TALTSON TRANSMISSION EXPANSION PROJECT
TRANSMISSION ALTERNATIVES STUDY

FINAL REPORT

EXECUTIVE SUMMARY

The existing Taltson Hydroelectric Project generates 18 MW of power at Taltson Twin Gorges facility and supplies the power to Fort Fitzgerald, Alberta and Hay River, Northwest Territories. This facility was built in 1964-65 by Northern Canadian Power Commission (NCPC) to supply power to the Pine Point mine and associated community. After closure of these facilities in 1986, the power supply was transferred to Northwest Territories Power Corporation (NTPC). However, because of significantly lower requirements the full potential of Taltson Twin Gorges facility has not yet been utilized.

In 2003 studies were carried out to investigate the opportunity of increasing the capacity of the existing plant and supplying power to four diamond mines located north of Great Slave Lake, in the vicinity of Snap Lake, Gahcho Kué, Ekati and Diavik mines. Between 2004 and 2006 further feasibility and environmental work was carried out. A proposal was made to increase power transfer to 54 MW by expanding generating facilities on Taltson River and Nonacho Lake and adding 161 kV and 69 kV transmission lines.

In June 2008 Teshmont Consultants LP was contracted to further study the Taltson transmission system. The goal of the study was to present the optimum technically and economically feasible route to stakeholders and concerned parties. Teshmont was asked to assess four alternative transmission routes based on technical and financial viability, as well as environmental and social impact.

Teshmont subcontracted Valard Construction for construction methodology, construction schedule and cost estimate support. AD Gould and Associates provided geotechnical expertise and foundation recommendations.

The first of the routes, named Baseline Alternative, has previously been studied. This route starts from Twin Gorges and spans along the east side of Great Slave Lake to Gahcho Kué, Snap Lake, Ekati and Diavik mines. Three different Baseline Alternative options were considered to supply power to Snap Lake.

The second alternative, named Trans-Island Option, starts from Twin Gorges and spans north over Great Slave Lake via the Simpson Islands to Snap Lake, Gahcho Kué, Ekati and Diavik mines. This option requires two relatively short submarine cable crossings, along with several special crossing structures.

The third alternative, named Submarine Cable Option, starts from Twin Gorges and spans north through Great Slave Lake, west of Simpson Islands, to Snap Lake, Gahcho Kué, Ekati and Diavik mines. Cable crossing length for this option would be between 60 and 70 km.

The fourth alternative, named West Route, starts from Twin Gorges and spans along the west side of Great Slave Lake, passing through Fort Smith, Fort Providence, and Yellowknife to Snap Lake, Gahcho Kué, Ekati and Diavik mines. This route is the longest alternative considered.

Electrical system studies were carried out for all four alternatives, including the three Baseline options. It was concluded that all routes are technically feasible. Due to line length, shunt reactor and series compensation stations are required along the route, as well as SVCs for reactive power and voltage support at the loads side. Single line diagrams of the substations were developed for the Baseline and Trans-Island options, based on the required equipment.

Desktop routing studies were performed for the Trans-Island, Submarine Cable and West Route options. The study was based on NAD 83 datum topographic maps, with a scale of 1:50,000. As a result of these studies, preliminary routes were selected for the above three options.

For the alternatives that include submarine cables, preliminary cable parameters and types were determined. Supply, transportation to site, installation methodology, and environmental impact were discussed.

For overhead transmission portions, electromagnetic field effects such as audible noise, radio interference, and electric and magnetic field magnitudes within right of way were calculated for use in the environmental impact assessment. A specification for the final route, LiDAR survey, was prepared.

Two aerial field studies were conducted for the Baseline and Trans-Island routes. During these studies the constructability of the line was assessed, and the possibility of locating special structures was investigated, especially over large bodies of water and lakes. At several environmentally and socially sensitive areas, the preliminary established routes were diverted and optimized.

During the second field survey, a geotechnical survey of the area was carried out. Based on this survey and aerial photo interpretation, four types of soil were identified. For these soil conditions, preliminary foundation designs were developed.

Following the desktop and system studies, and field survey, the construction methodology and project schedule were developed. The construction methodology addresses utilizing existing and constructing new winter roads, building temporary access trails, stage camps and marshalling yards, and labour camps. The objective was also to locate appropriate areas for barging and hauling material along the line route. Portions of the route which are not easily accessible by land were identified, and helicopter erection and stringing was proposed.

Stretches of the route with vegetation were identified, and the need to clear the right of way was assessed.

High level cost estimates were developed for all four alternatives based on budgets obtained from equipment and material suppliers, current market conditions and recent bids. These cost estimates are presented in Table 0-1. Following the alternatives assessment and cost estimate carried out in this study, the Baseline Option is the most favourable and is recommended for construction.

Table 0-1
Summary of Cost Estimates

Option	Length (km)	Estimated Cost in 2008 CAD
Baseline	693	[redacted] Ø
Trans-Island	731	[redacted] +40M
Submarine Cable	726	[redacted] +50M
West Route	1244	[redacted] +220M

The Trans-Island Option is the second most feasible alternative, with line length comparable to the Baseline Option. Crossing Great Slave Lake over a series of islands with an overhead line creates significant environmental impact in this environmentally sensitive region. Two submarine cable crossings would also be required to cross Hearne Channel and the channel between Blanchet and Eaton Islands. Due to the depth of Great Slave Lake, these would be some of the deepest cable crossings in the world. Combined with the uncertainty of the configuration of the lake bottom and difficulties in transporting, installing and maintaining the cables in remote and extreme climate areas, this option is less attractive than the Baseline Option.

The Submarine Cable Option assumes crossing Great Slave Lake with a 60 – 70 km long cable, and is more expensive than the Trans-Island alternative. Comments made for cable crossings of the Trans-Island Option also apply for this option. Additionally, in case of cable failure, the repair time in these extreme weather conditions will be approximately six months to a year, resulting in low reliability of the scheme. This alternative is not recommended.

The West Route Option is the longest alternative, with line length at the limit of technical feasibility. Intermediate series and shunt compensation would be required to maintain operating parameters stable and within limits. These intermediate stations will need to be accessible for maintenance and during forced outages. As this is the longest alternative, it would be most expensive for construction, operation and maintenance, and is therefore not recommended.

5 CONCLUSION

Four options for the Taltson Transmission Expansion were evaluated in this report, based on the following criteria. The results of the assessment shown Table 5-2 indicate that the Baseline option is the most favourable.

- **Technical feasibility:** System studies performed show that all four alternatives are technically feasible. The West Route alternative, due to its length, is at the limit of feasibility. Issues with dynamic performance of the series compensation are likely to occur, due to the high expected single fault-to-ground rate. The Baseline Option is the most technically feasible option.

- **Complexity of required equipment:** All of the transmission options require shunt compensation and SVC at the load side. The West Route Option requires three intermediate stations for series compensation and switched capacitor banks. The Submarine Cable and Trans-Island options require cable termination stations, where the shunt reactors can be incorporated. All of the shunt reactor compensation required for the Baseline Option can be placed on the high voltage sides of the mine substations.

- **Constructability:** For the Trans-Island Option there will be two submarine cable crossings required to cross Hearne Channel and the channel between Blanchet and Seaton Islands. Due to the depth of Great Slave Lake, these would be some of the deepest cable crossings in the world. The window for cable crossing construction will be only two to three months per year. The three alternative routes cross over the MacKay crossing using three islands in the lake. This will require construction of rock-filled steel coffer dams around the towers for ice protection.

- **Operational cost (line losses):** Operational cost of the West Route will be the highest among all the alternatives, due to its length. The other three alternatives are equally favourable in terms of losses.

- **Clearing required (footprint of the line):** The West Route Option will require more clearing compared to other options, as about 75% of the line is below the tree line. No need for clearing is foreseen above the tree line.

- **Visual impact of the line:** Crossing the Great Slave Lake over a series of islands with an overhead line creates significant environmental impact in this environmentally sensitive region. Similarly to MacKay Lake crossings, the three alternatives will cause significant visual impact.

- **Terrain and soil variability:** The terrain for all the options considered is mostly rocky, which will enable easier and faster construction. However, the West Route Option passes through many marshy areas that may require special design and heavier foundation types. There is no information available regarding the configuration of the lake bottom which increases the risk for the Trans-Island and Submarine cable options.

- **Construction access:** The transmission lines are located in remote areas, and access for the majority of the transmission line is by winter roads. The West Route Option requires more access roads due to its length, which can stretch the construction schedule.
The Baseline Option section between the Snowdrift River and the tree line is accessible for construction only by helicopter.

- **Construction schedule:** The main components that define the schedule are the availability of winter roads and electrical equipment (specifically transformers) long delivery time, which could be up to 24 months. The transformers must be ordered in the early months of 2009, so they can be hauled on site and installed in 2011. The schedule of the Trans-Island and Submarine Cable options are additionally constrained by the cable long delivery time, which is in the range of 18 months. The cable must be ordered mid 2009, so it could be shipped in the winter 2010/2011, and then barged through MacKenzie River and installed in the summer 2011. This is realistic schedule for the Trans-Island option, due to the short cable length. Cable installation for the Submarine Cable option will require more vessels to lay the cable. The duration of installation season is generally very short and uncertain. For the Submarine Cable option it would be realistic to expect that the cable installation may not be completed before the end of summer 2012.

- **Construction logistics:** Considering the transmission line length and remoteness of the location, construction of the line will be dependent on availability of winter roads. At some stretches, helicopter construction will be necessary. The staging areas have been selected to suit these requirements. The supply of the material to the site will have to be carefully planned and synchronized with the availability of winter roads. Special consideration will have to be given for shipment of heavier equipment, such as transformers and cables.

- **Cost of the line and substation equipment:** High level cost estimates were developed for all four alternatives based on budgetary prices obtained from the equipment and material suppliers, current market conditions and recent bids. The cost estimates are presented in the Table 5-1. Due to line length and complexity of the equipment, the West Route Alternative is the most expensive. The cost of the cables makes the Submarine Cable and Trans-Island Options more expensive than the Baseline Option.

- **Maintainability of the line and associated equipment:** Maintenance could be a serious issue for a project of this size in northern regions. We think that the maintenance efforts are proportional to the length of the line and complexity of the equipment. Equipment for the West Route is very complex, thus skilled staff will be required for maintenance. There will be additional maintenance requirements for the coffer dams for the three alternative routes that cross MacKay Lake.

- **Reliability of the line and associated equipment:** A significant number of line-to-ground faults is expected due to lightning strikes to the line and climatic conditions. Ground faults are proportional to the length of the overhead portions of the lines. For the West Route, these ground faults will stress the series capacitors' insulation, eventually causing their failure and outage of the whole scheme. Cables will also have significant effect on the reliability of the scheme. Outage of a cable, especially for the Submarine Option, will cause long service outages, possibly exceeding six months, depending on the season when the outage happened. To improve reliability, mitigation measures must be considered for line-to-ground faults. Some of these measures are single phase re-closure, and/or installation of surge arresters along the line. However, more detailed studies must be performed due to the risk of resonant overvoltages.

Table 5-1
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West	1244	[redacted] +220 M

Table 5-2
Evaluation of the Transmission Alternatives

Criterion	Baseline	Trans-Island	Submarine	West Route
Technical feasibility				
Number of substations and equipment required				
Footprint of line (clearing required)				
Visual impact of line				
Terrain variability (foundations)				
Construction access issues				

Table 5-2
Evaluation of the Transmission Alternatives

Criterion	Baseline	Trans-Island	Submarine	West Route
Construction schedule/duration				
Logistics and logistical risk in construction				
Basic cost of line				
Contingencies				
Operation cost (line losses)				
Maintainability				
Reliability				

Legend:

Not Recommended
The Least Favorable Option
Less Favorable Option
Favorable Option