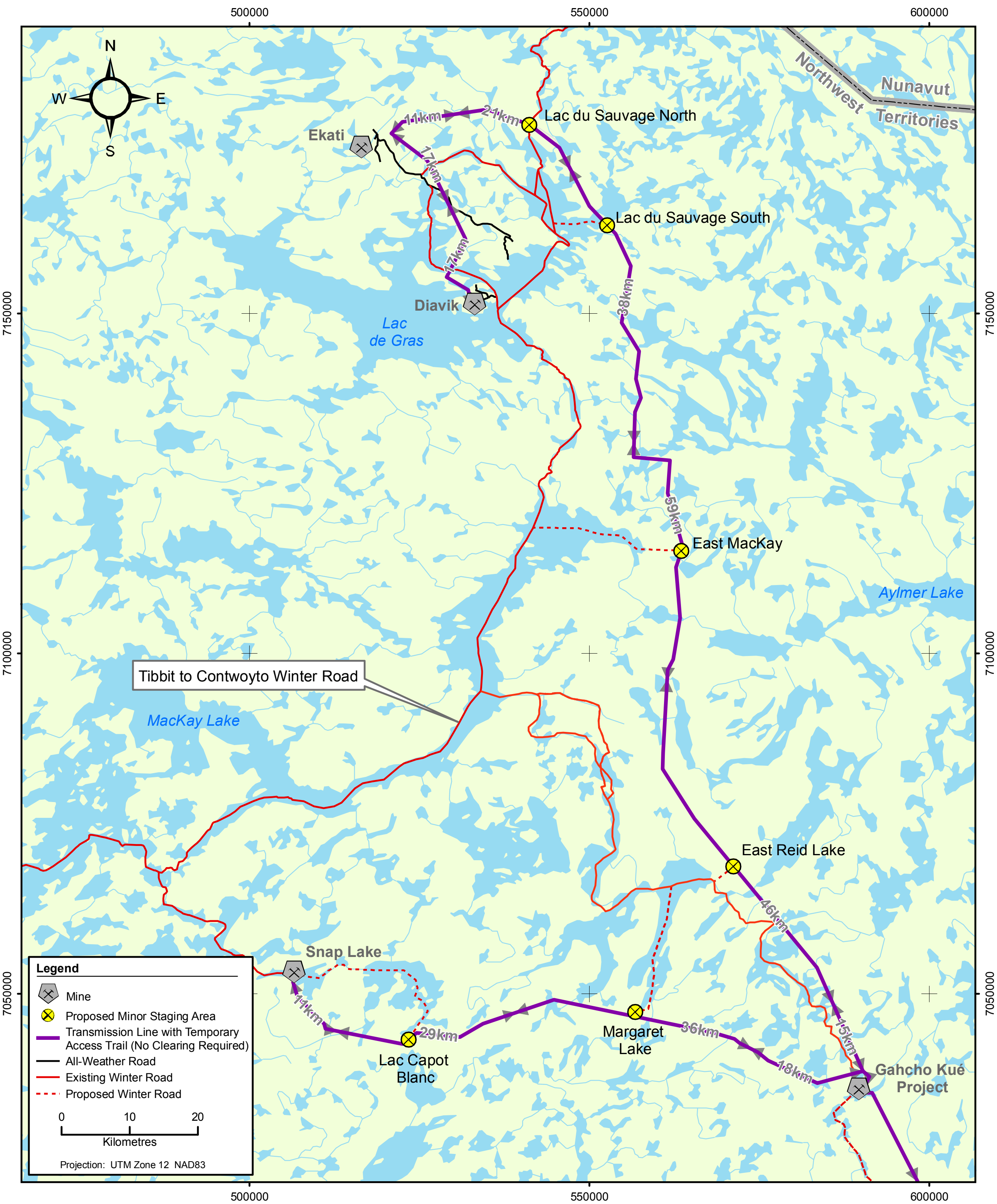

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Access and Staging Areas in the Northern Sector	Figure 6.5.5

6.5.2.6 CONSTRUCTION ACCESS FOR GAHCHO KUÉ TO SNAP LAKE SECTOR OF TRANSMISSION LINE

The Gahcho Kué to Snap Lake sector of the transmission line extends approximately 94 km running east/west between the mine sites. Construction access to this sector would be via existing ice road corridors to the mine sites, with ice road spurs developed on several of the major lakes for winter delivery of materials to two staging areas between Gahcho Kué and Snap Lake. Access and staging areas are shown in Figure 6.5.5. Materials would also be delivered along winter track developed on the line right-of-way westward from Gahcho Kué. Staging areas are to be approximately 2 ha in size.

6.5.2.7 CONSTRUCTION ACCESS FOR EKATI TO DIAVIK SECTOR OF TRANSMISSION LINE

Existing all-weather road extending south of Ekati mine site towards Misery Pit and a short section of winter track would be used for construction of this 33 km section of transmission line. Staging for construction would be from the mine sites.

6.5.2.8 INTERIM AND LONG-TERM ACCESS MANAGEMENT OF WINTER ROADS

Winter roads would operate for approximately 3 months per year for three (or possibly four) years, typically mid-January to late March. At the conclusion of construction, the winter access route beyond Twin Gorges would be fully decommissioned as required in the closure plan. The winter road from Fort Smith to Twin Gorges may be retained under continued permitting if required for operations.

During construction, access onto the winter roads would be restricted to vehicles directly involved in construction. The road would be gated near the Fort Smith entrance point, with access controlled via a manned gatehouse. Use of the road for private purposes would be prohibited, unless specifically sanctioned by the developer and contractor.

Access by snowmobile onto the winter road sectors cannot be effectively prohibited, and it is noted that the first section of the former Fort Smith to Twin Gorges road corridor are often used for winter access into the areas east of Fort Smith. It would be anticipated that some recreational users may reach Twin Gorges and beyond both during the construction period while this road is in service, and subsequent to completion. Effective decommissioning of the road beyond Twin Gorges should ensure that access to this area is very difficult. Once the road route is fully established and construction is winding down, a specific closure and access management plan would be developed to control public access.

6.5.3 Construction Accommodations

6.5.3.1 GENERAL REQUIREMENTS

Significant accommodation facilities would be required during the construction phase of the Project. Larger traditional fixed camps would be required at the main facility development sites of Twin Gorges and Nonacho Lake, smaller stationary camps at several of the key staging areas along the transmission line, and mobile camps and barge camps used along portions of the transmission line that are amenable to right-of-way track development or barge access respectively. To the extent possible, local lodges and existing mine site accommodations would also be used for construction in these areas.

Camp facilities would be removed at the completion of construction, with the exception of a small facility at Nonacho Lake and a new permanent accommodation facility at Twin Gorges. These facilities would be required for ongoing operation and for maintenance of the Project infrastructure.

6.5.3.2 LARGE CAMP DESCRIPTION

During the three-year construction phase, two main land-based large camps would be located along the southern section of the Project, one at Twin Gorges, and one at Nonacho Lake. Camp facility layout is shown in Figure 6.5.6 and Figure 6.5.7 for Twin Gorges, and Figure 6.5.8 for Nonacho Lake.

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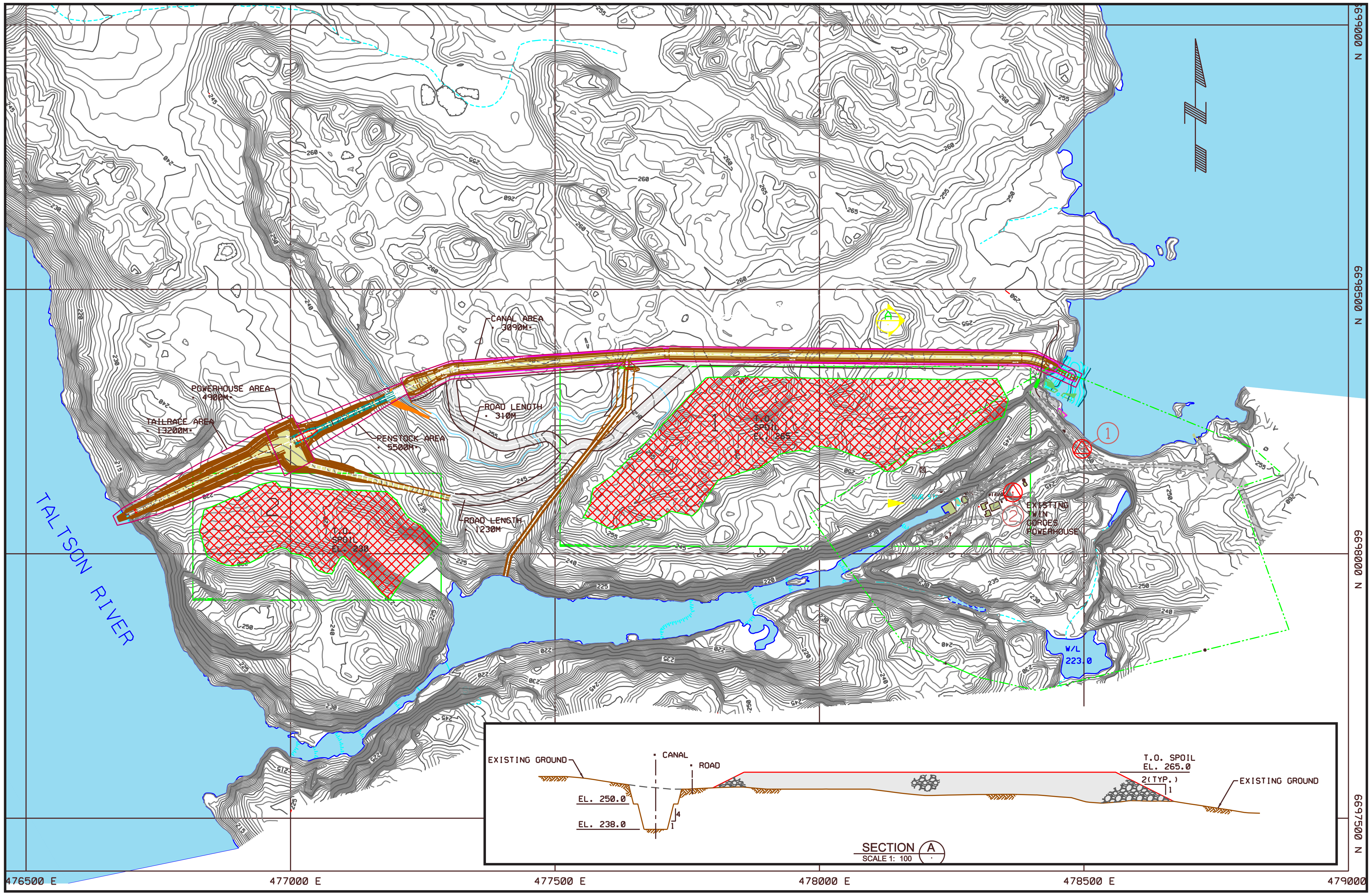


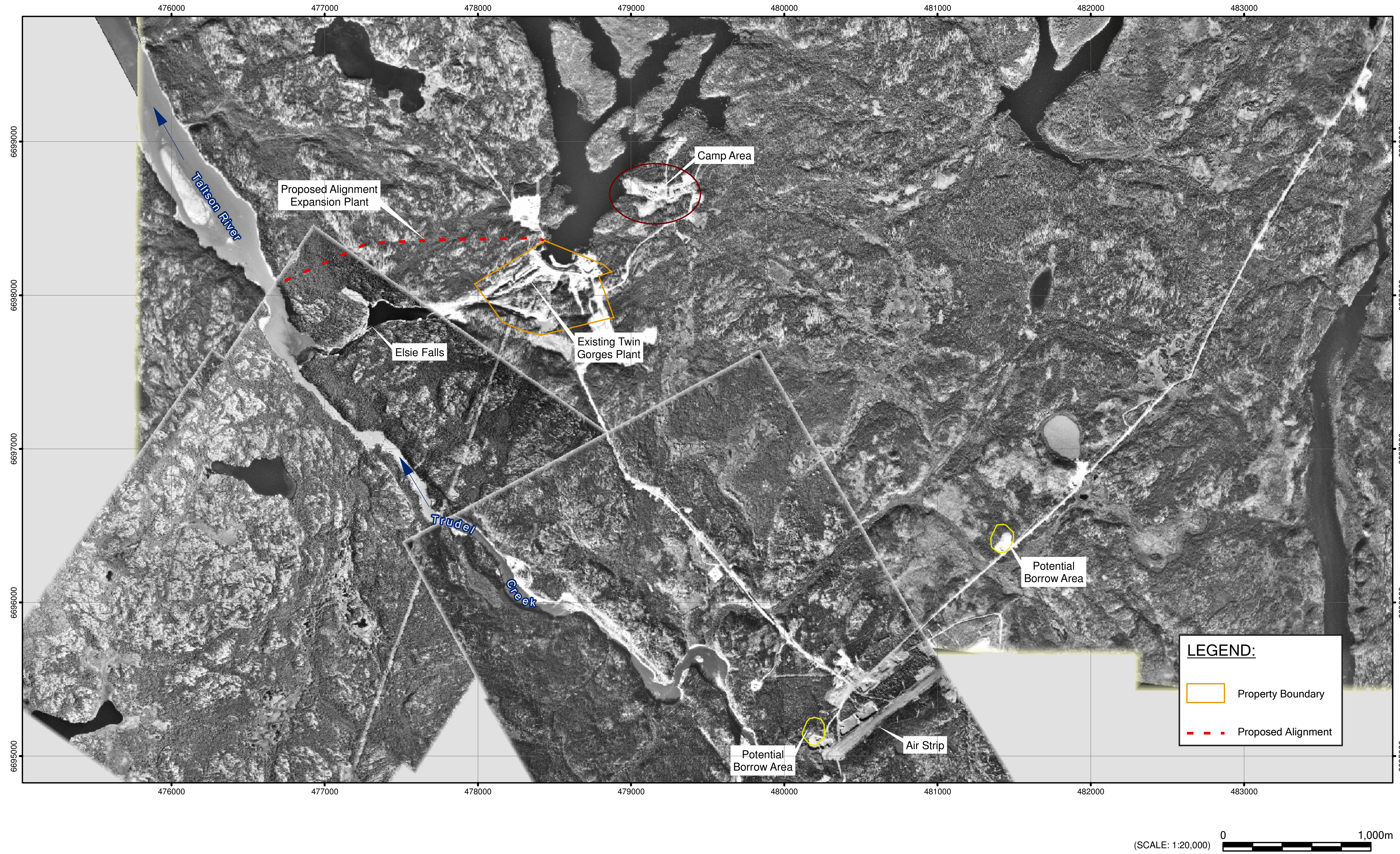
LEGEND:

- Spoil/Laydown/Camp Area
- Survey Control Point
- Property Boundary

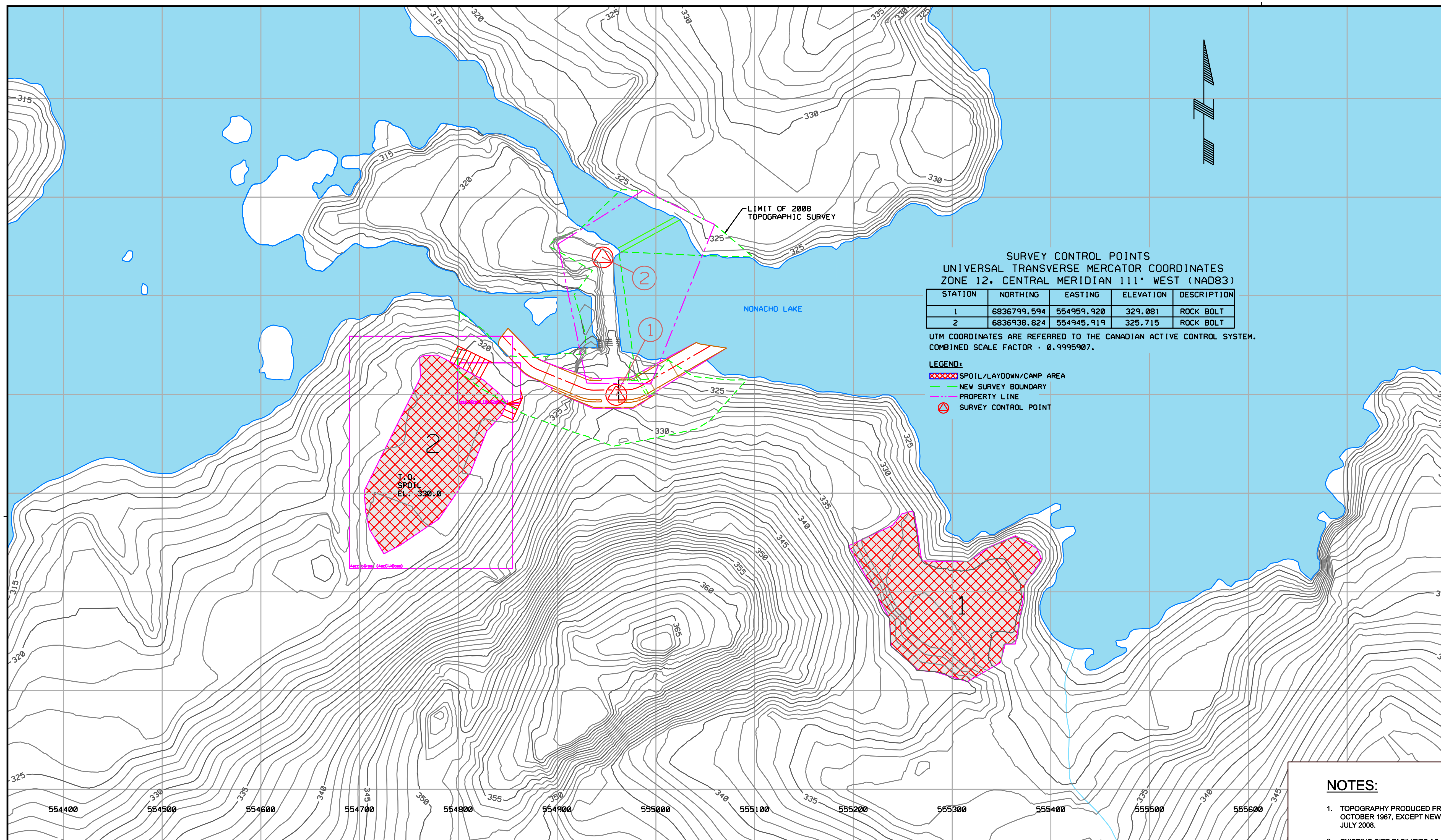
NOTES:

1. TOPOGRAPHY PRODUCED FROM AERIAL PHOTOGRAPHS TAKEN IN OCTOBER 1967.
2. EXISTING SITE FACILITIES AS SURVEYED BY HIW SURVEYS LTD., JULY 2003.
3. COORDINATE GRID IS NAD 83 UTM ZONE 12.
4. ELEVATIONS BASED ON BENCHMARKS SET BY HIW SURVEYS IN 2003.
5. CONTRACTOR'S FACILITIES TO BE LOCATED ON SPOIL AREAS.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Twin Gorges Expansion Plant Construction Spoil and Laydown Areas	Figure 6.5.6



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report** **2009**	**Twin Gorges Expansion Plant** **Construction Facilities Overview**	**Figure** **6.5.7**



STATION	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	6836799.594	554959.920	329.081	ROCK BOLT
2	6836938.824	554945.919	325.715	ROCK BOLT

NOTES:

1. TOPOGRAPHY PRODUCED FROM AERIAL PHOTOGRAPHS T OCTOBER 1967, EXCEPT NEW SURVEY PRODUCED BY FIE JULY 2008.
2. EXISTING SITE FACILITIES AS SURVEYED BY HIW SURVEYS 2003.
3. COORDINATE GRID IS NAD 83 UTM ZONE 12.

TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	Nonacho Lake Spoil and Laydown Areas Site Plan	**Figure** 6.5.8

The temporary Twin Gorges camp would accommodate a maximum of 200 people during peak construction and over the three-year life would accommodate an estimated 160,000 person-days. The camp would be located approximately 700 m east of the existing power facility in an area previously used for camp development during the original Twin Gorges construction (Figure 6.5.7). The camp would consist of five large trailer units housing bedrooms and washrooms, each unit accommodating approximately 40 people. The kitchen and recreation areas would be separate trailer units. The total camp footprint would be approximately 10,000 m^2 based on unit layouts provided by potential suppliers. The former camp area that was originally cleared totals approximately 80,000 m^2 in extent, hence the new facilities would require only a fraction of this area. The camp would source water from the Forebay or a series of drilled wells, and incorporate a wastewater treatment facility discharging to a buried septic field. Based on an estimated water use of 400 litres per person per day, Twin Gorges camp would use an estimated 80 m^3/day. Water would be treated as required to meet Canadian Drinking Water Guidelines. As with the small existing facility at Twin Gorges, high-temperature incineration would be used for disposal of most wastes, with recycling and disposal of some waste products possible via backhaul on the winter road.

New permanent accommodation and kitchen and recreation facilities would be constructed on the site of the existing house and bunkhouse at the Twin Gorges site. These facilities may use some portions of the temporary camp, relocated to this position at the end of construction.

The temporary Nonacho Lake camp would accommodate a maximum of 50 people during peak construction, and over the three-year life would accommodate an estimated 55,000 person-days. The camp would be located approximately 300 m southwest of the existing dam. The camp would consist of two trailer units housing bedrooms and washrooms, each unit accommodating approximately 40 people. The kitchen would be a separate trailer unit. The total camp footprint would be approximately 2,000 m^2. This camp would source water from the lake and incorporate a wastewater treatment facility discharging to the river. Nonacho camp would use an estimated 20 m^3 per day. High-temperature incineration would be used for disposal of most wastes, with disposal and/or recycling of some waste products possible via backhaul on the winter road.

6.5.3.3 Small Camp Description

Small camps would be necessary for construction of the transmission line. Small camps would be highly self-contained modular facilities suitable for accommodating up to 40 people. Small camps may be relocated during the construction period depending on work progress and scheduling. Small camps would require a source of fresh water but otherwise be self-contained. Water would be treated as required to meet Canadian Drinking Water Guidelines. High-temperature incineration would be used for waste disposal. Currently, small camps dedicated to transmission line construction in the southern sector are forecast to be installed at Twin Gorges between the airstrip and the South Valley Spillway, Taltson Lake staging area, and Sparrow Bay on Nonacho Lake. For the East Arm Sector, small camps at both Charlton Bay and McLeod Bay staging areas and at treeline south of Gahcho Kué would be used. For the northern sector, small camps at Gahcho Kué, East Mackay Lake and Ekati are planned. If accommodations at the mine sites are available, camps at those locations would not be required. For the Gahcho Kué to Snap Lake sector, small camps would be necessary at the mine sites if accommodations are not available. No intermediate camps are forecast in that sector. A summary of Project temporary infrastructure is provided in Table 6.5.1.

Table 6.5.1 — Temporary Infrastructure Type and Location

Yard No	Site Name	Northing	Easting	Comment	Camp
1	Twin Gorges	6698100	478700	Major materials staging area and camp	Main Camp
2	Spillway Staging	6700500	485000	South Valley Spillway laydown	N/A
3	Indian Shack	6728000	495000	North end Indian Shake Lake, minor staging area	N/A
4	King Lake	6775000	525000	King Lake north shore, minor staging area	N/A
5	Taltson Lake	6812000	536000	North Shore Taltson Lake near line –major staging area	Small Camp
6	Taltson River	6834000	545000	North Bank – minor staging area	N/A
7	Nonacho Lake South	6854000	562000	Nonacho Lake by Walker Lake – minor staging area	N/A
8	Nonacho Lake Dam	6836400	554750	Major staging area, laydown	Main Camp
9	Sparrow Bay	6879500	571500	Sparrow Bay near line crossing – major staging area	Small Camp
10	Charlton Bay	6947776	593446	Barge landing, major staging	Small Camp
11	McLeod Bay	6966048	600287	Barge landing, major staging	Small Camp
12	Treeline	7008556	599544	Small staging	Small Camp
13	Gahcho Kué Mine Camp	7035976	589705	Major staging	Small Camp or use Existing Facilities
14	East Reid Lake	7068709	571246	Minor staging area	Main Camp
15	East Mackay Lake	7115137	563603	Major staging area	Small Camp or

Yard No	Site Name	Northing	Easting	Comment	Camp
					use Existing Facilities
16	Lac du Sauvage S	7163001	552673	Minor staging	Small Camp
17	Lac du Sauvage N	7177810	541207	Minor staging	Small Camp
18	Ekati Mine Camp	7174734	516319	Major staging	Small Camp or use Existing Facilities
19	Diavik Mine Camp	7151843	532704	Minor staging	Small Camp or use Existing Facilities
20	Margaret Lake	7047306	556801	Minor staging	N/A
21	Lac Capot	7043298	523479	Minor staging	N/A
22	Snap Lake Mine Camp	7053290	506350	Major staging and small camp or use existing facilities if possible	Small Camp or use Existing Facilities
23	Twin Gorges Camp Facilities	NA	NA	See Figure 6.5.7	Large Camp
24	Twin Gorges Material Spoil Areas	NA	NA	See Figure 6.5.6	
25	Twin Gorges Material Sources	NA	NA	See Figure 6.5.7	
26	Nonacho Camp Facilities and Spoil Areas	NA	NA	See Figure 6.5.8	Large Camp
27	Proposed Winter Roads	NA	NA	See Figures 6.5.1 – 6.5.5	

6.5.4 Construction Methodology

6.5.4.1 GENERAL CAVEAT

The construction organizations ultimately awarded the construction contracts would be responsible for their work methods and practices, which would generally be expected to accord fully with land use approvals, licenses and permits. The feasibility assessment done to date must necessarily develop at least one approach that accords with the site conditions and design in order to arrive at reasonably reliable estimates of construction costs and construction schedule. However, it is possible that detailed development planning undertaken by the actual construction contractors would lead to sound reasons for altering some of the specific construction methodology set forth herein, based on a fuller understanding of the site conditions, changed economics of material supplies and/or labour, specialty experience, or a host of other valid reasons. Based on the current work and understanding, and having obtained detailed input from knowledgeable constructors on all main components of the Project, one feasible approach the Developer feels could be used for the construction of the main components of the Project is outlined below.

An overall Project schedule has also been developed from the methodology presented below, and is presented in Section 6.5.6.

6.5.4.2 DESIGN DEVELOPMENT

It is the Developer's current approach that the majority of the Project component design would be completed in parallel to the final stages of regulatory review, and construction contracts and procurement orders for long-lead items would be fully prepared before final approvals. As the final design development is reasonably time-consuming, this approach is necessary if construction is to commence in the same year as the Project approvals and other conditions precedent are obtained. The design process would require substantial additional site evaluation and survey, but no land disturbance of any significance is anticipated. The design process is therefore not described further in this report.

6.5.4.3 SITE PREPARATION AND MATERIALS DELIVERY

A start date of September is considered optimal for contract commencement, as a mobilization period of three to four months would be necessary prior to the winter season to allow the contractors to assemble materials and equipment, and likely establish a marshalling yard in Fort Smith. Site activities are assumed to commence in winter 2009/2010. Access development and delivery sequencing anticipated on the basis of this assumption are as described below by Project sector.

6.5.4.3.1 Southern Sector

The winter season 2009/2010 would largely need to be devoted to fully re-establishing the former winter road corridor from Fort Smith to Twin Gorges, if this activity has not been previously carried out, pioneering the winter mainline northwards from Twin Gorges to Nonacho Lake, and clearing and site preparation of all camp and staging areas. The main camp at Twin Gorges would be delivered and set up. Where feasible, camps would be delivered and established and equipment delivered to the staging areas farther along the southern sector for work to commence the following summer.

Haulage to occur in this season would include the following:

- delivery of construction equipment, camp infrastructure, diesel fuel and related supplies to Taltson Twin Gorges,
- delivery of bulk cement and large volumes of explosives to Taltson Twin Gorges,
- delivery of small construction equipment to the camp site at Nonacho, and to the transmission staging yards, and
- delivery of tower foundation materials to the staging/laydown yards (grout, cement, steel plates, rock anchors, etc.).

It is not anticipated that the transportation of heavy loads would be required in this season beyond Twin Gorges.

In the 2010/2011 winter season, virtually all of the materials for the transmission line would be delivered to the laydown yards located between Twin Gorges and the north end of Nonacho Lake. These materials would include the following:

- tower structural steel, guy wires, cross-arms (steel) and line hardware and conductors;
- large amounts of Jet fuel to the staging yards for helicopter operation the following summer season (pumped into tanks);
- some diesel fuel for small equipment, generators, etc.;
- staples and other camp-related items at the major camp locations at Twin Gorges and Nonacho Lake;
- turbines, generators and transformers/electrical equipment for the plant at Twin Gorges (bulky and some heavy loads requiring special transport); and
- camp, cement, control gates, construction equipment and other heavy loads to Nonacho Lake Dam.

In the 2011/2012 winter season, all of the major equipment must be removed as construction activities complete at the various sites. Some conductor stringing may still be required in the following spring season, but this would be completed by helicopter and require little equipment. Removal of the following would be required:

- camp equipment and supplies from Nonacho Lake and Twin Gorges,
- construction equipment from Nonacho Lake, Twin Gorges and all staging yards, and
- other related cleanup and decommissioning activities.

In the event that all demobilization could not be completed, it would be endeavoured to bring all equipment and materials as far back as Twin Gorges, such that only the Fort Smith to Twin Gorges winter road would be required in the following winter for a complete demobilization.

6.5.4.3.2 East Arm Great Slave Lake Sector

Commencing as soon as the ice has left Great Slave Lake, barges would be dispatched from Hay River in the summer of 2010 for the Charlton Bay and McLeod Bay staging area locations on the East Arm of the Lake. Initial delivery would provide small self-sufficient camps or include barge mounted camps, earthworks and hauling equipment and fuel for site preparation. Follow-on delivery later in the season would deliver all construction materials, transmission line components, fuel, and camp provisions to the prepared staging areas. Barges may be left over winter at the shorelines near the staging areas, or be returned to Hay River.

In the autumn of 2011, complete demobilization and removal of all equipment and camp by barges from the East Arm back to Hay River would occur.

6.5.4.3.3 Northern Sectors

In winter 2009/2010, ice road spurs to key staging areas would be constructed, and the staging sites prepared and the small camps delivered. Foundation materials would be delivered to the staging areas.

In winter 2010/2011, ice road spurs would again be developed to the staging areas, and all remaining transmission line components, fuel and installation equipment, and camp provisions would be delivered to the staging areas. All substation equipment would be delivered to the mine sites.

In winter 2011/2012, ice road spurs would be developed as required, as some areas may have been demobilized by track. All camps and equipment remaining in all sectors would be removed at least back to the mine sites.

6.5.4.3.4 Summary of Materials Delivery and Demobilization by Sector

A summary of anticipated delivery quantities for materials and fuel during the delivery periods for each of the three main sectors is provided in Table 6.5.2.

Table 6.5.2 — Summary of Material Delivery by Sector and Period

Sector	Delivery Mode	Period 1 Delivery	Materials (T)	Fuels (L)	Period 2 Delivery	Materials (T)	Fuels (L)	Period 3 Transport	Demob
Southern	Winter Roads	Winter 2009/ 2010	3,500	220,000	Winter 2010/ 2011	4825	1,250,000	Winter 2011/ 2012	Full
East Arm	Barge	Summer 2010	970	267,000	Autumn 2011	NA	NA	NA	Full demob in Period 2
Northern	Winter Roads	Winter 2009/ 2010	2,100	350,000	Winter 2010/ 2011	2200	400,000	Winter 2011/ 2012	Full

Depending on the trucking arrangements, these delivery volumes would typically require in the range of 100 – 150 truckloads per season on the Southern Sector access roads, and approximately 60 - 80 truckloads per season on the Northern Sector access.

6.5.4.4 HAZARDOUS MATERIALS

During construction, the bulk of materials required for the Project would be inert. Materials that may pose environmental and human risks include:

- fuels and oils for operation and maintenance of construction equipment,
- jet fuel for helicopter supported construction,
- explosives at the Nonacho Lake control structure and Twin Gorges intake and, where required, along the transmission line to prepare rock for accepting transmission tower foundations,
- bulk cement delivery at Twin Gorges and Nonacho Lake control structure and associated dust control, and
- grout at tower foundations.

These materials would be transported, handled, and stored in accordance with up-to-date industry health and safety guidelines and standards. Brief descriptions of the anticipated materials handling procedures are presented in the following sections.

6.5.4.4.1 Fuel and Fuel Storage

The fuel types, quantities and containers to be used would be determined by the contractors retained to undertake the work. Table 6.5.3 identifies the locations of storage, major fuel types and volumes, and estimated containers required for the construction activities, and which could be on site at any one time.

Where dependent on road access, bulk fuel and lubricant delivery would occur exclusively during the winter seasons, with tank trucks pumping fuels into the various fuel storage facilities and freight trucks delivering drums as required. Camps and staging areas supported by barge supply would receive fuel supplies exclusively in the summer for work through the following complete year.

Bulk fuel storage would generally utilize double-walled Enviro tanks, likely leased for the duration of the works. Drum storage of fuels would be kept to a minimum, but would be required for lubricants and small quantities of gasoline for small engines. Specific drum storage facilities would be constructed where necessary, or drums kept in trailers.

Propane in moderate quantities would be required at all camp and staging areas. Propane would be stored in 1,000 lb. tanks at the larger camps, and in smaller tank trailers at the staging areas.

Fueling facilities for helicopter operations would generally be developed in isolation from the rest of the specific staging area.

At demobilization, remaining fuels would be pumped back into tank trucks, and drums loaded onto freight transports for removal from the sites. The empty storage tanks would then be loaded onto trailers for return to origin, either by winter road or by barge.

Table 6.5.3 — Location, Types and Volumes of Site Stored Fuels

Location	VOLUMES Jet Fuel (L)	Diesel (L)	Containers	Number Required	Comments
Twin Gorges	36,000	30,000	10,000L	7	Transmission line requirements only
Indian Shack	41,000	15,000	10,000L	6	Staging Area
King Lake	143,000	41,000	40000L	4	Staging Area
Taltson Lake	53,000	40,000	10,000L	9	Staging Area
Taltson River	38,000	15,000	10,000L	6	Staging Area
NL South	43,000	16,000	10,000L	6	Staging Area
Sparrow Bay	101,000	60,000	40,000L	5	Staging Area and Camp
Charlton Bay	89,000	56,000	40,000L	4	Staging Area and Camp
McLeod Bay	74,000	50,000	40,000L	4	Staging Area and Camp
Treeline	65,000	25,000	10,000L	10	Staging Area and small camp
Gahcho Kué N	47,000	8,000	10,000L	6	Existing Mine
East Reid	93,000	13,000	10,000L	10	Staging Area
East Mackay	148,000	17,000	40,000L	5	Staging Area
Lac Sauvage S	70,000	11,000	10,000L	8	Staging Area
Lac Sauvage N	27,000	5,500	10,000L	4	Staging Area
Ekati E	11,000	2,600	10,000L	0	Use existing facilities
Ekati S	20,000	4,300	10,000L	0	Use existing facilities
Diavik N	18,000	4,000	10,000L	0	Use existing facilities
Gahcho Kué W	22,000	4,800	10,000L	0	Use existing facilities
Margaret Lake	65,000	10,000	10,000L	8	Staging Area
Lac Capot	45,000	8,000	10,000L	6	Staging Area
Snap Lake	11,000	2,600	10,000L	0	Use existing facilities
Twin Gorges	5,000	440,000	40,000L	6	For General Camp and Construction
Nonacho Lake	5,000	365,000	40,000L	9	For General Camp and Construction

6.5.4.4.2 Explosives

Significant volumes of explosives would be required for the rock excavation works at both Twin Gorges and Nonacho Lake. Estimated quantities are shown in Tables 6.5.4 and 6.5.5. Bulk explosives would be primarily in the form of bagged materials, with some stick explosives required for work below the water table. Explosives would be delivered during the two winter road seasons of 2009/2010 and 2010/2011. Explosives shipments would require dangerous cargo provisions (isolation) in the operation of the winter roads.

The transportation, storage and use of explosives are the responsibility of the blasting contractor, as per the Explosives Act and Regulation permits and certificate held by the contractor. Therefore, although Dezé Energy Corporation can identify the type of explosives to be used (i.e., pellet ANFO and water-resistant encased (stick) explosives in and around water), the transportation, storage and use of the explosives, including volumes, magazines types and locations, primers, etc. cannot be identified until the construction contractor has been retained and their blasting plan submitted in application for their permits. Dezé commits to adhering to all Natural Resource Canada and GNWT Acts and Regulations pertaining to transportation, storage and use of explosives required for construction of the Taltson Expansion Project as well as to ensuring public and employee safety and to security of explosives in consideration of national safety.

In general, it is anticipated that explosives would be stored in a dry and secure storage area (such as a seacan), in a remote area removed from construction activity and combustibles (including forest). Restrictions to access and activity would be enforced around the explosives storage area and signage would be in place, as per the applicable guidelines. Access by the general public to the Twin Gorges site and other areas where blasting is anticipated would not be permitted. Explosives would be stored during the construction phase only, from 2009 to 2011.

6.5.4.4.3 Cement Delivery and Storage

Large volumes of bulk cement and fly ash would be required as winter shipments for continued construction during the following season. Cement would be transported by typical cement carrier trucks with facility for blowing cement and fly ash into the storage facilities. On site, cement and fly ash would be stored in large bulk storage silos, and re-loaded into the transport carrier for movement to the batch plant silos as construction proceeds. All handling of cement would be by contained air methods, and dust emissions from cement and fly ash handling would be minimal.

6.5.4.4.4 Grouts

Grout would be required primarily for the transmission line tower foundations and anchors. Grouts utilized in this work are chemical-based grouts that set up in very cold temperatures. Grout would be delivered in bags small enough for handling, and shipped on pallets within waterproof wrapping. Grout would be stored in specific facilities at line staging areas and along the line corridor. Specialized grout mixing equipment would be used for the majority of the tower foundation installation work, with limited handling required.

6.5.4.5 General Equipment List

The specific equipment spread to be used in the construction of the generation facilities, control facilities, and the transmission lines would be determined by the contractors retained to undertake the work. Tables 6.5.4, 6.5.5 and 6.5.6 identify the type and volume of equipment and estimated numbers typical of these types and scale of activities for the Nonacho Lake site, Twin Gorges site, and the transmission/substation facilities respectively.

Table 6.5.4 — Equipment List: Nonacho Lake Site

Item	Number	Detailed Comments
Light vehicles (ATVs, trucks, Snowmobiles, boats, etc.)	5	Contractor: 3, Owner: 2
Excavators Tank drills Air Tracks Compressors Dozers Rock Trucks Cranes Concrete Pumps Mixer Trucks	3 2 2 3 1 2 2 1 2	General requirements for this type of construction activity assuming remote conditions.
Construction tent frames	0	No tent frames used
Construction trailers	15	Nonacho Camp: 3 sleeping units of 6 trailers each, 1 kitchen unit of 6 trailers, Total 12 trailers Site Offices: 3 (trailer offices)
Total area (m^2) of temporary Structures	8,450 m^2	Nonacho Camp: 3,000 m^2 Site Offices: 250 m^2 (3 trailers) Nonacho Workshops: 200 m^2 (Est: 1 20x20 m shop) Nonacho Lake Batch Plant 5,000 m^2
Type and volume of drilling mud	0	The construction drilling does not require drilling mud.
Explosive material (kg)	8,000 kg of ANFO 500 kg stick	Nonacho: 40,000 tonnes rock ANFO use: 0.2 kg/tonne (average from various construction documents for explosive consumption)
Area of sumps (m^2)	0	Water intake sumps would not be required as water would be pumped directly from Nonacho Lake)

Item	Number	Detailed Comments
Small generators and/or pumps	4	Nonacho: 4 (2 generators, 2 pumps)

Table 6.5.5 — Equipment List: Twin Gorges Site

Item	Number	Detailed Comments
Light vehicles (ATVs, trucks, Snowmobiles, boats, etc.)	20	Twin Gorges: Contractor: 16, Owner: 4
Excavators Loaders Tank Drills Air Tracks Compressors Dozers Rock Trucks Crusher Plant Batch Plant Mixer Trucks Cranes Concrete Pumps	5 3 4 4 8 2 6 1 1 5 3 2	General requirements for this type of construction activity assuming remote conditions.
Construction tent frames	0	No tent frames used.
Construction trailers	46	Twin Gorges Camp: 5 sleeping units of 6 trailers each, 1 kitchen unit of 6 trailers, site offices: 10 trailers
Total area (m^2) of temporary structures	6,200 m^2	Twin Gorges Camp: 4,500 m^2 (from land use application) Site offices: 800 m^2 (10 trailers) Twin Gorges Workshops: 900 m^2 (Est: 1 25x20 m shop, 4 10x10 m shops)
Type and volume of drilling mud	0	The construction drilling does not require drilling mud.
Explosive material (kg)	160,000 kg of ANFO 1000 kg stick	Twin Gorges: 800,000 tonnes rock ANFO use: 0.2 kg/tonne (average from various construction documents for explosive consumption)
Area of sumps (m^2)	0	Water intake sumps would not be required as water would be pumped directly from Twin Gorges Forebay.
Small generators and/or pumps	8	Twin Gorges: 8 (5 generators, 3 pumps)

Table 6.5.6 — Equipment List: Transmission Line

Item	Number	Detailed Comments
Light vehicles (ATVs, trucks, Snowmobiles, boats, etc.)	10	Contractor: 8, Owner: 2
Excavators Mulchers/Faller-bunchers Dozers Nodwells Air Tracks Compressors Drills Cranes Heavy Trucks	6 6 4 8 6 20 20 12 8	Equipment spread depends on scheduling of activities and fronts of work open at any given time.
Construction tent frames	0	No tent frames used
Construction trailers	67	Camps: Twin Gorges 9, Main Staging 16, Barge sites 12, Treeline 6, Other staging areas 24
Total area (m^2) of temporary structures	6,560 m^2	Camps and Site Office Trailers: 5,360 m^2 Staging Area Workshops: 1,200 m^2 (Est: 1 10x10 m shop at each of 12 staging areas)
Type and volume of drilling mud	0	The construction drilling does not require drilling mud.
Explosive material (kg)	1,000 kg of stick	Limited blasting for boulder removal and foundation preparation.
Area of sumps (m^2)	0	Water intake sumps would not be required as water would be pumped directly from large water bodies (i.e., Taltson River, nearby lakes).
Small generators and pumps	36	Staging areas: 36 (2 generators and 1 pump for each of the 12 staging areas)

6.5.4.6 TWIN GORGES FACILITY CONSTRUCTION

6.5.4.6.1 Access and Infrastructure Set-Up

Assuming the 2009/2010 winter road development commencement for site activities, the new main camp and ancillary construction sites (batch plant, aggregate crusher, etc.) would be installed in the spring of 2010 at Twin Gorges. Work would then commence on the access road to the new powerhouse, the canal, and the powerhouse excavation. A 10 m wide road would be cleared and graded along the entire length of the power canal to allow for works access. Branch roads would lead to the intake area and to the powerhouse.

6.5.4.6.2 Spoils Areas and Disposal

Significant volumes of silt and waste rock would be developed from the excavations necessary to complete the Project. It is proposed that excavated spoil be placed in two separate areas, shown as Areas 1 and 2 on Figure 6.5.6. Waste rock from the power canal excavation would be stored in Area 1, and spoil from the penstocks, powerhouse, and tailrace would be stored in Area 2. Spoils are located between the North Gorge alignment and the existing plant to minimize the environmental footprint of the overall Project, as this area between the plants would be essentially isolated from the surrounding areas. Area 2 is entirely in a recent burn zone and comprises bare rock. Area 1 is largely small deciduous tree cover with fairly deep silt soil cover over rock. Estimated maximum excavation volumes for the power canal are 700,000 m^3, and for the remaining components, 300,000 m^3, assuming a bulking factor of 1.5. Storage volumes available from Area 1 and Area 2 are estimated as 930,000 m^3 and 450,000 m^3 respectively, assuming stable slopes of 2H to 1V, and maximum spoil pile heights of 7 m.

The major excavations would be staged to provide waste rock to contain and cover the silt soil that would be encountered in the central section of the power canal, and over the entire area of the lower penstocks, powerhouse and tailrace areas. In the vicinity of the powerhouse, rock waste would need to be placed preferentially near the facilities in order to have a firm base for the laydown and other construction infrastructure. The erodible silt spoils would ultimately be covered entirely by rock waste for long-term stability.

6.5.4.6.3 Contractor Facilities

The contractor's site office, concrete plant, laydown and other facilities would be developed on an initial rock waste blanket in Area 2 (Figure 6.5.6). An area of 18,000 m^2 is anticipated to be required for construction infrastructure close to the powerhouse excavation. Area 2 is estimated as comprising close to 60,000 m^2, leaving sufficient area for the noted spoil volumes.

6.5.4.6.4 Excavations

Excavation in soils would be carried out with tracked excavators and rock trucks. Excavation of rock would be by drill and blast methods using tank and air-track drills, and rock removal by large tracked excavators and rock trucks. Spoils would generally be spread by dozer in the noted spoil areas. Testing of drilling core materials and surface samples indicates a very low level of any mineralization in the shield granites and gneiss present throughout the Twin Gorges site. No issues related to acid rock drainage (ARD) are anticipated. Should rock conditions alter, additional acid-base accounting testing would be carried out.

6.5.4.6.5 Concrete Works

As excavations are completed for key structures such as the powerhouse and intake, forming and concrete operations would commence. Concrete would be batched on-site at the powerhouse batch plant. Concrete aggregates would be sourced from extensions of existing pits, with preliminary locations as shown in Figure 6.5.7. The Twin Gorges site in general has an excellent source availability of various aggregate materials. Processing of concrete aggregates would involve sieving, crushing and possibly washing of fine aggregates. Washing operations can be completely confined to the borrow pit areas and would not result in contaminated surface runoffs. Water for batching of concrete would be sourced from the Forebay. Concrete would generally be placed by mobile concrete pump or for small quantities, by overhead crane.

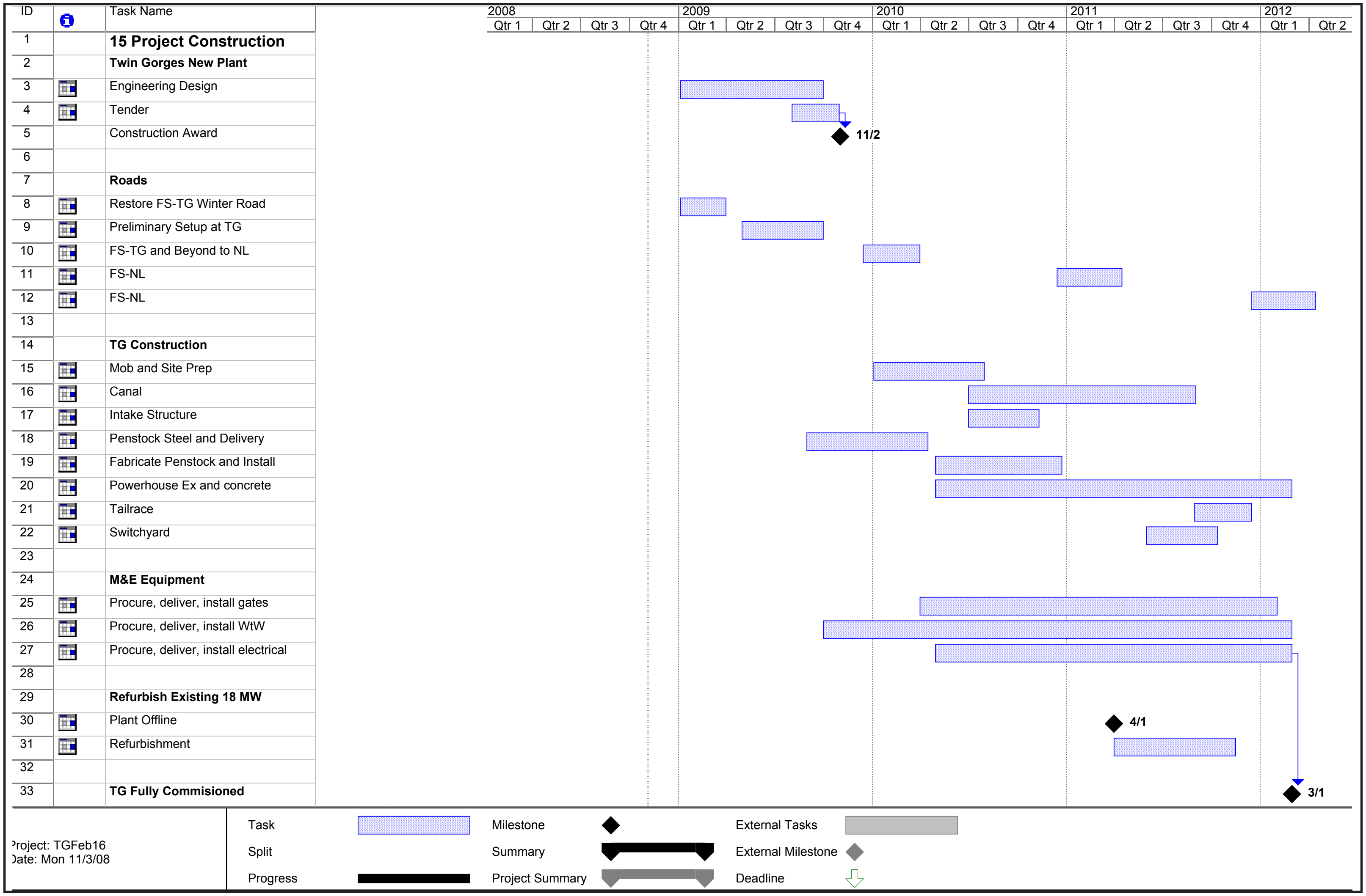
6.5.4.6.6 Penstock Works

The steel penstocks would require specialist labour for fabrication and assembly. It would be a contractor decision whether to fabricate (roll, weld, sandblast, coat/line) the penstocks on site using flat plate steel brought in on the winter road, or truck completed sections of pipe (cans) into the site, store this material until ready for installation, and only assemble the sections into penstocks. Sufficient space is available on the site for the development of a fabrication shop.

6.5.4.6.7 Development Schedule and Duration

A schedule of activities for the construction of the Twin Gorges facilities based on the above general methodology and sequencing is shown in Figure 6.5.9. Materials delivery was discussed in Section 6.5.4.3 above. The primary generation equipment and all other mechanical and electrical equipment would arrive during the 2010/2011 winter and be stored until the powerhouse is ready for such installation. Concreting and superstructure completion would continue through the 2011 summer and fall. Construction activities are likely to be run on double shift in summer periods with long hours of daylight. All key activities would continue through the winter through the use of hoarding and heating methods. The powerhouse would be completed by late 2011 and commissioned by the first quarter of 2012.

Demobilization would largely occur via the 2011/2012 winter road and as necessary in the following year.



TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	Project Construction Schedule Twin Gorges Expansion Plant	Figure 6.5.9

6.5.4.7 NONACHO LAKE CONTROL STRUCTURE CONSTRUCTION

6.5.4.7.1 Nonacho Lake Level Adjustment

The level of Nonacho Lake would require lowering over a period of several months to allow full completion of the proposed new control facilities. A 0.5 m high concrete weir is proposed to extend entirely across the ragged rock sill of the existing spillway, this forming a key component of the new facilities. As cofferdam construction is impractical and environmentally unattractive, it is proposed that the water level be taken down through the autumn of 2010 by leaving the existing sluice gates open. With the inflow gauge re-installed on the Taltson River above Porter Lake, it would be possible to estimate inflows to the lake and control the lake discharge to establish the required lower level at the existing rock sill and maintain the level by adjusting the gates. The control of the lake level with the existing facilities is only feasible during the winter/early spring, and would be lost as soon as freshet commences. A period of approximately two months would be necessary to complete the work, at which point the sluice gates would be shut to continue with other work.

6.5.4.7.2 Access and Infrastructure Setup

Initial camp and limited materials for the construction of the Nonacho Lake control structure may be delivered to the construction site on the 2009/2010 pioneering of the winter road, depending on the progress for this route. In this event, some work would be undertaken at this site in the 2010 summer. If the final schedule requires work to commence earlier, camp and initial equipment may be airlifted in during the late winter of 2010. All remaining materials would be delivered on the 2010/2011 winter road, and construction would proceed as soon as possible in the late winter once the camp and laydowns have been established. Initial activities would be to set up the camp and the batch plant, and to establish cement and aggregate stockpiles and/or premixed concrete stock. No significant access development is required as this site has a very confined area.

Proposed camp and other facilities are located in Area 1 as shown on Figure 6.5.8. This area is a relatively flat expanse of essentially bare rock. Camp infrastructure would comprise a 50-person camp, first aid facility, offices, workshop, staging area and equipment storage, and total approximately 8,000 m^2. The area available totals approximately 18,000 m^2. The batch plant and aggregate processing and storage would be set up in Area 2, also an area of bare rock and scrub.

6.5.4.7.3 Spoils Areas and Disposal

Spoils from excavation of the control structure water passage would be all rock, and are proposed to be spoiled to Area 2. Estimate spoil volume is 60,000 m^3 assuming a bulking factor of 1.5. Area 2 would provide a volume of approximately 90,000 m^3 with stable slopes of 2H to 1V and a maximum spoil pile height of 6 m, allowing sufficient space for the batch plant and associated aggregate storage.

6.5.4.7.4 Excavations and Earthworks

Excavations associated with the control structure at Nonacho Lake would be entirely in strong granitic rock, as there is no overburden on the site. All rock excavation would be by drill and blast using tank and air-track drills, with large excavators and rock trucks for loading and hauling.

A significant proportion of the excavated rock material would be processed and used entirely for either concrete aggregates, structural fills, or as material for the dam rehabilitation. The production of fine aggregates would likely require washing, and settling ponds would be required for this process.

Rehabilitation of the existing dam would include the permanent closure of the existing sluice gates, the placement of a blanket of low permeability material and rockfill upstream of the existing structure to eliminate the bulk of the leakage through the rockfill dam, and a small raise of the dam with similar materials to gain additional freeboard. Specific in-stream activities associated with the Nonacho Lake works are discussed in Section 6.5.5

Acid-base accounting testing of surface exposures at this site indicate no risk of acid rock drainage potential (Appendix 6A). The rock excavation materials would be monitored to ensure the ARD potential remains very low.

6.5.4.7.5 Concrete Works

The first concreting operations would be to establish the spillway crest raise, assuming that the Nonacho Lake level can be brought slightly below the existing sill of the rock spillway. As the period of lake level control would end in May, at which time full batch plant infrastructure would not likely be complete, the use of premixed concrete delivered in bags would be considered. Excavation works would need to be staged such that access onto the dam and spillway remain available for this period.

Once the batch plant is functional, concrete would be available and would be moved by transit mixer and placed by mobile concrete pump or by overhead crane. As structural facilities are completed, mechanical and then electrical installation would proceed.

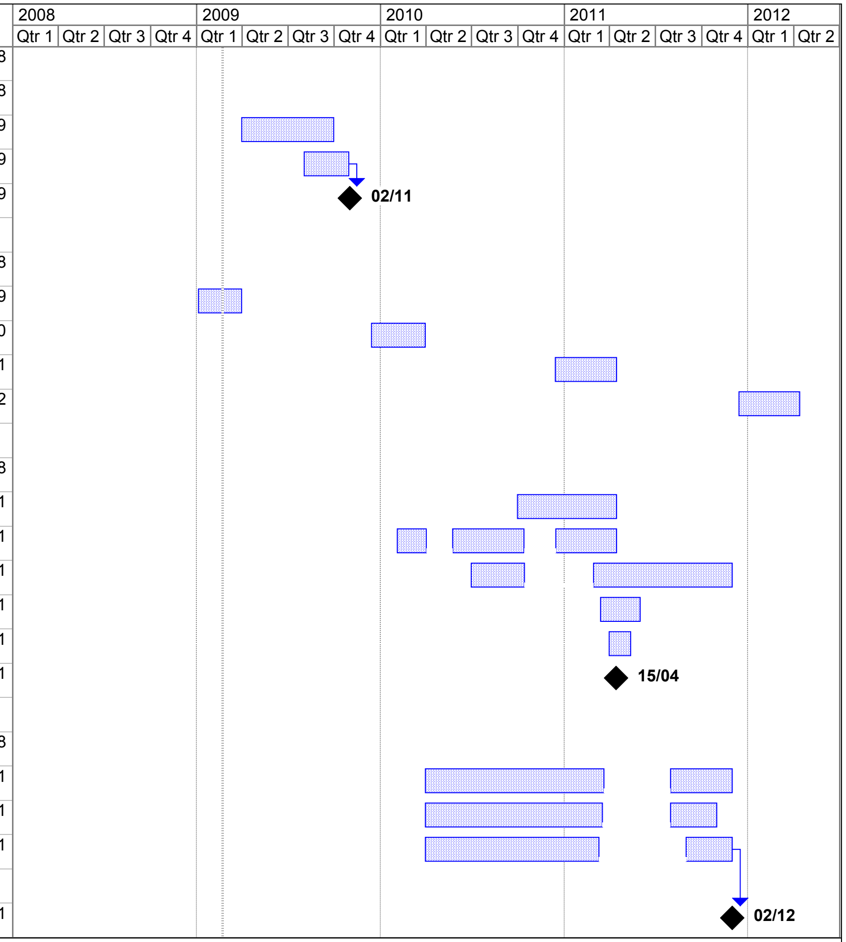
6.5.4.7.6 Development Schedule and Duration

A schedule of activities for the construction of the Nonacho Lake facilities is shown in Figure 6.5.10. Materials delivery was discussed in Section 6.5.4.3 above. In this schedule, it is assumed that Nonacho Lake facility construction commences with some preliminary work in 2010, and again when the 2010/2011 winter road reaches Nonacho Lake. Materials for this work would need to be delivered during the 2010/2011 winter and be stored until required for use or installation. Construction of the control structure would not likely commence until canal excavations were largely complete such that blasting would not damage newly-placed concrete. A rock plug would be left in the upstream end of the entrance canal until the structure is complete, and then be removed by blasting and final excavations. Concreting and superstructure completion would continue through the 2011 summer and fall.

Construction activities are likely to be run on double shift during summer periods with long hours of daylight. All key activities would continue through the winter through the use of hoarding and heating methods. The control structure would be completed and commissioned by late 2011 or early 2012.

Demobilization would occur via the 2011/2012 winter road. All construction infrastructure would be removed with the exception of a kitchen and small accommodation trailer unit, which would be left to function as permanent operation and maintenance facilities. Alternatively, these facilities may be designed into the control structure itself, and all other facilities removed.

ID	Task Name	Duration	Start	Finish
1	**15 Project Construction**	1 day?	Mon 18/02/08	Mon 18/02/08
2	**Nonacho Lake Control**	1 day?	Mon 18/02/08	Mon 18/02/08
3	Engineering Design	131 days?	Wed 01/04/09	Wed 30/09/09
4	Tender	65 days?	Mon 03/08/09	Fri 30/10/09
5	Award	1 day?	Mon 02/11/09	Mon 02/11/09
6				
7	**Roads**	1 day?	Mon 18/02/08	Mon 18/02/08
8	Restore FS-TG Winter Road	62 days?	Mon 05/01/09	Tue 31/03/09
9	FS-TG and Beyond to NL	77 days?	Tue 15/12/09	Wed 31/03/10
10	FS-NL	88 days?	Wed 15/12/10	Fri 15/04/11
11	FS-NL	87 days?	Thu 15/12/11	Fri 13/04/12
12				
13	**NL Contstruction**	1 day?	Mon 18/02/08	Mon 18/02/08
14	Gates Open to Lower Lake	141 days?	Fri 01/10/10	Fri 15/04/11
15	Mob and Site Prep	231 days?	Thu 04/02/10	Fri 15/04/11
16	Control Structure	274 days?	Thu 01/07/10	Thu 01/12/11
17	Dam Modifications	57 days?	Tue 15/03/11	Wed 01/06/11
18	Spillway Raise	31 days?	Fri 01/04/11	Fri 13/05/11
19	Begin lake storage	1 day?	Fri 15/04/11	Fri 15/04/11
20				
21	**M&E Equipment**	1 day?	Mon 18/02/08	Mon 18/02/08
22	Procure, deliver, install gates	342 days?	Thu 01/04/10	Thu 01/12/11
23	Procure, deliver, install hydro	318 days?	Thu 01/04/10	Mon 31/10/11
24	Procure, deliver, install electrical	313 days?	Thu 01/04/10	Thu 01/12/11
25				
26	**NL Fully Commisioned**	1 day	Fri 02/12/11	Fri 02/12/11



Project: Original6.5-9
Date: Fri 20/02/09

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report 2009**	**Project Control Structure Construction Schedule Nonacho Lake**	**Figure 6.5.10**

6.5.4.8 TRANSMISSION LINE CONSTRUCTION

6.5.4.8.1 General

Transmission line construction would proceed in a phased approach involving a variety of construction methods depending on the sector terrain, access availability, environmental constraints, and requirements of the overall Project schedule. The transmission line would be constructed in segments, and is not likely to be completed in a linear manner from Twin Gorges to the mine sites. The methodology and scheduling described herein has been developed with the input of a qualified construction contractor, and is one approach considered feasible and cost-effective. Ultimately, the selected contractor may seek variations on this approach.

6.5.4.8.2 Access and Staging Area Development

The development of reliable access and staging areas is a key component of the overall construction methodology. Temporary access and proposed locations of staging areas have been presented in Section 6.5.2. Once these staging areas are developed, camps established, and equipment delivered, 5 m wide tracks would generally be constructed out to the line alignment, typically 2 to 8 km away from the staging area. Above treeline, no clearing or significant grading would be required to establish these tracks. In the southern and East Arm sectors, clearing would be required along the tracks. This work would be carried out in the cold weather season.

6.5.4.8.3 Line Corridor Clearing

A 30 m wide line corridor would be cleared of most vegetation to ground up to treeline, a distance of approximately 356 km from Twin Gorges. Clearing of the right-of-way would be by machine methods during the cold weather season where temporary access trails are feasible, and by hand slashing where there is only aerial access. Hand slashing and bucking would typically be carried out in the warmer weather season. Machine clearing would be done either by mulching the brush to the ground level with excavator-mounted brush cutters, by dozer-mounted cutters in areas with larger trees, or by a rotary-drum mulcher in the swamp areas. Brush raking, piling, and burning may be necessary if not cleared by mulching, to reduce the risk of fire. Each tower site would need to be cleared to ground level with an area of 30 m by 30 m to allow foundation installation. Where feasible, the cleared corridor outside of tower locations would be limited in width to 15 m, and the low brush left along the sides of the right-of-way.

For machine clearing, a production of eight hectares/day has been assumed, and an average clearing width of 20 m assumed to account for low tree density and burned areas along the right-of-way. This provides a linear production estimate of approximately 4 km/day.

For hand slashing, an average clearing rate of 0.25 hectares/day (0.5 km of ROW) has been assumed for one three-person crew working a shift of 11 hours.

6.5.4.8.4 Foundations

Once clearing a section is complete, a track would be developed along the fully-cleared section of the right-of-way suitable for traverse of construction equipment, where this is feasible. The track may deviate from the right-of-way in certain areas to avoid water bodies, wetlands, bluffs or sensitive areas. Tower foundations would then be surveyed in, and foundation hardware placed by hand or by small machine. For rock foundations, tracked or skid-mounted air-track drills, compressors, and grouting equipment, or Nodwell-mounted drills would be used for anchor installation. For foundations in overburden, Nodwell-tracked vehicles equipped with backhoes, cranes, dual rotary drills with downhole hammers, and tracked excavators with buckets or drills would be used. This equipment can only be used where track access is available. In areas where only helicopter access is available, similar but smaller or lighter equipment would be used with small- and medium-lift helicopters. Depending on conditions, this work would likely be carried out in the summer.

For rock anchor foundations and anchors, a crew size of six working two shifts of 11 hours/day is estimated to achieve six tower sites per day. For the overburden drilled anchors or micro pile foundations and anchors, a crew size of six persons working two shifts of 11 hours/day is estimated to achieve four tower sites per day.

6.5.4.8.5 Tower Assembly

Tower assembly would occur on the staging areas subsequent to the delivery of materials, with delivery typically occurring in the winter except in the East Arm sector where delivery occurs in the summer by barge. Tower assembly is quite time-consuming and drives the requirement for significant staging area extent to remain well ahead of the tower erectors. Small truck cranes and hauling vehicles would be used for assembly and storage of the towers. Tower assembly would be primarily a spring/summer activity. In the northern sector where access is much better, line components would be moved along the corridor, and tower assembly would likely occur at the tower location.

6.5.4.8.6 Tower Erection

Tower erection is the delivery and placement of the assembled towers on the respective foundations. This work would be primarily carried out with medium-lift helicopters for crew movement and heavy-lift helicopters for tower placement in the southern and East Arm sectors, and to a larger extent by mobile crane (where possible) in the northern sectors. Based on the current staging area distribution, tower placement by helicopter is expected to average 17 towers per day, for a total distance of approximately 6 km/day.

6.5.4.8.7 Conductor Installation

Conductor installation in parts of the Southern and East Great Slave Lake sections would be carried out using helicopter construction methods during the warm weather season. A medium-lift helicopter would be used to tension string the conductor. Anticipated progress for this work is approximately 2 km/day of completed line.

For the sections of line above treeline, and some portions of the line in the Southern and East Arm sectors, conductor installation by ground-based methods (slack stringing) would be carried out during the cold weather season when access is available. An estimated production of 3.5 km/day of completed line is anticipated for this method.

6.5.4.8.8 Substations

A new interconnection substation would be required at Twin Gorges. This substation is likely to be located immediately adjacent to the existing plant, on the canal bench of the new plant. The substation work would involved levelling, concrete foundation placement, backfilling with gravels and installation of step-up transfers, bus line, breakers and associated protection and control equipment.

Step-down substations are required at all of the mine sites. Mine substations would typically have a footprint of 35 m x 45 m. Substation works would involve the construction of an access road, site drainage, compacted granular pad sized to the substation footprint, limited amount of reinforced concrete for equipment foundations, structural steel support structures, and installation of substation electrical equipment. A pre-manufactured control building on skids would be installed at each site.

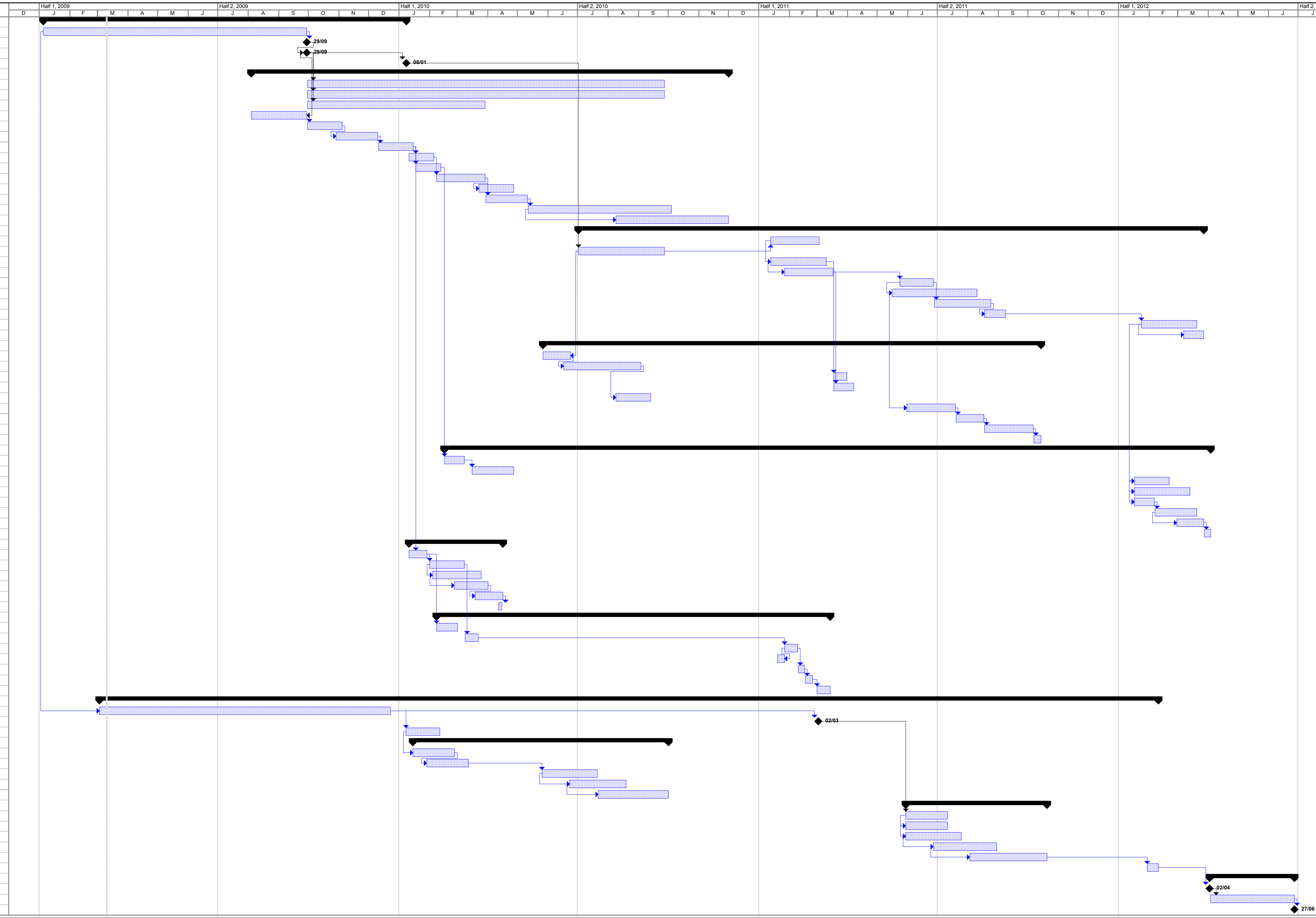
Material delivery for substation construction would necessarily occur in the winter prior to construction. Substation works at each mine site would take approximately six to eight weeks to complete.

6.5.4.8.9 Development Schedule and Duration

A broad schedule of activities for the construction of the transmission line and substation facilities is shown in Figure 6.5.11. Materials delivery was discussed in Section 6.5.4.3. In this schedule, it is assumed that the line work commences with some preliminary work in 2009 on foundations, full materials delivery by the end of the winter road season of 2010, demobilization in the winter road of 2011/2012 and construction completion by early 2012.

TALTSON TRANSMISSION EXPANSION PROJECT - BASELINE OPTION

ID	WBS	Task Name
1	**1**	**Project Start Up**
2	1.1	Specification, Engineering, and Award (Separate Sheet)
3	1.2	Environmental Approval
4	1.3	Contract Award
5	1.4	Construction Start
6	**2**	**Material**
7	2.1	Order & Deliver - Conductor, Insulators & Hardware
8	2.2	Order & Deliver - Substation Materials
9	2.3	Order & Deliver - Foundations
10	2.4	Design & Detail Towers
11	2.5	Prototype Tower Test
12	2.6	Purchase Raw Materials for Towers 600 tonnes
13	2.7	Fabricate Towers 600 tonnes
14	2.8	Bundle & Ship Towers 600 tonnes
15	2.9	Purchase Raw Materials for Towers 750 tonnes
16	2.10	Fabricate Towers 750 tonnes
17	2.11	Bundle & Ship Towers 750 tonnes
18	2.12	Purchase Raw Materials for Towers Bal 3650 tonnes
19	2.13	Fabricate Towers 3650 tonnes
20	2.14	Bundle & Ship Towers 3650 tonnes
21	**3**	**Southern Section**
22	3.1	Mob incl hauling materials to site & camp set up
23	3.2	Clearing - Hand
24	3.3	Clearing - Machine
25	3.4	Foundations & Anchors - Machine
26	3.5	Foundations & Anchors - Helicopter
27	3.6	Assemble Towers
28	3.7	Erect Towers
29	3.8	Tension String Conductor - Helicopter
30	3.9	Slack String Conductor
31	3.10	Demobilization
32	**4**	**East Great Slave Lake Section**
33	4.1	Mob incl hauling materials to site & camp set up
34	4.2	Clearing - Hand
35	4.3	Clearing - Machine
36	4.4	Foundations & Anchors - Machine
37	4.5	Foundations & Anchors - Helicopter
38	4.6	Assemble Towers 750 tonnes
39	4.7	Erect Towers 750 tonnes
40	4.8	Tension String Conductor - Helicopter
41	4.9	Demobilization
42	**5**	**Northern Section**
43	5.1	Mob incl hauling materials to site & camp set up
44	5.2	Install Foundations & Anchors
45	5.3	Install Foundations & Anchors
46	5.4	Assemble Towers
47	5.5	Deliver Towers to Site
48	5.6	Erect Towers
49	5.7	Slack String Conductor
50	5.8	Demobilization
51	**6**	**Gahcho Kue to Snap Lake Section**
52	6.1	Mob incl hauling materials to site & camp set up
53	6.2	Install Foundations & Anchors
54	6.3	Assemble Towers 600 tonnes
55	6.4	Erect Towers 600 tonnes
56	6.5	Slack String Conductor
57	6.6	Demobilization
58	**7**	**Ekati to Diavik Section**
59	7.1	Mob incl hauling materials to site & camp set up
60	7.2	Install Foundations & Anchors
61	7.3	Assemble Towers
62	7.4	Deliver Towers to Site
63	7.5	Erect Towers
64	7.6	Slack String Conductor
65	7.7	Demobilization
66	**8**	**Substations**
67	8.1	Order Long Lead Substation Equipment
68	8.2	Transformer and Substation Equipment Delivery
69	8.3	Mob incl delivery of materials
70	**8.4**	**Civil Work**
71	8.4.1	Snap Lake
72	8.4.2	Gancho Kue
73	8.4.3	Ekati
74	8.4.4	Diavik
75	8.4.5	Twin Gorges
76	**8.5**	**Electrical**
77	8.5.1	Snap Lake
78	8.5.2	Gahcho Kue
79	8.5.3	Ekati
80	8.5.4	Diavik
81	8.5.5	Twin Gorges
82	8.6	Demobilization
83	**9**	**Project Close Out**
84	9.1	Construction Finish
85	9.2	Record Drawings and Reports
86	9.3	Project Close



Project: Taltson Transmission Expansi
Date: Tue 10/03/09

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External MileTask | Split

TALTSON
Hydroelectric Expansion Project

Developer's Assessment Report 2009

Transmission Line Construction Schedule

Figure 6.5.11

Assuming a construction start in early October, 2009, several months of mobilization, materials procurement and delivery would occur prior to the first season of winter road construction. The first works would occur in the northern section in the winter of 2009/2010, with the construction of the line section from Gahcho Kué to Snap Lake, and foundations installed in the section between Ekati and Diavik, and along the main northern section between Gahcho Kué and Ekati. The substations at Gahcho Kué and Snap Lake would be developed and equipment installed.

In the summer of 2010, materials delivery by barge would occur to the landing sites on the East Arm of Great Slave Lake, and hand clearing, foundation installation and tower assembly would proceed from the staging areas by machine and by helicopter. Also during this summer, clearing would occur along the Southern Sector.

In the winter of 2010/2011, clearing and foundation installation would occur along the Southern Sector and the final sections of the East Arm sector. Work may continue on the Northern Sector, or be deferred to the 2011/2012 winter depending on resourcing.

In the summer of 2011, work would complete on the line assembly in the Southern and East Arm sectors. All remaining substations work would also be completed at the mine sites. Demobilization would occur from the barge camp staging areas.

In the winter of 2011/2012, work would be completed on the northern section, and commissioning of the line would occur. Complete demobilization would occur in all sectors. The total construction duration on this schedule is approximately 31 months from award to commercial operation.

6.5.5 In-stream Works

6.5.5.1 General

The in-stream and near-stream works associated with the Expansion Project comprise works related to the construction of winter roads and development of the transmission corridor, which occurs primarily in winter, and to direct in-stream works necessary to connect the new Project facilities to the existing Forebay, to the Taltson River, and to Nonacho Lake. At Nonacho Lake, the in-stream activities would be related to the following work components:

- rehabilitation or replacement of the existing rockfill dam at Nonacho Lake,
- excavation of a new inlet channel from the lake to the new release facilities adjacent to the rockfill dam, and
- raising of the existing rock-cut spillway by approximately 0.5 m with a concrete weir.

At Twin Gorges, the in-stream works would be related to the following work components:

- excavation of a new inlet canal into the existing Forebay adjacent to the right abutment of the existing Twin Gorges dam,
- excavation of a tailrace channel into the Taltson River below Elsie Falls,
- connection of a by-pass canal to the existing Forebay on the left abutment of the existing dam, and

- construction of a minimum release facility at the South Valley Spillway,

A more detailed description of each of these in-stream works is provided below. No direct in-stream works are anticipated to be required for transmission line construction.

6.5.5.2 Water Body Crossings of Winter Road Corridor and Transmission Line

The winter road, transmission line and temporary access trails would cross rivers, streams or lakes as shown in Table 6.5.7. All crossings by winter road or trail would be constructed in accordance with DFO Operational Statement for Ice Bridges and Snow Fills. Approximately 214 crossings are anticipated.

The transmission line would cross approximately 676 rivers, streams or lakes as shown in Table 6.5.7. All crossings would be constructed in accordance with DFO Operational Statement for Overhead Line Construction.

Table 6.5.7 — Stream and River Crossing Data

Feature	Region	Watercourse Crossings	Water Body Crossings	Total
Winter Road	Boreal	446	89	135
	Tundra	11	55	66
Temporary Access Trail	Boreal	5	7	12
	Tundra	1	0	1
Transmission Line	Boreal	111	193	304
	Tundra	133	239	372

6.5.5.3 Repair of Nonacho Lake Dam

Existing works at Nonacho Lake were developed in 1968 to enhance storage and provide a more regulated winter/spring flow release for the Twin Gorges plant, and included the following components:

- A 10 m high, 60 m long rockfill dam across the natural Nonacho Lake outlet, including three timber sluice passages through the dam, controlled by manually-operated slide gates.
- A 65 m wide rock-cut spillway adjacent to the dam.

The facilities have not been altered since construction. As very limited impermeable core materials were available in the immediate area and complete flow curtailment was not an issue at the time of construction, the dam has had significant leakage since it was built. While not a safety issue, the leakage is not desirable within the new arrangement and the sluice passages have reached their service life and need to be decommissioned or rehabilitated. As there is no capability to isolate the gates for such work, decommissioning is likely the only option.

As a part of the proposed Taltson Hydroelectric Expansion Project, and in addition to the new control facility to be constructed at this location, the key components of the work at Nonacho Lake are the repair/replacement of the dam to reduce the leakage, the decommissioning of the sluice gates, and a small concrete raise placed on the crest of the existing spillway. Specific in-stream activities associated with these works are described below.

Rehabilitation to reduce leakage and raising of the dam height by one metre would be undertaken through one of two methods. The first method to be considered would be the placement of a series of coarse and finer rock layers on the upstream face and top of the existing dam (see Figure 6.4.4). The procedures would be undertaken without dewatering or construction of a cofferdam, and would involve the following steps:

1. Removing submerged timber and logs immediately upstream of the dam by grappling.
2. Placing by dump a thick layer of coarse materials sourced from the canal excavations for the new control facility.
3. Placing by dump or excavator a layer of finer materials down to sand fraction over the coarser materials – materials processed from canal excavation.
4. Placing of another layer of coarser materials for protection of the finer layer on the upstream surface, and raising of the top surface.

The sluice gates and upstream water passages would be decommissioned by closing the gates, placing rock fill into the passages, and possibly injecting concrete into the water passages to permanently seal the zone between the existing face of the dam and the gate.

The second approach to be considered further in final design would be to utilize the existing dam as a coffer dam, route the leakage water into a small control facility (conduit and gate) that can be closed at completion or left functional to add to minimum releases below the dam, and construct a new earthfill dam, likely with a cutoff core of fine materials or possibly sheet piles, immediately downstream of the existing dam. Materials would be sourced from the excavation of the new canals. This approach is contingent on the ability to close and seal the existing sluice gates to a degree that leakage rates are controllable. At this time, complete closure of the gates is understood to be unlikely, but methods may be available to reach a viable leakage state. If achievable, this approach would require a minimum of in-stream works associated with the dam rehabilitation.

6.5.5.4 EXCAVATION FOR NEW NONACHO LAKE CONTROL STRUCTURE CHANNEL

The in-stream works associated with the new gated control structure would be limited to the connection of the intake canal to the lake. The canal would be constructed behind a rock plug, which would be removed when the facilities are ready to be watered up. As described below for the North Gorge facilities, some removal of rock below lake level would be required to achieve acceptable entrance conditions for the new release facility. This material would be excavated by the following steps:

1. Excavated rock is placed into the lake in the area that is to be removed, building up a temporary pad on which equipment can work in the dry.
2. Blast holes are drilled from the surface through the rock berm into the sound rock below the pad, and the canal plug is drilled off.
3. The holes are charged and blasted.
4. All rock is removed by special long-arm excavator machines working from the pad limit, removing it as they work back to shore. A temporary bridge may be required to facilitate removal of material from both sides of the canal.
5. Detailed bathymetry remains to be completed for a full definition of the area required for removal. At this time, it would be expected that the pad could extend approximately 15 m out into the lake, with a width commensurate with the canal width.

6.5.5.5 NONACHO LAKE SPILLWAY RAISE

A concrete sill is proposed to be placed across the existing rock cut spillway to raise the storage capacity of the lake by 0.5 m. This work would be undertaken primarily in the dry, once the lake level has been lowered through the previous winter. Access to the spillway area would be across the rock dam. The work would comprise forming and placing reinforced concrete along the entire crest of the spillway. Concrete would be placed by mobile pump and slick line from the right abutment of the rockfill dam.

6.5.5.6 TWIN GORGES NORTH GORGE CANAL AND TAILRACE ROCK PLUGS

In-stream works required for construction of the new canal, penstock, powerhouse and tailrace facilities is limited to the connection of the intake canal to the Forebay, and the connection of the tailrace canal to the Taltson River downstream of Elsie Falls. The actual excavation of the majority of the canals would occur behind rock plugs left in place until the plant is able to be watered up – this occurs late in the construction schedule. In addition to the rock plug, rock material is required to be removed from the actual Forebay and river bed to attain the required entrance and exit depths of the canals. The following procedure is proposed for removal of this material in concert with the rock plug:

1. Excavated rock is placed into the Forebay or river in the area that is to be removed, building up a temporary pad on which equipment can work in the dry.
2. Blast holes are drilled from the surface through the rock berm into the sound rock below the pad, and the plug is drilled off as well.
3. The holes are charged and blasted.

All rock is removed by special long-arm excavator machines working from the pad limit, removing it as they work back to shore. A temporary bridge may be required to facilitate removal of material from both sides of the canal.

Detailed bathymetry remains to be completed for a full definition of the area required for removal. At this time, it would be expected that the pads could extend approximately 10 m out into the Forebay and river channel, with a width commensurate with the canal widths.

6.5.5.7 SOUTH GORGE BY-PASS FACILITY

Similar to the main intake canal, excavation and control structure construction for the gated by-pass facility on the left abutment of the existing dam would take place behind a rock plug. On completion of the facilities, the plug would be removed by blasting and backhoe excavation, and the canal connected to the Forebay. The methodology for removal of the rock plug is the same as for the main canal plugs.

6.5.5.8 MINIMUM RELEASE FACILITY AT THE SOUTH VALLEY SPILLWAY

The minimum release facility would be constructed behind a cofferdam placed around the right abutment of the South Valley Spillway. The work would involve excavator placement of clean fill materials, or possibly an aquadam (water filled bags) around the work area in the Forebay. Excavation and construction works for the small facility would then occur behind the cofferdam in the dry. Some leakage and pumping from the excavations would be anticipated. The cofferdam would be removed at the completion of the work.

6.5.6 Project Development Schedule

Based on the methodology and timelines described in some detail above in Sections 6.5.4 and 6.5.5, an overall Project Development and Construction Schedule has been developed and is shown in Figure 6.5.12. This schedule includes all phases of project development from the ongoing regulatory process through design and construction.

The regulatory process is anticipated to continue through most of 2009, with Project approvals occurring in the 3rd or possibly 4th quarter, in time for award of contracts such that mobilization can occur prior to the winter. The design and contracting development must occur in conjunction with the regulatory process in order that longer-lead materials can be ordered and contracts are ready for award once Project approvals are obtained. The design process would involve detailed drawings and specification development, and further fieldwork (Lidar imaging for transmission corridor) in the summer of 2009.

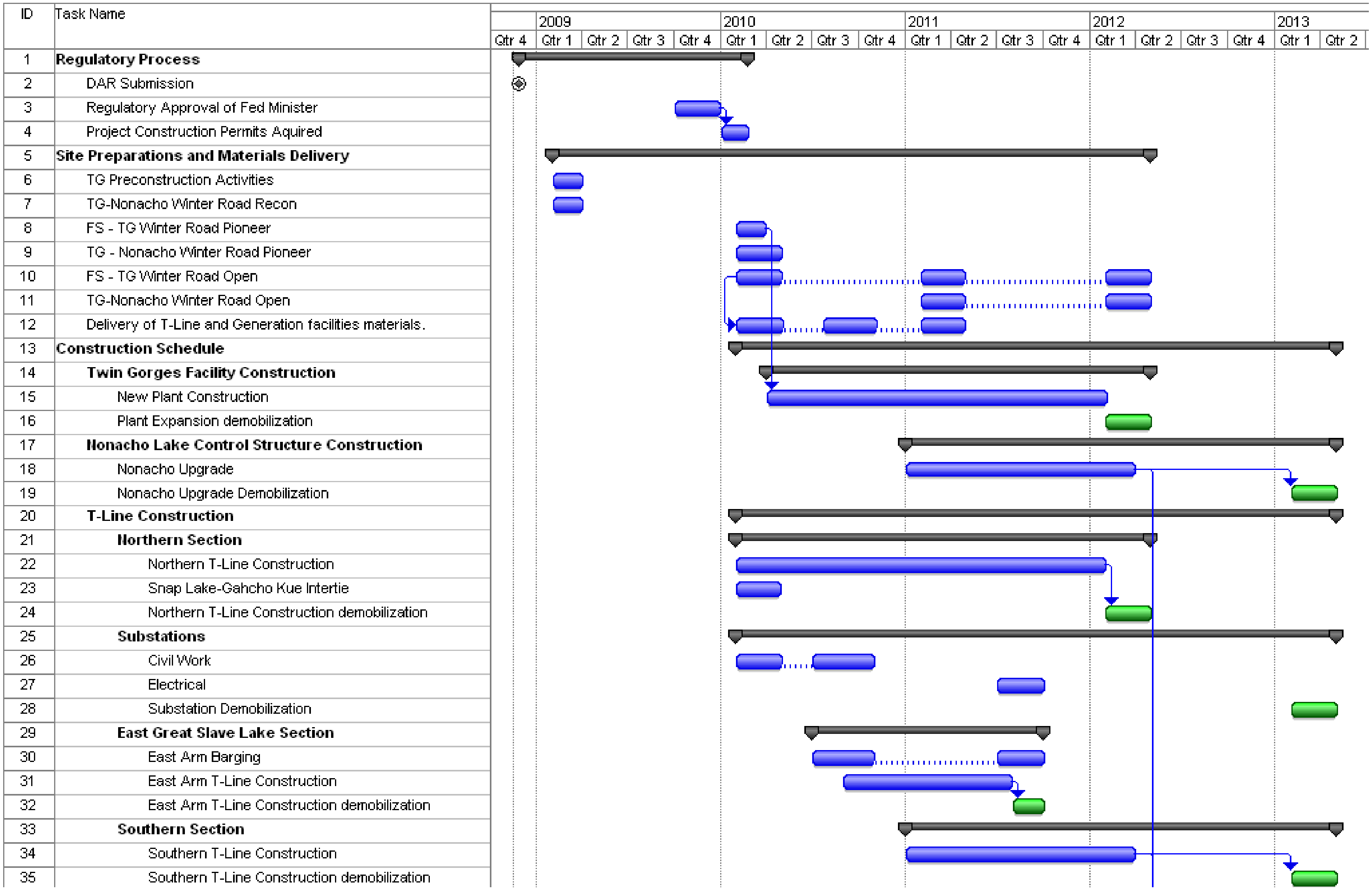
All construction activities are dependent on the winter road developments for the Project. These include both the restoration of the former winter road corridor from Fort Smith to Twin Gorges (possibly re-opened previously by NTPC), the major new winter road sector from Twin Gorges to Nonacho Lake, and the use of the annual Tibbitt to Contwoyto corridor and additional ice road spurs in the Northern Sector.

Activities related to the Twin Gorges expansion plant occur in a 27-month period from the winter of 2010 through to early 2012. Nonacho Lake facilities are planned for construction in the 15-month period from early 2011, when the winter road is available to Nonacho Lake, to spring, 2012.

Transmission line construction would occur generally in the summer/autumn and winter seasons. The line development would not occur in a linear manner, but would be developed according to available access. Currently, the early completion of the line sector connecting Snap Lake to Gahcho Kué is contemplated to aid in the construction of the Gahcho Kué facilities. On the current schedule, line work would be undertaken through a 31 month period commencing in October, 2009 and running until April 2012.

Critical path activities for the Taltson Expansion Project are the winter road development and the construction of the generation and control facilities at Twin Gorges and Nonacho Lake, respectively. Provided that early lead items are procured in a timely manner, the transmission line construction is currently not on the critical path.

The Commercial Operation date for the Expansion Project is forecast for April, 2012.



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Integrated Project Development Schedule**	**Figure 6.5.12**

6.5.7 Project Employment Opportunities During Construction

6.5.7.1 CONTRACTING APPROACH

The developer's preferred approach to construction phase activity is to select two qualified and suitable contractors to organize and deliver the construction of the Project. One contractor would be responsible for the construction of the civil works including the control structures and new generating plant, while the other would construct the transmission system. Contractors would be required to meet standards and conditions established by the developer. Contract(s) for the operation of the generation and control facilities and transmission line would be established once construction is completed. The approach to the operational contracts has not yet been fully developed. The standards and conditions to be established by the developer would include requirements, during the operational phase, for the contractor and sub-contractors to meet specified requirements related to employment and training.

6.5.7.2 DIRECT EMPLOYMENT ESTIMATES

The Project developer's current estimates indicate that the Project would result in approximately 500-700 construction jobs during the initial phase of development of the Project facilities and transmission line. These estimates are preliminary, but provide a good basis for examining the types of positions and the expectations for employment of South Slave and NWT residents. The job figures would be defined with greater certainty as the design for the Project is finalized and would likely be higher when all ancillary and support positions are defined. The length of these jobs is variable, lasting from one or two months to two years. These jobs would result in about 4,950 person-months of work or approximately 412 person-years of activity. Job estimates are based on feasibility level studies undertaken for new generation and control facilities as well as transmission line and substation construction. Notional estimates for Project employment activity are shown in Table 6.5.8 below.

Table 6.5.8 — Estimated Employment Levels: Project Construction

Site and Activity	Number of Employees	Duration of Work (Months)	Total Person-Months of Work
Twin Gorges Plant			
Camp Logistics and Management	31	24	744
Excavation and Civil Works	258	Variable	800
Specialized Mechanical and Electrical	72	12	864
Mobilization/Demobilization	26	4	40
Sub Total	387	>40	1,340
Nonacho Lake			
Camp Logistics and Management	6	12	72
Excavation and Civil Works	44	Variable	200
Specialized Mechanical and	10	8	80

Site and Activity	Number of Employees	Duration of Work (Months)	Total Person-Months of Work
Electrical			
Sub Total	60	>20	352
Transmission Line			
Camps and Logistics	12-17	23	1077
Clearing	14-28	8.5	121
Foundations	6-48	8.5	150
Tower Assembly (yards)	18-36	3.5	301
Tower Setting	6-12	3	31
Conductor Pulling	25	6.5	185
Sub Total	81-166	53	1865
Substations			
Clearing and Foundations	12-36	4.5	96
Installation and Testing of Electrical Equipment	12-48	4.5	126
Subtotal	24-84	9.0	222
Construction Phase – Totals	**522-697**	**>98**	**4953**

It is important to note that construction phase activities would occur over a three-year period. Employment patterns would by necessity follow the construction schedule.

Based on the Project plan, position titles for the available jobs during the construction and operational phase of the Project are outlined in Table 6.5.9 below.

Table 6.5.9 — Direct Employment Opportunities by Skill

Job Type	Specific Job Titles	
Skilled	Project Manager Foreperson Camp Superintendent Plant Superintendent Human Resource Manager Financial Manager Heavy Equipment Operator Helicopter Pilot Diamond Drill Operator Power System Lineperson Journeyperson Lineman Construction Blaster	Heavy Equipment Mechanic Electrical Control Technician Electrical Engineer Carpenter Engineering Inspector Power System Electrician Power Station Electrician Structural Ironworker Stationary Engineers Surveyor Camp Cook
Semi-Skilled	Security Officer Community Liaison Officer	Payroll Clerk Cook Helper

Job Type	Specific Job Titles	
	First Aid Attendant Apprentice Power System Electrician Apprentice Lineperson Truck Driver Administrative Clerk Human Resource Clerk	Heavy Equip Mechanical Assistant Security Officer Safety Officer Surveyor's Assistant First Aid Attendant Finance Clerk
Unskilled	Housekeepers Construction Camp Attendant Construction Labourer General Labour	

The jobs outlined above are divided into three general categories: skilled jobs, semi-skilled jobs, and unskilled jobs. While most of the operational phase jobs fall into the skilled job category, with many requiring trades certification or completion of post secondary studies, the construction phase is expected to provide a broader range of employment opportunities.

Skilled positions generally require professional or vocational certification and in some cases, extensive experience. Credentials may include a university degree or professional or journeyperson certification. With the exception of some specific job areas (e.g., heavy equipment operators) it is generally difficult to fill skilled jobs from the existing labour pool unless they are drawn from other employers. While this might occur in some cases, it is not the intention of the Project to source personnel from other regional and territorial employers. Examples of jobs which would be classified as skilled positions include project management positions, equipment operators, certified electricians and linespersons, inspectors, certified cooks, heavy equipment mechanics, surveyors, and pilots.

Semi-skilled jobs may require at least a high school diploma and many would also require a college certificate or diploma. Generally, positions of this nature require some experience working in the field. Jobs in the semi-skilled category include apprentices, safety and security officer, first aid attendant, and surveyor and mechanics assistants.

Unskilled positions have variable academic requirements and include labourers, housekeepers, camp attendants and cooks.

Sourcing individuals to fill jobs in all employment categories would require matching skills and knowledge of applicants with the requirements of each position. The Expansion Project intends to do this on a case-by-case basis while ensuring that all employees can meet minimum standards related to job performance and work, as well as worksite and camp safety.

Estimates at this point suggest that about half of the jobs on the Project would be classified as skilled while one-quarter would be semi-skilled and one-quarter would be unskilled. The Project expects to have greater success hiring regional and territorial residents to fill the semi-skilled and unskilled jobs on the Project.

6.5.7.3 Indirect Employment Opportunities

In addition to direct employment, the Project is also expected to result in indirect and induced employment both in the communities close to the Project activities as well as in the territorial commercial centre of Yellowknife. Types of employment resulting from subcontracting or increased economic activities associated with income earned by employees on the Project may include work in the following areas:

- accommodation and food services,
- air, marine and ground transportation services,
- banking, communications, and administration services,
- building and industrial supplies,
- camp and catering services,
- cleaning and janitorial services,
- engineering and environmental services,
- fuel, water, sewage, and solid waste services,
- general contracting,
- logistics,
- surveying,
- trades services, and
- travel services.

6.6 PROJECT OPERATIONS

6.6.1 General Approach

The specific arrangements for operation of the Expansion Project remain under evaluation. It is likely that an Operations and Maintenance Contract with an experienced plant operations entity such as Northwest Territories Power Corporation (NTPC) would be put in place. This type of arrangement is considered the most effective since NTPC would very likely need to continue to operate the existing Taltson Twin Gorges plant and maintain the existing 115 kV intertie to the South Slave communities. The new plant operations could be easily integrated into existing control and dispatch facilities operated by NTPC.

6.6.2 Staffing

As a remote site facility, a small staffing component would be on site continually, and standby staff would be available for unforeseen events. It is anticipated that two full-time operators would be on site at Twin Gorges at all times, with rotations similar to the existing operations, hence a total of six to eight fully-trained operators would be required. During maintenance periods, which would be more extensive than current because of the increase in the number of generation units, additional staff would be on site, with numbers depending on the specific tasks to be undertaken.

Operations staff would be required to operate the plant in accordance with dispatch instructions from the operations control centre, likely located in either Fort Smith or Yellowknife. This facility could be an adjunct to the existing NTPC dispatch centre or a separate facility, depending on the operations group structure. The Project would continue to be operated in full coordination with the diesel generation facilities at Fort Smith and Hay River.

The Nonacho Lake facility would not be manned, but would require regular visits by operations staff to ensure the facilities are functioning properly. It is anticipated that significantly more time would be spent at the new facilities than is currently required for the existing sluice gate operation.

In addition to plant operations staff, linemen would be required for maintenance, emergency repair, and standby service for the transmission line and substations. Operational experience would be required to define the necessary levels of staffing for the line operations, but it is anticipated that at least one full crew would be continually employed.

It is anticipated that a long-term monitoring program would also be required during at least the early years of operation of the Expansion Project. Monitoring would involve the collection of environmental and other data from the Taltson Basin for ongoing comparison with baseline conditions. This work would involve both specialist and support resources from the local communities, and likely occur on an annual basis, typically during the summer season. Some winter work may also be required.

6.6.3 Inspection and Maintenance

A systematic inspection and maintenance plan would be implemented for both major infrastructure and installed equipment to accord with manufacturer's recommendations and industry experience with the specific equipment. Regular inspections and monitoring of water levels, leakage, cracks, etc., would occur on the key structures on an ongoing basis. These inspections would be carried out in accordance with the most recent versions of the Canadian Dam Safety Guidelines (Canadian Dam Association), and comprehensive inspections under these guidelines would be undertaken periodically in accordance with the risk level and consequence ratings established for the facilities.

Regular equipment maintenance would be carried out by operations staff, or in some cases by specialized personnel or manufacturers' service representatives working in conjunction with operations staff.

A full inspection of the water conveyance system downstream of the intake gates would be carried out periodically, typically on an annual or bi-annual basis. This inspection would be done on a unit-by-unit basis such that continued operations of the other units can occur. Additional crews would be brought in for these scheduled maintenance sessions.

Transmission line inspection would occur by helicopter over the entire transmission line route at least once and likely twice per year. The crews would be inspecting the line and towers for damage to conductors or insulating hardware, failing guidelines or foundations, potential tree hazards, and any other situation that may influence line reliability. If a repair is noted to be required, crews would then be organized and dispatched in conjunction with a line outage, if required, to carry out the work. The dispatch of crews could occur from the mines or from Twin Gorges, depending on the location of the work to be undertaken. Typically, the transport would be by helicopter.

6.6.4 Ongoing Operational Modeling and Field Programs

The effective operation of the Expansion Project would ultimately require the combination of a number of sophisticated monitoring and predictive modelling tools with an interface to the plant control system. As well, a reasonable level of operational flexibility within the facility design would be required and included to deal with unexpected variations in flows and other basin characteristics for which only a limited understanding is currently possible. To begin this process, fieldwork, record collection, analysis and interpretation have been used to create a number of numerical models to simulate both past and future operation of the facility within the Taltson River basin. These have been described in previous sections as the energy generation and basin models, which have been used to develop the preliminary design of key characteristics of the Expansion Project and predict the effects of Project operations looking forward. Both the models and the final design would continue to be updated as required to include any new data or Project requirements such that the Project as constructed would be optimized for the defined operational criteria, subject to whatever limitations and constraints are placed on the development. Longer-term operational experience, data collection and analysis, and dedicated monitoring programs would ultimately be required to gain a more thorough understanding of the basin hydrological behaviour and potentially gain further benefits from the Project – this in itself is not atypical of such developments.

The presentation of general operational predictions as provided below is based on the current design and on the model development undertaken to date. The flows, water levels, releases, and generation output as described herein are all based on the use of historic flow records in the models to predict typical operations of the expanded system.

6.6.5 Nonacho Lake Control

6.6.5.1 Normal Operations

The Nonacho Lake control structure is a key component of the Taltson Expansion Project, as it would manage the delivery of regulated flow for generation at the Twin Gorges plants through the storage and controlled release of water from Nonacho Lake. This flow management process aims to provide to Twin Gorges a year-round flow equal to the total design use of the plants plus the minimum release requirements at the South Valley Spillway. The flow management for the Twin Gorges site is complex for a variety of reasons, the key ones being:

- Flows into Nonacho Lake are highly variable from year to year.
- Unregulated releases spill from Nonacho Lake through Tronka Chua Gap and over the spillway.
- Variable flow transit times from Nonacho Lake to Twin Gorges occur, depending on base flow levels in the Taltson River and intermediate lake elevations.
- Highly variable and unregulated flow is provided by the Tazin River into the Taltson River above Twin Gorges, forming approximately 40% to 50% of the total flow at Twin Gorges.

The control functions that would occur at the Nonacho Lake facility would follow seasonal patterns, wherein high freshet inflows into Nonacho Lake would be stored while the Tazin River supplies most of the design flow to the Project, and then released in increasing volumes as the Tazin River flow tapers off in the summer, fall, and winter. The process of setting a particular release from Nonacho Lake through the control structure would commence with an assessment of what flow would be required at Twin Gorges at a future point in time, typically three to four weeks ahead of the current date. The look-ahead is required since releases from Nonacho Lake would take three to four weeks to arrive at Twin Gorges, depending on baseline flow levels in the river and lakes between Nonacho Lake and Twin Gorges. Flow gauging on the Tazin River and its tributaries would be used to assess the current flow and forecast the Tazin contribution at that future time. The accuracy of that assessment would initially be fairly poor, but would gradually increase as data is collected and assessed and Tazin River characteristics and behaviour become better understood.

Once a target release from Nonacho Lake is established, which would likely be done on a daily basis, the other releases occurring from the lake through the Tronka Chua Gap, through the mini-hydro turbine, and over the spillway would be totalled, from which a net release through the control structure would be calculated. Operational rating curves for the lake itself would then be checked to ensure that minimum or maximum lake levels, minimum releases and any other specific criteria allow such a flow release. The release would then either be fully or fractionally implemented or not, depending on the operative conclusions for all of the conditions precedent. To implement a release, the control gates would be automatically adjusted, based on the known stage-discharge gate-opening function for the control gates. This process would be fully automated and run continuously year-round. All control facility functions and release calculations would be displayed in the main control room at the Twin Gorges plant and reviewed by operations staff daily.

As Nonacho Lake is large and levels change slowly, and the Tazin River flows would change more on a weekly basis, daily changes in releases from Nonacho Lake would generally be quite small. Any significant change would be cause for review by operations staff. Generally, larger changes can result from an operational constraint being implemented, such as release curtailment due to low lake level. Release functions at Nonacho Lake would normally be run in automated mode by the overall plant control system, but would have the facility to be manually controlled from both Twin Gorges and from the Nonacho Lake control facility itself.

Scenario runs for the Project using a reasonably sophisticated model incorporating the above logic and the key hydrologic characteristics of the entire Taltson basin are presented in detail in Chapter 13. These results show typical conditions of Nonacho Lake water levels; release quantities from the spillway, control structure and Tronka Chua Gap; and downstream levels. This type of program would form the basis of the forecasting and flow release criteria for control structure as the program continues to be developed and enhanced with additional data and features.

6.6.5.2 Scheduled Maintenance and Shutdowns

Very little maintenance would be required on the Nonacho Lake control structure, other than a regular annual shutdown of the mini-hydro plant for servicing. As the discharge through the small hydro plant is small, the gates would simply be opened slightly to make up for the outage, if required at all. Gate servicing can be carried out by isolating one of the four control gates with stop-logs, and maintaining full reservoir and release control through the remaining three gates. The servicing period for gates and the hydro plant would be set for summer when all gates are normally closed and releases are occurring naturally over the spillway. Scheduled shutdowns at Nonacho Lake would therefore not result in any significant change in flow releases or other control functions.

6.6.5.3 Unscheduled Shutdowns

Unscheduled shutdowns at Nonacho Lake would be related to an outage of the hydro plant or a gate failure scenario. The hydro plant would be backed up by a diesel generator, fully capable of powering the gates and control systems. The diesel plant would be connected via an automatic transfer switch to immediately commence operation should the hydro plant have an outage. An alarm would also be sent to Twin Gorges to alert staff that an outage had occurred. Fuel capacity for approximately 14 days of operation would be kept at the Nonacho Lake facility, allowing a sufficient period for either additional fuel delivery or repair of the hydro plant. No change in control operations would occur through this period. In the event that neither the hydro plant nor the diesel generator was functional, a DC battery system would maintain settings of the gates for a period of days, and then shut the control system at the current gate settings.

The failure of a single gate would cause control functions to shift to the remaining functional gates. An alarm would be sent to Twin Gorges control. Once a repair team arrived, the gate would be closed, isolated with stop-logs, and repaired.

Unscheduled shutdowns at Nonacho Lake would not result in any significant changes in flow releases or other control functions.

6.6.6 Twin Gorges Operations

6.6.6.1 Normal Operations

The Expansion Project would comprise both the existing 18 MW plant and the new generating plant at Twin Gorges. Water management goals would seek to operate the plants at or near plant capacity 100% of the time. However, output of these plants would vary depending on the availability of water, and possibly on the available load to be serviced. Recent discussions with customers indicate that the full capacity of the Expansion Project is likely to be marketable, hence continuous operation at or near full output is anticipated to be desirable as long as sufficient water is available.

Hydrological analysis based on historic records indicates that there would be periods where insufficient water is available for full output, and production would be curtailed. The new plant would produce approximately 40% more energy from the same available water in the Forebay than the existing plant, due to the increased available head on the new plant and the higher efficiency of more modern generation equipment. Optimal operation of the two plants would therefore have the new plant running preferentially to the existing 18 MW plant when insufficient water becomes available to run both plants – i.e., as available flows at Twin Gorges drop, the operation of the existing plant would be scaled back first. Hydrological analysis based on historic records suggests that there have been periods where the existing plant would have been entirely shut down, and total output reduce to approximately 30 MW. However, there is no period in the last 25 years of record where such extreme dry periods have occurred.

In normal operations, the flows through the generation plants would be set to be in complete balance with the inflows into the Forebay, thereby minimizing the Forebay level fluctuation. However, as the Forebay inflows are about 50% unregulated (Tazin River flows), and the only regulation point at Nonacho Lake is 150 km away (up to 4 weeks in flow time), only a modest level of inflow control would actually ever exist on the Twin Gorges Forebay. As inflows drop, plant output would necessarily be curtailed to avoid decreasing headpond levels. As the inflows increased, plant output would be stepped up to use more flow. Once the total plant use limit was reached, the remaining excess flows would need to be spilled through either the South Valley Spillway or the new South Gorge spillway facility. For control of Forebay levels by ramping of plant output, load demand must exist such that the output power can be reduced or dispatched.

The process of monitoring headpond level and setting plant output to attain inflow/outflow balance would likely be the standard method of operation of the plants, except in extended periods of high inflows, when other operational modes can be used. This process is completely automated and reliable with larger Forebay areas such as exists at Twin Gorges, as the reservoir levels move quite slowly. Though not used in current operations because this balance of inflow and power output is not possible, headpond level control is expected to work quite well in the Expansion Project to maximize power generation from available flows.

Irrespective of the operational mode to be employed, the overall goal in normal operations would be to minimize the spilling of water from the Twin Gorges Forebay. The operating level of the Forebay would normally be maintained at or slightly below the current South Valley Spillway level through much of the operating period. Except in periods of high Tazin River flows or imbalances in the Tazin River and Nonacho Lake releases that result in too much water reaching the Forebay, only the minimum release flow would be passed through the South Valley Spillway into Trudel Creek, or alternatively through the new spillway. Predicted Forebay levels and releases into Trudel Creek for normal operational scenarios are discussed in detail in Chapter 9.

6.6.7 Plant Outages

6.6.7.1 Scheduled Outages and Normal Shutdowns

Hydro-generation machinery is proven technology and in general is highly reliable. However, scheduled outages (shutdowns) for inspection and servicing would be required for the Expansion Project at least on an annual basis. These operations would be scheduled up to a year ahead of time, and typically would allow a number of inspection and servicing tasks to be completed in a very specific time window. There may also be brief scheduled shutdowns necessary for implementation of new control features or replacement of equipment – typically these would be on a single unit basis and could be accommodated with several days' notice to customers.

Currently, the existing Twin Gorges facility undergoes a scheduled shutdown for a period of approximately one week each year in September to ensure reliable service through the peak winter generation season. It would be envisaged that the scheduled servicing for the new plant would be staggered from the existing plant and then across the two new units, such that only 18 to 28 MW (depending on overall plant size) of generation would be unavailable at any given time during the scheduled maintenance period. It is rare, but not unrealistic, to expect brief but complete scheduled generation outages to be required for such events as switchyard or transmission line outages.

During a scheduled outage, the normal shutdown procedure would be invoked, with output from the machine(s) to be taken off-line gradually ramped down over a period of perhaps 10 minutes, and then the generator taken off-line and machine gates closed. If maintenance on the machines themselves is required, the penstock may be dewatered and draft tube gates closed, and the turbine dewatered.

For a short-term scheduled outage, it is likely that the water originally used for generation of the out-of-service unit(s) would need to be spilled through the South Gorge Spillway and over the South Valley Spillway. Due to the flow time lag between Nonacho Lake and Twin Gorges, it would be impractical and likely very difficult to try to time any change in Nonacho Lake release to reduce flows to balance the scheduled outages, although operational experience may ultimately show this timing is feasible for contiguous outages associated with annual maintenance. For the new plant, the outage of an 18 MW unit would require the spill of approximately 53 m^3/s of flow through the servicing period. For the existing plant, the outage of the 18 MW unit would require the spill of approximately 74 m^3/s of flow through the servicing period. For the larger plant, the outage of a 28 MW unit would require the spill of approximately 83 m^3/s through the servicing period. While existing servicing periods are normally in September, it is envisaged that scheduled servicing periods for the Expansion Project would be moved to early spring, when the availability of water is seasonally the lowest, and potential generation loss would be minimized over the long term.

The availability of at least three generation units and two separate plants in the Expansion Project would provide enhanced reliability of hydro generation for the existing connected customers on the Fort Smith/Hay River distribution system.

6.6.7.2 UNSCHEDULED OUTAGES AND EMERGENCY SHUTDOWNS

An unscheduled outage is an unplanned curtailment in generation arising from either a pre-programmed "trip" of the system, or by an emergency stop procedure implemented by an operator. Unscheduled outages would occur on occasion through unexpected electrical or mechanical failures, lightning damage to the transmission line or switchyards, or other large electrical fault occurrences. In typical hydroelectric facilities, unscheduled outages take the systems out of service about 2% of the year, though this figure varies depending on the age of equipment and particular site conditions. Typically, outage times are in the range of several minutes to several hours on manned projects, but much longer outages can occur if significant conductor or tower damage occurs in remote locations. Emergency stops with operator intervention are very rare, but can be required due to unforeseeable events such as impending damage to facilities from flooding, debris, fires, complete failure of the control system, or other catastrophic events.

In an unscheduled or emergency outage, the affected unit or entire plant is taken off-line virtually instantaneously, and the turbines completely shut down over a period typically of about 10 seconds duration. All pre-existing generation flows would then be staged into the Forebay, raising the Forebay level until inflows and releases through both the South Gorge Spillway and over the South Valley Spillway are balanced. This situation would remain until the system was put back into operation. For the maximum plant output, if both plants were affected, the pre-existing inflow would be approximately 180 m^3/s for the 36 MW plant, and 240 m^3/s for the 56 MW expansion. As an unscheduled outage is by definition unplanned, the pre-existing spill from the Forebay at the South Valley Spillway would likely be close to or at the minimum release. In many instances, unscheduled outages are corrected within minutes, but this would not always be the case. The extent and timing of generation loss and spill operations from the Forebay is not amenable to accurate prediction, and statistical methods would need to be employed to gain a full understanding of the likelihood of outage scenarios.

For unscheduled outages, no adjustment of Nonacho Lake flow releases would be viable in reducing South Valley Spillway volumes unless a prolonged outage was forecast after the initial trip. Any adjustment of the flow release from Nonacho Lake would also need to be in accord with the rule curves lake elevation, and release adjustments may not be possible. Ramping of flows associated with the scheduled and unscheduled outages of the plant are discussed below.

6.6.7.3 FLOW RAMPING IN TRUDEL CREEK AND DOWNSTREAM OF PLANTS

Basic strategies for normal operating conditions and scheduled and unscheduled shutdown operations have been discussed above. The overriding objective of the plant operations would be to keep the river and Forebay system in a stable or slowly changing state, and avoid transient operations that lead to large fluctuations in flows over short periods of time. However, normal start-up and both scheduled and unscheduled outages of any of the generation units may lead to temporary but fairly large-scale changes in flows both in Trudel Creek and downstream of the plant. Over several hours to days, the flows in these reaches would reach a new equilibrium. These more rapid changes from equilibrium conditions are termed flow ramping. Typical flow ramping scenarios anticipated for the Expansion Project are presented in the following sections.

6.6.7.3.1 Ramping from Normal Shutdown of Single Units

Several weeks per year would likely be devoted to plant maintenance, where one of the generating units is shut down. While efforts may be successful in curtailing the releases from Nonacho Lake such that inflows are reduced through the maintenance period, some spill of inflows must be anticipated through the South Gorge Spillway and/or over the South Valley Spillway during this period. As a generating unit is shut down, flows would decrease as described in the normal shut-down procedure.

At the completion of plant maintenance, as the plant is brought back fully on-line, additional generating unit flows would enter the Taltson River downstream of the plants, adding to the flows already in this reach from the units still in service and from flows coming through Trudel Creek. The additional flows would decrease over a period of several days as the Forebay level is brought below the spillway crest and the Trudel system comes back into low flow equilibrium. The maximum rapid-flow increase for this scenario is approximately 83 m^3/s over the background flow in the Taltson River downstream of the plants, which would likely be at least 150 m^3/s (two units running). Any normal shutdown and start-up of a single unit would result in a similar ramping situation if the shutdown was for more than about eight hours.

A typical scheduled outage and restart scenario would result in the hydrographs shown in Figure 6.6.1 for Trudel Creek immediately below the South Valley Spillway, and a point in the Taltson River immediately downstream of the plants. These hydrographs assume minimum baseline flows in the Trudel Creek system at the time of the outage, and with restoration to these minimum flows as full production is restored. Water levels associated with this outage and restart scenario are shown in Figure 6.6.2 for a point downstream of the South Valley Spillway and a point in the Taltson River below Elsie Falls.

6.6.7.3.2 Ramping from Unscheduled Major Outage

An outage lasting a few minutes would be by far the most common form of plant disruption, and would typically be caused by a lightning strike on or very near the line causing a momentary fault or failure in line load stability. These outages would generally occur during the summer months when background river flows are likely to be quite high. Unscheduled major outages and start-up from such an outage can result in larger flow ramping scenarios. In the event of a major outage, the South Gorge Spillway would normally be operated in synchronization with the generation units, such that the gates of this spillway would automatically open after a fixed time period. For an outage that is corrected within a period of tens of minutes, the spillway would not be opened, and only minor disruptions to flows below the plant would occur. No spill would occur at the South Valley Spillway, as the Forebay would absorb the small increment in total volume without spilling. The generation units would be brought back online and loaded as quickly as possible.

In the far more rare event of a complete plant outage from full production levels that was not corrected within a fairly short period, the South Gorge Spillway would be opened and begin spilling approximately 30 m^3/s, and an increment of up to 210 m^3/s of flow would slowly begin to be released over the South Valley Spillway into Trudel Creek as the Forebay level rises. The Forebay rise required for complete spilling of the excess water would be approximately 0.75 m, well within the normal operating range of the Forebay.

An outage may occur at any time of year. In the winter, background flows in Trudel Creek may be at or close to the minimum release of 4 m^3/s from the South Valley Spillway through to the tailrace of the existing plant. In the summer, there could be significant background flows in Trudel Creek. For the minimum flow case, flows in the Taltson River would gradually drop to the South Gorge spillway discharge capacity (30 m^3/s) plus the minimum baseline flow of 4 m^3/s, for a total of about 34 m^3/s below Elsie Falls. This flow is above the current Water Licence Minimum of 28 m^3/s. This situation would exist in the Taltson River until flows from Trudel Creek increased. It is estimated that for minimum baseline flow conditions in Trudel Creek, the incremental flows over the South Valley Spillway would take approximately 8 to 12 hours to reach the area of Elsie Falls and the plant tailraces.

In an outage lasting more than about 8 to 12 hours, on start-up, the South Gorge Spillway would first be closed, and increments of approximately 80 m^3/s would then be introduced to the river below the plants on top of the base flow there as each unit was started and loaded (assuming the new plant has two units). While all three turbine units are capable of being started and fully loaded within a few minutes, a staged start-up and loading process would be implemented to minimize the flow ramping in the Taltson River downstream of the plants. Typically, one unit would be loaded every four to six hours, which would allow flows through Trudel Creek to decrease. A typical complete outage and restart scenario would result in the hydrographs and water levels shown in Figure 6.6.3 and Figure 6.6.4.

The outage and restart hydrographs have been routed through a model to predict water levels at the same cross-sections on Trudel Creek and Taltson River below the plant to illustrate other relevant ramping scenarios where baseline flows are much higher than the minimum. These results are shown for two locations in Trudel Creek and the Taltson River downstream of Twin Gorges (Figure 6.6.5) for a two-year return period flood ($Q_2 = 45\ m^3/s$), and a 10 year return period flow ($Q_{10} = 161\ m^3/s$) for the full outage and restart scenario in Figure 6.6.6 and Figure 6.6.7 for Trudel Creek and the Taltson River respectively. For outages and restart scenarios which occur during periods of larger base flows, significantly shorter times for response through the Trudel Creek system would occur. The hydrographs provided here provide an indication of the maximum periods in which Taltson River flows are significantly impacted below Elsie Falls.

It should also be noted that flow and water level fluctuation associated with major outages and restart scenarios would be limited to the river reach between Twin Gorges and Tsu Lake, and would decrease moving downstream towards the lake. No impacts of temporary changes in plant operations such as occurs during an outage would be observed in the river below Tsu Lake.

6.6.7.3.3 Ramping from Unscheduled Partial Outage

In the more likely event of a line outage affecting only one or the other of the complete plants, a similar series of events would occur as described above, but total flow rates curtailed are respectively lower at 165 m^3/s and 75 m^3/s for the new plant and existing plant respectively. For the case of an extended outage of the Expansion Plant with 56 MW of installed capacity, the South Gorge Spillway would begin spilling 30 m^3/s, and after several hours, flows over the South Valley Spillway would increase from the baseline (4 m^3/s minimum assumed here) to approximately 140 m^3/s. Flow staging below the plants would alter from full flow of 240 m^3/s down to a minimum of 109 m^3/s – the sum of the existing plant (75 m^3/s) plus spillway (30 m^3/s) plus Trudel minimum (4 m^3/s). This situation would exist in the Taltson River until flows from Trudel Creek increased.

At plant restart, the new plant units would be loaded through the same staged scenario as described previously, with a lag of four to six hours likely occurring between unit start-ups. For the first unit start-up, the South Gorge Spillway would be closed in synchronization with the loading of the unit, and a total incremental discharge of approximately 50 m^3/s would then be added to the Taltson River for a total maximum flow of 290 m^3/s. Assuming the Trudel flows ramp down over this lag period, at the next unit start-up, a full incremental flow of 80 m^3/s would be added to the background flow, for a total flow of 320 m^3/s. A typical partial outage and loading scenario would result in the hydrographs shown in Figure 6.6.8, and the water levels shown in Figure 6.6.9.

It must be anticipated that both of the transmission lines would have annual outages caused by lightning, as this is an operational experience for current plants in the Northwest Territories. While the majority of these lightning strikes are cleared quite quickly, at least one significant outage annually would not be unrealistic. These outages would typically occur in the summer months and may last anywhere from a few hours to several days. Outages caused by ice and wind loading would be very rare for the proposed line as no major water body crossings are required, and appropriate design and construction methodology can virtually eliminate this possibility in normal terrain. Maintenance of the right-of-way clearing limits in treed areas is also of paramount importance in reducing line outages.

Figure 6.6.1 — Ramping Flows for Scheduled Outage and Restart (Single Unit)

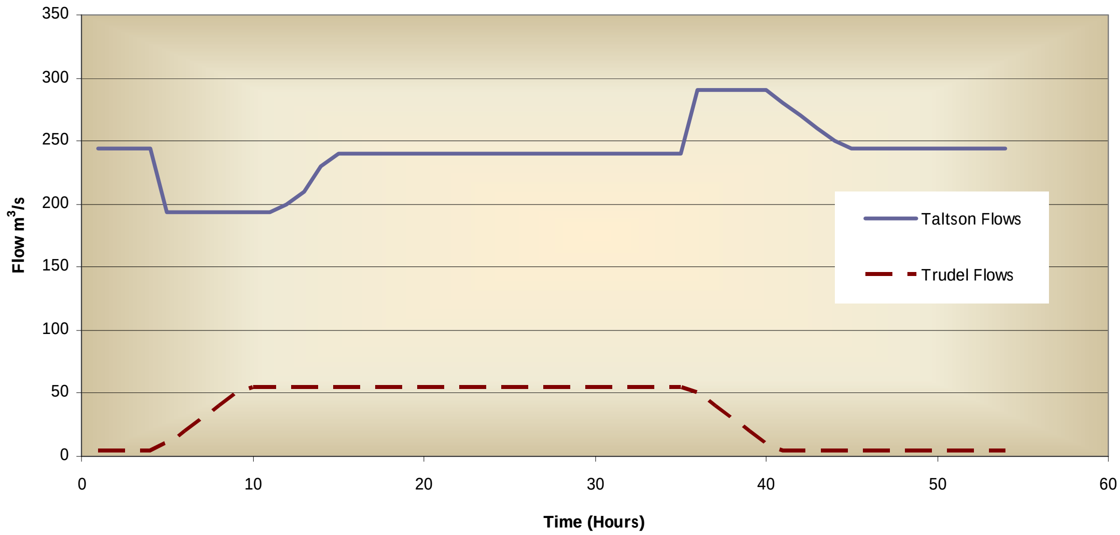


Figure 6.6.2 — Water Levels for Scheduled Outage and Restart (Single Unit)

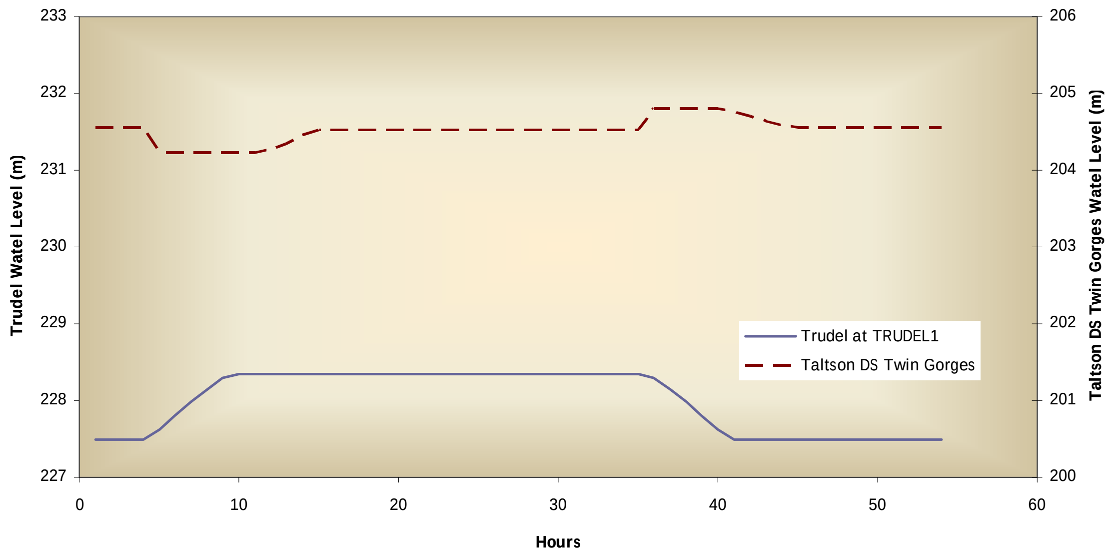


Figure 6.6.3 — Ramping Flows for Full Outage and Restart

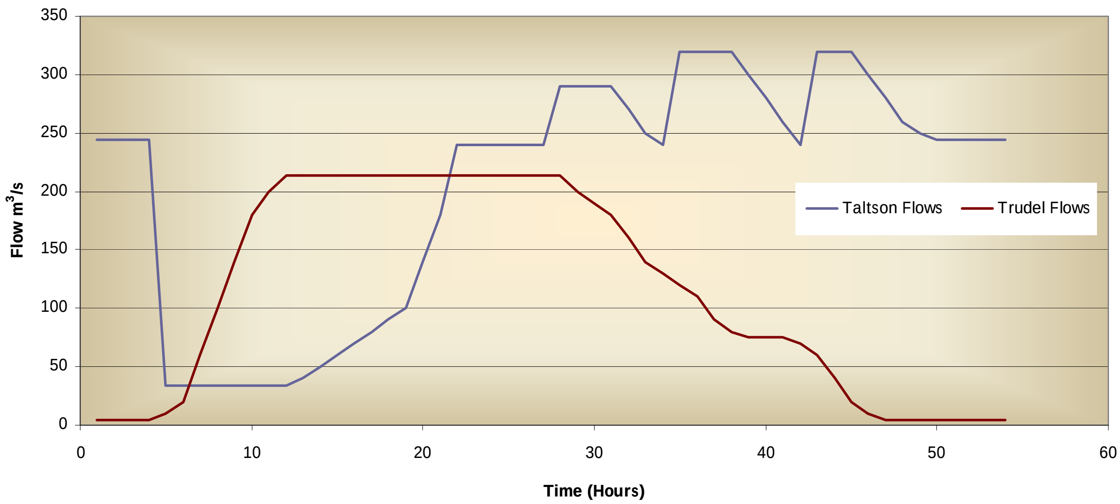
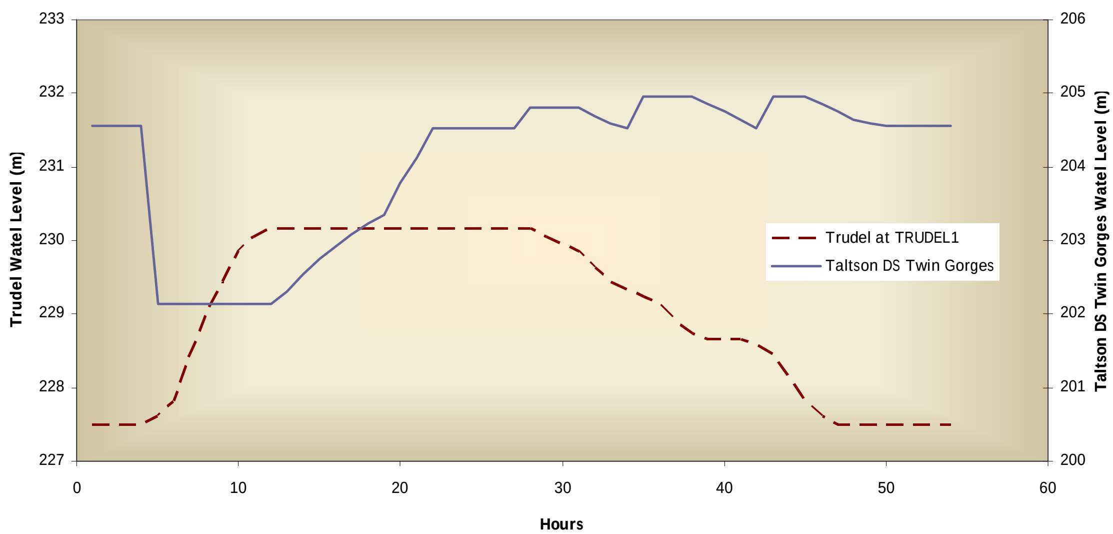
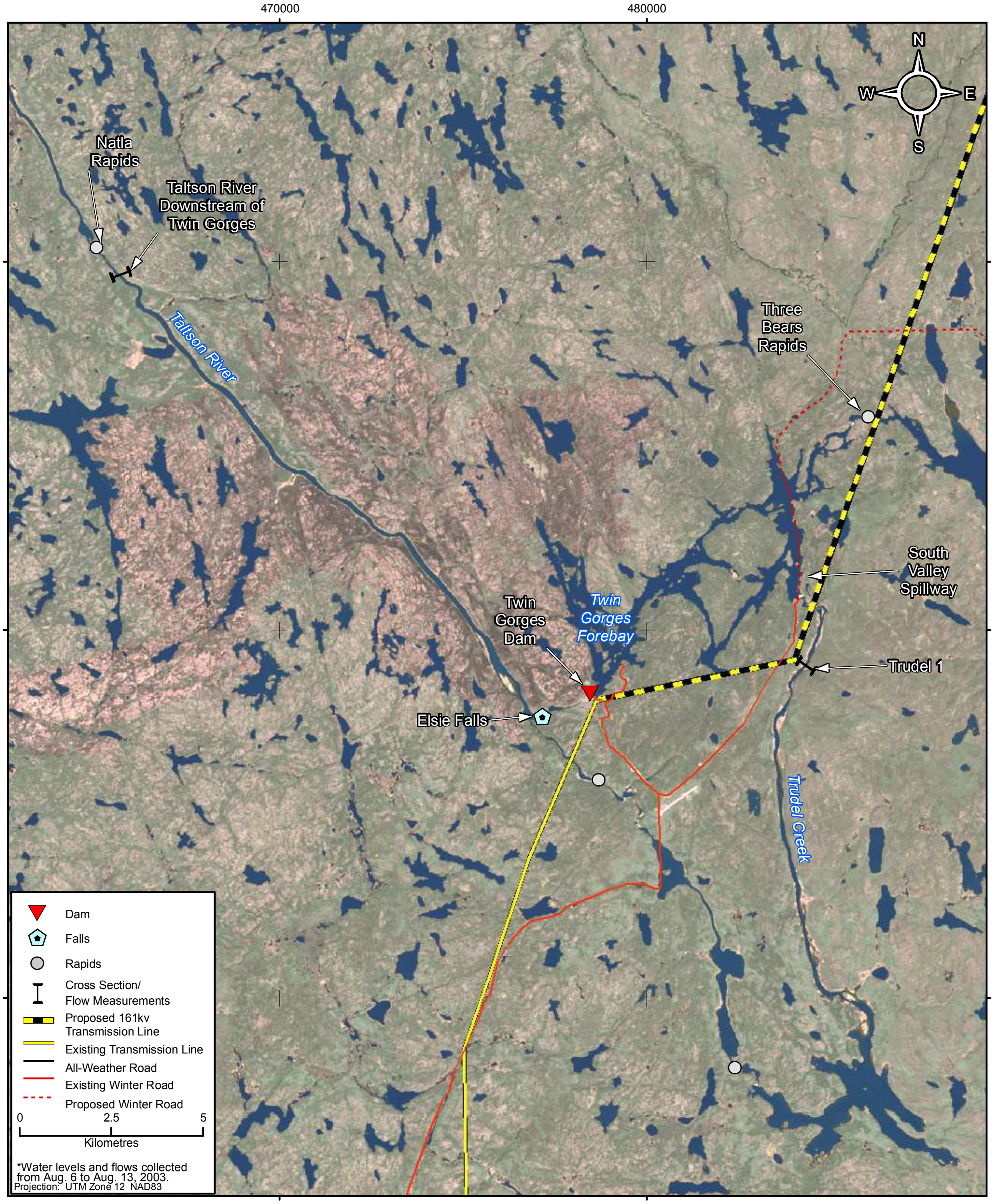


Figure 6.6.4 — Water Levels for Full Outage and Restart





TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report 2009**	**Cross Sections Used to Illustrate Water Levels in Trudel Creek and the Taltson River below Twin Gorges under a Full Outage Scenario**	**Figure 6.6.5**

Figure 6.6.6 — Water Levels in Trudel Creek for Full Outage and Various Base Flows

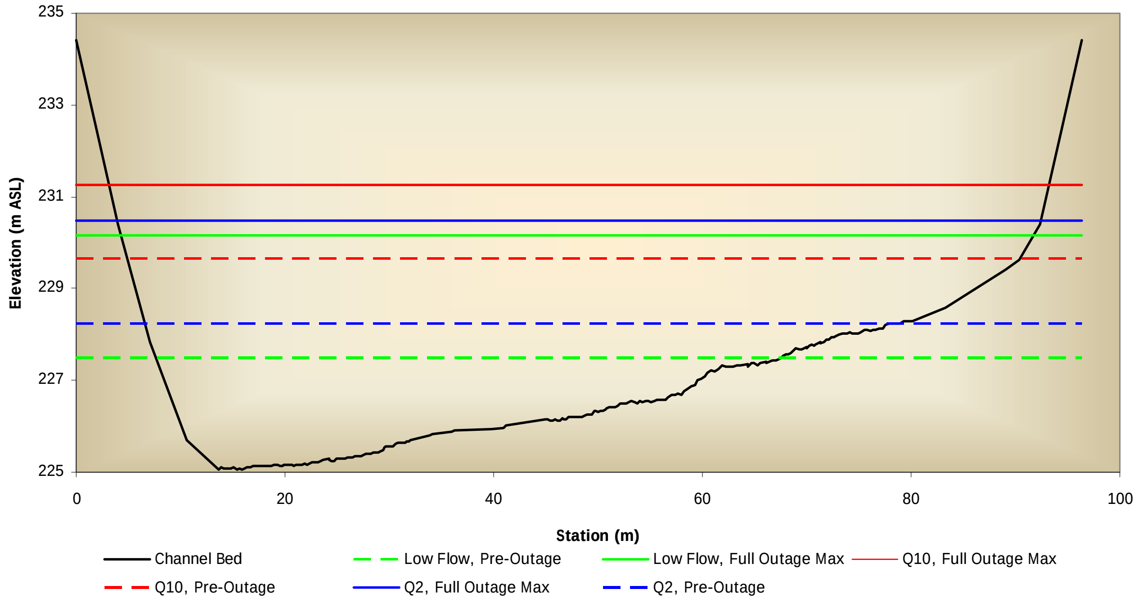


Figure 6.6.7 — Water Levels in Taltson River for Full Outage and Various Base Flows

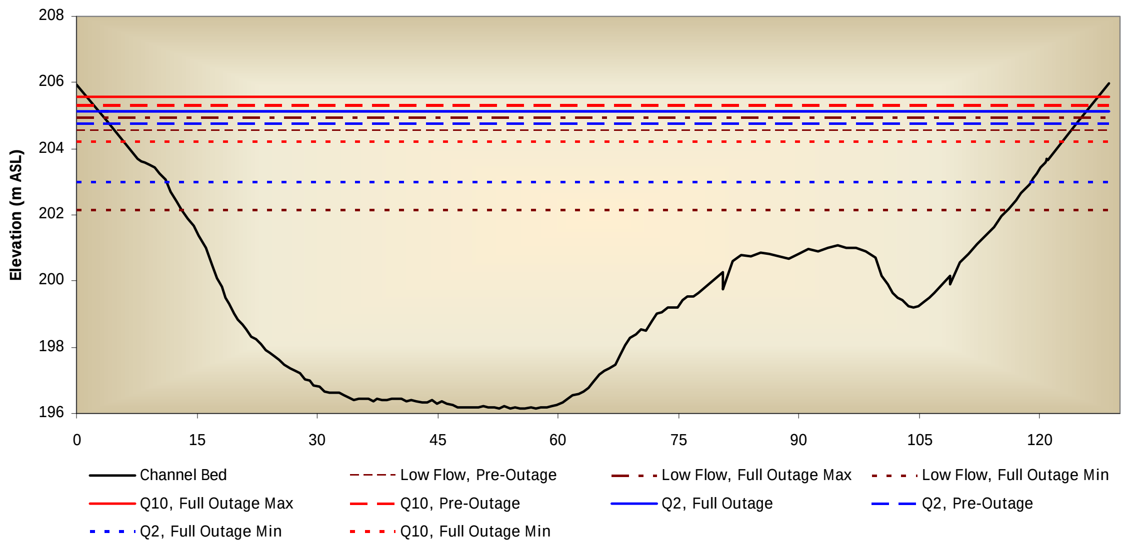


Figure 6.6.8 — Ramping Flows for Partial Outage and Restart (56 MW plant)

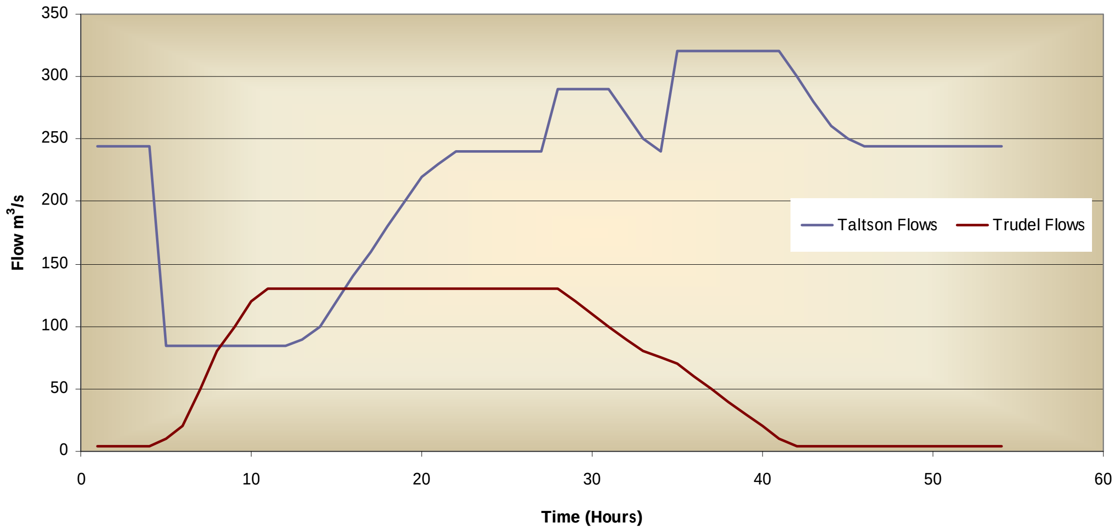
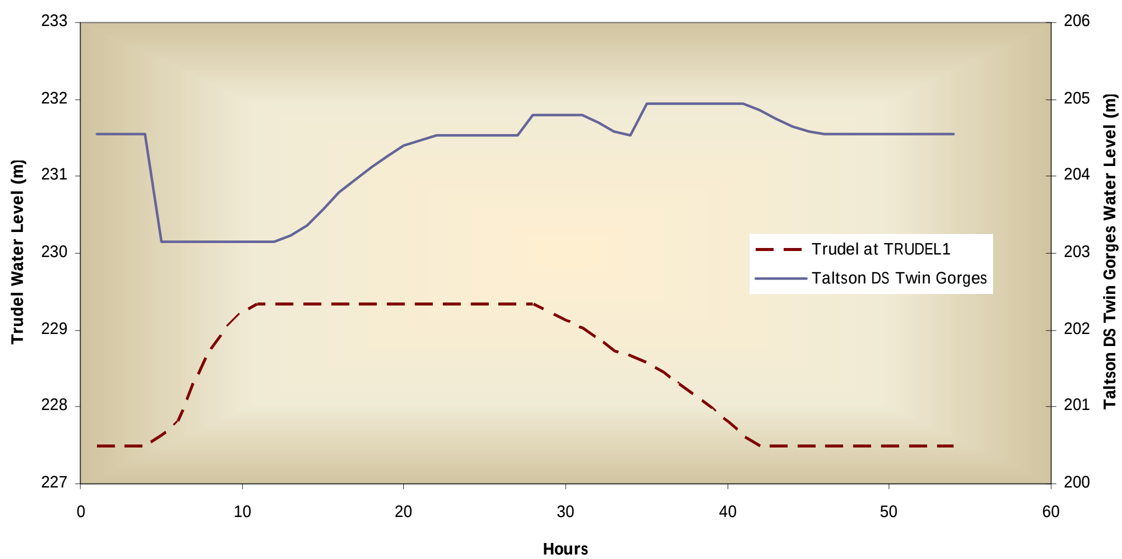


Figure 6.6.9 — Water Levels for Partial Outage and Restart (56 MW plant)



6.6.7.4 Flow Ramping in Taltson River Below Nonacho Lake

Some reasonably rapid but much lower flow fluctuations would also occur in the Taltson River immediately below the outlet of Nonacho Lake due to operational requirements of the control structure. For example, flow releases through the control structure may be curtailed reasonably rapidly when the elevation of Nonacho Lake reaches certain trigger levels. Typically, there would be a number of these trigger elevations, which results in a step function rating curve for discharge. Modelling currently suggests steps in the range of 30-50 m^3/s in discharge would be effective for water management and to ensure that lake level excursions stay within acceptable limits (a relatively rapid discharge drop from 80 m^3/s to 50 m^3/s, as an example). As the lake level would be below the new crest of the spillway when these trigger points were reached, these types of fluctuations would be seen in the river flows below the lake outlet. In the lowest lake level trigger, all flow is proposed to be curtailed except the minimum release of 14 m^3/s. This situation would only occur during late winter/early spring, and would remain in place until the freshet flows began to raise the lake level.

Natural releases over the spillway would decrease quite slowly, as the spillway has significant crest width. Similarly, natural flows through the Tronka Chua Gap would decrease slowly (over a period of months) with lake level.

6.6.8 Reduced Output Operations – Interim Loss of Customer Load

It is entirely feasible that the customer load base may have an interim decrease in the future, such as would occur as one or more of the diamond mines ramps down and closes. It is anticipated that approximately five years' notice would be provided by the customers on their intent to close or significantly alter their power demand; however, it is recognized that the economics of the mining industry are difficult to predict, and a shutdown and consequent loss of load could occur on relatively short notice. In the event that no additional customer load can be developed to take up the full power output of the Project at the same time as load is lost, the Project operation very likely would be re-tuned to better match the actual load requirements. The water management plan would be altered to minimize uncontrolled spills, and re-balance inflow and generation requirements at the Forebay to the extent possible.

A scenario whereby two mines would close (with no immediate new customers) would result in a loss of approximately 20 MW of load. From the baseline of a 56 MW expansion facility, this type of load loss is approximated by the 36 MW study case fully evaluated in this report. Project operations between these limits (for instance, with one mine closed) are anticipated to have impacts between these assessed limits. The revised water management plan to be put in place under this scenario would be developed to minimize any negative impacts of flow and elevation changes in the Taltson River system to the extent possible, based on the results of the modeling and impact assessment described herein.

In the reduced load scenario, all Project facilities would remain fully functional and ready for restoration of full generation at short notice. No decommissioning or removal of any infrastructure would be invoked in the interim operating mode. Depending on the installed capacity of the Expansion Project plant, it is possible that a reduced load scenario could be supported exclusively by generation from the new plant. In this case, the existing plant would be kept completely functional, but not operated on a continuous basis. The existing plant would be run during maintenance periods of the expansion plant. Minimum flows below the generation facility would be maintained by releases over the South Valley Spillway through Trudel Creek.

Depending on the specifics of the longer-term cause of the interruption in load demand, the development of a medium-term decommissioning plan for the affected sectors of the transmission line and/or substations may be instigated. These plans are discussed in more detail in Section 6.8.

6.7 PROJECT PERFORMANCE

6.7.1 Energy Generation and Power Output Reliability

6.7.1.1 GENERAL APPROACH

With the concept design, plant sizing, and operations logic developed, a relatively accurate assessment of the Expansion Project performance can be made in terms of energy generation and power capacity reliability with a detailed hydrological generation computer model. As noted in Section 6.2, this model works from the long-term baseline hydrological inflow set, on a monthly time step, and incorporates a set of assumptions on basin storage and release characteristics, operating rules for the control structure at Nonacho Lake, the generation plant water conveyance losses, machine performance, and operations logic for dispatch of the two generating plants. The operating rules for the Nonacho Lake structure were discussed in Section 6.2, and characteristics of the plants presented in Section 6.4. The baseline hydrological input is the set of 1962 to 2007 gauge records for the WSC gauges in the vicinity of Twin Gorges shown in Figure 6.2.1.

Distributing and routing these flows through the storage and generation model provides an estimate of the flows at Twin Gorges Forebay available for generation. Figure 6.7.1 shows available flows assuming a 36 MW Expansion Project (54 MW total plant). Figure 6.7.2 shows available flows assuming a 56 MW Expansion Project (74 MW total plant). Ideally, these flow records would be a relatively flat line at the Project full output level, or approximately 180 m^3/s for the 54 MW total plant size, and 240 m^3/s for the 74 MW total plant size. However, because the storage in the system is limited to flows entering the system above Nonacho Lake, and the Tazin inflows are unregulated, flows above and below the full demand line occur regularly throughout the record. For flows above the plant use requirements, spills would occur, with decreasing spill trends for the larger installed capacities. Available flows below the full demand line mean that the plant is not able to run at full capacity (a capacity factor below 1.0 for the total plant) with a resulting drop in energy and power output during the period of lower flows.

To maximize the utilization of the water available in the Forebay, a number of key operating assumptions are carried in the generation model at Twin Gorges, as follows:

- A Forebay level just below the spillway crest is maintained, and associated gross head on the plants is assumed constant, though in fact it would vary by a small amount. The current fixed-head assumption is conservative in terms of energy production.
- The new plant is operated preferentially over the existing 18 MW plant – that is, as available flows to the Twin Gorges Forebay decrease, the existing plant output is gradually curtailed to shut down, prior to the new plant output being curtailed. This is a result of the new plant operating with approximately 11 m more head than the existing plant and significantly higher efficiency generation equipment. These factors lead to a result that the same available flow would create a minimum of 40% more energy in the new plant than the existing plant.

Figure 6.7.1 — Available Flows at the Twin Gorges Site, 1962 to 2007 (54 MW Plant)

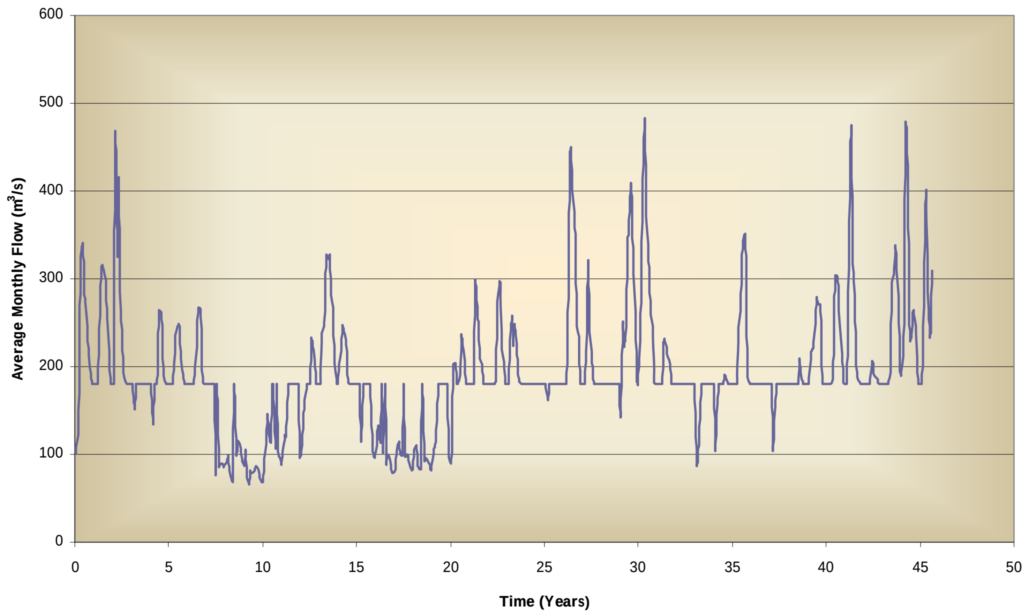
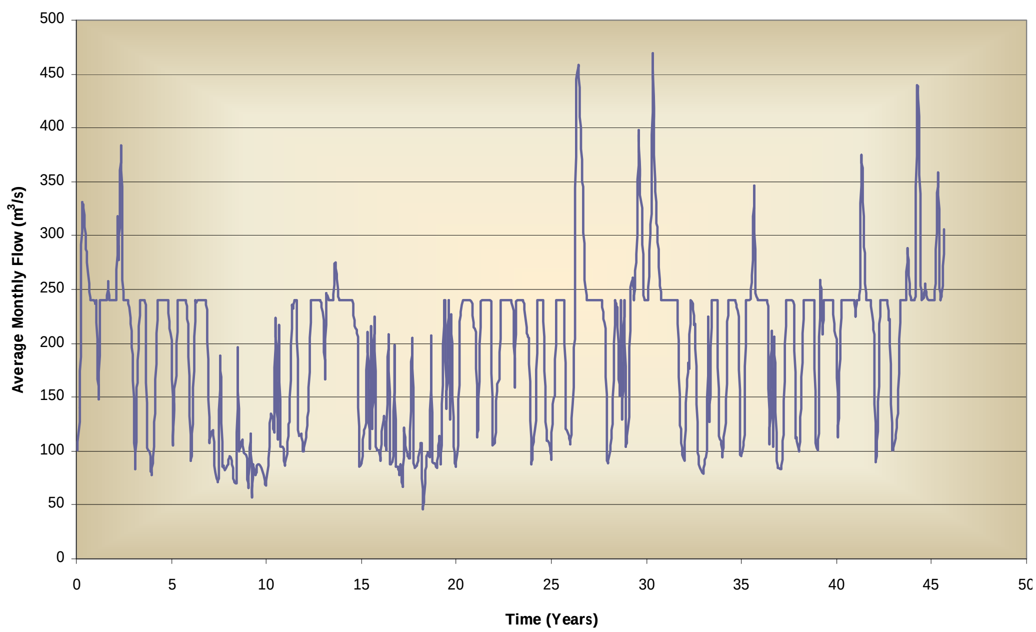


Figure 6.7.2 — Available Flows at the Twin Gorges Site, 1962 to 2007 (74 MW Plant)



6.7.1.2 Period of Record Energy Output and Capacity Factor

Using the available flow record discussed above, the Project generation output is shown as capacity factors over the 45-year period of record, where capacity factor indicates the fraction of full plant output that is achieved during each month. As capacity factor is the percentage of operation at full output for a specific month of the record, the average capacity factor over the entire record can be interpreted as a type of overall generation reliability estimate. For instance, an average capacity factor of 0.9 would indicate that, over this period of record, the plant would run at full capacity 90% of the time.

Since the existing and new plants operate under specific on/off rules, separate capacity factor charts for the existing and Expansion plants are needed to show the individual plant performance, and a combined output chart would show the overall output performance. The outputs for the existing 18 MW plant, an Expansion plant of 36 MW, and the combined system totalling 54 MW are shown in Figure 6.7.3, Figure 6.7.4 and Figure 6.7.5 respectively.

The outputs for the existing 18 MW plant, a new plant of 56 MW, and the combined system totalling 74 MW are shown in Figure 6.7.6, Figure 6.7.7 and Figure 6.7.8 respectively.

A summary table of the plant operating results is provided in Table 6.7.1.

Table 6.7.1 — Summary of Project Output Assessment

PROJECT	36 MW EXPANSION PLANT			56 MW EXPANSION PLANT		
Specific Plant	**18 MW Existing**	**36 MW New Plant**	**54 MW Total Plant**	**18 MW Existing**	**56 MW New Plant**	**74 MW Total Plant**
Average Annual Energy (GWh)	131	309	440	92	424	516
Capacity Factor	0.83	0.98	0.93	0.58	0.86	0.80

Based on the historic record, these results indicate that there is very high reliability in operation of a 36 MW Expansion Project, with the new plant delivering full output on average 98% of the time. As the existing plant is shut down first in any water shortage, it has a lower overall capacity factor, with full output on average 83% of the time.

The charts indicate periods for which significant output deficits occur in the record, where the plant output can drop to below 60% of full capacity. Two specific periods of very significant deficits occurred during multi-year dry events in 1968 to 1972 and 1978 to 1981 that strongly affect the generation statistics. In these multi-year dry sequences, the storage at Nonacho Lake cannot provide sufficient flows for continued generation at full output. However, as discussed further in Chapter 8, there have been no events of that duration since the early 1980s in the Taltson Basin.

For the larger Expansion Project, a much higher available flow is necessary for full plant output, and this flow is available less often. The capacity factor for the new plant is estimated as 0.86 (full output 86% of the time), but the existing plant output is curtailed much more often to support generation in the new plant, with an associated capacity factor of only 0.58. The overall capacity factor for the Project over this period of record is estimated as 0.80. Again, capacity factors have been much higher since 1985 than as indicated from the use of the entire record. The trend in the more recent flow data is discussed further in Chapter 8 on plant sizing study work.

Figure 6.7.3 — Generation Output for Existing 18 MW Plant (36 MW Expansion)

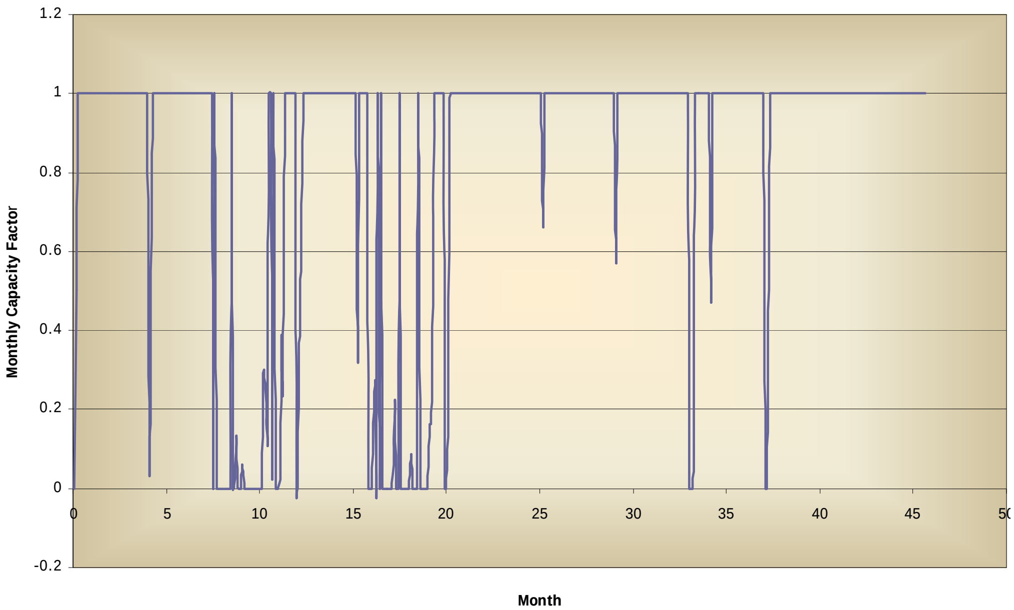


Figure 6.7.4 — Generation Output for 36 MW Plant

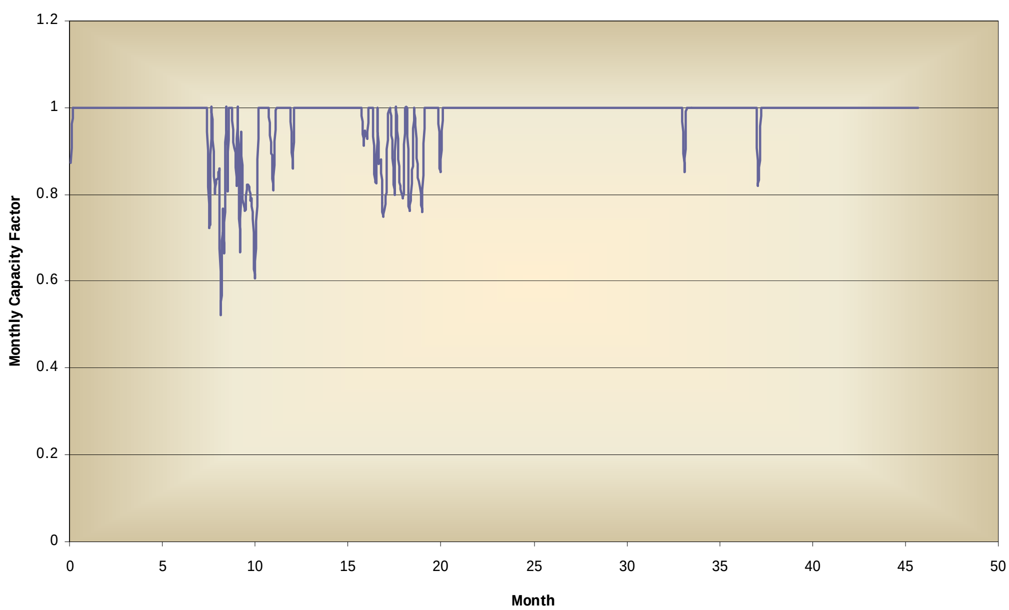


Figure 6.7.5 — Generation Output for Combined 54 MW of Total Capacity

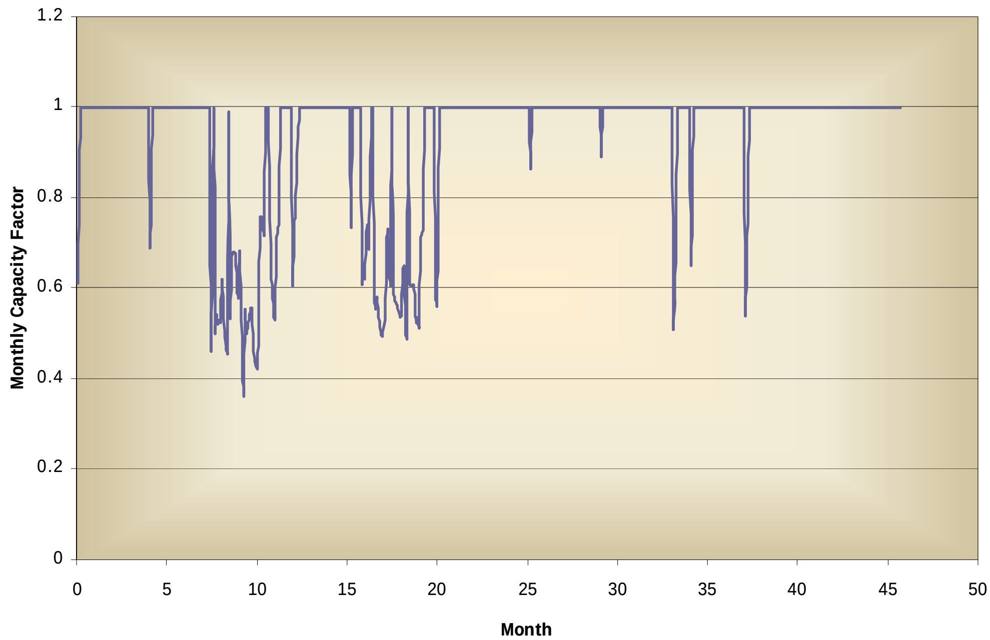


Figure 6.7.6 — Generation Output for Existing 18 MW Plant (56 MW Expansion)

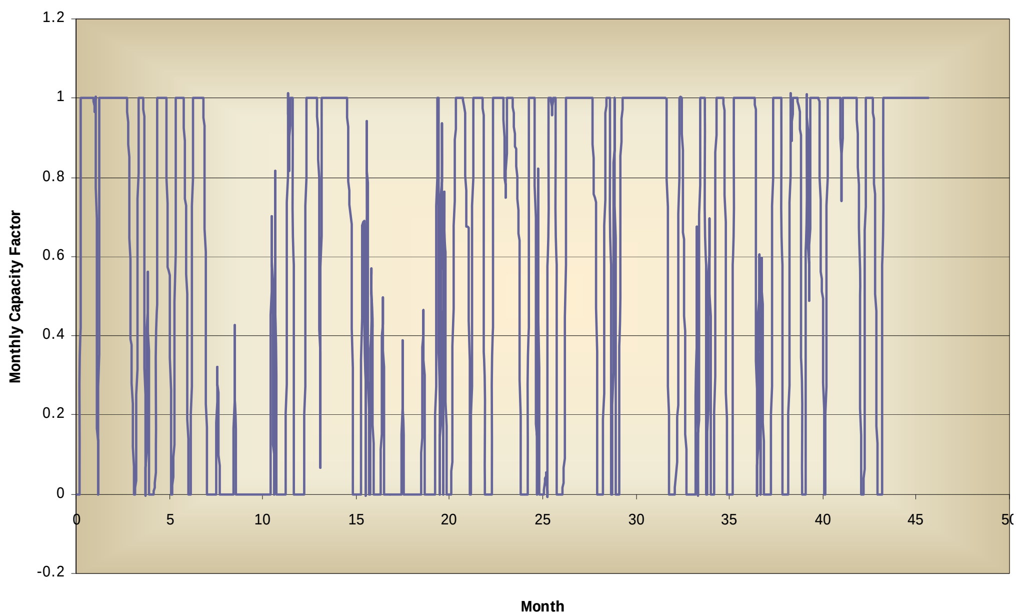


Figure 6.7.7 — Generation Output for 56 MW Plant

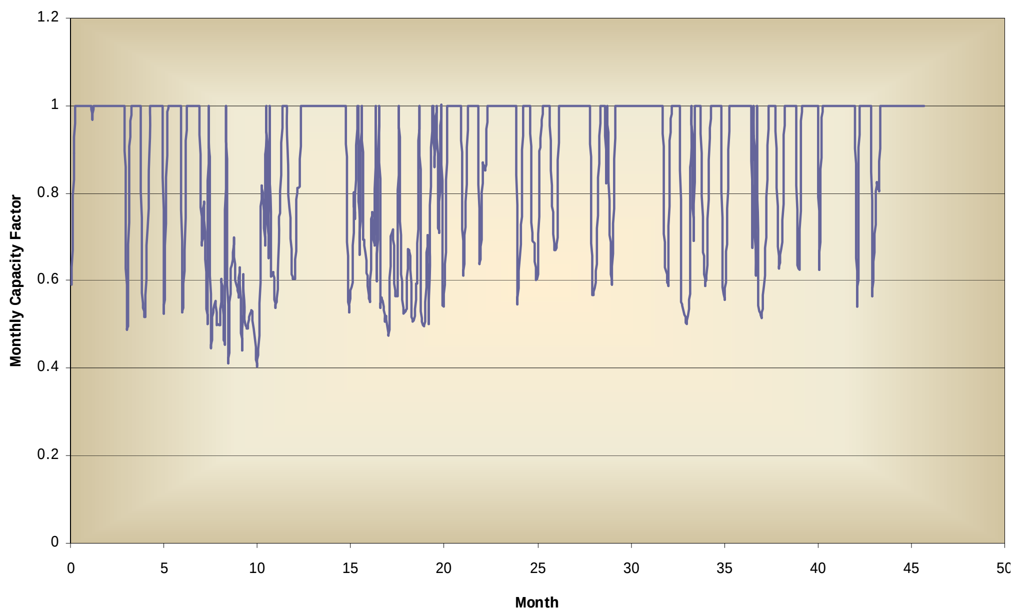
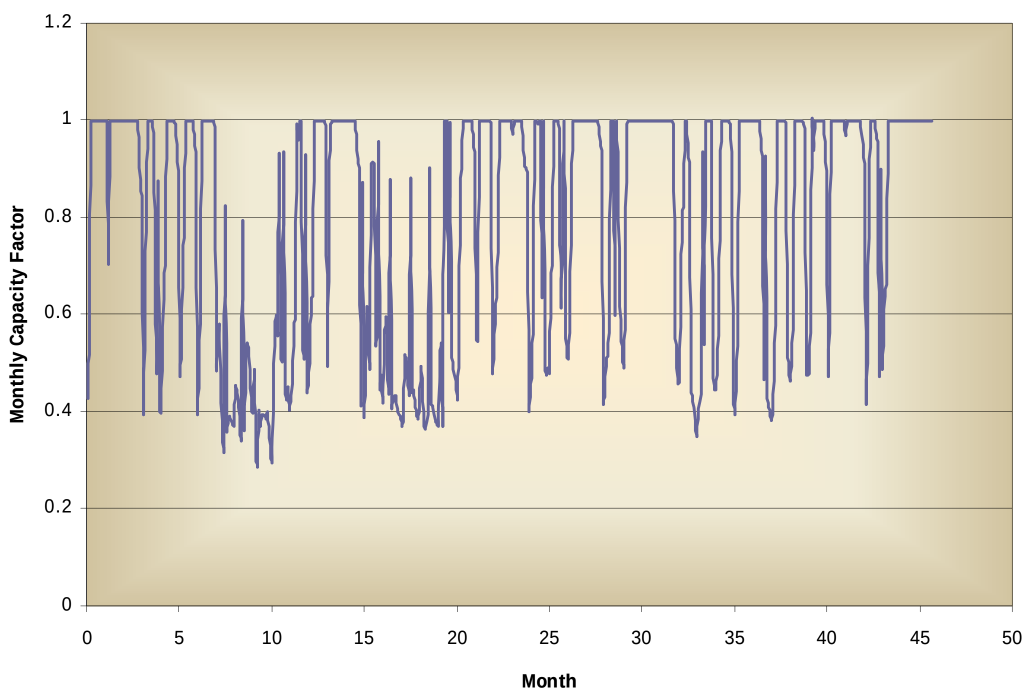


Figure 6.7.8 — Generation Output for Combined 74 MW of Total Capacity



6.7.1.3 Firm Power and Capacity Delivery Bands

For mining operations with a constant or slowly varying base load profile, the customer is ideally provided firm power, defined by a target power level delivery (in MW) with a reliability that is quite high. Typically for hydroelectric installations with large storage components, firm power may be defined as the level of output that is met or exceeded 98% of the time. The capacity factor plots shown in Figures 6.7.5 through Figure 6.7.8 provide a good indication of long-term power output levels meeting certain levels of reliability (from a hydrological basis only, and not including scheduled or forced outages). Considering Figure 6.7.5 for the 36 MW Expansion, a capacity factor of 0.5 is met throughout the period of record, with the exception of several months in the first very dry period (1968 to 1971). This 27 MW power band would therefore be considered firm. For some customers, firm power may have more value than power that has a lower reliability. Above the traditional firm power band, additional bands can be defined that have lower overall delivery reliability, but still provide full power delivery most of the time. In this way, the capacity output of the Expansion Project can be partitioned into these bands of capacity with different average reliability. While not meeting the rigorous reliability demanded by typical grid-connected customers, these non-firm capacity delivery bands would still provide large-scale diesel generation offsets, and would be very valuable to both the customers and to the Developer.

The larger Expansion Plant would not provide additional firm power for the Taltson system. This can be seen in Figure 6.7.8, where a capacity factor of approximately 0.35 results in about the same reliability across the record as 0.50 does for the smaller plant expansion. Firm power thus stays at approximately 26 MW (35% of 74 MW). However, significantly more non-firm energy is available with the larger plant.

While the prediction of long-term average energy utilizing historic records is a reasonable approach, predicting firm power to a high degree of accuracy is less reliable with historic records, as it is quite sensitive to any low flow periods in the record, which may or may not occur in the future.

6.7.2 Outages, System Losses and Net Delivery

6.7.2.1 General

The energy output assessment described above provides the gross generation of the integrated system of the existing and new power plants at Twin Gorges. From the gross generation, net available power and energy must be estimated to allow for scheduled and unscheduled outages of the system, and line losses in delivery of power to various points on the transmission system. These are considered in turn below.

6.7.2.2 Scheduled Outages

Scheduled outages would be defined periods, typically annually but possibly on a longer cycle, where each of the generating units at the two plants would be taken out of service and inspected or maintained or both. For the existing plant, scheduled outage periods typically last about a week. Subsequent to the refurbishment of the plant as proposed in the Expansion Project, it is likely that the scheduled maintenance could be shortened to just several days, and as well moving to a longer duration between maintenance periods. For the new plant, scheduled maintenance would be required initially as the systems were adapted to the specific operating regime. Once proven out, scheduled maintenance on the new plant that would require full outages of machines would likely be quite limited for many years. An estimate of three days per unit per year has been used in the current assessment.

6.7.2.3 UNSCHEDULED OUTAGES

Unscheduled outages relate to plant trips due to equipment malfunction or more commonly, lightning strikes or other electrical faults on the transmission line. In the current studies, non-reclosable lightning trips are estimated to occur up to eight times per year on the line. As the line can be sectioned between load centres, only those trips that occur between Twin Gorges and Gahcho Kué would affect the entire transmission system, and it is considered unlikely, but possible, that lightning would simultaneously take out both the new 161 kV line, and the existing 115 kV line. Lightning trips can require physical repairs on occasion, which can be quite lengthy depending on the actual damage.

Inspection of current records for high voltage lines operated in the Northwest Territories indicates a very high reliability on line performance. While trips associated with lightning do occur regularly during the summer, they rarely have resulted in damage, and a typical outage may be less than a minute (D. Grabke, personal communication, 2008). In a rare case when the line is damaged, a significant outage does generally result.

For the longer and more remote transmission line system associated with the Expansion Project, outages would be somewhat more complex to recover from, as the load is heavily partitioned into blocks, which would have to be shed and then reconnected in an orderly fashion to retain line voltage stability. Nevertheless, it is anticipated that the sophisticated protection and control equipment available in newer systems would limit most lightning and simple fault outage times to a few minutes or less. Ground or phase-phase faults would be rare, but would result in substantially longer outages, as the source of the fault must be investigated and fully cleared before restart.

Unscheduled outages can also be caused by equipment failure within the plant. Industry records would show that this is rare due to the availability of very reliable equipment, the fact that the machines are generally not highly stressed in normal operations, and that a certain level of redundancy exists in a number of the more critical operating systems of modern plants.

Overall, the industry standard loss in delivery time of approximately 2% would seem to be a reasonably conservative estimate of downtime related to all unscheduled outage factors for the Expansion Project. (D. Grabke, personal communication, 2008).

6.7.2.4 TRANSMISSION LINE LOSSES

Transmission voltage and conductor size optimization studies have been undertaken in the line feasibility study work to define the most cost-effective arrangement for the delivery of the required power to the various mines. The 161 kV voltage has been chosen as the best alternative between 115 kV and 230 kV; the lower voltage has very high transmission losses, and the 230 kV is significantly more expensive and suffers from higher voltage oscillations leading to voltage stability issues. Conductor sizing has been based on an extensive cost/benefit optimization study and results in a balance of capital and installation costs (cost) and lower line loss costs (benefit) within the assumptions made for the key variables. Line losses in the system affect both capacity and energy delivery capability to the customers.

The summary of anticipated line loss per segment of line for two options of the preferred alignment is shown in Table 6.7.2, for a load distribution developed from very early discussions with all of the mine customers, for both expansion scenarios. The two options differ physically only in the line voltage on the spur line from Gahcho Kué to Snap Lake. Even with the very large conductor, total line losses are significant due to the long length of line. For the assumptions utilized herein, losses are estimated in the range of 8% to 10 % of capacity for the 54 MW Expansion, and 11% to 15% for the 74 MW plant. Further conductor studies may be undertaken to assess if reducing line losses further would be economic.

Table 6.7.2 — System Line and Distribution Loss Summary

CONFIGURATION	OPTION 1: 69 KV Gahcho Kué to Snap Lake			OPTION 2: 161 KV Gahcho Kué to Snap Lake		
Line Sector	Line Voltage (kV)	Line Losses (MW)		Line Voltage (kV)	Line Losses (MW)	
		54 MW	74 MW		54 MW	74 MW
Twin Gorges to Gahcho Kué	161	2.42	5.30	161	2.29	5.02
Gahcho Kué to Snap Lake	69	1.08	2.33	161	0.05	0.11
Gahcho Kué to Diavik	161	0.24	0.52	161	0.24	0.52
Ekati-Diavik	69	0.37	0.81	69	0.37	0.81
Other System losses	NA	0.29	0.54	NA	0.25	0.50
Total Losses (MW)		4.4	9.50		3.2	7.06
Total Load onto Line (MW)		42	62		42	62
Percentage Losses		10%	15%		7.6%	11%

6.7.2.5 SUPPLY AND DEMAND SUMMARY

Incorporating allowances for system outage and transmission line losses as discussed above from predicted annual energy generation output, a summary of anticipated annual energy delivery capability to the customer base for the two plant systems is shown in Table 6.7.3.

Table 6.7.3 — Summary of Supply Capability for 54 MW and 74 MW Plant Sizing

Plant Size (MW)	Gross Annual Generation (GWh/y)	Net Output after Outage (GWh/y)	Existing Customer Base Demand (GWh/y)	Net Energy onto Northern Line (GWh/y)	Average Annual Line Losses (GWh/y)	Net Energy Available to New Customers (GWh/y)
54	440	431	65	366	28	338
74	516	506	65	441	51 [1]	390 [1]

[1] Assumes the same distribution of load as per 2006 initial discussions.

From a capacity standpoint, the plant sizing of 54 MW as originally envisaged was a good match to loads anticipated from discussions with potential mine customers in 2006. This load and demand summary is shown in Table 6.7.4.

Table 6.7.4 — Annual Generation Capacity and Energy Delivery Summary – 54 MW Expansion

Customer	Peak Load at Load Centre (MW)	Capacity Delivery Losses (MW)	Total Load at Twin Gorges (MW)	Annual Energy Requirements (GWh)
Forts Smith Resolution Fitzgerald Hay River	8-13	Included	8-13	65
Ekati Mine	11	0.4	11.4	100
Diavik Mine	9	0.2	9.2	75
Snap Lake Mine	12-14	0.1	12-14.1	100
Gahcho Kué Mine	10	2.42	12.4	80
Line Losses				28
Total Demand	**50–57**	**3.2**	**53-58**	**448**
Plant Output			**54**	**431**

Shortly after the Project Description was submitted, confidentiality agreements were signed with each of the mines that now preclude the release of detailed load requirements for each customer. Actual and forecast mine energy consumption has increased significantly since the initial customer discussions used to guide earlier plant sizing studies, and a more attractive scenario for both customer and developer may be closer to that shown in Table 6.7.5 for the larger expansion project. The load is shown as an aggregated demand from the customers in this case, as individual distribution is the subject of negotiation.

In both of these summary tables, the load centre demands are quoted peak demands, and it is highly unlikely that all peak demand would occur simultaneously. Typically, sizing a plant to 90% of this sum would provide sufficient reliability such that individual peaking requirements can be met. A 54 MW plant is therefore a good fit for the loads and associated losses as originally defined in 2006, and as shown in Table 6.7.4. A 74 MW installed capacity at Twin Gorges is an appropriate plant sizing for the more-recently defined peak loads including line losses, as per the scenario shown in Table 6.7.5 In fact, forecasted load requirements of the existing mines suggest continued load growth that may exceed even the larger available peak capacity.

For both plant sizes, approximately 26 MW of this energy would be 100% firm, with the remaining bands non-firm at various lower but still valuable overall reliabilities.

Table 6.7.5 — Annual Generation Capacity and Energy Delivery Summary – 74 MW Expansion

Customer	Peak Load at Load Center (MW)	Capacity Delivery Losses (MW)	Total Load at Twin Gorges (MW)	Annual Energy Requirements (GWh)
Fort Smith Fort Resolution Fort Fitzgerald Hay River	8-13	Included	8-13	65
Diavik, Ekati, Snap Lake, Gahcho Kué (proposed)	50-60	7.0	57-67	450
Line Losses				50
Total Demand			**70-75**	**565**
Plant Output			**74**	**506**

Note: Mine energy requirements and load profiles are now subject to confidentiality agreements.

6.8 PROJECT CLOSURE

6.8.1 General

For large-scale northern developments such as the Taltson Hydroelectric Expansion Project, detailed plans are necessary to ensure that any ecological disturbance resulting from the Project is mitigated to the extent possible. These detailed restoration plans not only demonstrate a proponent's commitment to minimizing environmental impacts, but also ensure that restoration is achieved efficiently within a relatively short time frame and at a relatively economical cost.

After an ecosystem is degraded, damaged or destroyed, reclamation and restoration activities are implemented to initiate or accelerate ecosystem recovery. Reclamation tends to focus on physical or social objectives, such as terrain stabilization, assurance of public safety, and aesthetic improvement. Restoration tends to focus on biological objectives such as promoting a renewal of habitat structure (ecosystem integrity), re-establishing ecological sustainability (resilience), and guiding ecosystems back to historic growth trajectories (resumption of former functional processes and re-expression of historical ecosystem characteristics). In developing a closure, reclamation and restoration plan, it is important to recognize the following:

- A reference ecosystem or historical documentation is necessary to understand the pre-disturbance conditions, so that the ultimate goal of restoration can be clearly defined.
- Although distinct from restoration, reclamation is intended to re-establish pre-disturbance abiotic conditions, and thus provides the physical environment within which ecological (biotic) restoration can occur.
- Prior to disturbance, organisms, nutrients and other materials were exchanged with the surrounding landscape. Disturbed sites should be considered within a wider landscape context so that this linkage becomes a goal of restoration.
- The re-establishment of cultural interactions in disturbed areas can be a positive influence on the integrity of some ecosystems.

The Taltson Hydroelectric Expansion Project would have a design and operational life exceeding 40 years. Within this lengthy development and operations timeline of the Project, and possibly extending well beyond the currently forecast lifespan, closure and restoration plans would be required at a number of stages. Firstly, restoration plans would be required to address impacts of temporary works associated with construction. These plans need to consider both seasonal and final decommissioning of construction infrastructure. Secondly, plans for revised modes of operations of the Project may be required, such as would occur if the load requirement is temporarily reduced. Ultimately, a final closure and restoration plan for the "permanent" Project infrastructure itself may come to be required. To address issues for which an adequate forecast of requirements can be made at this time, the Project operations and closure scenarios are addressed in terms of the following basic divisions:

- Short-term and temporary components with a life expectancy of less than five years including: winter roads, construction camps, staging areas and storage facilities.

- Medium-term components with a life expectancy ranging from 20 to 30 years such as: the 161 kV Transmission Line and associated steel towers and the 69 kV line and associated smaller towers, between the existing and proposed diamond mine sites. In addition, four new substations, one at each of the diamond mine sites.
- Long-term components with a life expectancy ranging from 60 to 80 years such as the Nonacho Lake control structures and the hydroelectric generating station complete with all appurtenances and related infrastructure.

These closure and restoration plans are discussed in more detail in the following sections.

6.8.2 Applicable Policies, Regulations & Industry Standards

Much like the construction of a new facility, the closure and restoration of a facility involves permitting, engineering analysis and design, and a de-construction phase. During the Project life cycle, policies, regulations and industry standards for care and maintenance, closure, and restoration shall be followed so as to minimize the overall environmental effect of the Project and in turn, reduce the need for reclamation and restoration activities. This applies to every stage from Project design to decommissioning. Project activities would comply with the following regulations, and to the extent applicable and practical, would adhere to the following policies, standards and guidelines as outlined below.

6.8.2.1 Regulations

- The Department of Fisheries and Oceans Canada (DFO), Northwest Territories Operational Statements (specifically those related to riparian zones, stream crossings and ice bridges) relate to potential sedimentation, pollution, and bank erosion issues. The protection of water bodies during any site abandonment would be a primary concern; restoration in riparian areas would require careful planning and consultation with DFO.
- The Government of the Northwest Territories (GNWT) Forest Management Act is currently undergoing revisions to include impacts associated with industrial development; until such revisions are complete, the “GNWT (ENR) Commercial Timber Harvest Planning and Operations, Standard Operating Procedures Manual (2005)” shall provide general guidance for the planning of forest clearing activities. An authorization from ENR would be required for the Project advancement. The Dezé Energy Corporation would seek input from ENR regarding the detailed planning of restoration activities, particularly with regards to re-vegetation.
- As a result of the Project review, the Mackenzie Valley Environmental Impact Review Board (MVEIRB) may recommend conditional approval of the Project (thereby establishing some terms related to abandonment and restoration) and if approved, the Mackenzie Valley Land and Water Board (MVLWB) may also establish Project-specific terms on any necessary permits.

6.8.2.2 POLICIES

- Indian and Northern Affairs Canada, Mine Site Reclamation Policy for the Northwest Territories, 2002.

This policy may be applicable to the marshalling yards located along the winter roads to the mines, the larger distribution centres at the mine sites, and to the eventual decommissioning of the proposed sub-stations at the Ekati, Diavik, Snap Lake and Gahcho Kué mines sites. Application of this policy would help to ensure that reclamation and restoration objectives of the project sites (located at the mines) would complement those of the mining company.

6.8.2.3 INDUSTRY STANDARDS

- Manitoba Hydro (July) 1995. Fur, Feathers, and Transmission Lines. Available online at: http://www.hydro.mb.ca/environment/publications/fur_feathers.pdf

This document is a best practice guide for environmental management of hydroelectric developments in Manitoba, and contains a section describing the decommissioning of hydroelectric infrastructure.

In 2002, The Canadian Electricity Association signed a Memorandum of Understanding (MOU) with DFO regarding consultation, compliance with the Fisheries Act, stewardship, education and training, and research and monitoring.

The Northwest Territories Power Corporation is a member utility of the Canadian Electricity Association. Although not members, the NWT Energy Corporation (03) Ltd. and the Dezé Energy Corporation would also respect the MOU during the development of the Taltson Hydroelectric Expansion Project.

6.8.2.4 GUIDELINES

- Goals, objectives, or guidelines put forth by regional land settlement agreements (including IMAs), and/or local or regional wildlife management boards.
- Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas. Parks Canada and the Canadian Parks Council, 2008.

This guideline may be applicable if the proposed Thaydene Nene National Park is established in the east arm region of Great Slave Lake before Project restoration and reclamation activities are complete. By incorporating these principles into the Taltson abandonment and restoration plans, the Dezé Energy Corporation demonstrates a genuine commitment to the environment.

- The Ecological Restoration Guidelines for British Columbia (Government of British Columbia/Forest Renewal BC) describes the best practices used in another Canadian jurisdiction. Currently, there are no equivalent guidelines for the NWT.
- The California Stormwater Best Management Practice Handbooks are a comprehensive resource for addressing sediment and erosion control issues, as well as wastewater management (http://www.cabmphandbooks.com/).
- The Society for Ecological Restoration International (SER) provides direction related to international best practices. Resources include the SER International Primer on Ecological Restoration (2004) and Guidelines for Developing and

Managing Ecological Restoration Projects. 2nd Edition (2005). Available online at: www.ser.org.

6.8.2.5 TIMELINES

The application for necessary permits would take place in advance of potential changes in operational status to give time to study all relevant alternatives. In advance of any significant change in requirements, anticipated time frames are as follows:

- Short-term project components – two years, or included in initial permitting.
- Medium-term project components – three to five years.
- Long-term project components – seven to ten years.

During these time periods, Dezé would prepare closure and restoration plans for submission and subsequent approval from relevant First Nations, federal, territorial and municipal authorities. Dezé would seek community and stakeholder input via public and private meetings during the preparation of the final closure and restoration plans.

6.8.3 Closure and Restoration Goals and General Processes

6.8.3.1 GENERAL

Although ecological disturbance resulting from the Taltson Hydroelectric Expansion Project is anticipated to be minimal, several isolated sites and the winter road would be restored to a near-natural state upon the completion of construction activities in the short term. Longer-term restoration would need to consider the permanent infrastructure components. Environmental disturbance associated with project construction activities may result in the following localized conditions requiring restoration:

- vegetation removal and habitat deterioration;
- soil compaction, erosion, permafrost degradation, and potential soil contamination;
- drainage control/impoundment, and disruption of natural hydrological regime; and
- accumulation of waste and debris.

Restoration efforts would include some initial planned actions and reliance upon the natural resilience of the ecosystem.

6.8.3.2 RESTORATION PLAN GOALS

The goals of the Expansion Project conceptual restoration plan would include the following achievements:

- recovery of degraded sites associated with project construction to a former state containing characteristic assemblages of species that are present within the surrounding ecosystem;
- maintenance and perpetuation of indigenous species to the extent possible, and avoidance of the establishment of invasive species;

- representation of all functional groups/key species necessary for the continued development and/or stability of the restored ecosystem;
- development of self-sustaining populations of key species necessary to ensure stability and succession along the desired restoration trajectory;
- to the extent possible, elimination or reduction of threats to the health and integrity of the restored ecosystem from the surrounding landscape;
- the re-expression of resiliency to normal periodic stress events in the local environment;
- once restored, the development of self-sustaining and persistent characteristics that make the restored areas almost indistinguishable from the surrounding ecosystem; and
- the resumption of traditional cultural activities throughout the restored area.

6.8.3.3 Biotic Interventions

Restoration efforts would include some biological interventions, such as:

- limited re-vegetation (by planting propagules and/or seedlings) in sensitive areas, such as where erosion may be an issue;
- reintroduction/replacement of coarse detritus and woody debris, to provide small animal cover in disturbed areas. Slash could be used intact and/or chipped to provide coarse detritus during restoration activities; and
- replacement of stockpiled soils or surface strippings to enable revegetation by natural succession, or re-vegetation as necessary.

6.8.3.4 Landscape Restrictions

The extent of restoration would be limited by the following restrictions:

- The presence of a hydroelectric dam fundamentally alters the natural hydrological regime. This regime can only recover once the dam infrastructure is decommissioned and removed.
- The investment associated with such an infrastructure development requires that, to the extent possible, the project be protected from the threat of forest fire. The natural fire regime can be deregulated once project construction sites are no longer active and permanent infrastructure sites are decommissioned.
- The northern climate includes a limited growing season, which slows the rate of restoration; however, this limitation is also reflected in the surrounding ecosystem.

6.8.3.5 Restoration Funding and Resourcing

Dezé Energy Corporation would be responsible for the restoration of sites directly impacted by the Project, thus restoration costs are built into the overall project budget.

The equipment and labour required to complete restoration activities would be provided by the construction contractor. Restoration professionals would design and lead site-specific activities; it is anticipated that additional workers would be hired from local communities to assist in labour-intensive activities such as tree planting.

Re-vegetation activities may require plant propagules and nursery-grown seedlings of northern species. A northern supplier would be the preferred alternative for providing this service. The use of seeds in re-vegetation activities would be avoided unless an approved northern seed mix is available.

6.8.3.6 Duration of Restoration Activities

The duration of restoration activities would depend upon site-specific conditions and the level of restoration being completed. In general, the duration of restoration activities is influenced by the size of the site and the degree of restoration required (larger areas, requiring more extensive restoration, would be of longer duration).

As access to the Project sites is largely governed by seasonal restrictions, restoration activities may require the use of helicopters to complete the work in a timely fashion (beyond seasonal access periods).

As the Expansion Project is anticipated to operate for at least 40 years, it is practical to incorporate the effect of natural recovery within planned restoration activities during this timeframe.

6.8.4 Closure and Restoration of Short-Term Project Components

6.8.4.1 Winter Roads

Constant travel with heavy loads over winter roads may compress the underlying vegetation. However, with exposure to rain and long hours of sunlight during the summer months, the vegetation usually recovers sufficiently and new growth occurs. Provided the applicable guidelines for winter road construction are adhered to, it is anticipated that little work is required to restore the areas used for winter roads.

Winter road restoration activities would include:

- general clean up of the winter road prior to each seasonal closure of the winter road,
- applying GNWT recommendations for windrowing of brush, and
- establishing barriers to future access.

6.8.4.2 Construction Camps

The construction camps would consist of assembled modular and trailer type structures. The footprint for these camps would be kept to a minimum. Site restoration activities for the construction camps would include:

- disassembly and removal of all modular structures from the site via the winter road,
- removal from site, via the winter road, of salvage materials and materials that can not be burned or buried on site,
- burning of all materials that are approved for disposal via open-fire burning at an approved on-site location,
- removal and disposal of all non-salvage materials that can be disposed of at an approved on-site location,

- where material cannot be disposed of on-site, material would be removed from site and disposed of, with prior authorization, at an approved waste disposal facility,
- removal and spreading of granular base material at an approved on-site location, and
- distributing and levelling of previously-stockpiled topsoil over the areas.

6.8.4.3 SEWAGE LAGOONS (IF UTILIZED)

The sewage lagoon would be used while the hydroelectric plant construction camp is on-site. Site restoration activities for the sewage lagoon would include:

- removal and disposal of sludge at an approved on-site location,
- clean up of liner at an approved on-site location,
- removal of liner from the site via the winter road, and
- removal and spreading of granular base material.

6.8.4.4 STAGING AREAS AND STORAGE FACILITIES

Staging areas are required during the construction of the proposed transmission line and the proposed generating station. Site restoration activities for staging areas would include:

- general clean-up of each staging area prior to spring break-up,
- distributing and levelling of previously stockpiled topsoil, and
- use of helicopters to transport the labour force, small equipment and materials to the affected areas.

It is proposed that all temporary storage facilities would be supported on wooden blocks and/or on small precast concrete slabs.

Site restoration activities for all temporary storage facilities would include:

- removal from site, via the winter road, of salvage materials and materials that can not be burned or buried on site,
- removal and disposal of all non-salvage materials that can be disposed of in an approved on-site location,
- removal and stockpiling of granular base material, for future use, at an approved on-site location,
- distributing and levelling of previously-stockpiled topsoil over the areas that had temporary storage facilities,
- re-vegetating of the areas that are covered with topsoil with vegetation suitable to northern climatic conditions,
- use of standard construction and seeding equipment for the above-described work, and
- transporting all equipment to and from the site via the winter road.

6.8.4.5 SHORT-TERM PROJECT COMPONENT RESTORATION ALTERNATIVES

The overall footprint for the short-term project components would be kept to a minimum. The structures and facilities for the short-term project components are typical of requirement for construction of a project of this scope and nature. They are considered simple and temporary and would not be constructed or installed to a permanent standard. Closure and restoration of these temporary short-term project components would be straightforward, easy to implement, and to a large extent would be included in the major construction contracts themselves as demobilization costs.

6.8.5 Closure and Restoration of Medium-Term Project Components

6.8.5.1 GENERAL

The medium-term project components would be constructed or installed to a minimum standard with an estimated life expectancy of 20 to 30 years. Certain sectors of the transmission line and associated substations are the project components most likely to be decommissioned in this time frame, as the diamond mines eventually close and those sites are restored.

Three to five years prior to the potential abandonment of any significant sector of the transmission line and/or substations, Dezé, with the help and input from all stakeholders, would study all alternatives to extend the use of the line infrastructure and substations. This may include, but would not be limited to, finding new customers, making modifications to the lines and/or substations and negotiating a new supply price of electricity with existing customers if it ensures that the lifespan of a business such as a mine can be extended. In the event that it is concluded by all stakeholders that the line and station infrastructure is to be decommissioned, a formal closure and restoration plan would be developed at that time. The general considerations to be included in such a plan are described below.

6.8.5.2 TRANSMISSION LINES

The transmission line sector(s) to be decommissioned would be taken down, and materials salvaged. The de-construction of the line would occur over several winters, using construction activities as described for the erection of the line. Site restoration activities for the transmission line would include:

- off-site removal and disposal of all salvageable materials;
- removal and disposal of all non-salvage materials that can be disposed of at an approved on-site location;
- cutting all anchors that are embedded in concrete or rock to ensure they are flush with the concrete or rock foundation surface;
- leaving any buried foundations in the ground with connections cut smooth with the surface;
- use of helicopters to lift the towers from their foundations and to transport the labour force, small equipment, and materials; and
- use of other equipment (e.g., Cat D6 or Nodwell, etc.) during winter to help with the removal and roll-up of the conductor cables.

6.8.5.3 SUBSTATIONS

The proposed substations are located at the mine sites and therefore the de-construction and removal of any substations would occur only if any mines were shutting down permanently and implementing their abandonment and restoration plans. Site restoration activities for the substations would include:

- off-site removal and disposal of all salvageable materials,
- removal and disposal of all non-salvage materials that can be disposed of at an approved on-site location,
- cutting of all anchors embedded in concrete or rock flush with any concrete or rock foundation surface,
- leaving concrete foundations that had in the past supported equipment in the ground and in a clean state, and
- placing granular material flush with the top of the concrete foundations and levelling the newly-placed granular material, or following the specific mine site restoration plans for the particular site in question.

6.8.5.4 MEDIUM-TERM PROJECT COMPONENTS ALTERNATIVES AND COSTS

Alternatives for the abandonment and restoration plan for these components are more complex. Over a period of five to seven years, Dezé would involve the public and all stakeholders to develop alternatives and perform applicable studies, design and analysis to ensure a sound and educated decision was made with respect to the final abandonment and restoration of the medium-term project components. Dezé would provide the required long-term management and maintenance to ensure that the designed restoration plan would be carried out and work as planned. Dezé would also provide the required financial and other resources over several years.

An accurate cost estimate for the abandonment and restoration of the medium-term project components would depend on many factors, such as availability of qualified and experienced contractors and related labour force, specialized equipment such as helicopters, and climatic conditions. Presently Dezé estimates that the abandonment and restoration cost of the medium-term project components are equal to the cost of constructing and installing the same components, plus an appropriate allowance for inflation. There would likely be considerable value in the salvage of transmission line materials.

6.8.6 Closure and Restoration of Long-Term Components

6.8.6.1 GENERAL

The long-term project infrastructure components would be constructed or installed to a standard with an estimated minimum life expectancy of 60 to 80 years. The useful life of these facilities may be increased indefinitely by maintenance and upgrading of equipment. The abandonment and restoration plan for these components would be a major undertaking.

In the event that all mine customers are removed from service and the 161 kV transmission line is decommissioned or removed at some distant point in the future, the Nonacho Lake control and the generation facility would revert to supply of community load only. This scenario is the minimum foreseeable operating condition for the life of the Expansion Project, anticipated to be upwards of 40 years. At this point, the existing plant would be some 85 years old, and likely have reached the end of its service life. The new plant would require life-extension upgrades, but very likely be fully serviceable for continued operation. Nonacho Lake control facilities would likely require refurbishment, but otherwise would be sound. Therefore, in all likelihood the generation components of the proposed Taltson Hydroelectric Expansion Project would continue to be used to supply electricity to Fort Smith, Fort Resolution and Hay River, NWT, while the older existing 18 MW Taltson Twin Gorges Plant would be decommissioned. Water management would likely revert to a situation not dissimilar from the current conditions in the Taltson Basin.

It is the opinion of Dezé that the only conceivable reason to fully abandon the proposed Taltson Expansion Project would be if there was a permanent lack of water supply, or if a power source that was less expensive to operate and which rendered hydroelectric power obsolete were to be developed. Neither of these two scenarios is considered foreseeable.

In the highly unlikely event that a full closure would be required, Dezé would study all alternatives to extend the use of the Project, and solicit advice and input from all stakeholders in regard to closure and flow management options, seven to ten years prior to the potential abandonment of the generating station and related infrastructure. At this stage of the Project, with no debt and only operational costs, it is quite likely that other markets would have become available for the power, such as connection by new transmission facility to the grid in Saskatchewan, Alberta or British Columbia, or interconnection with other NWT communities and possibly Yellowknife.

Below is a very brief outline of the steps that Dezé would follow if full abandonment and restoration of the proposed Taltson Expansion Project were to be implemented.

6.8.6.2 CLOSURE OF GENERATING STATION AND INFRASTRUCTURE

Assuming that an alternative to power supply from Taltson is found for the existing customers, full abandonment would include the removal of the complete Expansion Project and subsequent restoration of the Nonacho Lake site, Twin Gorges site, dam, penstocks, reservoir, infrastructure and any other areas that Dezé used during the operation of the Taltson Expansion Project. To achieve full closure and restoration, the following steps would likely be required:

- carry out an initial abandonment and restoration study,
- develop a detailed computerized study and implementation schedule,
- hold public and stakeholder consultation sessions,
- collect engineering and environmental data and perform analysis to determine the pre- and post-abandonment conditions,
- determine the environmental impact and develop mitigation measures,
- study and address water rights issues,
- develop and evaluate alternatives,
- perform economic analysis with respect to the costs of lost generation capacity and energy and the cost of replacing same,
- develop detailed cost estimates for the alternatives studied and for the overall proposed abandonment and restoration plan,

- develop and implement a decision process to abandon or not to abandon the Taltson Hydroelectric Expansion Project, and
- obtain applicable permits and implement the approved abandonment and restoration plan.

6.8.6.3 Long-Term Project Components Alternatives and Costs

The long-term project components would be constructed or installed to a permanent standard with an estimated life expectancy of 60 to 80 years. The useful life of these facilities may be increased indefinitely by maintenance and upgrading of equipment. The abandonment and restoration plan for these components would be a major undertaking and Dezé has provided a brief outline in the corresponding section as to what is required to develop a detailed abandonment and restoration plan for the long-term project components. This process would also derive an accurate cost estimate for the optimal abandonment and restoration plan. Throughout this time, Dezé would provide the required annual maintenance to ensure overall success of this process.

6.9 HUMAN RESOURCES

It is estimated that direct employment for the Project would require approximately 412 person-years of activity during the two- to three-year construction period, and 8 to 10 person-years during operations.

Of the positions created, approximately one-half of construction jobs would require unskilled and semi-skilled labour; the remainder would require skilled labour, as would all operations positions.

Indirect employment would be created by the demand for auxiliary services in nearby centres; no numerical estimates of these positions have been evaluated.

Project employment opportunities are discussed in detail in Section 6.5.7 and Section 6.6.2.

6.10 DESIGN AND OPERATIONAL MITIGATION

6.10.1 General

The over-reaching goal of the project design and layout has been to utilize the existing generating system infrastructure to the maximum extent possible and minimize the incremental environmental footprint. Within this design development, and extending to the new transmission facilities, significant long-term mitigation measures have been adopted to reduce environmental impacts, and enhance environmental benefits. Shorter-term mitigation measures would also be adopted in the construction of the Project – these appear in the specific methodology and scheduling of construction, particularly for the transmission line. Operations of the plants would be undertaken in a manner so as to fulfill all aspects of minimum release requirements, minimize flow disruptions, and maximize generation benefits from the Expansion Project. A summary of the design, construction and operational mitigation measures to be adopted in the Project is presented below.

6.10.2 Design Mitigation Features

The Expansion Project design has incorporated a number of key mitigation strategies to decrease perceived negative project impacts. Negative impacts may include terrestrial or hydrological disturbance, wildlife and fishery impacts, access changes to previously remote regions, emissions, and other more minor impacts. Key design mitigation features are described below by project component in Table 6.10.1.

Table 6.10.1 — Design Mitigation Features and Goals

Project Component	Mitigation Feature	Mitigation Goal
Nonacho Lake Control Structure	Intake velocities associated with the mini-hydro generating plant at the Nonacho Lake control structure would be low.	Lower risk of fish entrainment.
	No development at Tronka Chua Gap. Continued unregulated releases into Tronka Chua system.	Maintain flows into upper reaches of that system when Nonacho Lake levels are above the natural saddle.
Twin Gorges Generation and Ancillary Facilities	Large dimensions for entrance geometry of gate and canal structures to promote low velocity entrance conditions.	Minimize entrainment of fish into gate discharge areas and turbine flows.
	Provision of a gated by-pass spillway next to the existing facility to maintain flow levels over and below Elsie Falls during plant shutdowns or other outages.	Ensure that minimum flows of approximately 30 m^3/s would continue below the generation plants even if all of the generation units are out of service.
	Multiple turbine units used for new plant, with similar size to existing unit.	Sustains operational equilibrium conditions, and avoid transient conditions to the extent possible when moving from use of one unit to the next.

Project Component	Mitigation Feature	Mitigation Goal
	Intake design to eliminate possibility of entrainment of air in the water column.	Minimize likelihood of increased total gas pressure in the water and risk to fish from changes in total gas pressure.
	Conveyance canal leading to turbines constructed so as to have minimal fish habitat values and low velocity.	Discourages fish from entering the water passage leading to gates and to the turbines. Forms substantial ice cover for operational stability.
	Tailrace canal of new plant remains watered up even if plant is shutdown.	Reduces risk of stranding fish in tailrace if units shut down.
	Minimum release facility developed in existing South Valley Spillway. Release facility has full redundancy.	Ensures minimum release flows into Trudel Creek are made independently of Forebay elevation.
Transmission Line	Discontinuous clearing of ROW where possible and when clearance requirements can be met by natural terrain.	Limits use of the ROW for linear access and preserves foliage for wildlife use.
	Routing of transmission line altered to minimize interference with caribou migration paths and avoid known archaeological sites and raptor nest areas.	Lower impact to caribou and preserve archaeological heritage of the region.
	Elimination of overhead steel ground wire except near substations.	Reduces the danger to migratory birds.
	Possible use of bird diverters in known key migratory bird paths.	Reduces the danger to migratory birds.
	Avoiding use of herbicides for vegetation control.	No introduction of foreign substances into pristine environment.

6.10.3 Construction Mitigation Measures

Construction methodology and scheduling incorporates a number of important impact mitigation strategies. These are summarized in Table 6.10.2.

Table 6.10.2 — Construction Mitigation Measures

Primary Activity or Component	Mitigation Measure	Mitigation Goal
Access and Staging Provision	Use of winter roads and small access tracks	Limit long-term footprint of facility and avoid linear access development
	Decommissioning of all roads and staging at project completion	Allow natural recover process to occur by preventing any further use.
Corridor Clearing	Chipping of woody debris in place of burning wherever possible.	Maintains biological integrity and reduces emissions
	Hand clearing in sensitive areas	Reduce impact in more sensitive bird zones and lower corridor footprint
Tower Setting	Use of helicopter tower placement in most sectors below treeline.	Reduce land use impact from road construction; lowering construction impact from noise, etc. in any particular location.
In-steam Works	Canal and other works largely undertaken in the dry behind rock plugs.	Limit in-stream impacts from excavations required for new facilities.
Project -Wide	Environmental Management Plans in place for all activities.	Minimize construction impacts through effective protection and response strategies.

6.10.4 Operating Basis Mitigation Measures

Many of the operating decisions of the plant would be guided by environmental requirements specifically set to minimize project impacts. The key operational strategies anticipated to be implemented are noted in Table 6.10.3.

Table 6.10.3 — Operating Strategies for Impact Mitigation

Project Component	Operating Strategy or Limits	Mitigation Goal
Nonacho Lake Control Structure	Maintain minimum flows out of Nonacho Lake of 14 m^3/sec into the Taltson River, a minimum water level in Nonacho Lake of 321.71 masl, and maintaining maximum lake levels within historic range.	Ensures aquatic integrity is maintained in the Taltson River downstream of Nonacho Lake. Ensures lake level fluctuations stay within historic levels such than no new flooding occurs and shoreline biodiversity is maintained.
Basin Flow Gauge System Installation	New gauging installations and real time monitoring allows proper release levels to be set from Nonacho Lake	Maintains river flow equilibrium and avoids large fluctuations in water levels out of season; prevents any new flooding.
Minimum Release Facility	Release is unrelated to Forebay level and takes priority over power generation flows. A minimum release of 4 m^3/s is anticipated.	Maintains aquatic and biological integrity of Trudel Creek system irrespective of Taltson River upstream conditions or plant operations.
South Gorge By-pass Facility	Synchronized operation for programmed release if units go off-line.	Maintains flows in the Taltson River below the generating plants until flows re-direct through Trudel Creek.
Twin Gorges and North Gorge Plants	Ramping (staging) normal stop/start operations and outage restarts.	Minimize flow changes in the Taltson River below the generating plants.
	Maintenance schedules would be designed to take only one turbine off-line at any one time, whenever possible.	Minimize the reduction and/or redirection of flow through the facilities, and maintain flow consistency in so far as possible in Trudel Creek.
System-Wide	Monitoring Programs developed for key indicators and with specific goals to assess project impacts	Fine-tune project operations to minimize negative impacts.