CAPITAL PROJECT JUSTIFICATION ADDENDUM
FOR

BIPOLE III WESTERN ROUTE 500kV HVdc
TRANSMISSION LINE & 2000MW CONVERTERS
Addendum Number 06

REVIEWED BY:
(Owning Dept Mgr - Transmission)

(Owning Dept Mgr – Power Supply)

NOTED BY:
(if applicable)

Coordinating Div:

Constructing Div:

Financial:

PREV. APPROVED BUDGET $: (Use $ value from approved CPJ or last approved CPJ Addendum)	$2,247,835,000
REVISED BUDGET $: (Total Net Cost)	$3,953,749,000
START DATE: (1st Cost Flow)	2001 06
PREV. APPROVED ISD: (Use In-service Date from approved CPJ or last approved CPJ Addendum)	2017 10
REVISED ISD: (Indicate "Mult" if more than 1)	2017 10
RISK MATRIX/ BUSINESS CASE TIER:	Tier 2 (950 pts)
INVESTMENT REASON: (Category and % Split)	Operational Enhancement (60%) New/increased Gen. Delivery (20%) Capacity Enhancement (20%)

RECOMMENDED FOR IMPLEMENTATION:

Owning Div. Mgr – Transmission:

Owning Div. Mgr – Power Supply:

Vice-President – Transmission:

Vice President – Power Supply:

OWNING DIVISIONs:	Transmission Planning & Design New Generation Construction
I.M. NODE NUMBER:	1.5.2.1
W.B.S. NUMBERs:	P:04218, P:04221, P:10155, P:14363 P:14364, P:14518, P:15533 - P:15537, P:15540 – P15544, P:15696, P:15697
MAJOR ITEM ☒	**DOMESTIC ITEM** ☐
PREPARED BY:	K.L. Kent (Complex Owner) A.A. Poulin (Complex Manager) H.S. Jhinger (Proj. Mgr, Converters)
DATE PREPARED:	2009 08 18
REPORT NUMBER:	

ADDENDUM NUMBER	DATE (yyyy mm dd)	REVISION	REVISED BY	APPROVED BY
05	2007 05 15	Revised western route placeholder. Increase costs due to Construction and material cost increases.	A.A. Poulin / J.B. Davies / K.L. Kent	MH Board of Directors (Minute #786-07-05)
04	2005 06 23	Western route placeholder. Defer the in-service date by five years from 2012 10 to 2017 10.	J.B. Davies / K.L. Kent	Executive Committee (Minute #1090.06)
03	2004 04 06	Defer the in-service date by two years from 2010 10 to 2012 10.	J.B. Davies / K.L. Kent	Executive Committee (Minute #1030.05)
02	2003 11 12	Defer $2,462,000 worth of budget requirements from 2003/04 to future years.	C.A. Nieuwenburg	Executive Committee (Minute #999.05)
01	2003 05 08	Change northern termination from Radisson to Henday, increasing length by 20 km and costs by $8,245K.	J.B. Davies / K.L. Kent	Executive Committee (Minute #993.03)
-	2001 06 13	Original CPJ	J.B. Davies / K.L. Kent	Executive Committee (Minute #900.11)

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CAPITAL PROJECT JUSTIFICATION ADDENDUM

Project Name (This section is required for all Addendums).

Bipole III Western Route 500kV HVdc Transmission Line & 2000MW Converters

Recommendation (This section is required for all Addendums).

Increase the budget for the Bipole III complex by $1706 million to a revised total of $3954 million, in order to incorporate the following:

- review of estimates for all components of the complex (total increase of $739 million to the base estimate, 2009$),
- inclusion of contingency for all components of the complex (total increase of $525 million to the base estimate, 2009$), and
- the resultant changes to interest and escalation (increase of $442 million).

Project Scope (This section is be filled out only if there is a change to the scope).

No change to the high-level concept at this time. Potential future changes to scope (cost and schedule) that may be forthcoming in a subsequent CPJ Addendum (i.e., are not part of this submission) are as follows:

- Changes to the existing transmission network or at existing generation facilities that may be necessary as a result of the Bipole III transmission line and converters being added to the system.
- Changes that may be necessary for an HVdc transmission line and converters rated at 2500MW.
- Application of Transmission Development Fund (TDF) and/or Adverse Effects policies that may be recommended for the Bipole III complex.

Background (This section is be filled out only if there is information relevant to the recommendation).

CPJ Addendum #04, submitted in April 2005, was the first introduction to the Capital Expenditure Forecast of a western-routed 500kV HVdc transmission line with 2000MW of converters. The budget submitted with CPJ Addendum #04 was a placeholder only, pending completion of studies by System Planning, and was based on a 2001 estimate prepared by Teshmont Consultants.

CPJ Addendum #05, submitted in May 2007, addressed an increase of 45km to the length of the transmission line, as well as increases being experienced in transmission line material and construction costs due to market prices. The cost of licensing, property and converters were not updated at that time, nor was contingency identified in that estimate.

This CPJ Addendum #06 covers re-estimates that have been prepared since either the 2001 Teshmont report or the May 2007 CPJ Addendum, for all components of the Bipole III complex. These re-estimates result in an increase of $739 million to the base estimate, detailed as follows (all amounts are in 2009$).

TRANSMISSION-RELATED ITEMS (total increase of $142 million to base estimate):

a) <u>500kV dc Transmission Line</u>
The base estimate for the transmission line has increased by $72 million due to a design change from double to triple conductor, in order to lower the surface field gradient to accepted worldwide practices and thus minimize flashovers, and by $25 million due to the application of the Transmission Line Agreement (TLA), or unionization of labour.

Background (This section is be filled out only if there is information relevant to the recommendation).

b) Northern 230kV Collector Lines
Reflects increases since 2001 to both construction material and labour costs ($23 million). Also reflects an increase of 39km to the overall length of transmission line construction required ($9 million). In addition, the line from Limestone to Conawapa, previously assumed to be established with the construction power for the Conawapa G.S, is now required first for construction power of the Northern Converter Station ($9 million).

c) Licensing & Environmental Assessment
Costs have increased by $2 million due to more comprehensive aboriginal and community consultations.

d) Sectionalize 230kV Transmission Line R49R at Riel
This is a new item, estimated at $2 million. R49R sectionalization is required to accommodate and reliably transmit a 2000MW Bipole III at Riel. This had been recommenced with the Riel Sectionalization project but was deferred to coincide with Bipole III converters.

In addition to the above, the risk assessment yielded a contingency estimate of $143 million (see the Risk Analysis section for details). These changes, along with an increase of $57 million for interest and escalation, make the total net increase equal to $343 million and the revised total net cost equal to $1477 million, for the transmission-related portion of the complex.

CONVERTER-RELATED ITEMS (total increase of $596 million to base estimate):

e) Riel Converter Station
Converter and HVdc equipment costs remain relatively unchanged; however, the costs for synchronous condensers have more than doubled. Studies have also recommended the addition of a fourth synchronous condenser for the 2000MW Bipole ($193 million combined increase). Other increases to the base estimate include: higher construction management, project management and engineering costs, which were not fully considered in the 2001 placeholder ($49 million); and increase in site size, development and infrastructure costs driven by safety and maintenance requirements, as well as additional facilities for fast drain and oil spill containment systems ($29 million).

f) Northern Converter Station at Conawapa
Converter and HVdc equipment costs remain relatively unchanged. Changes to the base cost are as a result of: inclusion of the construction camp previously assumed to be built and covered by the Conawapa G.S. Project ($38 million); higher construction management, project management and engineering costs not fully considered in the 2001 placeholder ($61 million), and site size increase of 2.2 times that assumed in 2001 and the associated increase in site development and infrastructure costs driven by safety and maintenance requirements, as well as additional facilities for fast drain and oil spill containment systems ($54 million).

g) Riel Site Development for Converters & 230kV Switchyard
Part of the switchyard will be established under a separate project, Riel Sectionalization; however, the concept was developed to more easily accommodate the future HVdc requirements (5 bays and 12 breakers vs. just 3 bays and 9 breakers) and reconfiguration to accommodate a transfer bus scheme, therefore 50% of the equipment costs are included in this estimate ($33 million). An expansion of the 230kV switchyard is required with Bipole III to output the 2000MW, establishing 4 new bays and 11 breakers, and required terminations for HVdc equipment are included in the base estimate ($51

Background (This section is be filled out only if there is information relevant to the recommendation).

million). Half of the site development costs at Riel are included here as attributable to the Converter Station and 230 Switchyard, whereas the 2001 report did not have any site development costs (assumed it would be developed at Riel prior to Bipole III). Like the northern converter station, the site size at Riel has increased (approx. 2.6 times) due to maintenance and security requirements, changes to oil spill containment systems, and planning the layout to accommodate for future additions to the station (i.e. paralleling line and additional 500kV and 230kV AC lines). The associated site development and infrastructure costs have increased ($28 million).

h) Northern 230kV Switchyard
Estimate has increased by $25 million to accommodate the following scope changes: two temporary additional AC lines required to transmit a 2000MW Bipole in the interval when Bipole III is in service before Conawapa G.S. (due to the change in generation sequence), and three lines for future Gilliam Island addition, for a total of 8 bays and 32 breakers.

i) Property for the Riel Converter Station
Not previously included in the estimate. Includes $6 million worth of station site properties and $12 million worth of buffer properties, all purchased from private owners.

j) Construction Power Station for Northern Converter
This item was not previously included, as it had been assumed to be part of the construction of the Conawapa Generation Station. Due to a change in sequencing this complex will be the first to require construction power, and hence the estimated cost of $15 million is now part of this complex.

k) Electrode Lines and Stations
Other components not previously included that have now been estimated are for the electrode lines and stations for both the Northern and the Riel Converter Stations, for a total of $2 million.

In addition to the above, the risk assessment yielded a contingency estimate of $382 million (see the Risk Analysis section for details). These changes, along with an increase of $384 million for interest and escalation, make the total net increase equal to $1363 million and the revised total net cost equal to $2477 million, for the converter-related portion of the complex.

JUSTIFICATION—BUSINESS CASE ANALYSIS (SUMMARY):

Justification and Link to Corporate/Business Unit Goals (This section is be filled out only if there is a change to some aspect of the recommended alternative).

On July 4th, 2001 a System Planning report entitled "Minimum Transmission Requirements for HVDC Bulk System Reliability" (SPD 01/7) was issued and subsequently approved. A major recommendation of that report was for a Bipole III transmission line routed east of Lake Winnipeg. Converter capacity to be connected to the line would be considered in subsequent studies.

At the request of the MHEB, System Planning examined reliability alternatives to an eastern routed Bipole III line. The report entitled "Manitoba HVDC Reliability Alternatives" (SPD 2006/11) was issued on October 4th, 2006, and concluded that Bipole III routed west of Lakes Winnipegosis and Manitoba with 2000 MW of converter capacity was the leading reliability alternative to an eastern routed line.

JUSTIFICATION—BUSINESS CASE ANALYSIS (SUMMARY):

Justification and Link to Corporate/Business Unit Goals (This section is be filled out only if there is a change to some aspect of the recommended alternative).

Based on the conclusions of this report, a recommendation was made by the Executive to the MHEB to proceed with Bipole III, routed west of Lakes Winnipegosis and Manitoba, and with 2000 MW of converter capacity.

Capital Investment Categorization:

Driver	Category	Sub-category	Split	Amount
Reliability-Outage Related	Operational Enhancement	New Asset Addition	60%	$2,372,250,000
Reliability-Load Related	Capacity Enhancement (for domestic load)	New Asset Addition	20%	$ 790,750,000
Reliability-Load Related	New/increased Generation Delivery (for domestic load)	New Asset Addition	20%	$ 790,750,000
				$3,953,750,000

ANALYSIS OF ALTERNATIVES: (This section is be filled out only if there is a change to which alternative is being recommended).

Economic Analysis

Discount Rate	%	For current corporate rates see G911 For clarification on hurdle rates, contact Economic Analysis Department

Recommended Option	**NPV (= PV of BENEFITS - PV of COSTS)**
No change.	

Other Alternatives Considered	**NPV (= PV of BENEFITS - PV of COSTS)**
No change.	

Risk Analysis - (This section is be filled out only if there is a change to the project risk).

Contingency (total of $525 million in base 2009$):

The contingency estimate is based on risk assessments that were conducted to identify areas of uncertainty or potential fluctuation, and is detailed as follows:

TRANSMISSION-RELATED ITEMS (total contingency of $143 million or 15% of the base costs):

a) 500kV dc Transmission Line (total contingency = $116 million or 15% of the base costs)
- A potential change to the detailed route selection or line length of up to 10%, as the final route has not yet been determined ($87 million).
- Related to lack of geotechnical information, uncertainty with soil conditions calls for the purchase of extra foundation types to allow for flexibility during the tight construction window ($15 million).
- Potential premiums in association with maximizing aboriginal content ($10 million).
- Higher compensation to property owners for damages during construction, based on National Energy Board (NEB) compensation settlements recently experienced in Alberta ($4 million).

Risk Analysis - (This section is be filled out only if there is a change to the project risk).

b) Licensing & Environmental Assessment (total contingency = $13 million or 21% of the base costs)
- Greatest risk for licensing is in the costs for aboriginal and community consultations ($9 million).
- Potential for even more extensive environmental monitoring and assessments, based on our experiences with the Wuskwatim project ($4 million).

c) Northern 230kV Collector Lines (total contingency = $10 million or 12 % of the base costs)
Design uncertainty and exact location of the northern converter station could increase the total line lengths assumed.

d) Property for 500kV dc Transmission Line (total contingency = $4 million or 18% of the base costs)
Potential increases in land values, by as much as 50%, based on the NEB compensation settlements recently experienced in Alberta. Note however that this risk estimate does not include any costs for expropriation of land and the associated legal expenses.

CONVERTER-RELATED ITEMS (total contingency of $382 million or 26% of the base costs):

e) Riel Converter Station (total contingency = $200 million or 39% of the base costs)
Based on a Range Estimating session, recommend contingency for equipment costs due to limited number of suppliers worldwide and variability on exchange rates ($100 million for converters and $100 million for synchronous condensers).

f) Northern Converter Station (total contingency = $135 million or 18% of the base costs)
Based on a Range Estimating session, recommend contingency for equipment costs due to limited number of suppliers worldwide and variability on exchange rates ($100 million for converters); and potential for higher costs associated with northern work ($35 million).

g) Riel Site Development for Converters & AC Switchyard (total contingency = $25 million or 19% of the base costs)
Final Design for Phase A of the Riel Switchyard won't be available from the engineer and procure contract until January 2010, while final design for Phase B is three to six years away. There is also uncertainty with line protection, cyber security, and building strength. Re-work is anticipated for site preparation, as construction will be started ahead of final design to protect against the risk of a wet summer delaying the construction progress.

h) Northern 230kV AC Switchyard (total contingency = $15 million or 31% of the base costs)
Based on a Range Estimating session, recommend contingency for potentially higher costs associated with northern work.

i) Construction Power Station for Northern Converter Station (total contingency = $4 million or 27% of the base costs)
Design and construction estimate are based on a conceptual Single Line Diagram (SLD) only; the site size and exact location of the Converter Station is not yet confirmed.

j) Northern and Riel Electrode Lines (total contingency = $3 million or 36% of the base costs)
The length of the lines is not certain, as Electrode sites have not yet been determined. Also provides for the use of steel towers if necessary (base estimate assumes wood).

Risk Analysis - (This section is be filled out only if there is a change to the project risk).

Management Reserve (total of $334 million in base 2009$):

Also identified during the risk assessment but not included in the contingency estimate at this time, are the management reserve items listed below. Though each of the components covered by this list has a contingency amount included within the project estimate, there is potential for further increases above those contingency amounts, for the following factors:

- Premium if basing the converters estimate on pricing received from the most experienced supplier ($102 million, high probability).
- Uncertainty on the northern interconnecting station modifications at Henday Converter Station and Long Spruce Generating Station, as the scope is not well defined at this time ($20 million, high probability).
- Allowance for greater requirement for engineering, project management and construction management on the Northern Converter Station and the Riel Converter Station projects ($14 million, high probability).
- Allowance for poor soil conditions during construction of the Northern Converter Station ($12 million, high probability)
- Market conditions for transmission line construction labour may increase costs by as much as 20% ($70 million, low probability).
- Market conditions for transmission-related materials or commodities (e.g., towers, hardware, conductor, insulators, foundations, communications equipment) may increase by 10-25% ($61 million, low probability).
- Increase to design, supply and install (construction) costs for the Northern 230kV AC Switchyard if a gas-insulated station (GIS) is chosen instead of an air-insulated station (AIS), due to unknown soil conditions ($55 million, low probability).

Some of the schedule-related risks associated with meeting an October 2017 in-service are as follows:

- The detailed route selection must be finalized by December 2010.
- An Environmental Licence must be received by September 2012.
- Certain activities will need to proceed in parallel with the environmental licensing process:
  - acquiring permits to work on crown lands,
  - purchase of some materials and/or purchase of extra towers and foundations types to accommodate unexpected conditions due to lack of geotechnical information,
  - temporary permits for site investigation activities (including field drilling) in order for design of foundations to be finalized and materials ordered for the construction start date.
- Completion of the northern portion of the Western route is based on having five winter seasons for access and construction. The southern portion of the Western route can be built year-round, however it is subject to more property and land access issues.

RESOURCE REQUIREMENTS AND CAPITAL BUDGET ESTIMATE:

Resource Requirements (This section is be filled out only if there is a change to the resource requirements).

No change.

Total Budget - (This section is required for all Addendums).

The impact on annual budget requirements is as follows (in thousands of dollars):

Fiscal Year	Previous CPJ / CPJ Addendum	This CPJ Addendum	Increase (Decrease)
Prev. Actuals	$ 7,613	$ 7,613	$ -
2007/08	$ 1,875	$ 1,955	$ 80
2008/09	$ 2,901	$ 17,878	$ 14,977
2009/10	$ 9,298	$ 33,037	$ 23,739
2010/11	$ 12,994	$ 80,542	$ 67,548
2011/12	$ 25,115	$ 110,970	$ 85,855
2012/13	$ 172,475	$ 271,913	$ 99,438
2013/14	$ 331,532	$ 671,609	$ 340,077
2014/15	$ 420,146	$ 691,071	$ 270,926
2015/16	$ 579,614	$ 823,189	$ 243,576
2016/17	$ 535,141	$ 866,711	$ 331,570
2017/18	$ 145,948	$ 375,335	$ 229,387
2018/19	$ 3,184	$ 1,926	$ (1,258)
Total	$ 2,247,835	$ 3,953,749	$ 1,705,914

Proposed Schedule (This section is be filled out only if there is a change to the project schedule).

No change.

Related Projects (This section is be filled out only if changed).

No change.

Reference Documents (This section is be filled out only if changed).

No change.