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1.0 EXECUTIVE SUMMARY

Yukon Energy Corporation is planning to construct a 175 km, 138 kV transmission line connecting Carmacks and Stewart substations along a route generally following the Klondike Highway. This line would tie the existing Whitehorse-Aishihik-Faro (WAF) system to the existing Mayo-Dawson (MD) system.

As a part of the feasibility study report being prepared for Yukon Energy Corporation, Stantec Consulting was retained to provide initial cost estimates for the project. To make the best use of available expertise and experience, the project scope was divided between Stantec Consulting and Teshmont Consultants. Stantec's scope included the cost estimate for the substations at Carmacks, Stewart Crossing and Pelly Crossing. Teshmont was responsible for estimating the transmission line costs and underground cable (where applicable). Stantec Consulting has compiled the overall report.

This report presents an opinion of probable cost for the proposed Carmacks-Stewart transmission line, the substations at Carmacks, Stewart Crossing and Pelly Crossing. The basis of the report is technical information including basic equipment sizing, single line diagram, proposed route maps, terrain survey report and other design assumptions provided by Yukon Energy Corporation.

The opinion of probable cost has an accuracy of $\pm$ 25 %. No contingency allowance has been considered.

The report contains cost estimates for four possible options:

Option 1 consists of the overhead transmission line built for 66 kV operations. The 138 kV to 66 kV transformation being done at Carmacks substation.

Option 1a is similar to option 1 but the transmission line includes a 10 km section of buried cable near Pelly Crossing, with associated reactors at either end of the cable section.

Option 2 consists of the overhead transmission line built for 138 kV operations. The 138 kV to 66 kV transformation being done at Stewart Crossing.

Option 2a is similar to option 2 but the transmission line includes a 10 km section of buried cable near Pelly Crossing, with associated reactors at either end of the cable section.

Estimates have also been prepared for a fiber optic cable ADSS (all-dielectric, self-supporting cable) underbuild on the existing line structures, in addition to the above four options.

The two substations at Carmacks and Stewart Crossings consist of circuit breakers, disconnect switches, transformers and VAR control equipment like

air-core reactors, synchronous condensers and capacitor banks. At each substation two (2) pre-engineered buildings are proposed. One building is proposed for locating the synchronous condenser and it's associated control panel, 6.9 kV switchgear, battery and charger, and other station service equipment. The second building is proposed for the line protection panels, transformer and reactor protection panels and the communication panel. A plot size of 70m x 60m is considered at each location (Carmacks and Stewart Crossing) for installation of various substation equipment and the pre-engineered buildings.

At Pelly crossing, for options 1 & 2 a plot size of 25m x 10m is proposed to accommodate a fused-switch, transformer, dead-end tower and an electrical control building. For options 1a and 2a additional space would be required to accommodate reactors. Therefore, a plot size of about 35m x 40m is proposed at either end of the cable to transmission line connection.

The proposed 66 kV overhead line would be supported on YEC typical 66 kV tangent (T) structure, a single wood pole, with vertical post insulators in a delta configuration. The average span is assumed to be 100m.

The 138 kV overhead line would be supported on YEC typical tangent (T) , braced wood H-frame with suspension insulators and with side guys for line deflections.

Cross-linked polyethylene, lead sheath, copper conductor cable directly buried one meter deep for a distance of 10 km in the environmentally sensitive area has been considered for options 1a and 2a.

Various conditions and factors assumed while preparing the probable opinion of costs are included in the respective sections. Specifications prepared to get the budgetary quotations, vendors' quotations and technical literature are attached at the end of the report. All information received from Yukon Energy Corporation is also attached.

The estimated costs without fiber optic cable for various options are as follows:

OPTION	TRANSMISSION LINE COSTS ($)	CARMACKS SUBSTATION COSTS ($)	STEWART CROSSING SUBSTATION COSTS ($)	PELLY CROSSING COSTS ($)	TOTAL COSTS ($)
1	13,061,000	5,531,000	5,375,000	480,000	24,447,000
1a	17,776,000	5,531,000	5,375,000	1,433,000	30,115,000
2	13,229,000	5,346,000	5,066,000	480,000	24,121,000
2a	19,310,000	5,346,000	5,066,000	2,020,000	31,742,000

The estimated costs with fiber optic cable for various options are as follows:

OPTION (Please See Note below)	TRANSMISSION LINE COSTS ($)	CARMACKS SUBSTATION COSTS ($)	STEWART CROSSING SUBSTATION COSTS ($)	PELLY CROSSING COSTS ($)	TOTAL COSTS ($)
1	15,494,000	5,551,000	5,395,000	500,000	26,940,000
1a	20,117,000	5,551,000	5,395,000	1,453,000	32,516,000
2	15,749,000	5,366,000	5,086,000	500,000	26,701,000
2a	21,765,000	5,366,000	5,086,000	2,040,000	34,257,000

A proposed project schedule showing engineering, procurement and construction activities is attached to this summary.

NOTE:
The options referred in Section 2 for Transmission Line Cost estimate with fiber optic cable are as follows:

Executive Summary Option 1 is same as Option 1B of Section 2.
Executive Summary Option 1a is same as Option 1C of Section 2.
Executive Summary Option 2 is same as Option 2B of Section 2.
Executive Summary Option 2a is same as Option 2C of Section 2.

2.0 TRANSMISSION LINES

2.1 Information provided by Yukon Energy Corporation (YEC)

- YEC Request for Proposal fax dated December 23, 2002 from Alex Love to Rick Steinke describing the request for services, information resources available, basic design assumptions, design options and related single line diagrams. YEC later advised that Option 2b need not be considered.
- Carmacks-Stewart Transmission Line Project Preliminary Terrain Survey Maps, 1:50,000 scale, January 31, 2001
- Report titled “Carmacks-Stewart Transmission Line Project, Preliminary Terrain Survey”, October 2000, C. Mougeot, M. Sc. Geology, Mougeot Geoanalysis
- Draft report titled “Proposed Carmacks-Stewart 66 kV Transmission Line, Corridor Review & Refinement, Klondike Highway Route”, February 3-4th, 2001, I. A. Hayward, P. Eng.
- 66 kV Structures Typical data, 2 sheets consisting of 66 kV typical and 66 kV with underbuild
- 138 kV Structures Typical data, 7 sheets consisting of 138 kV Aishihik Transmission Line: Structure List, Tangent Structures, Tangent Structures with O.H.G., Transposition Structure, Angle Structure and Sidehill Tangent Structure, and two Plan and Profile sheets.
- YEC fax dated April 11, 2003 from Alex Love providing BOM for 66 kV Structures
- Record Notes of tele-conference with Alex Love on March 19, 2003
- YEC Memo dated April 11, 2003 from Alex Love to Gil Mourant responding to Teshmont inquiries

2.2 Assumptions

For estimating the costs of the transmission line options, the following assumptions were made:

- Assumed same line route as shown on Preliminary Terrain Survey Maps and points of intersection for both 66 kV and 138 kV options
- Assumed 30 meter right of way for the entire length of line for clearing for both 66 kV and 138 kV options
- Assumed clearing by brushing, no reduction in costs due to merchantable timber, no stumpage fee
- Assumed mobilization and demobilization at 4% of line costs which included clearing, construction surveys, supply and installation of structures, conductors, fiber optic cable, and underground cable

- Assumed necessary access available from Klondike Highway and therefore no line access management plan or line roads deactivation required
- Assumed construction surveys at 3.5% of line costs which included clearing, supply and installation of structures, conductors, fiber optic cable, and underground cable
- Assumed YEC typical 66 kV tangent structure, single wood pole with vertical post insulators with an average span of 100 meters for 66 kV options
- Assumed YEC typical 138 kV structures, wood H-frames for tangents and 3 pole guyed wood frames for angles and deadends for 138 kV options; assumed average span of 200 meters for tangent structures
- Assumed pole heights increase by 3 meters (10 feet) to accommodate fiber optic cable underbuild
- Assumed 397 MCM Ibis conductor for the 66 kV line options and 267 MCM Partridge conductor for the 138 kV line options
- Assumed polymer suspension and strain insulators for both 66 kV and 138 kV options
- Assumed 10 km continuous length for underground cable
- Assumed engineering costs at 12% of line costs
- Assumed cost estimate as a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance

2.3 Option #1 - 66 kV Overhead Line

Option #1 consists of a proposed 175 km 66 kV overhead line from Stewart Crossing to Carmacks, Yukon. The proposed transmission line is adjacent to and follows the Klondike Highway from Stewart Crossing to Carmacks as shown as the proposed new route on the Preliminary Terrain Survey Maps.

2.3.1 Overhead Line

The proposed 66 kV overhead line was based on YEC typical 66 kV tangent (T) structure, a single wood pole, with vertical post insulators in a delta configuration, with an assumed average span of 100 meters.

Angles and deadends were selected on the basis of the points of intersection of a line drawn through the proposed new route. Light angle (LA) structures selected by line deflection of 3 to 15 degrees are based on single wood poles, with double vertical post insulators in a delta configuration, with a single guy. Medium angle (MA) structures selected by line deflections of 16 to 45 degrees are based on vertical

corner, single wood poles with suspension insulators (running angle), and two guys. Heavy angle (HA) structures selected by line deflections of 46 to 90 degrees are based on vertical corner, single wood poles with strain insulators, jumpers and three guys. Deadend (DE) structures are based on 3 single wood poles with strain and post jumper insulators, jumpers, and two guys each.

Wood poles were based on Class 2 with an average height of 15.2 meters (50 feet).

For soil, foundation type was based on direct bury in soil. For rock, drill and blast hole, set culvert, backfill with blasted rock, set pole and backfill annular space around pole in culvert with sand or pea gravel. For permafrost, use 1525 mm (5 feet) longer pole, set pole 600 mm deeper in ground, and install 3 guys and screw anchors unless previously guyed. For swampy conditions, set pole in culvert. For steep slopes, use 1525 mm (5 feet) longer pole, set pole 600 mm deeper in ground, and install 3 guys and screw anchors unless previously guyed. Guy anchors based on deadman log in soil, screw anchor through pilot hole in permafrost or grouted rod in rock.

1. Overhead Line Cost Estimate

   An Overhead Line Cost Estimate was prepared for Option #1 66 kV Alternative without ADSS and without underground cable is attached.

   The line cost is broken down into the following items:

   - mobilization and demobilization cost
   - clearing cost
   - construction survey cost
   - supply and installation of structures cost
   - supply and installation of conductors cost
   - engineering cost

   Line contractor's mobilization and demobilization cost is estimated at 4% of the line cost, which includes clearing, construction surveys, supply and installation of structures and conductors.

   Clearing cost is based on brushing a 30-meter r.o.w. for the entire length of the line.

   Construction survey cost is estimated at 3.5% of the line cost, which includes clearing, supply and installation of structures and conductors. Contractor survey tasks include survey r.o.w. for

clearing, stake pole and guy anchor locations, and provide structure as built information

Supply and installation of structures cost is based on the estimate of costs for material including transportation, and construction for each type and quantity of structure. Quantities for each structure and terrain type was estimated from the line route on the Preliminary Terrain Survey Maps. Structure materials include all materials for the structure, ie poles, arms, braces, guys, anchors, insulators, hardware, etc….

Supply and installation of conductors cost is based on the estimate of costs for material including transportation, and stringing of conductors. A 5% contingency was added to the quantity to allow for sag and inclined spans.

Engineering cost is estimated at 12% of the line cost, which includes mobilization and demobilization, clearing, construction surveys, supply and installation of structures and conductors. Engineering costs is based on the following items:

- 3% survey
- 1% geotechnical investigation
- 3.5% design which includes line routing, structure and foundation design, preparation of drawings, specifications, and bid documents, bid evaluation, material procurement and QC/QA audits, permitting, and project management
- 4.5% construction observance

The Overhead Line Cost Estimate is a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance.

2.4 Option #1A - 66 kV Overhead Line with Cable Section

Option #1A is similar to Option #1 with the exception that 10 km of overhead line has been deleted and 10 km of underground cable has been added. The 10 km section was assumed to be north of Pelly Crossing.

2.4.1 Overhead Line with Cable Section

The overhead line for Option #1A is the same as for Option #1.

The underground cable is based on *see attachment cable assumptions.*

2.4.2 Overhead Line With Cable Section Cost Estimate

An Overhead Line with cable section cost estimate was prepared for Option #1A - 66 kV Alternative without ADSS and with underground cable is attached.

Option #1A cost estimate is similar to Option #1 cost estimate except the supply and installation of underground cable is added to the line cost estimate and is included in the calculations for mobilization and demobilization, construction surveys, and engineering costs. The supply and installation of structures and conductors costs are deleted for the10 km section north of Pelly Crossing.

The Overhead Line with cable section cost estimate is a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance

2.5 Option #1B - 66 kV Overhead Line with ADSS and Without Underground Cable

Option #1B is similar to Option #1 with the exception that a fiber optic cable ADSS underbuild has been added.

2.5.1 Overhead Line With ADSS and Without Underground Cable

The overhead line for Option #1B is the same as for Option #1 except that the poles are assumed to be 3 meters (10 feet) longer.

The fiber optic cable is based on see attachment conductors insulators FO cable assumption.

2.5.2 Overhead Line With ADSS and Without Underground Cable Cost Estimate

An Overhead Line with ADSS and without underground cable cost estimate was prepared for Option #1B - 66 kV Alternative with ADSS and without underground cable is attached.

Option #1B cost estimate is similar to Option #1 cost estimate except the supply and installation of fiber optic cables is added to the line cost estimate and is included in the calculations for mobilization and demobilization, construction surveys, and engineering costs. The supply and installation of structures cost is modified for the longer poles.

The Overhead Line with ADSS and without underground cable cost estimate is a probable opinion of cost with a ± 25% projection of

accuracy to be used for preliminary project analysis, with no contingency allowance.

2.6 2.6 Option #1C - 66 kV Overhead Line with ADSS and Underground Cable

Option #1C is a combination of Option #1A and 1B with both the ADSS and the underground cable added to the line.

2.6.1 Overhead Line With ADSS and Underground Cable

The overhead line for Option #1C is similar to Option #1B with the exception that 10 km of overhead line has been deleted and 10 km of underground cable has been added. The 10 km section was assumed to be north of Pelly Crossing.

2.6.2 Overhead Line with ADSS and Underground Cable Cost Estimate

An Overhead Line with ADSS and underground cable cost estimate was prepared for Option #1C - 66 kV Alternative with ADSS and with underground cable is attached.

Option #1C cost estimate is similar to Option #1 cost estimate except the supply and installation of fiber optic cables and underground cables is added to the line cost estimate and is included in the calculations for mobilization and demobilization, construction surveys, and engineering costs. The supply and installation of structures cost is modified for the longer poles and reduced for the 10 km section deleted. The supply and installation of conductors cost is reduced for the 10 km section deleted..

The Overhead Line with ADSS and underground cable cost estimate is a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance.

2.7 Option #2 - 138 kV Overhead Line

Option #2 consists of a proposed 175 km 138 kV overhead line from Stewart Crossing to Carmacks, Yukon. The proposed transmission line is adjacent to and follows the Klondike road from Stewart Crossing to Carmacks as shown as the proposed new route on the Preliminary Terrain Survey Maps.

2.7.1 Overhead Line

The proposed 138 kV overhead line was based on YEC typical 138 kV structures as follows:

- tangent (T), braced wood H-frame with suspension insulators, with two side guys for line deflections of 0 to 3 degrees;
- angle, 3 to 15 degrees, 3 wood pole frame, cross braced, with side guys

Tangent structure quantities were based on an average span of 200 meters.

Angles and deadends were selected on the basis of the points of intersection of a line drawn through the proposed new route.

Light angle (LA) structures selected by line deflection of 3 to 15 degrees are based on a 3 wood pole frame, cross braced, with suspension insulators (running angle), with one to two side guys.

Medium angle (MA) structures selected by line deflections of 16 to 45 degrees are based on a 3 wood pole frame, cross braced, with strain and post jumper insulators, with two to six side guys.

Heavy angle (HA) structures selected by line deflections of 46 to 90 degrees are based on a 3 wood pole frame, cross braced, with strain and post jumper insulators, with six guys.

Deadend (DE) structures are based on a 3 wood pole frame, cross braced, with strain and post jumper insulators, jumpers, and six to ten guys.

Wood poles were based on Class 2 with an average height of 18.3 meters (60 feet).

For soil, foundation type was based on direct bury in soil. For rock, drill and blast hole, set culverts, backfill with blasted rock, set poles and backfill annular space around poles in culverts with sand or pea gravel. For permafrost, use 1525 mm (5 feet) longer poles and set poles 600 mm deeper in ground. For swampy conditions, set poles in culverts. For steep slopes, use one 1525 mm (5 feet) longer pole and either one or two poles 3048 mm (10 feet) longer, set poles 600 mm deeper in ground. Guy anchors based on deadman log in soil, screw anchor through pilot hole in permafrost or grouted rod in rock.

2.7.2 Overhead Line Cost Estimate

An Overhead Line Cost Estimate was prepared for Option #2 138 kV Alternative without ADSS and without underground cable is attached.

The line cost estimate is broken down into the same items as for Option #1.

The Overhead Line Cost Estimate is a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance.

2.8 Option #2A - 138 Kv Overhead Line with Cable Section

Option #2A is similar to Option #2 with the exception that 10 km of overhead line has been deleted and 10 km of underground cable has been added. The 10 km section was assumed to be north of Pelly Crossing.

2.8.1 Overhead Line with Cable Section

The overhead line for Option #2A is the same as for Option #2.

The underground cable and trench is the same as for Option #1.

2.8.2 Overhead Line with Cable Section Cost Estimate

An Overhead Line with cable section cost estimate was prepared for Option #2A - 138 kV Alternative without ADSS and with underground cable is attached.

Option #2A cost estimate is similar to Option #2 cost estimate except the supply and installation of underground cable is added to the line cost estimate and is included in the calculations for mobilization and demobilization, construction surveys, and engineering costs. The supply and installation of structures and conductors costs are deleted for the10 km section north of Pelly Crossing.

The Overhead Line with cable section cost estimate is a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance.

2.9 Option #2B - 138 Kv Overhead Line with ADSS and Without Underground Cable

Option #2B is similar to Option #2 with the exception that a fiber optic cable ADSS underbuild has been added.

2.9.1 Overhead Line with ADSS and without Underground Cable

The overhead line for Option #2B is the same as for Option #2 except that the poles are assumed to be 3 meters (10 feet) longer.

The fiber optic cable is the same as for Option #1.

2.9.2 Overhead Line With ADSS and without Underground Cable Cost Estimate

An Overhead Line with ADSS and without underground cable cost estimate was prepared for Option #2B - 138 kV Alternative with ADSS and without underground cable is attached.

Option #2B cost estimate is similar to Option #2 cost estimate except the supply and installation of fiber optic cables is added to the line cost estimate and is included in the calculations for mobilization and demobilization, construction surveys, and engineering costs. The supply and installation of structures cost is modified for the longer poles.

The Overhead Line with ADSS and without underground cable cost estimate is a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance.

2.10 Option #2C - 138 Kv Overhead Line with ADSS and Underground Cable

Option #2C is a combination of Option #2A and 2B with both the ADSS and the underground cable added to the line.

2.10.1 Overhead Line with ADSS and Underground Cable

The overhead line for Option #2C is the similar to Option #2B with the exception that 10 km of overhead line has been deleted and 10 km of underground cable has been added. The 10 km section was assumed to be north of Pelly Crossing.

2.10.2 Overhead Line with ADSS and Underground Cable Cost Estimate

An Overhead Line with ADSS and underground cable cost estimate was prepared for Option #2C - 138 kV Alternative with ADSS and with underground cable is attached.

Option #2C cost estimate is similar to Option #2 cost estimate except the supply and installation of fiber optic cables and underground cables is added to the line cost estimate and is included in the calculations for mobilization and demobilization, construction surveys, and engineering costs. The supply and installation of structures cost is modified for the longer poles and reduced for the 10 km section deleted. The supply and installation of conductors cost is reduced for the 10 km section deleted.

The Overhead Line with ADSS and underground cable cost estimate is a probable opinion of cost with a ± 25% projection of accuracy to be used for preliminary project analysis, with no contingency allowance.

3.0 SUBSTATIONS

3.1 List of Assumptions

At this stage, preliminary information is available, therefore, to prepare the cost estimate certain assumptions had to be made. Following are some of the major assumptions that have been considered:

1. Cost Estimate is ± 25% accurate.

2. Land costs for the substations were not considered.

3. Sites where substations will be located are assumed to be level ground, i.e. no major land filling or cutting is required.

4. Revenue metering is not required.

5. Following are the site conditions (for Dawson) that have been considered while specifying the equipment:

Elevation	330 m
Design ambient temperature	(-50°C to +30°C)
Wind velocity	20.8 m/s
Annual Total Precipitation	350 mm
Seismic Data	Za (Ground Acceleration) = 2 Zv (Ground Velocity) = 4 V (Zonal velocity ratio) = 0.2
Soil resistivity (ρ)	62 Ω-m
Terrain	Generally well-drained gravelly sand to gravelly loam. Areas present with organic rich material with ice rich permafrost.

6. 25 kV line (single-phase) to local loads at Stewart crossings already exists.

7. 5 km O/H line to Pelly Crossings is not to be considered, this will be done by others.

8. Grounding switches are not provided . Manually applied grounding chains will be used.

9. For the HV disconnect switches:

   (a) Only manually operated.

   (b) Status indication is not considered.

   (c) Interlocks will be only through padlocks only and switching procedure. No Kirk key interlocks were considered.

10. Only one DC battery and dual battery chargers were considered for the DC system.

11. Substation will be provided with two (2) lightning spires.

12. Line protection will be in the form of ‘A’ and ‘B’ impedance relays.

3.2 Option #1 Transmission at 66 kV

3.2.1 Description of Electrical System

Single Line diagram showing the configuration envisaged for the Carmacks – Stewart Crossing proposed transmission line is attached. The main feature of this line is that the overhead transmission line will be built for 66 kV operations. The 138 kV to 66 kV transformation will be done at the Carmacks substation.

At Carmacks a 60 m x 70 m substation has been proposed to accommodate the various equipment. A preliminary layout (Sketch # SK3) showing the proposed location of various equipment is attached. Since the site is not as yet finalized, the orientation and access to the substation are not identified.

A similar layout has been proposed for Stewart Crossing. There is no 8 MVAR reactor at this substation, therefore, its space and other vacant area would be used for locating the 6.9 kV reactors. 225 kVA transformer and the transformer supplying power to local load are located near the substation building. Space for the auto-transformer would be used for the 66 kV/6.9 kV transformer for options 1 and 1a, and for options 2 and 2a the space would be retained for the auto-transformer. A preliminary layout (Sketch # SK4) showing the proposed location of various equipment is attached.

At Pelly Crossing a plot size of 25 m x 10 m is proposed to accommodate a dead-end tower, fused-switch, transformer (PEL-T1) and an electrical control building (for DC battery & charger and a repeater panel for fibre optic communication system). A preliminary layout (Sketch # SK2) for the proposed substation at Pelly Crossing is attached. The sketch has been prepared for options 1a and 2a. Please refer to the notes on the sketch for it to be applicable for Option 1.

The following activities regarding Civil / Structural work scope for the substations with respect to geotechnical investigation, survey, site preparation, foundations and buildings have been considered:

3.2.2 Geotechnical Investigations

It is assumed that the selected sites are relatively flat, and having competent soil for the substation foundations. This feasibility study assumes that no permafrost will be encountered.

A geotechnical report will be prepared for each of the sites. A borehole program will be carried out and logged. It is proposed to drill 3 to 4 boreholes at Carmacks and Stewart Crossing. Drilling of one (1) bore

hole is envisaged at the Pelly crossing site. A report will be prepared for each location giving recommendations for pile foundations, spread pad footings, gravel finish and building slabs.

3.2.3 Survey

Prior to the start of Civil works, a survey will be conducted to establish battery limits, reference elevations and the design drainage slopes.

After rough civil work is carried out, a detailed survey will be carried out to locate the buildings, transformers and substation foundations.

3.2.4 Site Preparation

Once the initial survey is done, the sites will be cleared and grubbed. The subgrade will be sloped for surface drainage. If the geotechnical report makes a recommendation, a layer of geotextile will be provided to improve the subgrade stiffness. The site will be finished with about 200 mm of washed gravel.

After the site is sloped and prior to application of the gravel finish, the foundations and slabs will be installed. At this time the foundations for fence post and the perimeter chain link fencing, access gate and man gates will be installed and erected.

It is proposed that all equipment and slabs will be supported on cast-in-place friction piles. Slabs will be cast on the piles to support the transformers and buildings. The slabs will have void form provided to protect against frost heaving of the subgrade material.

The balance of piles will be provided with pile caps and anchor bolts. The equipment will be anchored and grouted into place.

3.2.5 Buildings and Transformers

Site buildings will be provided as pre-engineered metal building packages. The buildings will be fabricated and painted off-site, shipped to site as pieces in crates and assembled on site.

Transformers will be provided with oil containment. This will be achieved by providing a concrete curb on the transformer slabs.

3.2.6 Basis of Cost Estimate

The cost estimate for this option is based on the following:

1. Pre-engineered substation building of size 12 m x 12 m for locating the synchronous condenser with piggyback motor and

associated control panel, VFD for piggyback motor, 6.9 kV switchgear, DC battery and battery charger. Since the building is over-dimensioned for transportation, it may have to be shipped in two parts of 12 m x 6 m each.

2. 138 kV, 8 MVAR reactor is already available with Yukon Energy Corporation at Faro and will be made available as a free-issue item for this project. Therefore, only transportation costs have been considered for this reactor.

3. A disconnect switch and a potential transformer have been additionally considered (not shown on the single line diagram) on the 66 kV side of the 138 / 66/ 6.9 kV auto-transformer to enable line isolation and still continue to supply the 6.9 kV switchboard and station service loads.

4. To obtain budgetary quotations, brief technical specifications were prepared and inquires were sent to various (about five) vendors. The bids were technically evaluated against major technical criterion specified. Those not meeting the specification requirements were not considered for estimation purposes. Prices of technically acceptable quotations were tabulated. Since the specifications are preliminary at this stage and vendors' prices cannot be firmed up, average price of technically acceptable quotations were considered for the capital cost estimate.

5. Attached Table – 1 gives the list of vendors to whom the inquiries were sent and their status (i.e. bids received or not, technically acceptable or not is mentioned).

6. Items that were not inquired for budgetary prices, were estimated based on past experience and other available data.

7. Cost for foundations, piling, trenching and other civil work was estimated on the basis of the proposed layout; preliminary equipment dimensions, weights and locations.

8. Union labor rates have been considered for execution of the work.

9. Since board and lodging facilities for the workforce may not be available at Stewart Crossing, daily travel time from Mayo has been considered for construction work. Accommodation is available at Carmacks, but Pelly Crossing work would be commuted from Carmacks.

10. No taxes have been considered in the estimates.

11. Spreadsheet providing details of the probable costs for substations at Carmacks, Stewart Crossing and Pelly Crossing are attached.

TABLE - 1

EQUIPMENT	BIDS SENT TO	BIDS RECEIVED	TECHNICALLY ACCEPTABLE	REMARKS
Battery and Battery Charger	Battery Electric	Yes	Yes	
138 kV and 66 kV Circuit Breakers	ABB	Yes	Yes	
	ALSTOM	Yes	No	Spec. requirement of live tank type not complied
	GE	Yes	No	
	SIEMENS	Yes	No	
6.9 kV, 2 MVAR and 3 MVAR Capacitor Banks	ABB	Yes	Yes	
	C & H	No	-	
	GE	Yes	Yes	
	GRAFTONWEST	No	-	
	T & D	Yes	Yes	
	TRENCH	No	-	
138 kV and 66 kV Current Transformers	ABB	No	-	
	GE	Yes	No	Offered dry type in deviation to technical spec.
	RITZ	Yes	Yes	
	TRENCH	Yes	Yes	
	GRAFTONWEST	No	-	
138 kV and 66 kV Disconnect Switches	ALSTOM	Yes	Yes	
	GRAFTONWEST	Yes	No	Price not comparable
	GS T & D	Yes	Yes	
	JOSLYN	Yes	No	Price not comparable
	MORPAC	Yes	No	
	S & C	No	-	
6.9 kV,100 kVA, Zigzag winding Transformer with grounding resistor	EECOL	No	-	
	SQUARE D	No	-	
	T & D	Yes	Yes	
	WESCO	No	-	
	WESTBURNE (ROCKWELL)	Yes	No	Offered dry type in deviation to technical spec.
6900/600 V, 225 kVA, Distribution Transformer	EECOL	No	-	
	SQUARE D	No	-	
	T & D	No	-	
	WESCO	No	-	
	WESTBURNE (ROCKWELL)	Yes	Yes	
Lighting Fixtures	HUBELL	Yes	Yes	
138/6.9 kV, Transformer	ABB	No	-	
	ALSTOM	No	-	
	GE	No	-	
	HYUNDAI	Yes	Yes	
	INNOVELEC	No	-	
	SIEMENS	No	-	
	T & D	Yes	Yes	

EQUIPMENT	BIDS SENT TO	BIDS RECEIVED	TECHNICALLY ACCEPTABLE	REMARKS
138/66 kV, Transformer	ABB	No	-	
	ALSTOM	No	-	
	GE	Yes	Yes	
	HYUNDAI	Yes	Yes	
	INNOVELEC	No	-	
	SIEMENS	Yes	Yes	
	T & D	Yes	Yes	
66/6.9 kV, Transformer	ABB	No	-	
	ALSTOM	No	-	
	GE	Yes	No	Price not comparable
	HYUNDAI	Yes	Yes	
	INNOVELEC	No	-	
	SIEMENS	Yes	Yes	
	T & D	Yes	Yes	
138 kV, 5 MVAR & 10 MVAR Reactors	ABB	No	-	
	C & H	No	-	
	GE	No	-	
	GRAFTONWEST	No	-	
	T & D	No	-	
	TRENCH	Yes	Yes	
66 kV, 1.25 MVAR & 2.5 MVAR Reactors	ABB	No	-	
	C & H	No	-	
	GE	No	-	
	GRAFTONWEST	No	-	
	T & D	No	-	
	TRENCH	Yes	Yes	
6.9 kV, 2 MVAR & 3 MVAR Reactors	ABB	No	-	
	C & H	No	-	
	GE	No	-	
	GRAFTONWEST	No	-	
	T & D	No	-	
	TRENCH	Yes	Yes	
6.9 kV Switchgear for Carmac and Stewart Crossing Substations	ABB	No	-	
	C & H	No	-	
	GE	No	-	
	SIEMENS	Yes	Yes	
	SQUARE D	Yes	Yes	
	WESTBURNE (ROCKWELLL)	Yes	No	Price not comparable
Synchronous Condenser	ABB	No	-	
	ASI ROBICON	Yes	Yes	
	C & H	No	-	
	GE	Yes	Yes	
	SIEMENS	No	-	
	TECO	Yes	No	Price not comparable
138 kV CVT	ABB	No	-	
	GE	No	-	
	GRAFTONWEST	No	-	
	RITZ	No	-	

EQUIPMENT	BIDS SENT TO	BIDS RECEIVED	TECHNICALLY ACCEPTABLE	REMARKS
	TRENCH	Yes	Yes	
138 kV VT	ABB	No	-	
	GE	Yes	No	Offered dry type in deviation to technical spec.
	GRAFTONWEST	No	-	
	RITZ	Yes	Yes	
	TRENCH	Yes	Yes	
66 kV VT	ABB	No	-	
	GE	Yes	No	Offered dry type in deviation to technical spec. and price not comparable.
	GRAFTONWEST	No	-	
	RITZ	Yes	Yes	
	TRENCH	Yes	Yes	
Station Service Voltage Transformer (66 kV)	GRAFTONWEST	Yes	Yes	

3.3 Option #1a Transmission At 66 Kv with Cable Section

3.3.1 Description of Electrical System

Single Line Diagram showing the configuration envisaged for the Carmacks – Stewart Crossing proposed transmission line option 1A is attached. Option 1A is similar to option 1, that is the overhead transmission line will be built for 66 kV operations, but the transmission line includes a 10 km section of buried cable near Pelly Crossing, with associated reactors at either end of the cable section. The 138 kV to 66 kV transformation will be done at Carmacks substation.

Single Line Diagram at Pelly Crossing has been modified by the addition of disconnect switches to enable isolation of reactors and transformer for maintenance purpose without affecting power transmission between Carmacks and Stewart Crossing. The same is attached as Sketch # 1.

3.3.2 Civil Works

Activities like geotechnical investigations, survey, site preparation, buildings and foundations would be similar to that described for Option 1 except that at Pelly Crossing there would be an additional site at the other end of the cable section.

3.3.3 Cost Estimate

Basically the methodology adopted for preparation of cost estimates for the substations for option 1A is similar to option 1, except for the additional equipment required at Pelly Crossing.

A spreadsheet providing details of the probable costs for substations at Carmacks, Stewart Crossing and Pelly Crossing are attached.

3.4 Option #2 Transmission at 138 kV

3.4.1 Description of Electrical system

Single Line Diagram showing the configuration envisaged for the Carmacks – Stewart Crossing proposed transmission line is attached. The main feature of this line is that the overhead transmission line will be built for 138 kV operations. The 138 kV to 66 kV transformation will be done at Stewart Crossing Substation. The three-winding auto-transformer would be located at Stewart Crossing instead of Carmacks. An additional 138/6.9 kV transformer would be provided at Carmacks for the 6.9 kV loads.

3.4.2 Civil Works

Activities like geotechnical investigations, survey, site preparation, buildings and foundations would be similar to that described for Option 1.

3.4.3 Cost Estimate

Basically the methodology adopted for preparation of cost estimates for the substations for option 2 is similar to option 1. Spreadsheet providing details of the probable costs for substations at Carmacks, Stewart Crossing and Pelly Crossing are attached.

3.5 Option # 2a Transmission at 138 kV with Cable Section

3.5.1 Description of Electrical System

Single Line Diagram showing the configuration envisaged for the Carmacks – Stewart Crossing proposed transmission line option 2A is attached. Option 2A is similar to option 2, that is the overhead transmission line will be built for 138 kV operations, but the transmission line includes a 10 km section of buried cable near Pelly Crossing, with associated reactors at either end of the cable section. The 138 kV to 66 kV transformation will be done at Stewart Crossing Substation.

The Single Line Diagram at Pelly Crossing has been modified by the addition of disconnect switches to enable isolation of reactors and transformer for maintenance purpose without affecting power transmission between Carmacks and Stewart crossing. The same is attached as Sketch # 1.

3.5.2 Civil Works

Activities like geotechnical investigations, survey, site preparation, buildings and foundations would be similar to that described for Option 1 except that at Pelly Crossing there would be an additional site at the other end of the cable section.

3.5.3 Cost Estimate

Basically the methodology adopted for preparation of cost estimates for the substations for option 2A is similar to option 1, except for the additional equipment required at Pelly Crossing.

A spreadsheet providing details of the probable costs for substations at Carmacks, Stewart Crossing and Pelly Crossing are attached.

4.0 RECOMMENDATION

Based on our opinion of probable costs summarized under 'Executive Summary' for various options, the following are our conclusions and recommendations:

1. Cost estimates for 66 kV (Option 1) and 138 kV (Option 2) transmission voltage systems are almost the same, the estimate for 138 kV system being marginally lower. To provide for any future plans of system voltage upgrades and take advantage of lower transmission losses, it is recommended to select the 138 kV transmission voltage (Option 2) at this point in time itself. This would also avoid relocation of the 3-winding auto-transformer from Carmacks Substation to Stewart Crossing Substation in the future.

2. The option to use underground cable for a 10 km distance is about $ 6 million more for 66 kV system and about $ 8 million more for 138 kV system, than the option to have overhead transmission line all through. A socio-economic cost-benefit analysis is required to conclude whether the cable option should be preferred or not.

3. Additional cost for running a fiber optic cable underbuild on the proposed transmission line structures, is about $ 2.5 million.