Appendix A-4

Capex Basis Report for 1.0 mbpd

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1.0 INTRODUCTION

As part of this study, Capital and Operating estimates were prepared to support and validate the buiness case and technical aspects of the report. These estimates bring together the project objectives and design conditions.

The Alberta to Alaska Railway is envisioned to transport bitumen along with other products such as minerals generated from the Alberta Oil Sands and along the proposed route. The Railway has been designed to start in the Fort McMurray, Alberta area and travel through to Delta Junction in Alaska.

The design of the railway and supporting infrastructure has been around shipping of bitumen in 192-car unit trains along the proposed mainline. The construction of the railway comprises of earthworks, track, structures, handling facilities, storage facilities, maintenance facilities, yards, signalling and communications systems. While this railway is purpose built for the hauling of bitumen it does not preclude any other commodities normally handled by railways.

In addition, the estimate allows for rolling stock, maintenance rolling stock and makes allowances for logistics, handling, preliminaries, environmental issues and permits, and owners costs.

Design progress is limited at this pre-feasibility stage (PFS) and the estimate is based on the CIQS Class D estimate to provide an order of magnitude cost only with a low degree of precision. A significant proportion of the estimate is based on assumptions and allowances given that design progress is 0-5% complete, appropriate for a PFS report.

2.0 GENERAL OVERVIEW

As this Pre-Feasibility report is a desktop based study; geotechnical, hydrological and environmental studies will be required in order to increase the margin of accuracy for earthwork and structures. These studies will provide the data needed to refine the track profiles and produce the preliminary design for the structures. It is anticipated that this work would be completed in a future phase of study.

In order to proceed with the evaluation; certain hypotheses and assumptions were devised to account for excavation conditions, based on existing or interpolated geotechnical information to define a split between common excavation and hard rock excavation.

Construction costs have been derived from a variety of methods as follows:

- Manual calculation
- Benchmarked rates and prices derived from recent projects
- Budget prices from local companies in British Columbia
- Budget prices from companies offering construction services complementing the project

The estimates include for earthworks, track construction, bridges, culverts, tunnels, rolling stock, buildings, workshops and facilities, signals and communications, environmental costs, construction camps, logistics, access roads, power, utilities, EPCM costs, allowance for owners costs and contingency. The accuracy of this information is based on the limited extent of the information that has been defined.

The CapEx estimate provides an output that reflects the potential range of costs likely to be incurred, not simply the cost with the highest probability of occurring (P50 estimate, Single Point Estimate). Single point estimates do a historically poor job of representing the actual variability associated with cost estimating, usually resulting in cost over-runs during construction.

In statistical analysis a P50 estimate represents 50% of the area under a distribution bell curve, and illustrates the cost that is most likely to be incurred, but still gives a 50% likelihood of cost over-runs. A P80 estimate would represent 80% of the area, and would represent only a 20% chance of cost over-runs.

When converted to a cumulative "S" curve, the significance is better demonstrated. Probability is synonymous with the likelihood of "under-run". At the upper end of the scale, there is a 100% chance of "under-run" and a 0% chance of "over-run".

Within the CapEx estimate, each activity has been assessed for a range of quantity variation and a range of unit rate variation. The output has derived a minimum and maximum range for cost and by using excel formula, a beta distribution cost range has been calculated which has produced as P5 and a P95 for comparison. The 'most likely' is calculated to be around the P50 point.

3.0 RATES AND PRICES

Prices are in CAD$ money of the day.

The cost range represents a 5% to 95% cost certainty.

4.0 QUANTITIES AND ASSUMPTIONS

At the PFS study level, allowances are made for major cost items that are anticipated but not as yet fully identified, e.g., bridges and major earthwork fills. In such circumstances, the number and general type of major cost items are based on previous conditions and experience. As a result, the estimate has an allowance for a number of bridges in ranges of span lengths and vertical clearance prior to specifying where the bridges are expected to be located.

4.1 EARTHWORKS

- The site clearance is assumed to be a mixture of light, medium and dense vegetation, split equally three ways.
- The quantity of site clearance area has been derived from the length of the route multiplied by an average width of 20 meters.
- It has been assumed that tree felling would be required to 33% of the overall site clearance quantity and again the density of this area has been split three ways between light, medium and heavy density of tree covered areas.

- It is assumed that trees would be hauled from the site on average a distance of 1500 m; any saleable timber is assumed to have a net value of zero over transport cost.
- Ditch clearance of a 50 m run has been allowed every 3 km of the route for the entire route.
- Simulations run through CAD on the proposed alignment have derived an overall anticipated volume of cut and fill.
- A split has been undertaken between rock and common material by using geomorphological interpretation.
- It is assumed that the rock can be used within the fill embankment with little or no crushing.
- It is assumed that rock would be blasted prior to excavation.
- The length of haul is assumed to be 3 km on average.
- It is assumed that cut and fill would balance, and therefore where there is an imbalance of cut and fill, a borrow pit would be established to provide any shortfall. The borrow pits are assumed to be 2 m deep following extraction of required soils. The rates for establishment of the borrow pit allow for stripping back soil to the side and subsequent reinstatement of that soil to landscape around the void.
- It is assumed that surplus unsuitable disposal will be adjacent to the site.
- Haul roads are included throughout the site for the movement of earthworks equipment to facilitate construction. The estimate makes allowance for 20% of the railway route haul roads to be a maintained temporary surface, to allow most construction traffic to pass until construction is complete.
- Topsoil is assumed to be spread to slopes to cuttings and embankments to control soil erosion.
- A sum allowance has been made for construction of temporary heavy haul bridges.
- It is assumed that permafrost conditions exist along part of the route defined, and the treatment of this is through the use of rock excavated from within the cuttings, transported to permafrost areas to form a base layer within embankments.

4.2 TRACK

- Items included are: rail, ties (concrete), fasteners, installation, grinding, 12” (300 mm) depth cushion ballasting, de-stressing, flash-butt welding, level crossings, hi-rail take-offs, signs, turnouts, wheel stops.
- Total track length estimated is 2,550 km.
- 33 sidings are included within the estimate and a further 4 crew change sidings are allowed plus yards at Fort McMurray and Delta Junction. This number of sidings has been selected to achieve the output production of 1,000,000 barrels per day.
- Concrete ties are assumed to be spaced at 600 mm centers (1,640 per km).
- It is assumed that track laying would be undertaken with a track laying machine (TLM), with an output of 1,800 m per day, and comprises a team of 21 people including loading gang.

4.3 BRIDGE AND STRUCTURES

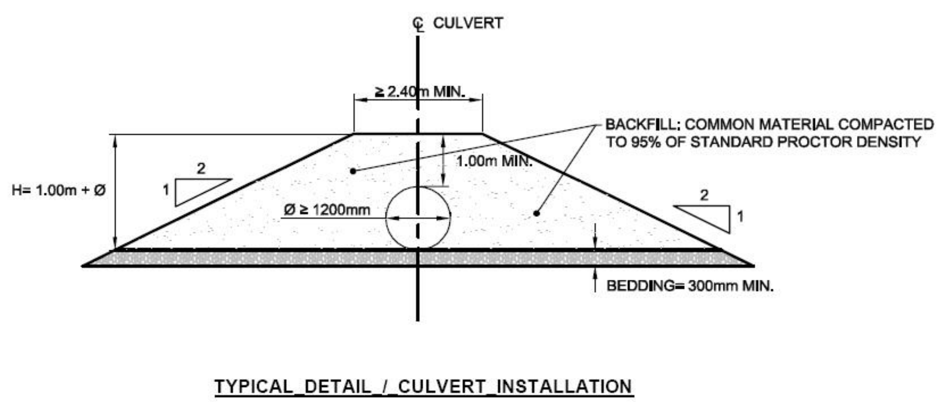
- It is assumed that the bridges are constructed of steel girder, which are delivered in segments and assembled locally.

- Workings and laydown areas are included within the overall linear rates for the bridges.
- Logistics costs (i.e. movement of materials around site) are included within the enabling works section.
- Culverts (ranging in diameter from 0.9 m to 3.6 m) have been derived from a desktop study of the topography and the hydrology.

Culvert Information:

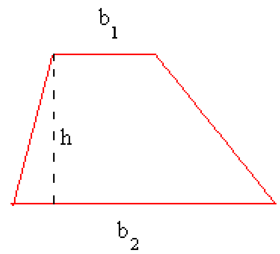
The total length of track alignment was estimated at about 2,412 km and it was assumed to have a culvert at every 0.75 km for diameters greater than 900 mm. By dividing 2,412 km by 0.75 km, it gives about 3,216 culverts. A similar calculation was done by dividing 2,412 km by 0.5 km and that gives around 4,824 culverts. The difference between 4,824 and 3,216 gives a total of 1,608 culverts which we assumed to be culverts of 900 mm of diameter & less. A 10% of contingency is added to the number of culverts which gives us a total of 5,306 culverts for diameters between 0.9 m to 3.6 m. The ratio of percentage of each culvert size was based on the ratio of culverts from previous projects. An assumption was made that all culverts will have the same length that is 35 m for any size of culvert. The total height (h) is the sum of bedding which in our case is 300 mm, the diameter of culvert and to that 1 m is added, which is the distance from top surface of diameter till the sub-grade (see Figure 1). The previous on some previous projects, we came up with a ratio of percentage for each culvert size. H is the diameter of culvert and to that 1 m is added, which is the distance from top surface of diameter till the sub-grade.

Figure A4-1: Typical Detail/Culvert Installation



4.3.1 Area and Volume of Trapezoidal

The area of trapezoidal was found using the following equation:



$$\text{Area} = \frac{(b_1 + b_2)}{2} \times h$$

Where b_2 was found using trigonometric ratios and b_1 is 2 times the value of the diameter. Once the area of trapezoidal was found, this value was then multiplied by the length of culverts (which we have assumed to be 35 m) for all sizes of diameter.

<u>Sample Calculation for culvert of 1.2Ø</u>

h= diameter + bedding +1= 0.2 + 0.3 + 1 =2.5 m
H= diameter + 1 m = 1.2 + 1= 2.2 m
b_1= 2*D = 2*1.2 = 2.4 m
b_2= (2*(2*2.2) + (2*1.2)) =11.2 m

A_{rea}= (b_1+ b_2)/2*h = (2.4+11.2)/2*2.5= 17 m^2
$V_{ol\ of\ trap.}$= Area *L= 17 m^2*35 m= 595 m^3

<u>Fill:</u>

The total quantity of fill was then multiplied by total number of culverts.
Fill for total culverts: 1,174 culverts*595 m^3= 698,539.94 m^3

<u>Excavation:</u>

For the excavation quantity, we used the following equation:

Excavation= Bedding*2*L*b_2, where bedding is 300 mm & Length of culvert is assumed to be 35 m and 2 is used since excavation needs to be done on both sides of the slope.

<u>Sample Calculation for culvert of 1.2Ø</u>
Excavation= Bedding*2*L*b_2
Excavation=0.3 m*2*35 m*11.2 m= 235.20 m^3

Total quantity of excavation was then found by multiplying the quantity of excavation by total number of culverts.

Total $_{excavation}$ = 235.20 m^3 * 1,174=276,128.73 m^3

Cost of Fill

Cost for different items was next calculated. Based on RSMeans 2011, the price for fill is $60/$m^3$. Total cost for filling was calculated using following equation:

Sample Calculation for culvert of 1.2∅
Cost of fill ($) = Total quantity of fill (m^3)* $60/$m^3$
Cost of fill ($) = 698,539.94 m^3 * $60/$m^3$ = $41,912,396.31

Cost of Excavation

Based on RSMeans 2011, Cost of excavation is $40/$m^3$, and it is calculated as follows;

Sample Calculation for culvert of 1.2∅
Cost of Excavation ($) = Total quantity of excavation (m^3)* $40/$m^3$
Cost of Excavation ($) =276,128.73 m^3 * $40/$m^3$ = $11,045,149.14

Rip Rap

Rip rap, erosion protection is an essential part of culvert design since it protects the slope from erosion. In this study, a riprap of 300 mm is used. Based on previous projects, we came up with an equation in order to calculate for the area of riprap;

A=2*D*11/4 D+D*5/4D = 27/4D^2
B=2*7/4D*5/4D= 35/8 D^2
C=2*D*D=2D^2
= ∑ 105/8 D^2 & we multiply the sum by 2, since there are 2 sides of the slope, where D is the diameter of the culvert

Sample Calculation for culvert of 1.2∅
Area $_{rip\ rap}$= ∑ 105/8 D^2 *2
Area $_{rip\ rap}$ = (105/8)*1.2^2 * 2=37.80 m^2

Once obtained the area of rip rap, this value is next multiplied by the bedding (450 mm) and by the total number of culverts of that particular diameter to get the volume of rip rap needed.

Volume $_{rip\ rap}$ =37.80 m^2 *0.45 m*1174= 19,970.02 m^3

From RSMeans 2011, we get a price for rip rap that is about $62.50/L.C.Y (length cubic yard). A 6% inflation is added to this price and the price is now $66.25/L.C.Y. With a ratio of conversion from cubic yard to cubic meter (1 yd^3= 0.76455485799241 m^3).

Sample Calculation for culvert of 1.2∅

Cost of rip rap ($) =Volume of rip rap ($m^3$) * $66.25*(1/L.C.Y) * 1/0.76455 * (1L.C.Y/m^3)

Cost of rip rap ($) =17.01 m^3 * ($66.25/0.76455) =$1,473.95

CSP:

For the CSP (Corrugated Steel Pipe), the basis of estimate was taken from AIL TTOG from February 1999. Since the prices are of year 1999, $632.76/m is an adjusted price for year 2011 for diameters that have a cover range between (5.5 m<cover ≤ 9.5 m), but this price needs to be inflated by 6% (3 % for year 2012 & 3% for year 2013) and it gives us $670.73/m for year 2013. When the price for some diameters that were not available, therefore the next price for higher diameter was chosen for that particular diameter. In order to calculate for total price of CSP, the following equation was used;

Sample Calculation for culvert of 1.2∅

CSP ($) = Price (inflated by 6%) *L*# of culverts, where L is the length of culvert being 35 m.

CSP ($) = $670.73/m *35 m*1174 = $27,560,507.02

Installation

The crew and equipment prices taken for the assembly of the culvert was taken from the AIL Installation Guide for Bolt-A-Plate Structural Culverts, with pricing taken from the RSMeans 2011, with the number of days equalling (L/5).

For the installation of culverts, the price for RSMeans 2011 is $4,402.8/day, where a 15% contingency is added to this price which makes it $5,063.22/day. This price includes; 1 foreman, 1 crane operator, 1 small crane, 1 forklift, 1 walk behind rollers and a single-drum vibratory roller per day. For culverts that are between 0.9 m up to 1.8 m, a ratio of 35 days/5 days is used, while for culverts between 2.1 m up to 3.6 m, a ratio of 35 days/3 days is applied, since bigger culverts need more time to be installed compared to smaller culverts. The total installation is calculated by following equation:

Sample Calculation for culvert of 1.2∅

Installation = Price per day*# of days* # of culverts.

Installation =$5,063.22/day * 35 days/5 days*1,174= $41,610,133.97

Finally each row was summed up to give total cost ($) and the grand total was the sum of cost of rip rap, fill, excavation, CSP and installation.

Total Price

Grand Total ($) = Cost of rip rap + Cost of fill + Cost of excavation + Cost of CSP + Cost of installation.

Grand Total ($) = $15,105,870.80+ $273,253,802.73 + $ 57,934,132.28 + $177,790,653.07 + $203,687,579.32

Grand Total ($) =$727,772,035.21

4.3.2 Culvert Pricing

Table A4-1 – Reference Pricing for Culverts

Diameter	**1.2 m**	**1.8 m**	**2.4 m**	**3.0 m**	**3.6 m**
1999 PRICING	$278.75/m	$419.70/m	$556.80/m	$783.25/m	$931.00/m
ADJ. PRICE (cover ≤ 5.5 m)	$459.94/m	$692.51/m	$918.72/m	$1292.36/m	$1536.15/m
ADJ. PRICE (5.5 m<cover ≤ 9.5 m)	$632.76/m	$952.72/m	$1263.94/m	$1777.98/m	$2113.37/m
ADJ. PRICE (YEAR 2013) (5.5 m<cover ≤ 9.5 m)	$670.73/m	$1009.88/M	$1339.78/m	$1884.66/m	$2240.17
ADJ. PRICE (cover > 9.5 m)	$710.81/m	$1070.24/m	$1419.84/m	$1997.29/m	$2374.05/m

For the CSP (Corrugated Steel Pipe), the basis of estimate was taken from AIL TTOG from February 1999. These values were used to calculate the cost of materials (CAD) depending on the cover for each culvert.

Table A4-2 – Culvert Installation Prices

Crew	**Pricing from RSMeans 2011 ($/day)**
1 Foreman	$290.80
1 Crane Operator	$372.00
5 Labourers	$1,374.00
1 small crane	$1,525.00
1 forklift	$450.00
Walk-behind Rollers	$143.00
Single-drum Vibratory Roller	$248.00
TOTAL :	$4,402.80
Adjusted price for Year 2013	**$5,063.22/day**

The crew and equipment prices taken for the assembly of the culvert was taken from the AIL Installation Guide for Bolt-A-Plate Structural Culverts, with pricing taken from the RSMeans 2011, with the number of days equalling (L/5). All prices are in CAD

Table A4-3 – Excavation & Backfill Prices

Task	**Pricing**
Excavation	$40/m^3
Backfill	$60/m^3

All prices are in CAD and taken from RSMeans 2011.

4.4 TUNNELS

- There are two tunnels identified and their combined length is 10 km.
- Drill and blast technique is assumed.
- Ventilation has been allowed.

4.5 SIGNALS AND COMMUNICATIONS

The estimate for signalling options is based on the following:

- Signalling to sidings
- Signalling at intermediate and repeater positions
- Hot bearing detection
- Wheel impact load detection
- Communications associated with the detection
- Fibre cable
- Computer controls
- Power generators at siding locations

No other signalling equipment has been allowed or included.

Communications system is based on data radio.

4.6 FACILITIES

- Yard, workshop, maintenance, accommodation and facilities have been allowed within the estimate.
- It is assumed that the office space required is 25 m2 per person and that 120 people are accommodated within the administration building.
- Allowances for power and utilities to the maintenance and administration buildings are included within the gross floor area rates for each building.

4.7 ENABLING WORKS & PRELIMINARIES

- The total access road length is assumed to be 146 km serving the construction camps along the alignment; for this estimate we assume 10.25 m wide (average of 9.5 m and 11 m top and bottom of road construction), with a layer of subbase material of 250 mm deep and 100 mm of crushed material for the running surface; further, it is assumed that the earthworks on average is 2 m cut and 2 m of embankment for 50/50 of the route and that cut and fill (including crushed road construction material) volumes balance.
- It is assumed that there are 24 major construction camps capable of housing 200 men. One camp every 100 km.
- Site set up is included within the construction activity rates and prices
- Insurances are assumed to be within owner's costs.