Nalcor Energy – Lower Churchill Project

Decision Gate 3 Basis of Estimate

LCP-PT-ED-0000-EP-ES-0001-01

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	Name	
	Name	
	Name	
	Name	

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1.0 Purpose

This *Decision Gate 3 Basis of Estimate* presents the philosophies and approaches used for development of the DG3 Capital Cost Estimate (CCE) for the Project used to support the Decision Gate 3 recommendation for Nalcor Energy's Lower Churchill Project (hereafter referenced to as LCP or the Project).

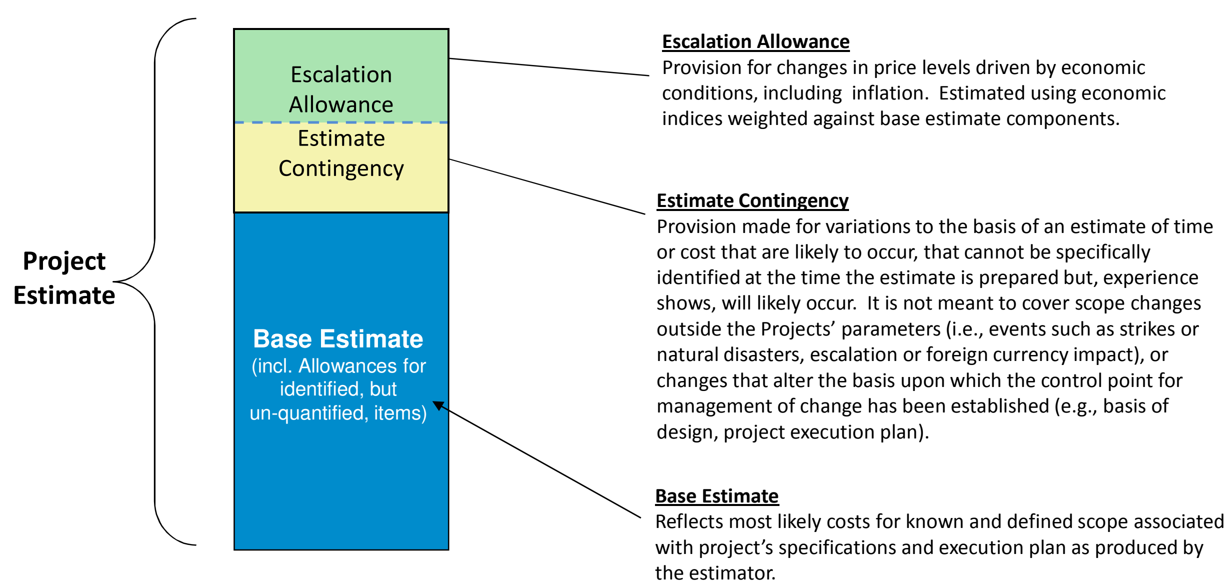
This *Decision Gate 3 Basis of Estimate* also provides the critical context and clarity as to the scope of the estimate and the approach used to develop the estimate, as well as providing critical information that an experienced cost engineer can use to assess the quality and completeness of the estimate. The document is also intended to provide Project team members clarity as to how the estimate was developed, what are the estimate's limitations, main assumptions, exclusions, etc.

The *Decision Gate 3 Basis of Estimate* provides a key basis to assist with management of change and as such, it will become one the Project's Key Controlled Document.

2.0 Scope

The Capital Cost Estimate is comprised of three (3) components as illustrated in Figure 2-1.

Figure 2-1: Capital Cost Estimate Components



This *Decision Gate 3 Basis of Estimate* presents how the Base Estimate portion of the Capital Cost Estimate was determined. These costs represent the sum of labor, permanent and consumable materials, equipment, and sub-contractor costs to be incurred by contractors in order to build the physical components of the Projects, referred to as Project Direct Costs. Also covered are the costs to be incurred by the Owner and Contractors for the support of the construction activities (access roads, camp facilities and air travel, construction offices and supervision, etc.) referred to as Project and Construction Indirect Costs.

This Basis of Estimate excludes Escalation Allowance and Estimate Contingency, the basis of which are contained in documents Decision Gate 3 Capital Cost Escalation Report, reference no. LCP-PT-ED-0000-EP-RP-0003-01, and results of the Estimate Uncertainty review undertaken by Westney. Combined these substantiate the basis of the overall DG3 capital cost estimate as used in the DG3 Cumulative Present Worth (CPW) analysis for the following sub-projects of the LCP:

- Muskrat Falls Generation (MFG)
- Labrador Transmission Assets (LTA)
- Labrador – Island Transmission Link (LITL)

This report excludes the basis for the operating cost estimate prepared for DG3. Reference Decision Gate 3 Operating Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0003-01 for details.

The report Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01, presents the overall Project Cost Estimate, including of Estimate Contingency and Escalation Allowance.

Note: This report explicitly excludes the Maritime Link sub-project.

3.0 Definitions

LCP-PT-MD-0000-PM-LS-0001-01 Project Dictionary, Acronyms & Abbreviations List is the approved dictionary of definitions for the Project.

Allowance	Costs added to the base estimate, based on experience, to cover foreseen but not fully defined elements.
Analogous Estimate	An estimate based on previous similar projects.
Base Estimate	Reflects most likely costs for known and defined scope associated with project's specifications and execution plan.
Baseline	The project scope, in terms of quantity, quality, timing, hours, costs, etc that establishes a formal reference for comparison and verification of

	subsequent efforts, progress, analysis and control.
Decision Gates	A Decision Gate is a predefined moment in time where the Gatekeeper has to make appropriate decisions whether to move to the next stage, make a temporary hold or to terminate the project. The option to recycle to the current stage is considered an undesirable option unless caused by changes in business conditions.
Escalation	Provision for changes in price levels driven by economic conditions. Includes inflation.
Estimate Contingency	Provision made for variations to the basis of an estimate of time or cost that are likely to occur, that cannot be specifically identified at the time the estimate is prepared but, experience shows, will likely occur. **Note**: Estimate Contingency does not cover scope changes outside the Project's parameters, events such as strikes or natural disasters, escalation or foreign currency impact, or changes that alter the basis upon which the control point for management of change has been established as captured in key project documents (e.g. basis of design, project execution plan).
Physical Component	A breakdown of major physical components identified/associated with the LCP.
Project Exchange Rates	A fixed set of foreign exchange rates used in the CCE for conversion of all foreign currencies to Canadian equivalent for the purposes of establishing the CCE.
Project Scope	A concise and accurate description of the end products or deliverables to be expected from the project and that meet specified requirements as agreed between the Project Stakeholders. It represents the combination of all project goals and tasks, and the resources and activities required to accomplish them.
Risk	An uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives.
Shareholder	For Nalcor Energy, the Shareholder is the Province of Newfoundland and Labrador.
Work Breakdown Structure	The decomposition of the project scope into more manageable packages of work or deliverables. Each WBS element will have an approved budget that will be defined in the Project Budget.

4.0 Abbreviations and Acronyms

AACEI	Association for Advancement of Cost Engineering International
ac	Alternating Current
BOQ	Bill of Quantities
CAPEX	Capital Expenditure
CCE	Capital Cost Estimate
CF	Churchill Falls
dc	Direct Current
DG3	Decision Gate 3
EA	Environmental Assessment
ECC	Energy Control Centre
EPC	Engineer, Procure & Construct
EPCM	Engineering, Procurement, and Construction Management
ES	Estimating Software (HCSS Heavy Bid estimating software)
FOREX	Foreign Exchange
HADD	Harmful Alteration, Disruption or Destruction
HSE	Health, Safety and Environment
HVac	High Voltage alternating current
HVdc	High Voltage direct current
IBA	Impacts and Benefits Agreement
IPE	International Project Estimating
kV	kilovolt
MFG	Muskrat Falls Generation
MHI	Manitoba Hydro International
ML	Maritime Link
MTO	Material Take Off
MW	Megawatt
NE	Nalcor Energy
LCP	Lower Churchill Project
LITL	Labrador-Island Transmission Link
LTA	Labrador Transmission Assets
OPEX	Operating Expenditure
OPGW	Optical Ground Wire
PMT	Project Management Team
RCC	Roller-Compacted Concrete
ROW	Right Of Way
SLI	SNC-Lavalin Inc.
SOBI	Strait of Belle Isle
SP	Soldier's Pond
Te	Metric Tonne (1000 kilograms)
WBS	Work Breakdown Structure

5.0 Reference Documents

LCP-PT-ED-0000-EN-RP-0001-01	Basis of Design
LCP-PT-MD-0000-PC-LS-0001-01	Project Work Breakdown Structure and Code of Accounts
LCP-PT-MD-0000-PC-BD-0001-01	Lower Churchill Project – Asset Schematic by Project
LCP-PT-MD-0000-PM-ST-0002-01	Overarching Contracting Strategy
LCP-SN-CD-0000-PM-LS-0001-01	LCP Master Package Dictionary
LCP-PT-MD-0000-FI-PR-0004-01	Cost Allocation Principles
LCP-PT-MD-0000-PC-PL-0001-01	Project Controls Management Plan
LCP-PT-ED-0000-EP-RP-0003-01	Decision Gate 3 Capital Cost Escalation Report
LCP-PT-ED-0000-EP-ES-0002-01	Decision Gate 3 Capital Cost Estimate
LCP-PT-MD-0000-PM-RP-0001-013	Trade Labour Rates for use in Preparation of Capital Cost Estimates
LCP-PT-MD-0000-PM-PL-0002-01	Project Change Management Plan
LCP-PT-ED-0000-EP-ES-0003-01	Decision Gate 3 Operating Cost Estimate

AACE International Recommended Practices
RP 34R-05 Basis of Estimate
RP 31R-03 Reviewing, Validating and Documenting the Estimate
RP 42R-08 Risk Analysis and Contingency Determination Using Parametric Estimating

6.0 Responsibilities

Not Applicable

7.0 Format of this Document

This *Decision Gate 3 Basis of Estimate* is divided into the following sub-sections:

- **Part A – General Estimating Approach**
  Presents common information applicable to the entire estimate, including overall approach used to prepare the cost estimate.

- **Part B – Owner's Project Management and Other Costs**
  Presents the basis of the estimate for Owner's PM Cost, including a number of specific items such as Nalcor's contribution to the Labrador Fibre Project.

- **Part C – EPCM Services**
  Presents the basis of the estimate for provisions of engineering, procurement and construction management support to the Owner through the EPCM Consultant

- **Part D – Muskrat Falls Generation (SLI Component 1)**
  Presents the basis of the estimate for those items that required for construction of the Muskrat Falls Generation Station under the management of Component 1 of the EPCM Consultant.

- **Part E – HVdc Specialties and Switchyards (SLI Component 3)**
  Presents the basis of the estimate for those items that required for construction of all switchyards, converter stations, new synchronous condenser facility at Soldier's Pond, project construction and operations telecommunications, electrodes, transition compounds for the Project under the management of Component 3 of the EPCM Consultant.

- **Part F – Overland Transmission (SLI Component 4)**
  Presents the basis of the estimate for those items that required for construction of all transmission lines, including the 350kV HVdc LITL, 315kV HVac LTA, MF construction power, and various grid interties for the Project under the management of Component 4 of the EPCM Consultant.

- **Part G – SOBI Crossing**
  Presents the basis of the estimate for the SOBI Crossing as prepared by Nalcor.

- **Part H – System Upgrades – Island Interconnected Transmission System**
  Presents the basis of the estimate for island system upgrades with the interconnection, including Holyrood Units 1 & 2 Conversion to Synchronous Condenser Support and various breaker replacements at existing terminal stations.

It should be noted that Parts D, E and F extensively leverage the various draft estimate reports prepared by the SLI team during Gateway Phase 3. The lead author has attempted to maintain this content as intact as possible, however taken the liberty to re-organize and clarity the material to ensure a level of consistency throughout.

8.0 Project Scope Description

The Churchill River is located in Labrador in the Province of Newfoundland and Labrador, Canada. The existing 5,428 megawatt (MW) Churchill Falls Generating Station, which began producing power in 1971, harnesses about 65% of the potential generating capacity of the river. The remaining 35% is planned to be developed via two sites on the lower Churchill River, known as the Lower Churchill Project (LCP).

The LCP consists of two undeveloped hydroelectric sites and associated transmission systems: Gull Island Hydroelectric Development, located 225 km downstream from the existing Churchill Falls Generating Station; and Muskrat Falls Hydroelectric Development, located 60 km downstream from the proposed Gull Island Hydroelectric Development.

This Basis of Estimate is relevant for the Muskrat Falls Hydroelectric Development, which consists of a generating station of 824 MW capacity and associated transmission systems.

The Project's scope is defined in the Basis of Design, document no. LCP-PT-ED-0000-EN-RP-0001-01 Rev. B2, while a summary is presented below.

Phase I of the LCP is comprised of four sub-projects:

- Muskrat Falls Generation (MFG)
- Labrador Transmission Assets (LTA)
- Labrador – Island Transmission Link (LITL)
- Maritime Link (ML)

This report presents the Basis of Estimate for the CCE for all but the Maritime Link.

8.1 Muskrat Falls Generation

Muskrat Falls Generation includes the following sub-components which are broken down under the five principal areas of the development.

- 22 km of access roads, including upgrading and new construction, and temporary bridges;
- A 1,500 person accommodations complex (for the construction period);
- A north Roller Compacted Concrete (RCC) overflow dam;
- A south rock fill dam;
- River diversion during construction via the spillway;
- Five vertical gate spillway;
- Reservoir preparation and reservoir clearing;
- Replacement fish and of terrestrial habitat;
- North spur stabilization works;

- A close coupled intake and powerhouse, including:
  - 4 intakes with gates and trash racks
  - 4 turbine/generator units at approximately 206 MW each with associated ancillary electrical/mechanical and protection/control equipment
  - 5 power transformers (includes 1 spare), located on the draft tube deck of the powerhouse
  - 2 Overhead cranes each rated at 450 Tonnes

8.2 Labrador Island Transmission Link (LITL)

The LITL consists of the overland high voltage direct current (HVdc) Transmission system and associated HVdc converter station systems, the Strait of Belle Isle (SOBI) Crossing and a new synchronous condenser facility. Specifically it includes:

- AC Switchyard at Soldier's Pond on the Avalon Peninsula;
- Muskrat Falls HVdc converter stations: HVdc bipolar converter station; 315 kV ac, converted to ±320 kV dc; Pole capacity of 450 MW;
- Shoreline pond electrode located on the Labrador side of the Strait of Belle Isle. The Anse-au-Diable shoreline pond electrode will be connected to the converter station at Muskrat Falls with dual overhead conductors supported on a wood pole line from the pond electrode site to the HVdc transmission line Right of Way and from there on will be supported on the HVdc Line structures.
- Soldier's Pond HVdc converter station: HVdc bipolar converter station; 230 kV ac, converted from ±350 kV dc; Pole capacity of 450 MW; and Shoreline pond electrode located on the east shore of Conception Bay
- The Dowden's Point shoreline pond electrode will be connected to the converter station at Soldiers Pond with dual overhead conductors supported on a wood pole line.
- HVdc Transition Compounds for the Strait of Belle Isle submarine cable terminations
- 3 Mass Impregnated 450MW capacity each submarine cables crossing the SOBI protected using HDD boreholes and seabed rock berm placement.
- One transition compound for each side of the Strait of Belle Isle submarine cable crossing, with associated switch works to manage the junction of multiple submarine cables and the overhead transmission line.
- Overhead transmission line from the Muskrat Falls converter station to Soldiers Pond converter station: 900 MW, ±320 kV dc, bipolar line, single conductor per pole; Galvanized lattice steel guyed suspension and rigid angle towers; 1100 km long.
- New synchronous condenser at Soldier's Pond – 3 x 150 MVar units

- Conversion of Holyrood Thermal Units 1 & 2 to synchronous condenser support
- Breaker upgrades/replacements at the Sunnyside Terminal Station
- ECC Upgrades and fibre communication connections to Soldier's Pond.
- Operations Telecommunication system.

Note: For the purposes of the EPCM Contract, the scope of work does not include any infrastructure or services associated with the actual crossing of the Strait of Belle Isle, ECC upgrades, or the Holyrood conversions.

8.3 Labrador Transmission Asset (LTA)

LTA consists in the AC transmission line system form Churchill Falls to Muskrat Falls, specifically:

- Churchill Falls switchyard extension;
- Muskrat Falls switchyard;
- Transmission lines from Muskrat Falls to Churchill Falls: double-circuit 315 kV ac, 3 phase lines, double bundle conductor, single circuit galvanized lattice steel guyed suspension and rigid angle towers; 247 km long.
- 735 kV transmission line at Churchill Falls interconnecting the existing and the new CF switchyards
- Labrador Fibre Project (Nalcor's participation in Bell Aliant led initiative)

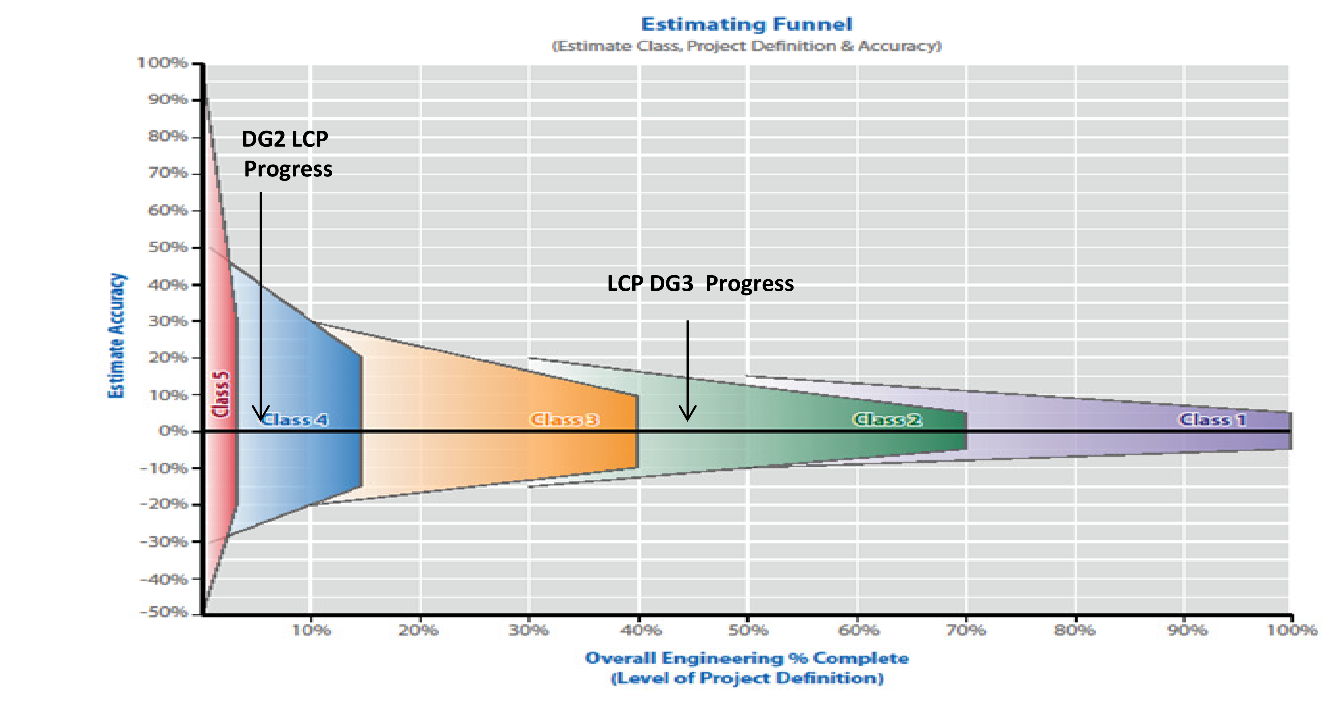
Part A: General Estimating Approach

9.0 Estimate Maturity Continuum

During the lifecycle of all projects, such as the Lower Churchill Project, it is the expectation that the capital cost estimate evolves and becomes more accurate as the project definition matures, as illustrated in Figure 9-1. (Note: While the amount of total engineering completed is often used to characterize the level of project definition, according to International Project Analysis Inc. (IPA) a more holistic view should also encompass knowledge of site factors and conditions, as well as the amount of engineering definition and project execution planning).

Consistent with this and as illustrated in Figure 9-2, the CCE for the LCP has followed such a progression from the late 1990's to the DG2 estimate, through to the current DG3 estimate, and eventually to validated estimate at Financial Close. During this time further technical and execution studies have revealed new insights, constraints, and opportunities that must be considered in the selection of final design layouts, execution strategies, and construction schedules, all of which have led to the ultimate determination of the DG3 CCE that will be used to base a sanction decision upon.

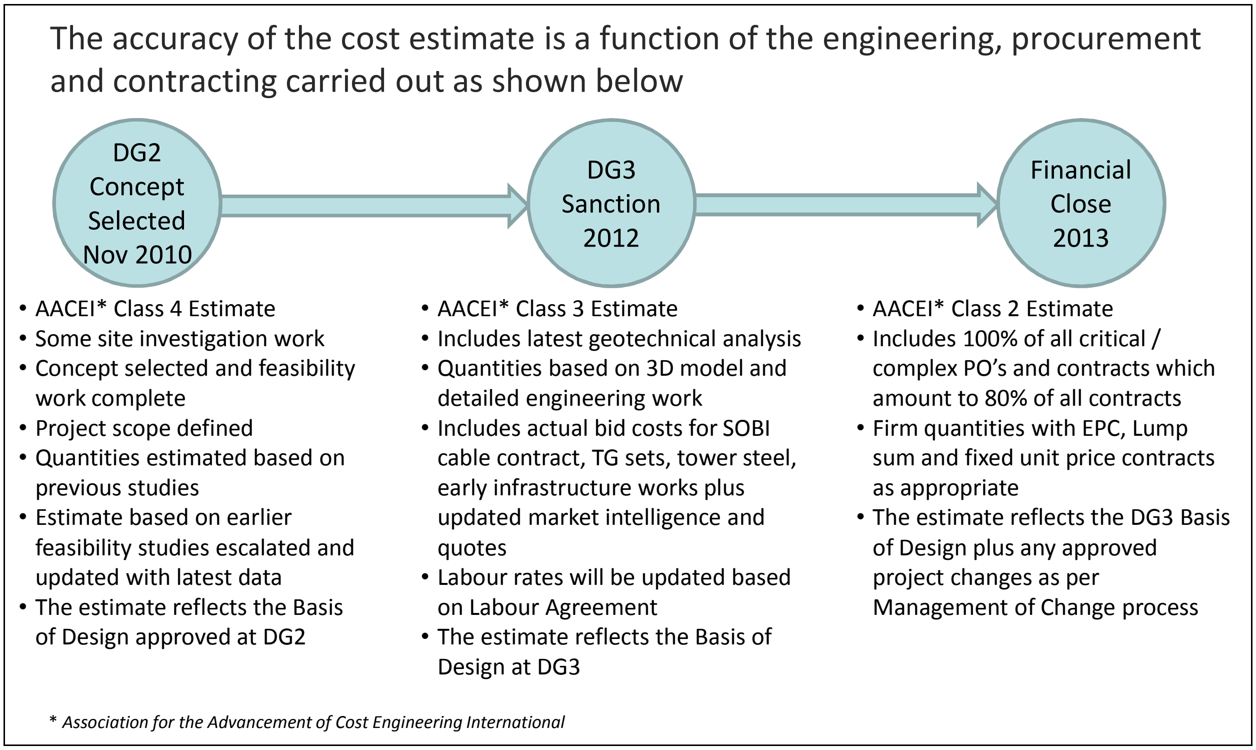
Figure 9-1: Cost Estimate Maturity Model



Nalcor has adopted the recommended estimating practices of the Association for Advancement to Cost Engineering (AACE) International for use in planning the development of the LCP. AACE International is recognized within the engineering, procurement and construction industry as the leading authority in total cost management, including cost estimating standards, practices and methods. While AACE International is yet to publish a cost estimate classification system for hydro or transmission projects, Nalcor has built upon the general guidance contained within

Recommended Practice No. 17R-97 to map the level of estimate maturity required for each of the gate decisions within Nalcor's Gateway Process. The result of this mapping is shown in Table 9-1.

Figure 9-2: LCP CCE Envisioned Estimate Progression



It should be noted that the classification scheme shown in Table 9-1 does not include reference to expected estimate accuracy; rather will be determined using probabilistic techniques in line with the AACE International Recommended Practice 42R-08 using P10 for low side and P90 for high side basis.

Table 9-1: Estimate Classes required for Decision Gates

Required for	Decision Gate 1	Decision Gate 2	Decision Gate 3	Financial Close	Mid-Point Check
Class [1]	AACEI Class 5	AACEI Class 4	AACEI Class 3	AACEI Class 2	AACEI Class 1
Estimate Purpose	Opportunity Screening	Alternative Selection	Sanction / Control	Financing	Check Estimate
Project Definition	0% to 2%	1% to 15%	10% to 40%	30% to 70%	50% to 70%

10.0 DG3 Project Cost Estimate – Attributes and Key Characteristics

During the development of estimate plan for the development of the DG3 Capital Cost Estimate, the work plan and resulting effort to develop a quality estimate had to be commensurate with the intended purpose of the estimate. To this effect, the DG3 CCE was designed with a key purpose of:

- Verifying the Decision Gate 2 estimate;
- Providing an increased level of confidence in outcome;
- Seeking an Effective Project Approval or Sanction; and
- Establishing the Project Budget.

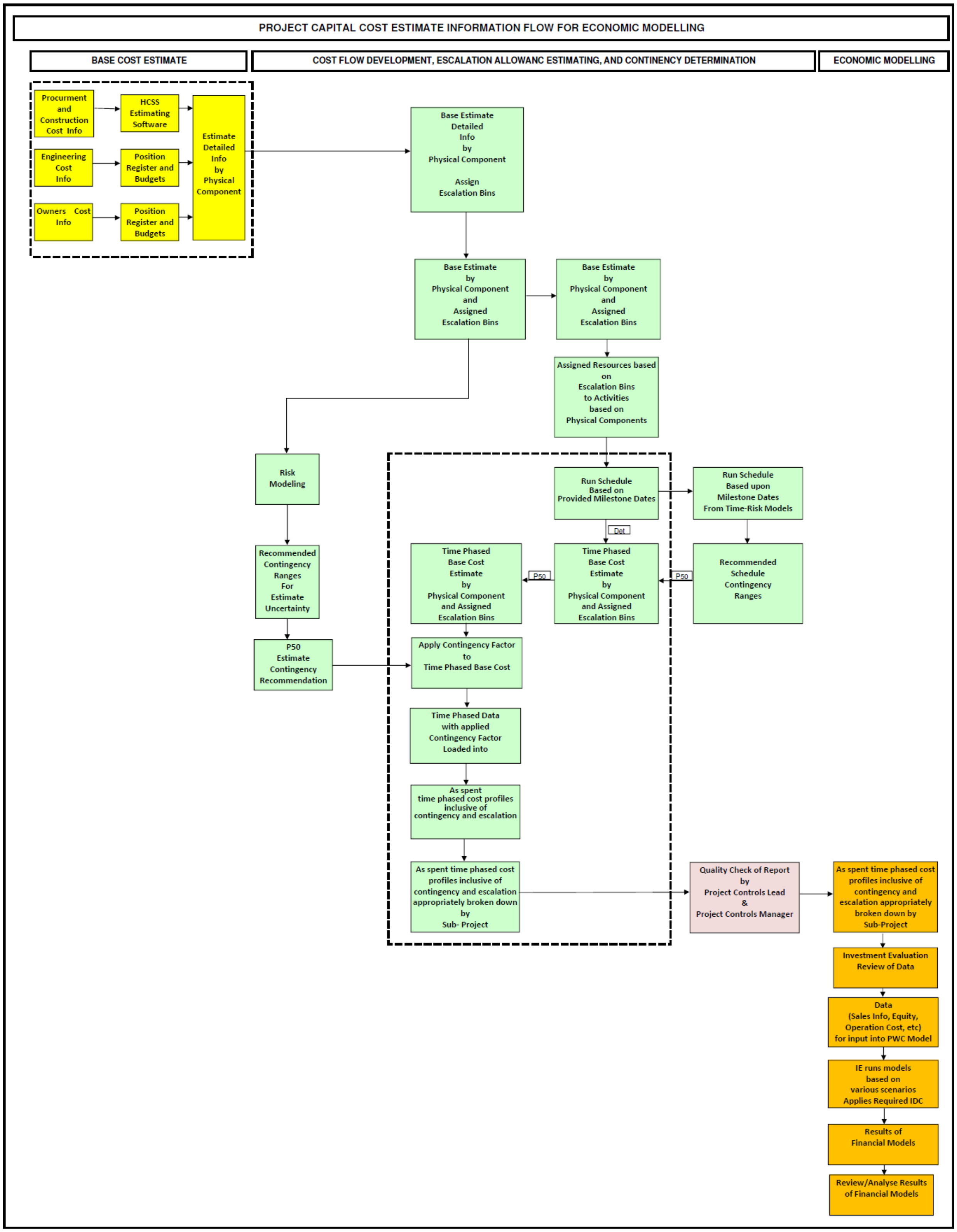
Table 10-1 summarizes the key planned attributes and key characteristics for the DG3 CCE, that shaped the estimate development.

In order to achieve the purpose outlined above, the DG3 CCE produced by the Project Team was required to be provided as input into Cumulative Present Worth (CPW) analysis undertaken by Nalcor Investment Evaluation to confirm that the LCP was the preferred option for meeting the Province's long term electricity needs. Figure 10-1 illustrates the overall process flow to ensure quality information is presented for CPW analysis.

Table 10-1: DG3 Project Cost Estimate – Attributes and Characteristics

Attribute	Key Characteristic
Intended Purpose	(i) Verify the Decision Gate 2 estimate (ii) Provides increased level of confidence in outcome. (iii) Seek Effective Project Approval or Sanction (iv) Establishes the Project Budget
Project Definition (i.e. level of engineering design complete)	(i) Completed design documents including drawings and outline specifications at the end of Gateway Phase 3. (ii) All project execution strategies in-place for execution. (iii) Complete working drawings for early construction packages being issued for Request for Proposals. (v) Expended engineering effort from 30% to 40% of total.
Preparation Methodology	(i) Deterministic based for both direct and indirect cost (ii) Majority of estimate prepared from measured and priced quantities obtained from the completed design drawings and outline specifications. (iii) Price and performance factors developed specifically for the Project (e.g. project labor agreement, results from contract bids for long-lead equipment and early works construction packages, bulk material prices, and productivity rates) and benchmarked against historical projects. (iv) Production rates and timeline durations aligned with detailed construction schedule. (v) A very minor proportion of the estimate is in the form of allowances.
Level of Precision	Medium to High
Cost Flow	(i) Aligned with Project Control Schedule (ii) Monthly cost flow available for each major commodity and for each currency and for each WBS Physical Component.

Figure 10-1: Overall Cost Estimate Development Process Flow



11.0 Overall Cost Estimating Approach and Methodology

As indicated earlier, during Gateway Phase 2 Nalcor opted to develop its cost estimates in accordance the principles espoused by AACE International. Specifically for the Base Estimate, AACE International Recommendation Practice No. 36R-08 was to be followed as reasonably practical. This practice was continued in order to produce the DG3 CCE.

The development of the DG3 CCE was led by Nalcor under the direction of the Sr. Estimator reporting to the Nalcor Project Controls Manager, with the EPCM Consultant SNC-Lavalin, having the responsibility to prepare a Class 3 estimate for the Project's scope encompassed within the EPCM Services Agreement, LC-G-002, with Nalcor providing guidance on key parameters, including the labor rates to be used.

Commencing Gateway Phase 3 and the mobilization of SNC-Lavalin Inc. as EPCM Consultant, the Nalcor Project Team had the benefit of having just produced the DG2 CCE, which included a significant amount of market intelligence, in particular for labor rates. Extensive benchmarking and third party reviews were undertaken for critical areas where construction methodology and performance factors were at risk.

For execution purposes, the EPCM Services is broken into Components to reflect similar scopes of work for execution related purposes; specifically:

- Component 1: Muskrat Falls Hydroelectric Development
- Component 3: High voltage direct current transmission system specialties
- Component 4: High voltage overhead transmission lines (ac and dc) including:
  - Sub-component 4A: HVdc overhead transmission lines Muskrat Falls to Soldiers Pond
  - Sub-component 4B: HVac overhead transmission lines Muskrat Falls to Churchill Falls

The estimating activities completed by the EPCM Consultant reflect a similar work organization.

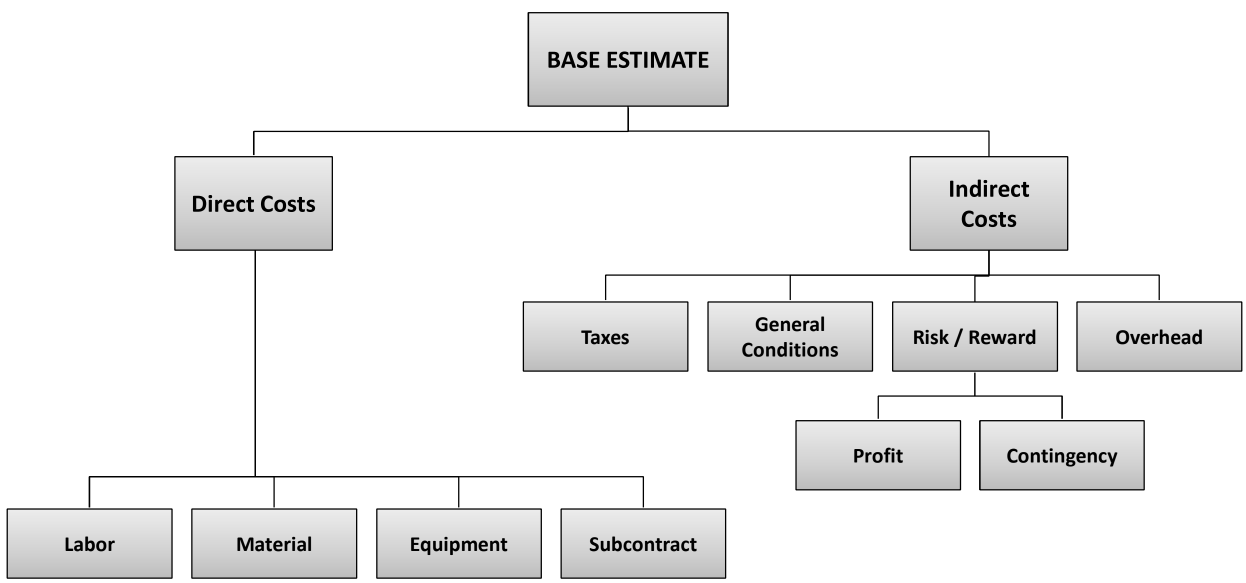
Nalcor internal resources took the lead in developing the estimate for all other aspects of the project, including engineering, construction / project management, SOBI Marine Crossing, Other Island Upgrades, and all other owner's cost. These costs are each discussed under different parts of this *Decision Gate 3 Basis of Estimate*.

11.1 Estimate Plan

As illustrated in Figure 11-1, the overall estimating approach adopted for the DG3 CCE basically reflects what a construction contractor would need to do to evaluate project costs (both direct and indirect) for which a bid is being prepared. This approach could be best described as a bottom-up first principle estimate or deterministic estimate as opposed to a parametric or stochastic method. As such, for each item to be estimated in a given portion of scope under evaluation, crews and production rates were developed by estimators, quantified and multiplied in order to establish the estimated cost of each of the required activities to be performed for the scope to be constructed. However, to a very limited extent, some elements of the scope of the estimate, where insufficient information was available at the time of the estimate, were evaluated using benchmarks from other recent similar projects in comparable condition and estimator experience.

Section 14.0 provides further insight into the key inputs that were considered by the estimators to estimate the direct and indirect costs for the Base Estimate component of the DG3 CCE, while more extensive discussions are provided in Parts B through H.

Figure 11-1: Estimate Elements



The segregation of estimating responsibilities as indicated earlier in this Section 11.0 is summarized in Table 11-1. This table presents the assignment of responsibility for development of the various components of the Base Estimate portion of the CCE.

The CCE development schedule supported the ability to secure key market intelligence via procurement price data for use in preparing the estimate in particular for long-lead items where responses to RFPs were planned to be received, analyzed and incorporated in the CCE. Items for which final RFPs were planned to be received included:

- Turbines and Generators
- SOBI Cable Supply & Installation
- AC Tower Steel
- MF Construction Power
- MF Site Access and Clearing
- MF Accommodations Complex

In other cases where RFPs were not planned to be issued or received, mini-specifications were to be prepared to facilitate the collection of budgetary prices. Table 11-1 indicates whether the price basis used in in the CCE would be supported by a RFP or executed contract.

Table 11-1: Estimating Responsibility Assignment

WBS number	Sub-Section	Physical Element	Estimate Responsibility	Bid Price to be Available
1000		**Support Facilities – General**		
	1110	Access Road	SLI	Yes
	1150	Construction Bridge over spillway approach channel	SLI	Yes
	1300	Construction Power	SLI	Yes
	1400	Construction Telecommunications	SLI	No
	1510	Accommodation Complex	SLI	Yes
	1570	Site Services Infrastructures	SLI	No
	1800	Offsite Logistics, Infrastructure and Support - General	SLI	No
	1910	HVGB Office	SLI	No
2100		**Reservoir – General**		
	2110	Reservoir	SLI	No
	2120	Water Sampling Stations	SLI	No
	2130	Trash Management System	SLI	No
2300		**Dams & Cofferdams**		
	2301	Phase 1, Riverside cofferdam	SLI	No
2310		**RCC Dams**		
	2320	North Dam	SLI	No
	2321	Upstream Concrete Face	SLI	No
	2322	Downstream Concrete Face	SLI	No
	2323	Crown Top Concrete	SLI	No
	2330	South Dam	SLI	No
	2331	Upstream Concrete Face	SLI	No
	2333	Crown Top Concrete	SLI	No
	2390	Upstream RCC Cofferdam or *(Sheet pile option)*	SLI	No
2340		**Earth Cofferdams**		
	2341	Upstream Cofferdam	SLI	No
	2342	Downstream Cofferdam	SLI	No
	2343	Intake Upstream Cofferdam (approach channel)	SLI	No
2400		**Spillway – General**		
	2401	Phase 1, Spillway Excavation	SLI	No
	2402	Discharge Channel Rock Plug	SLI	No
	2410	Spillway Concrete Structure	SLI	No
	2420	Gates, Guides & Hoist	SLI	Budgetary
2500		**Approach Channel – General**	SLI	No
2800		**North Spur – General**		
	2810	North Spur Rock Berm	SLI	No
	2820	North Spur Downstream Stabilization	SLI	No
	2830	North Spur – Pumpwells	SLI	No
	2840	North Spur – Crest Unloading & North End	SLI	No

WBS number	Sub-Section	Physical Element	Estimate Responsibility	Bid Price to be Available
3000		**Powerhouse & Related Structures**		
3100		**Tailrace - General**		
	3101	Phase 1, Tailrace Rock Plug	SLI	No
	3102	Phase 1, Powerhouse Excavation	SLI	No
3200		**Intake & Penstock - General**		
	3220	Concrete Intake Structure	SLI	No
	3230	Intake & Spillway Interface Structure	SLI	No
	3240	Intake Gates, & Trash racks	RFP	Budgetary
	3250	Concrete Intake Penstock Structure	SLI	No
3300		**Powerhouse & Related Structures**		
	3310	Concrete Powerhouse Phase 1	SLI	No
	3311	Concrete Powerhouse Phase 2	SLI	No
	3320	Superstructure (Structural & Architectural)	SLI	No
	3330	Draft Tubes Gates & Hoist	SLI	Budgetary
	3360	Powerhouse Crane Equipment	SLI	Budgetary
	3361	Powerhouse Elevators Equipment	SLI	Budgetary
3400		Turbine & Generator		
	3410	Turbine	SLI	Yes
	3420	Generator including excitation system, control & protection	SLI	Yes
	3440	Electrical Ancillary Equipment	SLI	No
	3450/60/70/80/90	Major Equipment (Bus bar, Generator circuit break, Generator Step-up Transformer, Station Auxiliary Transformer with disconnect switch) (small transformer, Surface Grounding, phone, DG set, etc.)	SLI	Budgetary
3500		**Balance of Plant - General (B.O.P)**		
	3510	Protection	SLI	No
	3550	Mechanical Ancillary Equipment (HVAC, Compressors, pumps, reservoirs, piping, etc.)	SLI	No
	3560	Communications (Communication System, microwave system, fiber optic, etc.)	SLI	No
4000		**Switchyard / Substation - General**		
	4100	Churchill Falls Extension		
	4300	Muskrat Falls Switchyard	SLI	No
	4500	Soldier's Pond Switchyard	SLI	No
6000		**Overland Transmission Line**		
6100		**AC Overland Transmission**		
	6110	Gull to Churchill Falls	SLI	No
	6130	Switchyard to Converter Station	SLI	No
	6140	Gull Island to Muskrat falls	SLI	No
	6160	Collector lines to Switchyard	SLI	No
6200		**DC Overland Transmission**		
	6210	Gull Island to Strait of Belle-Isle	SLI	No
	6220	Strait of Belle-Isle to Taylors Brook	SLI	No
	6230	Taylors Brook to Soldiers Pound	SLI	No
	6270	Muskrat Falls to Strait of Belle-Isle	SLI	No
6300		**Electrodes Lines**		
	6310	Electrode Lines - Labrador	SLI	No
	6320	Electrode Lines - Newfoundland East	SLI	No

WBS number	Sub-Section	Physical Element	Estimate Responsibility	Bid Price to be Available
7000		**System Upgrades - General**		
7100		Island System Upgrades East		
		Soldier's Pond Synchronous Condensers	SLI	No
		Holyrood Units 1 & 2 Conversion	Nalcor	No
		Terminal Station Breakers	Nalcor	No
8000		**DC Specialties**		
8100		**DC Specialties - Marine Crossings**	Nalcor	No
	8110	DC Specialties-Marine Crossings-SOBI	Nalcor	Cable EPCI Only
8200		**DC Specialties - Converter Stations**		
	8210	Labrador Converter Station	SLI	Budgetary
	8220	Soldier Pond Converter Station	SLI	Budgetary
8500		**DC Specialties - Transition Compound**		
	8510	Transition Compound - Labrador	SLI	No
	8520	Transition Compound - Northern Peninsula	SLI	No
8600		**DC Specialties - Electrodes**		
	8610	Electrode – Labrador	SLI	No
	8620	Electrode – Newfoundland East	SLI	No
9000		**Other Specialties – General**		
9110		**Fish Habitat Compensation - General**		
	9112	Fish Habitat Compensation Muskrat Falls	Nalcor	No
	9113	Fish Habitat Compensation SOBI	Nalcor	No
	9115	Fish Habitat Compensation Electrode Labrador	Nalcor	No
	9116	Fish Habitat Compensation Electrode NL East	Nalcor	No
9120		**Terrestrial Habitat Compensation – General**		
	9122	Terrestrial Habitat Compensation – Muskrat Falls	Nalcor	No
9200		**Operations Telecoms**		
	9220	Operations Telecoms – Muskrat Falls	SLI	No
	9221	Operations Telecoms – LTA	SLI	No
	9230	Operations Telecoms – LITL	SLI	No
10000		**Management, Engineering & Others**		
		EPCM Services	SLI	Yes
		Owner PMT	Nalcor	N/A
		Insurance	Nalcor	No
		Environment Assessment	Nalcor	No
		Property and Lands	Nalcor	No
		Permitting and Regulatory Compliance	Nalcor	No
		IBA & other Aboriginal Costs	Nalcor	No
		Historical Cost	Nalcor	No
		Pre-commissioning & Commissioning	Nalcor	No

11.2 Estimate Development Timeline

The Estimate Plan was bounded by the timelines established by Nalcor for sanctioning of the Project in fall 2012. SLI were to prepare and submit to Nalcor by 15-Dec-2011 all works required to substantiate as Class 3 estimate, which would be assessed and challenged by Nalcor in order to finalize the DG3 CCE. As such the CCE development followed a two-phase process:

- Phase 1 – Preliminary DG3 CCE Development occurring from DG2 up to 15-Dec-2011
- Phase 2 – Finalization of DG3 CCE occurring post 15-Dec-2011 up to mid-June 2012

Phase 1 was concluded on the planned date; however significant review and estimate modification occurred during the period to reflect final alignment with all available information, including alignment with the envisioned execution plan. During Phase 2 several estimate reviews workshops were held, including a third party estimate review by Validation Estimation LLC, in order to ensure a quality DG3 CCE was recommended. The result was the finalization of the DG3 CCE for submittal of capital cost flows for CPW modeling on 16-Jun-2012.

11.3 Estimating Organization

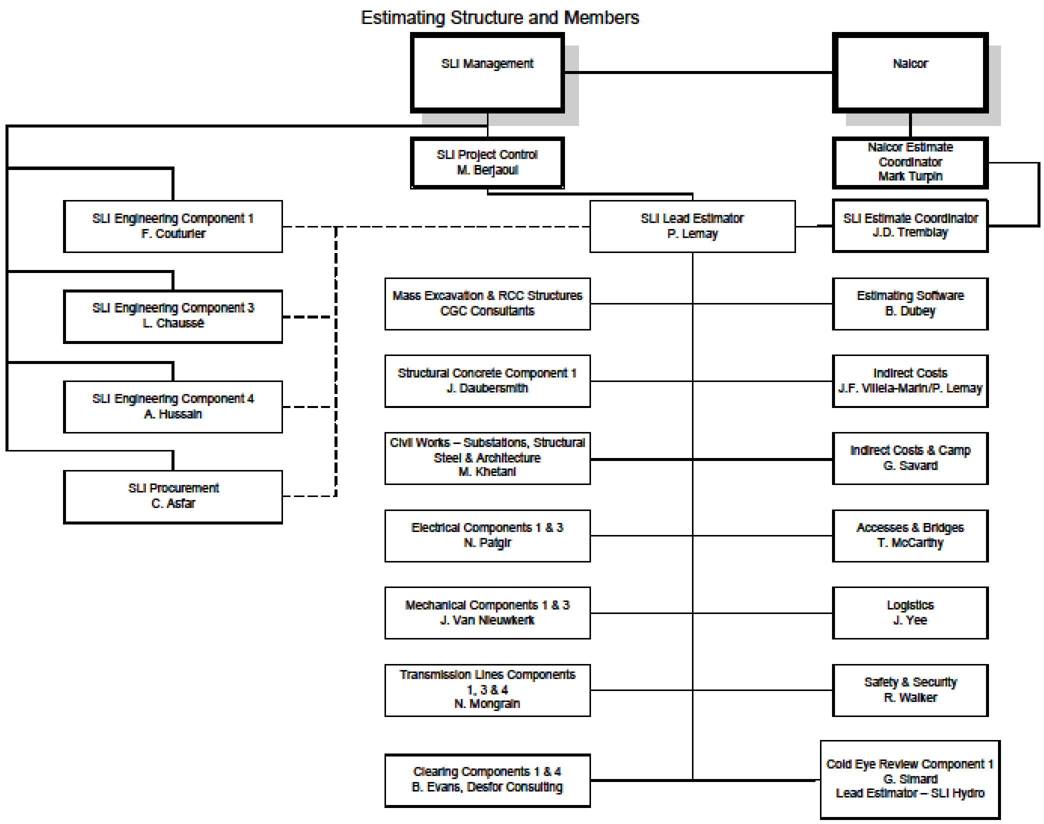
The strategy put forward by Nalcor, with SNC-Lavalin, to develop the DG3 CCE was to pull together an estimating team comprised mainly of seasoned estimators having extensive experience in their respective fields. For that scope within the umbrella of the EPCM Services, these estimators were in most parts sourced directly from SLI staff. However, where in-house expertise was not available, external specialized consultants were called upon. Figure 11-2 presents an organization chart detailing who the members of the SLI estimating team were and their respective role in the development of the CCE.

Within the SLI team, the Lead Estimator was responsible for providing the framework and ground rules to be considered by all estimating team members. In addition to performing key portions of the estimate, the Lead Estimator provided assistance and validation to members of the team.

Coordination between Nalcor, SLI and the Engineering departments of each of the Project Components was provided by the Estimate coordinators from both Nalcor and SLI.

Seasoned estimators capable of taking over parts of the estimate from their head office location (mainly Calgary, Alberta) where provide with respect to electrical and mechanical works.

Figure 11-2: SLI Estimating Team



Most of the estimating team was comprised of SLI personnel with the exception of the following external consultants:

- Jim Daubersmith, Daubersmith Inc.: Powerhouse structural concrete estimate
- CGC Consultants: Powerhouse and spillway mass excavation estimate
- Desfor Consulting: Transmission Lines ROW clearing, access study and estimate.

The SLI Hydro Division Lead Estimator provided additional support to the Project estimating team through cold eye reviews of the estimate prior to closure.

For specific critical components of the Project where productivity and performance exposure was considered the greatest, specifically the Muskrat Falls excavation and concrete works, Nalcor had independent estimates completed using the following consultants:

- John Mulcahy, Heavy Civil Construction Specialist
- Paul Hewitt, Independent Project Estimate (note: worked with Nalcor to develop the DG2 estimate)

11.4 Estimating Tools

In an effort to develop a true database estimate, HCSS Heavy Bid Estimating software version 2010.3 (HCCS) was selected as the software to be utilized by the Project team. Unfortunately, the proficiently level of many of the members of the estimating team was limited, while limited time was available to support their competency development.

In order to ensure the team remained focus on develop a quality estimate rather than on learning software, a spreadsheet template was provided by the SLI Lead Estimator to every member of the estimating team. Each estimator performed his estimate using the tools and methods with which they were familiar and proficient and transferred the results of their respective estimate to the spreadsheet template. All the completed templates were forwarded to the SLI Lead Estimator who had them integrated into HCSS. The estimated costs were segregated into the relevant cost categories usually considered for capital cost estimates as follows:

- Labour
- Equipment
- Permanent Materials
- Consumable Materials
- Sub-contractors

Nalcor extensively reviewed the coding of the estimate in order to assert a level of comfort in the quality of the estimate, given the number of independent estimators providing input, resulting in extensive coding changes to ensure estimate alignment with the Project's WBS.

The following estimating activities were performed by the estimating team and were integrated into HCSS:

- Assemble the project Material Take-offs (MTO's) from engineering (which were later transposed into Quantification Basis Reports – reference Section 14.1.7);
- Perform bottom up estimate on a first principle basis (quantities, crews, production rates and unit costs);
- Perform reasonable evaluation based on past experience for similar projects in comparable conditions if needed;
- Perform all commercial bid evaluations on equipment and bulk materials quotes;
- Compile and use In-House pricing as necessary;
- Prepare Basis of Estimate for estimator-specific scopes;
- Participate in estimate reviews with the engineering and project management team; and
- Populate estimating forms for integration of estimates into HCSS.

In the final stages of the CCE development, the output of HCSS was extracted and used in the preparation of escalation models (reference Decision Gate 3 Capital Cost Escalation Report, LCP-PT-ED-0000-EP-RP-0003-01) and capital cost flows (reference Decision Gate 3 Capital Cost Estimate, LCP-PT-ED-0000-EP-ES-0002-01).

12.0 Project Coding Structure

In order to meet intended purpose, the CCE has been broken into a logical structure consistent with the Project's Work Breakdown Structure, as defined in the document Project Work Breakdown Structure and Code of Accounts, reference no. LCP-PT-MD-0000-PC-LS-0001-01, as presented below.

The CCE for the procurement and construction works, as developed in the estimating software HCSS, utilizes a nine digit coding system,

- First digit represents the Project number, where 3 = MFG, 4 =LITL and 6 = LITL (reference Lower Churchill Project – Asset Schematic by Project, document no. LCP-PT-MD-0000-PC-BD-0001-01 for high-level demarcation) as shown in Figure 12-1;
- Digits 2 through five represents the Physical Component as extracted from the Project's WBS; and
- Digits six through nine serve to further breakdown these physical components into estimated work items comprising the actual work activities to be estimated.

All procurement and construction works have also been coded on a Commitment Package basis consistent with the LCP Master Package Dictionary, document no. LCP-SN-CD-0000-PM-LS-0001-01, as listed in Table 12-1. This asset allocation and coding process assisted in confirming all project-scope had been accounted for within the Base Estimate.

The Base Estimate component of the CCE is presented by on a Project/Physical Component as well as on a Commitment Package basis within the Decision Gate 3 Capital Estimate Report, document no. LCP-PT-ED-0000-EP-ES-0002-01.

LCP Phase 1 Work Breakdown Structure (WBS)

1 LCP General (1.Functional Group)
- 1.0 LCP General
  - 1.0.00 General Administration
- 1.1 Project Management
  - 1.1.00 Project Management General
- 1.2 Engineering
  - 1.2.00 Engineering General
- 1.3 Environmental Affairs
  - 1.3.00 Envronmental Affairs General
- 1.4 Impact & Benefits Agreement
  - 1.4.00 Impact & Benefits Agreement
- 1.5 Construction Management
  - 1.5.00 Construction Mgmt. General
- 1.7 Operations General
  - 1.7.00 Operations Management General
- 1.8 Power Sales and Marketing
  - 1.8.00 Power Sales & Marketing Gen.
- 1.9 Project Financing
  - 1.9.00 Project Financing General

3 Muskrat Falls (3.Physical Component)
- 3.0 Muskrat Falls General
  - 3.0.00 Muskrat Falls General
- 3.1 Infrastructure and Support
  - 3.1.00 Infrastructure & Support Gen.
  - 3.1.0X Offices
  - 3.1.10 Access
  - 3.1.20 Other Permanent Facilities
  - 3.1.30 Construction Power
  - 3.1.40 Construction Telecoms.
  - 3.1.50 Accomodation Complex
  - 3.1.70 Housing Facilities HVGB
  - 3.1.80 Offsite Logistics Infrastructure and Support
  - 3.1.90 Vehicles
- 3.2 Reservoir Dams & Spillway General
  - 3.2.00 Generation Facilty General
  - 3.2.10 Reservoir
  - 3.2.30 Dams and Cofferdams
  - 3.2.40 Spillway
  - 3.2.80 North Spur
- 3.3 Power Facilities General
  - 3.3.10 Powerhouse Channels
  - 3.3.20 Intake
  - 3.3.30 Powerhouse & Related Facilities
  - 3.3.40 Power Generation
  - 3.3.41 Turbine
  - 3.3.42 Generator
  - 3.3.43 Electrical Ancil./Auxil. System
  - 3.3.44 Mechanical Ancil./Auxil. System
  - 3.3.45 Protection, Control & Monitoring
  - 3.3.46 Generator Transformers
- 3.6 OL Transmission
  - 3.6.00 OL Transmission General
  - 3.6.16 MF Collector Lines
- 3.9 Other Specialties
  - 3.9.00 Other Specialties General
  - 3.9.10 Habitat Compensation
  - 3.9.11 MF Fish Habitat Compensation
  - 3.9.12 MF Terestrial Habitat Compensation
  - 3.9.20 Operations Telecommunications
  - 3.9.22 Operations Telecommunications - Muskrat Falls

4 Island Link (4.Physical Component)
- 4.0 Island Link General
  - 4.0.00 Island Link General
- 4.1 Infrastructure and Support
  - 4.1.00 Infrastructure & Support Gen.
  - 4.1.0X Offices
  - 4.1.10 Access
  - 4.1.20 Other Permanent Facilities
  - 4.1.30 Construction Power
  - 4.1.40 Construction Telecoms.
  - 4.1.50 Accomodation Complex
  - 4.1.70 Housing Facilities HVGB
  - 4.1.80 Offsite Logistics Infrastructure and Support
  - 4.1.90 Vehicles
- 4.4 Switchyards
  - 4.4.00 Switchyards General
  - 4.4.50 Soldiers Pond Switchyard
- 4.6 OL Transmission
  - 4.6.00 OL Transmission General
  - 4.6.10 Overland HVac Transmission
  - 4.6.13 AC Tx Muskrat Falls Switchyard to Converter Station
  - 4.6.20 Overland HVdc Transmission
  - 4.6.22 Labrador-Island HVdc Tx
  - 4.6.30 Electrode Lines
  - 4.6.31 Electrode Line - Labrador
  - 4.3.32 Electrode Line - Island East
- 4.7 System Upgrades
  - 4.7.00 System Upgrades General
  - 4.7.10 Island Upgrades - East
  - 4.7.12 New Synchronous Condensers
  - 4.7.14 AC Line Rebuilds
  - 4.7.15 Holyrood Plant Modifications
- 4.8 DC Specialties
  - 4.8.00 DC Specialties General
  - 4.8.11 Marine Crossing - SOBI
  - 4.8.21 Labrador Converter Station
  - 4.8.22 Soldiers Pond Converter Station
  - 4.8.51 Transition Compound Labrador
  - 4.8.52 Transition Compound Northern Peninsula
  - 4.8.61 Electrode Labrador
  - 4.8.62 Electrode Newfoundland East
- 4.9 Other Specialties
  - 4.9.00 Other Specialties General
  - 4.9.10 Habitat Compensation
  - 4.9.11 LITL Fish Habitat Compensation
  - 4.9.12 LITL Terestrial Habitat Compensation
  - 4.9.20 Operations Telecommunications
  - 4.9.23 Operations Telecommunications - Island Link

6 LTA (6.Physical Component)
- 6.0 Island Link General
  - 6.0.00 Island Link General
- 6.1 Infrastructure and Support
  - 6.1.00 Infrastructure & Support Gen.
  - 6.1.0X Offices
  - 6.1.10 Access
  - 6.1.20 Other Permanent Facilities
  - 6.1.30 Construction Power
  - 6.1.40 Construction Telecoms.
  - 6.1.50 Accomodation Complex
  - 6.1.70 Housing Facilities HVGB
  - 6.1.80 Offsite Logistics Infrastructure and Support
  - 6.1.90 Vehicles
- 6.4 Switchyards
  - 6.4.00 Switchyards General
  - 6.4.10 Churchill Falls Switchyard Ext.
  - 6.4.30 Muskrat Falls Switchyard
- 6.6 OL Transmission
  - 6.6.00 OL Transmission General
  - 6.6.10 Overland HVac Transmission
  - 6.6.14 AC Tx Muskrat Falls to Churchill Falls
- 6.9 Other Specialties
  - 6.9.00 Other Specialties General
  - 6.9.20 Operations Telecommunications
  - 6.9.25 Operations Telecommunications - Labrador Transmission Asset

Figure 12-1: LCP – Asset Schematic by Project

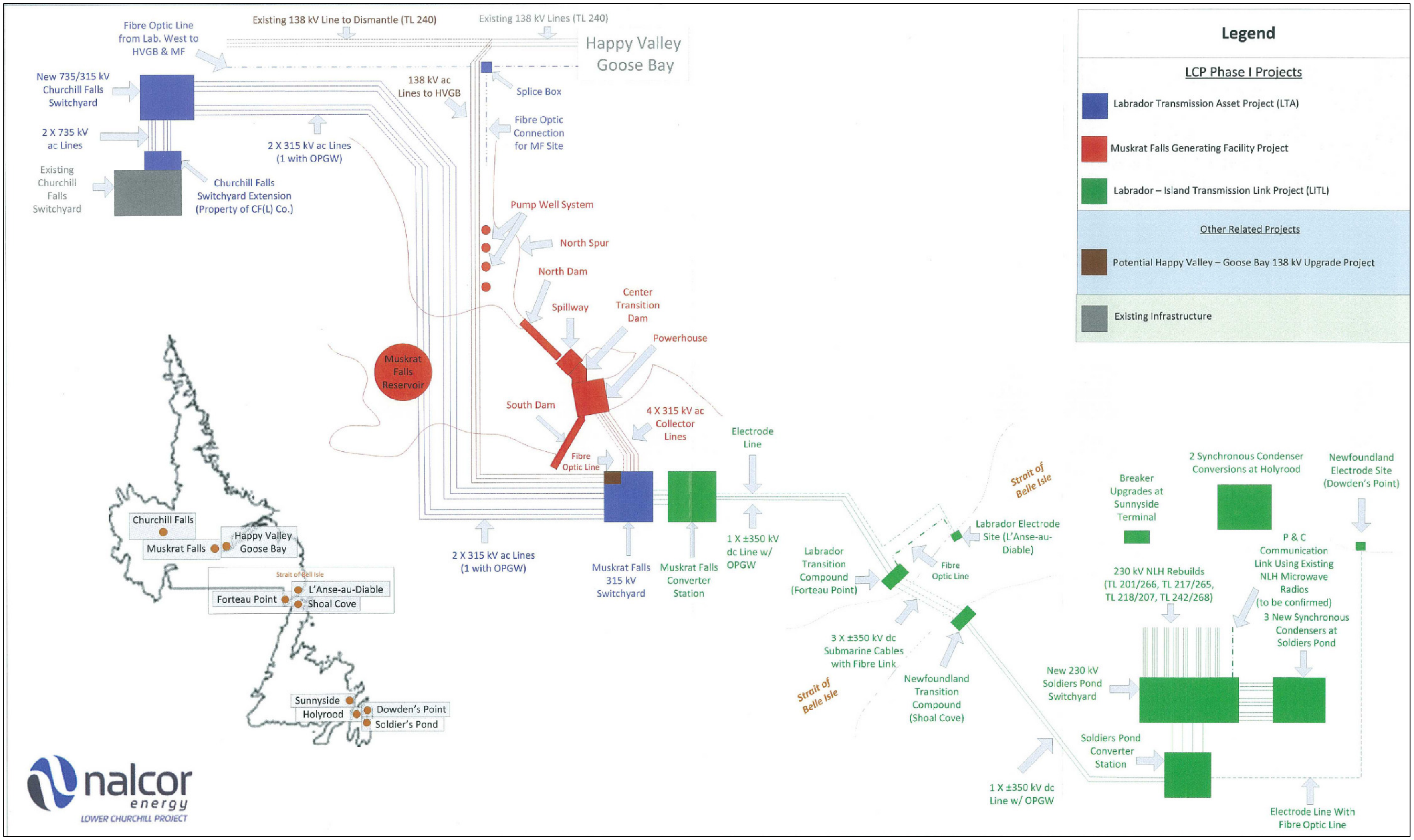


Table 12-1: Listing of Commitment Packages

Component	Reference No.	Package Name
C1	CH0002	Supply and Install Accommodations Complex Buildings
C1	CH0003	Supply and Install Administrative Buildings
C1	CH0004	Construction of Southside Access Road
C1	CH0005	Supply and Install Accommodations Complex Site Utilities
C1	CH0006	Construction of Bulk Excavation Works and Associated Works
C1	CH0007	Construction of Intake and Powerhouse, Spillway and Transition Dams
C1	CH0008	Construction of North Spur Stabilization Works
C1	CH0009	Construction of North and South Dams
C1	CH0023	Construction of Reservoir Clearing South Bank
C1	CH0024	Construction of Reservoir Clearing North Bank
C1	CH0029	Construction of Site Restoration at Muskrat Falls
C1	CH0030	Supply and Install Turbines and Generators
C1	CH0031	Supply and Install Mechanical and Electrical Auxiliaries (MF)
C1	CH0032	Supply and Install Powerhouse Hydro-Mechanical Equipment
C1	CH0033	Supply and Install Powerhouse Cranes
C1	CH0034	Supply and Install Powerhouse Elevator
C1	CH0039	Supply and Install McKenzie River Permanent Bridge
C1	CH0046	Supply and Install Spillway Hydro-Mechanical Equipment
C1	CH0048	Construction of Site Clearing Access Road & Ancillary Areas
C1	CH0049	Supply and Install Log Booms
C1	CH0050	Supply of Concrete including Batch Plant (MF)
C1	CH0052	Construction of Habitat Compensation Works
C1	PH0014	Supply of Generator Step-up Transformer
C1	PH0015	Supply of Isolated Phase Bus
C1	PH0016	Supply of Generator Circuit Breakers
C1	PH0035	Supply of Station Service Transformers
C1	PH0036	Supply of Auxiliary Transformers
C1	PH0037	Supply of 25kV Switchgear
C1	PH0038	Supply of Emergency Diesel Generators
C1	PH0053	Supply and Install Temporary Used Camp
C1	PH0058	600V Switchgear
C1	SH0001	Physical Hydraulic Model
C1	SH0018	Provision of Catering, Housekeeping and Janitorial Services (MF)
C1	SH0019	Provision of Security Services
C1	SH0020	Provision of Medical Services
C1	SH0021	Provision of Road Maintenance and Snow Clearing Services (MF)
C1	SH0022	Provision of Fuel Supply and Dispensing Services (MF)
C1	SH0040	Provision of Garbage Removal and Disposal Services (MF)
C1	SH0041	Provision of Ground Transportation Services (HVGB to MF)
C1	SH0051	Provision of Buildings Maintenance Services (MF)

Component	Reference No.	Package Name
C3	CD0501	Supply and Install Converters and Cable Transition Compounds
C3	CD0502	Construction of AC Substations and Synchronous Condensers Facilities
C3	CD0503	Construction of Earthworks at Various Power Distribution Sites
C3	CD0508	Supply and Install of Electrode Sites
C3	CD0509	Construction Telecommunication Services - Phase 2
C3	CD0510	Supply and Install Permanent Communication Systems
C3	CD0512	Construction of Construction Power Facilities
C3	CD0534	Supply and Install Soldiers Pond Synchronous Condensers
C3	CD0535	Construction Telecommunication Services - Phase 2 Remote Camps
C3	CD0538	Supply and Install Accommodations Camp (CF)
C3	PD0505	Supply of Switchyard Equipment, AC Substations at CF, MF and SP
C3	PD0513	Supply of 138/25 kV Transformers
C3	PD0514	Supply of 138 kV & 25 kV Circuit Breakers
C3	PD0515	Supply of 230 kV, 138 kV & 25 kV Disconnect Switches
C3	PD0518	Supply of 138 kV Capacitor Voltage Transformers
C3	PD0519	Supply of 25 kV Vacuum Interrupters
C3	PD0520	Supply of 25 kV 6 x 3.6 MVAR Capacitor Banks
C3	PD0522	Supply of Pre-fabricated Control Room Building
C3	PD0523	Supply of Substation Service Transformer
C3	PD0529	Supply of 25 kV Reclosers
C3	PD0530	Supply of 138 kV & 25 kV Surge Arrestors
C3	PD0531	Supply of MV Instrument Transformer
C3	PD0533	Supply and Install Early Works Telecom Devices
C3	PD0537	Supply of Power Transformers, AC Substations at CF, MF and SP
C3	PD0561	Supply of D20 RTU and Cabinet (CF) - Construction Power
C3	PD0562	Supply of Protection Front Panels and Protection Relays (CF) - Construction Power
C3	PD0563	Supply of 138 kV Circuit Switcher (CF), MV Switches & Fuse Cut-outs - Construction Power
C3	SD0536	Provision of Integrated Commissioning Support Services
C3	SD0560	Provision of Early Works Construction Telecommunication Services (MF)

Component	Reference No.	Package Name
C4	CT0319	Construction of 315 kV HVac Transmission Line (MF to CF)
C4	CT0327	Construction of 350 kV HVdc Transmission Line - Section 1
C4	CT0341	Clearing of Right-of-Way for 315 kV HVac Transmission Line (MF to CF)
C4	CT0342	Construction of AC Transmission Lines - Island
C4	CT0343	Clearing of Right-of-Way for HVdc Transmission Line - Section 1
C4	CT0345	Clearing of Right-of-Way for HVdc Transmission Line - Section 2
C4	CT0346	Construction of 350 kV HVdc Transmission Line - Section 2
C4	PT0300	Supply of Transmission Line Conductors - 315 kV HVac
C4	PT0301	Supply of HVac Insulators - 315 kV HVac
C4	PT0302	Supply of Steel Towers - 315 kV HVac
C4	PT0303	Supply of Tower Hardware - 315 kV HVac
C4	PT0304	Supply of Optical Ground Wire (OPGW) - 315 kV HVac
C4	PT0307	Supply of Steel Tower Foundations - 315 kV HVac
C4	PT0308	Supply of Steel Tower Foundations - 350 kV HVdc
C4	PT0326	Supply of Steel Wires - 315 kV HVac
C4	PT0328	Supply of Transmission Line Conductors - 350 kV HVdc
C4	PT0329	Supply of HVdc Insulators - 350 kV HVdc
C4	PT0330	Supply of Steel Towers - 350 kV HVdc
C4	PT0331	Supply of Tower Hardware - 350 kV HVdc
C4	PT0334	Supply of Steel Wires - 350 kV HVdc
C4	PT0335	Supply of Anchor Materials - 315 kV HVac
C4	PT0336	Supply of 25 kV Distribution Line Hardware
C4	PT0337	Supply of 25 kV Distribution Line ADSS Fibre Optic Cable
C4	PT0338	Supply of 25 kV Distribution Line Conductors
C4	PT0339	Supply of 25 kV Distribution Line Insulators
C4	PT0340	Supply of Wood Poles for 138/25 kV Distribution Line
C4	PT0347	Supply of Re-terminations Materials
C4	PT0351	Supply of Wood Poles
C4	PT0352	Supply of Anchor Materials - 350 kV HVdc
C4	PT0353	Supply of Optical Ground Wire (OPGW) - 350 kV HVdc
C4	ST0309	Provision of Geotechnical Investigation Services - 315 kV HVac
C4	ST0310	Provision of Geotechnical Investigation Services - 350 kV HVdc
C4	ST0311	Provision of Survey Services - 315 kV HVac
C4	ST0312	Provision of Survey Services - 350 kV HVdc

Component	Reference No.	Package Name
SM	SM0700	Provision of General Freight Forwarding Services
SM	SM0701	Provision of Third Party Quality Surveillance & Inspection Services
SM	SM0703	Provision of Happy Valley-Goose Bay Project Office Space
SM	SM0704	Provision of Surveying Services
SM	SM0705	Provision of Laboratory Services
SM	SM0706	Supply and Maintenance of Project Vehicles
SM	SM0707	Provision of Helicopter Services
SM	SM0709	Provision of Air Transportation Services
SM	SM0710	Supply and Maintenance of various IT Equipment
SM	SM0713	Provision of Geotechnical Investigation Services
SM	SM0714	Provision of EPCM Services - SNC Lavalin Inc.
SM	SM0715	Provision of Expediting Services
SOBI	LC-SB-001	Sea Current Monitoring Program
SOBI	LC-SB-002	Iceberg Tracking Program
SOBI	LC-SB-003	SOBI Submarine Cable Design, Supply and Installation
SOBI	LC-SB-008	HDD Detailed Design
SOBI	LC-SB-010	Landfall HDD Construction
SOBI	LC-SB-011	Subsea Rock Protection Design, Supply and Installation
SOBI	LC-SB-014	Geotechnical Program at Forteau Point
SOBI	LC-SB-017	Ocean Characteristic Monitoring and MetOcean Report
SOBI	LC-SB-018	Provision of Third Party Equipment Manufacturing, Supply and Installation Surveillance Services
SOBI	LC-SB-022	Provision of Drilling Rig and Surface Spread for HDD Program
SOBI	LC-SB-023	Drilling Fluids Services for HDD Program
SOBI	LC-SB-024	Directional Services for HDD Program
General	LC-G-002	EPCM Services
General	LC-PM-082	Independent Engineer

13.0 Cost Strategy

The CCE for the LCP is a new "bottom-up" estimate reflecting the latest project configuration as defined in the latest engineering documents as available at the time the estimate was prepared. As discussed in Section 10.0, the intended purpose of the estimate was to support a Project Sanction decision; hence the estimate to be of Class 3 or better.

As stated in the Project's Overarching Contracting Strategy, reference no. LCP-PT-MD-0000-PM-ST-0002-01, the project has a cost strategy of striking the optimal balance of absolute cost against cost predictability. Hence a key requirement for the CCE, inclusion of Estimate Contingency and Escalation Allowance, is to be highly predictability of the final outcome, while not presenting an overly conservative view. The need to maintain this balance influenced the estimating process with respect to the inclusion of various allowances for design growth and other changes within the Base Estimate.

As a general principal, the non-transparent inclusion of allowances for design growth and other change within the base estimate was to be minimized. Rather it was decided that such provisions were to be identified and incorporated within the estimate uncertainty/risk review process for which a recommended Estimate Contingency could be developed, rather than run the risk of laying various levels of contingency. The Base Estimate was to be developed to represent an expected case of the out-turn cost, based upon all the relevant input factors into the estimate, thus the expected Estimate Contingency to reach a P50 outcome (excluding strategic risk exposure) could be expected to be low.

Future cost growth due to market escalation was to be excluded from the Base Estimate, and incorporated with the Escalation Allowance calculations, presented within the report Decision Gate 3 Capital Cost Escalation Report, reference no. LCP-PT-ED-0000-EP-RP-0003-01.

As a key element of the estimate that could potentially be subject to large variation is contractor's expected overhead and profit. The Project is intended to be developed using a number of large contract packages with either lump sum or unit price compensation basis. While this strategy supports the need to maintain a balance between desire for cost predictability and absolute cost, it generally not considered to be the lowest cost strategy. The shift of this performance risk to the contractor comes with significant uncertainty as to what the contractor's view is of this risk, and resulting cost premiums for overhead and profit. However in consideration of the size of these packages, the potential reward is significant, hence the view that the traditional 5% provision for profit is sufficient, with 10% provision for contractor overhead, including home office support.

13.1 Use of Allowances

The CCE includes no allowances other than those indicated in the details of the following sections of this Basis of estimate document for specific items for which they were deemed necessary to properly estimate the work item. These specific allowances were evaluated based on past projects and estimator experience in their specific fields.

13.2 Price Base

With acknowledgement that the extensive price dataset compiled to result in the DG3 estimate was generated over a 12-month period (May 2011 to May 2012), the practically of the time-synchronization of the entire price-basis for the estimate is considered near impossible, the DG3 CCE is considered to be in January 2012 CDN$.

As detailed in Section 14.0, throughout the development of the CCE, the estimating team sourced current available pricing information for material, equipment and labor. However given the variability in time of sourcing this information, the price basis differs (i.e. transmission line conductor quotes are for November 2011, while structural concrete quotes are for March 2012).

Material and equipment quotations were obtained during the period of Q4-2011 through Q1-2012 for turnkey packages (e.g., converter stations, synchronous condensers, spillway gates, etc.), free-issued hardware (e.g., conductor, tower steel, etc.), and construction consumables (e.g., concrete, rebar, explosives, etc.). Trade labor, the single largest cost element of the Project, is considered effective from May 2012 to May 2013, further discussed in Trade Labor Rates for Use in the Preparation of Cost Estimates, document no. LCP-PT-MD-0000-PM-RP-0001-01.

With consideration of the weighted-aggregate of the source data, it has been concluded that the estimate generally represents a January 2012 CDN$. Section 14.0 provides further detail on the price-basis for the estimate.

13.3 Treatment of Foreign Currencies

Consistent with the approach described in Section 12.7 the Project Controls Management Plan, reference no. LCP-PT-MD-0000-PC-PL-0001-01, a set of Project Exchange Rates was established for the purpose of establishing the Base Estimate in Canadian equivalent currency. These exchange rates were fixed as of 14-December-2011 and are listed in Table 13-1.

While limited, the CCE did include price quotations in non-Canadian funds. Key items for which quotations were obtained in non-Canadian funds and for which currency conversion was applicable included:

- Muskrat Falls Trash Rack Cleaning Machine
- Transmission Conductor
- Transmission Hardware

In the case of the large EPC contracts, specifically HVdc Converters, Turbines & Generators and Submarine Cable the basis of the cost estimate was in Canadian dollars.

In many instances three to four quotations were received, some of which were in USD. Almost exclusively, through the normalization process, a Canadian currency-based quote was selected as input into the CCE. In circumstances where a quotation in non-Canadian funds was selected as the preferred quote, conversion to Canadian equivalent was made using the Project Exchange Rates provided in Table 13-1.

Table 13-1: Project Exchange Rates (from x-rates.com as of 14-Dec-2011)

Currency	1 CAD	in CAD
American Dollar	0.964227	1.0371
Argentine Peso	4.44561	0.224941
Australian Dollar	0.966455	1.03471
Botswana Pula	7.34929	0.136068
Brazilian Real	1.80148	0.555101
British Pound	0.622632	1.60608
Brunei dollar	1.2588	0.794408
Bulgarian Lev	1.45142	0.688979
Chilean Peso	502.693	0.00198929
Chinese Yuan	6.13423	0.16302
Colombian Peso	1871.97	0.000534197
Croatian Kuna	5.56807	0.179595
Danish Krone	5.51582	0.181297
Euro	0.742113	1.3475
Hong Kong Dollar	7.50469	0.13325
Hungarian Forint	226.084	0.00442313
Iceland Krona	117.836	0.00848635
Indian Rupee	52.0058	0.0192286
Indonesian Rupiah	8871.1	0.000112726
Iranian Rial	10596.9	9.43676E-05
Israeli New Shekel	3.67049	0.272443
Japanese Yen	75.2799	0.0132838
Kazakhstani Tenge	142.6	0.00701264
Kuwaiti Dinar	0.2682	3.72856
Latvian Lat	0.517476	1.93246
Libyan Dinar	1.86327	0.53669
Lithuanian Litas	2.56237	0.390264
Malaysian Ringgit	3.07375	0.325335

Currency	1 CAD	in CAD
Mauritius Rupee	28.2611	0.0353843
Mexican Peso	13.3933	0.0746642
Nepalese Rupee	82.3354	0.0121455
New Zealand Dollar	1.28045	0.780978
Norwegian Kroner	5.76324	0.173513
Omani Rial	0.370745	2.69727
Pakistan Rupee	86.4233	0.011571
Philippine Peso	42.6233	0.0234614
Qatari Rial	3.50979	0.284918
Romanian Leu	3.22448	0.310127
Russian Ruble	30.6566	0.0326194
Saudi Riyal	3.61585	0.27656
Singapore Dollar	1.25973	0.793818
South African Rand	8.05704	0.124115
South Korean Won	1117.3	0.000895016
Sri Lanka Rupee	109.718	0.00911424
Swedish Krona	6.74224	0.148319
Swiss Franc	0.91406	1.09402
Taiwan Dollar	29.2444	0.0341945
Thai Baht	30.1609	0.0331555
Trinidad/Tobago Dollar	6.16323	0.162252
Turkish Lira	1.81573	0.550744
Venezuelan Bolivar	4.14105	0.241485

14.0 Overview of Cost Estimate Inputs

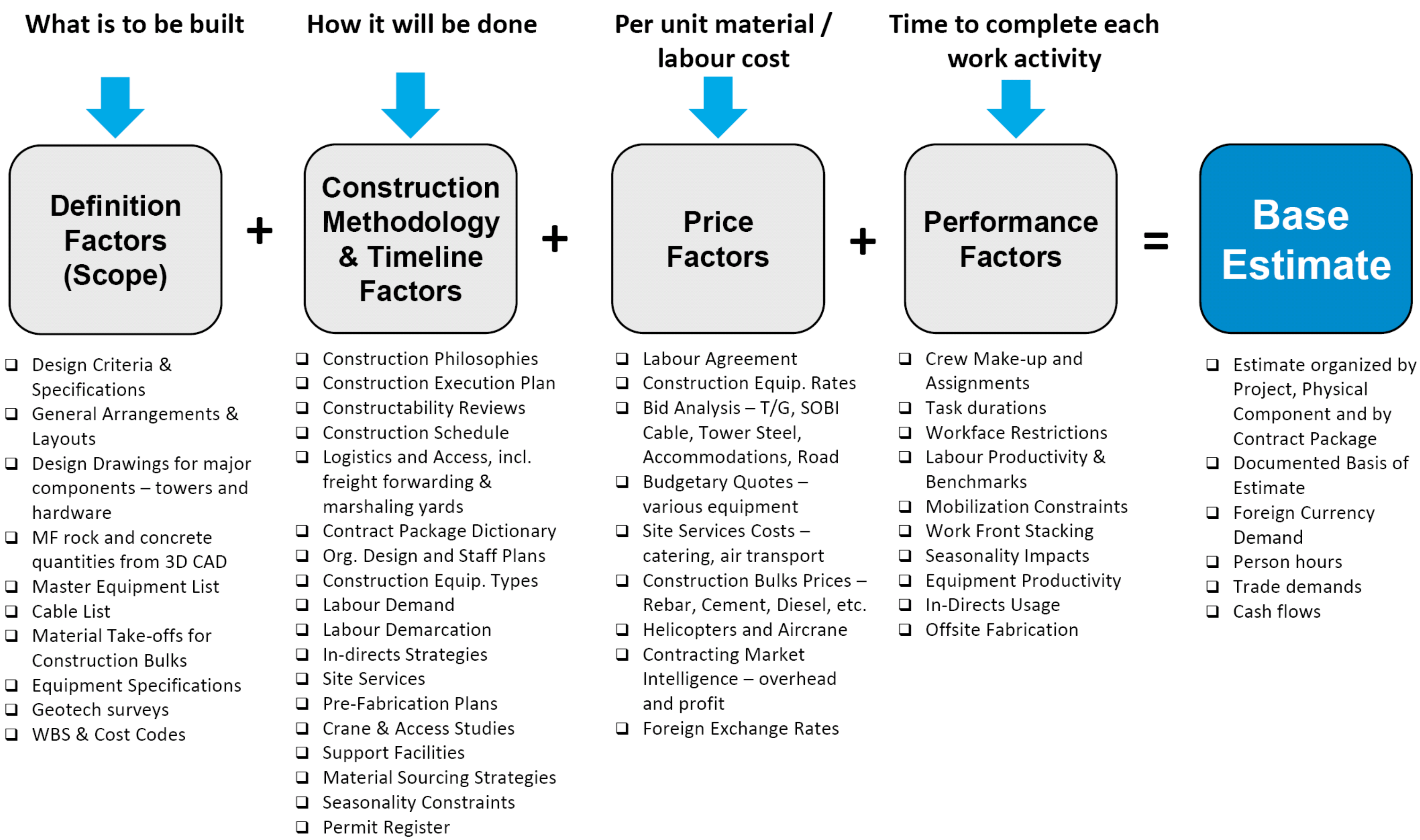
The development of the Base Estimate component of the DG3 CCE considers four (4) key groupings of inputs:

1. Definition / Scope – what is to be built
2. Construction Methodology and Timeline – How it will be done
3. Price – Per unit material and labor cost
4. Performance – measure of productivity or time required to complete each work activity

Expanding upon the estimate plan, Nalcor further defined the key elements that fall within each of the 4 groupings that would be considered during the development of the DG3 CCE to produce the listing shown in Figure 14-1.

The following sub-sections provide an overview of the key elements within these four (4) inputs that form the core of the basis upon which the DG3 CCE was prepared. Further detailed commentary of the relevant inputs is provided within Parts B through H of this *Decision Gate 3 Basis of Estimate*.

Figure 14-1: Extensive Data Set is considered in each of the Four Inputs



14.1 Definition / Scope Basis

The CCE integrates the engineering layout, definition and quantification as developed by each of the SLI Components engineering teams and the Marine Crossings team for the SOBI Crossing during the period leading up to the conclusion of Phase 1 of CCE development (Dec 2011). Subsequent to that period aspects of the design were progressed, with several project changes incorporated into either the Base Estimate or the Estimate Uncertainty review analysis completed at the end of May 2012.

The following sub-sections discuss the key documents that provide the definition basis used to develop the DG3 CCE. Inputs provided to the estimating team, mainly scope definition and quantification, for the purpose of the DG3 CCE were aligned with these documents and capture the latest intended technical scope and performance the Project.

14.1.1 Basis of Design

All design and engineering work performed for Muskrat Falls Generation during Gateway Phase 3 builds on final feasibility study Review and Confirmation of Muskrat Falls Layout, Structures and Interfaces, reference no. MFA-SN-CD-3000-CV-RP-0001-01, issued shortly after DG2 as well as the Basis of Design, reference no. LCP-PT-ED-0000-EN-RP-0001-01, Rev B1 issued at DG2. This Basis of Design has subsequently been revised and reissued as Revision B2 to reflect the outcomes of Gateway Phase 3. Both these documents served as basis for establishing the design criteria to be considered for the complete design of the Project's facilities and systems.

14.1.2 Design Criteria and Design Briefs

As part of the detailed design process, a significant number of Design Briefs (see Table 14-1) and Design Criteria (see Table 14-2) and System Studies were prepared by SLI engineering with the guidance of the Basis of Design and key design philosophies produced by Nalcor. These documents framed the design as envisioned. These documents were available to support the quantification process undertaken by the estimating team.

Table 14-1: Design Briefs Relevant to the DG3 CCE

Document No.	Title
ILK-SN-CD-8200-EL-DB-0001-01	Muskrat Falls to Soldier's Pond HVdc Island Link Converter Station Design Brief
ILK-SN-CD-8200-EL-RP-0001-01	Protection Design Brief (HVdc Network)
ILK-SN-CD-8200-EL-RP-0003-01	Converter Stations and Substations Auxiliary Services Design Brief
ILK-SN-CD-8500-EL-DB-0001-01	Cable Transition Compounds Design Brief
ILK-SN-CD-8600-EL-DB-0002-01	Shoreline Pond Electrodes - Design Brief
LCP-SN-CD-1400-TE-DB-0001-01	Telecommunication System - Design Brief Construction Phase
LCP-SN-CD-9200-TE-DB-0001-01	Design Brief (Phase 3)
MFA-SN-CD-1500-EL-DB-0003-01	Design Brief - Fault Calculations
MFA-SN-CD-1570-EL-DB-0001-01	Design Brief - Short Circuit Calculations

Table 14-2: Design Criteria Relevant to the DG3 CCE

Document No.	Title
MFA-SN-CD-6140-TL-DC-0001-01	315 kV HVac Tower Design Criteria Muskrat Falls to Churchill Falls Transmission Line
MFA-SN-CD-6140-TL-DC-0002-01	315 kV HVac Lines Design Criteria
MFA-SN-CD-6140-TL-DC-0004-01	315 kV HVac Foundation Design Criteria Muskrat Falls to Churchill Falls
ILK-SN-CD-6200-TL-DC-0001-01	350 kV HVdc Line Design Criteria
ILK-SN-CD-6200-TL-DC-0006-01	350 kV HVdc Line Tower Design Criteria
ILK-SN-CD-6200-TL-DC-0007-01	350 kV HVdc Line Foundation Design Criteria
MFA-SN-CD-6300-CV-DC-0001-01	Shoreline Pond Electrodes - Civil/Marine Design Criteria
ILK-SN-CD-6310-TL-DC-0001-01	Electrodes Lines Wood Pole Design Criteria
ILK-SN-CD-8600-EL-DC-0001-01	Shoreline Pond Electrodes - Electrical Design Criteria
MFA-SN-CD-0000-CV-DC-0001-01	Design Criteria - Hydraulic
MFA-SN-CD-0000-EV-DC-0001-01	Design Criteria - Erosion and Sedimentation Control
MFA-SN-CD-0000-GT-DC-0001-01	Design Criteria - Geological
MFA-SN-CD-0000-GT-DC-0002-01	Design Criteria - Geotechnical
MFA-SN-CD-1112-CV-DC-0001-01	Design Criteria - South Side Access Road
MFA-SN-CD-1320-EL-DC-0002-01	25 Kv Construction Power Line and 138kV Tap – Design Criteria
MFA-SN-CD-1500-EL-DC-0002-01	Design Criteria - Site Accommodation Complex and Electrical Utilities
MFA-SN-CD-2000-EV-DC-0002-01	Environmental Design Criteria Site Water Control
MFA-SN-CD-2420-ME-DC-0001-01	Design Criteria - Spillway - Mechanical
MFA-SN-CD-3000-EN-DC-0001-01	Design Criteria for Component 1 - Hydro Generation
MFA-SN-CD-3300-CV-DC-0001-01	Design Criteria - Civil
MFA-SN-CD-3320-AR-DC-0001-01	Design Criteria - Powerhouse Architecture
MFA-SN-CD-3340-EL-DC-0001-01	Design Criteria - Powerhouse Major Electrical Equipment
MFA-SN-CD-3350-ME-DC-0001-01	Design Criteria - Powerhouse Hydro Mechanical
MFA-SN-CD-3360-ME-DC-0001-01	Design Criteria - Powerhouse - Cranes and Elevator
MFA-SN-CD-3400-EN-DC-0001-01	Design Criteria - Turbine and Generator Units
MFA-SN-CD-3430-EL-DC-0002-01	Design Criteria - Electrical DC Auxiliary System
MFA-SN-CD-3430-EL-DC-0003-01	Design Criteria - Electrical AC Auxiliary System
MFA-SN-CD-3440-ME-DC-0001-01	Design Criteria - Mechanical Auxiliary
MFA-SN-CD-3450-EL-DC-0001-01	Design Criteria - Powerhouse Protection, Control and Monitoring

14.1.3 Single-Line Diagrams

The Single-line Diagrams (SLDs) were revised early in 2012 to reflect the final operating configuration as agreed with Nalcor's System Planning and supported by all system studies completed during Gateway Phase 3. The three key SLDs forming the basis of the estimate are listed in Table 14-3.

Table 14-3: Project Single Line Diagrams

Title	Reference No.
230kV Soldiers Pond Switchyard Single-Line Diagram	ILK-SN-CD-4500-EL-SL-0007-01 Rev. B1
735-315 CF Switchyard Extension Single-Line Diagram	MFA-SN-CD-4100-EL-SL-0001-01 Rev. B1
315-138kV Muskrat Falls Switchyard Single Line Diagram	MFA-SN-CD-4300-EL-SL-0011-01 Rev. B1

14.1.4 Plot Plans and Layout Drawings

An extensive number of plot plans and layout drawings were produced to characterize the boundaries and scope of the Project. These documents were prepared in 2011 and issued to the estimating team to support the quantification process. A detailed listing is contained is within Volume 18 of the supporting document to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

14.1.5 Short-Form Technical Specifications

For permanent plant equipment for which the results of RFPs were planned not be available (as discussed in Section 11.3), short-form technical specifications were produced in line with the documented design criteria and design briefs noted in Section 14.1.2 to support the pricing requirement of the estimate. Key items included:

- HVdc Converter
- Synchronous Condenser
- Power Transformers

A detailed list and copies of those specifications that were available to support the estimate are contained in Volumes 31 and 32 of the supporting document to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

14.1.6 Master Equipment List

All the major permanent mechanical and electrical equipment that are to be included in Muskrat Falls were compiled into a preliminary Master Equipment List. This list presents equipment that is ultimately to be individual tagged and incorporated into the Owner's asset management database. As an estimating tool, this list also ensures that the cost of all the required equipment has been captured. The master equipment list for Muskrat Falls is contained within Volume 24 of the supporting document to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

14.1.7 Quantification Process and Bill of Quantities

Leveraging the extensive engineering works completed up to the end of 2011, SLI engineering provided to the estimating team all the required quantities capturing the complete scope of work for each of the structures, facilities or systems to be estimated, following the contract packaging breakdown for the Project. The inputs provided to the estimating team took the form of quantity tables and spreadsheets that were developed by engineering using various means and methods that could be summarized as follows:

- Use of the CATIA 3D Modeling tool to extract volumes, surfaces and lengths of key materials required for the construction of the fill and concrete structures, formwork areas, main piping lengths, etc. CATIA 3D included all available geotechnical information with respect to bedrock and overburden elevations as determined from the analysis of the 2010 geotechnical field investigations at Muskrat Falls.
- Use of Lidar topography survey data and ortho-photos to extract vegetation coverage areas for reservoir and right-of-way clearing.
- Use of SLDs and Piping and Instrumentation Diagrams for the material take-off of the equipment included in the various systems considered by these diagrams.
- Use of transmission lines routing drawings for tower spotting and material take-off by type of tower including all steel and hardware.
- Material take-off of civil works quantities using traditional methods of cut and fill volumes calculations for all switchyards and various facilities along the Project ROW.

The result has been summarized in a number of key quantification basis, listed in Table 14-4 below, that substantial the basis of all quantities that form the basis of the Project Cost Estimate. Copies of all quantification basis are contained within the following volumes of the supporting document to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01:

- Volumes 19 & 20 – LTA / LITL Switchyards and HVdc Specialties
- Volume 21 – Muskrat Falls
- Volume 22 – LTA and LITL Overland Transmission

Further Volume 18 presents the detailed bill of quantities for the Powerhouse and Spillway civil and concrete works, which represents probably the most complex and interdependent of the entire work scope.

The Project Cost Estimate quantities have been developed using the Metric System of measurement. Cable and wire have been measured in American Wire Gauge (WG).

Table 14-4: Listing of Quantification Basis Documents

Contract Package Quantification Basis
Volume 21 – Listing of Quantification Basis
CH0002 - Accommodations Complex Buildings
CH0003 - Administrative Buildings
CH0004 - South side Access Road
CH0005 - Accommodations Complex Site Utilities
CH0006 - Bulk Excavation Works
CH0007 - Intake and Powerhouse, Spillway and Transition Dams
CH0008 - North Spur Stabilization Works
CH0009 - RCC dams & river Dams
CH0023/CH0024 - Reservoir Clearing South Bank / North Bank
CH0030 - Design, Supply and Install Turbines and Generators
CH0031 - Supply and Install Mechanical and Electrical Auxiliaries (MF)
CH0031 - Drawings supporting the Supply & Install Mechanical & Electrical Aux.
CH0032 - Powerhouse Hydro-Mechanical Equipment
CH0033 - Supply and Install Powerhouse Cranes
CH0034 - Supply and Install Powerhouse Elevator
CH0039 - McKenzies River Permanent Bridge
CH0046 - Spillway Hydro-Mechanical Equipment
CH0047 - Design, Supply and Installation of trash Clearing System
CH0048 - Site Clearing Access Road & Ancillary Areas
CH0049 - Supply and Install Log Booms
CH0031 - Supply and Install Mechanical and Electrical Auxiliaries (MF)
PH0014 - Generator Step-up Transformer
PH0015 - Isolated Phase Bus
PH0016 - Generator Circuit Breakers
PH0035 - Station auxiliary Service Transformers
PH0036 - Accommodation & Construction Site distribution System -Aux Transformers
PH0037 - Accommodation & Construction Site 25 kV Switchgear
PH0038 - Accommodation & Construction Site Diesel Generators
SH0019 - Provision of Security Services
SH0020 – Provision of Medical Services
SH0021 - Provision of Road Maintenance and Snow Clearing Services (MF)
SH0022 - Provision of Fuel Supply and Dispensing Services (MF)
SH0040 - Provision of Garbage Removal and Disposal Services (MF)
SH0041 - Provision of Ground Transportation Services (HVGB to MF)
SH0051 - Provision of Buildings Maintenance Services (MF)
Kenamu & Paradise Bridges - Access Roads for North Spur & Quarries
Clearing Estimation Costs - Hvac Lines
Clearing Estimation Costs - Hvdc Lines

Contract Package Quantification Basis
Volumes 19 and 20 – Listing of Quantification Basis
CD0501 – Civil & Electro-mechanical
CD0502 – Civil
CD0502 Electro- mechanical
CD0503 Civil
CD0508 Electrode Ponds
CD0534 Electro - mechanical
PD0533 SD0560 Telecom
CD0509 CD0535 Telecom
CD0510 Telecom
CD0512 Construction power
SD0536 Commissioning
CD0538 Churchill Falls Accommodations Complex
Volume 22 – Listing of Quantification Basis
315 kV HVac MF to CF Transmission lines
350 kV HVdc MF to SP Transmission lines

14.1.8 Capital and Operating Spares

Provisions for capital and operating spares have included within the Base Estimate of the CCE as recommended by the Nalcor LCP Tchnical and Design Integrity group and aligned with the operational philosophies. Sparing provisions include:

- Critical overland transmission spares
- Spare converter transformers at Soldier Pond and Muskrat Falls
- Spare segment of SOBI cable with carrousel

14.2 Construction Methodology and Timeline Basis

The following sub-sections discuss the key input into the Project Cost Estimate with respect to Construction Methodology and Timeline Basis as used to develop the DG3 CCE. Further details on the relevant considerations for each respective SLI Component and SOBI Crossing are detailed within Parts D through G.

14.2.1 Alignment with Project Control Schedule

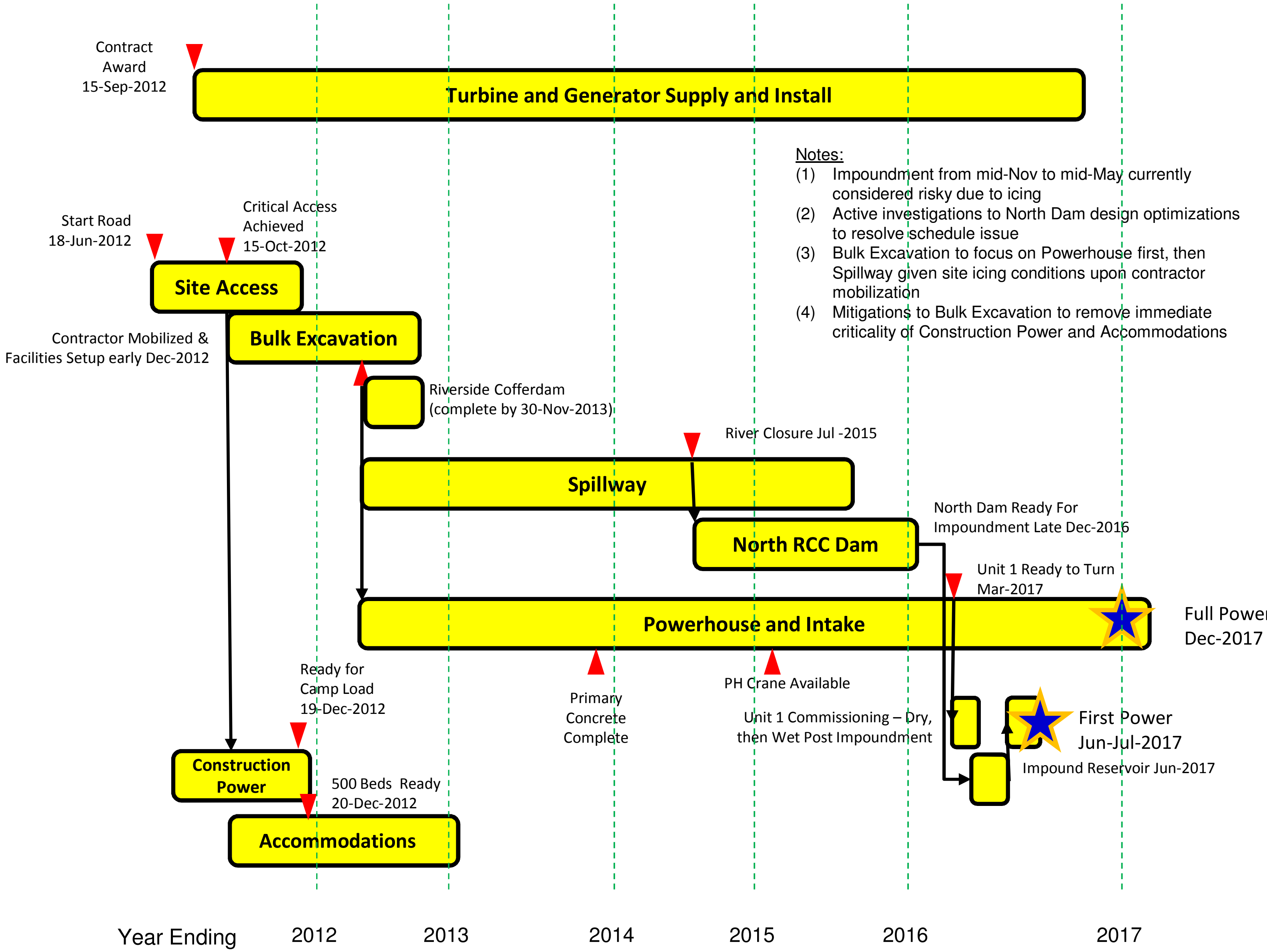
The DG3 Capital Cost Estimate reflects the key timelines and sequences as contained in the Target Milestone Schedule, reference no. LCP-PT-ED-0000-EP-SH-0001-01, and further reflected in the Project Control Schedule. This schedule indicates early works construction commencing in June 2012 following release from Environmental Assessment and ends with commissioning of the final turbine/generator unit and thus full power in January 2018. Figure 14-1 presents the underlying logic for the Muskrat Falls portion of the PCS, which essentially is the critical path for the Project.

The relevant portions of the latest Project Control Schedule while in development (at its developed stage on 13-Sep-2011 were provided to each estimator along with the other documents required for them to produce the estimate. Final time phasing was also conducted and validated at estimate intermediate close-out using the December 2011 Schedule for the issuance of the SLI DG3 estimate deliverable on 15-Dec-2011 thus concluding Phase 1 of the DG3 CCE estimate development.

During Phase 2 (post 15-Dec-2011), additional effort was expended to further detail and validate the DG3 Estimate and ensure final alignment with the Project Control Schedule. This exercise enabled the Project team to review and validate certain scheduling assumptions as well as the participation in constructability workshops of various components of the Project, mainly the Powerhouse, the Transmission Lines and Switchyards works. This process allowed the Estimating Team to review and fine tune portions of the CCE, increasing its overall accuracy.

Attachment B.1 and B.2 present the planned construction build sequence for both Muskrat Falls Generation and LTA and LITL Overland Transmission respectively.

Figure 14-1: Underlying Muskrat Falls Schedule Logic for Project Control Schedule



14.2.2 *Alignment with Contracting Strategy*

The DG3 CCE is intended to be aligned with the contracting strategy established in the Overarching Contracting Strategy, reference no. LCP-PT-MD-0000-PM-ST-0002-01, which has been further detailed on a package level with the LCP Master Package Dictionary, reference no. LCP-SN-CD-0000-PM-LS-0001-01. Using this guiding framework, the estimating team developed the Project Cost Estimate in a contractor-style framework where the estimate for each respective contract package was determined, including requirements for in-directs and considerations for profit and risk.

The effort to ensure alignment with contract packages helped to ensure the capture of all cost and verify the alignment of the entire project scope with the estimate. Estimate review workshop included a focus on ensuring alignment with the LCP Master Package Dictionary, including identification of scope gaps.

14.2.3 *Alignment with Construction Execution and Management Plans*

The DG3 CCE is intended to be aligned with the overall construction execution and management plans for the Project that were under various stages of development at the time of the development of the estimate. These plans outline the basic execution philosophies and plans for the Project that in turn identified key activities that were required to be included with the CCE, either as a Project indirect or Owner's Other Costs.

Logistics and marshaling strategy is discussed within the Overall Logistics Plan, and further elaborated with the C4 Construction Execution Plan.

For specific insights reference the documents listed in Table 14-5, as well as supporting Management Plans as discussed within Project Execution Plan (Scope and Approach), reference no. LCP-PT-MD-0000-PM-PL-0001-01 Rev. B2.

Table 14-5: Key Project Planning Documents

Title	Reference No.
Project Execution Plan (Scope and Approach)	LCP-PT-MD-0000-PM-PL-0001-01 Rev. B2
Construction Management Plan	LCP-PT-MD-0000-CS-PL-0001-01 Rev. B1
Component 1 Construction Execution Plan	LCP-SN-CD-0000-CS-PL-0003-01 Rev. A1
Component 4 Construction Plan	Draft Only
Construction Execution Plan	LCP-SN-CD-0000-CS-PL-0002-01 Rev. B1
Overall Logistics Plan	LCP-SN-CD-0000-SC-PL-0006-01 Rev. B1

14.2.4 Site Services and Indirect Requirements

The DG3 CCE is predicated upon a philosophy that Nalcor (with SLI) will operate the Muskrat Falls Generation Site, including the provision of all project in-directs to contractors. This open-for-business approach has been encompassed within the Project cost estimate by way of the definition and estimation of a number of site services activities that will be contracted directed by Nalcor, including:

- The establishment and operation of a 1,500 person accommodations complex and all supporting utilities;
- Provision of construction power to all contractors (not free-issued);
- Provision of overall site security including the Main Gate;
- Provision of overall medical and fire protection services for the site, including reservoir clearing operations;
- Provision of construction telecommunications services at the site;
- Provision of a centralized fuel depot for sale of fuel to contractors;
- Provision of busing service between accommodation complex and HVGB airport and surrounding communities; and
- Provision of garbage and waste removal from site.

For all other worksites, with the exception of Churchill Falls, the DG3 CCE assumes that contractors will be required to provide all required supporting in-directs for their activities, including the provision of housing for SLI and Nalcor representatives.

14.3 Price Basis

The following sub-sections discuss the key aspects of the Price Basis used to develop the DG3 CCE. Further details on the relevant considerations for the CCE are detailed within Parts B through G.

14.3.1 Permanent Plant Equipment and Material

As discussed in Section 11.1, with the assistance of Procurement, extensive budgetary price information was collected for all permanent plant equipment. To facilitate this process, mini-specifications were prepared by engineering and issued to vendors under a request for budgetary quotes. The resulting submissions were analyzed by the engineering team, with procurement and estimating, to arrive at a recommended pricing basis for the estimate. Almost exclusively, the average of the two highest vendor quotes was selected as the pricing basis of the DG3 CCE. Provisions for shipment to site were also included in the price selected as the basis of the estimate.

For selective, high-volume, low-unit cost items including cable tray, cable, instruments, rock bolts, etc. SLI's Global Procurement System was mined to provide a current price basis.

No provisions were made for import duties, while customs and brokerage support would be provided by Nalcor's existing broker.

Table 14-5 below presents the price basis for selected components, which are further discussed in Parts B through G. A detailed list and copies of price summaries and vendor quotes to support the estimate are contained in Volumes 15, 16 & 17 31 and 32 of the supporting document to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

Table 14-5: Pricing Basis for Selective Permanent Plant Equipment

Item	No. of Quotes Received	Comments
Tower Steel	12	
AC Conductor	7	
DC Conductor	6	
AC and DC Insulators	2	
OPGW	6	
Converter Station	3	
Synchronous Condensers	3	
Transition Compound	3	
Turbine and Generator	3	RFP Responses
Powerhouse & Intake Hydro-Mechanical	3	
Spillway Hydro-Mechanical	3	
Powerhouse Elevator	3	
Powerhouse Crane	3	

SOBI Mass Impregnated Cable	3	RFP Responses
Generator Step-up Transformers	4	
Power Transformers	3	
Circuit Breakers	4	
Disconnects	5	
Surge Arrestors	3	
Powerhouse Motor Control Centre	-	In-house Data
Powerhouse Isolated Phase Bus	1	

14.3.2 Construction Bulks and Consumables

As with Permanent Plant Equipment, procurement provided assistance to the estimating team to secure multiple vendor quotes to support the selection of a sound unit price basis for the estimate. Again to augment this initiative, the SLI Global Procurement System and intelligence of the experienced estimating team was able to provide substantial and valid unit price data.

Table 14-6 below presents the price basis for selected construction bulks. Volumes 15, 16 & 17 of Back-up Material provides information supporting the price basis for the items listed in Table 14-6 as well as other items of the estimate.

Table 14-6: Pricing Basis for Selective Construction Bulks

Item	No. of Quotes Received	Comments
Conventional Concrete Supply (all-in)	3	
Roller Compacted Concrete	2	
Rebar (all black)	3	All within Atlantic Canada
Structural Steel (Fabricate and Delivery)	3	
Rockbolts	3	
Blasting Agents	1	
Jet Grouting	1	
Cable Tray		
MV XLPE Cables	3	
Junction Boxes	2	
Lighting Fixture	2	

No provisions were made for import duties, as all items are assumed to be procured within North America.

14.3.3 Construction Indirect Costs

Construction indirect costs included in the CCE are based on typical costs, based on past experience, incurred by contractors required for executing their awarded construction work packages such as:

- Contractor mobilization and demobilization costs

- Rental, installation and operation of temporary construction site offices and facilities
- Contract administration and management personnel
- Site supervision, health and safety, survey and Contractor quality assurance personnel over viewing work performed by own foremen and direct workforce
- Utility supply such as air, water, electricity, etc.
- Job office expenses
- Vehicles, site communication, heavy equipment repair and maintenance shops and ownership insurance.
- In consideration on the Project`s Contracting Strategy, an administration fees to cover contractor home office expenses, overhead and profits were included to the estimated items as follows:
  - A 10% of direct costs allowance was added to all electrical, mechanical, powerhouse superstructure and architecture as well as substations electrical and civil works.
  - A 15% of direct costs allowance was added to the powerhouse concrete works
  - A 15% of direct cost allowance was added transmission line construction, including ROW clearing.
  - A 15% of direct cost allowance was added to reservoir clearing activity.
  - An allowance of 40% of direct costs was included in the mass excavation, dams and cofferdams estimate to cover contractor in-directs as direct and indirect values are at cost.
  - All other estimates developed using market pricing or budget quotes are deemed to be inclusive of profit and administration at a reasonable rate.

14.3.4 Craft Wage Rates

As a key cost driver, determination of prudent labor rates to form the basis of estimate has been given close consideration, since at the date of finalization of the Base Estimate, collective agreement negotiations were still underway.

Through a combination of a comprehensive labor market survey, which has included current and forecasted labor rates for major projects across Canada, discussions with project developers, and close consideration of the planned collective agreement structure for the Project, Nalcor has developed prudent labor rates and shift rotations as the basis for the Decision Gate 3 capital cost estimate.

Details of these recommended craft wage rates and labor demarcation are contained in the report Trade Labour Rates for use in Preparation of Capital Cost Estimates, reference no. LCP-PT-MD-0000-PM-RP-0001-013. The craft labor rates recommended within this comprehensive study includes all shifts, burdens/benefits, and premiums. Key assumptions underlying the recommended labour rates include:

- Labour rotation is assumed to be 20 days working, 8 days off (20/8) for all aspects of the Project (note that the collective agreement will provide contractors with the ability to work various work schedules);
- 30% of total labor will be on night shift at Muskrat Falls works only;

- Transmission is wall-to-wall IBEW, including ROW clearing; and
- Weighted average all-in rate used in consideration of ratio of working foremen, journeyperson and apprentices.

Table 14-7, 8 & 9 provides a listing of some of the key trade rates assumed for within the CCE as of May 2012. Labor rate escalation is considered as part of the calculation of the overall Escalation Allowance contained within the DG3 CCE.

Table 14-7: Typical Wage Rates using in the CCE for Muskrat Falls Generation

Trade	All-in Average Hourly Rate
Teamster – Group 3 (e.g. concrete truck driver)	$67.76
Operating Engineers – Group 4 (e.g. dozer operator)	$67.52
Electrician	$69.60
Rodman (rebar worker)	$69.77
Carpenter	$64.74

Table 14-8: Typical Wage Rates using in the CCE for Transmission Works

Trade	All-in Average Hourly Rate
Linesperson	$63.16
Operator	$57.92
Utilityperson	$53.84
Blaster or Driller	$57.92

Table 14-9: Typical Wage Rates using in the CCE for Reservoir Clearing

Trade	All-in Average Hourly Rate
Class 1 Labourer (general labourer)	$62.79
Class 5 HEO (Dozer, D6 and over)	$64.05

14.3.5 Housing Costs and LOA

The labor and housing strategy for the Project assumes the following:

- 1,500 person accommodations complex at Muskrat Falls which will be home to all works at the Muskrat Falls Site, including AC Switchyard and HVdc Converter.
- Estimate 95% of workers will be on rotational travel, with the balance of 5% from the local catchment area living out of the MF accommodations.
- Accommodations provided free-of-charge to MF contractors and EPCM staff.

- 150 person accommodations facility at Churchill Falls for construction of CF Switchyard Extension.
- Transmission and reservoir clearing contractors provide mobile camps.
- No accommodations constructed for Soldier's Pond works, Dowden's Point Electrode, and Shoal Coal Transition Compound in lieu of constructing and operating camps given to proximity to local housing. Workers paid LOA, which is considered conservative considering proximity to St. John's and normal 70 km travel free zone.

While the catering services contract for the Project has not been bid, the estimating team undertook various benchmarking against current and historical analogue operations (e.g. IOC Labrador West, Vale Long Harbour, Voisey's Bay, HQ's Eastmain 1A) in order to recommend an all-in rate for catering, housekeeping and building maintenance of $90 per day to be carried for each site.

14.3.6 Construction Equipment Rates

Construction equipment rates taken mainly from WEB based Equipment Watch July 2011 (www.equipmentwatch.com). For specialized equipment not present in the Equipment Watch tables, rates were developed from past experience on similar projects in comparable conditions. Additionally these rates were compared against those available and used by the third party check estimates developed by both Mulcahy and Hewitt.

Fuel consumption per equipment included in the tables was used to determine the fuel consumption for the Project. The fuel costs reflected in these tables are the following diesel fuel and gasoline rates.

The equipment rates used in the CCE are presented in Attachment B.3, while selective rates are provided in Table 14-10.

Table 14-10: Typical Construction Equipment Rates used in the CCE

Item	All-in Hourly Rate
BACKHOE CAT 385CL	358.28
BACKHOE CAT 365B	240.31
TRUCK CONCRETE 8M3	115.29
Crane Crawler 300 Ton	430.00
DOZER C/W U-BLADE CAT D9R	199.20
Loader Cat 992k 7.0 BCM	434.90
TRUCK DUMP CAT 773D 52T	177.44
TRUCK DUMP CAT 777D 97T	255.55
Feller Buncher	136.00
Nodwell	67.00

14.3.7 Fuel and Electricity Rates

Fuel and electricity rates were provided by Nalcor Investment Planning and NLH System Planning based upon the Corporate Planning Assumptions, January 2012. Table 14-11 lists these items.

Table 14-11: Fuel and Electricity Prices

Item	Price	Source / Comments
Ultra Low Sulfur Diesel Fuel (L)	$1.44	Nalcor IE, Delivered to HVGB
Gasoline (L)	$1.44	Nalcor IE, Delivered to HVGB
Propane (L)	$1.60	Nalcor IE, Delivered to HVGB
Electricity (kWh)	$0.03	NLH System Planning based upon highest rate class available in Labrador (>1000kVA customer) and includes demand charges

Notes:

1. 2012 pricing is PIRA Energy Group, World Oil Market Forecast, December 22, 2011
2. Post 2012 pricing is PIRA Energy Group long term forecast, Nov, 2011
3. Canada-US exchange as per Nalcor Energy Corporate Planning data Forecast, Dec 2011.
4. Average retail margin allowance by PUB-PPO as assessed for NLH rural region.
5. Taxes include applicable Provincial tax, Federal excise tax and 13% HST.

Provisions for electrical power consumption at Muskrat Falls were made based upon a load of 15MW and total usage of 170,000,000 kWh over the duration of the construction program. This included all loads related to accommodations and administration complex, and contractor's usage.

Power consumption included within contractor in-directs for overland transmission works is estimated at 2,500,000 kWh, while at Solider's Pond, Transition Compounds and Churchill Falls the consumption is estimated at approximately 7,810,000 kWh.

Estimated total diesel fuel consumption is 50,000,000 L, with details provide in Table 14-12. Supporting documentation to the CCE includes a fuel consumption report providing total consumption per equipment type.

Table 14-12: Fuel Consumption – Key Users

Contract Package	Volume (L)	Comments
CH0007 – Powerhouse, Intake & Spillway	11,000,000	
HVac and HVdc ROW Clearing and Lin Construction	8,800,000	
CH0006 – Mass Excavation	8,000,000	
CH0009 – North and South Dams	5,100,000	
SM0706 – Project Vehicles (Nalcor / EPCM)	3,200,000	Gasoline – Light Fleet
CH0008 – North Spur Stabilization	2,600,000	
CH0023 / 24 – Reservoir Clearing	2,600,000	
SH0021 – Snow Clearing and Road Maintenance	1,000,000	

14.3.8 Site Services Costs

As discussed in Section 14.2.4, Site Services for Muskrat Falls will be provided by Nalcor as operator of the site. To that effect, scopes of work have been developed for to support the CCE. Pricing data for these services have been obtained through estimator experience, first principal estimating, and third party benchmarks with historical data.

For example, the cost estimate for Contract SH-0041 Ground Transportation Services has been developed with consideration of the number of passengers and buses required to move workers to and from the airport and local communities

14.3.9 Trade Labor Rotational Travel

Craft labour and contractor management rotational air travel was estimated by establishing the foreseeable number of round trips according to the number of anticipated turnarounds for construction personnel on site. Key assumptions underlying the estimate include:

- Craft trades on rotational travel are provided economy class airfare to/from work location to home assuming 20 days on with 8 days off rotation, thus a trip every 210 MH worked or every 28 days = 13 times per year.
- Craft labor is sourced from Labrador (5%), Island (60%), Maritimes (20%), and Ontario/Quebec (15%). For estimating purposes, assume Moncton serves as a proxy for Atlantic Canada air fare cost, while Montreal is an appropriate proxy for Ontario/Quebec labor market.
- Based upon market intelligence, it will be cost effective to operate an air charter for the Island route, while other Canada to be via commercial airlines.
- Volume discounts of 35% off sticker price are a conservative assumption for commercial airfare.
- All air travel is coach/economy class.

- Workers travel on company time for one-way, hence effectively cost four hours of wages for travel. This will cover initial mobilization and demobilization of workers.
- All-in wage rate is assumed to be $70 per hour on average.
- No reimbursement for overnight requirement.
- An average travel allowance of $75 per trip is provided per individual to account for ground transportation to/from airport, meals and incidentals.
- Transportation to/from HVGB airport is provided by Nalcor under Contract SH-0041 Ground Transportation Services.
- Charter rates are based upon 50 person aircraft (DASH 8-300) with effective utilization rate of 75%.
- Flight distance to/from St. John's to HVGB is 1130 miles, while flight distance to/from Deer Lake and HVGB is 750 miles.

The result of this analysis is a recommended allowance of $1,200 per round trip, which is dispersed over construction packages at a rate of $0.80 per man-hour. It should be noted that this assumes that all workers are eligible for this amount, given that some of the work will be executed on the Island and workers may or may not rotate or may come from other locations.

Air travel costs for Owner's and EPCM personnel are captured in Owner's Costs.

14.3.10 IBA Designated Packages

As indicated in the Overarching Contracting Strategy, there are selected Muskrat Falls Generation packages which are nominated for Innu Nation partnered companies. The DG3 CCE does not include any overhead premiums to reflect this strategy, rather all such premiums shall be considered a part of the estimate uncertainty review undertaken in order to recommend an appropriate Estimate Contingency. .

14.4 Performance Basis

The following sub-sections discuss the key aspects of the Performance Basis used to develop the DG3 CCE. Further details on the relevant considerations for the CCE are detailed within Parts B through G.

14.4.1 Demarcation of Union Jurisdictions

The DG3 CCE has been developed with demarcation of union jurisdictions that is consistent with the Project Labor Strategy and presented in the trade labor rates contained within the report Trade Labour Rates for use in Preparation of Capital Cost Estimates, reference no. LCP-PT-MD-0000-PM-RP-0001-013. Simply stated the labor strategy assumes:

- Muskrat Falls will be constructed using a traditional civil-trades mix of the Building Trades (e.g. Operating Engineers, Teamsters, Carpenter, Iron Workers and Laborers) led labor agreement as is typical for all hydro projects in Canada. Other Building Trades will sign-on to the Collective Agreement negotiated with these five (5) unions.

- Transmission (including ROW clearing), switchyard and converter works will be undertaken using a wall-to-wall agreement with the IBEW.

- Reservoir clearing will be undertaken by traditional forestry practices, with collective agreement between Construction Labor Relations Association (CLRA) of Newfoundland and Labrador Inc. and the Labourer's International Union of North America (LIUNA), Local 1208, Construction, Rock and Tunnel and General Workers Union.

The union jurisdictions and demarcations within this framework is considered to be consistent with historical practice in Canada for similar works, thus validating the underlying direct and indirect crewing and production rates forming the basis of the CCE. To ensure consistency, internal experience construction resources confirmed the crew assignments against these labor agreements.

Further, the CCE explicitly assumes that the following resources are not within the Muskrat Falls Collective Agreement:

- Document Control and Administrative Support Staff
- Laboratory Technicians
- Survey Technicians
- Medical and Security Officers

14.4.2 Craft Norms and Production Rates

Within consideration of the labor strategy discussed above, Nalcor believe it would be viable to use historical performance norms as the basis for preparation of the CCE. Hence the objective ensuring the estimating organization contained seasoned estimators who possess first-hand knowledge of these production rates.

All direct craft labor norms and production rates based on readily available published productivity charts (e.g. RMS Means), and/or SLI historical data and estimator experience, predominately for similar works in the Province of Quebec. These estimates were compared against those produced by both Mulcahy and Hewitt and found be consistent with their experiences outside this region.

All base hours for electrical, mechanical, structural steel and architectural work estimates are based on US Gulf Coast to which a site-specific adjustment factor was applied to the chart hours.

For major items for which a turn-key lump sum budget or bid price was obtained for the purpose of the estimate, an evaluation based on past experience and proxy crews was conducted to establish the total labour hours by trade required for the construction of these items.

The location of the work site has been considered in the estimate, with items such as travel costs, typical work shifts and material and equipment transportation costs included. Particular consideration has been given the remote location and logistics constraints posed by working in winter.

Tables 14-12 and 14-13 provide several of the key productivity assumptions for labour and construction equipment. Further detailed information on the production rates contained within the estimate is included in Parts D through F.

Table 14-12: Selective Craft Labor Norms used in Intake and Powerhouse Concrete Works

Activity	Quantity	Production Rate	Unit of Measure
Form Fabrication	55,200 m^2	2.52	person-hours/m^2
Erect and Strip Forms	200,300 m^2	4.62	person-hours/m^2
Concrete Placement	329,300 m^3	0.51	person-hours/m^3
Concrete Incidentals	200,300 m^2	0.99	person-hours/m^2
Batch Concrete	329,300 m^3	0.38	person-hours/m^3
Haul Concrete	329,300 m^3	0.40	person-hours/m^3
Rebar Placement	19,870 MT	10.00	person-hours/MT
All-in Concrete Placement Rate	**329,300 m^3**	**5.97**	**person-hours/m^3**

Table 14-13: Selective Construction Equipment Productivity used in Excavation Works

Activity	Equipment	Production Rate	Unit of Measure
Overburden Excavation	CAT 992 Loader	150.0	m^3/hr
Production Drilling	ROC D7 Drills	20.0	m/hr
Rock Excavation	CAT 992 Loader	250.0	m^3/hr
Load and Haul	5 CAT 775F Trucks	250.0	m^3/hr

14.4.3 Pre-Employment Training

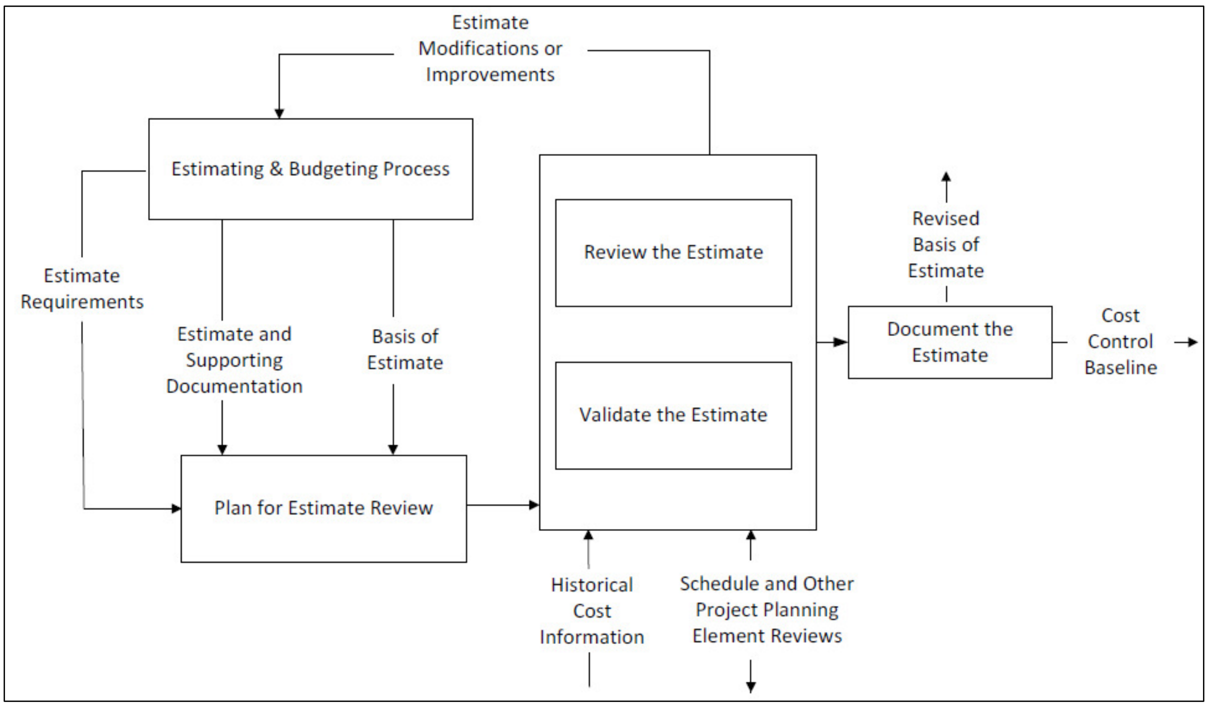
Consistent with the provisions being negotiated within the collective agreements with the RDC and IBEW for the Project, pre-employment training will be undertaken prior to mobilization to site and to the cost of the union.

15.0 Estimate Review Process

Estimate review is an important step in the establishment of the DG3 CCE. Generally speaking a review process is required to ensure that the estimate meets Project requirements, in terms of estimate quality, accuracy and documentation.

Late in Phase 1 and early of Phase 2 of the CCE development, a review process similar to that shown in Figure 15-1 was applied, with modification or improvements made to the CCE as a result of the review.

Figure 15-1: Estimate Review Process



The Estimating Team generally followed the estimate review process outlined in AACE International Recommended Practice 31R-03 Reviewing, Validating and Documenting the Estimate, which includes three main process steps:

1. **Review** – typically qualitative in nature and focused on ensuring that the estimate technically meets requirements. This quality review determines if the estimate covers the entire Project scope, was developed using required practices, is structured and presented in the required format and is free from errors and omissions.

2. **Validation** – typically quantitative in nature and focused on ensuring that the estimate meets the Project requirements in regard to its accuracy, appropriateness and competitiveness. The estimate is typically benchmarked against various cost metrics, including third party published data, similar completed projects or past detailed estimates. A validation process should be completed even if the review team also

prepared the estimate, Preference should be given to having an independent third party complete the validation process.

3. **Documentation** – the end result of the estimate review process should be a set of clear, consistent and reliable documentation that follows industry standards or best practices and has Project Team concurrence. Any recommended changes to the estimate should be documented and the Basis of Estimate should be updated to reflect these changes.

15.1 Initial Estimate Review – November 2011

Implementing this process, the initial estimate review took place in November 15-18, 2011 and assembled Nalcor and SLI relevant representatives. The complete scope of the estimate was covered over the three and a half days of the review. Work sessions each focusing on sub-components of the estimate were conducted. Each estimator presented the details of their respective estimate which lead to constructive discussions between all attendees and actions being recommended. These Actions Items were logged in a register and addressed prior to the December 15 issue of the DG3 Estimate SLI Deliverable, thus concluded Phase 1 of the CCE development.

A detailed list of the action log from this review is contained within Volume 41 of the supporting document to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

15.2 Alignment with Commitment Packages – Winter 2012

In February 2012 and as part of Phase 2 of the CCE development, it was decided to proceed with structuring the CCE into Commitment Packages. For each of the Commitment Packages, a package dictionary was prepared by the Components Engineering departments outlining all aspects of the packages including, scope, major quantities, work included and excluded, interfaces with other packages, schedule conditions, etc. This effort required a fair amount of coordination between engineering units.

The estimating team was deeply involved in the review process of the package dictionaries content, mainly to cross reference the scope of the packages reflected in the estimate with the scope stated in the package dictionaries. This exercise served as a Quality Assurance process which led to both Package Dictionaries and Packages in the estimate to be revised and aligned with one another. During the review workshop, action items were logged in a register and addressed.

A detailed list of the action log from these reviews is contained within Volume 41 of the supporting document to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

15.3 Hollman Review

In March of 2012, Validation Estimating, LLC was engaged by Nalcor to undertake a review of the estimate with to determine if it met the objectives of

1. meeting industry expectations and requirements for an AACE International Class 3 estimate;
2. serving as a basis for Gate 3 decision economic evaluations; and
3. serving as a basis for control budgeting of the next phase.

The results of this review were incorporated in the finalization of the DG3 CCE, the establishment of the Original Control Budget, and the documentation of this *Decision Gate 3 Basis of Estimate*. Overall the reviewer, John K. Hollman, concluded that *"… while not perfect, LCP Gate 3 estimate in its current state is one of the best mega-project "base" estimates that this reviewer has seen in some time. My conclusion is that this is in large part due to the active involvement of the owner leads in striving for best practices and quality."*

15.4 Manitoba Hydro International's DG3 Review

As part of the DG3 review and validation process, Manitoba Hydro International (MHI) was contracted by the Government of Newfoundland and Labrador to confirm whether the Infeed Option was the least cost option for the Province. As part of this review, MHI did review the DG3 CCE, including having various levels of engagement with the Project Team. MHI stated in its conclusions:

"Based on the amount of engineering completed and the number of tenders for which estimates have been provided by potential suppliers, MHI considers the Decision Gate 3 cost estimate to be an AACE Class 3 and thus would be considered reasonable for a Decision Gate 3 project sanction."(MHI Review, October 2012, page 78)

16.0 Benchmarking

During Phase 2 of the DG3 CCE development, selective benchmarking was undertaken to verify the quality of the estimate and validate key risk areas. The following sub-sections describe several of these activities.

16.1 Third Party Check Estimates

Nalcor employed the services of two (2) independent estimators to prepare "check" estimates for the Muskrat Falls civil and concrete works against the primary estimate activity being undertaken by SLI. This area is considered to have the greatest degree of exposure due to performance and productivity, hence the value of having multiple views.

Mulcahy and Hewitt were each provided with the same bill of quantities, construction schedule, and labor rates, while each was left to their own devices to determine appropriate production rates, fleet rates, and construction methodology upon which the estimate was be determined.

From this exercise and subsequent reconciliation exercise, it was apparent that each estimator had their own view of how the work would be undertaken, in particular construction methodology (e.g. crawler versus tower cranes). The result of this review concluded that despite having varying production assumptions and views on in-directs and mark-up, all three (3) estimates were within very close proximity, thus confirming the estimate being prepared by the SLI estimators.

16.2 PowerAdvocate

PowerAdvocate were engaged to undertake price benchmarking using its proprietary database of information and represent multiple suppliers in each category from multiple utilities across North America. Nalcor requested PowerAdvocate to benchmark our price points for a selection of permanent plant equipment (i.e. AC Conductor, AC Insulators, and Power and GSU Transformers) in order to validate the robustness of these high volume components. Further PowerAdvocate were requested to benchmark:

- Switchyard Construction In-directs
- Transmission Construction Overhead and Profit

All data points were been adjusted to reflect first quarter 2012 Canadian dollars

PowerAdvocate concluded that for all material prices, our estimate assumptions were generally conservative, with opportunity for further price reduction during actual bid events.

In the case of Transmission Construction Overhead and Profit, PowerAdvocate's benchmark average is 2.3% above the budgetary estimate and the benchmark minimum 8% below that contained in the CCE. Nalcor has explained this by virtue of the size of the construction contract that forms the basis of the estimate, hence the aggregate overhead and profit value is quite large.

PowerAdvocate found it difficult to benchmark construction in-directs given the amount of variance in interpretation of what is in and what is out.

As PowerAdvocates final report was presented in June 2012, the results of this benchmarking did not influence the DG3 Base Estimate, rather was considered in the Estimate Uncertainty review conducted in late May.

16.3 Benchmarking Against Current Hydro Projects

Nalcor through its affiliation in the Canadian Electrical Utilities (CEU) Project Management Network regularly meets with peer companies. From recent meetings, as-built production rates for concrete works at Wuskwatim in Manitoba, and the on-going Smokey Falls project in Northern Ontario were obtained. This information reaffirmed that the planned production rates for the Muskrat Falls concrete works are reasonable and achievable.

17.0 Estimate Packaging

As discussed in Sections 12.0 and 15.2, all procurement and construction works have also been coded on a Commitment Package basis consistent with the LCP Master Package Dictionary, document no. LCP-SN-CD-0000-PM-LS-0001-01.

The CCE as presented in the Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01, includes an estimated value for each Commitment Package that is planned to secured, while Volumes 1, 2 & 3 of the supporting estimate include detailed HCCS reports for each Commitment Package. This estimate coding activity has allowed the estimate to be effectively established for control as per the approach set forth in Project Controls Management Plan, reference no. LCP-PT-MD-0000-PC-PL-0001-01.

Commitment Package assignment was reviewed extensively through Phase 2 of the CCE development, including various workshop sessions (reference Section 15.2).

18.0 CCE Cost Flows

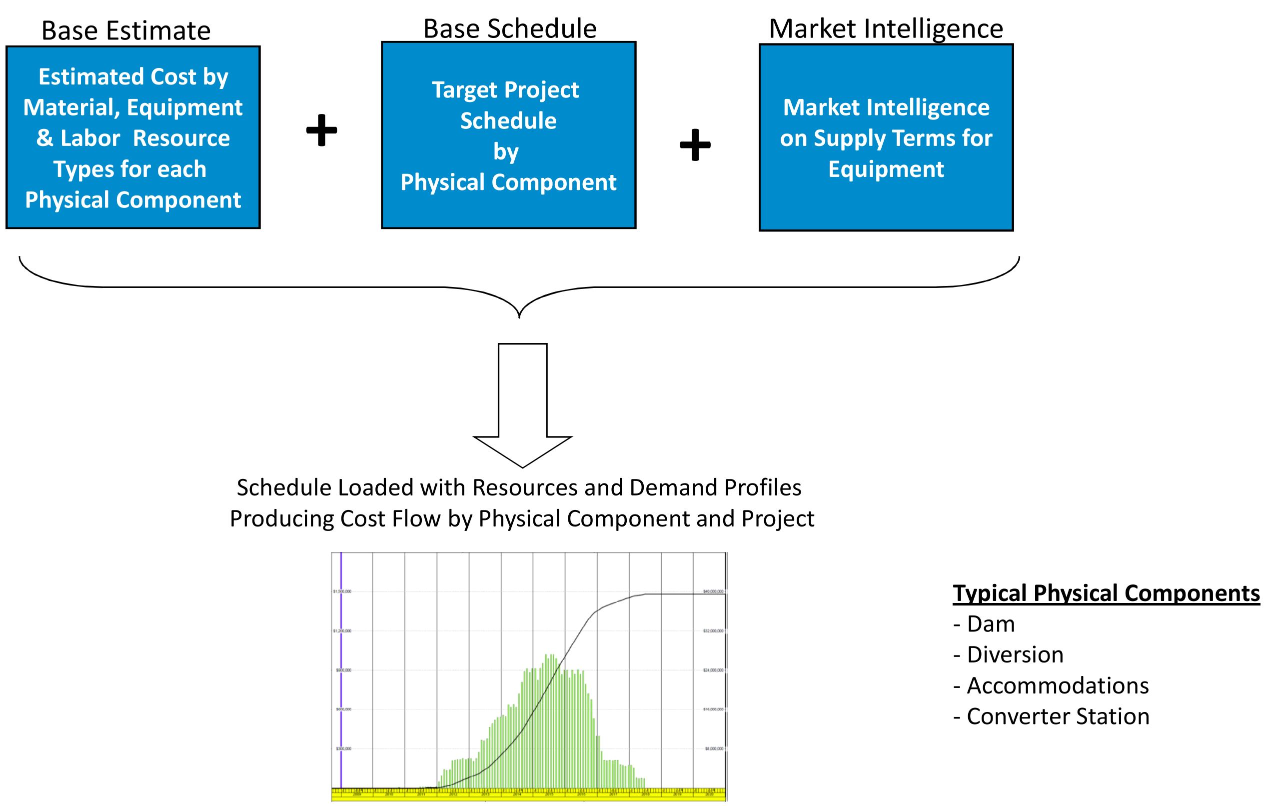
Figure 18-1 provides an overview of the technique or methodology used to translate the DG3 CCE into cost flows. In general terms, the Base Estimate is broken into key components of material, equipment and labor resource types of each Physical Component (e.g. Powerhouse, Reservoir Clearing, etc.) and is synchronized with the project schedule in Primavera Project Planner to produce cost flows. The resulting cost flows and then offset to produce cash flows.

Cost and cash flows produced for the purposes of the DG3 CPW analysis are contained within Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

These cost flows of the Base Estimate is used as an input into estimating the Escalation Allowance as is discussed within Decision Gate 3 Capital Cost Escalation Report, reference no. LCP-PT-ED-0000-EP-RP-0003-01.

Using a similar approach, the linkage of the Base Estimate and Project Schedule has facilitated the production of labor histograms for each Project, Physical Component, Commitment Package, and trade.

Figure 18-1: Determination of CCE Cost Flow



19.0 Estimate Exclusions and Exceptions

The Base Estimate component of the DG3 CCE contains no known exclusions. Nalcor developed a "Missing Items List" that was used to capture any identified gaps via provisional allowances, which were subsequently incorporated within the CCE.

The CCE is based upon the level of engineering definition and project planning available, while potential Project Changes have been considered as part of the Estimate Uncertainty review.

Potential Project Changes not included within the CCE are:

- DAN-0042: Single-Shower Arrangement in MF Accommodations Complex
- DAN-0096: Muskrat Falls Sports Complex
- DAN-0014: Expansion of Powerhouse Transformer Firewall
- PCN-0053: Construction Power - CF(L)Co Support & Assistance
- PCN-0054: Wood Utilization - South Side Access road and Ancillary Areas
- PCN-0055: Muskrat Falls Spillway Configuration – use of 5 vertical gates in lieu of hybrid approach
- PCN-0056: Addition of 2nd Service Bay on North Side of Powerhouse
- PCN-0058: Spillway Discharge Channel Concrete Liner
- Replacement of Forestry Access Road at Muskrat Falls
- TQ-0001: North Overflow Dam – RCC Steps – removal of CVC on downstream face of the dam

The CCE excludes the consideration of geotechnical investigations that were undertaken in spring 2012 by AMEC at each of the CF and MF switchyards and Soldier's Pond sites. The results of these assessments were considered in the estimate uncertainty assessment referenced above.

The CCE excludes any monies for site restoration costs, as it is assumed that the residual value of temporary site assets at Muskrat Falls (e.g. accommodations complex) will provide sufficient funding for any identified works.

The CCE excludes IDC and other Project Financing costs were captured as additional cost stream within the economic model prepared by Nalcor Investment Evaluation.

Historical costs up to 30-Apr-2012 as reported in the Monthly Project Progress Report for April 2012 have been included within the CCE for each of MF Generation, LTA and LITL.

20.0 Estimate Uncertainties and Opportunities

Consistent with the approach discussed within Section 12.4 of Project Controls Management Plan, reference no. LCP-PT-MD-0000-PC-PL-0001-01, a detailed review of the uncertainties and opportunities associated with the DG3 CCE was undertaken as part of a cost risk analysis. This quantitative assessment included an analysis of all areas of estimate uncertainty, including potential cost fluctuations due to definition or performance risk. The result was the determination of an "Expected Cost" and recommended Estimate Contingency. Some of the key areas of potential fluctuation considered in the analysis are listed in Table 20-1.

Table 20-1: Areas of Potential Fluctuation

Area of Potential Fluctuation	Key Influencers
Catering, Housekeeping & Site Services	• Market conditions – limited number of IBA-designated bidders • Support services and required to attract and retain skilled labor (e.g. menu choices, single-bath dormitories) • Increase in total person-days due to overall performance
Engineering and PM	• Competition for experienced resources within NL and Canada influences compensation rates • Increase in overall organization size to provide increased oversight and management of contractors
Intake, Powerhouse and Spillway Construction	• Engineering definition, incl. quantities confirmed; expect very limited variation • Productivity exposure influenced by availability of experienced construction labor and quality supervision • Wage rate exposure influenced by competition for resources within NL and Canada
HVdc Transmission Line Construction	• Quantities and material prices are mature, expect very limited variation • Productivity exposure influenced by availability of experienced construction labor and quality supervision • Indirect support requirement to support remote operation (e.g. medical services, camps and catering)
Synchronous Condenser	• Price fluctuation due to limited suppliers in the market • Scope growth due to design progression

21.0 Estimate Class and Estimate Accuracy

Estimate accuracy is the degree of confidence that the estimated cost will be close to the final project cost. As a project becomes better defined and less likely to change the more confidence there is that the estimate will accurately predict the final project cost. While influenced by its inherent complexity, in general terms the accuracy of a project's cost estimate is a function of two (2) key elements:

1. level of Front-End Loading (i.e. project definition) completed
2. understanding and mitigating project's risk exposure

For the LCP, the shaping characteristics which have increased the overall accuracy of the DG3 CCE are:

- Primary Driver:
  - High degree of project definition (i.e. represented by amount of engineering completed)
- Secondary Drivers:
  - Non-technically complex Project
  - Significant amount of effort expended to prepare estimate
  - High quality reference cost data available

Nalcor completed an estimate accuracy assessment using the approach set forth in AACE International Recommended Practice 42R-08 Risk Analysis and Contingency Determination Using Parametric Estimating. Westney Consulting Inc. undertook the review and concluded several findings, including:

"The scope for the project is well defined and represents design development consistent with project sanction. Considerations, such as likely geotechnical conditions and quantity variations due to further design development, were quantified based on the experience of the project team and used as a basis for assessing the possible outcomes.

The estimate and quantification are consistent with the requirements of project sanction. In many cases, pricing was based on actual bids and budgetary quotes. "Check" estimates were developed by industry experts for key areas, including the Muskrat Falls powerhouse and dam works. Other pricing was benchmarked against representative projects. The effects of weather, labour/skills availability, and supervision were also considered and/or benchmarked. Overall, this project's degree of design development, definition, and methodology is consistent with an AACEI Class 2 estimate."

22.0 Reconciliation to DG2

Since Decision Gate 2 (DG2), enhanced operational, reliability and construction-driven changes were made to the generating station and transmission assets. These changes refined the anticipated project cost, as seen at Decision Gate 3 (DG3). All Project Changes have been captured within the Project's Management of Change process as discussed within Project Change Management Plan, reference no. LCP-PT-MD-0000-PM-PL-0002-01.

The following sub-sections highlight these changes, while Table 22-1 highlights some of the fundamental parameters which have changed. Table 22-2 provides a listing of the major EPC/turnkey contracts for which the cost estimate have changed since DG2, as well as some of the underlying reasons for this change.

Table 22-1: Key Parameter Change between DG2 and DG3

Parameter	DG2	DG3	Change (%)
Total Person hours (millions)	15.0	20.0	+33%
Average Labor Hourly Rate	Long Harbour	Hebron	+8 to +13%
Diesel Fuel ($/L)	1.00	1.44	+44%
Concrete ($/m^3)	300	275	-8%
Rebar ($/kg)	1.80	2.00	+11%
Tower Steel ($/MT)	2,800	2,300	-18%
SOBI Mass Impregnated Cable ($/m)	585	690	+18%

Table 22-2: Price Change for Major EPC/Turnkey Contracts

EPC Contract	DG2 to DG3 Price Change	Key Influencers
Turbine and Generators	Lower $70 million	• General market conditions and strong competition amongst 3 pre-qualified suppliers
HVdc Converter Stations	Minimal	• Price has held relatively constant since pre-DG2
SOBI Cable	Higher +$60 million	• Engineering definition, including system operating voltage increase from 320 to 350kV, lengthen Land Cable from HDD exit point to Transition Compound, and embedded communications fibre for HVdc system. • Market conditions for cable installation vessels
Synchronous Condenser	Lower $40 million	• General market conditions and price for commodities • Improved design definition

22.1 HVdc Overland Transmission

- Operability / Reliability Driven Change
  - Operating voltage optimization (320 to 350kV) – less losses – results higher towers and different conductor
  - Ice loading criteria and physical data collection – results in more robust towers

- Constructability Driven Change
  - Access for remote Southern Labrador and LRM sections
  - Detailed line routing and construction methods, longer route (30 km) and more difficult access (e.g. helicopter construction)
  - Definition of ROW Clearing Scope – approx. $130M
  - Supporting infrastructure – marshalling yards, camps, etc.

- Market Driven Change
  - Increased Labor cost
  - Increased Material cost – budgetary prices or bids for all material

Table 22-3: LITL: Key Parameter Change from DG2 to DG3

Parameter	DG2	DG3	Change (%)
Operating Voltage (kV)	320	350	+10%
# of Towers	~3,900	3,633	-6.5%
Tower per km	3.34	3.38	-
Tonnes of Steel (MT) – Towers and Foundations	~14,730	37,112	150%
Total Construction Person hours (millions)	3.0	4.5	+50%

22.2 MF Powerhouse, Intake, Dams and Reservoir

- Operability / Reliability Driven Change influencing overall layout
  - Hydraulic flow conditions for T/G Unit 1
  - Stability of Intake Structure
  - Operability of Spillway Gates in winter
  - Flow conditions downstream of spillway – erosion mitigating
  - Results in significant increase in concrete quantities, thus materials and person-hours which is the major cost driver for MF
  - Changes identified with computer model were subsequently confirmed with Physical Model built in Edmonton (Northwest Hydraulics)

- Constructability Driven Change
    - Reservoir Clearing Execution
    - Winter Construction Constraints
    - River Management (i.e. riverside RCC cofferdam)
    - Site Indirect Services – power, batch plant, general services

Table 22-4: Muskrat Falls Generation: Key Parameter Change from DG2 to DG3

Parameter	DG2	DG3	Change (%)
Excavation (Overburden & Rock) (Mm^3)	5.0	4.1	-18%
Structural / Conventional Concrete (CVC) (m^3)	180,000	450,000	+150%
Reinforcing Steel / Rebar (MT)	14,750	24,000	+63%
Formwork (Intake/PH/Spillway) (m^2)	103,000	237,000	+130%
Structural Steel (MT)	4,000	3,200	-20%
Cofferdam Fill Structures (m^3)	600,000	895,000	+50%
Roller-Compacted Concrete (RCC) (m^3)	307,000	225,000	-27%
Spillway Gates	4	5	1 Gate
Total Construction Person hours (millions)	7.0	9.3	+33%

22.3 Engineering, PM & Other Owner Cost

- Significant increases in EPCM and owner costs as a result of:
    - EPCM contract awarded after DG2
    - Benefits strategy negotiated after DG2
    - 95% of engineering completed in NL. Significant premium to attract and retain workforce in St. John's
    - Strong competition for experienced personnel from Hebron, Vale Inco and across Canada
    - Release from generation EA two years later than expected resulting in delays to sanctioning, increased carrying costs for Nalcor
    - Additional unplanned reviews by PUB and MHI

22.4 MF and CF Switchyards

- Operability / Reliability Change:
    - Finalization of Single-Line Diagrams resulted in significantly larger footprint at Churchill Falls which could not be accommodated by simply expanding existing CF yard – hence large civil scope growth

  - Addition of 138kV capacity at MF Switchyard to facilitate future HVGB connection (Note: Not included within the capital cost for LCP Phase I).

- Constructability Driven Change
  - Site services support at CF for 2+ years
  - Poor foundation conditions at Muskrat Falls require material replacement
  - Logistics / transport cost for heavy lift items (i.e. transformers)

22.5 MF Site Support Services

Primarily driven by the highly competitive market in Camps and services that has developed in Canada and NL since DG2 Including:

- Operating costs for increased person-hours of construction effort for Muskrat Falls
- Market costs for services such as catering and housekeeping
- Laboratory and Surveying Scope increase for larger, more complex MF plant
- Medical and security requirements
- Increased Cost of services such as ground transportation, drug and alcohol testing, pre-employment medical screening, road maintenance, vehicles

22.6 HVac Overland Transmission

- Constructability Driven Change
  - Detailed line routing and construction methods resulted in detailed understanding of ROW clearing scope
  - Increased support services costs driven by highly competitive market in Canada regarding– marshalling yards, catering, camp, travel, medical support, etc.

- Market Driven Change
  - Increased Labor cost
  - Increased Material cost – budgetary prices or bids for all material are now in hand and are higher than estimated at DG2

Table 22-5: LTA: Key Parameter Change from DG2 to DG3

Parameter	DG2	DG3	Change (%)
Operating Voltage (kV)	345	315	-9%
# of Towers	~1,200	1,278	+7%
Tower per km	4.85	5.17	+7%
Tonnes of Steel (MT) – Towers and Foundations	~10,000	10,370	+4%
Total Construction Person hours (millions)	1.2	1.7	+40%

22.7 HVdc Converters & Specialties, and Island Upgrades

- Operability / Reliability Driven Change
  - Operating voltage optimization (320 to 350kV) resulted in required stability with existing island system, less line losses which followed detailed system planning studies carried out post DG2
  - Requirement for Indoor Cable Transition compounds to reduce salt contamination risk
  - Redundancy/reliability requirements resulting in additional cable switching facilities to facilitate remote energization of the spare cable

- Design Evolution Driven Change
  - Increased scope of Holyrood Conversion for Synchronous Condenser support
  - Finalization of Electrodes Sites
    - The electrode line length in Labrador was increased to the SOBI in order to achieve the required technical grounding requirements, site investigation work to determine this was post DG2.

22.8 SOBI Crossing

- Market Driven Change
  - Confirmed cable supply / install prices from RFP

- Design Evolution Driven Change
  - Final project definition and cable routing
  - Confirmed ice protection requirements for shoreline and seabed

- Constructability Driven Change
  - Actual HDD drilling rates from 2011/12 pilot program were favorable compared to as-planned

22.9 MF Site Infrastructure

- Constructability Driven Change
  - Requirement to replace existing forestry access road, the condition of this road was found to be unsuitable when work started
  - Increase in construction power load following study work
  - Construction telecommunications
  - Movement of MF Accommodations Complex due to poor geotechnical issues at DG2 location
  - Allowances for offsite access upgrades – port facilities and bridging for movement of heavy items

- Market-Driven Change
  - The highly competitive market conditions for accommodation complexes across Canada

Part B: Owner's Project Management and Other Costs

23.0 Owner's Project Management and Other Costs

23.1 Scope and Approach

Nalcor prepared the Owner`s Project Management and Other Costs in accordance to the Cost Code of Accounts established and utilized since 2007. This structure facilitated the identification of key scopes of work and associated resource requirements that would be required during post DG3. The following sections provide the basis for each of these items.

23.2 Assumptions, Exclusions and Exceptions

The following items are excluded from Other Owner`s Costs:

- Costs related to the securing of Project finance have been identified by Nalcor Treasury and have been included in debt financing calculations completed by Nalcor Investment Evaluation
- Any foreign currency related exposure
- Costs related to the Churchill Fall Redress agreement as a part of the New Dawn agreement with the Innu Nation
- Environmental Assessment and Aboriginal Affairs that must be allocated to Gull Island
- Costs related to joint venture stewardship of the Maritime Link

23.3 Allocation of Shared Costs

All common and shared costs for Owner's Project Management and Other Costs have been allocated within the CCE consistent with the principles set forth in accordance to the document Cost Allocation Principles, reference no. LCP-PT-MD-0000-FI-PR-0004-01.

Similarly all shared costs between LCP Phases I and II related to Environmental Assessment and Aboriginal Affairs have and will continued to be allocated by Project Controls, with Nalcor`s Finance and Accounting team's concurrent, in accordance to above referenced document.

23.4 Project Team

The Owner`s Project Team Costs have been estimated based upon a detailed organization charts and associated mobilization and demobilization plans, document in a position register, were prepared to account for all individuals to be engaged in the above mentioned activities. Effort was made to ensure careful alignment with the roles and responsibilities set forth in the Project Execution Plan (Scope and Approach), reference no. LCP-PT-MD-0000-PM-PL-0001-01, and supporting Management Plans.

Various review sessions were conducted with both Project and Functional managers to determine these staffing requirements, paying particular attention to mobilization and de-mobilization dates, as well as which positions would be either part-time or full-time assigned to the field.

The Owner`s Project Team cost can be broken down into two major categories: (1) Labour Cost, and (2) Other Cost.

Labour costs are related to personnel mobilized as contained with the Project Position. For each position in the position register there are a number of associated parameters which are used to calculate the cost. These parameters are outlined in Table 23-1. Given the Owner`s Team is largely in-place, actual costs associated with each position were applied where current positions were filled and reasonable assumptions were made regarding compensation for vacant positions, taking into account current market conditions. Actual costs for each position include base salary, payroll burdens, pension allocations and mandatory government payments such as Income tax, CPP and UI payments.

A detailed approved staffing plan with associated Organization Charts can be found in the Back-up Material of Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01, while Figure 23-1 presents a histogram for the entire Owner's Project and RFO team.

As of May 2012, there are 183 positions within the Owners' Team Project Management Team, with 135 positions filled with 48 remaining to be filled. Over the life of the Project, the maximum number of positions reaches its peak at 156 filled positions, in April, May and June of 2013. This includes the Policy and Planning Group, who fall under the Gull Island Project.

Figure 23-1: Owner's Project Team and RFO Team Mobilization

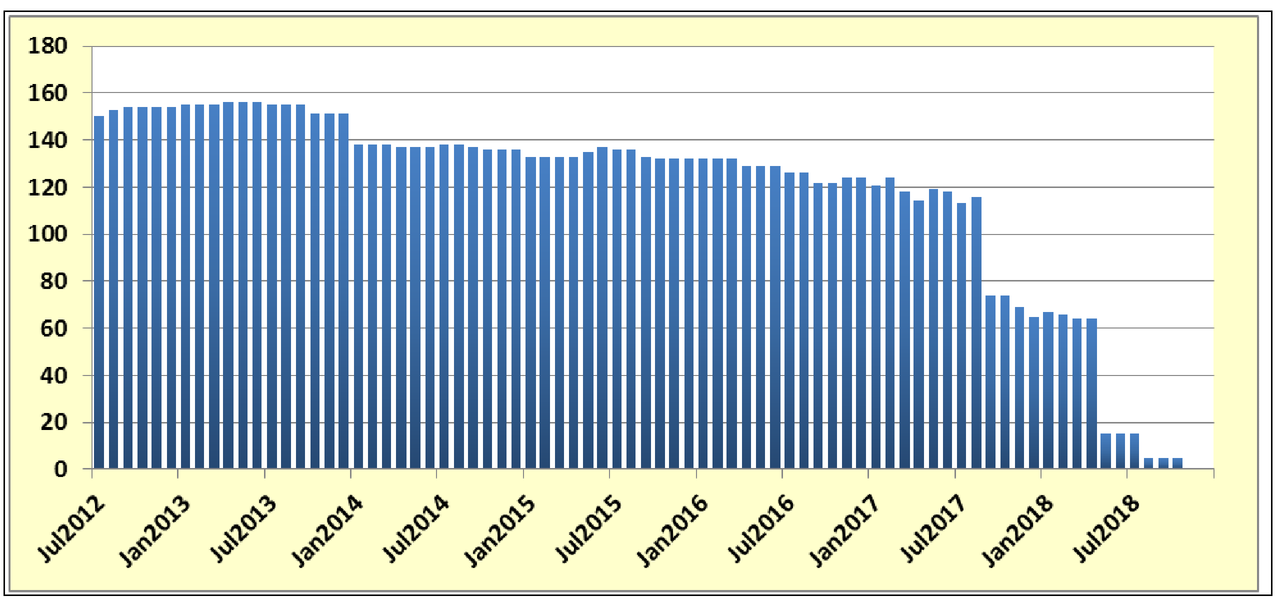


Table 23-1: Parameters for Calculation of Labor Costs

Parameter	Explanation
Hourly Rate	Basic hourly rate associated with each position, varies by position. For the 183 Owners' Team Project Management Team positions, the average hourly rate is $97.04.
Hours per Day	Hours worked per day. Varies based on if the position is located in the home office or field. Home office positions are 8 hour days, while work in the field is on 10 hour days.
Days per Week	Number of Days Worked in a Week. Note, full time field positions working on a rotation basis, have a work week equal to their rotation length. For field positions, default is 6 days a week, and for Home office is 5 days per week.
Weeks worked per year	This model is based on a 52 weeks a year.
Overtime Allowance	5% is allowed for home office positions, and 0% for the field.
Field Rotation	Full time field positions, will be based on a 14/4 rotation
Field Uplift	Work completed in the field will have a 15% uplift applied to the hourly rate.
Field Start Dates	Field Start Date for the MF Site Manager is set to Start of Roads Construction (1-Jun-2012). All remaining field and part time field start dates are set to Start of Mass Excavation + 6 months (1-May-2013).
Living Allowance	For selected positions (i.e. Senior Construction Management and Engineering positions anticipated to relocate). For St. John's based positions that receive a living allowance, the hourly rate has been increased by $15/hr, to compensate.

Other Costs are related to non-labor associated cost. Some may be indirectly linked to personnel, such as the office lease, which depends on office size, which in turn depends on manning levels.

Table 23-2 lists the expenses that are applied to all positions on the noted frequency.

Table 23-2: Expenses Allowances for All Team Members

Expense	Allowance Included	Frequency
Desktop Computer	$3,000	One-time
End User Desktop Software	$1,000	One-time
Office Set-up	$2,000	One-time
Computer Systems Overhead	$300	Monthly
Standard Application Maintenance	$42	Monthly
Office Supplies and Materials	$200	Monthly
Land Line Telephone	$100	Monthly
Training and Seminars	$200	Monthly

Table 23-3 lists the expenses that are applied to specifically identified positions on a reoccurring basis.

Table 23-3: Reoccurring Expenses Allowances for Specific Positions Members

Expense	Eligible Positions	Allowance Included	Frequency
Blackberry Monthly Cost	Managers and Leads	$150	Monthly
Primavera Monthly Maintenance Cost	Planners and Schedulers	$85	Monthly
Living Allowance for HVGB	Field Position Managers and Senior Engineering	$5,500	Monthly
Field Accommodations Cost	Full-time Field Positions	$80	Daily
Field Accommodations Cost	Part-time Field Positions	$40	Daily
Turnaround Travel	All Part-time or Full-time Field Positions	$1,208	Rotation
Business Travel		$385	Monthly

23.5 Ready for Operations Team

Similar to Owner`s Project Team costs, the cost estimate for the Ready for Operations Team has been prepared using a staffing plan, mobilization schedule and associated position register.

A detailed staffing plan for the Ready for Operations Team can be found in in the Back-up Material of Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

23.6 Project Team Business Travel

Project Team travel is calculated based on department requirements and is inclusive of Business Travel, Vendor Visits, Site Visits Special Project Meetings and is based on the following three categories:

- Local Travel (within Province)
- North America Travel
- International Travel

All business trips are calculated on a one-week rotation with travel on Monday, four nights hotel accommodations, five day car rental and five day per diems and return to home office on Friday.

All costs allowances for business travel is captured within the reoccurring expense category for the Owner's Project Team.

Table 23-4: Business Travel Allowances

Item	Allowance per Trip
Return flight within NL	$800
Return flight within Canada, but outside NL	$1,200
Return flight outside of Canada	$4,000
Hotel	$150
Rental Car	$50

23.7 Project Office Lease and Operating Costs

The Project Team has its Home Office at Hydro Place (5th Floor), which encompasses the SOBI Marine Crossing Team, while a significant portion of the team are co-located with the EPCM Consultant in its Torbay Road Project Office. Additionally a small satellite office is operated at Happy Valley – Goose Bay, primarily serving as a communications center.

Office costs at Hydro Place are calculated based on Nalcor corporate allocation for office space at Hydro Place (entire 5th Floor) and equates to $800 per month per person location, while cost at Torbay Road payable to SNV-Lavalin as per the EPCM Services Agreement is $600 per month per person location. The Project Team has analyzed its staffing requirements and has determined that no additional office space is required for the duration of the project.

For Labrador works, the initial plan will be to rent available space for up to 30 people to support early works construction, until such time as the site offices at Muskrat Falls are available. These will be constructed at the Accommodations Complex and are considered part of the construction in-directs costs.

On the Island, a small office for approximately 20 persons is planned to leased at or near Deer Lake to support the management of the overland transmission works. Other sites (Transition Compounds, Electrodes, Churchill Falls, and Soldier`s Pond) will be served via construction trailers which have been captured as part of construction in-directs.

23.8 Information Systems and Information Technology

The Information Systems and Technology estimated developed to support the LCP is aligned with IS guiding principles and the overall IS Strategy. Based on regular discussion with Project stakeholders and assessment of business requirements, the budget includes the computer systems and services required to support all Project requirements.

Business units within Nalcor receive an annual allocation from Corporate IS (both capital and operating) to cover costs associated with new corporate applications, infrastructure updates (servers/storage), licensing for corporate applications that BU's utilize (e-mail, MS office, etc.) and IS support services. Operating costs are coordinated (based on head count) through the Hydro Finance and LCP F&A departments.

The following assumptions were used in developing the IS/IT budget:

- Based on projected user base of approximately 140 member Nalcor Project Team
- Assumes LCP specific systems and services only. They indicate predicted allocations to sustain the current computing environment and assume reasonably static business requirements.
- Any additional cost increases/decreases in maintenance or manpower costs would be based on changing business scope
- Anticipate increased hardware costs in 2012 to support Muskrat Falls operations startup including Nalcor and SLI desktop and server infrastructure
- Propose reducing IS/IT staff to 3 post First Power and possibly to 2 in 2018 integrated within Nalcor Operations
- Budget does not include costs allocated from IS Corporate
- Based on the existing portfolio of applications and systems that are currently in place to support the Project, we do not foresee significant changes in the baseline infrastructure and application systems that have been established.
- Future year expenditures will be primarily targeted at maintenance and regular support operations however experience has shown that new application and software products will be required as the Project moves through the various phases of construction.
- The IS budget also considers the typical yearly variations in hardware and software systems including inflationary increases.
- From a resourcing perspective, and based on the support model adopted to support the Muskrat Falls and remote site locations, the resource plan forecasts a reduction in staff beginning in 2014 and further reductions in late 2016 as the Project transitions to Operations.

All personnel costs for IT services are captured as part for the Owner`s Project Team cost per person year included in Staffing Database.

The following sub-sections provide a detailed description of the IS/IT Budget by cost category. Complete details for the budget estimate are contained in the Back-up Material of Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

23.8.1 Hardware Purchases

Primarily covers costs associated with new hardware assets required to support back-end infrastructure (servers, network, storage, print) and end user computing systems (desktop, laptop, mobility, tokens).

- Server Equipment (domain controllers, file/print , application)
- Network Equipment (routers, switches, firewalls, web accelerators)

- Deskside Equipment (desktop, laptops, workstations)
- Peripheral Equipment (Printers, Plotters, Scanners, Videoconferencing)
- Mobility Equipment (Cell Phones, Smart Phones, Tablets)
- Facilities Fit-up (Project Office, Site Offices – Nalcor/SLI)

23.8.2 Software Purchases

Primarily covers costs associated with planned software and application assets (either server based or named user) purchased to support IS Projects identified throughout the budget period. Examples include Ares G2 upgrade, Benefits Reporting and Land Acquisition. Also covers Project specific (e.g. PSCAD) and standard user licenses (e.g. Microsoft) required for end user desktop systems.

23.8.3 Software (Integrated Tool)

This category of software includes costs specifically around the development, licensing, implementation, consulting, training for software identified as the “Integrated Tool” suite. This includes costs identified specifically for Ares, Documentum and Aconex systems.

23.8.4 IT Maintenance / Support

Covers costs associated with the ongoing maintenance and support of the LCP software and application portfolio, hardware support and printer lease costs. Also includes hosting and access costs for external based applications such as Aconex.

These costs are typically invoiced annually throughout the year.

Annual maintenance costs for software can increase from 3-10% per year depending on vendor.

23.8.5 Utilities

The utilities budget generally covers cost associated with data services (e.g. IPVPN data link form Hydro Place to Torbay Road), voice services (Centrex) and data charges for mobile devices.

23.8.6 IT Professional Services

Covers temporary IS support (e.g. backfill) or consultancy costs (e.g. IS project support, SME)

23.8.7 IT Application Development

General development costs for LCP applications (e.g. GIS, web development)

23.8.8 SLI Site Hardware and Operational Costs

In addition to those items mentioned above, an early estimate for site IT technology, including phones, was developed by SLI which estimates a start-up cost of $868k and an annual reoccurring cost of $60k. For the purposes of establishing the CCE, this early estimate has been increased to a provisional amount of $2 million, and has been allocated against Commitment Package SM0710.

23.9 Labrador Fibre Project

As part of the Labrador IT Initiatives, the project will cost share through the Provincial Government a portion of the infrastructure requirements. Regular IT Communication services will be provided to the project and included as part of construction in-directs. Nalcor`s share of this initiative is $8.3 million, all of which is allocated to the Labrador Transmission Assets.

23.10 Training

Allowances for Project Team training has been included within the reoccurring expenses associated each position as indicated in Section 23.4.

Provisions for pre-employment training that Nalcor may sponsor are captured in costs associated with our Industrial Benefits Commitments.

No specific allowances have been made within this Project Cost Estimate for specialized RFO training, other than what is included within the Energy Control Centre software upgrades. This decision was made with consideration that the RFO team would be fully engaged in the project prior to First Power, and participates in the integrated commissioning scope.

23.11 Industrial Benefits and Gender Equity Programs

The success of the LCP Construction Projects Benefits Strategy (BS) is dependent on partnerships with existing governmental departments, labour organizations, and stakeholder groups. LCP will optimize existing programs and services to achieve the objectives set for in the Benefits Strategy and the Gender Equity and Diversity Program. Table 23-5 outlines the estimated contributions required by LCP to implement required initiatives.

In summary, the Project Cost Estimate includes an estimated amount of $1.2 million for programs related to meeting Nalcor Commitment to Benefits.

Table 23-5: Summary of Costs for Implementation of Benefits Commitments

Commitment	Implementation Strategy	Budget Holder	Partnerships	Estimated LCP Contribution
Supplier Development Sessions (3.5 BS)	Lead: Consultation Technical: Supply Chain	Consultation	Department of Business, Business Organizations	Included in Consultation Communications Budgets
Safety Sessions potential contractors (3.6 BS)	Lead: Consultation Technical: Safety	Consultation	Department of Business, Business Organizations	Included in Consultations and Communications Budget
Procurement Website (3.9 BS)	Lead: Communications Technical: Procurement	Communications		Included in Communications Budget
Gender Equity and Diversity (5.0 BS)				
Pre- Employment Training	Work with existing programs to prepare workforce	Benefits	Province of NL Government of Canada (list of programs can be provided). LCP has successfully partnered in these programs using In-kind contributions, however cash contributions can be used to leverage funding	$500 000 (LCP has also committed to lending Innu Nation $2 million for training in advance of payments under the IBA.)
On the Job Training	Apprenticeships are factored into staffing estimates. Province pays for block training. On the Job Training for New Entrants can be subsidized by existing programs if desired. LCP will work with contractors to integrate new worker who have been previously trained through pre-employment programs	Construction	Same as above	$500 000
Supervisory Training	Work with labour organizations and contractors to ensure consistency with LCP obligations. Contractors and Labour Organization have their own supervisory programs. Some modifications may be required to meet LCP obligations	Benefits	Labour Organizations Contractors, Government Programs	$200 000
Career Fairs, Recruitment	Human Resources and Communications	HR and Communications		Recruitment Strategy
Applicant Data Bases, providing contractors and	LCP Employment database already in effect. Contractors and Unions have applicant lists. LCP will provide			

unions with stakeholder database contacts	contractors and unions with contacts in stakeholder groups		
Gender Sensitivity, Cultural Awareness, Respectful workplace	Included in new hire orientation		
LCP Promotional Material	Communications	Communications	
Appropriate sized safety equipment and tools	Safety gear should be available in women's sizes. This equipment is not more expensive and all contractors should have this as a course of doing business		
Shift scheduling considering work and family balance	There should not be an additional cost to this clause, any more than considering safety, or cultural requirements		
Working with organizations to develop and support caregiving solutions	This is not an onsite day care, but working with organizations to come up with community solutions.		
Diverse Supply Community	Work with existing organizations and provide contractors with a list of potential subcontractors		
Reporting and Monitoring	Benefits System Implemented through project Controls	Project Controls	
Achieving Goals and Targets	Implementing above initiatives will be instrumental in achieving goals and targets.	Benefits	$500 000 (This amount should be kept in reserve and used to optimize other opportunities as they arise.)
Total			**$1.2 million**

23.12 Tax and Audit Support Services

Nalcor F&A group prepared an assessment of the required Tax and Audit Support Services that would be required on the Project. Key assumptions included:

- Support will be a combination of corporate resources and external services
- Project F&A will also provide support to the audit function
- Rates for external services:
  - tax services = $275 per hour
  - audit services = $225 per hour
- Rates for corporate services:
  - tax services = $150 per hour
  - audit services = $150 per hour

- 2012 & 2017 - time = 1/2 month equivalent (for each of corporate and external support for tax and audit services
- 2013 - 16 - time = 1 month equivalent for each of corporate and external for each of tax and audit services

23.13 Corporate Administration Costs

Nalcor F&A group prepared an assessment of the estimated fees associated with Corporation Administration or provision of shared services to the Project, specifically those areas falling underneath the VP of HROE (safety, HR, environment). Corporate Administration fees also cover costs associated with telephone network services, computer infrastructure at Hydro Place, LAN costs.

23.14 Public Relations

Nalcor employs a number of external public relations firms to support the communications activities for the Project. No detailed estimate was able to be extracted from Nalcor communications, rather a review of historical incurred cost was made in order to estimate potential future cost. Based upon this review, a provisional amount of $250,000 per year totaling $1.5 million was included in the Project Cost Estimate.

23.15 Promotions and Reward Programs

Nalcor will its EPCM Consultant will be fully implementing its Health and Safety Plans developed for the Project, which encompasses reward and recognition for safety working behaviours. In consideration of the cost for implementing such programs, a provisional amount of $250,000 per year totaling $1.5 million over the life of the Project has been included in the Project Cost Estimate.

23.16 Corporate Memberships

Nalcor's current HR policy was reviewed along with historical costs to determine an allocation for Corporate Memberships per person year.

In addition to personnel related memberships, the LCPPI also have made allowances for Corporate Membership fees related to memberships associated with third party "Think Tank" organizations such as Power Advocate and Global Insight.

The Project Cost Estimate includes a provisional amount of $150,000 per year totaling $900, 000 for corporate memberships.

23.17 Third Party Studies and Assessments

In addition to the EPCM Services contract with SLI, the Management Team has reviewed additional engineering work to be performed and have made the necessary allowances for such services such as specialty engineering studies related to system reliability, risk reviews with the Project`s risk advisory (Westney Consulting), or contract claims avoidance strategies.

The Project Cost Estimate includes a provisional amount of $1.4 million for third party studies and assessments.

23.18 Third Party Management Consultants

Third Party Management Consultants are used on an ad hoc basis to augment the Owner`s Project Team, where a full-time presence is not warranted. The Project Cost Estimate includes a provisional amount of $350,000 for such support.

23.19 Legal Services for Contracting and Procurement

External legal counsel from McInnis Cooper has and will continued to be used by Nalcor`s Supply Chain Management team in the establishment and administration of all contracts and purchase orders. Using current rates for the nominated individuals, along with Supply Chain`s resource projections of 1 FTE through end of 2013 and then 0.5 FTE to Project close-out.

23.20 Independent Project Reviews

As part of Nalcor Gateway Process, independent project reviews occur to validate the Project Team`s readiness for a Decision Gate. The Project Cost Estimate includes provisions for such IPRs to occur prior to Project Sanction, prior to First Power, and a mid-way checkpoint.

The Project Cost Estimate includes a provisional amount of $400,000 for these reviews. No provisions are included in the estimate for reviews or reports sanctioned by the Government of Newfoundland and Labrador (e.g. MHI or PUB reviews).

23.21 Team Functionality Initiative

Nalcor has engaged the services of Deloitte (Agreement LC-PM-093) to support improved organizational effectiveness. As this program was at the inception phase at the time the Project Cost Estimate was prepared, a provisional allowance of $750,000 was made, spread over the life of the Project.

23.22 Environmental Assessment

23.22.1 Generation Project EA

The Generation Project, encompassing Gull Island, Muskrat Falls and LTA was released from Environmental Assessment on 15-Mar-2012. As developed by the EA&A team, the Project Cost Estimate includes all provisions related to future planned expenditures to deliver upon the commitments and conditions of the EA release as detailed in LCP Generation Environmental Assessment Commitments / Requirements Management Plan, reference no. LCP-PT-MD-0000-EA-PL-0001-01. All commitments / requirements detailed in this Plan have been valuated, summarized and form the basis of the Project Cost Estimate. A detailed spreadsheet of these costs is contained in the Supporting Documentation of Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

No specific provisions have been made to address court challenges of the EA process or outcome by external stakeholders (e.g. aboriginal groups or NGOs).

All Generation Project EA related costs are allocated to Gull Island, Muskrat Falls, and LTA projects as per the Principals of Cost Allocation.

23.22.2 LITL EA

The LITL Project is still in the Environmental Assessment process at the time of development of the Project Cost Estimate. As developed by the EA&A team, the Project Cost Estimate includes all provisions related to future planned expenditures to finalize the EA as well as to implement specific commitments or anticipated conditions of EA Release. A detailed spreadsheet of these costs is contained in the Back-up Material of Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

23.23 Aboriginal Affairs and Commitments

23.23.1 Innu Nation IBA

As developed by the EA&A team, the Project Cost Estimate includes all provisions related to costs associated with implementation of the IBA. Specific provisions included:

- IBA Process Agreement up and including 2012 - $4.4 million.
- IBA Implementation Payments of annual payment of $5 million per year from 2013 through 2017, totaling some $25 million.
- Other costs related to Environmental Management Committee and various third party supports.

Note: All costs associated with the Upper Churchill Redress Agreement are not considered part of LCP costs and thus are not included in the CCE.

All IBA related costs are allocated to Gull Island, Muskrat Falls, and LTA projects as per the Principals of Cost Allocation.

23.23.2 Other Aboriginal Groups

As developed by the EA&A team, the Project Cost Estimate includes provision for on-going consultation with aboriginal groups, legal support to address aboriginal claims, and process agreements with other aboriginal groups. No specific provisions have been made to address court challenges by aboriginal groups related to aboriginal rights.

All costs are allocated to Gull Island, Muskrat Falls, and LTA projects as per the Principals of Cost Allocation.

23.24 Habitat Compensation Works

In accordance to the requirements of Fisheries and Oceans Canada (DFO), Nalcor must provide for fish habitat compensation for areas impact by the creation of the Muskrat Falls reservoir. The scope of the planned works is described within Design Philosophy for Fish Habitat Compensation, reference no. LCP-PT-ED-0000-EN-PH-0016-01.

Nalcor current plans are to construct replacement habitat in the Pinus River and Edward's Brook locations. The total estimated cost for these works is approximately $10.3 million which is direct cost of Muskrat Falls Generation.

23.25 Property and Lands

The Project's Property and Lands function have completed an assessment of the property and lands that are required by the Project, based upon the Real Property Acquisition Strategy, reference no. LCP-PT-MD-0000-PP-ST-0001-01. This strategy reaffirms that for the most extent, property and lands related concerns exist on the Avalon Peninsula portion of the LITL, while all other lands are largely owned by the Crown.

In the case of the Avalon Peninsula, using the detailed Lidar survey conducted for the transmission lines, all potential land acquisitions and property easements were able to be identified and used in the estimate.

For each of MF, LTA and LITL an estimate was prepared under the following categories:

- Land Purchases
- Fees (Crown and other)
- Legal Fees (internal and external)
- Survey Costs
- Land Appraisal Servicers
- Damages and Claim
- Staff Expenses
- Helicopter Support

Key assumptions supporting the DG3 Project Cost Estimate include:

- Land requirements for TLs are based upon the selected ROW, which identifies all easements and private properties that will be impacted.
- Preliminary property valuation has been based on internal knowledge, considering historic activities and precedents in the Province.
- Fees for crown land usage have been determined based current published rates by the Province.
- Assume use of third party land appraisal for services related to appraisal of all lands to be acquired.
- Legal support for land acquisition and usage via outside legal counsel (McInnis Cooper).
- Provisional allowance included for settlement of claims.

23.26 Permits

Nalcor`s Regulatory Compliance Team completed an assessment of required construction permits in accordance to the framework established with Regulatory Compliance Plan, reference no. LCP-SN-CD-0000-RT-PL-0001-01. Table 23-6 lists the estimated permits and associated permit fees associated with the planned work scope that must be obtained by Nalcor, and thus exclude those required to be obtained by contractors for their own temporary works (e.g. temporary fuel tank). The overall cost estimate is $115,699.51, including HST.

The bulk of the costs are for permits pertaining to Section 48 of the *Water Resources Act.* Where proposed bridge sizes were unknown, the fee for bridges 5m – 10m was applied. The fee schedule for Section 48 is provided in Figure 23-2.

Other required permits include: water use, utility systems, commercial cutting and operating for forestry clearing (renewed each year), borrow material extraction (renewed each year), and building code permits (no HST applied). All fees are indicated on the provincial government website and permit applications associated with the governing department.

It should be noted that stumpage fees associated with timber harvesting and royalties associated with the extraction of borrow material is not included.

Federal approvals associated with the *Fisheries Act* and *Navigable Water Protection Act,* do not require any fees. This estimate does not include the Letter of Credit to be provided to the Department of Fisheries and Oceans as a guarantee for fish habitat compensation works.

It should be noted that stream crossing infrastructure and/or approach has yet to be determined for transmission and reservoir preparation activities, therefore conservative estimates were employed. More accuracy can be provided as information is available regarding stream crossing infrastructure and/or approach.

Table 23-6: Summary of Permits and Associated Fees

		Permits Required								Cost		
		South Side Access Road	Construction Power	Bulk Excavation	AC Line	DC Line	Reservoir Clearing (north bank)	Reservoir Clearing (south bank)	Water Requirements/ Buildings	Price	HST	
	Culvert	19	4	6	0	84	22	35	0	$ 100.00	$ 13.00	$ 19,210.00
	Bridge (<5m)	0	0	0	194	0	0	0	0	$ 100.00	$ 13.00	$ 21,922.00
	Bridge (5m-10m)	0	0	0	6	196	17	25	0	$ 200.00	$ 26.00	$ 55,144.00
	Bridge (>10m)	3	0	0	0	0	0	0	0	$ 500.00	$ 65.00	$ 1,695.00
	Stream Diversion	0	0	1	0	0	0	0	0	$ 500.00	$ 65.00	$ 565.00
	Forestry	1	0	0	1	4	1	1	0	$ 21.00	$ 2.73	$ 189.84
	Quarry	36	0	0	0	0	0	0	0	$ 80.00	$ 10.40	$ 3,254.40
	Water Wells	0	0	0	0	0	0	0	6	$ 100.00	$ 13.00	$ 678.00
	Water Use	0	0	0	0	0	0	0	8	$ 500.00	$ 65.00	$ 4,520.00
	Water and Sewer	0	0	0	0	0	0	0	1	$ 500.00	$ 65.00	$ 565.00
	Sewage Pumping	0	0	0	0	0	0	0	1	$ 500.00	$ 65.00	$ 565.00
	Water Pumping	0	0	0	0	0	0	0	1	$ 500.00	$ 65.00	$ 565.00
Building Accessibility Registration	Accomodations Buildings < 250 m^2	0	0	0	0	0	0	0	17	$ 100.00	$ -	$ 1,700.00
	Accomodations Buildings 250 - 600 m^2	0	0	0	0	0	0	0	1	$ 200.00	$ -	$ 200.00
	Accomodations Buildings > 600 m^2	0	0	0	0	0	0	0	2	$ 400.00	$ -	$ 800.00
	Administration Buildings < 250 m^2	0	0	0	0	0	0	0	2	$ 100.00	$ -	$ 200.00
	Administration Buildings 250 - 600 m^2	0	0	0	0	0	0	0	3	$ 200.00	$ -	$ 600.00
	Administration Buildings > 600 m^2	0	0	0	0	0	0	0	1	$ 400.00	$ -	$ 400.00
Fire and Life Safety	Accomodations Buildings < 250 m^2	0	0	0	0	0	0	0	17	$ 50.00	$ -	$ 850.00
	Accomodations Buildings 250 - 600 m^2	0	0	0	0	0	0	0	1	$ 200.00	$ -	$ 200.00
	Accomodations Buildings > 600 m^2	0	0	0	0	0	0	0	2	$ 400.00	$ -	$ 800.00
	Administration Buildings < 250 m^2	0	0	0	0	0	0	0	2	$ 50.00	$ -	$ 100.00
	Administration Buildings 250 - 600 m^2	0	0	0	0	0	0	0	3	$ 200.00	$ -	$ 600.00
	Administration Buildings > 600 m^2	0	0	0	0	0	0	0	1	$ 400.00	$ -	$ 400.00
												$ 115,723.24

Figure 23-2: Schedule of Permit Fees

Newfoundland Labrador

Government of Newfoundland and Labra
Department of Environment and Conservat
Water Resources Management Divis

Application No: ______________
(for department use onl

Application Fee Schedule

In accordance with Section 21 of the *Executive Council Act*, the following application fee(s) must be paid to obtain a Permit as required under Section 48 of the *Water Resources Act, SNL 2002 cW-4.01*:

Bridges:	(a)	Bridge spanning less than 5 metres	$100
	(b)	Bridge spanning 5 metres or more but less than 10 metres	$200
	(c)	Bridge spanning 10 metres or more but less than 30 metres	$500
	(d)	Bridge spanning 30 metres or more	$1000
	(e)	Small bridges (ATV, snowmobile or pedestrian bridges)	$50
Culverts:	(f)	Culvert less than 1200 mm in width, or diameter	$50
	(g)	Culvert greater than, or equal to, 1200 mm in width, or diameter	$100
Fording:	(h)	Fording (per site) or transmission line inspection	$50
	(i)	Winter or ice road across any body of water	$50
Dams & Related Works:	(j)	Hydro-electric power project control dam	$2,000
	(k)	Other control dams including dykes and berms	$500
	(l)	Water intake greater than 100 mm diameter or an infiltration gallery	$500
	(m)	Pipe or conduit installed under any body of water including intakes less than 100 mm in diameter	$50
Drainage Works:	(n)	Storm drainage works involving discharge into a body of water	$200
	(o)	Ditching system for peat mining or agriculture	$200
	(p)	Settling basin	$100
Marine Works:	(q)	Wharf, dock, boathouse or slipway, or dredging for same	$100
Other Works:	(r)	Water course diversion, channelization or infilling	$500
	(s)	Exploratory drilling within a waterbody, or within 15 metres of a waterbody	$100
	(t)	Other construction, grubbing, clearing or installation of structures within 15 m of the high water mark of a body of water if not specifically carried out in conjunction with any other category of this fee schedule	$50

The above permit fees must accompany each separate application for approval and the fee is non-refundable. Please enclose your cheque or money order made out to the **Newfoundland Exchequer Account** or attach a cashier's receipt for the correct amount. The application cannot be reviewed until payment in full has been received.

This section must be completed so that a receipt can be issued

Type of Project: ______________ **Location:** ______________	**Fee: $** ________ **+13% HST: $** ________ **Total Enclosed: $** ________

For Department's Use Only Revenue Centre #: 1226 500 4150 2764

Payment Enclosed: ____________ Verified by: ____________ Date: ____________ Receipt#: ____________

Form: Fee Schedule Microsoft Word/02 HST Registration No: 107442683

23.27 Commercial and Financing Agreements

Nalcor F&A group prepared an assessment of the estimated fees associated with Commercial and Financing support required for execution of the Project. A significant portion of this cost is associated with the establishment of the various commercial agreements that must be established for the Project. The underlying assumption is that Financial Close will occur in Q4-2013.

Key scopes falling into this category include:

- Commercial labor and other corporate labor charges including support from Corporate, Investment Evaluation, Legal and Systems.
- Commercial Third Party - largest driver is $2.5 million for commercial agreements support and $1.4 million for data room manager/due diligence; estimates were derived based on current and planned activities.
- Independent Engineer services up to the point of Financial Close

All costs related to project financing raising activities, including the following items are excluded from the CCE and are developed by Nalcor Treasury as a separate data feed into the CPW analysis undertaken by Nalcor Investment Evaluation. Items excluded:

- Lead Arranger Fees
- Standby Fees
- Legal Fees – including costs of Nalcor, lenders, and the Federal Government
- Financial Advisors – including PriceWaterhouseCoopers and Kensingston Financial
- Interest During Construction charges – including debt interest and return on equity

The Supporting Documentation of Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01, presents a detailed estimate in support of this scope.

23.28 Interest During Construction Costs

The CCE does not include any costs with respect for the incurring of Interest during Construction (IDC). IDC provisions have been made by Nalcor Treasury and provided to Nalcor Investment Evaluation as a separate input stream to the CPW analysis.

Similarly, the Historical Costs contained within the CCE exclude any IDC charges that are currently contained on the Balance Sheet, as noted in Table 23-7.

Project	Financing	Interest	Total
MF	$7,036,237.84	$5,373,948.72	$12,410,186.56
LITL	$3,069,830.82	$7,404,278.61	$10,474,109.43
LTA	$1,041,445.81	$0.00	$1,041,445.81
Totals	**$11,147,514.48**	**$12,778,227.32**	**$23,925,741.80**

23.29 Historical Costs

The CCE includes all historical incurred costs for MF, LTA and LITL up to the period of April 30, 2012 as reporting in the Project Monthly Report for April and have been allocated to the respective sub-Project. All forward costs related to the Project are captured in the CCE.

23.30 Third Party Inspection Services

Inspection services relate to tagged equipment bulk purchases and capital cost equipment are included in the EPCM services estimate under Package SM0701 - Provision of Third Party Quality Surveillance & Inspection Services. The estimated value of this scope is based upon an early assessment of the procured items that would require third party inspection services, their expected source location, and use of industry norms for determination of effort.

23.31 Integrated Commissioning Support

SLI Component C3 team completed an assessment of the required integrated commissioning support required for final testing and operational readiness of the entire electrical system. The details of this assessment are presented in Volume 38 of the Supporting Documentation to the Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

23.32 Municipal / Business Tax

The Project Cost Estimate does not include any provisions for Municipal or Business Tax as Nalcor and its subsidiaries are non-taxable Crown corporations.

23.33 Vehicle Fleet

The Project Cost Estimate includes provision related to supply and operation of a vehicle fleet that will be used by the Owner's Project Team and EPCM Consultant.

The total allowed vehicle fleet has been assumed to be 70 vehicles maximum, having average price of $35k each (including accessories), with annual O&M cost of $2.5k over the life of use. These rates have been benchmarked against Nalcor's corporate fleet operations are considered reasonable.

It should be noted that these fleet requirements exclude those that will be provided by the various service providers at Muskrat Falls for their own usage (e.g. survey and laboratory contractors).

23.34 Helicopter Services

The EPCM Consultant estimated the requirement for helicopter services in support of the Project. From a demand perspective, the requirement is to support the overall transmission works, in particular LITL.

The total estimated demand encompassed within the CCE is 4,600 hours.

As Nalcor has existing service arrangements with Canadian Helicopters for regular, minimal usage charters, with rates shown in Table 23-8, these rates were utilized as the basis for market rates in the calculation of the estimate as follows. While there has been no provisions included within the estimate for full-time charter or designated aircraft, these rates are considered reasonable given projected demand.

Table 23-8: Helicopter Charter Rates

Aircraft Type	Hourly Rate	Fuel Burn /Hr	Sling Capacity
AS350BA	$1427.00	170	1800
AS350B2	$1770.00	180	2557
Bell 206B	$1112.00	110	900
Bell 206L	$1191.00	130	1200
Bell 212	$3132.00	378	3500
Bell 407	$1864.00	200	2646
AS350B3	$1864.00	180	2750

Note: Hourly rental rate includes pilot, lubricants, but excludes fuel and landing fees.

- From Table 24-7, B206L is $1191 /hour, plus fuel at 130L/hr, plus landing fee of $11.60 each
- Fuel is noted at $1.62 per L
- Thus assume all in-hourly cost for a B206L at $1420

23.35 Freight/Logistics

All transportation and freight costs associated with the shipment of material from Ex Works to either the transmission marshaling yards, Muskrat Falls, or the various switchyard sites has been included within the material pricing. The Project Team is still assessing the optimal logistics and transport approach, which will likely see opportunities for more cost effective shipping due to synergies.

23.36 Freight Forwarding Services

As detailed the Construction Execution Plan for the Overland Transmission works, there is a plan to develop two (2) marshaling yards – one on the Island near Deer Lake or at the Corner Brook Port location, and the second located at Happy Valley – Goose Bay. The costs associated with the construction of both marshaling yards is contained in the indirect construction cost estimate, while the operation of both yards is assumed to be undertaken by a 3rd party freight forwarder service provider (Commitment Package SM0700).

The scope of this works would include the supply of all personnel to operate the yard, excluding one (1) representative from the EPCM Consultant at each location. The freight forwarder would be responsible for site operation, including security, snow clearing, container movement, issue and tracking of materials to the transmission contractors. The estimate assumes the yards will operate of a 12 hours per day operation with 6 FTE in each yard. The HVGB yard is expected to be in operation for 4 years, while the Island yard is expected to be in operation for 3 years.

23.37 Health and Medical Services

The Project Cost Estimate includes provision for a central construction health and medical services at the Muskrat Falls site via a 3rd party service provider, while for all other locations this is the responsible of the selected contractor and has been included as part of construction in-directs. Specific details of the envisioned scope are contained in the document Engineering Quantity Tracking, SH0020 – Provision of Medical Services.

Quantification of the required provision of medical services is based on the assumption that the services at Muskrat Falls include the following:

- a well-equipped 24/7 medical facility at the Muskrat Falls construction camp site to cover the camp's medical requirements as well as a portion of the requirement for the reservoir clearing.
- Medical transport vehicles adequate to transport patients to the Happy Valley-Goose Bay hospital.
- For reservoir clearing operations, two (2) Mobile Treatment Centers (MTC), that can act as Medical Transport Vehicles, staffed by Emergency Medical Technicians (EMT).

For the overland transmission and HVdc switchyards and other specialties, it is assumed that a Level 2 First Aider is sufficient, in lieu providing EMTs and MTCs in each of the satellite camps.

Scope of medical services requirement was developed while preparing the medical services contract document to be issued for bids in late 2011 and integrate coordinated needs of Components 1, 3 and 4. Cost of medical services was estimated based on estimator experience and input from specialized vendors and service providers.

The CCE also includes the cost for helicopter medical evacuations (medevacs) based on the following assumptions:

- Over the course of the entire project, there will be one medevac made per week (both non-work related medical emergencies and work related injuries and illnesses) for a total of 50 medevacs per year for five years, resulting in a total of 250 medevacs for the project.
- Each medevac flight will have an average duration of three hours.
- Average cost for flight hour is $2,200.00.

23.38 Mandatory Pre-Access Drug and Alcohol Testing

All personnel working on any phase of the project outside the project office in St. John's will be required to undergo a Drug and Alcohol Screening Test and have a Medical Examination completed prior to being dispatched to site. The estimate included in the Project Cost Estimate is based on the current market value of those services and the projected number of personnel anticipated to work on the Project and comprises the following assumptions and rates:

- Cost of Drug and Alcohol Screen using current urine or mouth swab techniques will be $250.00 per test.
- Pre-access Medical Examination will be $250.00 per test.

It is projected that a total of 12,000 personnel (Nalcor, EPCM Consultant, and contractor personnel) will be engaged over the life of the project. This number also takes into consideration those personnel who will be away from the project for a period of three (3) months or more and will required to be retested.

23.39 Emergency Response and Other Safety Related Items

The projects emergency response plan has been approved and contracts for medical services have been awarded. Actual contract costs were used to determine overall life of the project Emergency Response costs. In addition to medical services, the project has accounted for additional emergency response costs such as having additional Fire Fighting Equipment on site and a standing agreement with helicopter service suppliers to ensure standby services are available in case of an emergency. Specific items of note include:

- Provisional allowance of $250,000 has been made for fire firefighting equipment – i.e. a fire truck.
- Allowance for 25 bunker suits @ $2,000 each and 15 Scott Air Packs @$5,600 each.
- Provisional allowance of $100,000 has been made for a rescue boat including one boat trailer and rescue equipment at the Muskrat Falls site.

The Project Cost Estimate includes provision for other health and safety related items, including Personal Protection Equipment (PPE) for the Owner's and EPCM Consultant's team (allowance of $345k) and Safety signage (allowance of $50k) on sites and on access road to main site as is detailed in in the document: *SH0020 – Provision of Medical Services*.

Nalcor has recognized that implementation of a behavioral-based safety program will take significant effort, including the appropriate use of reward and recognition programs. In consideration of the approximate total labour expenditure of 20 million person-hours on the Project, a provisional allowance of $2 million equating to $0.10 per hour has been made to provide for safety incentive programs.

23.40 Security Services

The Project Cost Estimate assumes as per the LCP Security Management Plan, reference no. LCP-PT-MD-0000-HS-PL-0005-01, and indicates that security at the Muskrat Falls site is under the control of Nalcor and uses a 3rd party service provider, while at other project work locations it is the responsibility of the principal contractor.

The estimate based on estimator experience and supplier input for the following

- On site 24-hr security service including security personnel, vehicles and equipment
- Security access swipe cards for access to main site and accommodation complex

Quantification basis for this work is captured in document: *SH0019 – Provision of Safety Services*.

23.41 Insurance

Nalcor's insurance program is depicted in Figure 25-3; it is one insurance program will be in place serving all three SPV's, providing phased coverage as the project progresses. The philosophy underlying the Project Cost Estimate is described in Lower Churchill Project - Insurance Philosophy, reference no. LCP-PT-MD-0000-LE-PH-0001-01.

Figure 23-3: Insurance Strategy

Insurance Approach

The insurance strategy for the Projects will be implemented in co-operation with Nalcor's insurance advisor, AON, as outlined below:

Placement Phase	Policy Type	MF	LTA	LIL
Early Works	Builders Risk	Yes	As required	As required (HDD only)
	Base Wrap-Up Liability	Early works only	Base Limits 2012-17	Base Limits 2012-17
	Base Pollution Liability	Early works only	Base Limits 2012-17	Base Limits 2012-17
Full Policy	Full Builders Risk	Yes - All	Yes - with sublimit on towers/lines	Yes - with sublimit on towers/lines (excludes SOBI marine)
	Additional Wrap-Up Liability	Yes - All	Yes	Yes
	Additional Pollution Liability	Yes - All	Yes	Yes
	Marine Builders Risk	N/A	N/A	SOBI only
	Delayed Start-Up	To be determined based on cost	Optional	Optional
	Marine Delayed Start-Up	N/A	N/A	Optional

The Project will include as part of the overall cost the provision of Builders Risk Insurance for all parties involved in the project. Contractors and Vendors will be responsible to include Errors and Omissions (E&O) if applicable General labiality insurance and Automotive Insurance as part of direct contract costs.

The CCE includes provisions for the following policies and associated limits provide in Table 23-9, with source estimates provided by Nalcor's broker, AON, in March 2012. The rates used by AON in the calculation of the policy premiums are considered indicative and based on AON market intelligence and preliminary discussions.

Table 23-9: Insurance Program Cover Summary

Policy	Policy Limit	Project Component
Wrap-up Liability	$100,000,000	ALL
Pollution Liability	$25,000,000	ALL
Property Damage	$1,000,000,000	Muskrat Falls
Property Damage	$25,000,000	LTA (excl. O/H T&D)
Property Damage	$250,000,000	LITL (Onshore, excl. O/H T&D)
Property Damage - Marine	$100,000,000	LITL – SOBI Marine Crossing

The Project Cost Estimate <u>does not</u> include any provisions for the optional delayed start-up coverage.

23.42 Performance Securities

Consistent with the strategy set forth in Overarching Contracting Strategy, reference no. LCP-PT-MD-0000-PM-ST-0002-01, Bid Bonds, Performance Bonds and Labor Material Bonds (as required) are contained within the estimated value of the supply or execution contracts.

Nalcor's Treasury, the Project Team's procurement team, along with third party specialists assessed the requirement for performance security provisions for each Commitment Package planned based upon a consideration of the following factors:

- Magnitude of potential loss to SPV on default and sufficiency of contractual indemnities;
- Availability and timing for obtaining replacement contractor if necessary;
- Extent of any potential delays to scheduled date for First Power; and
- Liquidity

The result was a recommend type of security required for only those packages referenced in Table 23-10.

Using a combination of internal knowledge and information available from 3rd party sources, a view of expected cost for each of the types of performance securities was estimated (reference Table 23-11). Given the number of factors that could influence the cost of such securities, it is recognized that the values contained in Table 23-11 should be considered as provisional allowances only.

Table 23-10: Supply and Construction Package with Performance Security Provisions

Package Ref. No.	Contract Package Title	Security Strategy
CH0002	Supply and Install Accommodations Complex Buildings	Bond
CH0003	Supply and Install Administrative Buildings	n/a
CH0004	Construction of Southside Side Access Road	n/a
CH0005	Supply and Install Accommodation Complex Site Utilities	Bond
CH0006	Construction of Bulk Excavation Works	Bond
CH0007	Construction of Intake and Powerhouse, Spillway and Transition Dams	Bond
CH0008	Construction of North Spur Stabilization Works	Bond
CH0009	Construction of North and South Dams	Bond
CH0023	Construction of Reservoir Clearing – South Bank	Bond
CH0024	Construction of Reservoir Clearing – North Bank	Bond
CH0030	Supply and Install Turbine and Generators	Bond + Letter of Credit
CH0031	Supply and Install Mechanical and Electrical Auxiliaries (MF)	Bond+ Letter of Credit
CH0032	Supply and Install Powerhouse – Hydro-Mechanical Equipment	Bond
CH0033	Supply and Install Powerhouse Cranes	Bond
CH0046	Supply and Install Spillway Hydro-Mechanical Equipment	Bond
CH0048	Construction of Site Clearing Access Road & Ancillary Areas	Bond

CH0050	Supply of Concrete Including Batch Plant (MF)	Bond
CT0319	Construction of 315 kV HVac Transmission Line (MF to CF)	Bond + Letter of Credit
CT0341	Clearing of Right of Way for 315 kV HVac Transmission Line (MF to CF)	Bond
CD0502	Construction of AC Substations & Synchronous Condenser Facilities	Bond
CD0501	Supply & Install Converters, Harmonic Filters and Transition Compounds	Bond + Letter of Credit
CD0502	Construction of AC Substations and Synchronous Condensers Facilities	Bond
CD0503	Construction of Earth Works at Power Distribution Sites	Bond
CD0508	Construction of Electrode Sites	Bond
CD0534	Supply and Install Soldiers Pond Synchronous Condensers	Bond + Letter of Credit
CT0327	Construction of 350 kV HVdc Transmission Line – Section 1	Bond + Letter of Credit
CT0343	Clearing of Right of Way for HVdc Transmission Line - Section 1	Bond
CT0345	Clearing of Right of Way for HVdc Transmission Line - Section 2	Bond
CT0346	Construction of 350 kV HVdc Transmission Line – Section 2	Bond + Letter of Credit
CT0342	Construction of AC Transmission Lines - Island	Bond + Letter of Credit
PT0330	Supply of Steel Towers - 350 kV HVdc	Bond
PT0302	Supply of Steel Towers - 315 kV HVac	Bond
PT0328	Supply of Transmission Line Conductors - 350 kV HVdc	Bond
LC-SB-003	SOBI Submarine Cable Design, Supply and Installation	Bond + Letter of Credit
LC-SB-010	Landfall HDD Construction	Bond
LC-SB-011	Subsea Rock Protection Design, Supply and Installation	Bond

Table 23-11: Estimating Basis for Performance Securities

Security Tool	Value of Security	Security Cost	Estimating Basis (Allowance = % Contract Price)
Parent Guarantee	N/A	Varies	0.3%
Performance and /or Labor and Materials Payment Bond (1,3)	50% of Contract Price	0.5% of contract price per annum	0.4%
Letter of Credit (LOC) (2,4)	15% of Contract Price	Assume 1.75% of LOC amount per annum	0.7%
Recommended Estimating Allowance for Identified Packages (5)			**1.0%**

Notes:

1.) AON presentation "The Performance Security Toolbox" dated 28-Sep-2011 indicates cost of surety at 0.3% to 1.2% of contract price per annum

2.) AON presentation "The Performance Security Toolbox" dated 28-Sep-2011 indicates cost of letter of credit from 0.5% to 2.0% per annum of Letter of Credit amount, however the value per annum and the cost of the LOC is proportional to the length of the contract (i.e. 5 year T/G contract will come with a higher LOC cost, however cost per annum will be less).

3.) For estimating basis assumed average contract duration is 2 years.

4.) For estimating purposes assumed average duration of contracts that require LOC is 3 years.

5.) Requirement for security tools differs depending on contract form, risk, etc. hence for estimating purposes assume a notional flat provision across all packages that performance securities are required.

Part C: EPCM Services

24.0 EPCM Services

24.1 Scope and Approach

Costs associated with engineering services contract were estimated based on the following four (4) components:

1. Engineering Services
2. Procurement Services
3. Construction Management Services
4. Associated Expenses

SLI, as EPCM Consultant, were tasked to preparing and submitting the final estimate for EPCM Services at the conclusion of Stage 2 of the EPCM Services Agreement, planned for 15-Dec-2011. However the deliverable as submitted did not substantiate the indicated person hours of effort in order to provide a basis for execution of Stage 3 of the Agreement. As a result of this Nalcor relied upon its internal resources in order to produce an estimate for the expected effort that would be expended by the EPCM Consultant.

Note: The estimate for EPCM Services excludes:

- All work related to SOBI Crossings, which is included in the SOBI Crossing estimate;
- Existing Island Upgrades under the responsibility of NLH as discussed in Part H; and
- All work associated with Maritime Island Link is to be performed by Emera and excluded from the estimate for EPCM services.

24.2 Estimated Hours

Nalcor and SLI did reach alignment of the engineering deliverables required to be produced under the EPCM Services Agreement, as well as the estimated effort to produce these deliverables, indicated in Table 24-1 below. In general terms, engineering services are based on determining the total number of deliverables multiplied by the applicable engineering norm to establish a total man hour estimate. Hourly rates as per the existing Agreement were applied to establish the total costs.

Table 24-1: Estimated Effort for Engineering Services

Component	Estimated Hours
Muskrat Falls Generation / Component 1	260,000
HVdc Specialties and Switchyards / Component 3	110,000
Overland Transmission / Component 4	105,000
Total	**475,000**

Person-hours estimates to provide procurement services were based on evaluating the total number of planned commitment packages (as indicated in the Master Package Dictionary, reference no. LCP-SN-CD-0000-PM-LS-0001-01) and determining the resources and associated durations required to manage each.

Person-hour estimates for construction management were based upon the estimate resources required to fulfill the Owner's obligations and meet the established strategy as set forth in the Construction Management Plan, reference no. LCP-PT-MD-0000-CS-PL-0001-01 Revision B1. To supplement this exercise, Nalcor had available detailed organization charts and mobilization plans for execution strategy for Gull Island that was predicated upon an integrated team.

These person-hour estimates for both procurement and construction management support were based on information provided by Nalcor Project Management Team which estimated, by discipline, staffing requirements needed by the EPCM Consultant for the duration of the project. Each discipline lead was tasked to provide estimated staffing requirements based on the scope of work they will be expected to provide to the project.

Using this information, and in consultation with project controls, a spreadsheet was developed estimating required EPCM Consultant person-hours for the duration of the project. Based on this work 2,652,129 man hours were estimated to be required for the entire project, which includes approximately 299,000 used to the end of March 2012. Key assumptions were used in this analysis which included the following:

- Home Office has 50 hour work week;
- Site has 60 hour work week;
- Average number of weeks per month is 4.2

Table 24-2: Estimated Person-hours

Person-hour Estimate	
Total Estimated Hours	2,652,129
Incurred Hours up to 21-Mar-2012	299,000
Estimated Hours 22-Mar-2012 and Onward	2,353,129

EPCM Hourly rates are all inclusive rates and include salaries burdens office overhead, copying charges, etc.

Based on the analysis completed, it is estimated that the EPCM Consultant will require 1,095,840 man hours at home engineering office in St. John's and 1,556,289 field based man hours at various construction sites. These estimates include 299,000 man hours and cost of $45,860,319 up to the 21-March-2012.

24.3 Reimbursable Labour – Home Office Personnel

With the support of the Finance and Accounting Team to analyze expenditures to-date information, and assignment terms and conditions agreed upon within the EPCM Services Agreement LC-G-002, Nalcor was able to establish an actual average hourly billing rate for home office staff as detailed in Table 24-3.

Table 24-3: Actual Average Hourly Rate for Home Office Personnel

Rate Element	Value
Base Rate	$55.72
Uplift (Blended rate 9.24%)	$5.16
Payroll Burden (38.1%)	$23.19
Office Overhead	$28.40
Computer Services	$7.22
Reproduction Services	$1.96
Total – Average Labour Hourly Cost For Home Office	**$121.65**

This Actual Average Rate is considered to be quite reasonable for go forward estimating purposes considering that:

- Total resource required are largely in-place, while supplemental resources are largely support team resources rather than managers, which have a lower actual hourly rate
- A decision has been taken to undertake specialized engineering works from Montreal.

24.4 Other Reimbursable Costs

Based on historical cost, Nalcor has completed an analysis on other reimbursable costs associated with SLI EPCM services. These costs are related to assignment costs, office facilities and services costs, business travel cost and additional rate costs. As some of the costs related to these items significantly fluctuate month to month, Nalcor used invoiced to-date cost and hours to estimate a reasonable cost for each item above. Table 24-4 presents a summary of other reimbursable costs and average rate used for in the Project Cost Estimate.

Table 24-4: Other Reimbursable Costs

Cost Element	Value
Assignment Cost	$20.00/hour
Office Facilities & Services:	
April 2012 to May 2012	$40,800/month
June 2012 to October 2012	$51,600/month
November 2012 Onward	$40,800/month
Business Travel	$1.00/hour
Additional Expenses	$7,500/month

24.5 Reimbursable Labor – Site Personnel

Using the available information on Base Rates as well as proposed Assignment Conditions for site, an assumption was made that the above hourly base rate will be consistent amongst all SLI personnel including site employees. For expatriate site personnel, Nalcor estimated an hourly average labour site cost of $118.42 which is made up of the following:

Table 24-5: Average Hourly Rate for Site Personnel – Expats

Item	Value
Base Rate	$55.72
Project Uplift	$8.36
Remote Location Uplift	$5.57
Additional Hours Uplift	$8.36
Payroll Burden	$29.72
Office Overhead	$7.69
Computer Services	$3.00
Total – Average Labour Hourly Cost – Site (Expats)	**$118.42**

It is assumed that 95% of all field or site based personnel will not be local hires (i.e. resident of HVGB).

Base rate for local SLI site personnel was also estimated at $55.72. Based upon the planned assignment conditions, local hires would entitled to either a Remote Location Uplift or Additional Hours Uplift the same total hourly billable rate as relocated personnel. For local site personnel, Nalcor estimated an hourly average labour site cost of $87.64 which is made up of the following:

Table 24-6: Average Hourly Rate for Site Personnel – Local Hires

Rate Element	Value
Base Rate	$55.72
Payroll Burden	$21.23
Office Overhead	$7.69
Computer Services	$3.00
Total – Average Labour Hourly Cost - Site (Local Hire)	**$87.64**

24.6 Additional Site Costs

In addition to hourly rates for relocated site employees, an additional $1,200 has been estimated per turnaround to cover travel to and from point of origin costs along with $90 per day for accommodations at site.

24.7 Average Billing Rate

Table 24-7 presents the Average Billing Rate as carried in the Project Cost Estimate.

Table 24-7: Average Billable Rate Summary

Assignment Location	Average Hourly Rate
Head Office Personnel	$121.65
Relocated Head Office Personnel	$121.65
Relocated Site Personnel	$118.42
Local Site Personnel	$87.64

24.8 Sensitivity Analysis

In support of the Project's Estimate Contingency recommendation, a sensitivity analysis was completed on a number of assumptions to determine the impact variances on estimated rates would have on the total EPCM estimate. When determining what variances to consider, an assessment of the potential risks was completed. Some of the risks identified include the following:

- The estimated base salary might increase beyond what is used in the estimate:
  - Market conditions may drive the average rate up due to a shortage in skilled labour.
  - The mix of employees may change resulting in a change in the estimated average rate.
- The estimated hours to complete the work might increase:
  - Project delays may extend the life of the project and cause an increase in hours.
  - The estimated manpower estimates might not be attainable.
  - Unforeseen scopes of work might impact the estimate.
- The field office Computer Service Rate might increase up to $7.00s per hour:
  - A potential dispute between Nalcor and SLI regarding an interpretation of what was included in the field office Computer Service Rate has been identified. Although Nalcor feels that the appropriate rate as stipulated in the Agreement is being used in this model, an analysis of a change in this rate has been included below.
- The average Assignment Cost per hour may increase:

- The mix of locals vs. expatriates may change. This would have a direct impact on the average Assignment Cost per hour.

Based on examining risks, including those identified above, an analysis of the effects that some of these risks may have on the overall estimate was completed. Table 24-8 presents a summary of that analysis.

Table 24-8: Sensitivity Analysis Check

Sensitivity Analysis Completed	Impact on Cost Increase / (Decrease)	Percent Increase / (Decrease)
Increase in base salary of 10%	$22,206,800	5.50%
Increase in estimated hours by 10%	$35,440,000	8.78%
Increase in estimated hours by 20%	$70,881,000	17.55%
Increase in field office Computer Service Rate to $7/hour	$4,383,000	1.09%
Increase in assignment costs by 10%	$2,515,000	0.62%
Increase in business travel cost to $1.50/hour	$629,000	0.16%
Increase in local hires for construction management from 5-10%	$(2,508,000)	(0.62%)

Part D: Muskrat Falls Generation (SLI Component 1)

25.0 Muskrat Falls Generation

25.1 Overview of Scope

As described in Part A, included within Muskrat Falls Generation (SLI Component 1) are the facilities, installations and equipment relative to infrastructure and main camp accommodations, the reservoir work, the dams and spillway and the powerhouse intake and turbine generators.

The following sections describe the basic assumptions considered as well as the means and methods utilized to develop the relevant cost estimates included in the CCE.

25.2 Commitment Packages

The CCE was developed based on the work breakdown structure (WBS) of the Project. As stated in Part A, these work items were later structured into commitment packages capturing the same scope of work in a fashion that allow for bid packages to be issued to potential bidders and contracts to be awarded, executed and managed up to and following procurement or construction completion.

Package numbers give an indication of the nature of the contract: “C” packages are Construction Packages, “P” packages are Purchase Orders or Procurement and “S” packages are Service Contract Packages. The second letter is Component specific; H for Component 1 (Hydro), D for Component 3 (DC Specialties) and T for Component 4 (Transmission). For each of these Commitment Packages a Quantification Basis report was prepared by SLI Engineering and are located in Volume 21 of the Supplemental Information to the Decision Gate 3 Cost Estimate,

The following list is the Commitment packages structure that was developed for Muskrat Falls Generation:

- CH0002 Supply and Install Accommodations Complex Buildings
- CH0003 Supply and Install Administrative Buildings
- CH0004 Construction of Southside Access Road
- CH0005 Supply and Install Accommodations Complex Site Utilities
- CH0006 Construction of Bulk Excavation Works and Associated Works
- CH0007 Construction of Intake and Powerhouse, Spillway and Transition Dams
- CH0008 Construction of North Spur Stabilization Works
- CH0009 Construction of North and South Dams
- CH0023 Construction of Reservoir Clearing South Bank
- CH0024 Construction of Reservoir Clearing North Bank
- CH0029 Construction of Site Restoration at Muskrat Falls
- CH0030 Supply and Install Turbines and Generators
- CH0031 Supply and Install Mechanical and Electrical Auxiliaries (MF)
- CH0032 Supply and Install Powerhouse Hydro-Mechanical Equipment
- CH0033 Supply and Install Powerhouse Cranes

- CH0034 Supply and Install Powerhouse Elevator
- CH0039 Supply and Install McKenzie River Permanent Bridge
- CH0046 Supply and Install Spillway Hydro-Mechanical Equipment
- CH0048 Construction of Site Clearing Access Road & Ancillary Areas
- CH0049 Supply and Install Log Booms
- CH0050 Supply of Concrete including Batch Plant (MF)
- CH0052 Construction of Habitat Compensation Works
- PH0014 Supply of Generator Step-up Transformer
- PH0015 Supply of Isolated Phase Bus
- PH0016 Supply of Generator Circuit Breakers
- PH0035 Supply of Station Service Transformers
- PH0036 Supply of Auxiliary Transformers
- PH0037 Supply of 25kV Switchgear
- PH0038 Supply of Emergency Diesel Generators
- SH0018 Provision of Catering, Housekeeping and Janitorial Services (MF)
- SH0019 Provision of Security Services
- SH0020 Provision of Medical Services
- SH0021 Provision of Road Maintenance and Snow Clearing Services (MF)
- SH0022 Provision of Fuel Supply and Dispensing Services (MF)
- SH0040 Provision of Garbage Removal and Disposal Services (MF)
- SH0041 Provision of Ground Transportation Services (HVGB to MF)
- SH0051 Provision of Buildings Maintenance Services (MF)

25.3 Access Roads and Laydown Areas

25.3.1 Scope

Includes:

- Clearing of the South Side Access Road to the main project site, access road to and the Accommodation Complex Site, Company's laydown area, 25kV construction power corridors, project site, switchyard, access road to and Contractor's laydown area and access road to and spoil area.
    - South Side Access Road Station 5+150 To 22+040
    - Camp Site Access Road Station 0+000 To 1+100
    - Accommodation Complex Site Area
    - Company's Laydown Area Grading
    - Contractor's Laydown Area Clearing Including Access Road
    - Project Site Area Clearing Including Switch Yard And Spoil Area
    - 25kV Power Corridor Clearing Including Tap Station Area

  Total estimated volume is 228.8 HA.

- Construction of approximately 17 km of access road from the end of the existing forest access road (Station 5+150) on the south side of the Churchill River to the main project site, the access road to and grading of the Accommodation Complex Site, and grading of Company's Laydown Area.
- Upgrading of approximately 6 km of new road alignment from the Trans Labrador Highway near the existing Churchill River Bridge to the end of the existing forest access road.
- Installation of 30m Permanent Bridge at McKenzie's River located approximately 2 km east of the Muskrat Falls site. The bridge shall be designed to accommodate the passage of a 250 tonne transformer.
- Upgrading the North Spur access road (3.9 km based on a layout of existing road on 1:50,000 provincial mapping), will require upgrading for hauling the materials required to make the improvements to the North Spur.
- Construction of a new road to the granular deposit, GR-5, which is located approximately 10 km west of Muskrat Falls access as measured on 1:50000 provincial mapping. A bridge is required on a tributary of Lower Brook.
- Construction of a new road to till deposit, T-4B, which is located approximately 4.0 km west of Muskrat Falls access as measured on 1:50000 provincial mapping.

Quantification basis for this work is captured in the following documents:

- CH0048 – Site Clearing Access Road and Ancillary Areas
- CH0004 – South Side Access Road
- CH0039 – McKenzie River Bridge
- Access roads for North Spur and Quarries, Strengthening of Kenamu and Paradise River Bridge

25.3.2 Price Base

For the construction of 17km of new access road on the south side of the river, roads to the granular deposit, GR-5, and till deposit, T-4B, and the construction of Company laydown areas and the pad for the accommodations complex, the DG3 CCE is the results from the Request for Proposals issued for both Commitment Packages CH0004 and CH0048.

Detailed design of the McKenzie River crossing has not been undertaken. The estimate was based on a 30m, two-lane bridge with reinforced concrete abutments, steel girders and concrete deck. No geotechnical information was available to quantify the bridge foundation. Based on a site visit and information available from other geotechnical investigations near the site, it was assumed that a piled foundation for the bridge abutment would not be required.

Price basis dual-lane permanent bridges for both Caroline Brook and McKenzie's River is based on engineering judgment and experience to construct a bridge as described with approximately 250 m^2 of deck area. The

The estimated cost of the access roads to the North Spur and Quarry No.1 were based on the cost of other road work in Labrador and factored to reflect the project's current construction costs on a per km basis.

25.4 Accommodations Complex and Administrative Buildings

25.4.1 Scope

Accommodations Complex

Scope includes a new 1,500 person accommodation complex, which encompassed an initial 150 person starter camp. Also included are associated furnishings, fittings, equipment, mechanical and electrical systems and components. Specific components of this package include:

- Accommodations Buildings (Dormitories) with shared-shower unit between 2 rooms;
- Starter Camp Kitchen / Dining / Recreation;
- Main Kitchen, Dining and Recreation Centre; and
- Weatherproof Corridors.

Administration Buildings

Scope includes administration buildings for a new 1,500 person accommodation complex, specifically:

- Administration office building (2,408m^2);
- Safety / inductions building (313m^2);
- Fire hall / ambulance shelter (334m^2);
- Communications building (200m^2);
- Camp maintenance workshop (428m^2);
- Security building (202m^2);
- Concrete laboratory;
- Surveyors/inspectors office building; and
- Washcar trailer units.

Utilities

Scope includes:

- Artesian wells;
- Water treatment system for the starter camp;
- Pump house / chlorination building and pumping station including all mechanical and electrical components and connections;
- Water storage tank including all mechanical and electrical components and connections;

- Buried water distribution system;
- Sewage disposal field for the starter camp phase;
- Sewage disposal field for the security building;
- Packaged sewage treatment plant including all mechanical and electrical components and connections;
- Gravity flow sewage distribution system including manholes;
- Diesel emergency generators and fuel tanks;
- Site electrical distribution system from 25kV to 600kV, including all transformers, cabling, poles, and lighting
- Helicopter landing pad including the chain link fence, gate and wind sock;
- Finish grading of accommodations complex site with granular topping including general areas around buildings, parking areas, and access roads to sewage treatment plant, water tank, electrical generators and helipad area; and
- Chain link fencing and security gates.

Quantification basis for this work is captured in the following documents:

- CH0002 – Accommodations Complex Buildings
- CH0003 – Accommodations Complex Administrative Buildings
- CH0005 – Accommodation Complex Site Utilities

25.4.2 <u>Price Base</u>

As indicated in Table 11-1, the estimate plan included the receipt of RFP prices as the price basis for the Accommodations Complex. Unfortunately the timing of the RFP closure slipped considerably, thus requiring the utilization of internal benchmark data for the establishment of the CCE.

The price basis for the administration buildings was based upon an historical all-in average for similar buildings.

- Administration office building and Safety / inductions building = \$2,000/m^2
- Fire hall / ambulance shelter = \$2,500/m^2
- Communications building, camp maintenance workshop, and security building = \$2,400/m^2

The price basis for the utilities is based upon quantified units of measure for each element comprising the utilities (e.g. fire hydrant) and the effort to install each unit. RSMeans 2011 were used as the basis for most material unit prices and installation man-hours, to which 25% was added to these unit prices to account for higher transportation and logistics cost for Labrador, based upon BAE-NewPlan's experiences for similar municipal works.

25.5 Mass Excavation Works

25.5.1 Scope

The scope of Mass Excavation Works includes:

- Spillway Excavation
- Powerhouse Excavation
- Approach Channel Excavation

Bills of Quantities (BOQ) were issued by engineering and a check BOQ was developed by estimators. Reconciled Engineering and Estimator BOQs revealed no significant differences in quantities. CCE Mass excavation major quantities are as follow:

- Overburden material at the Powerhouse site: 455,000 m^3
- Overburden material at the North Spur site: 600,000 m^3
- Rock excavation: total volume 2,092,000 m^3
  - Powerhouse : 1,590,000 (including rock plugs)
  - Spillway : 250,000 m^3
  - North Spur : 100,000 m^3
- 4.0 m long Rock bolt quantity: 882 units
- Wire mesh area and pins: 50,000 m^2

Rock bolts were quantified by engineering on the basis of available geotechnical information suggesting that the rock is of “excellent” quality (one bore hole on North side) to “very good” quality (one bore hole on South side) and based on rock bolt quantities for similar projects with similar rock conditions.

For a Project this size, the number of boreholes two is clearly insufficient to properly assess the quality of the rock. An investigation campaign will be required when the Project goes forward.

Costs were included to account for average 500 mm thick concrete mud slabs where the Powerhouse and Spillway are to be concreted.

The mass excavation estimate also includes a provision for the procurement, installation and operation of a 150 people starter-camp to lodge first workers and staff on site.

Quantification basis for this work is captured in the following Engineering documents:

- CH0006 - Construction of Bulk Excavation Works and Associated Civil Works
- CH0007 – Intake and Powerhouse, Spillway and Transition Dams
- CH0008 – Construction of North Spur Stabilization Works
- CH0009 – Construction of North and South Dams

25.5.2 Construction Methodology & Timeline

- General assumption is that rock quality is not a concern and Project is standard rock excavation project.
- All excavation activities estimated on a six (6) days per week basis to allow for a buffer for bad weather conditions. A total duration of 200 workdays is considered in the estimate for the mass excavation of the powerhouse and spillway.
- Rock excavation to start when overburden excavation has exposed sufficient areas to allow drill and blast operations to start.
- Excavation crew:
    - Cat 992K loader
    - 5 Cat 775F off-road dump truck
    - Cat D8 at dump site
- No provision is included for the cost of spare stand-by equipment on site.

25.5.3 Price Basis

- Labour rates considered for this portion of the estimate as contained in Part A.
- Equipment rates are a mix of *Equipment Watch* rates, as discussed in Part A, with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

25.5.4 Performance Basis

- Haul and dump distance of 2.5 km from site to stockpile
- Production drilling at 20 m/hr per drill using ROC D7 drills
- Large diameter line drilling performed with three drills at a rate of 15 m/hr.
- Rock excavation drilled and blasted on two work shifts on multiple faces at a daily average of 10,000 m^3 (or 5,000 m3/shift) to meet the duration in schedule.
- Load and haul production estimated at 250 m^3/hr per crew and 2 crews are considered.
- Overburden mass excavation production rate = 150 m^3/h
- Rock excavation – dry conditions production rate = 250 m^3/h
- Drilling are estimated at a rate = 54 m/h
- Dynamite operations are estimated at a rate = 250 kg/h
- Excavated rock will be dump and stock piled at the north shore quarry

25.6 Fill Structures: South Dam and Cofferdams

25.6.1 Scope

The scope of the Fill Structures: South Dam and Cofferdams includes the South Dam, various cofferdams required for powerhouse and spillway construction, and the upstream and downstream cofferdams for North RCC Dam. Reference Key Plan of Cofferdams and Dams contained in Attachment B.5 for further details.

The quantities for the Fill Structures: South Dam and Cofferdams were developed by the engineering, and validated by estimating through an independent take-off exercise which revealed minimal differences. The quantities provided by the engineering group were used to develop the RCC structures estimate and are as follow:

Quantification basis for this work is captured in the document "CH0009 – RCC Dams and River Cofferdams."

Summary of Quantities

Powerhouse Downstream Cofferdam
- Compacted Till – Zone 1: 12,900 m^3
- Compacted Granular – Zone 2C: 3,700 m^3
- Compacted Rockfill – Zone 3C: 12,400 m^3
- Riprap (produced by others) 4 Class 1: 1,200 m^3

Spillway Upstream Cofferdam
- Compacted Till – Zone 1: 8,000 m^3
- Compacted Granular – Zone 2C: 5,500 m^3
- Compacted Rockfill – Zone 3C: 43,000 m^3
- Riprap (produced by others) 4 Class 1: 3,000 m^3

Spillway Downstream Cofferdam
- Compacted Till – Zone 1: 5,700 m^3
- Compacted Granular – Zone 2C: 4,500 m^3
- Compacted Rockfill – Zone 3C: 33,660 m^3
- Riprap (produced by others) 4 Class 1: 2,400 m^3

North Downstream Cofferdam
- Compacted Till – Zone 1: 5,466 m^3
- Compacted Granular – Zone 2C: 2,489 m^3
- Compacted Rockfill – Zone 3C: 2,352 m^3

North Dam Upstream Rockfill Cofferdam
- Dumped Rockfill 0-900 mm: 220,000 m^3
- Boulders 1000-1200 mm: 20,000 m^3
- Boulders 1200-1500: 25,000 m^3
- Dumped Granular or Crushed Rock max 300 mm Zone 2E: 26,000 m^3

- Compacted Till - Zone 1: 19,000 m^3
- Compacted Granular - Zone 2C: 14,000 m^3
- Compacted Rockfill - Zone 3C (0-450 mm): 35,000 m^3
- Compacted Rockfill - Zone 3D (0-900 mm): 38,000 m^3
- Riprap (produced by others) 4 Class 1: 3,200 m^3
- Dumped Rockfill (access road) 0-900 mm: 75,000 m^3
- Dumped Till: 159,000 m^3

South Rockfill Dam

- Compacted Till – Zone 1: 22,118 m^3
- Compacted Filter – Zone 2: 15,373 m^3
- Compacted Rockfill – Zone 3, 3B and 4: 77,000 m^3

25.6.2 Construction Methodology and Timeline

- It is assumed that the main access road from the Trans-Labrador will be available for mobilization and commencement of the work in fall 2012, that the contractor's pad will be ready, that the soil will be dry (overburden), that the borrow pits are suitable for the production of material.
- The productivity considered to perform the work was based on a 6 day/week, 10 h/shift, 2 shifts/day schedule. In the CCE, while paid 7^{th} day, it is considered as a buffer day or make-up shift on which lost production on the previous 6 days can be recuperated.

The heavy equipment considered to develop the fill structures estimate are as follows.

Compacted Till Zones Heavy Equipment:

- CAT 325B Backhoe
- CAT D8N Dozer
- CAT 345B Backhoe
- CAT D5 Dozer
- Vibratory compactor CAT 563
- 13 – 10 wheels dump truck

Compacted Granular Zones Heavy Equipment:

- CAT 966F
- CAT D5G Dozer
- Vibratory Compactor CAT 563
- 6 – 10 wheels truck

Compacted Rockfill Zones Heavy Equipment

- CAT 992K

- CAT 365B Backhoe
- CAT D8N Dozer
- 4 CAT 775F Dump Truck
- CAT 325B Backhoe

Riprap Zones Heavy Equipment:
- CAT 365B Backhoe
- 2 CAT 775F Dump Truck

Dumped Rockfill Zones Heavy Equipment:
- CAT 992K
- CAT 365B Backhoe
- 2 CAT D8N Dozer
- 4 CAT 775F Dump Truck
- CAT 325B Backhoe

Boulders Zones Heavy Equipment:
- CAT 992K
- 3 CAT 365B Backhoe
- CAT D8N Dozer
- 4 CAT 775F Dump truck

25.6.3 Price Basis

- Labour rates considered for this portion of the estimate is as provided in Part A.
- Equipment rates are a mix of *Equipment Watch* rates, as provide in Part A, with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

25.6.4 Performance Basis

- Load, haul and placing compacted till production rate = 170 m^3/h
- Load, haul and placing compacted granular production rate = 170 m^3/h
- Load, haul and placing compacted rockfill production rate = 250 m^3/h
- Load, haul and placing riprap production rate = 125 m^3/h
- Load, haul and placing dumped rockfill production rate = 250m^3/h
- Load, haul and placing boulders production rate = 200m^3/h
- Load, haul and placing dumped granular production rate = 170m^3/h

25.7 North Spur Stabilization Works

25.7.1 Scope

The scope of work considered in the CCE was developed by the engineering group who provided bill of quantities to estimators. Quantities were validated by estimators through an independent take-off exercise which revealed minimal differences. The quantities provided by the engineering group were used to develop the North Spur Stabilization estimate and are as follow:

- Overburden Excavation: 368 242 m^3
- Overburden Excavation (2F Material): 228 638 m^3
- Till Blanket – Zone 1 North Shore deposit : 171 094 m^3
- Granular Material – Zone 2A: 123 462 m^3
- Granular Material – Zone 2C: 63 513 m^3
- Compacted Granular material – Zone 2F: 228 638 m^3
- Dumped Rockfill – Zone 3: 71 410 m^3
- Compacted Rockfill – Zone 3A: 14 222 m^3
- Compacted Rockfill – Zone 3A South Shore excavation: 14 222 m^3
- Compacted Rockfill – Zone 3B: 57 450 m^3
- Compacted Rockfill – Zone 3B South Shore excavation: 57 450 m^3
- Compacted Rockfill – Zone 3C: 58 115 m^3
- Compacted Rockfill – Zone 3C South Shore excavation: 116 231 m^3
- Riprap – Zone 4 – North Shore quarry: 22 200 m^3
- Zone 5 Material crushed stone max 31.5mm(permanent road):8 000m^3
- Compacted Rockfill – Zone 3C South Shore excavation (permanent road): 16 000 m^3
- Geotextile: 20 000 m^2
- Geomembrane: 60 000 m^2
- Slurry Cut-Off wall: 41 150 m^2

Quantification basis for this work is captured in the following Engineering documents: CH0008 – North Spur Stabilization Works.

25.7.2 Construction Methodology and Timeline Factors

Work on cofferdam to be performed before the 2014 flood. Approximately 200,000 m^3 , or 12% of the total excavated and filled material for the North Spur, borrowed rock will come from the south once the main upstream cofferdam is completed. The productivity considered to perform the work was based on a 6 days/week, 10 h/shift, 2 shifts/day schedule. In the CCE, the paid 7th day is considered as a buffer day or make-up shift on which lost production on the previous 6 days can be recuperated.

25.7.3 Price Basis

- Labor rates considered for this portion of the estimate are as provided in Part A
- Equipment rates are a mix of *Equipment Watch* rates, as discussed in Part A, with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

25.7.4 Performance Basis

- Overburden excavation estimated production rate: 100 m^3/h
- Placing compacted materials estimated production rate: 100 m^3/h
- Placing dumped Rockfill materials estimated production rate: 150 m^3/h
- Geotextile and geo-membrane installation rate: 250 m^2/h

25.8 North RCC Dam

25.8.1 Scope

The scope of the work considered in the CCE is the North RCC Dam. Reference Key Plan of Cofferdams and Dams contained in Attachment B.5 for further details.

The quantities for the North RCC Dam were developed by the engineering, and validated by estimating through an independent take-off exercise which revealed minimal differences. The quantities provided by the engineering group were used to develop the RCC structures estimate and are as follow:

Quantification basis for this work is captured in the document "CH0009 – RCC Dams and River Cofferdams."

Summary of Quantities

- RCC volume: 188 750 m^3
- Total formwork area: 25 000 m2

25.8.2 Construction Methodology and Timeline

- RCC lift height = 300mm/lift
- RCC will be pour by conveyor

Main assumptions are that green cuts will be made when needed by the RCC crew during formwork preparation for the next lift but will be kept to a minimum by the use of a low high paste low water demand (60% fly ash/40% cement) mix allowing for better maneuverability and a 16 to 20 hour setting time.

- Formwork will be fabricated on site by the formwork crew in sufficient quantities to allow continuous operations by jumping lower form panels.
- All formwork activities estimated on a 6 days/week, 10h/day basis.
- RCC activities estimated on a 7days/week, 20h/day basis.
- Foundations ready in 2014, RCC placement will begin in spring 2015

Formwork Crews:

- 1 Foreman
- 3 Carpenters
- 3 Laborers
- 1 Welder

RCC Crew:

- 3 Heavy equipment operators
- 1 Backhoe operator
- 1 Dozer operator
- 6 Concrete laborers

- 1 Foreman
- 1 Concrete conveyor operator
- 10 Highway truck operator

RCC Heavy Equipment
- CAT 315 DL Backhoe
- CAT D5 Dozer
- CAT D4 Dozer
- CAT 950H
- Vibratory compactor CAT cs 533E
- Boom truck with boom conveyor 100'
- 10 – 10 wheels dump truck
- 2 - twin shaft paddle batch mixer

North Dam
- Total duration of 90 workdays (3.5 months)
- A total of 60 upstream formwork panels will be needed
- Upstream formwork panels will be used up to 8 times
- A total of 155 downstream formwork panels will be needed
- A total of 108 RCC lifts of 300mm high will be made

Riverside Cofferdam
- Total duration of 52 workdays (2 months)
- A total of 54 formwork panels will be needed
- Formwork panels will be used up to 7 times
- A total of 56 RCC lifts of 300mm high will be made

25.8.3 Price Factors
- Labor rates considered for this portion of the estimate is as provided in Part A.
- Equipment rates are a mix of *Equipment Watch*, as discussed in Part A, rates with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

25.8.4 Performance Basis
- Formwork fabrication rate = 4 m^2/hr
- Formwork installation rate = 6.30 m^2/hr
- RCC average production/hauling/placing = 148 m^3/hr
- 2.5 km from concrete batch plant to RCC dam/cofferdam

25.9 Riverside RCC Cofferdam

25.9.1 Scope

The scope of the work considered in the CCE is the temporary Riverside RCC Cofferdam required for protection of the spillway structure from high-water events. Reference Key Plan of Cofferdams and Dams contained in Attachment B.5 for further details.

The quantities for the Riverside RCC Cofferdam were developed by the engineering, and validated by estimating through an independent take-off exercise which revealed minimal differences. The quantities provided by the engineering group were used to develop the RCC structures estimate and are as follow:

Quantification basis for this work is captured in the document “CH0009 – RCC Dams and River Cofferdams.”

Summary of Quantities

- RCC volume: 37 000 m^3
- Total formwork area: 6 600 m2

25.9.2 Construction Methodology and Timeline

The construction methodology assumed for this structure is similar, but scaled, to what is planned for the North RCC Dam. The scope of this work is included in CH0006.

25.9.3 Price Factors

- Labor rates considered for this portion of the estimate is as provided in Part A.
- Equipment rates are a mix of *Equipment Watch*, as discussed in Part A, rates with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

25.9.4 Performance Basis

- Formwork fabrication rate = 4 m^2/hr
- Formwork installation rate = 6.30 m^2/hr
- RCC average production/hauling/placing = 148 m^3/hr
- 2.5 km from concrete batch plant to RCC dam/cofferdam

25.10 Structural Concrete Structures

Direct costs were determined by a "bottom-up" contractor-style estimate, starting with detailed quantity takeoffs for each structural concrete element. Takeoff quantities were reconciled with BOQ values prior to the November 15-18 estimate review meeting later adjusted according to agreed action items identified during review meeting. Crews and productions were assigned to each element of work, and resource requirements (e.g. form fabrication quantities) were also determined for each element of work. Crane layouts were sketched to determine required capacities and number of cranes (see Figure 25-3).

Construction indirect costs related to the subject work scope are included in the estimate. In other words, the construction indirect costs included are sufficient to directly plan and supervise the work in the field only, including contractor's quality control personnel, construction engineering, and surveying. The Construction indirect costs were estimated in four groups so as to be able to rationally distribute them to determine total costs for the main components of work estimated: Spillway; Intake; Powerhouse; and Transition Structures.

Construction Materials were estimated based on cost experience and research, unit rates were established for all construction materials required. In general, all construction material rates were determined by side estimate and input to the estimate by m, m2, or m3 as appropriate. Labour related small tools, supplies, and safety equipment were input by the man-hour ($4.00) in the Construction indirect costs.

Included Items:

Supervision – Construction supervision and vehicles; quality control and assurance personnel; surveying; construction engineering. Established indirect wage rates are weighted to account for rotation of personnel.

Temporary Buildings – Office facilities; craft tool rooms/dry shacks; warehouses/shops; stair towers; winter protection enclosures (for Intakes and Powerhouse only). Scaffolding and walkways are included in the direct costs in the various formwork and false work fabrication items.

Utilities – Power and water hook-ups; water pumping and transportation; sanitary facilities; phone and internet expenses (for site offices and indirect personnel only).

Support Equipment – Crew pickups/flatbeds; hydraulic cranes; boom trucks; labour related small tools, supplies, and safety equipment ($4.00 for every man-hour, including indirect man-hours).

Administration and Profit – 15% contractor mark-up on all costs, including indirect costs. No other adders for bond, liability insurances, home office overhead, etc. are included.

Excluded Items:

Labour Related – No turnaround or rotation transportation (airfare) costs are included in the structural cost estimate as these costs are captured as a Project Indirect Cost detailed in Part A.

No costs for employee training, safety indoctrinations, drug testing, bonuses, or other compensation outside the agreed wage rates are included as these are addressed in the Project Indirect costs. No costs for camp (room and board) or other site services (other than construction office maintenance) are included.

Equipment, Construction Materials, Permanent Materials Related – No exclusions other than it was assumed access roads, equipment pads, yard areas, dewatering, snow removal, signs, barricades, etc. would be provided elsewhere in the estimate. No costs are included for any of these items, other than the costs included in the Construction indirect costs for surface water and snow control inside the structure footprints (only).

Contractor Overheads – Other than the 15% contractor mark-up on all costs (included in the Construction indirect costs), there are no other overhead or profit allowances. Separate allowances for items such as Bond, General Liability Insurance, Builders Risk Insurance, Home Office Overhead, etc. are not included.

Subcontractor Mark-ups – The assumption is that all the work is to be self-performed; hence any additional mark-ups due to subcontracted work are not included. If, for example, the contractor elects to subcontract the furnishing and placement of reinforcing steel on the project, a substantial mark-up would be required by the subcontractor (on approximately $100M worth of work).

25.10.1 Scope

Structural concrete estimate includes the direct and indirect costs for the following structural concrete elements of the project:

- Powerhouse Concrete Cofferdam
- Spillway Concrete Structure
- Spillway Centre Pier for temporary construction bridge
- Intake Concrete Structure
- Powerhouse Substructure
- North Transition Structure
- Centre Transition Structure
- South Transition Structure (estimated as part of the Powerhouse)

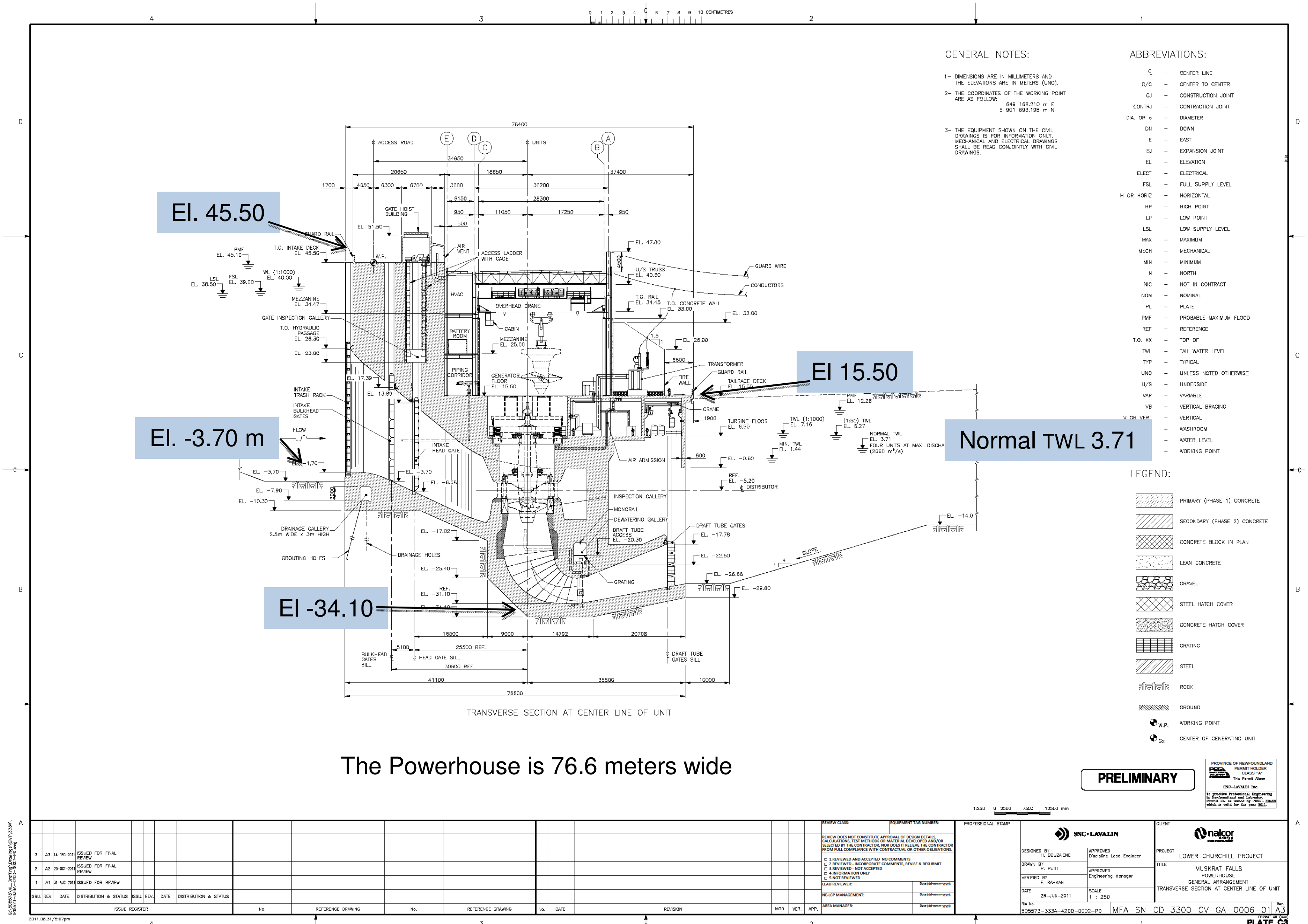
Structural concrete estimate includes costs for furnishing, forming, placing, finishing, and curing the structural concrete for the above listed elements. It includes installation of all scaffolding and shoring for concrete as well as furnishing and installing reinforcing steel and waterstops for those elements. It also includes installation only of primary anchors only for gate, stoplog, and trashrack assemblies as well as supply and install of miscellaneous embedded metals.

The structural concrete estimate does not include any other structural concrete elements (e.g. RCC dam facing, temporary structures other than the Spillway Centre Pier), structural steel, or grouting. It does not include embedded guides for gate, stoplog, and trashrack assemblies.

The quantities considered were provided to estimating by engineering and are derived from the CATIA model developed for the Project. An independent take-off by estimating revealed no significant differences with quantities provided by engineering.

Quantification basis for this work is captured in the document: *CH0007 – Intake and Powerhouse, Spillway and Transition Dams*.

Figure 25-1: Powerhouse and Intake Overall Dimensions



25.10.2 Construction Methodology & Timeline

In the CCE, the basic assumption is that the Intake-Powerhouse-Draft tube structures are to be constructed concurrently along with the Spillway and transition structures all in accordance to the master Project schedule provided to the estimating team. In effect, the sequencing of the work and the volumes of the components to be poured dictate the required monthly production rates.

However, following the above mentioned assumption, the monthly placement volumes obtained using the resulting production rates are quite high. In effect, 16 months are required to pour 284,000m^3 which represent two thirds of the structural concrete for all the structures resulting in an average of 17,775m^3 per month or roughly 585m^3 per day every day. Furthermore, in order to achieve this production, it is estimated that the necessary work schedule involves working 2 shifts, 7 days a week. In these conditions there is no float or margin to account for any unexpected events.

Sustaining such a high level of production for such an extended period of time will be quite challenging if not overly optimistic. As the critical path of the Project is generally through the centerline of the turbine/generator units, SLI's recommendation to alleviate the scheduling pressure on the structural concrete operations would be to remove from the critical path a portion of the concrete to be poured. This could be achieved by adding a construction joint upstream and downstream of the center portion of the Powerhouse, where the units are housed and pouring the Intake and Draft tube later.

Cold Weather Concreting – costs are included for heating concrete during winter months (generally ½ of each year) as well as a provision for a temporary building enclosure for the Intakes and Powerhouse only at a cost of $1320/m2 (plus heating and lighting costs) for a "substantial" building that would be insulated and structurally capable of supporting gantry cranes for work inside.

Remote Site –long truck hauls were considered necessary for mob/demob as well as the furnishing of all permanent and temporary materials and supplies.

Labour – Labour crafts were assigned by type of work as follow as discussed in Part A:

- Carpenters for formwork
- Labourers for concrete placing
- Operators for equipment
- Teamsters for trucking
- Cement masons for concrete finishing.

Crew sizes and makeups were established based on the elements of work.

Construction Equipment – Equipment is included in each crew. Cranes, forklifts, generators, compressors, welding machines, concrete pumps, manlifts, etc. are all included in the direct cost of each element of the work. Only pickups and limited support equipment such as hydraulic cranes and boom trucks are included in the construction indirect costs.

Concrete Placing – The cost of the work was estimated under the assumption that all concrete would be pumped, and the average pump boom size would be 52m. There is a good chance that a contractor would place at least some of the concrete by other means, but an overall unit placing cost derived from pumping all concrete with a 52m pump adequately meets the required precision of this estimate.

Mob & Demob – Included in the estimate is the employee travel time (not including bus and driver costs) to/from site one-way from camp (1/2 hour on top of each 10 hour shift); equipment transportation and setup/down; site facilities setup/down.

25.10.3 <u>Price Basis</u>

All direct costs, including labour, equipment, construction materials, and permanent materials are included. All work was assumed to be self-performed; no subcontractor costs are included (with the exception of provisions for mob/demob trucking). The potential (likely) added project cost due to mark-ups on subcontracted work could be significant but is not included in the structural concrete estimate.

- Labour rates are agreed "all-in" rates for each craft based on 10 hours a day 7 days a week as stated in Part A.
- Equipment rates are agreed "all-in" rates for each equipment resource as stated in Part A.

Construction Consumables – Unit rates considered are as follows:

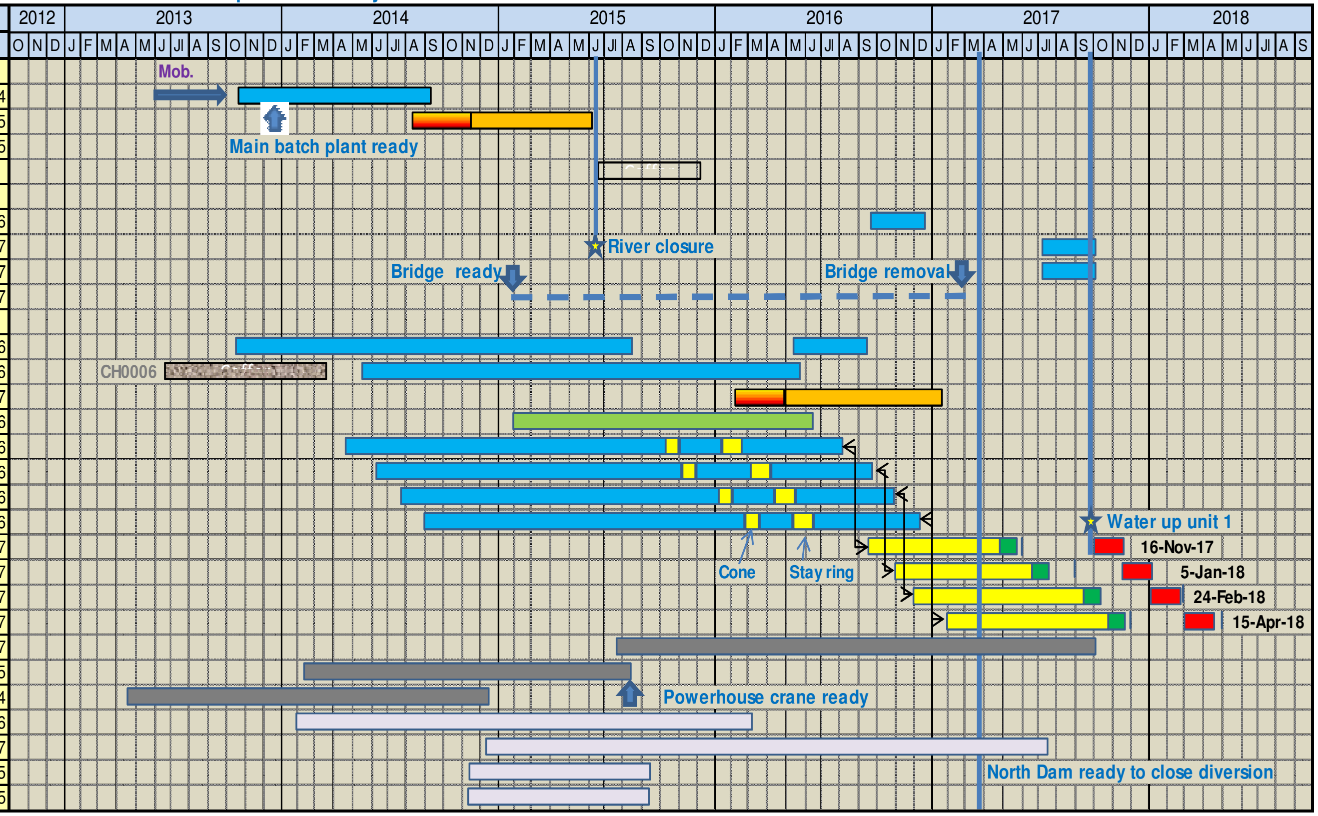
- Supply and transportation of CVC from the batch plant $275/m^3$
- Waterstop (all) $15/m
- Liquid Expansion Joint Filler $11/m^2$
- Rebar (all, black) $2.00/kg

Figure 26-2: Simplified Schedule of Powerhouse

Lower Churchill Project

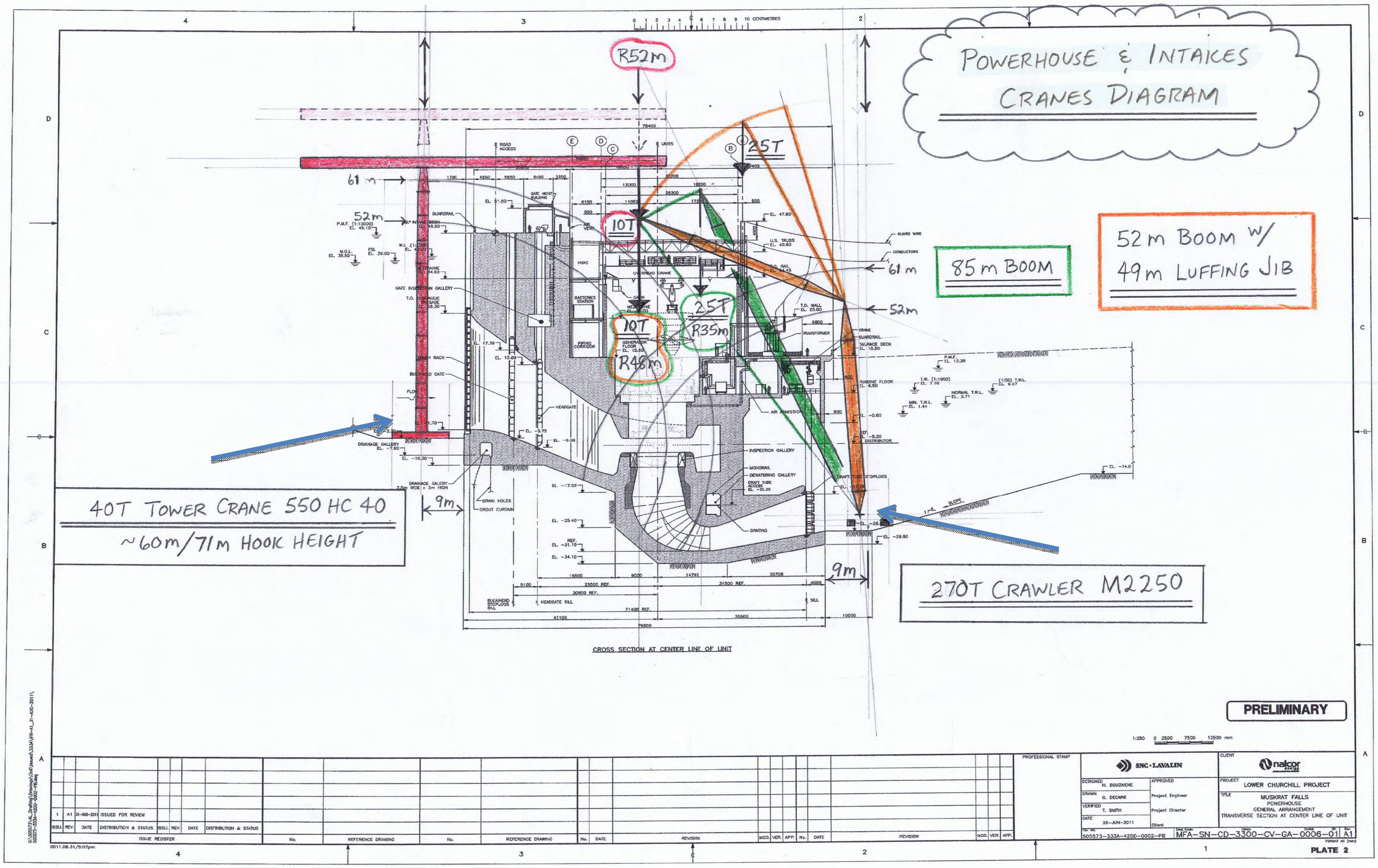
Simplified Summary Schedule Area Powerhouse

Package	Activity	Duration From	Duration To
	Spillway Phase 1		
CH0007	Spillway concreting	21-Oct-13	11-Sep-14
CH0046	Spill. Hydromech.	13-Aug-14	9-Jun-15
	River Closure		16-Jun-15
	Main Cofferdam		
	Spillway Phase 2		
CH0007	Rollway 1	19-Sep-16	17-Dec-16
CH0007	Rollway 2	4-Jul-17	2-Oct-17
CH0007	Rollway 3	4-Jul-17	2-Oct-17
CH0007	Upstream Temp. Bridge	29-Jan-15	5-Apr-17
	Intake and Powerhouse		
CH0007	Center Transition	14-Oct-13	20-Oct-16
CH0007	Intake	22-May-14	25-May-16
CH0032	PH Hydromech.	13-Aug-15	24-Jan-17
CH0007	Steel Structure	2-Feb-15	4-May-16
CH0007	Concrete Unit 1	24-Apr-14	10-Aug-16
CH0007	Concrete Unit 2	5-May-14	19-Sep-16
CH0007	Concrete Unit 3	17-Jul-14	31-Oct-16
CH0007	Concrete Unit 4	28-Aug-14	7-Dec-16
CH0030	Install Unit 1	7-Sep-16	28-May-17
CH0030	Install Unit 2	24-Oct-16	21-Jul-17
CH0030	Install Unit 3	28-Nov-16	13-Oct-17
CH0030	Install Unit 4	25-Jan-17	29-Nov-17
CH0031	PH Auxiliaries	21-Jul-15	2-Oct-17
CH0033	PH Crane	11-Feb-14	17-Aug-15
CH0034	PH Elevator	15-May-13	6-Dec-14
PH0014	Step Up Transformers	25-Feb-14	2-Mar-16
PH0015	Isolated Phase Bus	10-Dec-14	14-Jul-17
PH0016	Gen. Circ. Breaker	12-Nov-14	10-Sep-15
PH0035	Station Service Transformers	5-Nov-14	3-Sep-15



- Turbine & Generator Installation
- Concreting activities
- Steel structure + outside architecture
- Hydromechanical
- Hydromechanical embedded part
- Fabricate and Deliver
- Supply and Install
- Rock Excavation
- Pre-commissioning (dry tests)
- Commissioning and Commercial Power
- Season constrained milestones

Figure 26-3: Crane arrangement for concreting showing load at max reach



25.10.4 <u>Performance Basis</u>

Labour Productivity was factored to take into account remoteness, climate, and pace of work, large crew sizes, multiple shifts, and long work weeks resulting in labour not being as productive as it could be otherwise. Quantifying reduced productivity is subjective, but 60% to 80% of what could be expected under more favourable conditions is a reasonable estimate of what was assumed for hourly labour productivity. More favourable conditions would be: closer to metropolitan area; not as adverse climate conditions; 40 hours per week; single shift; smaller crew size; slower build-up to maximum crew size.

However, prior to CCE close-out, SLI has conducted a further review of the structural concrete component of the Project with respect to, amongst others, the aggressiveness of the concreting schedule, as described in the Construction Methodology & Timeline Factors section above. As a result of this review, SLI has elected to carry in the CCE and additional 200,000 labour hours to cover for the inherent loss of labour productivity that will result from the congestion of the concreting work areas and the strain on the supply chain of materials to the worksite.

25.11 Powerhouse and Spillway Heavy Mechanical Systems

25.11.1 Scope

The Powerhouse Heavy Mechanical and the Spillway Heavy Mechanical systems have been divided into two (2) packages due to schedule requirements and the need for the spillway to be operational for river diversion two years before the powerhouse is complete.

The scope of work for the Powerhouse Heavy Mechanical includes the following:

- 12 intake vertical emergency closure head gates, including embedded guides and wire rope hoists, for reach water passage;
- One (1) set of five bulkhead gates section for one (1) water passage, including 12 sets of embedded guides, for each water passage, and one (1) lifting beam designed to install and remove the bulkhead gates with a mobile crane;
- 12 sets of trashracks, including embedded guides, for each water passage;
- Four (4) sets of draft tube stoplogs, two sets per unit, with eight sets of embedded guides, for each water passage;
- One (1) draft tube stoplog handling overhead crane.

The scope of work for the Spillway Heavy Mechanical includes the following:

- five (5) spillway vertical gates, including three (3) vertical surface gates, and two (2) low level outlet gates;
- two (2) set of temporary upstream stoplogs needed for construction which will be modified to one (1) set of permanent upstream stoplogs;
- two (2) sets of temporary downstream stoplogs needed for construction;
- three (3) hoist houses with two (2) wire rope hoists, steel towers and two (2) stairs for the vertical surface gates;
- two (2) hoist houses with two (2) wire rope hoists for the low level outlet gates;
- one (1) monorail hoist for handling the permanent stoplogs;
- 18 sets of vertical embedded guides for the gates and stoplogs.

Quantification basis for this work is captured in the following documents:

- CH0032 – Powerhouse Hydromechanicals
- CH0046 – Spillway Hydromechanicals

25.11.2 Construction Methodology and Timeline

The installation crew for the Powerhouse Heavy Mechanical is estimated at 13 total staff working 10 hour days on a 20/8 rotation for 36 months. The installation crew for the Spillway

Mechanical is estimated at 10 total staff working 10 hour days on a 20/8 rotation for 28 months.

The Schedule was discussed with the two fabricators who supplied budget prices, and both agreed lead times were acceptable for fabrication and installation.

25.11.3 Price Basis

Direct costs include the design, supply, transportation, installation and commissioning of the above listed packages.

For the direct cost estimate, preliminary design was completed to determine weights of all components, and the costs were estimated from other comparable hydroelectric projects on a cost per kilogram basis. The estimate weights of all mechanical components for the Powerhouse Heavy Mechanical equipment is 7,726 tonnes, and for the Spillway Mechanical equipment is 2,843 tonnes.

Preliminary drawing and a summary specification were produced, and these were provided to three fabricators who were chosen as they had in house design capabilities and these companies were considered experienced in gate design and fabrication, and have participated in similar installations in remote sites similar to Labrador.

Budget prices were received from two of the three fabricators, and these prices were considered as acceptable as they were within 12% on the total price, so the higher of the two prices were used in the CCE. On a price per kilogram basis, the budget prices were considered reasonable.

Indirect costs were not included in the estimate, but one fabricator provided a man-hour estimate for the installation from which the SLI estimators produced indirect costs for these two packages.

The project should realize a saving if both of these packages are awarded to one contractor, but these two packages cannot be awarded simultaneously as the start times for each project are offset by six to nine months depending on how the packages are finally assembled. The start times will be finalized if the Draft Tube Stoplogs and embedded steel is included in the Powerhouse Heavy Mechanical or the Spillway Mechanical packages, and will depend on the final construction sequence for the powerhouse civil contract.

25.12 Powerhouse Superstructure

25.12.1 Scope

The scope includes Construction of Steel Structure for Powerhouse Superstructure, 46.965 m width, 198.840 m length and 27.80 m height (from +15.50 m to + 43.30 m). It also includes construction of two mezzanine floors at +25.00 and +34.47 m level, made of concrete floor over metal decking. Structural Steel for roof over mezzanine floors and catwalk access is also included as well as the steel columns and beams required to carry the loads of the two heavy overhead cranes in the Powerhouse. The scope also includes Metal access Doors, Ladders, Handrails, Guard Rails, Removable Handrails and Crane rails at Intake Deck.

Extension of the powerhouse structure by 2 bays for construction purpose is considered as an optional item (Option 1) and has been estimated separately as standalone case and is not included in the CCE.

Use the 2 units of steel superstructure as winter protection shelter is considered as an optional item (Option 2) and estimated separately as standalone case.

In-House pricing was used to estimate the majority of Architectural items and benchmarked with other projects using similar architectural systems as well as specialized supplier input. For very few of these items, information from Richardson Cost Data was used. Wherever no information was available, a lump sum provisional amount was provided. The final architectural cost included in the CCE was adjusted to reflect architectural costs encountered in similar projects in comparable conditions.

- Quantities are based on 40% engineering progress, as of 24 November, 2011. Any changes resulting from development thereafter are excluded.
- Bill of quantities were issued by engineering on a basis of heavy, medium and light profiles for an approximate total of 3 200 tonnes.
- Quantities include connection allowance of 10% and quantity growth allowance of 10%.
- All structural steel is generally painted, except specified otherwise.
- Concrete for mezzanine floor is included in concrete works for powerhouse.
- All miscellaneous embedded steel is included in concrete works for powerhouse.
- No additional allowance needs to be added.
- Any changes resulting from development thereafter like addition of roofs over mezzanine floors are excluded.
- Costs and labour productivity included in the CCE have also been benchmarked with similar projects in comparable conditions.

The scope includes guardrails along the south RCC dams, the intake, the center dam, the permanent access road and the tailrace deck.

- Foundation of the Guardrails is included in Civil / Concrete works of Powerhouse and is assumed to consist only of drilled holes for expansion anchors.
- Quantities are neat and do not include any kind of allowance what so ever.

Quantification basis for this work is captured in the document: *CH0007 – Intake and Powerhouse, Spillway and Transition Dams*.

25.12.2 Construction Methodology & Timeline

Construction will be carried out by multiple sub-contractors to the prime contractor will be chosen to perform the work under a competitive bidding process. Contractor will be given responsibility for the supply, construct, manage, perform and deliver the following on site construction activities in general:

- Craft Labour, Discipline foremen and for all construction / installation activities;
- Construction Equipment for all construction / installation activities;
- Permanent materials and associated bulks;
- Small tools, consumables and supplies;
- Scaffolding;
- Construction supervision and management;
- Temporary facilities & offices and expenses;
- Personnel transportation;
- Mob / Demob of Personnel, Equipment and all facilities
- Construction Equipment requirements have been identified on an as needed basis for individual crews;
- An average of $8.00 per Direct Labour Hour has been considered. On average the following breakdown applies;
  - Small Tools 4 – 5 % of DFL Cost.
  - Consumables 3 – 4 % of DFL Cost.
  - PPE 2 – 3 % of DFL Cost.

Any kind of pre-assembly / dry assembly at site is not envisaged. All structural steel components are stick built for erection purpose. Roof truss is assembled at shop and delivered in two parts.

25.12.3 Price Basis

Budgetary offers from fabricators were invited for supply, fabricate (including shop drawing), paint and delivery at site of structural steel components. Offers were received from OCEAN

STEEL of New Brunswick, SUPER METAL of Quebec and DAERONG of South Korea. Detailed bid evaluation was not carried out and it is assumed the bids are within the acceptable limits of exclusions. An average price of all three bids is considered for present estimation.

- All direct labour hours for Civil / Concrete / Steel are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- Construction Equipment rates are based on blue book hourly rates provided with the *Estimate Ground Rules*– September 12, 2011; and is inclusive of Fuel, Lubricants and Periodic routine maintenance but excludes operating personnel.

25.12.4 Performance Basis

- All direct labour hours based on readily available published charts and/or SLI historical data.
- All base hours based on USGC.
- A site-specific adjustment factor 1.25 for Structural Steel by prime account was applied to the chart hours.
- Factors that were considered for site conditioning include; Work week, Project Size, Plant Type, Work Space per Man, & Climate.
- Factors not considered for site conditioning include; Craft Availability, Craft Skill, Quality of Craft Supervision, & Union Influence

25.13 Powerhouse Crane

25.13.1 Scope

The Powerhouse Cranes are required for installation and maintenance of the generating units. The arrangement used is two (2) bridge cranes rated at 380 tonnes with two (2) trolleys on each rated at 190 tonnes. Each of the cranes will be supplied with a lift beam to lift 360 tonnes; and another lift beam to connect both cranes to lift 680 tonnes which is estimated to be the largest single piece for assembly of the generating units.

Cranes weights received from one of the three suppliers was estimated at 212 tonnes each, or 472 tonnes for both cranes with lifting beams.

Quantification basis for this work is captured in the document entitled: *CH0033 – Supply and Install Powerhouse Cranes*.

25.13.2 Construction Methodology and Timeline

Installation of this contract would take about three (3) weeks with 10 workers working 10 hour days on a 20 days working, 8 days off (20/8) rotation, and indirect costs such as accommodation and site transport were included in the direct costs.

25.13.3 Price Basis

Prices were received from three crane suppliers for supply, transport, and installation of the cranes including start up, commissioning and load testing. Prices received are within 15% and considered consistent with industry prices for this equipment.

Costs for the supply and installation of the rails on the powerhouse superstructure steel were included in the Powerhouse General Civil Contract.

25.14 Powerhouse Elevator

25.14.1 Scope

The powerhouse elevator is a passenger/freight elevator designed for access at seven landings from the drainage sump at EL.-20.2 m up to the Intake deck at El.45.5 m.

Quantification basis for this work is captured in the document: *CH0034 – Supply and Installation of Powerhouse Elevator*.

25.14.2 Construction Methodology and Timeline

Installation of this contract would take about 20 weeks with two workers working 10 hour days on a 20/8 rotation, and indirect costs such as accommodation and site transport were included in the direct costs.

25.14.3 Price Basis

Budget prices were received from two (2) suppliers, but only one elevator system complied with the specified requirements for the size of the cab and doorway, although higher priced it was carried in the CCE.

Costs for the concrete structure were included in the Powerhouse General Civil Contract.

25.15 Power Generation

A complete bid package has been issued to Alstom, Andritz and Voith on October 14, 2011 with expected return date of quotation of January 27, 2012. The scope of the work includes the supply, installation testing and commissioning of four (4) 206 MW Kaplan units including the following for each unit:

- Turbine
- 229 MVA Generator
- Governor
- Static excitation system

Further details are listed below:

DESCRIPTION	UNIT	QUANTITY
Turbines, vertical Kaplan, 206 MW, 35 m head	unit	4
Generators, vertical synchronous, 229 MVA, 15 kV, 0.9 p.f.,60 Hz	unit	4
Governors	unit	4
Static Excitation Cubicle	unit	4
Excitation transformer	unit	4
Unit Protection system (T/G group, GSU Transformer and line)	unit	4
Unit Control and Monitoring Systems	unit	4
Powerhouse Control System	unit	1

Quantification basis for this work is captured in the document: *CH0030 – Design, Supply and Installation of Turbines and Generators*.

Following the evaluation of the three (3) proposals, a provisional amount was included for this scope within the CCE.

25.16 Auxiliary Mechanical Works

25.16.1 Scope

The Mechanical Equipment Bill of Quantities received from project engineering is the basis for the scope of the Mechanical Equipment estimate and cover the following Powerhouse systems:

- Raw and cooling water system
- Fire protection system
- Service water system
- Shaft seal water system
- Dewatering system
- Drainage system
- Oily water drainage system
- Domestic water and Wastewater systems exclusive of appliances carried in architecture estimate
- High and low pressure compressed air systems
- Lubricating and hydraulic oil handling system
- Piezometer and water level system
- Powerhouse HVAC as well air fans in inspection gallery of main RCC dam
- Instrumentation and related piping systems
- Miscellaneous small hoist and handling systems
- Machine shop equipment

Mechanical Engineering Group also added a number of control panels required into BOQ to facilitate the electrical needs for the mechanical equipment material and labour cost calculation.

- Individual datasheets with applicable Codes and Nalcor standards to solicit the Vendor Bids for individual equipment were not received.
- Portable pumps assumed to be un-crated and stored in warehouse. No additional hours for permanent installation.
- Pre-commissioning spares have not been considered.
- Cost of Vendor Representatives has been excluded.
- No Material Take off Allowance was added.
- No Design Development Allowance was added.

HVAC:

HVAC BOQ received from project engineering department is the basis of mechanical HVAC account. Mechanical Engineering Group also added number of control panels required into BOQ to facilitate the electrical needs for the mechanical equipment material and labour cost calculation.

- Individual datasheets with applicable Codes and Nalcor standards to solicit the Vendor Bids for individual equipment were not received.
- Take off is measured through fittings.
- HVAC duct estimated by hrs per lb. Assumed fitting mix is 20 – 30% of weight.
- 20% waste included in weight.
- Pre-commissioning spares have not been considered.
- Cost of Vendor Representatives has been excluded.
- No Material Take off Allowance was added.
- No Design Development Allowance was added.

Piping:

- The BOQ has been verified by engineering against the P&ID's.
- BOQ includes all large bore, small bore piping and valves.
- Assumed local fabrication of piping spools.
- Pipe Insulation requirements were indicated on the insulation specifications.
- Pipe Paint requirements were indicated on the painting specifications.
- The piping layout is based on the 3D model.
- High point vents and low point drains captured on BOQ were developed by estimating, one vent or drain for every 150 LM of large bore piping.
- Assumed 5 - 10% of welds require NDE testing.
- Assumed 30% of welds on site and 70% shop welds where shop rates were estimated through contacting east coast suppliers
- Additional man-hours included for hydro testing and air blowing.
- Additional hours for material handling (prorated on LM of pipe).
- No Material Take Off allowance was added.
- No Design Development allowance was added.
- An allowance for Standard Pipe supports has been included. This includes man-hours as well as material cost.
- All BOQ quantities are "neat"

- No allowances were considered by engineering.

Instrumentation:

Instrumentation cable & bulks for the Auxiliary Mechanical Package were defined by estimation. An allowance including man-hours and material cost has been included in the estimate.

- Instrumentation items for the Auxiliary Mechanical Package have been defined by SNC engineering. No additional instrumentation items have been added by estimating.

Insulation:

- Piping systems requiring insulation have been identified in the project Insulation specifications.
- Insulation quantities have been calculated based on pipe and fitting length using the Denis formula.

Electrical:

- Electrical bulks for the Auxiliary Mechanical Package were defined by estimation.
- Electrical control panels for the Auxiliary Mechanical Package have been defined by SNC engineering. Control Panel assumed to have 50 LM Control Cable, 50 LM Power Cable, 25 LM Conduit & 12.5 LM of Tray.
- An allowance for cable, conduit, & tray for the Auxiliary Mechanical Package has been included. This includes man-hours as well as material cost.

Paint:

- Piping systems requiring painting have been identified in the project paint specifications provided by engineering.
- An allowance for paint material and labour has been included based upon system requirements as well as field touch-ups after welding

Also, the Mechanical Equipment Bill of Quantities received from project engineering is the basis for the scope of the Mechanical Equipment estimate and cover the following North Spur systems:

- Refurbish existing pump wells including pump removal, inspection, cleaning and reconnection.

Quantification basis for this work is captured in the document: *CH0031 – Supply and Installation of Mechanical Auxiliaries*.

25.16.2 Construction Methodology & Timeline

As a result of mechanical construction sequence prior and after installation of Power generation units, the estimate considers a 6 month period where little or no mechanical work is performed which extends the duration for which the temporary contractor installations would be required. For the calculation of the construction indirect costs it was assumed that two packages would be included in one contract.

Mechanical work was assumed to be performed using shared supervision of multiple crews as well as shared service and access equipment.

25.16.3 Price Basis

Detailed Technical bid evaluation (TBE) was not carried out for budget quotes; it is assumed the bids were within the acceptable limits of exclusions.

- All Items were sent for budget pricing through the SLI Procurement group.
- Mechanical and Piping packages were sent to multiple Vendors. When vendor response was limited In house pricing was used to estimate the remaining items.
- Those items that did not receive a budget quote were priced in house using data from similar major projects from the last eighteen months.
- Supply of piping and fittings, valves, accessories have been quoted by vendor or in house priced
- Shop Fabrication of spools pricing is based on multiple offers from East Coast Fabricators.
- HVAC equipment has been quoted by vendor or in house.
- Major Equipment has been quoted by vendor or in house.
- Electrical equipment for power and control of Aux Mechanical package was priced in house.
- Instrument cable for Aux Mechanical package was priced in house.
- Instrument hardware for Aux Mechanical package was vendor quoted.
- Insulation material has been quoted in house.
- An allowance for Standard Pipe supports has been included. This includes man-hours as well as material cost.

Budget quotes were obtained from suppliers for (or part of) the following systems:

- Mechanical system and equipment
- Piping bulks.
- Fire protection items.
- Sand filter.
- Mobile oil purifying unit.
- Oil storage tank
- Oil Water Separator

- Fans, diffusers, coils
- Shop Fabrication

In-house prices were carried for:

- Construction materials, mechanical equipment, electrical equipment and instruments not mentioned above and for which, generally, an 8% allowance was carried for freight.

25.16.4 Performance Basis

Labour productivity assumptions are as follow:

- All direct labour hours are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- The following productivity factors were added to the chart to account for the location of the Project:
    - 1.13 for Mechanical and HVAC systems man hours.
    - 1.55 for Piping / Insulation systems man hours.
- A 6% allowance was added to direct labour costs to account for congestion of the worksite.

25.17 Auxiliary Electrical Works

25.17.1 Scope

The Auxiliary Electrical work estimate includes the direct and construction indirect costs for the following elements of the project:

- Spillway Electrical Works
- North Spur pumping system upgrade Electrical Works
- RCC inspection gallery Electrical Works
- Building Electrical Services
- Electrical Ancillary / Auxiliary Systems
- Powerhouse Grounding Works
- Protection, Control and Monitoring
- Generator Transformers (4 working and 1 standby)
- Emergency Diesel generator
- Spare Parts and Special Tools
- Operations Telecommunication System - Muskrat Fall

All material take-off quantities were developed based on the single-line-diagram and drawings prepared by engineering. Cable lengths were estimated by evaluating horizontal and vertical runs throughout the Powerhouse along with the cable tray layout drawings.

Quantities are neat from engineering and no quantity allowance is considered at this stage of estimate.

This applies to the following WBS BOQ's:

- Powerhouse Station AC/DC Electrical Auxiliaries
- Generator Step-up (GSU) Transformers
- Generator Circuit Breakers
- Station Auxiliary Service Transformers
- Isolated Phase Bus
- MF Power Station BOQ Telecom, CCTV, PA, SACS, TELEPHONY
- MF Spillway BOQ Telecom, CCTV, PA, SACS, TELEPHONY

For the HV Power Transformers elements of the Electrical Works, an estimate validation check for Labour hours was performed using the Aspen Capital Cost Estimator estimating software.

Quantification basis of this work is captured in the following Engineering documents grouped in a single document:

- CH0031 – Supply and Installation of (Mechanical and) Electrical Auxiliaries

- PH0014 – Generator Step-Up Transformers
- PH0015 – Isolated Phase Bus
- PH0016 – Generators Circuit Breakers
- PH0035 – Station auxiliary Service Transformers

25.17.2 Construction Methodology & Timeline

No heavy lifting equipment has been considered as it is assumed all heavy permanent equipment such as the generator transformers are directly off loaded onto foundation by others.

As the duration of the Electrical Works for the Powerhouse and area considered in the CCE extends from mid-2014 to 2016, the construction indirect costs are calculated accordingly. The contracting packaging strategy to be developed with respect to Electrical Works could alleviate these costs be optimizing and possibly decreasing the overall duration of the electrical contractors need to be on site.

Scaffolding and accesses

- A provision of 5% of total direct Labour hours for Scaffolding labour and 3% of total direct Labour cost for scaffolding materials cost are included in the estimate.

Construction equipment

- Diesel Generators are used to provide requisite electrical supply to construction works
- Lifting and carrying equipment like forklifts, small cranes, pickup trucks, welding machines, etc. are estimated to be mobilized for the construction duration as required

Congestion of work site

- A small percentage of 4-5% idle time is assumed to account for site congestion
- Its assumed the work front from other disciplines will be available as per schedule

25.17.3 Price Basis

- Majority of Items were sent for budget pricing through the project Procurement group.
- For some of the high value items average costs of two higher quotes are considered.
- Those items that did not receive a budget quote were priced in house using data from similar major projects from the last eighteen months.
- For the accessories which were not quantified by engineering an allowance was used.

In-house prices were carried for:

- Construction materials.
- Mechanical equipment, electrical equipment and instruments.

Generally an 8% allowance was carried for freight.

25.17.4 Performance Factors

Labour productivity assumptions are as follow:

- All direct labour hours are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- A productivity factor of 1.44 over Richardson was added to the chart to account for the location of the Project
- A 6% allowance was added to direct labour costs to account for congestion of the worksite.

25.18 Reservoir Clearing

25.18.1 Scope

- The reservoir will be cleared using the "partial clearing criteria" as defined in Design Philosophy for LCP – Reservoir Preparation Plan, reference no. LCP-PT-ED-0000-EN-PH-0006-01.
- 40% of the area is located on the North Bank and 60% on the South bank.
- The clearing method will be by a mechanical harvesting operation.
- Total area to be cleared, including reservoir, road rights-of-way and storage yards, is approximately 2200 ha, total merchantable wood is approximately 448,000 m^3 which will be trucked out of the reservoir and piled at storage yards.
- Total road construction will be approximately 152 km and 99 streams will be crossed.

Quantification basis for this work is captured in the following documents:

- CH0023 - Construction of Reservoir Clearing South Bank
- CH0024 – Construction of Reservoir Clearing North Bank

25.18.2 Construction Methodology & Timeline

- Mechanical harvesting of merchantable & non-merchantable wood with feller-bunchers and skidded to roadside.
- Process merchantable wood at roadside to remove limbs and tops.
- Merchantable wood will be trucked to storage yards and piled.
- When possible deadfalls will be skidded to roadside as non-merchantable wood.
- Non-merchantable wood, including deadfalls, and slash from processing merchantable wood will be mulched at roadside and the mulched fibre will be left
- Any areas of deadfalls not skidded and areas of shrubs (alder and willow) will be mulched wherever they occur within the ice and stickup zones and the mulched fibre will be left
- Clearing of the North Bank is scheduled to start in mid-2012 and will be finished at the end of 2014
- Clearing of the South Bank is scheduled to start towards the end of 2012 and will finish in early 2016
- People employed by the clearing contractor must be very skilled – from operators and mechanics to foremen and supervisors.

25.18.3 Price Basis

- Labour and equipment rates as per general CCE rates as stated in Part A.
- Materials costs were obtained from suppliers of the various products used for the estimate and were FOB Goose Bay (e.g. bridges, culverts, material to construct bridge abutments, etc.)
- Certain items were estimated from past experience and bench-marking with industry contacts.

25.18.4 Performance Basis

- Assumed labour productivity at 70% based on rotation times of 20 days working, 8 days off rotation and evaluated by using industry standard productivity tables.
- Equipment productivity factored to account for operating in sandy soils which offer poor traction and for skidding full-tree uphill to honour Nalcor's requirement that, where possible, roads be constructed 2m below full supply level of 39m above sea level.
- 42 – 43 weeks/year considered as the time frames for clearing operations. Note: there may be times during winter months that operations will be curtailed because of extreme snow depths and the weeks/year will be less than considered average.

25.19 Trash Management System

25.19.1 Scope

To address long-term operational requirements for removal of floating and submerged debris from the reservoir that collects on the Intake Gates, a Trash Management System was provided in the CCE. The scope of work for the Trash Management System includes the one purpose built trash cleaning system:

- capable of cleaning floating debris in front of the intake;
- capable of cleaning the trashracks; and capable of cleaning debris from the rock; and
- capable of cleaning sediment trap in from of the intake trashracks.

The only system available that has the above three capabilities is a purpose built trash cleaner built in Germany by Muhr and distributed in North America by Lakeside Industries.

Quantification basis for this work is captured in the document: *CH0047 – Design, Supply and Installation of Trash Cleaning System*.

25.19.2 Construction Methodology and Timeline

Installation of this contract would take about six (6) weeks for eight (8) workers working 10 hour days on a 20/8 rotation, and indirect costs such as accommodation and site transport were included in the direct costs.

25.19.3 Price Basis

Prices from Muhr were provided for design, fabrication, transportation, installation, and commissioning of the Trash Cleaning System.

Costs for the supply and installation of the rails on the intake deck were included in the Powerhouse General Civil Contract.

25.20 Log Booms and Safety Buoys

25.20.1 ***Scope***

A lump sum amount is included in the CCE to cover the cost for the design, supply and installation 3 sets of Log Booms located upstream of the Powerhouse in the North Spur area and directly upstream of the Powerhouse Intake and approximately 4.5km downstream of the Powerhouse along with approximately 1km of access road to access this third log boom.

Also included is the design, supply and installation of a Safety Booms with safety buoys located directly downstream of the Powerhouse.

Quantification Basis for this work is included in the document: *CH0049 – Supply and Install Log Booms*.

25.21 Offsite Infrastructure Upgrades

25.21.1 Scope

The scope of planned offsite infrastructure upgrades in the CCE is the upgrades of the Paradise and Kenamu River bridges are located on the Trans Labrador Highway between the Churchill River Bridge and Cartwright to support the heavy loads required to be transported to Muskrat Falls.

At the time the DG3 CCE was prepared, the logistics strategy assumed the shipment of the main plant transformers from the Cartwright port via the TLH. The existing bridges have been designed according to the Canadian Highway Bridge Design Code (CAN/CSA S6) using the CL-625 truck design criteria. The transport of the transformer equipment exceeds the design capacity of the bridge and therefore strengthening of the superstructure is required.

The scope of the upgrade is based on discussion and meeting with the chief bridge engineer with the Department of Transportation and Works, Government of Newfoundland and Labrador. The existing bridge superstructure is steel truss type assembly. Based on best engineering judgement and experience, the submitted estimate is based on replacement of the bridges verses increasing capacity of critical elements.

Quantification basis for this work is captured in the document: *Access roads for North Spur and Quarries, Strengthening of Kenamu and Paradise River Bridge.*

25.21.2 Price Basis

The estimated cost allowance for the replacement of the existing Kenamu and Paradise bridges, located between the Churchill River Bridge and Cartwright, on the Trans-Labrador Highway (required to increase the load capacity to 250 metric tons) are based on the actual construction cost of the existing bridges which have been adjusted to reflect increases in labour and material cost.

Paradise River:

Existing bridge limited to 190 tonnes plus 48 tonne carrier (Note: this includes unhooking the tractor and winching trailer across bridge). Increase capacity to allow transport of 250 tonnes (Note: existing truss cannot be strengthened. Truss will need to be replaced).

- Install temporary bypass = $1.0 million
- Remove existing truss = $0.2 million
- Design, supply and install new truss = $3.5 million
- Remove temporary bypass = $0.1 million

Note: Assumes concrete abutments meet the structural requirements for a heavier loading.

Kenamu River:

Existing bridge limited to 130 tonnes plus 48 tonne carrier. Increase capacity to allow transport of 250 tonnes. Note: It may be possible to strengthen the existing truss, but, in the opinion of the Chief Bridge Engineer for the Department of Transportation and Works, it is likely the truss will need to be replaced.

- Install temporary bypass = $0.5 million
- Remove existing truss = $0.3 million
- Design, supply and install new truss = $3.5 million
- Remove temporary bypass = $0.1 million

Note: Temporary Bridge for bypass at Paradise River can be used at Kanamu River. There is salvage value in the temporary bridge and the existing trusses at Paradise and Kenamu Rivers but this has not been factored into the estimate.

25.22 MF Site Services

25.22.1 Scope

The scope of site services includes:

- Catering and Housekeeping – consists of providing food and lodging services for the workers at MF, including the operation of the accommodations complex for 1,500 persons in a hotel-style check-in/check-out fashion.
- Building Maintenance – consists primarily of providing the personnel required to maintain the Accommodation Complex and others offices on the site, including some specialized services (e.g. HVAC servicing)
- Road Maintenance and Snow Clearing – consists of maintenance of 30 km of gravel roads and three (3) bridges, including grading and calcium supply and installation for all roads at the Muskrat Falls site, except contractor constructed roads to quarries, borrows and laydown areas.
- Garbage Removal – collection and transportation of garbage within the Muskrat Falls limits.
- Fuel Supply & Dispensing – includes fuel storage tanks at Company Laydown Area, card operated dispensing system, supply of gasoline and diesel fuel to meet the requirements for the site construction. Also includes concrete refueling vehicle pad, an oily water separator for waste fuel and water separation, associated mechanical and electrical systems and components, and a computer system to track fuel usage.
- Ground Transportation – includes the provision of buses and drivers required for the transportation of the local workers between Happy Valley-Goose Bay and Sheshatshiu and the MF Accommodations Complex, as well as rotational workers between the Airport of HVGB and the MF Accommodation Complex.

25.22.2 Price Basis

Catering, Housekeeping and Building Maintenance

As discussed in Section 14.3.5, the cost for catering and housekeeping is based upon current market intelligence for similar unionized camp service operations, with benchmarks against historical projects. All costs are considered on a person-night basis, applied to the total estimated direct and indirect person-hours. Cost per night is estimated at $90 per person, comprised of:

- Catering = $63
- Housekeeping = $20
- Building Maintenance = $7

Snow Clearing

Snow clearing of site access roads and laydown areas under the direct responsibility of Nalcor has been estimated at $5.0 million. The basis of this estimate is a provisional allowance of $100,000 for each major clearing event, with 10 events per year, for 5 years of site operation.

Road Maintenance

Having identified the various activities needed to do the road maintenance, an estimate of the equipment, personnel and duration for each activity has been made based on the judgments and the expertise of various construction specialists who have done many times this work in recent years. Using this, an amount of $1.75 per meter of road per month for 60 month duration was assumed in the CCE.

Garbage Deposal

Waste disposal cost for approximately 5 years at the Muskrat Falls site is assumed to be $2.5 million. No calculation of waste stream volumes has been undertaken, however this value is considered to be sufficient when to compared to available benchmarks.

Fuel Depot

Provisional allowance of $750,000 included in the CCE basis upon historical data from similar projects.

Ground Transportation

The cost estimate is based upon the following key assumptions:

- Transport to/from Airport via Motor Coaches based out of HVGB. Each coach can carry 48 persons and has luggage capacity.
- Transport to/from HVGB / Sheshatshui - MF Accommodations Complex is via School Bus - 48 person capacity
- Contract is outside of the MF Collective Agreement - 1 stop at MF Accommodations Complex allowed per trip
- Assumed that service is provided for max. of 1700 persons, including 1500 persons on rotation, with 200 local hires
- Local hires are picked up and drop at the beginning/end of each shift from HVGB/Sheshatshui.
- Local hires have a 70/30 day/night split-shift, hence 140 day/60 night.
- Motor Coach drivers are residents of HVGB and do not stay in MF Accommodations Complex
- Motor Coach drivers are paid at comparable hourly wages as a Teamster within MF Collective Agreement

- Persons living in camp are on a 20/8 rotation
- Assume 10% additional personnel movement for visitors ("white hats")
- Trips to /from Airport will be driven by aircraft size. Assume 50 person aircraft (DASH 8) is on regular trips daily + 4 commercial flights per week
- Assume 2 bus loads per day to/from airport
- Motor Coaches to/from HVGB/Sheshatshui effectively on-hire 12 hours per day to facilitate split shift.
- Contractor provides, operates and maintains equipment.
- An airport service commences Jan-2013.
- Service to/from HVGB / Sheshatshui - MF Accommodations Complex commences Jan-2013.
- Bus drivers are on a split shift - mornings and evenings - effectively work 10 hours per day
- 1 FTE coordinator assumed to be employed by Service Provider
- 48 Person Motor Coach Hourly Operating Rate is $100/hr
- 48 Person School Bus Hourly Operating Rate is $40/hr
- Motor Coach or School Bus Driver Hourly Wage Rate is $64/hr
- Contractor overhead is 10%, and profit is additional 5%

25.23 Laboratory Services

Consistent with the on-site quality control philosophy discussed in Section 9.9 of Construction Management Plan, document no. LCP-PT-MD-0000-CS-PL-0001-01, the CCE includes for the provision of laboratory services at the Muskrat Falls site for testing of soils and concrete to ensure compliance with specifications.

Specific activities to be done by the laboratory services contractor will include providing all necessary inspection, sampling and test equipment, including consumables to carry out the following:

- Soil/Aggregate/Concrete Aggregate – Sampling and Testing
- Field Compaction Testing
- Sampling, curing, testing – plastic concrete – all areas at truck tail gate, chute and/or placement of formwork
- Verification of properties through trial batching on commissioning of Concrete Batch Plant at Site
- Testing for uniformity of mixed concrete after calibration of Batch Plant equipment and commissioning
- Early strength test
- Concrete-mix design adjustments and testing
- Grout – compressive strength and flow, viscosity, bleeding and expansion
- Concrete coring and testing of hardened concrete
- Supply, installation, calibration, proper operation and maintenance of all inspection, test and Laboratory equipment.
- Provide laboratory equipment spares, consumables and testing supplies to sample, test or operate equipment.
- Disposal of Concrete Waste

Note: The concrete laboratory testing building will be supplied and installed as part of the Administration Complex (Commitment Package CH0003).

The primary cost elements of the laboratory services is labor and vehicles. Quantification of this labor and vehicle requirements to complete the above scope has been completed by developing a resource plan against the planned concrete pouring program that is planned. As concrete production will occur on a 24-hr day cycle, hence capacity to support both shift cycles must be factored in the quantification of resource requirements.

Attachment B.6 provides a manpower loading for the soils and concrete testing scope, from which an estimated person-months of effort has been calculated to produce the CCE. Rates for laboratory technicians are commensurate with market rates, while this scope is considered to be outside of the collective agreement.

25.24 Survey Services

Consistent with the on-site quality control philosophy discussed in Section 9.9 of Construction Management Plan, document no. LCP-PT-MD-0000-CS-PL-0001-01, the CCE includes for the provision of survey services via a third party specialist firm.

Specific activities to be done by the survey services contractor will include:

- Providing all necessary all personnel required to execute surveying function including engineers, technicians, clerical support and supervision;
- Supplying all equipment and material needed to perform surveying on the sites including developing, maintaining and updating of working procedures for surveying and calibration of equipment.
- Maintaining Survey Records for its own activities including calibration records.
- Monitoring other Construction Contractor's works, through identification of witness and hold points on the construction Inspection and Test Plans and development of a single plan for Site surveying.
- Establishing primary control points and benchmarks within the Project Sites for other Construction Contractors to establish detailed lines and levels they require to carry out their contract work.
- Monitoring all surveys done by other Construction Contractors to ensure compliance with specified requirements and procedures, identify any problems that could result in delays or non-acceptance of works, or jeopardize another Contractor's work. Report all non-conformances to Company's Representative.
- Providing surveys of all investigation works.
- Independently carrying out and verifying quantity/measurement surveys for Construction Contractor's progress payments.
- Verifying correctness of work, completing daily and weekly reports to accurately reflect progress of work. Prepare site daily reports and submit to the Company's representative.
- Compiling survey records.
- Assisting the Company's Representative in reviewing and accepting Construction Contractor's survey procedures, electronic data, survey reports, field logbook entries, "As-built" survey mark-ups on drawings and Contractor's records.

Similar to the approach for laboratory services discussed above, a resource plan defining the requirements for survey technicians and engineers was defined to support the overall construction schedule and number of open workfaces. The result was the identification of a peak workforce of between 20 and 24 individuals. Attachment B.7 provides a manpower loading for the survey services scope, from which an estimated person-months of effort has been calculated to produce the CCE. Wage rates for survey technicians are based upon current collective agreement rates for *Labourers' International Union of North America and the Construction and General Labourers' Union, Rock and Tunnel Workers Local 1208.*

25.25 Price Summary

Hardware / Component	Price	Comments
CVC Structural Concrete	$275 / m3 (average)	Average of quotes received March 2012 for various strengths of concrete
CVC Spillway 30MPa	$229.00 / m3	Beton Provincial, Nov-2011
CVC Intake 30MPa	$216.00 / m3	Beton Provincial, Nov-2011
CVC Power House Phase I 30 Mpa	$218.00 / m3	Beton Provincial, Nov-2011
CVC Power House Phase II 30 Mpa	$252.00 / m3	Beton Provincial, Nov-2011
Rebar	$1,750 / MT	Average of quotes received March 2012
Slurry Cut off Wall	$320 / m2 + $250,000 (mobilization)	ICANDA, Nov-2011
Jet Grout	$1500 / m^2 + $250-300,000 (mobilization)	ICANDA, Nov-2011
Roller Compacted Concrete:		
RCC 15 MPa	$84.00 / m3	BETON PROVINCIAL, Nov-2011
RCC Conveyor Equipment	$1,300,000	ROTEC INDUSTRIES, Nov-2011
Rock Bolts HDR-25 x 4,000mm Type A	$85/each	National, Oct-2011
Rock Bolts HDR-25 x 6,000m Type A	$110/each	National, Oct-2011
Rock Bolts HDR-35 x 6,000mm Type C	$410/each	National, Oct-2011
Wire Mesh	$5.25 / m2	
Heavy Mechanical:		
Powerhouse Cranes	$8,557,000	2 cranes, COH INC., Oct-2011 COH INC.
Powerhouse Elevator	$393,365	THYSSENKRUPP ELEVATOR, Oct-2011
Powerhouse - Generator Circuit Breaker	$1,180,000/each	12,000 A
Balance of Plant-Electrical-Motor Control Centre:		
Motor Control Centre	$585,000 /each	2000 A, 600/347 V (ABB July 2011)
Unit Motor Control Centre	$174,539 / each	600/347 V, 3 phase, 4 wire, 1200 A, 42 kA IC, CSA Type 2 enclosure, NEMA wiring Class II, type C (ABB July 2011)
Essential Service MCC	$274,470 / each	600/347 V, 3 phase, 4 wire, 1200 A, 42 kA IC, CSA Type 2 enclosure, NEMA wiring Class II, type C (ABB July 2011)
Station Service MCC	$440,536 / each	600/347 V, 3 phase, 4 wire, 3000 A, 42 kA IC, CSA Type 2 enclosure, NEMA wiring Class II, type C

Intake MCC	$174,539 / each	00/347 V, 3 phase, 4 wire, 1200 A, 42 kA IC, CSA Type 2 enclosure, NEMA wiring Class II, type C (ABB July 2011)
Balance of Plant-Electrical-Transformers:		
Three-phase GSU Transformers	$3,836,827 /each	Three-phase, 175/230 MVA, 315 -15 kV, two winding, 60 Hz, oil-immersed, natural and forced air cooled (ONAN/ONAF). Includes oil and freight.
Three-phase station Aux. Service Transformers	$263,300/ each	Three-phase, 2500 kVA, 15kV-600Y/347 V, Dyn1, 60 Hz, dry type, self-cooled (ANN), station auxiliary service transformers (ABB July 2011)
Balance of Plant-Electrical-Isolated Phase Bus	$498,368 / unit	Internal SLI database
Balance of Plant-Electrical-Other:		
Emergency Diesel Generator Set	$495,000 / each	600 kW @ 0.8 pf, 600/347 V (Cummins, July 2011)
Pump Control Panel	$30,160 / each	Internal SLI database
Station Service Switchgear	$233909 / each	600/347 V, 3 phase, 4 wire, 4000 A, 42 kA IC, CSA Type 2 enclosure, (ABB July 2011)
Uninterruptible Power Supply (UPS)	$123,200 / each	20 kVA, 125 Vdc input and 600 Vac single phase bypass input, 120 Vac, 60 Hz output.

25.26 Key Metrics

	Major Quantities DG3 ESTIMATE		Production Rate	Key Unit Rates
	Quantity	Unit	Units / period	$ / unit
Mass Excavation				
Overburden Powerhouse	455,000	m3	275 m3 / hr	$12.00 / m3
Rock Excavation Powerhouse	1,590,000	m3	250 m3 / hr	$26.00 / m3
Rock Excavation Spillway	250,000	m3	225 m3 / hr	$30.00 / m3
Rock Excavation North Spur	100,000	m3	225 m3 / hr	$30.00 / m3
Rock Bolts (4.0 m long)	882	ea	3 ea / hr	$545 $ / ea
Powerhouse				
Strutural Concrete	328,000	m3	2 m3 / hr	$650 / m3
Formwork	200,000	m2	0.30 m2 / hr	$800 / m2
Steel - Rebar	20,000	mt	0.10 tonne / hr	$2 900 / tonne
Steel - Strutural	3,200	mt	0.50 mt / hr	$7 800 / mt
Spillway				
Strutural Concrete	62,000	m3	3.0 m3 / hr	$550 / m3
Formwork	37,000	m2	0.40 m2 / hr	$650 / m3
Steel - Rebar	3,200	mt	0.10 mt / hr	$2 900 / mt
Steel - Strutural	-	-	-	-
Fill Structures				
Powerhouse Downstreanm Cofferdam	30,200	m3	170 m3 / hr	$35 / m3
Spillway Upstream Cofferdam	59,500	m3	170 m3 / hr	$24 / m3
Spillway Downstream Cofferdam	46,260	m3	170 m3 / hr	$22 / m3
North Downstream Cofferdam	10,307	m3	170 m3 / hr	$25 / m3
North Dam Upstream Rock Fill Cofferdam	634,200	m3	250 m3 / hr	$20 / m3
South Rockfill Dam	114,491	m3	185 m3 / hr	$34 / m3
Roller Compacted Structures				
North Dam RCC Volume	188,750	m3	150 m3 / hr	$349 / m3
Total Formwork Area	25,000	m2	0.54 m2 / hr	$700 / m2
Riverside Cofferdam RCC Volume	37,000	m3	125 m3 / hr	$388 / m3
Total Formwork Area	6,600	m2	0.45 m2 / hr	$175 / m2
North Spur Stabilzation Work				
Overburden North Spur	600,000	m3	125 m3 / hr	$13 / m3
Granular Materials RockFill	1,022,000	m3	150 m3 / hr	$16 / m3
Geotextile	20,000	m2	40m2 / hr	$4 / m2
Geomembrane	60,000	m2	40m2 / hr	$6 / m2
Slurry Cut-off Wall	41,500	m2	125m2 / hr	$325 / m2
Reservoir Clearing				
Total Area	1,800	Ha	0.006 Ha /	$64 400 / Ha
Merchantable Wood	390,000	m3	18,4 m3 / hr	$3.50 / m3
Access Roads	157	Km	-	$90 000 / km
Stream Crossings	101	ea	-	$44 500 / ea

Part E: HVdc Specialties and Switchyards (SLI Component 3)

26.0 HVdc Specialties and Switchyards

26.1 Overview of Scope

As described in Part A, HVdc Specialties and Switchyards (SLI's Component 3) includes the facilities, installations and equipment relative to the Churchill Falls, Muskrat Falls and Soldier's Pond Switchyards, the Muskrat Falls Tap, the Muskrat Falls and Soldier's Pond AC/DC Converters, the SOBI Transition Compounds and Pond Electrodes, the Soldier's Pond Synchronous Condenser and the Telecommunication System.

These facilities are captured as follows in the Project Work Breakdown Structure discussed in Part A of this document:

- Project 4 – Labrador Island Transmission Link (LITL)
  - Switchyard at Soldiers Pond.
  - Muskrat Falls and Soldiers Pond HVdc converter stations:
  - Shoreline pond electrode located on the Labrador side of the Strait of Belle Isle.
  - Shoreline pond electrode located on the east shore of Conception Bay.
  - HVdc Transition Compounds for the Strait of Belle Isle submarine cable terminations:
  - New synchronous condenser at Soldiers Pond
  - Operations Telecommunication system

- Project 6 – Labrador Transmission Asset (LTA)
  - Churchill Falls switchyard extension;
  - Muskrat Falls switchyard

26.2 Commitment Packages

The CCE was performed based on the work breakdown structure (WBS) of the Project. These work items were later structured into Commitment Packages that capture the same scope of work in a fashion that allow for bid packages to be issued to potential bidders and Contracts to be awarded executed and managed up to and following procurement or construction completion. Package numbers give an indication of the nature of the contract: "C" packages are Construction Packages, "P" packages are Purchase Orders and "S" packages are Service Contract Commitment Packages. The following list is the Contract Commitment packages structure was developed for SLI Component 3:

- CD0501 Supply and Install Converters and Cable Transition Compounds
- CD0502 Construction of AC Substations and Synchronous Condensers Facilities
- CD0503 Construction of Earthworks at Various Power Distribution Sites
- CD0508 Supply and Install of Electrode Sites
- CD0509 Construction Telecommunication Services - Phase 2
- CD0510 Supply and Install Permanent Communication Systems
- CD0512 Construction of Construction Power Facilities

- CD0534 Supply and Install Soldiers Pond Synchronous Condensers
- CD0535 Construction Telecommunication Services - Phase 2 Remote Camps
- CD0538 Supply and Install Accommodations Camp (CF)
- CD0564 Construction of Land Mobile Radio System - Labrador
- PD0505 Supply of Switchyard Equipment, AC Substations at CF, MF and SP
- PD0513 Supply of 138/25 kV Transformers
- PD0514 Supply of 138 kV & 25 kV Circuit Breakers
- PD0515 Supply of 230 kV, 138 kV & 25 kV Disconnect Switches
- PD0518 Supply of 138 kV Capacitor Voltage Transformers
- PD0519 Supply of 25 kV Vacuum Interrupters
- PD0520 Supply of 25 kV 6 x 3.6 MVAR Capacitor Banks
- PD0522 Supply of Pre-fabricated Control Room Building
- PD0523 Supply of Substation Service Transformer
- PD0529 Supply of 25 kV Reclosers, MV Switches & Fuse Cut-outs
- PD0530 Supply of 138 kV & 25 kV Surge Arrestors
- PD0531 Supply of MV Instrument Transformer
- PD0533 Supply and Install Early Works Telecom Devices
- PD0537 Supply of Power Transformers, AC Substations at CF, MF and SP
- PD0561 Supply of D20 RTU and Cabinet (CF) - Construction Power
- PD0562 Supply of Specific Relays and Test Switches (CF) - Construction Power
- PD0563 Supply of 138 kV Circuit Switcher (CF) - MV Switches & Fuse Cut-outs - Construction Power
- SD0536 Provision of Integrated Commissioning Support Services
- SD0560 Provision of Early Works Construction Telecommunication Services (MF)
- SD0565 Provision of Land Mobile Radio System - Newfoundland

26.3 Quantification Basis

The following Quantification Basis has been prepared to document the basis of quantities used in the preparation of the CCE:

- CD0501 – Civil & Electro-mechanical
- CD0502 – Civil
- CD0502 Electro- mechanical
- CD0503 Civil
- CD0508 Electrode Ponds
- CD0534 Electro - mechanical
- PD0533 SD0560 Telecom
- CD0509 CD0535 Telecom
- CD0510 Telecom
- CD0512 Construction power
- SD0536 Commissioning
- CD0538 Churchill Falls Accommodations Complex

These documents are contained in Volumes 19 & 20 of the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

26.4 Basis of Direct Costs

The following general assumptions were considered for estimating the AC and DC above mentioned work items of Component 3.

For each of the sites, engineering was developed to provide sufficiently detailed material take off quantities for the CCE. Approximately 130 drawings were issued including site layouts and line diagrams.

Approximately 25 short-term specifications were issued by Engineering and provided to the Procurement team for the purpose of costing of the major equipment.

26.4.1 Scope

The scope of work includes, for each of the sites, all clearing and grubbing, cut & fill for site grading, fencing, slope protection, access roads, cable trenches and duct banks, concrete foundations, galvanized steel gantries and supports, pre-engineered buildings, Supply and Installation of all electrical equipment, auxiliary building mechanical works as well as mechanical handling equipment and operation and maintenance shops where required.

- Quantities are based on 40% engineering progress, as of 5 December, 2011.
- Quantities are neat and do not include any kind of allowance what so ever.
- The preliminary civil/structural design is based on the National Building Code of Canada.
- In the absence of geotechnical information, shallow footing with allowable soil bearing capacity of 150 kPa and a frost depth of 2.40 meters is considered for all the foundations.
- Site grading design is based on balanced cut and fill with site specific assumptions for overburden / rock ratios
- Piling for foundations not envisaged.
- Civil works related to Cathodic Protection are excluded.
- Requirement of fire protection of the power transformers at the Churchill Falls have been excluded.
- For miscellaneous works where quantities were not available estimating has assumed a quantity

Civil Works

All the site locations are considered as green field locations and any kind of demolitions are not envisaged with the exception of the existing Churchill Falls 230/138 kV switchyard and the existing 138/25kV Construction Power installations at Muskrat Falls 315/138 kV switchyard. All earthworks are considered to be performed during summer as these types of works are not recommended to be performed during winter to avoid freezing of granular foundation subgrade material and no provision has been added for winter works. Other civil works such as the construction of buildings are to be performed according to the Project Control Schedule.

- Access roads / approach roads are included.
- Ditches/Swales along periphery of the plot are considered as un-lined ditches and are part of site grading activities. No additional quantities are considered.
- Buried Cable Trenches are not envisaged. Precast Polymer Concrete cable trenches are considered.
- In the absence of geotechnical information, Excavation in rock is considered at some of the locations as per information available at this point in time and the agreed assumptions as to the presence of rock are carried in the CCE detailed in site-specific sections below.

Concrete

- Manholes / Cable Pull Pits are not envisaged at this time. If required to be placed outside the control buildings and between cable run, shall be included at a later date.
- Transformer blast/fire wall is considered in the Bill of Quantities.

Steel

- All Steel structures like Gantries and Support steel are considered as galvanized, unless specified otherwise.

Buildings

- All buildings are considered as Pre-Engineered Buildings.
- Civil / Concrete works up to grade are part of Civil/Concrete BOQ.
- Building wall acting as Firewall, if required is under concrete BOQ.
- Building includes electromechanical works like HVAC, Plumbing, and Lighting etc.
- Overhead Cranes, Handling equipment, Shop equipment, etc. are quantified and included in estimate.
- Building Includes Furniture, Furnishings and Kitchen / Washroom fittings / appliances.
- Tie-in points for Potable Water, Sanitary Drainage, and Lighting are considered available near building.

Electrical Works

All required supply and installation of electrical equipment including:

- Circuit breakers
- Disconnect switches
- Capacitor voltage transformers
- Current transformers
- Surge arresters
- Power transformers
- Batteries and chargers
- Busbars and overheard connections
- Grounding
- Control system (panels)
- Lighting and building electrical services

- Operations Telecommunication System - Island Link
- Tie in for Small Power for Lighting etc are considered available near building.
- Cathodic Protection works are not included.

Detailed list and copies of price summaries and vendor quotes to support the estimate are contained in Volumes 31 and 32 of the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

26.4.2 Construction Methodology & Timeline

Standard construction methods have been considered for of each of the facilities and installations. Productivity factors by discipline have been applied as indicated in the Performance Basis of subsequent sections. .

Where the remoteness of the site requires the provision of a camp to lodge workers and staff during construction, an estimate has been included in the CCE. The sites where such camps are required are indicated in the site-specific considerations below.

26.4.3 Price Basis

As discussed in Section 14.4 of Part A, the Price Basis switchyard and HVdc Specialty hardware was secured through the acquisition of an extensive amount of budgetary offers from various international supplies following the issuage of a a short-term specification. Generally, and where applicable, the average of two highest submitted prices were considered. Where not applicable an estimator judgment call was applied based on past experience.

Table 26-1 presents the price basis for the Switchyard and HVdc Specialty hardware. A detailed list and copies of price summaries and vendor quotes to support the estimate are contained in Volumes 31 and 32 of the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

Pre-engineered building was estimated on a unit cost per area basis in using the following assumptions:

- 1 level standards height : 1,800$ / m2
- 1 level “tall” building : 2,000$ / m2
- 2 levels standard building: 2,700$ / m2
- Foundation works for all buildings 600$ / m2

For site Testing, Commissioning and Training work of substation electrical equipment approximately 12% of total material costs is assumed.

Table 26-1: Price Basis for Switchyard and HVdc Specialty Equipment

Hardware / Component	Price
Circuit Breakers:	
4111 - Circuit Breaker Live Tank SF6, 800 kV, 50 kA, 4000 A, BIL 2100 kV	$1,022,500.00
4112 - Circuit Breaker Live Tank SF6, 362 kV, 31.5 kA, 2000 A, BIL1175 kV	$286,666.67
4114 - Circuit Breaker Live Tank SF6, 245 kV, 31.5 kA, 2000 A, BIL1050 kV	$190,000.00
4116 - Circuit Breaker Live Tank SF6, 145 kV, 31.5 kA, 2000 A, BIL550 kV	$190,000.00
Disconnect Switches:	
4121 - Disconnect Switch 800kV, 50 kA, 4000 A, BIL 2100 kV, vertical break	$153,500.00
4123 - Disconnect Switch 362kV, 31.5 kA, 2000 A, BIL 1175 kV, vertical break	$39,961.08
4126 - Disconnect Switch 245kV, 31.5 kA, 2000 A, BIL 1050 kV, vertical break	$27,761.67
4129 - Disconnect Switch with Ground Blades, 145kV, 31.5 kA, 2000 A, BIL 550 kV, vertical break	$17,786.67
4122 - Disconnect Switch with Ground Blades, 800kV, 50 kA, 4000 A, BIL 2100 kV, vertical break	$178,000.00
4124 - Disconnect Switch with Ground Blades, 362kV, 31.5 kA, 2000 A, BIL 1175 kV, vertical break	$48,601.92
4127 - Disconnect Switch with Ground Blades, 245kV, 31.5 kA, 2000 A, BIL 1050 kV, vertical break	$33,436.00
4130 - Disconnect Switch with Ground Blades, 145kV, 31.5 kA, 2000 A, BIL 550 kV, vertical break	$24,716.67
Instrument Transformer:	
4131 - Capacitor Voltage Transformer 6000/3750:1, 2 winding 0.5, BIL 2100 kV. 800kV	$31,450.00
4132 - Capacitor Voltage Transformer 2600:1:1, 2 winding 0.5, BIL 1175 kV. 362 kV	$15,950.00
4133 - Capacitor Voltage Transformer 693/1200:1:1, 2 winding 0.2, BIL 1050 kV. 245 kV	$12,600.00
4134 - Capacitor Voltage Transformer 600/1000:1, 2 winding 0.2, BIL 550 kV. 145 kV	$11,150.00
4141 - Current Transformer 2000/4000:1/1/1/1/5, Class 10P10, 0.2, TPX, BIL 2100 kV, Rate voltage 765 kV	$128,500.00
4142 - Current Transformer 2000/4000:1/1/1/1/5, Class 10P10, 0.2, TPY, BIL 2100 kV, Rate voltage 765 kV	$132,500.00
4143 - Current Transformer 2000/4000:5/5/5/5/5, Class 10P10, 0.2, TPY, BIL 2100 kV, Rate voltage 800 kV	$118,100.00
4144 - Current Transformer 2000/4000:1/1/1/1/5, Class 10P12.5, 0.2, TPX, BIL 1175 kV, Rate voltage 362 kV	$55,750.00
4145 - Current Transformer 2000/4000:1/1/1/1/5, Class 10P12.5, 0.2, TPY, BIL 1175 kV, Rate voltage 362 kV	$49,250.00
4146 - Current Transformer 1000/2000:1/1/1/1/5, Class 10P10, 0.2, TPX,	$47,050.00

BIL 1050 kV, Rate voltage 245 kV	
4147 - Current Transformer 1000/2000:1/1/1/1/5, Class 10P10, 0.2, TPY, BIL 1050 kV, Rate voltage 245 kV	$31,200.00
4148 - Current Transformer 1000/2000:1/1/1/1/5, Class 10P10, 0.2, TPX, BIL 550 kV, Rate voltage 145 kV	$32,350.00
4149 - Current Transformer 1000/2000:1/1/1/1/5, Class 10P10, 0.2, TPY, BIL 550 kV, Rate voltage 145 kV	$25,225.00
Surge Arrestors:	
4151 - Surge arrester metal oxide gapless, 588 kV, impulse 1416 kV, 20 kA	$30,450.00
4152 - Surge arrester metal oxide gapless, 288 kV, impulse 745 kV, 20 kA	$8,727.50
4153 - Surge arrester metal oxide gapless, 198 kV, impulse 465 kV, 10 kA	$7,525.00
4154 - Surge arrester metal oxide gapless, 132 kV, impulse 317 kV, 10kA	$2,420.00
Power Transformer:	
4201 - Power Autotransformer 168/224/280 MVA, 735/√3/315/√3/25 kV, Single Phase, 65oC ONAF, BIL 2100/1175/95	$3,115,000.00
4202 -Power Autotransformer 75/100/125 MVA, 315/√3/138/√3/25 kV, Single Phase, 65oC ONAF, BIL1175/550/95 with OLTC	$1,665,350.00
4203 - Power Transformer three-phase,315/25/25 kv,10 MVA	$815,000.00
4204 - Power Transformer three-phase 230/25/25 kv, 10 MVA	$738,000.00
Ground Transformers and Reactors:	
4241 - 500 kVA Pad-Mounted transformer	$21,651.00
4242 - 300 kVA Pad-Mounted transformer	$20,466.00
4245 - 125 Dry-type transformer	$51,100.00
MV Metal Clad Switchgear:	
4301 - 25 kv Switchgear two (2) incoming and six (6) out coming feeders	$672,500.00
4302 - 25 kv Switchgear three (3) incoming and six (6) out coming feeders	$760,000.00
4303 - 15 kv Switchgear three (3) incoming and six (6) out coming feeders (OPT to item 4302)	$687,500.00
LV Switchgear and Distribution Panels:	
Total lump sum price for the cost of Churchill, Muskrat Falls and Soldiers Pond	$210,322.00
Total lump sum price of Muskrat Falls Tap Station	$186,350.00
Battery and Charges:	
4411 - Battery Charger , 125V,250 A.	$49,168.00 (USD)
4412 - Battery Charger , 125V,125 A.	$37,026.00 (USD)
4413 - Battery Charger , 48V,350 A.	$37,026.00 (USD)
4414 - Battery Charger , 48V,200 A.	$36,586.00 (USD)
4421 - Battery,125V,1000 Ah, NiCa	$36,918.00 (USD)
4422 - Battery,125V,500 Ah, NiCa	$25,668.00 (USD)
4423 - Battery,48V,1200 Ah, NiCa	$17,594.00 (USD)
4424 - Battery,48V, 600 Ah, NiCa	$10,347.00 (USD)
Post Insulators:	

4641 - Post-type insulators 800 kV, BIL 2100 kV	$5,782.84
4642 - Post-type insulators 362 kV, BIL 1175 kV	$1,506.45
4643 - Post-type insulators 245 kV, BIL 1050 kV	$2,559.34
4644 - Post-type insulators 145 kV, BIL 550 kV	$1,278.95
MV XLPE Cables ($/m):	
5301 - 1x3C 240mm2 Cu, 25kV XLPE Cable	$265.66
5302 - 1x3C 240mm2 Cu, 15kV XLPE Cable	$241.64
Protection and Control Panels:	
Control & Protection Panels Churchill Falls extension	$2,590,140.00 (USD)
315kV Muskrat Falls Switchyard	$3,404,000.00 (USD)
315-138kV Muskrat Falls Switchyard	$2,703,800.00 (USD)
230kV Soldiers Point Switchyard	$4,002,060.00 (USD)
Relay Panels for different substations	$4,101,575.00
Bare Conductors and Bus Work:	
735kV Churchill Falls	$955,040.00
315kV Churchill Falls	$471,366.00
Muskrat Main Substation	$911,114.00
230kV Soldiers Pond	$1,048,921.50
138kV Muskrat Tap Substation	$300,432.30
Lighting Fixtures:	
4801 - 400w High Pressure Sodium outdoor flood light	$823.00
4802 - 250w High Pressure Sodium stanchion mounted light	$1,146.00
4803 - 18m High Lighting Lowering Pole	$45,806.41
4804 - 15m High Lighting Lowering Pole	$42,337.41
Synchronous Condenser +150 / -100:	$23,400,000.00
HVDC Converter:	
900 MW +/-350 kV Bipolar HVDC Converter Stations - Muskrat Falls	$131,500,000.00
900 MW +/-350 kV Bipolar HVDC Converter Stations - Soldiers Pond	$126,500,000.00
Transition Compound:	
Forteau Point Transition Component	$5,600,000
Shoal Cove Transition Component	$5,600,000
OH Cranes	
OH Crane 280 tons	$2,675,000.00
OH Crane 5 tons - Maintenance and Spare Parts Building	$74,500
OH Crane 5 tons - Yard Enclosure Building	$90,500

26.4.4 Performance Basis

Labour productivity assumptions used within the CCE are as follow:

- All direct labour hours are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- For civil works, productivity factor of 1.31 over Richardson was added to the chart to account for the location of the Project
- For electrical works, productivity factor of 1.44 over Richardson was added to the chart to account for the location of the Project
- For mechanical Works, productivity factors over Richardson were added to the chart to account for the location of the Project:
    - 1.13 for Mechanical and HVAC systems man hours
    - 1.55 for Piping / Insulation systems man hours
- A 6% allowance was added to direct labour costs to account for congestion of the worksite

26.4.5 Site-Specific Considerations

For each of the facilities and installations, some site-specific assumptions were made to adequately capture costs that relate to conditions that apply to these sites only. These site-specific considerations are indicated in the following sections.

26.5 New Churchill Falls Switchyard 735/315kV

The remoteness of this site will require the construction of a camp with a maximum capacity of 150 workers. The cost calculation in the CCE considers an average of 75 workers for a 48 months period at this site. Two (2) new 735kV interconnections lines will need to be built from the existing CF(L)Co. switchyard to feed the new Churchill Falls switchyard. Some work will need to be performed within the existing CF(L)Co. switchyard and it is assumed that all required permits and authorizations will have been secured by Nalcor at commencement of the Works.

26.5.1 Site Preparation and Access

Minimal access roads are required for this site as it next to the existing Trans Labrador Highway. Clearing and soil stripping works are included in the CCE.

26.5.2 Civil Works

As no geotechnical information was available for this site an agreed assumption of balanced cut and fill mass excavation work, comprising 50% overburden and 50% rock was considered in the CCE.

The switchyard area of the 735kV portion of the switchyard is 300m 348m x 246m275m. The area of the 315kV portion of the switchyard is 192m 220m x 175m210m. In order to reduce the earthworks it is considered in the CCE that the 735kV portion of the switchyard will be at a level 3m higher than the 315kV portion.

All earthworks including final grade using crushed stone as well as fencing around the full extents of the switchyard are included in the CCE including the oil containment and fire wall structure around the power transformers.

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, power transformer, gantries, etc. are included in the CCE.

26.5.3 Electrical Equipment

A provisional allowance for a 735/230kV transformer is included has been include in the Capital Spares as discussed in Section 14.1.8.

26.5.4 Other Works

An 11m x 30m pre-engineered type maintenance and operations building complete with a 5 tonnes overhead crane and all tools and equipment are included in the CCE. There are no provisions for cabinets, tool chests or heavy shelving.

A control building housing 44 control panels, batteries, chargers is also included.

26.6 Construction Power

The supply of Construction Power to Muskrat Falls will be provided by a new 138/25kV terminal station at Muskrat Falls with a tap to the existing 138kV transmission line between Churchill Falls-Happy Valley substations. This tap station will be located on the North side of the Churchill River with access from Trans Labrador highway. The construction power will be extended to the construction site and camp site through a 25 kV transmission line approximately 17km long crossing the Churchill River to the south side.

The new tap substation at Muskrat Falls and an extension by third transformer at Churchill Falls substation is required as supporting infrastructure for the construction of the Muskrat Falls power generation and the camp facilities.

26.6.1 Site Preparation and Access
Minimal access roads are required at this site as it is next to an existing road.

26.6.2 Civil Works
The area of the Muskrat Falls construction power substation is 100m x 100m. All earthworks including final grade using crushed stone as well as fencing around the full extents of the substation are included in the CCE.

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, power transformer, gantry, etc. are included in the CCE.

A provision for the demolition of the temporary Muskrat Falls Construction Power substation following completion of the works is included in the CCE.

26.6.3 Electrical Equipment
Supply and Installation of all electrical equipment required for Construction Power have been estimated using budget quotes provided by suppliers and in-house estimating.

Quantification basis for this work is captured in the following Engineering documents:

- PH0036 – Accommodation and Construction Site Distribution System – Auxiliary Transformers
- PH0037 – Accommodation and Construction Site 25kV Switchgear
- PH0038 – Accommodation and Construction Site Diesel Generators

26.6.4 Other Works
A 17 km wood pole 25kV transmission line will connect the new tap substation to the Muskrat Falls powerhouse construction site and the camp site. A provision of 100 000$ per km was made for the construction of the power line.

26.7 Muskrat Falls Switchyard 315kV and Converter Station 350kV DC

As this site is located next to the Muskrat Falls Main Camp facilities, it is assumed in the CCE that all workers and staff for this portion of the Project will be lodged at this Camp. For the 34 44 months duration of the construction work at this site it is expected estimated that the required accommodations needs at the Muskrat Falls main camp will peak at 208 workers. The estimate considers an average of 108for a peak of 276 workers will be required for a period of 44 months.

26.7.1 Site Preparation and Access

Minimal access roads are required at this site as it is next to an existing road that will have been constructed by the Project prior to the start of this work.

26.7.2 Civil Works

The extents of the Muskrat Falls AC Switchyard / HVDC Converter area including the required area to accommodate the Construction Power Tap facilities in the AC switchyard area are 187m 260m x 252m210m for the AC Switchyard and 354m X 304m for the HVDC Converter area. No rock excavation is anticipated at this site as the area will consist mainly of fill laid down in 2013 during the Powerhouse mass excavation activities and used as a lay down area until the substation work begins.

All earthworks including final grade using crushed stone as well as fencing around the full extents of the switchyard are included in the CCE including the oil containment and fire wall structure around the power transformers.

26.7.3 315kV Switchyard

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, gantries, etc. are included in the CCE.

A control building housing 60 control panels, batteries, chargers is also included.

26.7.4 Converter 350 kV DC

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, power transformers, surge arresters, filters, gantries, etc. are included in the CCE.

For the valves control building, typical engineering referenced with similar projects was performed. A provision of 2,700$+600$ / m2 was considered in the CCE.

26.7.5 Other Works

An 20m x 50m meter pre-engineered type maintenance and operations building complete with a 5 tonnes overhead crane and all tools and equipment are included in the CCE. There are no provisions for cabinets, tool chests or heavy shelving.

26.7.6 Price Basis

Switchyard

All standard electrical equipment was priced through issuance of short-form technical specifications for the purpose of obtaining budget prices from suppliers. Generally, and where applicable, the average of two highest submitted prices were considered. Where not applicable an estimator judgment call was applied based on past experience.

Converter 350 kV DC

For the converter's specialized electrical equipment a short-form technical specifications was issued for the purpose of obtaining budget prices from suppliers. This specification stated that Supply of equipment needed to include the design, manufacturing, quality control, transportation to site, storage and documentation. The supply is to include all equipment and materiel, required to provide a complete and operational converter station. The main equipment included in the Converters station are as follow:

- Thyristor valves and valve cooling system
- Converter transformer
- Smoothing reactors
- Surge arresters
- AC filters
- DC filters
- Measuring devices
- Control and protection system
- DC switching Device
- AC breakers and switching devices
- Busworks and insulators
- AC/DC station auxiliary power supply
- Smoke detectors in valve hall
- CCTV (camera system)
- Steel structures

26.8 Forteau Point and Shoal Cove Transition Compounds

The remoteness of these Forteau Point sites will require the construction of a remote temporary camp with for a maximum capacity of 80 workers at each location with a maximum capacity of 95 workers. The cost calculation included in the CCE for these camps considers an average of 39 workers for 24 months duration at. This temporary camp will also accommodate the workers required for the L'Anse-au-diable electrode site, as discussed in the Electrode sites section of this document.

However, as these facilities are located in the Transmission Line ROW, there could be an opportunity to save the mobilization and demobilization costs of the Forteau Transition Compound camp facilities, mainly the Forteau camp, if the personnel required for this work could be lodged at the camp required for the construction of the Transmission lines. The CCE currently carries distinct camp facilities.

The Shoal Cove site being deemed close enough to readily available lodging in the surrounding area, no construction accommodation camp is included in the CCE. However, the CCE considers a per diem cost of 80$ (per day) to cover accommodation costs for an average of 31 workers over a period of 23 months. A peak of 55 workers is expected at this site.

The transition compounds are required to interface the submarine/land cable terminated at both transitions compounds through air-bushing cable sealing ends and the DC transmission lines. However, the CCE includes no provision whatsoever for any interface with the SOBI Directional Drilling Contractor at these locations.

26.8.1 Site Preparation and Access

Access roads to both these sites are included in the CCE.

26.8.2 Civil Works

The extents of the Transition compounds area are 100m x 100m. As no geotechnical information was available for this site an agreed assumption of balanced cut and fill mass excavation work, comprising 100% overburden was considered in the CCE.

All earthworks including final grade using crushed stone as well as fencing around the full extents of the switchyard are included in the CCE including the oil containment and fire wall structure around the power transformers.

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, transformer, gantries, etc. are included in the CCE.

A 14m x 24m control building is also included in the CCE housing the control equipment provided by the Turnkey contractor.

26.8.3 Electrical Equipment

The transition compounds will be provided with all required switching equipment, including:

- 350 kV dc switchyard including all necessary disconnecting and ground switches, surge arresters, post isolator, bushings, voltages dividers, DC current transducers and busworks
- Gantries and steel structures for supporting the equipment on its foundations
- Auxiliary power supply: one 14.4 kV transformer and one 150 KW diesel generator
- LV and telecommunication
- Control and protection equipment
- Electrode line monitoring equipment

26.8.4 Other Works

In order to protect the Transition Compounds' electrical equipment from the salt spray inherent to their location near the SOBI, a 28m 36m x 43,235m x 13,5m high pre-engineered building is included in the CCE for each site. These building will consist mainly in a steel shell to house the cable sealing end, circuit breakers, surge arresters, current transformers, disconnect switches, etc. Main access doors will enable service vehicles to access the building and proceed to any assembly or maintenance work from within the building.

26.8.5 Price Basis

Following the issuance of a short-term specification, three (3) turn-key budget quotes were received for the Shoal Cove and Forteau Point Transition Compounds from the following suppliers:

- ABB
- Siemens
- Alstom

For the purpose of the CCE, the ABB budget quote was considered.

26.9 Soldier Pond Converter Station 350kV, Switchyard 230kV and DC Synchronous Condensers

26.9.1 Site Preparation and Access

An access road connecting the site to the Trans-Canada Highway (TCH) is included in the CCE, including slow lanes for entry and exit from the TCH. No provision for new interchange or area lighting is included.

26.9.2 Civil Works

The extents of the Soldier Pond Switchyard area are 314m x 500m. For the synchronous condenser, the yard area is 150m x 300m.

Following review of a 2008 report relative to a geotechnical study conducted at this site, an agreed assumption of balanced cut and fill mass excavation work, comprising 85% overburden and 15% rock was considered in the CCE excluding the synchronous condenser portion of the site.

In order to avoid disrupting an existing small pond near the Soldier Pond Project site, the Synchronous Condenser was detached from the main facilities and located approximately 140 meters to the (South-East). The assumption considered for the synchronous condenser site excavation work is 100% rock.

230kV Switchyard

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, gantries, etc. are included in the CCE.

A control building housing 72 control panels, batteries, chargers is also included.

Converter 350 kV DC

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, power transformers, surge arresters, filters, gantries, etc. are included in the CCE.

For the valves control building, typical engineering referenced with similar projects was performed. A provision of 2,700$+600$ / m2 was considered in the CCE.

26.9.3 Electrical Equipment

All standard electrical equipment was priced through issuance of short-form technical specifications for the purpose of obtaining budget prices from suppliers. Generally, and where applicable, the average of two highest submitted prices were considered. Where not applicable an estimator judgment call was applied based on past experience.

Converter 350 kV DC

For the converter's specialized electrical equipment a short-form technical specifications was issued for the purpose of obtaining budget prices from suppliers. This specification stated that Supply of equipment needed to include the design, manufacturing, quality control, transportation to site, storage and documentation. The supply is to include all equipment and materiel, required to provide a complete and operational converter station. The main equipment included in the Converter Station is as follow:

- Thyristor valves and valve cooling system
- Converter transformer
- Smoothing reactors
- Surge arresters
- AC filters
- DC filters
- Measuring devices
- Control and protection system
- DC switching Device
- AC breakers and switching devices
- Busworks and insulators
- AC/DC station auxiliary power supply
- Smoke detectors in valve hall
- CCTV (camera system)
- Steel structures

Synchronous Condenser

Following the issuance of a short-term specification, two turn-key budget quotes were received for the Synchronous Condenser from the following suppliers:

- Alstom for a 3 unit +150/-100 MVAr
- Toshiba for a 2 unit +300/-200 MVAr

For the purpose of the CCE, the Alstom budget quote was considered.

Labor & Travel

The Soldiers Ponds site being deemed close enough to readily available lodging in the surrounding area, no construction accommodation camp is included in the CCE. However, the CCE considers a per diem cost of 80$ (per day) to cover accommodation costs for an average of 165 workers over a period of 46 months. A peak of 340 workers is expected at this site.

26.9.4 Other Works

In order to perform the work related to the AC/DC Switchyard and Converter stations, the displacement and diversion of the LT-218 Holyrood existing line is required prior to commencement of the Work in 2013. These costs are included in the Component 4 – Transmission Lines portion of the CCE.

Furthermore, if, following detailed engineering studies, the location of the facilities was to change from what is currently assumed in the CCE, it could be required to relocate the TL-242 Holyrood line as well.

A 20m x 50m meter pre-engineered type maintenance and operations building complete with a 5 tonnes overhead crane and all tools and equipment are included in the CCE. There are however no provisions for cabinets, tool chests or heavy shelving.

For integration into existing Power Grid, modifications and upgrades to protection systems will be required at in the following Substations:

- Holyrood
- Western Avalon
- Oxen Pond
- Hardwood

The cost of the upgrades to protection systems is discussed in Part G.

26.10 L'anse-au-Diable and Dowden's Point Shoreline Pond Electrodes

The Dowden's Point site being deemed close enough to readily available lodging in the surrounding area, no construction accommodation camp is included in the CCE. However, the CCE considers a per diem cost of 80$ (per day) to cover accommodation costs for an average of 14 workers over a period of 12 months. A peak 20 workers is expected at this site.

The remoteness of the L'Anse-au-Diable site will require temporary construction accommodations. However, as stated above, due to its proximity to the Forteau Point Transition compound camp, the CCE considers that the workers of the L'Anse-au-Diable site will lodge at this camp. The cost calculation included in the CCE for the L'Anse-au-diable site workers at this camp is included in the cost of the Forteau Point camp as stated above (80 workers capacity with an average of 39 workers for 23 months duration).

Estimate is a unit rate based estimate based on scope, design and bulk quantities developed from the concept designs as detailed in the Shoreline Pond Electrodes - Design Brief SLI doc no. 505573-480B-47EM-0004 (the Design Brief).

All construction work, with the exception of the Dowden's Point dredging activities can be performed from shore.

26.10.1 <u>L'anse-au-Diable Pond Electrode</u>

This proposed site at L'Anse-au-Diable is in a south facing cove with somewhat rectangular dimensions of 130 m to 150 m wide and length of approximately 150 m. It is assumed that no excavation will be needed at this site as it is exposed rock.

The construction of this facility will occur over a 6 to 8 month period. The facility is close to existing access roads and will use standard civil equipment for construction. It is not anticipated that the contractor would need to mobilize any marine based equipment.

Approximately 400m of access road will be required to access the site; there will be a small lay down construction area constructed at the approach for the new breakwater. All material will be end dumped into the ocean and shaped with a long reach backhoe. Armour stone will be dumped on the slope and repositions with a crane or long reach backhoe.

- Marine works rates are based on non-union sites (marine contractors are generally non-union)
- All other land work rates are union
- No dredging is anticipated at L'Anse-au-Diable
- Sheet pile cut-off wall work has been included to avoid silting of the permeable material during breakwater construction
- There is no allowance for winter construction.
- Armour stone in the sizes required is readily available within a 10 km radius.
- Service Building is prefabricated off site.

26.10.2 Dowden's Point Pond Electrode

At the Dowden's Point Shoreline Pond Electrode, the crest of the breakwater aligns with the top of the existing bank and the sea side toe line coincides with the existing low tide shoreline. The depth of the soil above the bedrock at Dowden's Point is anticipated to be approximately 30 m, which would permit excavation without the need to blast bed rock.

The construction of this facility will occur over a 6 to 8 month period. The facility is close to existing access roads and will use standard civil equipment for construction. The current concept required that the contractor will mobilize marine based equipment for a dredging operation. Dredging costs are based on ocean dumping

Approximately 400m of access road will be required to access the site; there will be a small lay down construction area constructed at the approach for the new breakwater. All material will be end dumped into the ocean and shaped with a long reach backhoe. Armour stone will be dumped on the slope and repositions with a crane or long reach backhoe

- Unit Rates are based on historical data for Marine Construction in Atlantic Canada and Newfoundland.
- Dredging rates for Dowdens Point location assumed dredged spoils from dredging operations use disposal at sea.
- Rates assume availability of Marine contractors and competitive bidding.
- Rates are based on non union sites. (Marine Contractors are generally non-union)
- Disposal of mass excavation from Dowdens Point assumes a haul distance of 2 km.
- There is no allowance for winter construction.
- Service Building is prefabricated off site.
- Provisions have been included in the CCE for the relocation of the east coast trail at the Dowden's Point location.

26.10.3 Site Preparation and Access

For both sites, access roads to the site will be constructed to link with existing local roads (approximately 400 m). From the entrance to the site, the road will extend along the inside of the breakwater to provide access for maintenance of the shoreline pond electrodes. The width of the access road is assumed to be 6.0 m

26.10.4 Civil Works

The breakwater is designed to withstand the expected worst case site conditions, including wave action, tidal effects, pack ice and freezing inside the shoreline pond. Wave height is assumed to be 6.0 m and this is the basis for sizing and pricing the armour stone. Armour stone has a maximum size of 10 tonnes that will need to placed on the ocean side at a shallower slope than the natural angle of repose of the material which implies increased construction cost that has been considered in the CCE. The core material is a uniformly sized material to allow maximum water permeability through the breakwater berm. This material will need to be selected and treated to meet these requirements and has been estimated accordingly.

Only preliminary topographical and bathymetric mapping of the site area was available at time of the CCE.

Electrode Supports and Protection

The structural supports and protection for electrode and cables are designed utilizing concrete to withstand the expected worst case site conditions, including freezing spray, tidal effects, and freezing inside the shoreline pond. Fibre reinforced plastic (FRP) reinforcements will be used to eliminate corrosion problems due to currents.

The CCE caries minimal cast in place concrete as most of the concrete elements will be prefabricated

Relatively small quantities of cast in place concrete will be required to encase electrical ducts element at both Pond electrode locations. These quantities are assumed to be mixed and placed using portable mixers using hand fed bagged concrete

26.10.5 Electrical Equipment

The electrical work for the pond electrodes includes the following:

- The threading of the electrodes from the surface through a 300mm protective concrete pipe reaching 1,5m below the low water level and depositing the electrode in a submerged PVC saddle supported on concrete blocks with the help of divers.
- Anotec electrodes type 4884H priced through budget quotes from specialized suppliers, Anotec
- Electrode main feeder cable, of 750 mm2, Single core XLPE electrical cable at each location, estimated using load current bearing capacity and layout drawings
- 1 set of Telecommunication Service Panel and Optical Distribution Panel
- 1 set each of Service panel, Protection and Monitoring panel, 48 VDC battery chargers, 48 VDC battery bank, 120-240 V AC distribution panel, DC distribution panel, lighting control panel.
- The Electrode main feeder cable shall be laid in cable trench
- A small control building for which a provision has been included in the CCE

26.10.6 Other Works

The site will be fenced on all sides by chain link fencing to prevent public access to the pond. The fencing in contact with the berm needs to be a special isolated fence comprised of timber posts with isolators between each panel of chain link fence

26.11 Telecommunication system

The estimate for the telecommunication services required for the Project was prepared considering three phases of development as follow:

- Phase 1 - Early works construction phase
- Phase 2 - Construction Phase
- Phase 3 - Permanent (Operations) Phase

For each of these phases, design was sufficiently developed to allow for detailed quantification of all required equipment and services as well as for obtaining budget quotations from specialized suppliers. The details pertaining to the development of these estimates is presented below.

26.11.1 Telecommunication System – Early Works Construction Phase

The scope of the work involved in the provision of early works telecommunication is presented in engineering document 505573-480A-47ER-0015-00 entitled, Telecommunication system – Telecommunication Study Early Works Construction Phase – Technical Report. This report gives a summary description of the system requirements of the system and forecasts the quantities of required equipment for the provision of mobile connectivity for early construction work for Owner and EPCM services.

This construction work is to take place along the new access road, at the Muskrat Falls powerhouse area and the new accommodation Complex. The scope of work is further detailed in Engineering document 505573-480A-47ES-0004 entitled Telecommunication Devices – early works Construction Phase – Scope specification. A summary of the scope of work is presented below:

- Provision of Land Mobile Radio (LMRS)
- Provision Cellular Telephony services
- Provision of Data transmission services
- The forecasted number of users for these services range from 10 persons in the initial stage of the early works to 45 persons at its peak.
- The forecasted number of vehicles to be equipped with LMRS range from 9 vehicles in the initial stage of the early works to 34 vehicles at its peak
- The forecasted number of cell phones range from 7 units in the initial stage of the early works to 32 units at its peak
- The forecasted number of desk phones range from 4 units in the initial stage of the early works to 14 units at its peak
- The forecasted number of personnel radios range from 10 units in the initial stage of the early works to 45 units at its peak
- For the supply of sufficient bandwidth for the provision of the mobile services, the estimate considers the development of a service agreement with a Telecom Service Provider (TSP)

Contractors on site are to provide for their own telecom services and equipment for which the cost is considered in the construction indirect costs discussed Part A.

The early works telecommunication estimate is based on the provision of services starting in January June 2012 in the initial stages of the work until June 2012April 2013, considered as the beginning of the Phase 2 – Construction Phase.

Pricing of the telecommunication equipment was developed through the use of two sources:

- Budgetary Quotes or price lists received from specialized supplier for a variety of equipment required for this type of work from which the equipment required for this specific project were selected. The supplier who provided pricing information is Bell Alliant.
- In-house pricing based on estimator experience from the recent construction of comparable hydroelectric projects in similar conditions

Installation cost were estimated using information form budgetary proposal and estimator experience based on recent construction of comparable hydroelectric projects in similar conditions.

26.11.2 Phase 2 - Telecommunication System – Construction Phase

The scope and details of the work involved in the provision of the Construction Phase telecommunication system is presented in engineering document 505573-480A-47ER-0009-00 entitled, Telecommunication system – Design Brief – Construction Phase – Technical Report. This report gives a description of the requirements of the system and forecasts the quantities of required equipment and infrastructure for the provision of the telecommunication services throughout the duration of the Construction Phase work.

The Construction phase work will support the construction work force required to build the permanent hydroelectric infrastructure and associated transmission line infrastructure.

The anticipated number of users considered in the CCE is as follows (these figures are detailed in Appendix A of the 505573-480A-47ER-0009-00 Technical report):

- Approximately 150 users during the Starter Camp Phase at Muskrat falls
- Approximately 1600 users at peak during the Main Construction Phase
- Infrastructure and equipment considered in the CCE are to provide the following services:
- Data (Corporate and Entertainment);
- Telephony (Corporate and Entertainment);
- Video Conferencing;
- Cable Television (CATV) system;
- Land Mobile Radio System (LMRS);
- Cellular Telephony System (CTS) and Mobile Internet System (MIS);
- Building Management System (BMS);
- Network Management System (NMS);
- Closed Circuit Television (CCTV);
- Security and Access Control System (SACS);

- Supervisory Control and Data Acquisition (SCADA) and Protection.

The Muskrat Falls site includes all the facilities near the new Power Complex: the accommodation complex, Administration buildings, owner's laydown, contractor's laydown, power complex, and the construction power tap substation, etc.

The remotes sites are those located along the transmission lines: the new line from Muskrat Falls to Churchill Falls (Labrador) and the new lines from Muskrat Falls to Soldier's Pond (Newfoundland). There is also the reservoir clearing crew's needs included in the remote sites. The service available in the remote sites shall be essentially to SLI and Nalcor. This service will have limited capacity due to the same as the ones available in Muskrat Falls, but with some bandwidth limitations. The contractor will be required to provide his own telecommunication services.

The construction phase is to begin in November 2012 with the starter camp until April 2013 when the Main Camp Construction Phase shall begin and is scheduled to be completed sometime in 2017.

Pricing of the telecommunication infrastructure, equipment and services were developed through the use of two sources:

- Budgetary Quotes or price lists received from specialized suppliers for a variety of equipment required for this type of work from which the specific equipment required for this specific project were selected. The suppliers who provided pricing information are the following:
    - Cisco
    - Corning
    - Eaton
    - PANDUIT
    - Ruggedcom
    - 3M
- In house pricing based on estimator experience from the recent construction of comparable hydroelectric projects in similar conditions

Installation cost were estimated using information from budgetary proposals and estimator experience based on recent construction of comparable hydroelectric projects in similar conditions.

26.11.3 Phase 3 - Telecommunication System – Permanent Phase

The scope and details of the work involved in the provision of the Permanent Phase telecommunication system is presented in engineering document 505573-480A-47ER-0016-00 entitled, Telecommunication system – Permanent Phase - Design Brief.

The telecommunication system shall support the Protection, Control and Metering signals for all operation and maintenance activities of the project. It shall provide the platform for the administrative telecommunication systems associated with these activities. The telecommunication system shall be based on an Optical Transport Network (OTN) which shall use a Synchronous Optical Networking (SONET) cross-connected convergence section. The OTN shall use, as a physical medium, the Optical Grounding Wire (OPGW) installed as the guard cable of the electrical transmission network. This OPGW cable shall enclose 24 fiber optical strands.

Due to the changes on the existing transmission line at Soldiers Pond Station, it is required to include a Microwave Link from Soldiers Pond Station to Four Miles Hill telecommunication repeater. This link will bring the SCADA signals to the Holy Rood, Western Avalon, Hardwood, Oxen Pond and Soldiers pond stations.

An additional microwave link has been considered as backup of the submarine optical fibers which will cross the Strait of Belle Isle.

The following schedule is considered in the CCE for the execution of the Phase 2 telecommunication work:

- Issue of RFP by end of year 2012
- Execution to follow construction of the facilities from 2014 to 2017.

Pricing of the telecommunication equipment was developed through the use of two sources:

- Budgetary Quotes or price lists received from specialized suppliers for a variety of equipment required for this type of work from which the specific equipment required for this specific project were selected. The suppliers who provided pricing information are the following:
    - Alcaltel
    - Ciena
    - Cisco
    - Corning
    - Eaton
    - PANDUIT
    - Ruggedcom
    - 3M
    - XTERA
- In house pricing based on estimator experience from the recent construction of comparable hydroelectric projects in similar conditions

Installation cost were estimated using information from budgetary proposals and estimator experience based on recent construction of comparable hydroelectric projects in similar conditions.

26.12 Key Metrics

	Major Quantities DG3 ESTIMATE		Production Rate	Key unit Rates
	Quantity	Unit	Units / period	$ / unit
Switchyards				
Churchill Falls				
Civil - Earthworks (Balanced Cut and Fill)	275,000	m3	200 m3 / hr	$15 / m3
Civil - Rock Excavation	65,000	m3	175 m3 / hr	$25 / m3
Civil - Concrete	8,700	m3	0.08m3 / hr	$1 640 / m3
Transformers	6	unit	-	$3 115 000 / unit
Breakers, Disconnect switches, CTs.,etc.	1	LS	-	$33 724 000
Muskrat Falls				
Civil - All Earthworks (Cut and Fill)	Included in C1	m3	Included in C1	Included in C1
Civil - All Rock Excavation	n.a.	m3	n.a.	n.a.
Civil - Switchyard Concrete	6,080	m3	0.08m3 / hr	$1 658 / m3
Transformers	2	unit	-	$1 665 350 / unit
Breakers & Disconnect swithes	1	LS	-	$28 918 000
Soldiers Pond				
Civil - All Earthworks (Balanced Cut and Fill)	782,000	m3	200 m3 / hr	$15 / m3
Civil - All Rock Excavation	80,000	m3	175 m3/ hr	$25 / m3
Civil - Switchyard Concrete	4,360	m3	0.08m3 / hr	$1697 / m3
Breakers, Disconnect switches, CTs.,etc.	1	LS	-	$27 325 000
Converters Stations				
Muskrat Falls				
Civil - Converter Concrete	9,800	m3	0.09 m3 / hr	$1 582 / m3
Civil - Converter Buildings 1 and 2 levels	3,540	m2	-	$2 155 / m2
Major Equipment - Vendor	1	LS	-	$139 800 000
Soldiers Pond				
Civil - Converter Concrete	9,770	m3	0.09 m3 / hr	$1 578 / m3
Civil - Converter Buildings 1 and 2 levels	3,540	m2	-	$2 155 / m2
Major Equipment - Vendor EPC	1	LS	-	$134 400 000
Transition Compounds				
Forteau point (Lab.) & Shoal Cove (NFLD)				
Civil - Earthworks (Balanced Cut and Fill)	46,000	m3	200 m3 / hr	$15 / m3
Civil - Rock Excavation	n.a.	m3	-	-
Civil - Concrete	2,030	m3	0.07 m3 / hr	$1733 / m3
Civil - Buildings	3,108	m2	-	$2 155 / m2
Major Equipment - Vendor EPC	1	LS	-	$5 600 000
Synchronous Condenser				
Soldiers Pond				
Civil - Sync. Condenser Concrete	5,600	m3	0.10 m3 / hr	$1 414 / m3
Civil - Sync. Condenser Buildings 1 and 2 levels	2,820	m2	-	$2 155 / m3
Major Equipment - Vendor EPC	1	LS	-	$70 200 000
Major Equipment - Transformers	3	unit	-	$2 110 000 / unit
Totals (8 Sites)				
Civil - Earthworks (Balanced Cut and Fill)		m3	200 m3 / hr	$15 / m3
Civil - Rock Excavation	145,000	m3	175 m3 / hr	$25 / m3
Civil - Concrete	46,340	m3	0.085 m3 / hr	$1 595 / m3
Civil - Buildings	10,188	m2	-	$2 155 / m2
Breakers, Disconnect switches, CTs.,etc.	-	-	-	$89 967 000
Major Equipment - Transformers	11	-	-	$2 880 000
Major Equipment - Vendor EPC	-	-	-	$355 600 000

Part F: Overland Transmission (SLI Component 4)

27.0 Overland Transmission

27.1 Overview of Scope

The following Quantification Basis has been prepared to document the basis of quantities used in the preparation of the Project Cost Estimate:

The Overland Transmission scope of the Project for the LTA and LITL sub-Projects, as is being undertaken by SLI Component 4, includes:

- Two (2) new 315 kV single circuit HVac transmission lines, each approximately 250 km in length. The south transmission line (Line 1) and the north transmission line (Line 2) between Muskrat Falls (MF) and Churchill Falls (CF) consider a 50 m Right of Way (ROW) each. A 50 m distance between centerlines will be used when the lines are parallel to one another. See section 5.1 of this document for the outline of engineering assumptions for the HVac line.
- A new ± 350 kV bi-pole HVdc transmission line, approximately 1100 km in length. The future HVdc line from MF to SP considers a 60 m ROW; see section 5.2 of this document for the outline of engineering assumptions for the HVdc line.
- Approximately 35 km of electrode lines on wood pole structures, see section 5.3 of this document for the outline of engineering assumptions for the electrode line.
- Approximately 17 km of 25 kV distribution lines to supply power to the accommodation complex and camp. See section 5.4 of this document for the outline of engineering assumptions for the 25 kV construction power line.
- Modification to six existing transmission lines to accommodate the new ± 350 kV HVdc crossings. See section 5.5 of this document for the outline of engineering assumptions for the HVdc crossings.
- Re-termination of four existing 230 kV transmission lines into the future Soldier’s Pond Substation. See section 5.6 of this document for the outline of engineering assumptions for the re-termination of the 230 kV transmission lines.
- Approximately 600 m of two new single circuit 735 kV HVac transmission lines at the Churchill Falls Substation. See section 5.7 of this document for the outline of engineering assumptions for the 735 kV HVac transmission line.
- Approximately 500 m of four new 315 kV HVac transmission lines to interconnect the Muskrat Falls Powerhouse to the new Switchyard. See section 5.8 of this document for the outline of engineering assumptions for the 315 kV HVac interconnection.

27.2 Key References Documents

The CCE estimate is based upon the following key reference documents:

- LCP-PT-ED-0000-EN-PH-0021-01 – “Design Philosophy for HVac Transmission Lines”.
- LCP-PT-ED-0000-EN-PH-0022-01 – “Design Philosophy for HVdc Transmission Lines”.
- MFA-PT-ED-6200-TL-DC-0001-01 – “Meteorological Loading 315 kV Transmission Lines Muskrat Falls to Churchill Falls”.
- MFA-PT-ED-6200-TL-DC-0002-01 – “Overhead Transmission Meteorological Loading for the Labrador - Island Transmission Link”.
- LCP-PT-ED-0000-EN-RP-0001-O1 – “Basis of Design”.
- File No. TF1116574 – “315 kV HVac Transmission Line Foundations, Muskrat Falls to Churchill Falls: Geotechnical Design Parameters”
- 505573-361A-4ZEC-0001 – “315 kV HVac Route Selection Criteria”
- 505573-361B-44ER-0001 – “315 kV HVac Geotechnical Baseline”
- 505573-361B-43EC-0001 – “315 kV HVac Tower Design Criteria”
- 505573-361B-42EC-0001 – “315 kV HVac Foundation Design Criteria”
- 505573-462B-43ER-0001 – “315 kV HVac and 350 kV HVdc Cascading Assumptions”
- 505573-462C-4ZEC-0008 – “350 kV HVdc Line Design Criteria”
- 505573-462B-43EC-0001 – “350 kV HVdc Tower Design Criteria”
- 505573-462B-44ER-0001 – “350 kV HVdc Geotechnical Baseline”
- 505573-462B-43ER-0002 – “Assessment of Installing the HVdc Ground Return on a Separate Wood Pole Line”
- 505573-462B-43ER-0002 – “350 kV HVdc Foundation Design Criteria”
- 505573-462A-4ZEC-0002 – “Electrode Lines – Route Selection Criteria”
- 505573-463C-4ZEC-0001 – “Electrode Lines on Wood poles – Design Criteria”
- 505573-362C-4ZEC-0001 – “25 kV construction Power Line & 138 kV tap Design Criteria”

27.3 Quantification Basis

The following Quantification Basis has been prepared to document the basis of quantities used in the preparation of the CCE:

- List of bulk material – 315kV HVac Engineering Quantity tracking (SLI Doc. No. 500573-4600-33RA-I-0001)
- List of bulk material – 350kV HVdc Engineering Quantity tracking (SLI Doc. No. 500573-4600-33RA-I-0002)

These documents are contained in Volume 22 of the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

27.4 315 kV HVac Transmission Line – Engineering Assumptions

27.4.1 Tower Design and Testing

- The 315 kV lattice steel tower families are developed specifically for the LCP project. The tower design criteria is based on criteria document "315 kV HVac Tower Design Criteria (SLI No. 505573-361B-43EC-0001)" and "315 kV HVac and 350 kV HVdc Cascading Assumptions (SLI No. 505573-462B-43ER-0001)".
- The two transmission lines are estimated based on the 35 mm radial ice loading zone.
- OPGW dead-ending on suspension structures is considered.
- All tower weights are estimated based on the preliminary tower designs completed by SLI.
- The design of the tower family and associated foundations are engineered by SLI. The tower detailing and the prototype testing will be by the supplier.
- Tower Types A and B are guyed mast structures and tower types C, D and E are rigid self-supporting towers with four legs.
- Two special river crossing structure types have been considered for the Churchill River crossing, one tangent and one deadend.
- Phase transposition is assumed to take place near existing dead-end structures using additional insulators and hardware to facilitate the transposition. This estimate assumes that phase transposition will occur at three locations along each HVac line.
- Tower testing is included for the A and D type towers only. Tower types B, C and E will not be tested.

27.4.2 Hardware Assemblies and Testing

- The creation of 315 kV hardware assembly design requirement drawings for the tower family is included (i.e. assemblies for conductors, counterpoise, OHSW, and OPGW, etc.).
- All 315 kV assemblies will use reduced-corona hardware.
- Hardware assembly prototype testing is included, along with test witnessing by SLI.
- Third party inspection during manufacturing has not been included.

27.4.3 Centerline / Layout

- This estimate is based on the center line and layout on the route map drawings (SLI Doc. 505573-361A-4ZDD-0022-PA).
- The centreline for the estimate has been established based on document "315 kV HVac Route Selection Criteria (SLI Doc. 505573-361A-4ZEC-0001)".
- It is assumed that there is some flexibility to modify the centerline and PI (Point of Inflection) location in an effort to optimize the line layout.

- The survey data used for the preliminary layout was provided by Nalcor and based on 2010 LiDAR survey and orthophotography.
- The layout was completed based on document "315 kV HVac Line Design Criteria (SLI Doc. 505573-361C-4ZEC-0001)" as well as 40% completion of detailed engineering.

27.4.4 Quantities of Towers and Foundation Steel

- The quantity of towers estimated includes all basic/standard towers, body extensions, and leg/mast extensions, including nuts, bolts, plates, washers, and attachment vangs, as per the design drawings, specifications and other contract documents.
- The quantity of towers is based on preliminary (40% completed engineering) tower spotting using PLS-CADD.
- Maintenance spares have been considered in the estimate, based on the files provided by Nalcor "Capital Spares 315 kV HVac.xlsx" dated 23-Apr-2012 and "Capital Spares 350 kV HVdc.xlsx" dated 29-May-2012.
- Four types of foundations are considered:
  - Type 1 for granular soil with a net allowable bearing capacity of 250 kPa,
  - Type 2 for granular soil with a net allowable bearing capacity of 100 kPa,
  - Type 3 for rock foundations, and
  - Type 4 for a deep foundation using screw piles or driven steel piles.
- Two types of materials have been defined in the "315 kV HVac Geotechnical Baseline (SLI No. 505573-361B-44ER-0001)" as acceptable for the backfill to be installed for the steel grillage for the type 1 and type 2 foundations.
- Four types of guy wire anchors are defined:
  - Soil anchors for granular soil with a net allowable bearing capacity of 250 kPa,
  - Soil anchors for granular soil with a net allowable bearing capacity of 100 kPa,
  - Rock anchors, and
  - Steel pile anchors for weak soil conditions.
- The quantities of guy wire anchors are estimated based on the structure quantities from the preliminary design and layout. The guy wire length is assumed to be 40 m per guy, four guys per tower.
- The foundation types will be derived from the results of the geotechnical assessment completed by AMEC entitled "315 kV HVac Transmission Line Foundations, Muskrat Falls to Churchill Falls: Geotechnical Design Parameters" and the "315 kV HVac Geotechnical Baseline (SLI No. 505573-361B-44ER-0001)".

27.4.5 Quantities for Conductor, OHSW and OPGW Hardware Assemblies

- The quantity of hardware assemblies is based on total tower quantities, from the preliminary centerline and layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.4.6 Quantities of Insulators

- The quantities of insulators are based on the total tower quantities derived from the preliminary centerline and layout.
- Porcelain or toughened glass insulators are assumed to be acceptable in this estimate. The quantity and strength of insulators per tower is based on the document "315 kV HVac Line Design Criteria (SLI Doc. 505573 - 361C - 4ZEC - 0001)".
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.4.7 Quantities of Conductor and OHSW / OPGW

- Two-bundle, 795 kcmil, 26/7 ACSR "Drake", will be used as the phase and jumper conductor. The quantity is based on the linear line length, with an additional 4% included for sag and wastage. Reel length is estimated to be 3000 m.
- One OHSW will be installed using ½" grade 220 steel. The quantity is based on the linear line length, with an additional 2% included for sag and wastage. Reel length is estimated to be 3000 m.
- One OPGW will be installed using fibre type DWSM based on standard ITU-T6.654. The quantity is based on the linear line length, with an additional 5% extra included for sag, down leads, splices, and wastage. Reel length is estimated to be 6000 m.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.4.8 Quantities of Conductor Accessories

- Spacer dampers are assumed to be installed every 60 m, per phase, and are assumed to be adequate for the damping requirements of the line.
- 100% of the line has been considered for compression type splices, dead-ends and jumper connectors.
- Conductor splices are assumed to be installed approximately every 3000 m.
- Each 315 kV HVac line will have approximately five structures that will require the use of counter weights (25 kg each), considering four weights per phase. The quantities are based on the preliminary layout.

- Rigid spacers will be used on jumper conductors, assuming 6 spacers, per phase, per jumper.
- One jumper assembly per phase, per tower type C, D and E is considered.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.
- As a minimum, three aerial marker cones (1 white and 2 orange) will be included per crossing. They will be installed on the appropriate wire for each respective crossing. The estimate considers 35 crossings for each 315 kV HVac Line (20 highway crossings, 5 transmission line crossings, 10 river crossings).

27.4.9 Quantities of OPGW Accessories

- Two spiral vibration dampers per structure will be used on the OPGW as per the tower quantity estimation.
- OPGW splice boxes will be installed approximately every 6000 m and on the first structure outside of each substation.
- The OPGW down lead clamps will be installed every 1 m.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.4.10 Quantities of OHSW Accessories

- Two spiral vibration dampers per structure will be used on the OHSW as per the tower quantity estimation.
- The bonding conductor is assumed to be #2 ACSR “Sparrow” and the length is estimated to be 1.5 m for suspension towers and 2.0 m for dead-end structures.
- Splices will be installed approximately every 3000 m on the OHSW.
- 100% of the line has been considered for compression type splices.
- Bird diverters are not required and not included in the estimate.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.4.11 Counterpoise

- The counterpoise is assumed to be a 7.2 mm single-strand steel grade 50 wire. Length is estimated as the linear line length plus an additional 2% for wastage.
- A bonding conductor of 10 m, the same material as the counterpoise, is included per tower.

27.4.12 Quantities of Miscellaneous Hardware and Material

- The hardware required for tower grounding is included.
- Aerial structure number boards will be installed on every 10th structure.
- One structure number tag will be installed on every structure.
- Two danger signs will be installed on every structure.
- Six aerial line number boards will be included per line, and will be installed on the first structure outside each substation.
- Phasing signs will be installed on every 10th structure.

27.4.13 Geotechnical Investigations

The document "315 kV HVac Geotechnical Baseline (SLI No. 505573-361B-44ER-0001)" includes:

- The geotechnical report based on references from past soil investigations.
- Assessment of the foundation types to be used for each of the new 315 kV HVac towers.
- The selection criteria for the design parameters of soil and rock for each of the foundation types (1, 2, 3 and 4).
- The detail of the additional geotechnical investigations necessary to confirm the selection of the foundation types, including the location, type of investigation, and the estimated cost for those additional soil tests.

27.4.14 Electrical Effects / Considerations

The transmission line ROW is 50 m, which is assumed to be within the acceptable limits for:

- Edge of right of way electric / magnetic field levels,
- Edge of right of way audible noise levels, and
- Edge of right of way radio and television interference.

27.4.15 Distribution and Transmission Line Conflicts

Crossing line modifications for the HVac lines are not required and thus not included in this estimate.

27.5 ± 350 kV HVdc Transmission Line – Engineering Assumptions

27.5.1 Tower Design and Testing

- The ± 350 kV lattice steel tower families are developed specifically for the LCP project. The tower design criteria is based on criteria document "350 kV HVdc Tower Design Criteria (SLI Doc.505573-462B-43EC-0001)" and "315 kV HVac and 350 kV HVdc Cascading Assumptions (SLI No. 505573-462B-43ER-0001)".
- These steel towers will be designed for the combination of the meteorological loading zones (50 mm ice, Alpine [135 mm rime ice] and 75 mm ice); the different pollution levels (Inland and Coastal) and with and without electrode conductors, giving a total of ten different tower families.
- OPGW dead-ending on suspension structures is considered.
- The majority of towers used in the Labrador segment will be designed and constructed to support the electrode conductors from the Muskrat Falls substation to the grounding site at L'Anse-au-Diable.
- The design of the tower family and its foundations are to be done by SLI. Tower detailing and the prototype testing are by the supplier.
- Suspension tower types A and B are guyed mast structures, dead-end tower types C, D and E are rigid self-supporting four leg towers.
- Neither long-span, nor special crossing structures have been considered.
- All tower weights are estimated based on tower designs by SLI for tower types A and D of the F1, F2, F4, F6 and F7 families. These ten towers represent more than 85% of the towers for the 350 kV HVdc line.
- The geometry and weights of the remaining tower families and types were extrapolated based on the design of those ten tower types and based on the relative weights of the 315 kV HVac tower weights already defined for tower types A, B, C, D and E.
- Tower testing is included for six towers (four suspension towers and two dead-end towers); detailing is considered for twenty towers.

27.5.2 Hardware Assemblies and Testing

- The estimate includes the creation of the ± 350 kV hardware assembly design requirement drawings for the tower family (i.e. assemblies for conductors, electrode, OPGW, etc.).
- All pole conductor assemblies will use reduced-corona hardware.
- The hardware assembly prototype testing is included, along with witness testing by SLI.
- Third party inspection during manufacturing has been included.

27.5.3 Centerline / Layout

- The estimate is based on the center line and layout shown on the alignment sheet drawings (SLI Doc. 505573-462A-4ZDD-0001, 0002, 0003, 0004, 0005, and 0016).
- It is assumed that there is flexibility to modify the centerline and PI location in an effort to optimize the line layout.
- The survey data used for preliminary layout was provided by Nalcor and based on 2010 LiDAR survey and orthophotography.
- The centreline for the estimate has been established based on the document "± 350 kV HVdc Muskrat Falls to Soldier's Pond Transmission Line – Route Selection Design Criteria (SLI Doc. 505573-462A-4ZEC-0001)".
- The layout was completed based on the document "350 kV HVdc Line Design Criteria (SLI Doc. 505573-462C-4ZEC-0008)".

27.5.4 Quantities of Towers and Foundation Steel

- The quantity of towers estimated includes all basic / standard towers, body extensions, and leg/mast extensions, including nuts, bolts, plates, washers, and attachment vangs, as per the design drawings, specifications, and other contract documents.
- The quantities of steel towers are based on preliminary (40% complete engineering) tower spotting using PLS-CADD.
- Material extras for spares, un-foreseen re-routeing requirements, structure additions, design changes, etc. are not included.
- The quantities of guy wire anchors are estimated based on the preliminary design and layout. Guy wire length is assumed to be 40 m per guy, four guys per steel tower.
- Four types of foundations are defined:
    - Type 1 for granular soil with a net allowable bearing capacity of 250 kPa,
    - Type 2 for granular soil with a net allowable bearing capacity of 100 kPa,
    - Type 3 for rock foundations, and
    - Type 4 for a deep foundation using screw piles or driven steel piles.
- Two types of material have been defined in the "350 kV HVdc Geotechnical Baseline (SLI No. 505573-462B-44ER-0001)" as acceptable for the backfill to be installed for the steel grillages of type 1 and type 2 foundations.
- Four types of guy wire anchors are defined:
    - Soil anchors for granular soil with a net allowable bearing capacity of 250 kPa,
    - Soil anchors for granular soil with a net allowable bearing capacity of 100 kPa,
    - Rock anchors, and
    - Steel pile anchors for weak soil conditions.

- The quantity and weight of each of the foundation types are based on the relative quantities and weights of the foundation types for each tower type as defined for the HVac Lines.

27.5.5 Quantities for Conductor and OPGW Hardware Assemblies

- The quantities of hardware assemblies are based on the total tower structure quantities from the preliminary centerline/layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.5.6 Quantities of Insulators

- The quantities of insulators are based on total structure quantities, from the preliminary centerline/layout.
- Porcelain or toughened glass insulators are assumed to be acceptable in this estimate. The quantity and strength of insulators per structure is based on the document "350 kV HVdc Line Design Criteria (SLI Doc.505573-462C-4ZEC-0008)".
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.5.7 Quantities of Electrode conductor

- Two types of electrode conductor are used depending on the loading zone:
    - Single 1192.5 kcmil ACSR "Grackle" is considered for the 50 mm and 75 mm ice load zones, and
    - Single 1510.5 kcmil ACSR "Parrot" is considered for the 135 mm ice Alpine load zone.
- The quantity is based on the linear line length, with an additional 4% included for sag and wastage.

27.5.8 Quantities of Conductor and OPGW

- A single 3640 kcmil, 91/0 Strand, Aluminum Stranded Conductor (ASC) is used as the pole and jumper conductor. The quantity is based on the linear line length, with an additional 4% included for sag and wastage.
- Three types of OPGW cable were used depending on the loading zone:
    - 14.5 mm, 24 Fibre, 140 kN UTS - for the 50 mm ice load zone,
    - 15.5 mm, 24 Fibre, 177 kN UTS - for the 75 mm ice load zone, and
    - 20.6 mm, 24 Fibre, 277 kN UTS - for the 135 mm ice Alpine load zone.

- Each quantity is based on the linear line length, with an additional 5% extra included for sag, down leads, splices, and wastage.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.
- There is no OHSW on the HVdc line.

27.5.9 Quantities of Conductor Accessories

- The quantity of conductor accessories is based on total structure quantities from the preliminary centerline / layout.
- 100% of the line has been considered for compression type splices, dead-ends and jumper connectors.
- Splices will be installed approximately every 1200 m on conductor.
- One jumper assembly, per pole, per tower type C, D and E is considered.
- Preliminary layout has determined that the ± 350 kV HVdc line will have approximately 20 structures that will require the use of counter weights (25 kg each), four weights per pole.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.
- Three aerial marker cones (1 white and 2 orange) will be included per crossing. They will be installed on the appropriate wire for each respective crossing. There are 71 crossings (20 highways, 18 transmission line crossings, 6 water crossings, and 27 distribution crossings) included.

27.5.10 Quantities of OPGW Accessories

- Two spiral vibration dampers, per structure, will be used on the OPGW as per the tower quantity estimation.
- OPGW splice boxes will be installed approximately every 6000 m and on the first structure outside of each substation.
- OPGW down lead clamps have been assumed to be required every 3 m.
- Bird diverters are not required, and not included in the estimate.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.5.11 Counterpoise

- The counterpoise length is estimated as the linear line length plus an additional 2% for wastage.

- A bonding conductor of 10 m, the same material as the counterpoise, will be included per tower.

27.5.12 Quantities of Miscellaneous Hardware and Material

- The hardware required for tower grounding is included.
- Aerial structure number boards will be installed on every 10th structure.
- One structure number tag will be installed on every structure.
- Two danger signs will be installed on every structure.
- Ten aerial line number boards will be included per line, and will be installed on the first structure outside each substation.

27.5.13 Geotechnical Investigations

The document "350 kV HVdc Geotechnical Baseline (SLI No. 505573-462B-44ER-0001)" includes:

- The geotechnical report references from past soil investigations,
- The assessment of foundation types to be used for each of the new ±350 kV HVdc towers,
- The selection criteria for the design parameters of soil and rock for each of the foundation types (1, 2, 3 and 4), and
- The detail of the additional geotechnical investigations necessary to confirm the selection of the foundation types, including the location, type of investigation, and estimated cost for those additional soil tests.

27.5.14 Electrical Effects / Considerations

The transmission line ROW for the ± 350 kV HVdc line is 60 m, which is assumed to be within the acceptable limits for:

- Edge of right of way electric / magnetic field levels,
- Edge of right of way audible noise levels, and
- Edge of right of way radio and television interference.

27.5.15 Distribution and Transmission Line Conflicts

The estimate assumes that dead-end structures are required between and on either side of existing power lines when the HVdc line crosses two or more existing power lines. Based on this, six transmission line conflicts have been identified that require modifications. Details of the engineering assumptions made for the modification to these six transmission lines is in Section 27.8 of this document.

27.6 Electrode Lines on Wood Poles – Engineering Assumptions

27.6.1 Electrode Line Structures

- The electrode lines will be routed to two facilities for the electrode grounding, one at L'Anse-au-Diable and another at Dowden's Point.
- Tangent and angle structures will be single pole direct embedded, Class H1, wood poles, with a horizontal V-brace configuration.
- Dead-end structures will be Class H1, guyed, two pole H-frame structures.
- H1 wood pole sizing will range from 12.3 m (40 ft) to a maximum of 18.5 m (60 ft) in length.
- No long-span or special crossing structure is included.

27.6.2 Hardware Assemblies

- The Electrode line hardware assemblies used for the wood pole sections will be similar to the hardware specified in Section 27.4.2 of this document.

27.6.3 Centerline / Layout

- The centreline for the estimate has been established based on the document "Electrode Lines – Route Selection Criteria (SLI Doc. 505573-462A-4ZEC-0002)".
- The layout was completed based on the document "Electrode Lines on Wood Pole – Design Criteria (SLI Doc. 505573-463C-4ZEC-0001)".
- It is assumed that there is flexibility to modify the centerline and PI location in an effort to optimize the line layout.
- The survey data used for preliminary layout was based on available orthophotography; no LiDAR has been used for the electrode line routes.

27.6.4 Quantities of Poles and Foundations

- The quantity of wood poles is based on preliminary PLS-CADD spotting.
- Wood poles will be direct embedded using standard setting methods.
- The quantities of guy wire and anchors are estimated based on the preliminary design and layout. The guy wire length is assumed to be 30 m per guy, four guys per wood pole dead-end.
- Material extras for spares, un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.6.5 Quantities for Conductor Hardware Assemblies

- The quantity of hardware assemblies is based on total wood pole structure quantities from the preliminary centerline/layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.6.6 Quantities of Insulators

- The quantity of insulators is based on total structure quantities, from the preliminary centerline/layout.
- Porcelain or toughened glass insulators are assumed to be acceptable in this estimate. The quantity and strength of insulators per structure is based on the document "Electrode Lines on Wood Pole – Design Criteria (SLI Doc. No. 505573-463C-4ZEC-0001)".
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.6.7 Quantities of Electrode conductor

- Both the Labrador and Island Electrode wood poles lines will use single 1192.5 kcmil, ACSR "Grackle", as the conductor.
- The quantity is based on the linear line length, with an additional 4% included for sag and wastage.

27.6.8 Quantities of Electrode Conductor Accessories

- 100% of the electrode lines have considered compression type splices, dead-ends and jumper connectors.
- Stockbridge dampers will be used, as per the manufacturer's recommendation, for each span along the line.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.
- There is neither OHSW nor OPGW on the electrode lines.

27.6.9 Quantities of Miscellaneous Hardware and Material

- Aerial structure number boards will be installed on every 25th structure of the electrode line.
- One structure number tag will be installed on every structure.
- One danger sign will be installed on every structure.
- Aerial line number boards will be included, and will be installed on the first and last structure.

27.6.10 Geotechnical Investigations

- There will be no geotechnical investigation for the wood pole lines.

27.6.11 Electrical Effects / Considerations

Both electrode lines are considered as distribution lines, therefore, as per Newfoundland Hydro standard D1-11-66-R1, the ROW will be 9 m, which is assumed to be within the acceptable limits for:

- Edge of right of way electric / magnetic field levels,
- Edge of right of way audible noise levels, and
- Edge of right of way radio and television interference.

27.7 25 kV Construction Power – Engineering Assumptions

27.7.1 Structure design

- All construction power structures will be Newfoundland Hydro standard 25 kV wood pole structures.
- Two custom structures will be designed to accommodate a long-span river crossing.
- Standard setting methods will be used for each structure.

27.7.2 Hardware Assemblies

- All construction power hardware assemblies will be Newfoundland Hydro standard 25 kV assemblies.
- Custom hardware will be designed to accommodate the river crossing.

27.7.3 Centerline / Layout

- The construction power centerline has been established to follow the existing north road and the future south access road to the accommodation complex for the majority of the route.
- Part of the 25 kV center line will also follow the existing 315 kV HVac line to minimize the tree clearing required.
- It is assumed that there is flexibility to modify the centerline and PI location in an effort to optimize the line layout.
- The survey data used for preliminary layout was provided by Nalcor and based on 2010 LiDAR survey and orthophotography.

27.7.4 Quantities of Structures

- The quantities of wood pole structures are based on preliminary (40% complete engineering) spotting.
- Material extras for spares, un-foreseen re-routes, structure additions, design changes, etc. are not included.
- The quantities of guy wire and anchors are estimated based on the preliminary design and layout. Guy wire length is assumed to be 20 m per guy, four guys per dead end structure.

27.7.5 Quantities for Conductor and ADSS Hardware Assemblies

- The quantities of conductor and ADSS hardware assemblies are based on the total structure quantities from the preliminary centerline/layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.7.6 Quantities of insulators

- Quantity of insulators is based on total structure quantities, from the preliminary centerline/layout.
- The quantity and strength of insulators per structure will be based on Newfoundland Hydro distribution standards.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.7.7 Quantities of Conductor and OPGW

- A single 477 Aluminum Stranded Conductor (ASC) "Cosmos" will be used as the phase and jumper conductor. The quantity is based on the linear line length, with an additional 4% included for sag and wastage.
- 4/0 Aluminum Alloy Stranded Conductor (AASC) "Oxlip" will be used as the neutral wire. The quantity is based on the linear line length, with an additional 4% included for sag and wastage.
- Two ADSS cables, 48 fibres each, shall be installed and used for telecommunication. The quantity is based on the linear line length, with an additional 5% extra included for sag, down leads, splices, and wastage.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.7.8 Quantities of Conductor Accessories

- 100% of the line has been considered for compression type splices, dead-ends and jumper connectors.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.
- Three aerial marker cones (1 white and 2 orange) will be included for the river crossing.

27.7.9 Quantities of ADSS Accessories

- ADSS splice boxes will be installed approximately every 2000 m and on the first structure outside of the substation, as well as at required tap points.
- ADSS down lead clamps have been assumed to be required every 3 m.
- Bird diverters are not required, and are not included in the estimate.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.7.10 Grounding

- Ground rods will be installed at each guyed structure and/or at an interval of 3 structures per kilometre.

27.7.11 Quantities of Miscellaneous Hardware and Material

- One structure number tag will be installed on every structure.

27.7.12 Electrical Effects / Considerations

- The ROW for the 25 kV construction power line is 7.5 m wide, as per the Newfoundland Hydro Standard.

27.7.13 Distribution and Transmission Line Conflicts

- The proposed 25 kV construction power line will have to cross one existing distribution line.

27.8 Modification to Existing Lines for HVdc Crossings – Engineering Assumptions

The new ± 350 kV HVdc transmission line will only cross one existing transmission line per span. Six existing transmission lines will need alignment modifications to accommodate the new ± 350 kV HVdc transmission line structures. See Table 27-1 for the list of lines that will need to be modified:

Table 27-1: Existing Lines to be modified

Modification Number	Line to be modified	kV level	Structure Type
1	TL251	69 kV	Wood Pole
2	TL232	230 kV	Wood Pole
3	TL204	230 kV	Single Circuit Tower
4	NFP	138 kV	Wood Pole
5	NFP	138 kV	Wood Pole
6	TL201	230 kV	Wood Pole

Any change to an existing transmission line will utilize like structures and assemblies to maintain consistency.

27.8.1 Structure Design

- The tower weights are estimated based on weights provided in NALCOR Dwg. No. 220–T–222.
- The foundations are assumed to be grillage type foundations for each tower.
- All wood pole structures will be Class 1 poles ranging from 15.4 m (50 ft) to 24.6 m (80 ft) in length.
- Wood poles will be direct embedded with the addition of guying, if required.
- No long-span or special crossing structures are included.

27.8.2 Centerline / Layout

- The center line and layout proposed by SLI was selected to minimize the cost and impact to the existing lines.
- The survey data used for the preliminary layout was provided by Nalcor and based on 2010 LiDAR survey and orthophotography.

27.8.3 Quantities of Structures and Foundation Steel

- The quantity of towers/wood poles estimated includes all standard structures, body extensions, and leg/mast extensions, including nuts, bolts, plates, washers, and attachment vangs, as per the design drawings, specifications and other contract documents.
- The quantities of steel towers/wood poles are based on preliminary (40% complete) design.
- Material extras for spares, un-foreseen re-routes, structure additions, design changes, etc. are not included.
- The quantities for the steel grillage are estimated based on the preliminary design and layout.

27.8.4 Quantities for Conductor Hardware Assemblies

- The quantities of hardware assemblies are based on total structure quantities from the preliminary centerline/layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.8.5 Quantities of Insulators

- The quantities of insulators are based on total structure quantities from the preliminary centerline/layout.
- The strength and type of insulator selected for each line is listed in Table 27-2.
- Porcelain or toughened glass insulators are assumed to be acceptable in the estimate. The quantity and strength of the insulators will match that of the existing line.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

Table 27-2: Quantity of Insulators for each line to be modified

Modification No.	Line to be modified	kV level	Insulator Type	Insulator Quantity
1	TL251	69 kV	Tangent (line Post)	6
			DE (6 bells – 111 kN)	72
			Jumper (line Post)	6
2	TL232	230 kV	Tangent (14 bells – 111 kN)	84
			DE (16 bells – 111 kN)	576
			Jumper (14 bells 111 kN)	126
3	TL204	230 kV	DE (16 bells – 111 kN)	192
			Jumper (14 bells 111 kN)	42
4	NFP	138 kV	DE (9 bells – 111 kN)	324
			Jumper (8 bells – 111 kN)	72
5	NFP	138 kV	DE (9 bells – 111 kN)	324
			Jumper (8 bells – 111 kN)	72
6	TL201	230 kV	Tangent (14 bells – 111 kN)	42
			DE (16 bells – 111 kN)	576
			Jumper (14 bells 111 kN)	126

27.8.6 Quantities of Conductor and OHSW

- The quantity of conductor and OHSW is based on the linear line length, with an additional 4% included for sag and wastage.
- Table 27-3 outlines the existing types of conductor and OHSW required for each line modification.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

Table 27-3: Existing Conductor and OHSW Type

Modification No.	Line to be modified	kV level	Conductor / OHSW Type
1	TL251	69 kV	Single 266 Partridge ACSR
			No OHSW
2	TL232	230 kV	Single 1192.5 Grackle ACSR
			No OHSW
3	TL204	230 kV	Single 1192.5 Grackle ACSR
			½” Steel Grade 220 OHSW
4	NFP	138 kV	Single 397 Ibis ACSR
			No OHSW
5	NFP	138 kV	Single 397 Ibis ACSR
			No OHSW
6	TL201	230 kV	1192.5 Grackle ACSR
			No OHSW

27.8.7 Quantities of Conductor Accessories

- It is assumed that compression type splices, dead-ends and jumper connectors will be used for each line modification.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.8.8 Quantities of Miscellaneous Hardware and Material

- The hardware required for structure grounding is included.
- One structure number tag will be installed on every structure.
- Two danger signs will be installed on every structure.

27.8.9 Geotechnical Investigations

- The cost of soil compaction testing is included.

27.9 230kV Re-Terminations at the Future Soldier's Pond Substation – Engineering Assumptions

There are four existing transmission lines that will need to be reconfigured at the future Soldier's Pond substation site to accommodate the new ± 350 kV HVdc transmission line (See Drawing No. ILK-SW-CD-4500-CV-PL-0001-01). See Table 27-4 for the list of lines that will need to be reconfigured:

Table 27-4: Lines to be reconfigured at Soldier's Pond

Line No.	kV level	Structure Types
TL201	230 kV	Wood Poles
TL217	230 kV	Single Circuit Towers
TL218	230 kV	Single Circuit Towers
TL242	230 kV	Wood Poles

Any change to these existing transmission lines will utilize like structures and assemblies to maintain consistency.

27.9.1 Structure Design

- The estimated tower weights are estimated based on the weights provided in Nalcor Dwg. No. 220-T-222.
- The foundations are assumed to be grillage type foundations for each tower.
- All wood poles will be Class H1 poles ranging from 18.5 m (60 ft) to 24.6 m (80 ft) in length.
- The wood poles will be direct embedded with the addition of guying, if required.
- No long-span or special crossing structures have been considered.

27.9.2 Hardware Assemblies

- The hardware assemblies will be designed to match those of the existing transmission line assemblies in strength and function.

27.9.3 Engineering Studies and Front End Engineering

- Geotechnical investigation is not included.

27.9.4 Centerline / Layout

- The centerline and layout has been established to accommodate the new Soldier's Pond substation while minimizing the cost and impact to the existing transmission lines.

- It is assumed that there is flexibility to modify the centerline and PI location in an effort to optimize the line layout.
- The survey data used for preliminary layout was provided by Nalcor and based on 2010 LiDAR survey and orthophotography.

27.9.5 Quantities of Towers / Wood poles and Foundation Steel

- The quantity of structures estimated includes all standard structures, body extensions, and leg/mast extensions, including nuts, bolts, plates, washers, and attachment vangs, as per the design drawings, specifications and other contract documents.
- The quantities of steel towers are based on preliminary PLS-CADD spotting.
- Material extras for spares, un-foreseen re-routes, structure additions, design changes, etc. are not included.
- The quantities of steel grillage, guy wire and anchors are estimated based on the preliminary design and layout. The guy wire length is assumed to be 40 m per guy, four guys per steel tower.

27.9.6 Quantities for Conductor and OHSW Hardware Assemblies

- The quantity of hardware assemblies is based on total structure quantities from the preliminary centerline/layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.9.7 Quantities of insulators

- The quantity of insulators is based on total structure quantities from the preliminary centerline/layout.
- The tangent structure will use single "I" string insulators per phase, per tower.
- The dead-end structure will use double strain insulator sets per phase, per tower.
- Porcelain or toughened glass insulators are assumed to be acceptable. The quantity and strength of insulators will match those of the existing structures along the line to maintain consistency.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.9.8 Quantities of Conductor and OHSW

- A single 804 kcmil, Aluminum Alloy Conductor Steel Reinforced Trapezoidal Wire (AACSR / TW) will be used as the pole and jumper conductor for each circuit. The quantity is based on the linear line length, with an additional 4% included for sag and wastage.

- Two 1/2" Grade 220 OHSW, will be used on each circuit for lightning protection. The quantity is based on the linear line length, with an additional 4% included for sag and wastage.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.9.9 <u>Quantities of Conductor Accessories</u>

- 100% of the line has been considered for compression type splices, dead-ends and jumper connectors.
- Conductor splices will be installed approximately every 1800 m.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.9.10 <u>Quantities of OHSW Accessories</u>

- Dampers are assumed to be Stockbridge type, two per structure.
- Bird diverters will not be required, and are not included in the estimate.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.9.11 <u>Quantities of Miscellaneous Hardware and Material</u>

- The hardware required for structure grounding is included.
- Aerial structure number boards will be installed on the first structure outside of the substation.
- One structure number tag will be installed on every structure.
- Two danger signs will be installed on every structure.
- Aerial line number boards will be included per line, and will be installed on the first structure outside of the substation.

27.9.12 <u>Electrical Effects / Considerations</u>

- The 230 kV re-terminations will maintain a ROW width that will match that of the existing 230 kV line.

27.10 735 kV HVac Interconnection – Engineering Assumptions

Two new 0.6 km of 735 kV HVac transmission lines will be required between the existing 735 kV Churchill Falls switchyard and the future 735 kV switchyard extension (See drawing No. MFA-SW-CD-4100-CV-PL-0001-01).

27.10.1 Structure Design

- For estimating purposes, SLI has used the tower types and weights provided in document created by HATCH, titled "AC1020 – Tower Type Selection, 735 kV".
- Tangent towers shall be tower type "NFGA", a guyed V lattice tower.
- Dead-end towers shall be tower type "NFBL", a rigid self-supporting tower with four legs.

27.10.2 Hardware Assemblies

- The hardware assemblies will match those of the existing 735 kV transmission lines.
- The tangent towers shall have two double "I" string insulators and one "V" string insulator per tower.
- Dead-end towers shall have four strain insulator strings, per phase, per tower.
- Jumpers shall be "V" string insulators.

27.10.3 Centerline / Layout

- This estimate is based on the most efficient center line connection between the future addition to the existing 735 kV Churchill Falls switchyard and the future 735 kV / 315 kV Churchill Falls Switchyard (SLI Doc. No. 505573-480B-41DD-0001).
- The survey data used for the preliminary layout was provided by Nalcor and based on 2010 LiDAR survey and orthophotography.

27.10.4 Quantities of Towers and Foundation Steel

- The quantity of towers estimated includes all basic/standard towers, body extensions, and leg/mast extensions, including nuts, bolts, plates, washers, and attachment vangs, as per the design drawings, specifications and other contract documents.
- The quantity of towers is based on preliminary PLS-CADD spotting.
- Material extras for spares, un-foreseen re-routes, structure additions, design changes, etc. are not included.
- The quantities of steel grillage, guy wire, and anchors are estimated based on the preliminary design and layout. The guy wire length is assumed to be 60 m per guy, four guys per tangent tower.

27.10.5 Quantities for Conductor, OHSW and OPGW Hardware Assemblies

- The quantity of hardware assemblies is based on total tower quantities from the preliminary centerline/layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.10.6 Quantities of Insulators

- The quantities of insulators are based on total tower quantities from the preliminary centerline/layout.
- Porcelain or toughened glass insulators are assumed to be acceptable.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.10.7 Quantities of Conductor and OHSW / OPGW

- Four-bundle 54/19 ACSR, "Plover" will be used as the phase and jumper conductor. The quantity is based on the linear line length, with an additional 4% included for sag and wastage.
- One 9/16" grade 220 steel OHSW will be installed on each of the 735 kV lines. The quantity is based on the linear line length, with an additional 2% included for sag and wastage.
- One OPGW, 24 fibres cable, will be installed on each 735 kV line. The quantity is based on the linear line length with an additional 5% extra included for sag, down leads, splices, and wastage.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.10.8 Quantities of Conductor Accessories

- Spacer dampers for quad bundled conductor are assumed to be installed every 60 m per phase and are assumed to be adequate for the damping requirements of the line.
- 100% of the line has been considered for compression type splices, dead-ends and jumper connectors.
- Rigid spacers will be used on jumper conductors, assuming six spacers per phase, per jumper.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.10.9 Quantities of OPGW Accessories

- OPGW down lead clamps have been assumed to be required every 3 m.

- Two vibration dampers per structure will be used on the OPGW, per the tower quantity estimation.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.10.10 Quantities of OHSW Accessories

- Two vibration dampers per structure will be used on the OHSW, per the tower quantity estimation.
- 100% of the line has been considered for compression type splices.
- Bird diverters are not required, and are not included in the estimate.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.10.11 Quantities of Miscellaneous Hardware and Material

- The hardware required for tower grounding is included.
- One structure number tag will be installed on every structure.
- Two danger signs will be installed on every structure.

27.11 315 kV HVac Interconnection at Muskrat Falls Substation – Engineering Assumptions

Four (4) 0.5 km, 315 kV HVac single circuit transmission lines will be required for the interconnection between the powerhouse and the switchyard at the Muskrat Falls Substation (Drawing No.MFA-SN-CD-4300-CV-PL-0001-01).

27.11.1 Tower Design and Testing

- This interconnection will utilize the same 315 kV lattice steel tower family developed specifically for the LCP project. The tower design criteria is based on the document "315 kV HVac Tower Design Criteria (SLI Doc.505573-361B-43EC-0001)".
- The four lines will use the D and E type towers to complete the interconnection for this 50 mm radial ice loading zone.
- All tower weights are estimated based on tower designs completed by SLI.

27.11.2 Hardware Assemblies and Testing

- The interconnection will use the same hardware assemblies designed for the 250 km, 315 kV HVac line from MF to CF.
- All 315 kV assemblies will use reduced-corona hardware.
- The hardware assembly prototype testing is included, along with witness testing by SLI.
- Third party inspection during manufacturing has been included.

27.11.3 Centerline/Layout

- This estimate is based on the center line and layout that was established to facilitate the spans required to connect the new powerhouse to the 315 kV switch yard at the Muskrat Falls Substation.
- It is assumed that there is flexibility to modify the centerline and PI location in an effort to optimize the line layout.
- The survey data used for preliminary layout was provided by Nalcor and based on 2010 LiDAR survey and orthophotography.

27.11.4 Quantities of Towers and Foundation Steel

- The quantity of towers estimated includes all basic/standard towers, body extensions, and leg/mast extensions, including nuts, bolts, plates, washers, and attachment vangs, as per the design drawings, specifications and other contract documents.
- The quantity of towers is based on preliminary PLS-CADD spotting.

- Material extras for spares, un-foreseen re-routes, structure additions, design changes, etc. are not included.
- Steel grillage foundations will be used for these towers.

27.11.5 Quantities for Conductor, OHSW and OHSW Hardware Assemblies

- The quantities of hardware assemblies are based on total tower quantities, from the preliminary centerline/layout.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.11.6 Quantities of Insulators

- The quantities of insulators are based on total tower quantities, from the preliminary centerline/layout.
- Porcelain or toughened glass insulators are assumed to be acceptable. The quantity and strength of insulators is based on the document titled: "315 kV HVac Line Design Criteria (SLI Doc.505573-361C-4ZEC-0001)".
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.11.7 Quantities of Conductor and OHSW / OPGW

- Two-bundle 795 kcmil, 26/7 ACSR "Drake", will be used as the phase and jumper conductor. The quantity is based on the linear line length, with an additional 4% included for sag and wastage.
- One OHSW will be installed on each line, using 1/2" grade 220 steel. The quantity is based on the linear line length, with an additional 2% included for sag and wastage.
- One OPGW, 24 fibre cable, will be installed on each line, the quantity is based on the linear line length with an additional 5% extra included for sag, down leads, splices, and wastage.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.11.8 Quantities of Conductor Accessories

- Spacer dampers are assumed to be installed every 60 m, per phase, and are assumed to be adequate for the damping requirements of the line.
- 100% of the line has been considered for compression type splices, dead-ends and jumper connectors.
- Rigid spacers will be used on jumper conductors, assuming six spacers, per phase, per jumper.

- One jumper assembly, per phase, per tower type D and E is included.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.11.9 Quantities of OPGW Accessories

- Two spiral vibration dampers per structure, will be used on the OPGW as per the tower quantity estimation.
- OPGW down lead clamps have been assumed to be required every 3 m.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.11.10 Quantities of OHSW Accessories

- Two spiral vibration dampers, per structure will be used on the OHSW as per the tower quantity estimation.
- The bonding conductor is assumed to be #2 ACSR "Sparrow" and the length is estimated to be 1.5 m for suspension towers and 2.0 m for the dead-end structures.
- 100% of the line has been considered for compression type splices.
- Bird diverters are not required and are not included in the estimate.
- Material extras for un-foreseen re-routes, structure additions, design changes, etc. are not included.

27.11.11 Quantities of Miscellaneous Hardware and Material

- The hardware required for tower grounding is included.
- One structure number tag will be installed on every structure.
- Two danger signs will be installed on every structure.
- Aerial line number boards will be included per line, and will be installed on the first structure outside of the Muskrat Falls Substation.

27.11.12 Geotechnical Investigations

- Geotechnical investigation is not included.

27.11.13 Electrical Effects / Considerations

- Transmission line ROW is 50 m, which is assumed to be within the acceptable limits for:
  - Edge of right of way electric / magnetic field levels,
  - Edge of right of way audible noise levels, and

- Edge of right of way radio and television interference.

27.11.14 Distribution and Transmission Line Conflicts

- It is assumed that no line crossings will be required for this 315 kV interconnection.

27.12 Price Basis – Transmission Hardware

As discussed in Section 14.4 of Part A, the Price Basis transmission hardware secure through the acquisition of an extensive amount of budgetary offers from various international supplies. This included the prices for lattice steel towers, foundation steel grillages, rock anchor and anchor bolts, conductor, insulators, grounding material, OHSW, OPGW and accessories, guy wires, hardware fittings for conductor, insulator, OHSW, guy wire and poles.

In addition, the following allowances have been made to the base price:

- Allowances have been made for inspection visits
- Allowances are included for type tests of insulator strings and OPGW. Eight full scale tower tests (two for HVac and six for HVdc) are also included.

Tables 27-6 and 27-8 present the price basis for the AC and DC transmission hardware. A detailed list and copies of price summaries and vendor quotes to support the estimate are contained in Volume 17 of the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

Table 27-6: AC Transmissions Hardware Price Basis

Hardware / Component	Price	Unit
Conductor		
795 kcmil 26/7 ACSR "Drake"	$6,000.00	$/km (incl. freight & reel)
Insulators		
Porcelain or Toughened Glass CS-11 220 kN Suspension Insulators for Phase Conductor	$45.00	$/unit
Porcelain or Toughened Glass CS-3 70 kN Suspension Insulators for Jumpers	$20.00	$/unit
Tower Steel		
CIF	$2,300.00	$/MT
Tower Detailing A,B,C,D,E	$50,000.00	$/type
Load Testing A,D	$75,000.00	$/type
Conductor Hardware		
Conductor Suspension Assembly	$574.85	$/unit
Conductor Dead-End Assembly	$2,183.40	$/unit
Conductor Jumper Assembly	$311.40	$/unit
OHSW Hardware		
OHSW Suspension Assembly	$145.05	$/unit
OHSW Dead-End Assembly	$138.40	$/unit
Cables	$750.00	($/unit)
OPGW Conductor – Cable	$6,562.00	$/km
Anchor Steel	$4.00	$/kg

Note: All prices include freight.

Table 27-6: DC Transmissions Hardware Price Basis

Hardware / Component	Price	Unit
Conductors		
ASC 3640 kcmil	$23,000.00	$/km
1192.5 kcmil ACSR Grackle	$9,000.00	$/km
1510.5 kcmil ACSR Parrot	$11,500.00	$/km
Insulators		
300kN, 635 mm creepage, 195mm spacing	$180.00	$/unit
220 kN, 550 mm creepage, 171mm spacing	$130.00	$/unit
160 kN, 550 mm creepage, 171mm spacing	$110.00	$/unit
Hardware Accessories & Fittings		
Conductor Suspension Assembly (Type 1)	$1,401.18	$/unit
Conductor Suspension Assembly (Type 2)	$1,460.76	$/unit
Conductor Dead-End Assembly	$2,540.49	$/unit
Conductor Jumper Assembly	$1,199.41	$/unit
ACSR Grackle-Electrode Conductor Suspension Assembly	$973.43	$/unit
ACSR Grackle-Electrode Conductor Dead-End Assembly	$2,252.33	$/unit
ACSR Parrot-Electrode Conductor Suspension Assembly	$982.00	$/unit
ACSR Parrot-Electrode Conductor Dead-End Assembly	$2,652.15	$/unit
Cables	$750.00	$/unit
OPGW Conductor – Cable ($/km)		
140kN OPGW	$4,550.00	$/km
177kN OPGW	$5,000.00	$/km
277kN OPGW	$7,220.00	$/km

Note: All prices include freight.

27.13 Construction Assumptions – General

The assumptions reviewed in this document refer to the following estimates that are contained in the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

- One estimate for the HVac clearing and line construction,
- Four estimates for the HVdc clearing and line construction,
- Estimate for the two wood pole electrode lines,
- Estimate for required modifications to existing lines that will be crossed by the HVdc line in the Avalon Peninsula package,
- Estimate for re-terminating existing 230 kV lines at the proposed Soldiers Pond station,
- Estimate for a 735 kV connection at Churchill Falls, and
- Estimate for 315 kV interconnections at Muskrat Falls (powerhouse).

<u>Included in the Estimates</u>

- The quantities of construction work involved as provided in the engineering estimates are included.
- The crew sizes required and the productivity rates associated with completing the construction work are considered. The labour rates are based on information provided by the client with modifications for specialists, such as linemen.
- Material handling and transportation is included.
- Survey work has been considered.
- Geo-technical investigations are included.
- Management and administration costs including supervision; safety and environmental monitoring; and quality and cost control are included.
- Accommodation for on-site employees based on installation cost of $50,000, per camp bed, and a daily cost of $150, per person are considered.
- Travel for employees while on site and at the end of the rotation based on a 21/7 schedule is considered.
- $100,000 is included for existing HVac line outages.
- $2.195M is included for existing HVdc line modifications, outages, and undergrounding of 25 kV lines by others.
- $535,200 has been considered for civil material testing laboratories and services and is included under SM0705 Provision of Laboratory Services.

- Contractor target of 15% profit is included.
- Contractor Insurance of 1% is included.
- Contractor bonding of 1% is included.

Excluded from the Estimates

- Line inspections conducted by Nalcor and other utility companies are not considered.
- Salvage costs for TL240 between Happy Valley and Churchill Falls are not included.
- Environmental field visits for obtaining site information, etc. for regulatory compliances including stream crossings, etc are not included.
- Insurance for Nalcor supplied materials are not included.

27.13.1 Helicopter Costs

Helicopters will be used extensively to support the transmission line construction works. SLI and Nalcor will use small helicopters (three to five passengers) for supervision and to assist with medical evacuations and fire suppression. Geo-technical consultants will use small and medium helicopters to transport personnel and equipment for soil investigation. Construction contractors will use all sizes of these machines including heavy lift helicopters for setting towers, transporting men and equipment, and for stringing operations.

The cost for the helicopter usage is included in the construction assumptions that follow, or in the separate EPCM estimates. The rates used in the estimates for helicopters are in the following table:

Table 28-5: Rates used in the Estimates for Helicopters

Helicopter Type	Rate
Small Machines AStar, 206LR (4 or 5 passengers; light loads of material and tools)	$1,600 / hr
Medium Machines Various helicopters with capacity for 5 to 15 passengers or a lift capacity of 3300 to 9000 lb	$1,600 / hr
Heavy Lift Machines Erickson Air-Crane S64E (20,000 lb lift) Erickson Air-Crane S64F (25,000 lb lift)	$14,500 / hr

27.13.2 Material Marshaling

A logistics study is underway that will help to plan the management of the transmission line materials. The construction estimates are currently based on the assumption that there will be main marshalling yards established west of Happy Valley, and one near Corner Brook, on the Avalon Peninsula. Based on this model, the line contractors will be responsible for transporting the material from these main yards to the transmission line, using temporary lay-down locations, as necessary.

Approximately $5.7 M has been considered in the estimate for the Marshalling Yard Costs.

Costs associated with operation of the yards is included within package SM0700 – Freight Forwarding, as it is assumed that these yards will be outside of the Collective Agreement, with all labour provided under this third party service agreement, with only 1 SLI representative located in each yard. The yard is assumed to operate 12 hours per day, with 24 hr security presence.

27.13.3 Site Offices and Accommodations

The contractors will be responsible for establishing their own accommodation and office facilities. Exceptions include:

- Using the Accommodation Complex planned for the Muskrat Falls site during the construction of the first few kilometres of the HVdc line.
- Using space at a proposed marshalling yard/office/accommodation complex that would be built west of Happy Valley.
- Using a free-issued camp that could be provided to a contractor for the HVac line.

For all camps established by the contractors, they will be obligated to provide accommodations and office space to SLI and the client. These spaces would be used by managers, engineers, inspectors/lab techs and HS & E staff.

27.13.4 References

- Refer to Part 4 of the Construction Management Plan (SLI Doc. No. 505573-0000-30PL-1-0003) for detailed descriptions of the construction packages, line route conditions and schedule.
- Clearing Estimation Costs - HVac Lines (SLI Doc. No. 500573-4600-40RA-I-0001).
- Clearing Estimation Costs - HVdc Lines (SLI Doc. No. 500573-4600-40RA-I-0002).

27.14 315 kV HVac Line Construction

27.14.1 Construction Quantities

As identified in Section 27.4 - 315 kV HVac Transmission Line, LIDAR survey information and aerial photography has been used to define the corridor for the two 315 kV circuits and to spot the tower types and heights that meet the design criteria. The dimensions of the corridor have been used to estimate the labour costs of clearing the right-of-way. The quantities of the various towers and foundations have been used to estimate the labour costs of constructing the line.

27.14.2 Access

Accessibility to the two HVac lines is fairly well understood.

- The line route crosses the Trans Labrador Highway (TLH) twenty times, providing access to all of the work areas.
- Field investigation has taken place to review points of inflection and other areas of concern.
- A desk-top review of aerial mapping has been used to complete the tower spotting. It is assumed that no significant changes will be required.
- Based on the current assessment of access requirements, all structures can be accessed by a combination of:
  - Existing roads and trails,
  - Minor grading work, removal of small amounts of deadfall, stumps, rocks and other debris,
  - Installation of culverts and temporary bridges, and
  - If required, winter roads or frozen conditions for a small number of locations.

It is assumed that the TLH, including all bridges, etc. will provide unobstructed access for the project.

27.14.3 Survey

- The completed LIDAR survey which was complete and captured as historical cost.
- The costs associated with marking the boundaries of the right-of-way prior to clearing and the staking of the structure centres will be completed by SLI as part of the EPCM agreement.
- The staking of the structure foundations and survey of the as-built locations of the completed foundations will be the responsibility of the line contractor and is included in the estimate.

- A post-construction legal survey of the right-of-way is not included in the estimate. This is captured under Other Owner Cost, Part B.

27.14.4 Clearing and Access Construction

- A clearing and access study has identified clearing methods and the locations where culverts and temporary crossings need to be installed, which also identifies where off-right-of-way access is required. A copy of this study is contained within in Volume 8 of the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.
- Environmental constraints have been identified and accounted for in the execution of clearing and access construction work. Approximately 1% of the clearing and access estimate is earmarked for environmental mitigation.
- Estimated costs of clearing are based on experience from previous projects and are proportional to vegetation density. It is assumed that 89% of the clearing will be completed mechanically (feller-bunchers, mulchers), 7% will be cleared by hand (chain saws) and the remaining 4% will not require tree removal.
- The cost of removing access to the right-of-way following completion of construction has been included in the estimate.

27.14.5 Foundation Construction

- The location and types of foundations have been based on a preliminary study and a report by AMEC engineers. In addition, a desk-top study using a bare earth model was used to determine the likely type of foundation at each tower site.
- Site-specific foundation types will be reviewed and adjusted through a geo-tech survey to be undertaken as tree clearing work in being completed. It is assumed that this survey will not significantly change the quantities of the foundation types that are used for the construction estimate. The cost of the geotechnical survey is included in the estimate.
- It is assumed that the majority of anchors for guyed towers will be drilled to a depth of 10 metres.
- During construction, inspection and testing of the soil conditions encountered during excavations will confirm the foundation type that is being used for each tower. This may result foundation type changes that requires transport of different foundation steel on and off site. A unit price for these possible changes will be included in the tender packages. For the construction estimate, it is assumed that this will be a rare occurrence.
- It is assumed that all tower sites will be accessible by ground transportation. A small number of locations may require the contractor to take advantage of frozen conditions in the winter.

- Estimated costs associated with the installation of each of the foundation types are determined by previous experience with similar foundation that includes labour, equipment and material such as concrete and backfill.

27.14.6 Tower Assembly and Erection

- It is anticipated that all tower sites will be accessible by ground transportation. This includes hauling tower steel and the movement of cranes that are large enough to set the towers.
- Estimated costs associated with the assembly and erection of each of the tower types are determined by previous experience with similar projects. Tower weights are a determining factor.

27.14.7 Stringing – Conductor, OPGW and OHSW

- It is assumed that all tower sites will be accessible by cranes with man-baskets.
- It is expected that the contractor will use a small helicopter for stringing lead-lines. They will employ tension stringing techniques.
- The cost of installing rider poles at twenty highway crossings and four line crossings is included in the estimate. As well, the planning and precautions associated with safely completing the stringing across these crossings is included.
- It is assumed that no modifications or line outages will be required on TL240. Recloser blocking will be required.
- Reel lengths of about 3000 m will be used for conductor and OHSW. Two-bundle, Drake conductor will be used and spacer dampers will be installed.
- Reel lengths of about 6000 m will be used for the OPGW. Approximately 45 splices will be installed in each line.
- Estimated costs associated with stringing are determined by previous experience on similar projects.

27.14.8 Counterpoise

- It is assumed that the line route will be accessible for the installation of the counterpoise and related grounds and connections.

27.14.9 Continuity of Construction

It is unlikely that the HVac lines can be built consecutively from one end to the other. However, it is assumed that there will not be significant costs due to demobilizations or frequent transfers of men and equipment from one section of line to another.

27.15 ±350 kV HVdc Line Construction

27.15.1 Construction Quantities

As identified in Section 27.5, ±350 kV HVdc Transmission Line, ten families of towers are being designed to accommodate the conditions that will be met on the proposed transmission line between Muskrat Falls and Soldiers Pond. LIDAR survey information and aerial photography have been used to define the route and to make an initial pass at spotting towers. The initial estimate of quantities of foundations that are required is based on the proportion of foundation types proposed for the HVac lines.

27.15.2 Contract Packages

- For contract bidding purposes, the HVdc line route has been divided into four packages. An independent estimate for clearing and line construction has been created for each package. The productivity rates for each estimate are based on the travel distances, weather conditions and access requirements within each package.
- For each estimate, the dimensions of the corridor and approximate tree densities have been used to estimate the labour costs of clearing the right-of-way. The tower quantities within each package have been used to estimate the labour costs of foundation installation, tower assembly, setting and stringing.

27.15.3 Access

- A high-level desk-top study and helicopter surveys of portions of the line route have been used to provide a good estimation of the accessibility to all portions of the HVdc line route. The estimates for access requirements are based on the following observations:
- Most of the line route on the island of Newfoundland is accessible from existing roads that cross the line, dividing it into manageable segments.
- The portion of line through the Long Range Mountains has been estimated for helicopter access for all phases of work.
- The portion of line going north from the south coast of Labrador has been estimated for helicopter access for all phases of work.
- The line route across the interior of Labrador from Muskrat Falls to the Bujeault River is remote but there should be access to the majority of structures. However, there are few access points to this portion of line and it is proposed that approximately 45 km of class 1 road be built to the south-east end of this section. As well, the access road along the right-of-way will have to be built and maintained to accommodate the traffic that will need to travel. One central portion of the line will likely be accessible only with ice bridges during the winter.
- The estimates account for all of these identified conditions.

27.15.4 Survey

- The completed LIDAR survey which was complete and captured as historical cost.
- The costs associated with marking the boundaries of the right-of-way prior to clearing and the staking of the structure centres will be completed by SLI as part of the EPCM agreement.
- Staking of the structure foundations and survey of the as-built locations of the completed foundations will be the responsibility of the line contractor and is included in the estimate.
- A post-construction legal survey of the right-of-way is not included in the estimate. This is captured under Other Owner Cost, Part B.

27.15.5 Clearing and Access Construction

- A high level clearing and access study for the proposed HVdc line route has been used to approximate clearing methods and to estimate the work required to establish access along the right-of-way. The study also identifies the existing access available and the amount of off-right-of-way access that is required for clearing and line construction. A copy of this study is contained within in Volume 8 of the supporting documentation to the DG3 CCE, reference Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.
- It is assumed that the majority of environmental constraints have been identified and accounted for in the estimate of clearing and access construction work. Approximately 1% of the clearing and access estimate is earmarked for environmental mitigation.
- Estimated costs of clearing are based on experience from previous projects and are proportional to vegetation density. It is assumed that 79% of the clearing will be completed mechanically (feller-bunchers, mulchers), 19% will be cleared by hand (chain saws) and the remaining 2% will not require tree removal.
- The cost of removing access to the right-of-way following completion of construction has been included in the estimate.

27.15.6 Foundation Construction

- As indicated, the initial quantities and sizes of HVdc tower foundations have been estimated by using amounts that are proportional to the HVac design. It is assumed that as engineering work progresses, the final foundation designs will not cause a significant change in the construction estimate.
- It is assumed that the majority of anchors for guyed towers will be drilled to a depth of 10 metres.
- During construction, inspection and testing of the soil conditions encountered during excavations will confirm the foundation type that is being used for each tower. This may result foundation type changes that requires transport of different foundation steel on and

off site. A unit price for these possible changes will be included in the tender packages. For the construction estimate, it is assumed that this will be a rare occurrence.

- Access to tower sites for foundation installation will vary considerably throughout the HVdc line. The variability is accounted for within each estimate. This includes some areas where men and equipment will have to be transported by helicopter.
- Estimated costs associated with the installation of each of the foundation types are determined by previous experience with similar foundation. The estimates include labour, equipment and material such as concrete and backfill.

27.15.7 Tower Assembly and Erection

- Access to tower sites for tower assembly and erection will vary considerably throughout the HVdc line. The majority of towers will be assembled at the tower sites and set by crane. Some of these locations will require winter access. Two large areas (southern Labrador and the Long Range Mountains in the Northern Peninsula) will require the use of helicopters for setting towers. One or two shorter sections may require helicopter setting as well. The cost of setting towers under these conditions is included in the estimates.
- Estimated costs associated with the assembly and erection of each of the tower types are determined by previous experience with similar projects.

27.15.8 Stringing – Conductor and OPGW

- It is assumed that the majority of tower sites will be accessible by cranes with man-baskets. It is also assumed that the areas where towers are set by helicopter will require crews to work off the towers without man-lifts and be transported by helicopter.
- It is expected that the contractor will use a small helicopter for stringing lead-lines. He will employ tension stringing techniques.
- The cost of installing rider poles at highway crossings and line crossings is included in the estimate. As well, the planning and precautions associated with safely completing the stringing across these crossings is included.
- Modifications to existing circuits will be required is some cases and referenced below.
- Reel lengths of about 1000 m will be used for conductors.
- Reel lengths of about 6000 m will be used for the OPGW.
- Estimated costs associated with stringing are determined by previous experience on similar projects.

27.15.9 Counterpoise

- The installation of counterpoise will require a variety of forms of transportation. This is included in the estimate.

27.15.10 Continuity of Construction

Within each package of the HVdc line, contractors will be challenged to maintain a high level of productivity from their work-forces. It is unlikely that any package can be built consecutively from one end to the other. However, it is assumed that there will not be significant costs due to demobilizations or frequent transfers of men and equipment from one section of line to another.

27.16 Miscellaneous Packages

27.16.1 Additional Work - LCP Transmission System

The following section outlines the construction assumptions for all remaining work outside of the HVac and HVdc line construction:

- Two electrode lines
- Modifications to existing lines for crossings in the fourth section of the HVdc line
- 230 kV line re-terminations at Soldiers Pond
- 735 kV interconnection at Churchill Falls
- 315 kV interconnection at Muskrat Falls (Powerhouse)

These sub-projects are being developed as separate engineering packages but will be included with the larger bid packages when they are tendered. Not included is the 25 kV Construction Power scope.

The cost estimates to construct these packages were developed as follows:

- Based on experience, the crew size and equipment requirements were identified. Labour rates, equipment costs, indirect costs and overhead costs used for the major construction components were applied.
- The estimated number of crew days required to complete each sub-project is based on previous projects of similar scope.
- Access and clearing costs, if any, are based on a review of aerial mapping
- Outages and the extra time required for crossing other circuits or roads is included in the estimate of crew days required.
- It is assumed that no significant delays will be encountered It is assumed that there will be no major changes to the scope or location of these projects.

27.17 Key Metrics

The following table presents some indicative key metrics for the Overland Transmission portion of the CCE.

	Major Quantities DG3 ESTIMATE		Production Rate (hr.Crew)	Key unit Rates
	Quantity	Unit	Units / period	$ / unit
AC Lines				
ROW Clearing Area	2,370	HA	64.8	$12,736
Number of Towers	1,292	units	18.9	$41,380
Number of Foundations	1,774	units	7.6	$19,170
Tower Steel	9,713	tonnes	1.4	$5,504
Foundation Steel	1,500	tonnes	9.0	$22,672
Conductors	494	km	29.0	$110,595
DC Lines - Segment 1				
ROW Clearing Area (DC 1080 Km.)	6,270	HA	98.5	$21,626
Number of Towers **Seg. 1**	972	units	19.2	$42,392
Number of Foundations	1,173	units	6.5	$17,813
Tower Steel	8,434	tonnes	1.3	$4,886
Foundation Steel	1,710	tonnes	10.9	$12,219
Conductors	309	km	39.9	$171,879

Part G: SOBI Crossing

28.0 SOBI CROSSING

28.1 Overview of Scope

As described in Part A, SOBI Crossing includes:

- Three (3) 350kV, 450 MW Mass Impregnated HVdc submarine and land cables crossing the SOBI protected using HDD boreholes and subsea rock placement.
- One transition compound for each side of the Strait of Belle Isle submarine cable crossing (covered under Part E of this report), for junction of multiple submarine cables and the overhead transmission line.

28.2 References

The CCE is based upon the following engineering studies:

- Marine Crossings Team Decision Gate 3 Report, reference no. ILK-PT-ED-8110-MR-RP-0002-01
- Final Report - HDD Pilot Bore Field Investigation Program - Strait of Belle Isle, reference no. LK-ME-CD-8113-DR-RP-0001-01
- Geotechnical Site Investigation Proposed Landfall Location Forteau Point, Labrador, reference no. ILK-AM-CD-8113-DR-RP-0001-01

28.3 Estimate Exclusions

The DG3 CCE assumes that neither a Marine Warranty Surveyor nor a 3rd party Certifying Authority are required, hence no provisions for costs to support these services.

28.4 Landfall

The landfall section can be broken down into two main components, namely the HDD cable conduit which will provide a conduit from the ocean to the land, and a section from the cable conduit locations to the Transition Compounds that will have the cables buried in a trench.

28.4.1 Engineering Assumptions

During Gateway Phase 2 of the Project, feasibility studies and risk assessments were conducted which identified areas that required further knowledge and investigation prior to the initiation of the work in Phase 4. The gaps were primarily in the site specific geotechnical information on both Forteau Point and Shoal Cove.

To address these gaps, Nalcor executed significant geotechnical field programs on both sides of the SOBI. The field programs were necessary to characterize the rock properties where geotechnical information was not previously available. Data obtained will further refine the design and de-risk the HDD portion of the landfall.

On the Newfoundland side of SOBI, a HDD pilot bore was chosen as the best method to achieve these goals. This HDD pilot bore was successfully drilled in Shoal Cove with a portion reamed to a larger diameter. The work was executed by Mears Canada Corp. under agreement LC-SB-007. To ensure the appropriate data was gathered. The pilot bore drilled by Mears used typical HDD industry equipment, personnel, means and methods. Valuable information was gathered to characterize the bedrock properties and how they will react when using HDD methods (i.e. drilling muds) as opposed to typical geotechnical coring. Additionally, as this method of drilling is the same as will be used in Gateway Phase 4 it provided valuable data for refining the execution plan, schedule and cost impacts.

The field program on the Labrador side in Forteau was executed under agreement LC-SB-014, awarded to AMEC. Due to the remoteness of this site, a HDD pilot bore similar to Shoal Cove was not possible and as a result more conventional geotechnical methods were utilized. The work consisted of core drilling and surface test pits dug at several points around the potential drill entry locations where preparations were needed for constructing a drilling pad.

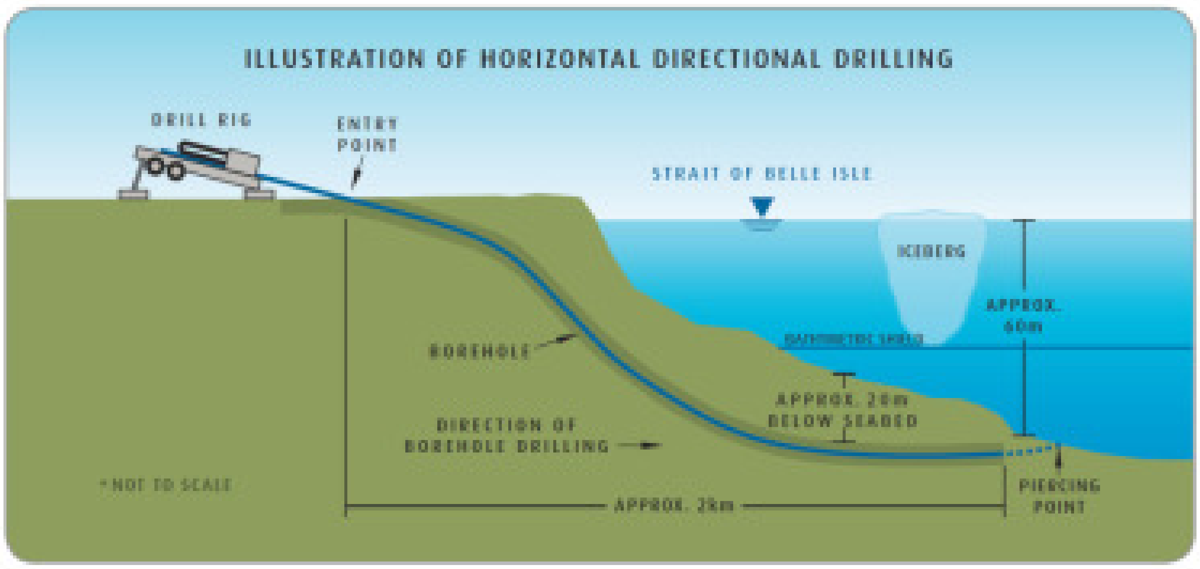
The cable conduit design has evolved through Gateway Phase 3 as data obtained from the field programs has been incorporated. Preliminary designs have been developed; however, these cannot be finalized until all parameters pertaining to the cable have been received. This is anticipated in Q3/Q4 of 2012 after the cable contract is awarded and the cable conduit-cable engineering interface is completed.

From the cable conduit to the TCs the cable will be installed in a trench that will protect the cable and provide an engineered environment to maintain consistent and constant thermal properties.

While the location of the Transition Compounds were finalized in Q2-2012, the specifics relating to trench dimensions are reliant on input from the cable vendor that will not be available until after award of the cable contract later this year.

For the purposes of DG3 CCE it is assumed that the three cables will be installed in one trench with a spacing of approximately 1 meter in a concrete cable chaseway. The trench lengths have been based on the most recent locations for the cable conduit and TCs.

Figure 28-1: Landfall Construction using HDD



28.4.2 Construction and Contracting Approach

The landfall portion is divided into two distinct scopes of work which are the cable conduit and the land trench. The execution of these two scopes requires different approaches and skill sets resulting in different execution and contracting models.

Cable Conduit

Due to the nature of drilling operations and the fact that there are still geotechnical uncertainties, it was determined that some of the more critical aspects of the drilling operation require closer monitoring and more control than a traditional HDD company can provide (e.g. steering and drilling fluids). High quality and tight control over such functions is essential to ensure a satisfactory cable conduit is provided, thus extensively reducing the risk of cable failure/complications during pull-in. In addition, establishing a contracting position where all the risk is placed on the HDD contractor will not result in best value, as based on lessons learned during the pilot bore campaign.

As a result this portion of the work will be on a reimbursable basis. Additionally, as some aspects of the work require a higher level of expertise and care, these services will be contracted separately to ensure a higher quality and effectiveness of the services in a similar manner that oil and gas wells are drilled. This approach reduces overall technical risk which maintaining best value.

The CCE assumes that the pilot hole completed at Shoal Cove in 2012 will not be re-issued.

Land Trench

The three (3) submarine cables will be pulled into the cable conduits, but they will need a section of buried cable to connect to the Transition Compounds, where the transition to overland lines occurs. Land trenching is the preferred method for this protection.

The work scope for the land trenching on each side of the SOBI will be treated as distinct work sites. However, some resources may be shared since the schedules to have this work completed are more flexible than the cable conduit installations, due to the shorter duration required for the trenching.

The chosen method of contracting for the land trenching will be a unit rate for each distinct aspect of the work (i.e. grubbing, blasting). Laying the cable and backfilling will be part of the cable supply and installation contract.

28.4.3 Price Basis

The landfall estimate contained within the CCE is built on the DG2 CCE and captured learning's that were taken from the field work that was executed in Gateway Phase 3. All relevant information obtained from the field work developed a greater understanding of the site specific conditions and were analyzed by our landfall engineering firm (Hatch). Based on this information Hatch provided a refined cost estimate for the cable conduit installation and unit rates that were utilized for the civil works portion of the landfall. These estimates were reviewed and deemed suitable for the DG3 CCE.

28.5 Submarine Cable

28.5.1 Engineering Assumptions

The submarine cable corridor has remained unchanged as proposed within the DG2 conceptual design report.

In support of the design, and to provide further definition of the submarine cable corridor SOBI Marine Crossing there was several general data acquisition programs completed. These consisted of the Marine Data Acquisition Program (LC-SB-004), the Iceberg Monitoring Program (LC-SB-002), and the Ocean Characteristic Monitoring Program and MetOcean Report (LC-SB-017).

LC-SB-004 was awarded in Q3 2011 and was executed from early July until the end of October covering both the SOBI and Cabot Strait (CAST) regions. Fugro GeoSurveys Inc. was contracted to perform the marine survey, which included; collection of bathymetry, sub-bottom profile and General Visual Inspection (GVI) data.

The water depths along the corridor, outside of the drill exit locations, range between approximately 60 m and 125 m, with 9 km of the route lying in depths greater than 100 m. Unconsolidated sediments rest directly on bedrock, and range in thickness from Forteau Point to Shoal Cove with intermittent exposures of bedrock.

The cable conduit entry locations in Shoal Cove and associated land trenches have been optimized to ensure the area identified as Long's Braya habitat can be completely avoided. Moving the entry locations Northeast to accommodate the endangered flowers added less than 100 m of additional length to the HDD bores, making the difference of minor impact in terms of drilling risks and schedule impacts. The area identified for cable conduit seabed exit locations in Forteau Point was optimized to achieve the shortest distance to the most favorable exit locations. This favorable area was identified as a result of the marine data acquisition program conducted in 2011.

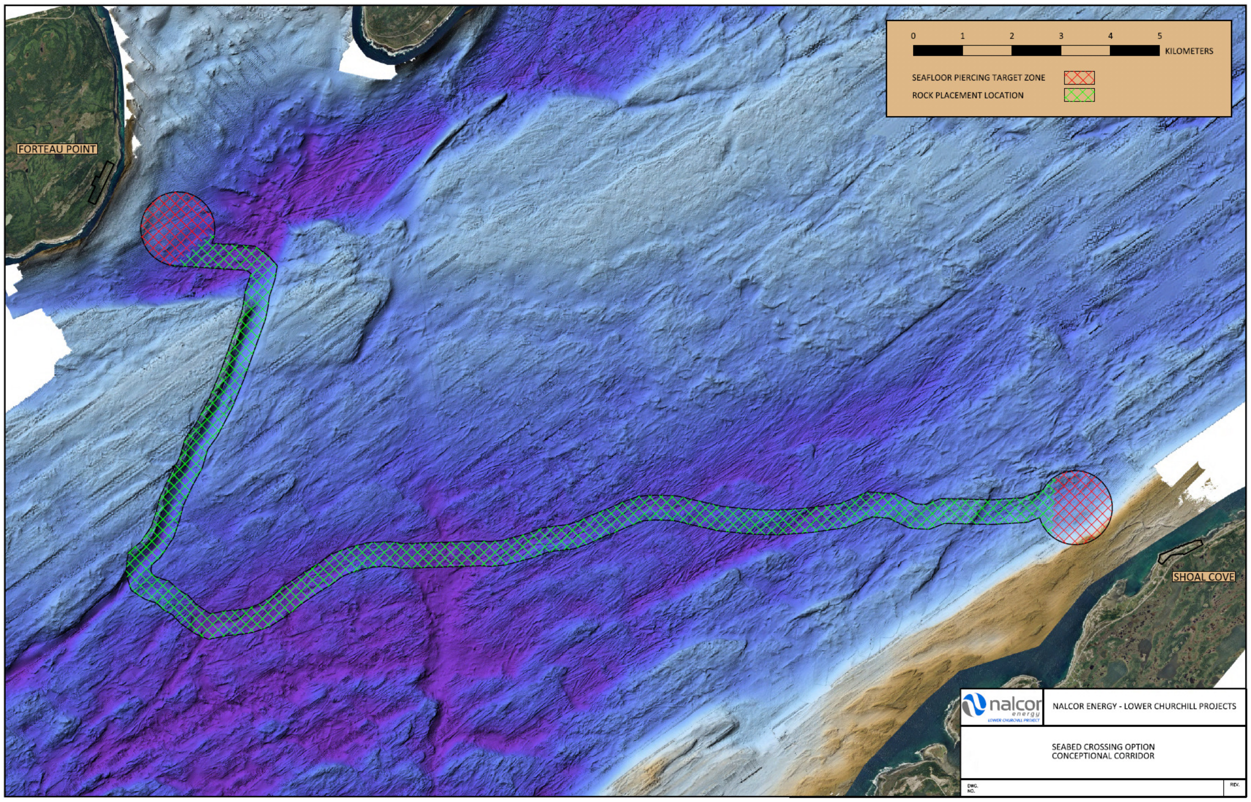
The trenched route for the land cable will extend from the HDD cable conduit entry location to the Transition Compounds.

Land cable length, per each cable, forming the basis of the DG3 CCE is as follows:

- Forteau Point = 1200 m
- Shoal Cove = 800 m

Provisions for seabed level prior to cable installation, via placement of 50,000 MT of rock has been assumed as required.

Figure 28-2: SOBI Submarine Cable Corridor



28.5.2 Submarine Cable Supply & Installation

Mass-Impregnated (MI) cables have been selected as the preferred cable technology for the SOBI. The cables will have a copper or aluminum conductor, and will be protected with two layers of armoring for tensile loading and rock impact protection.

The outer serving of the HVDC cable will consist of a double layer of polypropylene yarn in the submarine portions. Cable conduit sections and land cables will consist of an extruded sheathing of high density polyethylene. During the pull-in through the cable conduits, this sheathing will provide reduced friction between the steel conduit and the cable.

The cables will utilize a transition joint between submarine and land cables. The land cables will end in terminations located within each TC. Overvoltage protection for the cables will be provided by surge arresters installed adjacent to the terminations.

The cables will incorporate Fiber Optics (FO) for Distributed Temperature Sensing (DTS). These fibers will be embedded within the cable. DTS will allow the cable performance to be monitored and optimized while providing real time operational data which allows the operators to protect the cable insulation from overheating for its service life.

At the time the cable design, supply and install RFP was issued to potential bidders, the system design requirements were not finalized for the Labrador-Island Transmission Link. As a result, there was a significant continuous rating requirement for the system, which would follow an overload condition, and it was determined best, in conjunction with the System Planning Group of NL Hydro, that two cases would be presented within the cable performance specification for the SOBI HVDC cables: Base case would be ± 350 kV and 450 MW per pole with a 5 minute 2 p.u. transient overload, with the optional case of 2 p.u. as transient overload for 10 min and 1.5 p.u continuous. Refer to Project Change Notices PCN-015 and PCN-016 (Labrador to Newfoundland HVdc Link Overload Capacity for Submarine Cable).

Based on preliminary calculations, it was estimated that the cables for overload base case would be well within the limits of previously constructed and installed HVDC cables. However, the overload optional case would likely dictate a cable with conductor size among the largest, if not the largest, MI cable ever constructed having a high capacity for continuous power.

Following further design and progression of Gateway Phase 3 deliverables, a switching case has been developed for the cables in the SOBI. As a result, the base case cables, having continuous rating of 1286 A at 350 kV, with capacity for 5 minute transient overload at 2572 A has been the focus of the latest work through the contractual process (i.e. optional case was dropped). This cable design is well within the bounds of previous MI designs, and, satisfies the Phase 2 estimates previously provided at DG2. (Refer to Project Change Notice PCN-015 Newfoundland to Labrador HVdc Link Operating Voltage Increase from 320kV to 350kV).

The CCE assumes Fiber Optic (FO) for DTS strands will be incorporated into the HVDC cable system design. These fibers can be embedded within the cables.

The envisaged installation process is initiated by the transpooling of the cables onto a Cable Installation Vessel (CIV) from the manufacturing plant and transiting to the installation site. Submarine cable installation will commence subsequent to the completion of critical path onshore activities:

- Transition Compound construction
- Cable HDD conduit completion
- Land cable trench construction
- Land cable installation
- Land cable termination in Transition Compounds

To ensure streamlined pre-commissioning of the complete cable system, the land cables will be installed prior to the submarine cable installation campaign. The land cables will be shipped by a vessel to a suitable offloading marine terminal and subsequently transported on heavy or oversized road transportable reels. Once on site, the land cable will be offloaded and mounted in a spooling system. The land cable will be installed in the prepared land trench and whether the cable is pulled from or to the conduit exits will be finalized post cable contract award. There may be a requirement for a land cable to land cable joint. This requirement is dependent upon the final location of the TC's, the road transportable reel capacity and the diameter of the land cable. This would also force the requirement for an additional jointing bay along the land cable route. The land cable will be installed through the allotted locations at the base of the TC for termination. The completed land cable installation and termination will allow for the submarine system to be tested through to the termination once the transition joint between submarine and land cable is completed.

The current submarine installation philosophy consists of the installation of three (3) HVDC submarine cables in one continuous length from a CIV. The DG2 Conceptual Design Report indicates that the primary installation solution will include a joint; conversely, the cable installation proposals have all indicated no submarine cable joint as their primary solution with a modified second end pull in. The second end pull in would consist of floating the second end conduit pull in cable length with a secondary handling support setup (vessel, barge, secondary tensioning equipment onboard the CIV) to establish the proper catenary for the pull in. During detailed design the installation will be analyzed in depth to ensure an acceptable level of risk. The submarine joint method remains as a contingency.

Cable lay initiation would consist of the abandonment of the cable first end (capped by a pulling head) at the location of the first bore hole on either side of the SOBI. A messenger line from a high powered winch located onshore will be passed through the HDD conduit to the conduit exit on the seafloor. A ROV will be utilized to secure the pulling head to the prepared winch line and the vessel will pay out as the winch hauls the cable through the bore hole. Once the cable is secured onshore, the CIV will perform normal lay to the second pull-in as noted.

This operation would be repeated for the following two cables. Once the initial cable is installed a transition joint from submarine cable to land cable will be completed. Following the transition joint the cable will be tested and the protection campaign may commence. The current schedule ensures that there is adequate float so that protection and installation campaigns will not conflict unless there are unforeseen delays.

Spare equipment will be offloaded at a local storage port following installation during demobilization. The repair jointing method is detailed in the DG2 Conceptual Design Report [1] and explicitly defines the requirement for spare cable, lifting heads, and other ancillary equipment.

As noted, due to the competitive market for cable supply and installation, the bid process was initiated during 2011 and bids were received during Q4 2011. The strategy for the cable supply and install contract is to receive a lump sum price for the contract in its entirety. The cable installation season is currently envisaged to commence in Q2 2016, followed immediately by pre-commissioning of the cable system.

28.5.3 <u>Price Basis</u>

The cable supply and install portion of the cost estimate was generated by Nalcor and verified by information included in the cable supply and install proposal packages. The proposal costs have been normalized to ensure an all-inclusive estimate for the cable supply and install scope.

The DG3 CCE estimated cost for submarine cable supply is $690 CDN equivalent per meter, while the working day rate for the installation vessel is assumed to be $225,000 CDN per day.

The DG3 CCE also includes 3000m of spare submarine cable supply that will be stored on a supply carrousel from the cable supplier.

The DG3 CCE includes a separate fibre-optic line for communications (reference DAN-0011 Telecom Fiber Optic Across Strait Allowance) in the event that Nalcor are not successful in negotiating with the cable suppliers to supply and guarantee embedded fibre within the submarine cable.

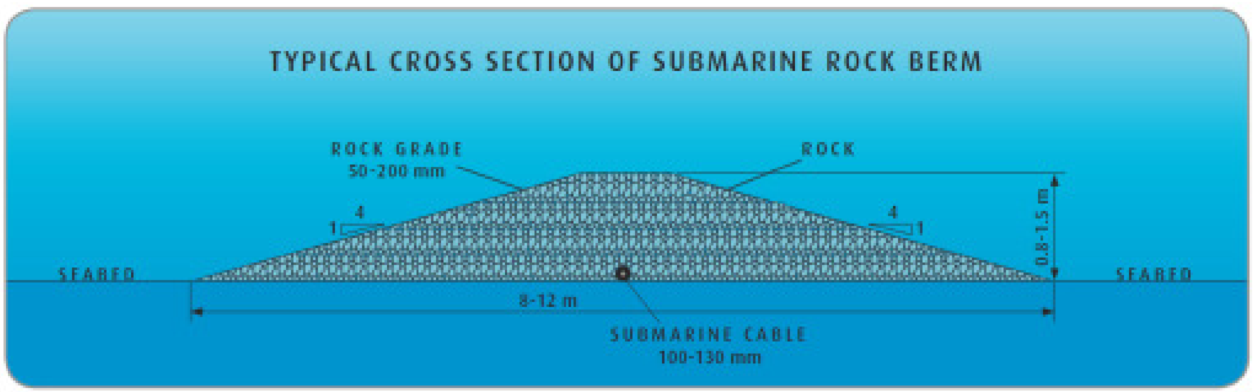
28.6 Seabed Protection

28.6.1 Engineering Assumptions

The primary method of protection of the cable on the seafloor is by means of constructing a rock berm over the cables – Subsea Rock Installation (SCI). This berm will provide on bottom stability for the cable and will provide protection from fishing activities, dropped objects and other external aggression. The preliminary design that was established in DG2 Conceptual Design Report remains unchanged.

The total estimated volume of rock protection is approximately 900,000 MT.

Figure 28-3: SOBI Submarine Cable Rock Berm



28.6.2 Construction and Contracting Approach

The CCE assumes that the SRI scope will be completed as a standalone contract and will be managed by the Nalcor with the contract being primarily based on cost per unit tonnage installed with the mobilization and demobilization being lump sum. Nalcor requests optional inclusion of a marine terminal and loading facility within the proposal.

28.6.3 Price Basis

The SRI portion of the estimate was based on the same assumptions provided within the DG2 Conceptual Design Report which was based on feasibility studies and previous east coast SRI works. This approach and cost was confirmed in discussion with one of the global SRI contractors in Q4 2011, and verified by information supplied through the cable and installation proposals for pre-leveling and the since removed SRI management by the cable vendors strategy.

Total cost per tonne of rock laid is estimated at $80 CDN / MT, which have been determined from feasibility study and verified in the Cable Supply / Install bid packages.

Part H: System Upgrades – Island Interconnected Transmission System

29.0 System Upgrades – Island Interconnected Transmission System

29.1 Overview of Scope

In December 2011 SLI completed studies with respect to the existing ±350 kV HVdc system between Muskrat Falls and Soldiers Pond. The document Stability Studies, reference no. LCP-SN-CD-8000-EL-RP-0001-01 incorporates the following Island Interconnected Transmission System additions:

- Conversion of Holyrood units to synchronous condenser capability; and
- Three (3) 150 MVAR high inertia synchronous condensers at Soldiers Pond (reference Section 26.9 for details).

In addition the following circuit breaker replacements were required:

- Bay d'Espoir 230 kV (1);
- Holyrood 230 kV (9); and
- Hardwoods 66 kV (4).

The study assumed the new 230 kV transmission line between Bay d'Espoir and Western Avalon had been completed. The cost of this transmission line cost is not carried in the upgrade requirements due to the Labrador Island HVdc Transmission Link as the cost is common to both the Isolated and Interconnected Island Alternatives.

In addition that scope identified in the document Stability Studies, reference no. LCP-SN-CD-8000-EL-RP-0001-01, upgrades the Energy Control Centre were identified and are discussed here-in.

The following sub-sections provide a detailed description of these system upgrades, excluding the new synchronous condenser facility at Soldier's Pond which is discussed in Part E. Complete details for the budget estimate are contained in the Back-up Material of Decision Gate 3 Capital Cost Estimate, reference no. LCP-PT-ED-0000-EP-ES-0002-01.

Attachment B.4 presents a Technical Note explaining the evolution of this scope, including the CCE basis.

29.2 Holyrood Conversion to Synchronous Condenser Support

Nalcor engaged AMEC to provide some engineering assistance in completing a high-level investigation into the scope and costs related to Holyrood Thermal Generation Station (TGS). AMEC has had significant involvement with other work at Holyrood in recent years, including various life extension studies, thus has an excellent overall knowledge of the facility. The premise is that the work would be a high level study, including a Class 5 cost estimate of the scope of changes required.

Phase 1 - Initial Re-purposing Modifications period: 2016 to 2020
In Phase 1, the station is modified by the end of 2016 to be able to operate as either a three (3) unit electricity generation facility or as a three (3) unit synchronous condenser facility. All new installations and modifications are to be complete by the end of 2016 so the plant can operate as either a synchronous condensing (SC) station or thermal generating station from the end of 2016 to the end of 2020 with quick change over capability from one mode of operation to the other.

HTGS Phase 2 - Optimized Re-purposing Modifications and Preservation: 2021 and Beyond
In Phase 2, the station is further modified so that the facility is available only as a three (3) unit synchronous condensing facility. It is expected that two (2) of the three (3) units would be operational in synchronous condensing mode at all times. This is required to provide the system with MVARS required to maintain overall voltage and stability for the Island grid.

AMEC draft study (dated 17-March-2012) concluded that the conversion could occur, however would require a number of modifications which they were able to quantify via a Class 5 estimate. The AMEC estimate, exclusive of the AMEC recommended contingency is included in this CCE. Estimate contingency for this scope has been defined as part of the broader contingency setting process.

Reference report "Holyrood Thermal Generating Station (Holyrood) - Synchronous Condenser Assessment Study" for further details.

29.3 Energy Control Centre Upgrades

The development of LCP Phase I includes the construction and/or modification of twenty sites which will require control and monitoring from the existing Energy Control Centre (ECC) which is located in St. John's and the Backup Control Centre (BCC) which is located in Holyrood.

Nalcor Project Execution and Technical Services (PETS) completed an investigation of the required scope of work and associated costs required to complete modifications to the Energy Control Centre, the Energy Management System (EMS) and other systems located within the ECC and BCC. It should be noted that this estimate is currently a "near Class 3" estimate with costs included to provide a Class 3 estimate at a later date. The estimate has developed by PETS was included in the CCE.

The estimate for this scope was split into three (3) different sections:

- upgrades to existing functionality,
- new requirements, and
- documentation requirements.

It should be noted that this estimate does not include the equipment or labour necessary to interface temporary construction facilities into the EMS system. Also, all SCADA and communications equipment required to transmit the data from the ECC and BCC to each of the sites are not included in this estimate. Most importantly, it assumes that the existing OSI Monarch EMS system will still be in service, will be suitable for these upgrades and will be used to monitor and control all necessary points. It also assumes that the LCP and associated modifications at the Energy Control Centre and Backup Control Centre will respect all applicable NERC and NPCC reliability standards. Although this statement does not mean that Nalcor will be seeking registration, it does mean that the new EMS infrastructure will be designed to reflect the requirements of NERC/NPCC standards as an engineering best practice.

In addition to the items listed above it should also be noted that this estimate does not include the implementation of a Special Protection System (SPS) which has been deemed to be required after the two HVdc links have been placed in service. A SPS is an extremely fast electrical protection system that takes automatic measures to prevent the collapse of the entire electrical system after severe electrical faults are experienced. Due to the criticality and speed requirements of this system, it is not feasible to implement the SPS as part of the existing EMS system, which polls at a minimum of two seconds. As a result, this estimate does not include the implementation of the SPS.

Reference report "Capital Cost Estimate Report Energy Control Centre Upgrades Requirement for Development of the Lower Churchill Project" for further details.

29.4 Breaker Replacements

The scope and cost estimates for the Breaker Replacements remains intact since the Decision Gate 2 CCE, specifically:

- Bay d'Espoir 230 kV (1);
- Holyrood 230 kV (9); and
- Hardwoods 66 kV (4).

No further information is available at the time of the DG3 CCE development.

A.0 Activity Flowchart (Excel Format)

A.1. N/A

B.0 Attachments/Appendices

B.1 Muskrat Falls Generation Build Sequence

B.2 HVac and HVdc Transmission Build Sequence

B.3 Construction Fleet Rates used in the CCE

B.4 Technical Note: System Upgrades – Island Interconnected Transmission System

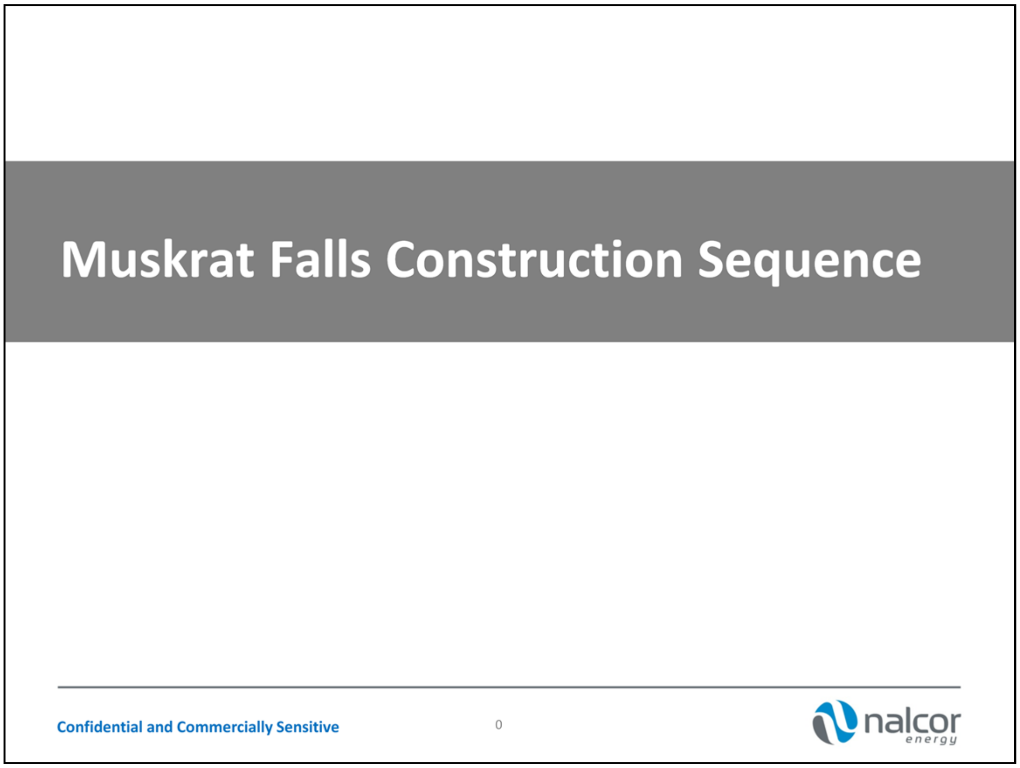
B.5 Key Plan of Cofferdams and Dams

B.6 Manpower Loading for Soils and Concrete Laboratory Scope

B.7 Manpower Loading for Survey Services Scope

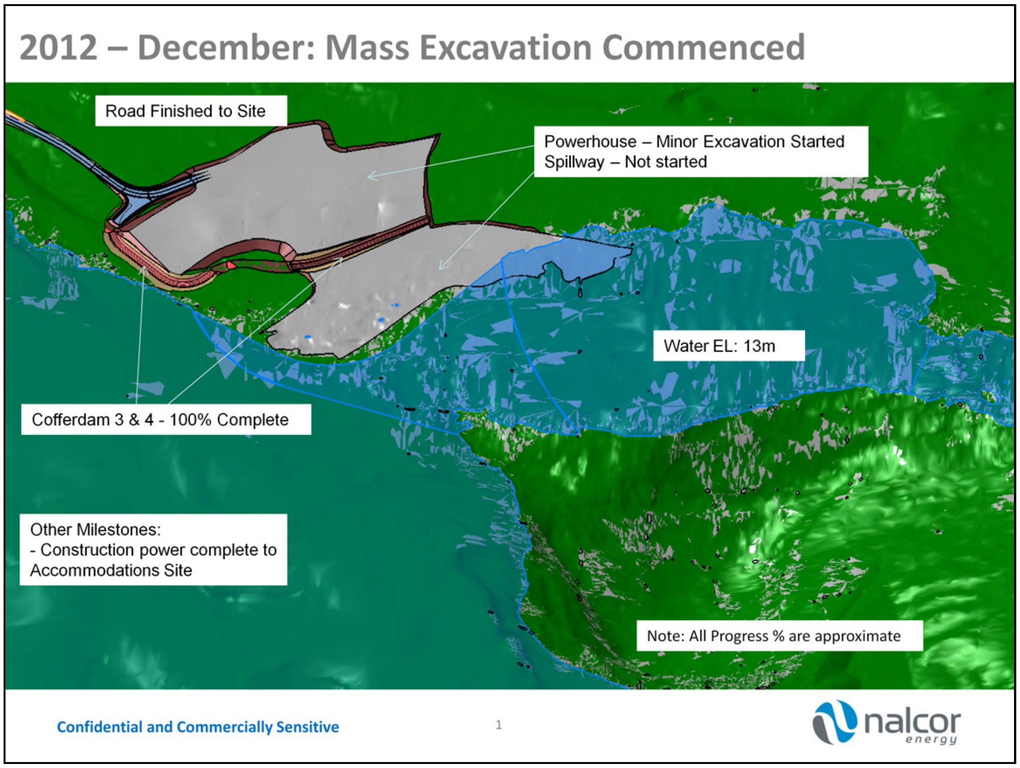
Attachment B.1

Muskrat Falls Generation Build Sequence



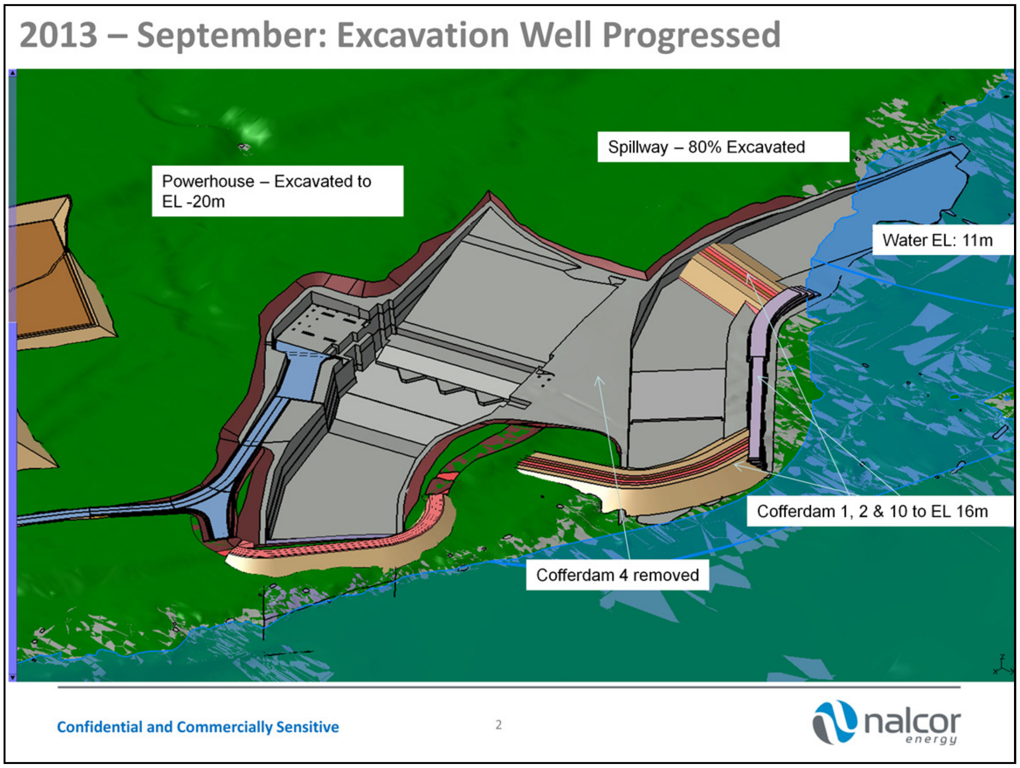
The following build sequence is a series of extracts from the 3D computer design tool that has been built by SNC-Lavalin called CATIA. This computer tool allows the designers to visualize the dam, powerhouse and other structures and develop drawings for use by the construction contractors.

The build sequence steps you through the each year of the construction and highlights critical activities.



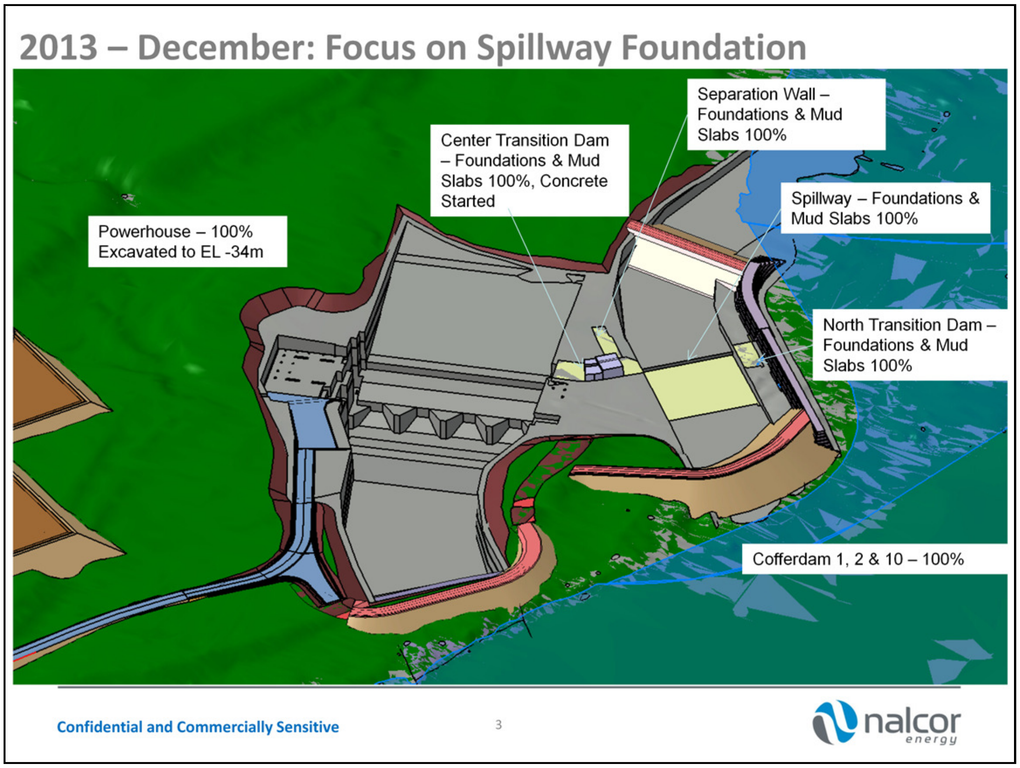
This slide is a view of the south side of the river looking downstream from the upper Muskrat falls. The light blue area shows the flooded area after the dam is complete, the green is the land.

Key milestones for the end of 2012 is to have the road complete to the falls area so bulk excavation grubbing of organic material at the powerhouse area can be completed prior to the surface freezing. Also Cofferdams 3&4 will be built to protect excavation area from river flood water levels.



This is a view of the south side of the river looking upstream at the lower Muskrat Falls.

Early 2013 Cofferdams 1 & 2 will be completed, while the riverside RCC (Roller Compacted Concrete) dam #10 will be complete by October 2013 to protect the powerhouse/spillway area for excavation. During late summer/ fall 2013 the main civil contractor will be mobilizing and setting up a concrete batch plant in preparation to move into the area once bulk excavation is complete. So by September of 2013 the powerhouse will be excavated down 20m with the spillway excavation at 80% with the cofferdams in place to protect the construction work during winter

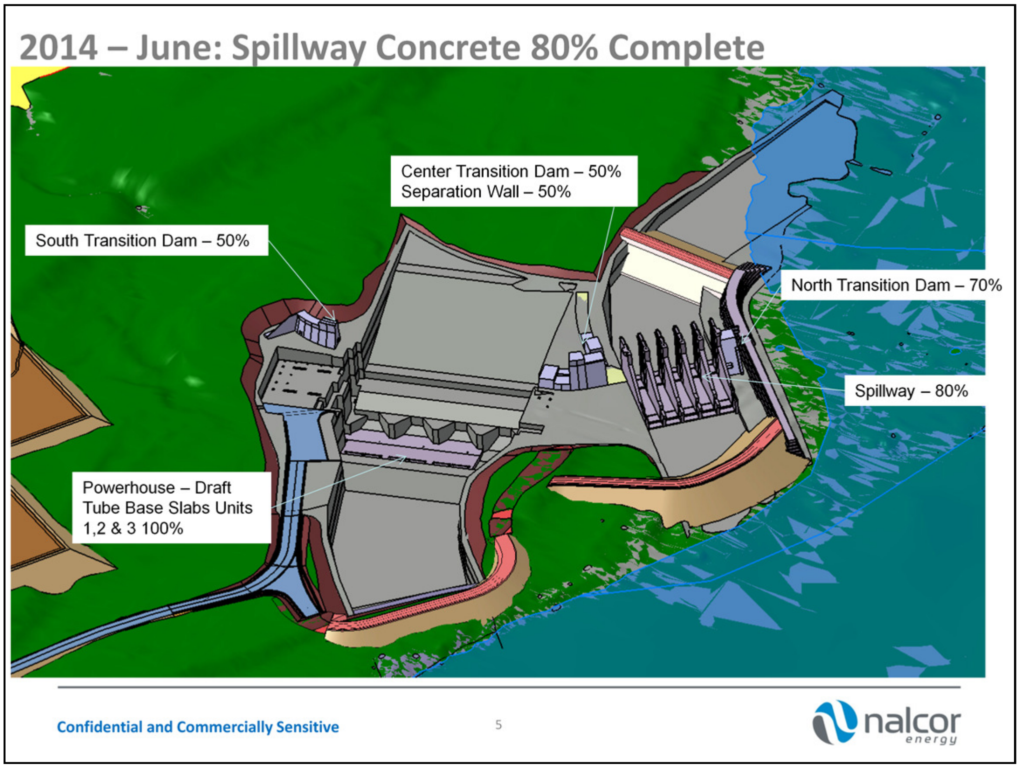


This is another view of the south side of the river looking upstream at the lower Muskrat falls

By the end of December 2013 the powerhouse will be excavated fully and the necessary foundations and mud slabs complete ready for the next phase of construction. Essentially, by the end of 2013 bulk excavation works will be complete and the civil contractor will have started pouring the foundations for the key spillway structures required for river diversion in 2015.

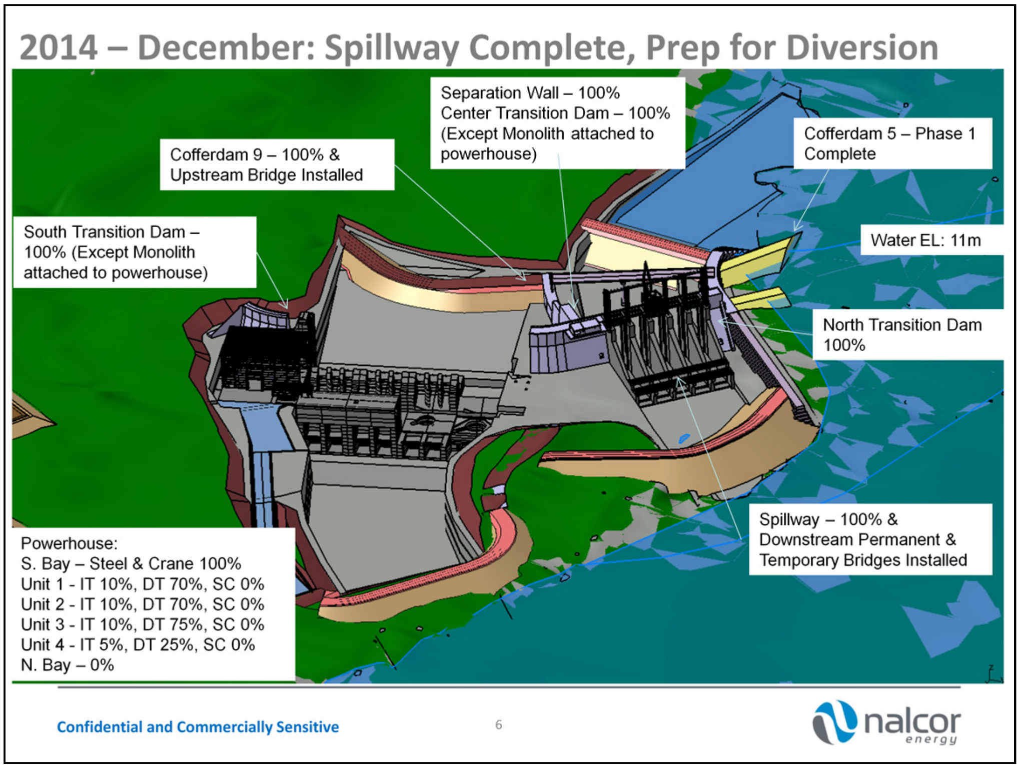
2013 – December: North Spur Stabilization Works Started

This is a view of the North side of the river at the North Spur. Because of previous land slips it is necessary to stabilize the North spur. This shows the downstream area being cleared ready for the stabilization works to commence. During Fall 2013 work will begin on the North Spur stabilization works



This is a view of the south side of the river looking upstream at the lower Muskrat falls

Mid 2014 the civil concrete work for the key structures (Spillway, Separation Wall and North & Center Transition Dam) required for river diversion will be more than halfway complete. In the powerhouse the concrete foundations will have been completed.



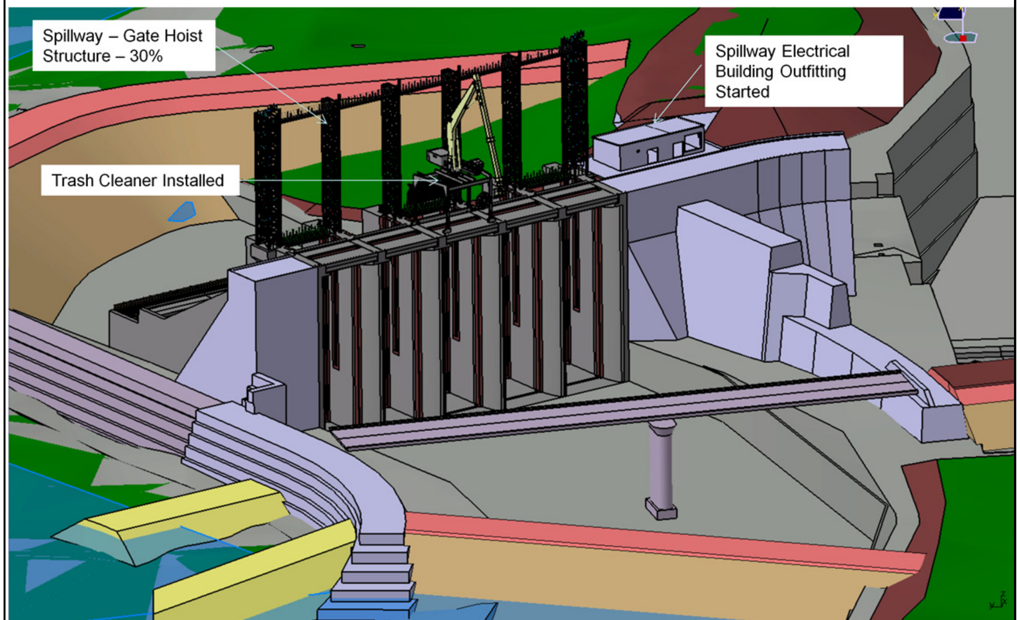
At the end of 2014 all civil concrete work within the spillway area will have been completed , downstream bridges installed and the area handed-over to the Hydro-Mechanical contractor for the installation of the spillway gates.

In the powerhouse during the fall the focus will be on completing the south assembly bay concrete and steel and installing the bridge crane so the turbine & generator (T&G) contractor can start assembly of the units in an enclosed environment. Also during this period the concreting of the units will be progressing from units 1 on the left (south) towards units 4 on the right (north) in the picture to align with the planned turbine installation.

To the south of the powerhouse the South Transition concrete dam will be nearing completion except the part that joins with the powerhouse intake structure.

To start work on the north dam, earlier in the year cofferdam #9 was installed which protects the upstream of the powerhouse and acts as a ramp to a temporary bridge installed on the upstream channel of the spillway. From the end of the bridge material will be deposited for the start of the river closure cofferdam #5.

2014 – December: Trash Rack Cleaner Installed



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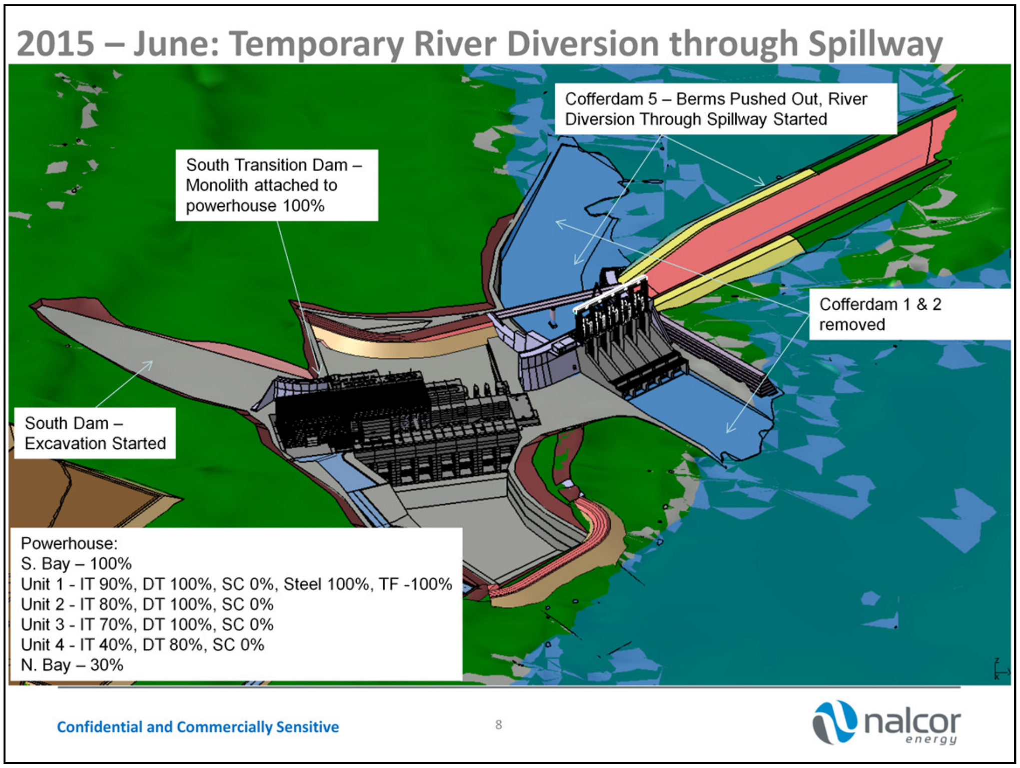
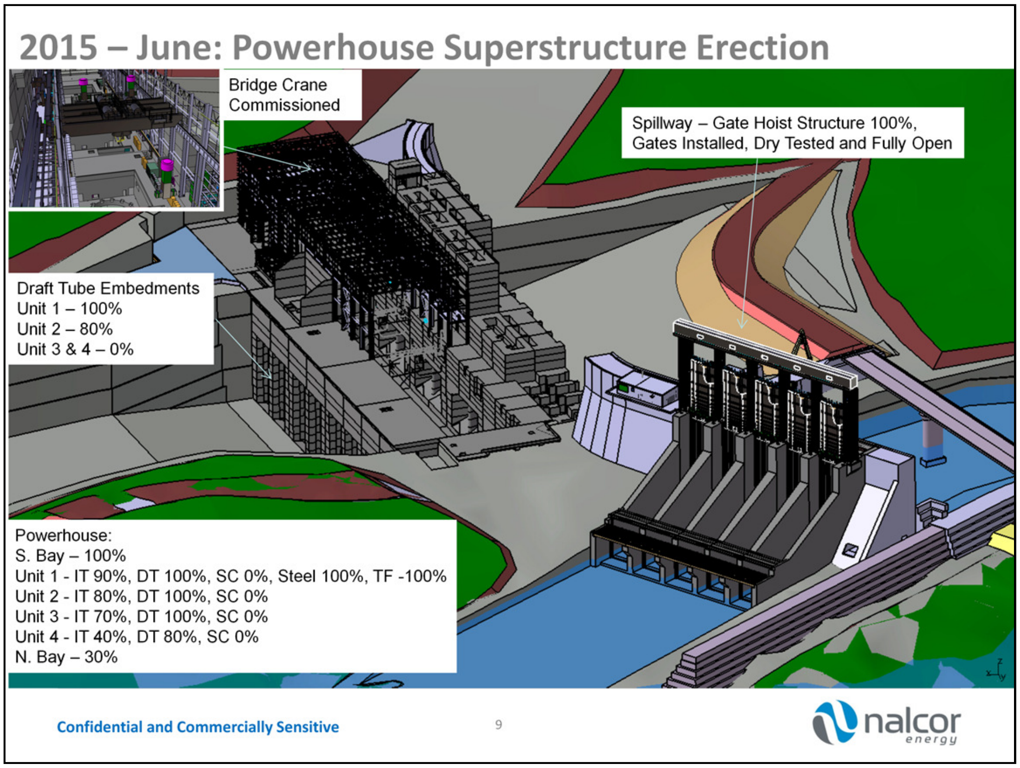
Another shot for Dec 2014 looking downstream at the spillway. The Hydro-Mechanical contractor will be assembling the gate hoist structure, installing the trash cleaning system which also acts as a hoist system for lifting stoplogs and installing control equipment in the spillway electrical building. Also in this picture the 2 “groins” of cofferdam #5 are shown in the bottom left hand corner. Rock groins are used to close off the river and eventually divert the river through the spillway



This is a view when the rock groins have been completed and the associated cofferdam in place to enable the river to be fully diverted through the spillway. The river diversion key project milestone is planned for May 2015 after the spring thaw. Prior to starting diversion the Hydro-Mechanical contractor will have installed and dry-tested all the spillway gates and the civil contractor will have removed cofferdams 1 & 2 protecting the spillway. River diversion through the spillway will start to occur as more and more cofferdam #5 material is deposited in the river – during this time all spillway gates will be fully open.



In the powerhouse during mid 2015 unit 1 will be fully enclosed, bridge crane functioning, primary concreting complete and secondary concreting of T&G components will be starting. Work will also have progressed on the intake structure with unit 1 area nearing completion and tie-in to the South Transition Dam having been completed.

2015 – June: North Spur Ready for Diversion

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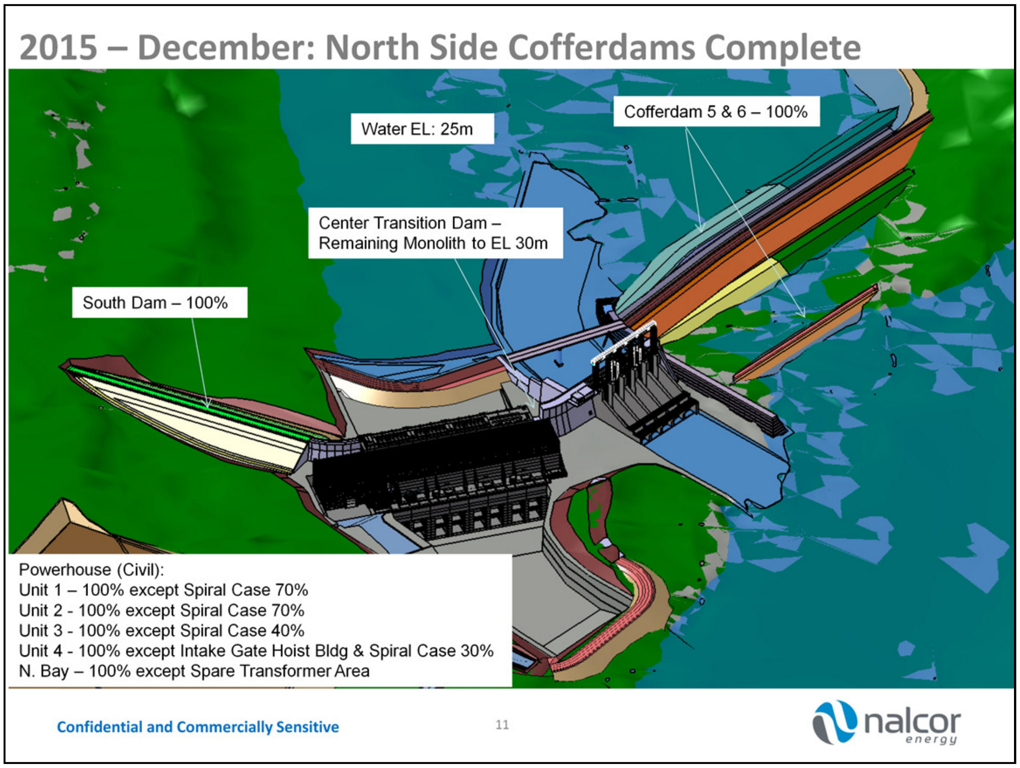
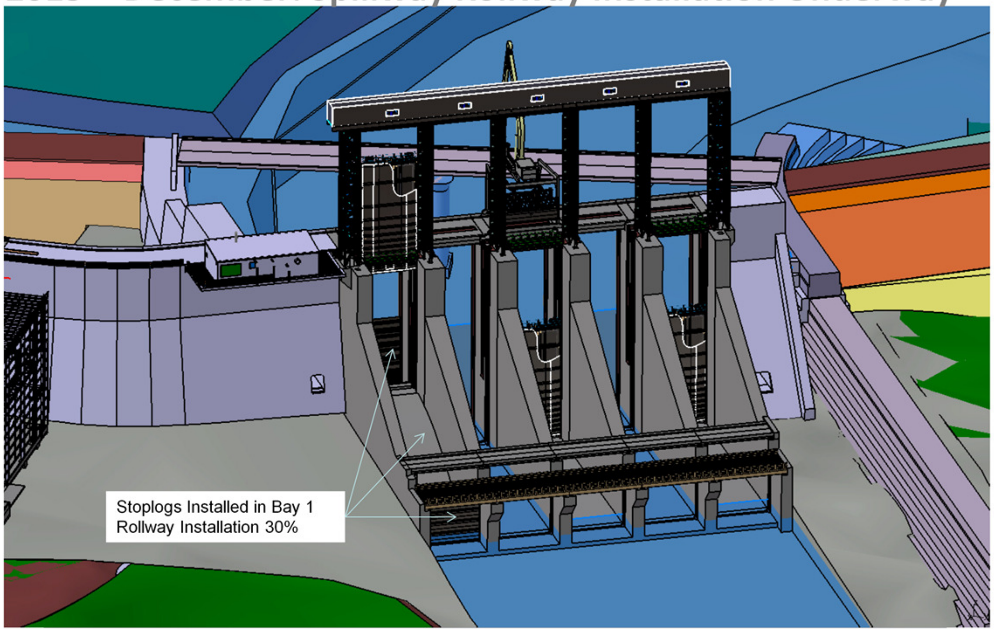
For river diversion to occur the North Spur stabilization works below elevation 27m will require to have been completed.



During the summer 2015 cofferdam #5 will have been completed after which the river flow will be fully diverted through the spillway. The spillway gates will then used to raise the water level from its natural 11m elevation and regulate it at a water level of 25m for the diversion "head pond".

By the end of 2015 cofferdam #6 will be finished to protect the downstream of the North Dam construction area. To the south of the Powerhouse the rock fill South Dam will be complete and the Center Transition Dam piece that ties into the powerhouse will be nearing completion.

2015 – December: Spillway Rollway Installation Underway



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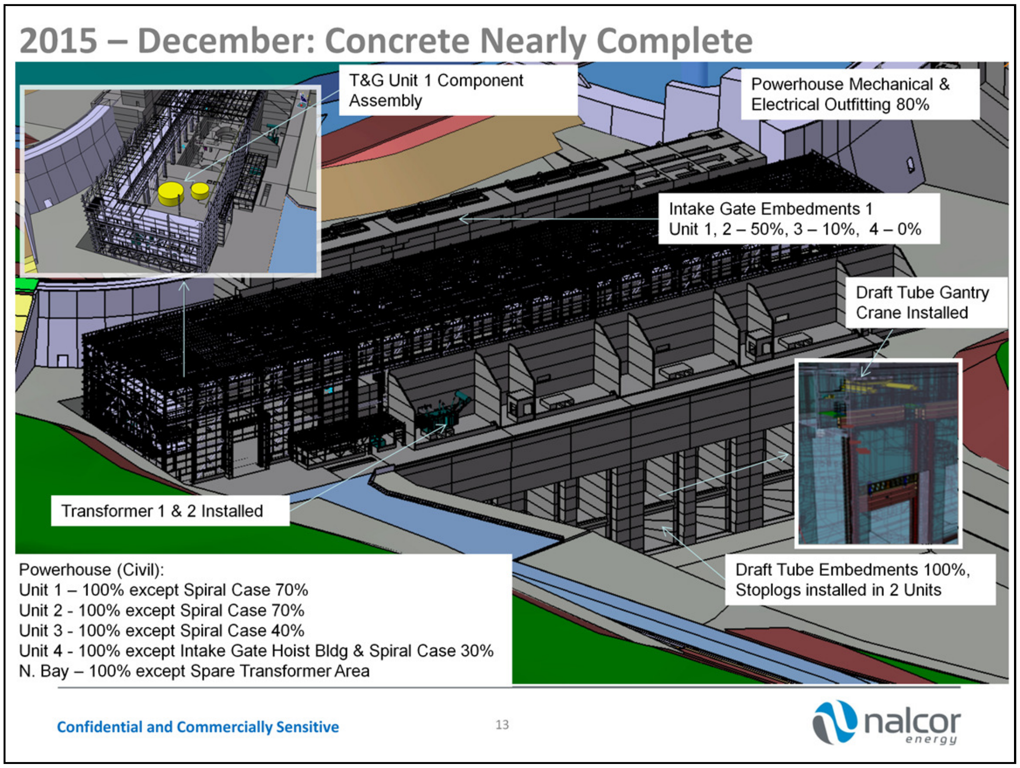
This is a view upstream of the spillway gates with the river fully diverted and flowing through the fully open gates. At the end of 2015 stoplogs will be installed in the spillway bay #1 to protect the area for the concreting of the parabolic rollway. Stoplogs are used to control the water level in the channel and to temporarily block flow through the spillway channel



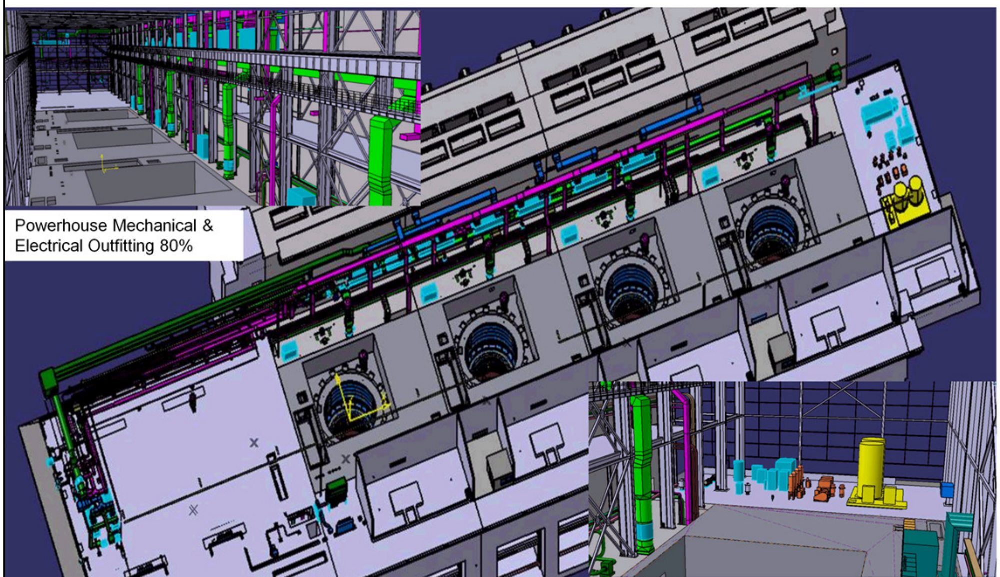
This is a view of the powerhouse looking upstream. At the end of 2015 the powerhouse concreting work will be nearing completion and with some work still remaining on intake gate hoist building and secondary concreting of the Turbine and Generator (T&G) units still on-going.

Turbine and Generator assembly of units 1&2 work will be on-going in the south assembly bay.

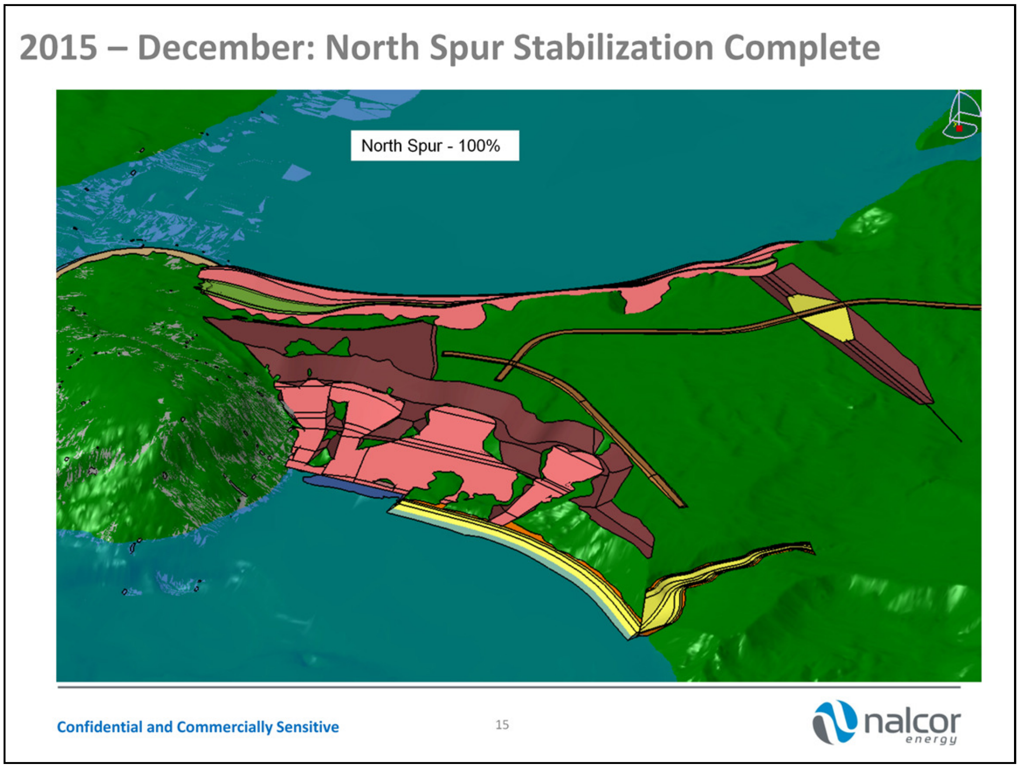
The Hydro-Mechanical contractor will be working on the intake gate infrastructure and have the work in the draft tube area complete and stoplogs installed in two units.

The Powerhouse Mechanical/Electrical contractor will be more than halfway through its outfitting work and 2 transformers will be installed.

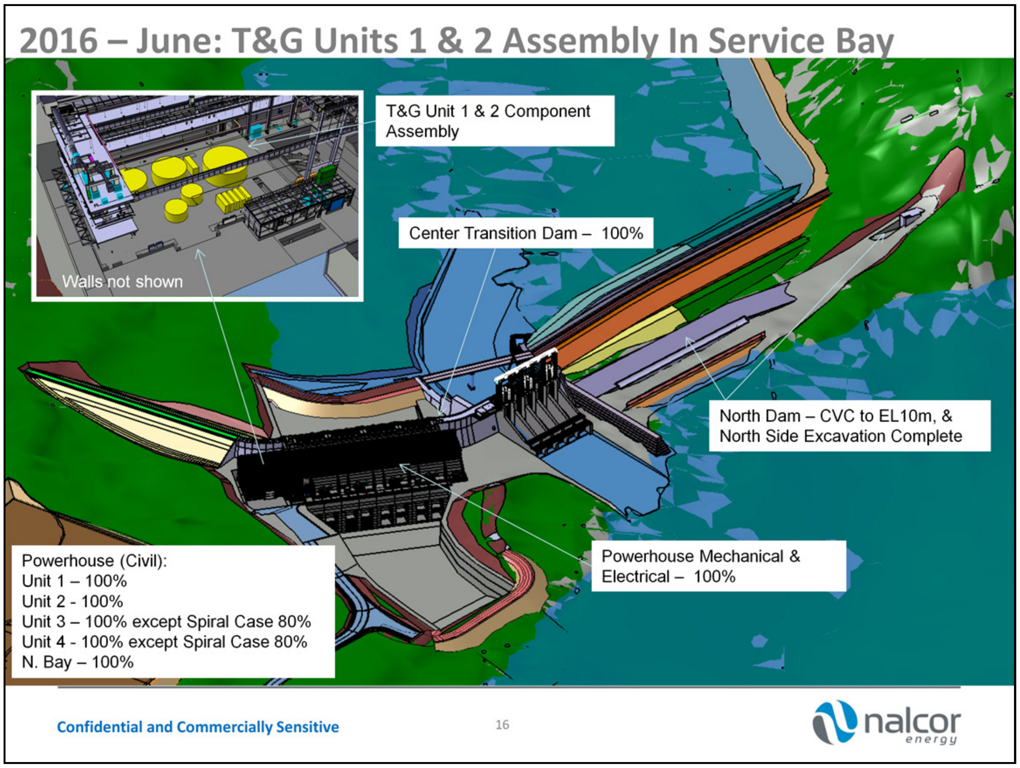
2015 – December: Powerhouse Outfitting 80% Complete



Picture showing the powerhouse mechanical/electrical auxillary infrastructure.

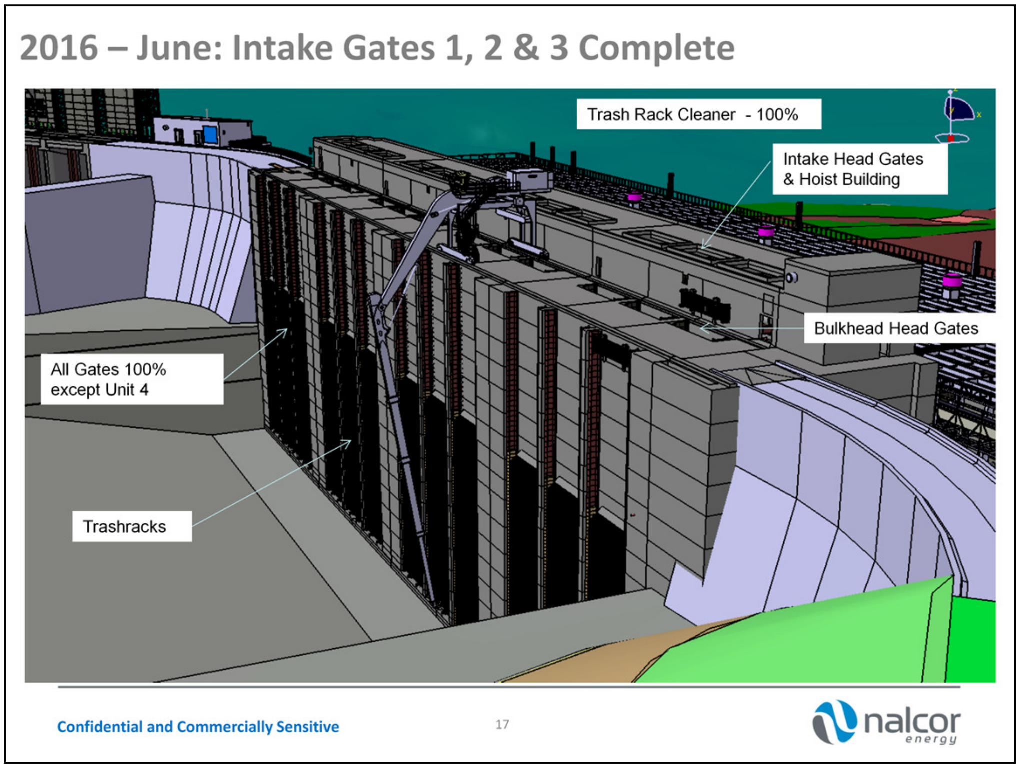


This is a view of the North Spur showing the stabilization work that has been ongoing as work as continued on the powerhouse and dam. The North Spur stabilization work will be completed before end of 2015

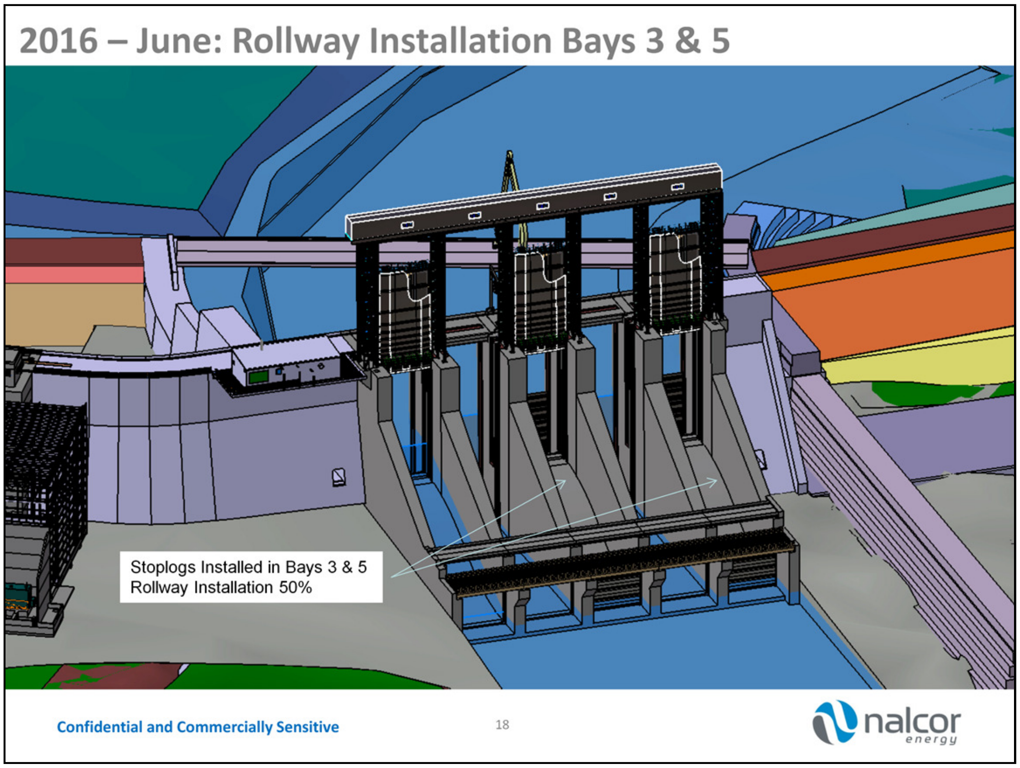


This is a view from the south side looking upstream at the dam. During the summer 2016 the North Roller Compacted Concrete (RCC) Dam will be in-progress.

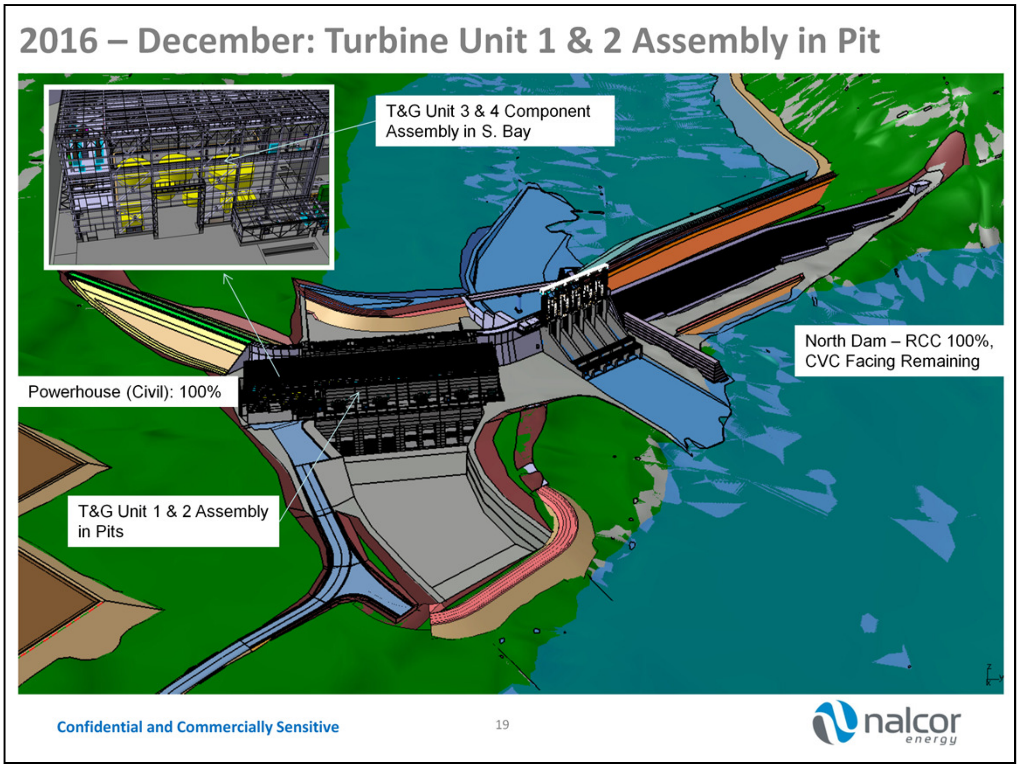
In the powerhouse, units 1 &2 will have achieved pit-free and installation of the turbines in these units will soon start. Secondary concrete of units 3 &4 will be near to completion. The mechanical/Electrical auxillary contractor's work will be finished.



The Hydro-Mechanical contractor during the summer 2016 will be dry-testing the intake gates and commissioning the trash rack cleaner.



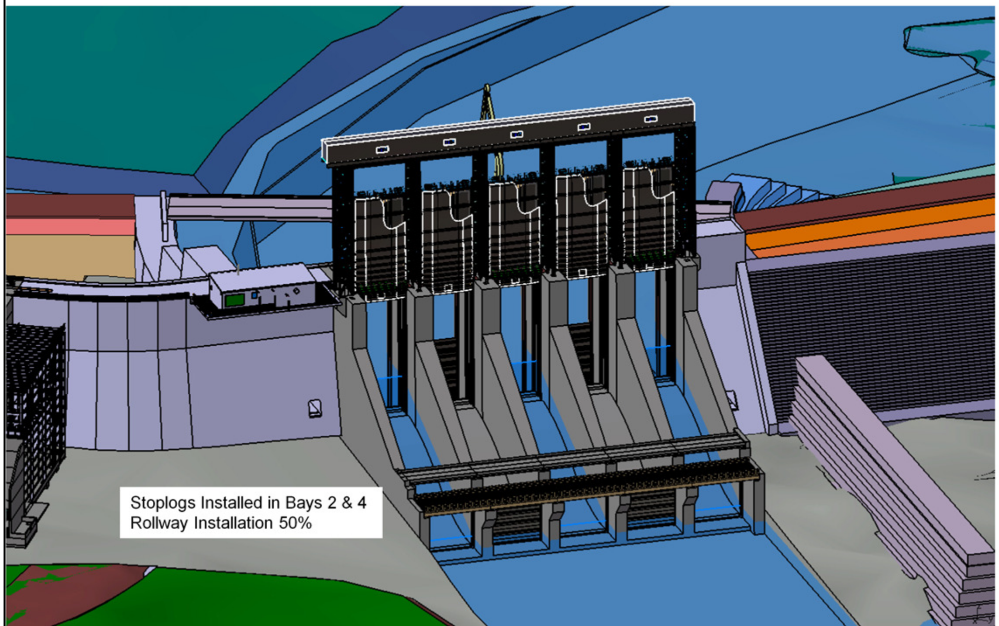
In the spillway stoplogs will be installed in bays 3 & 5 so the civil contractor can complete the rollway construction in those bays



At the end of 2016 the North Dam RCC work will be complete with the CVC downstream facing remaining to be installed.

In the powerhouse all concreting will be finished and T&G assembly work will be ongoing in pits 1 & 2 and while units 3 & 4will be pre-assembled in the south service bay.

2016 – December: Rollway Installation Bays 2 & 4



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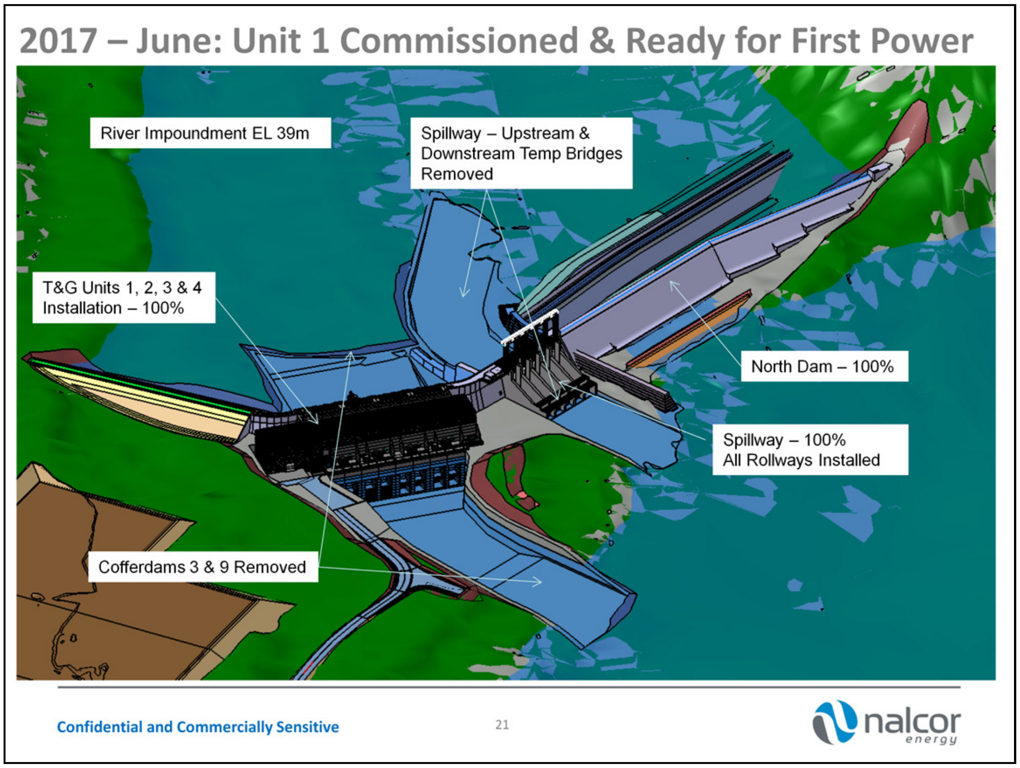
This is a view of the spillway looking upstream During the end of 2016 the final 2 rollways will be installed in spillway bays 2 & 4

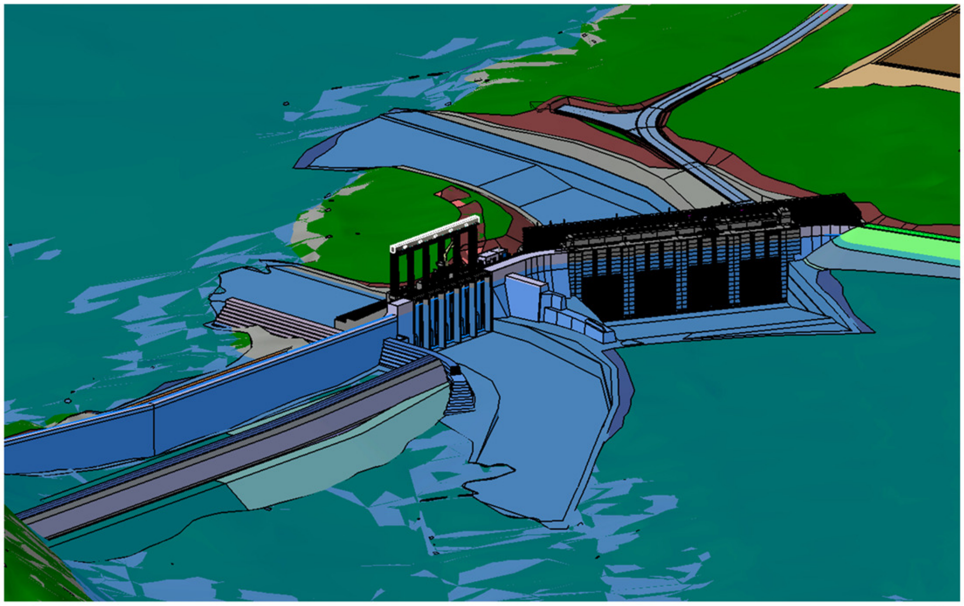


This is a view from the south side looking upstream

\By mid 2017 when all the major civil and hydro-mechanical work is complete, cofferdams 3 & 9 protecting the powerhouse will be removed and once the ice breaks up in the spring the river “impoundment” to elevation 39m will occur by regulating the river flow with the spillway gates. Soon there after water up and commissioning of the T&G units will commence.

Our target schedule is to achieve First Power mid 2017.

2017 – June – First Power Achieved



Attachment B.2

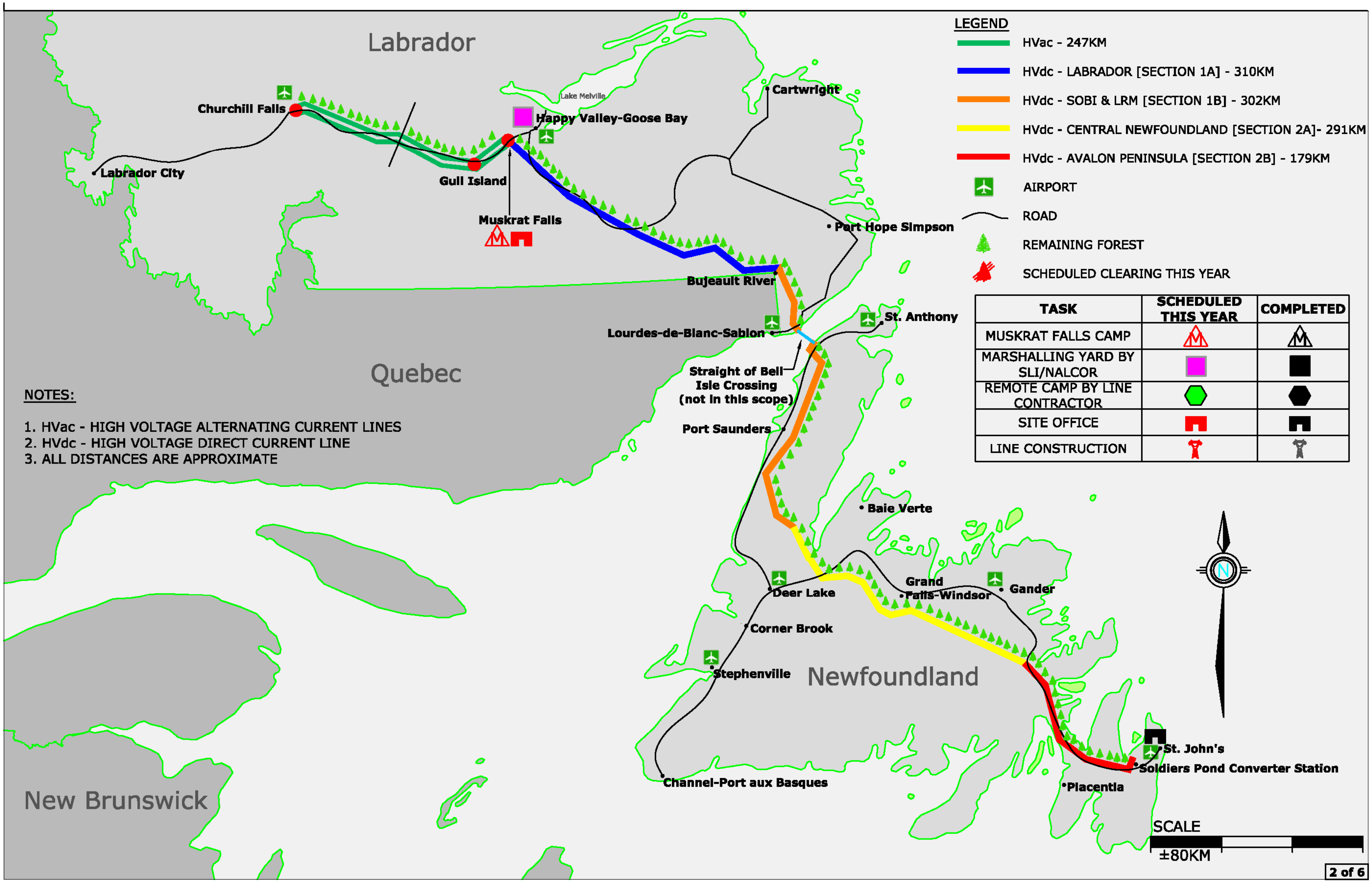
HVac and HVdc Transmission Build Sequence

Attachment B.2:

HVdc and HVac Transmission Construction Sequence

Construction Build Sequence – 2012

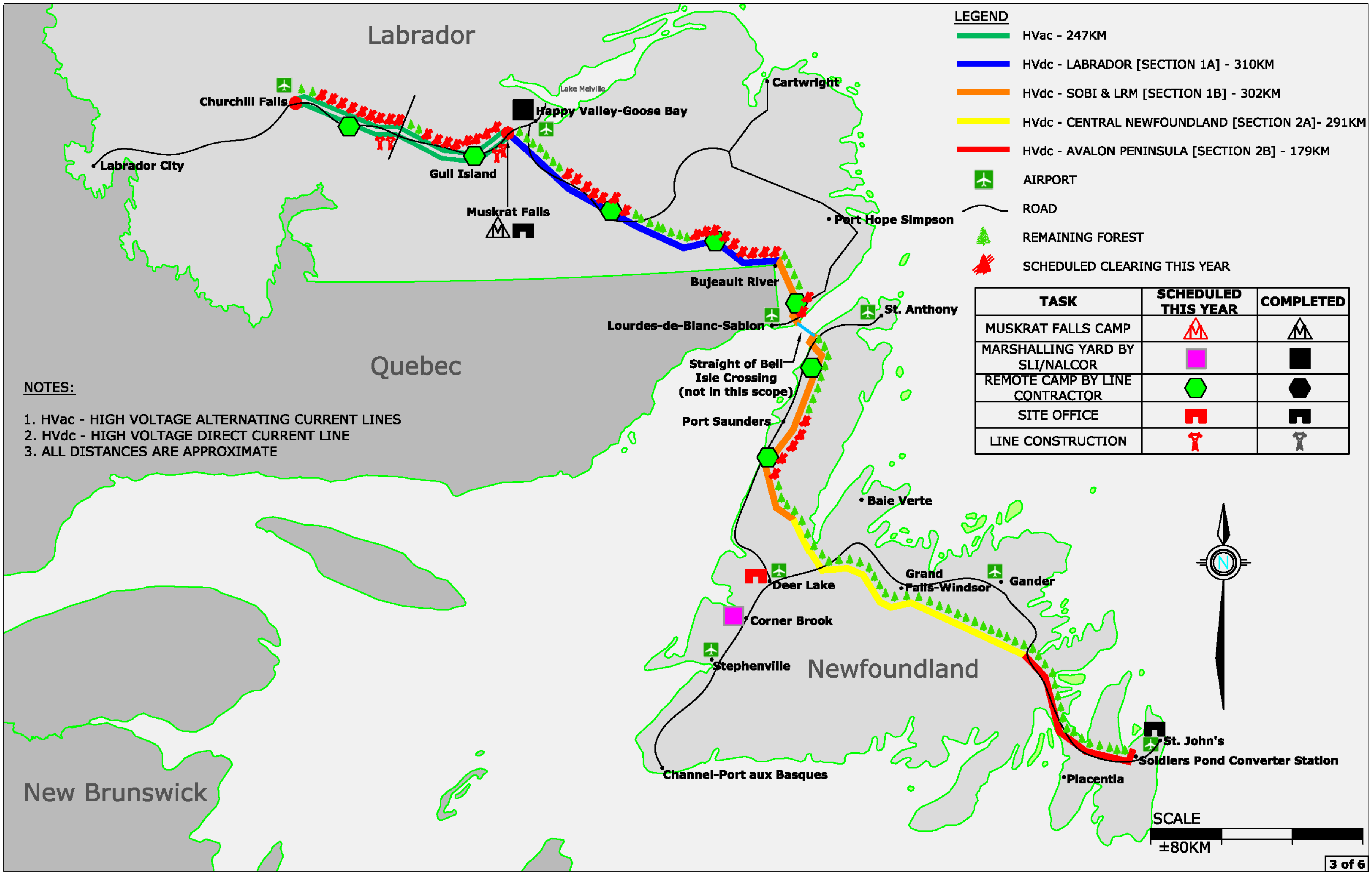
Establish Infrastructure in Labrador



TASK	SCHEDULED THIS YEAR	COMPLETED
MUSKRAT FALLS CAMP		
MARSHALLING YARD BY SLI/NALCOR		
REMOTE CAMP BY LINE CONTRACTOR		
SITE OFFICE		
LINE CONSTRUCTION		

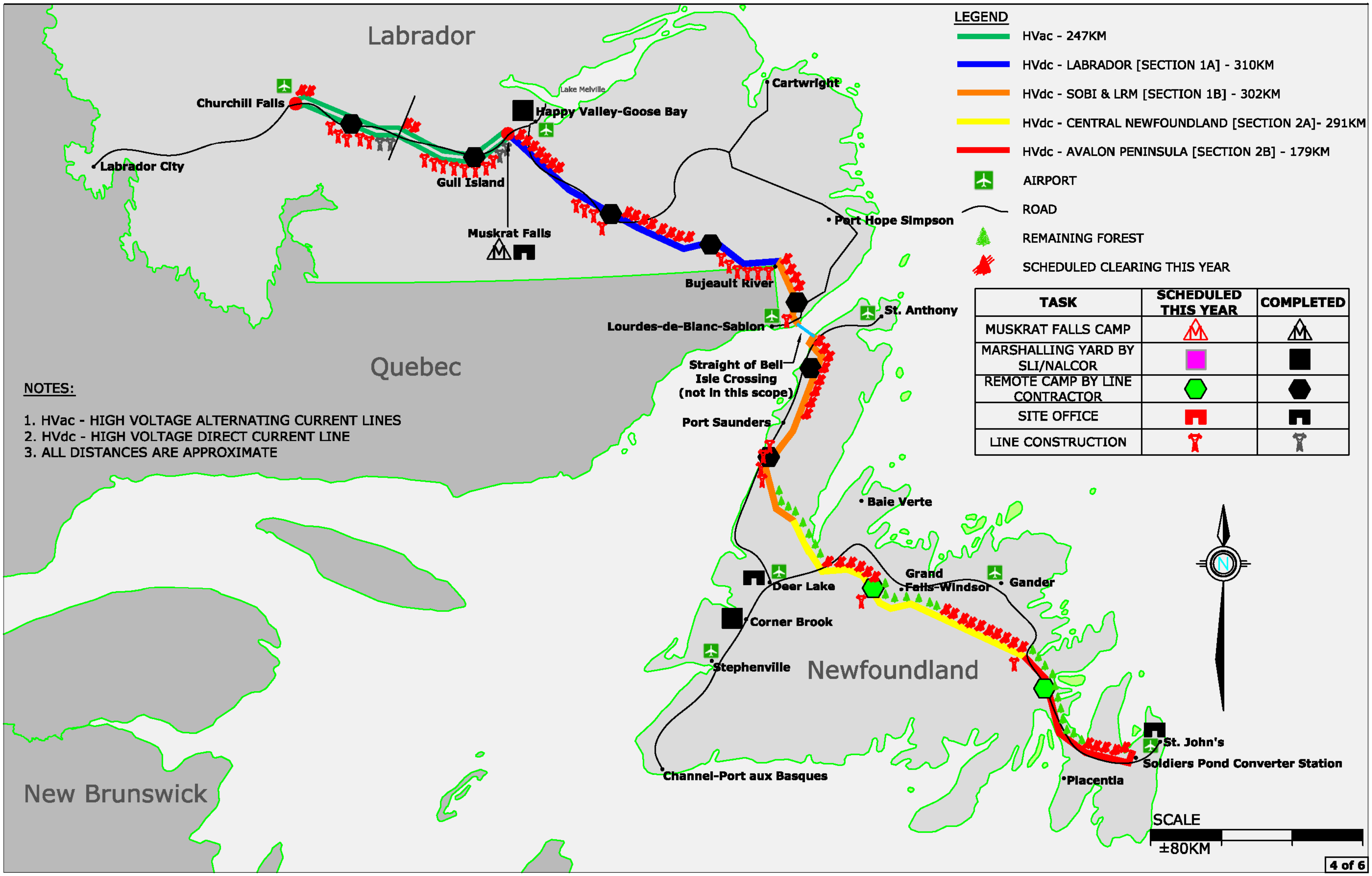
Construction Build Sequence – 2013

HVac ROW Clearing Well Advanced



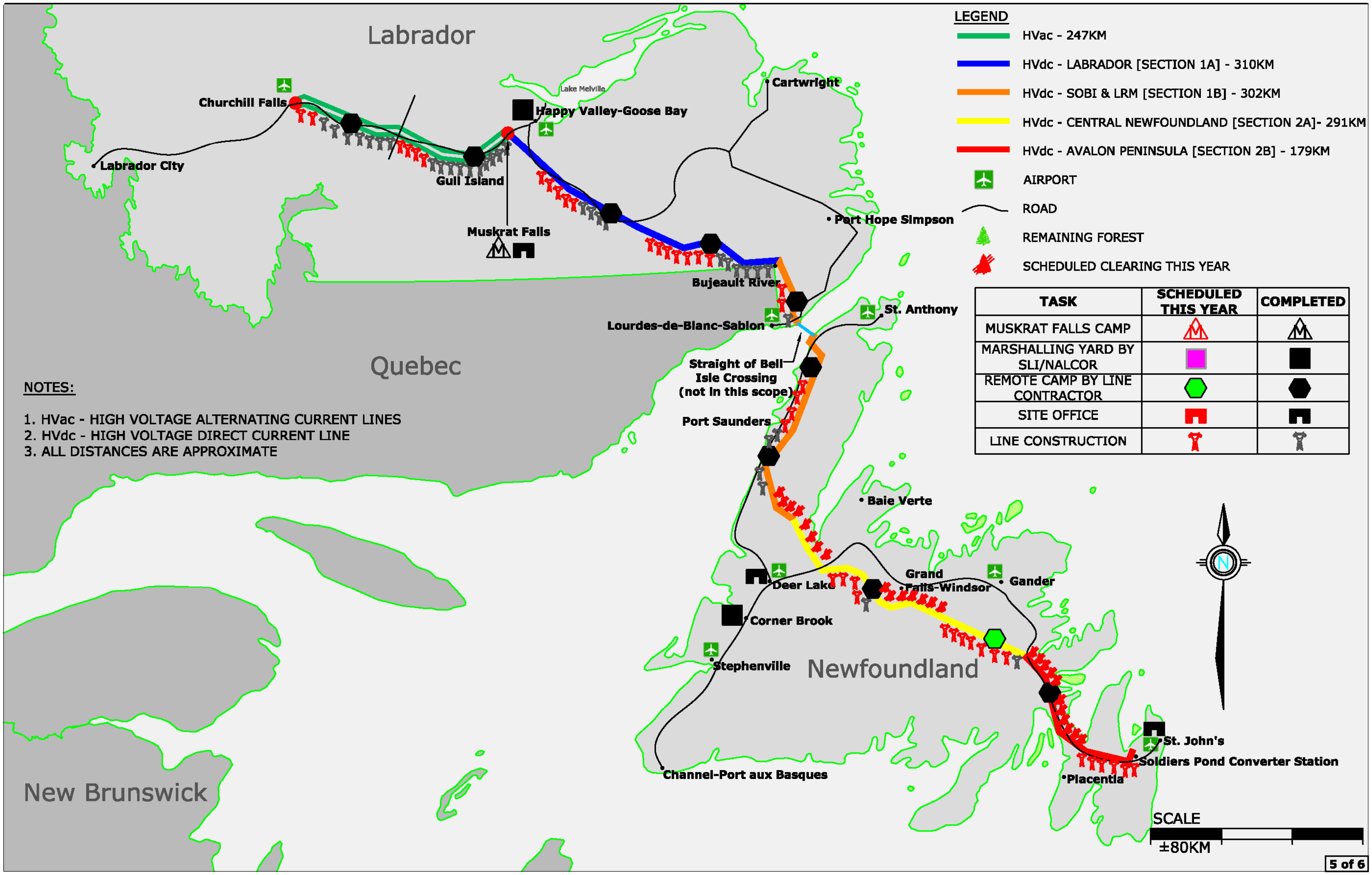
Construction Build Sequence – 2014

Remote Access Get First Priority



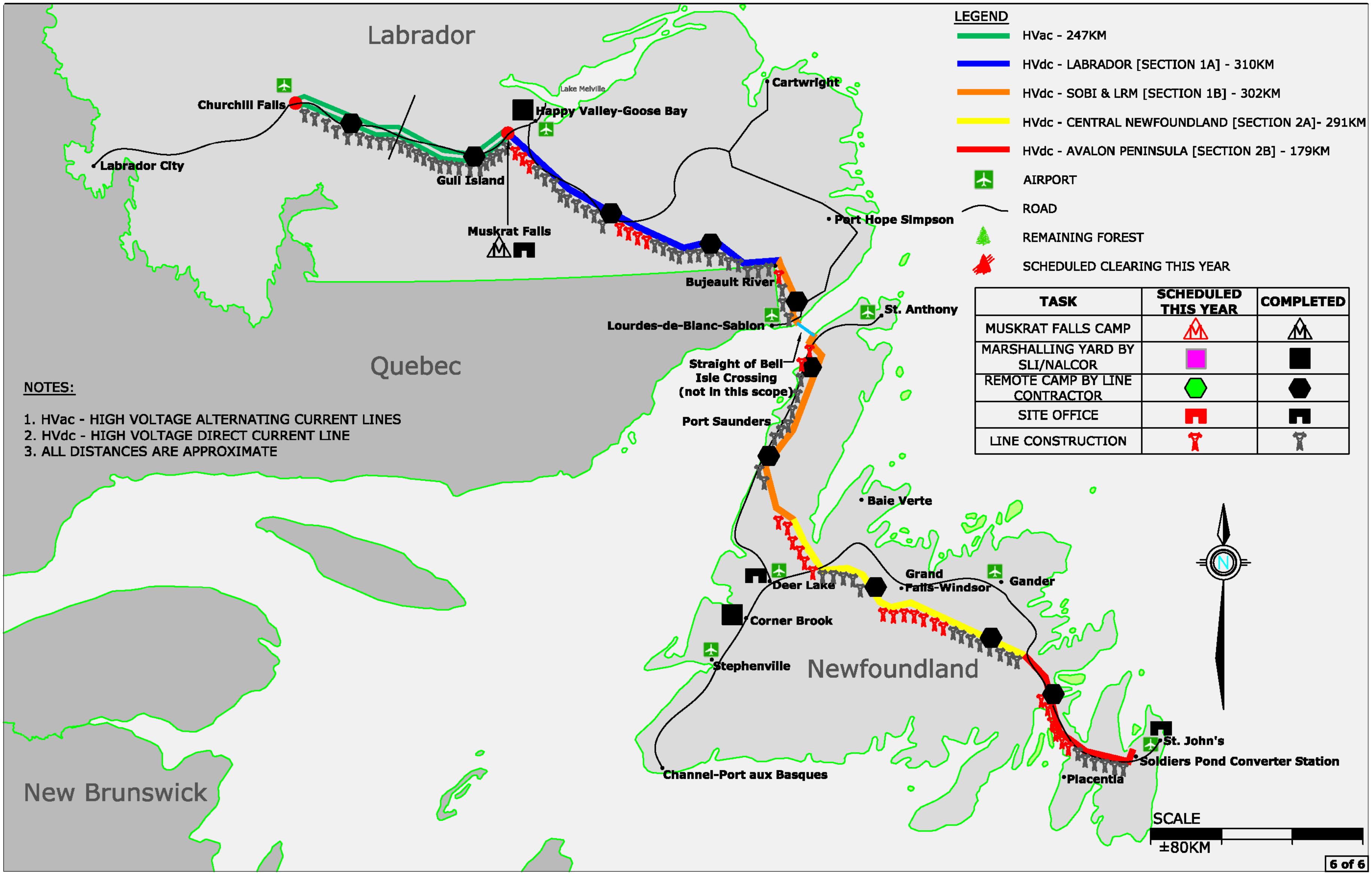
Construction Build Sequence – 2015

HVac Construction is completed

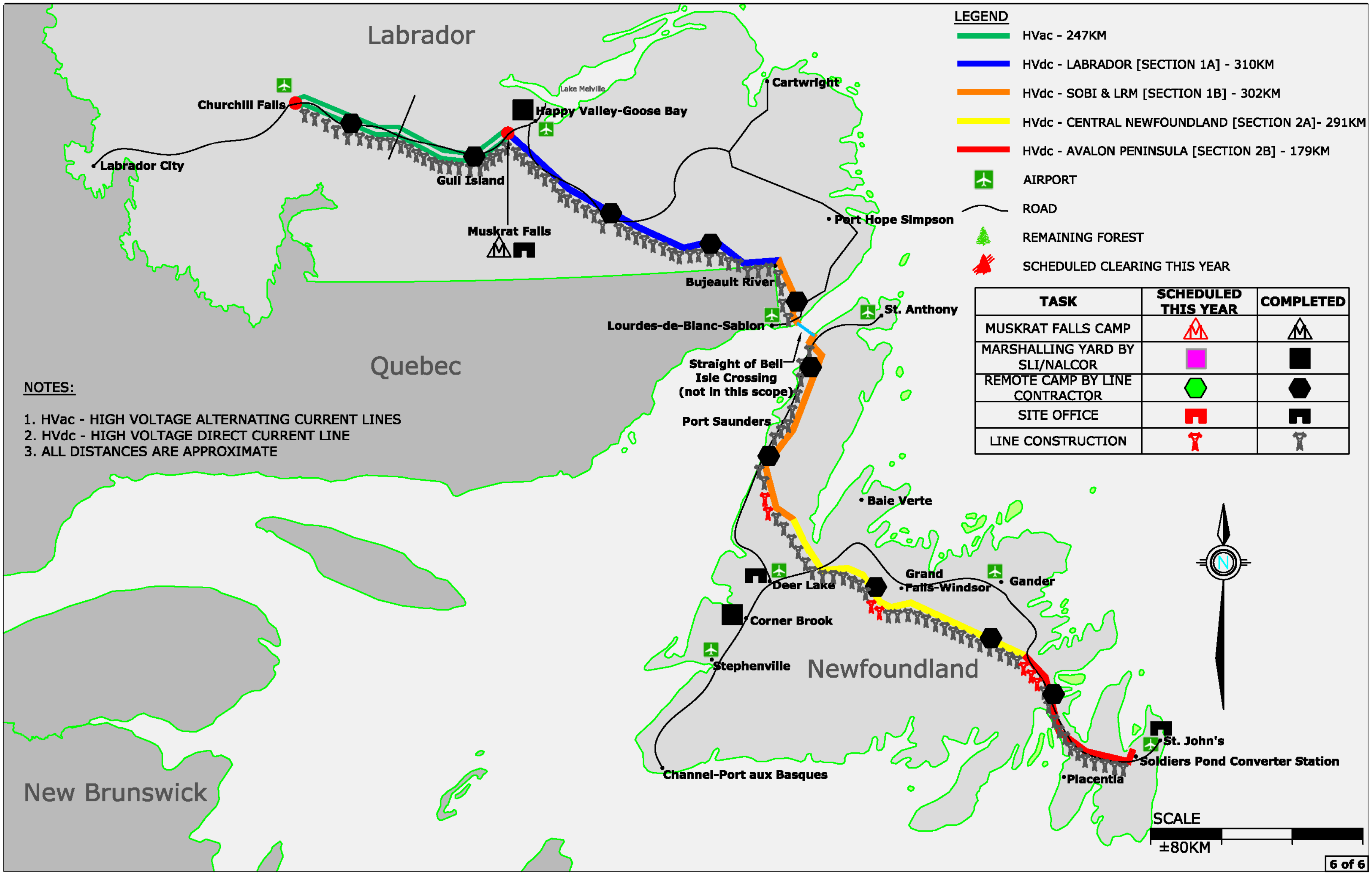


Construction Build Sequence – 2016

HVdc Construction is substantially complete



Construction Build Sequence – 2017
Winter reserved for final completion



TASK	SCHEDULED THIS YEAR	COMPLETED
MUSKRAT FALLS CAMP		
MARSHALLING YARD BY SLI/NALCOR		
REMOTE CAMP BY LINE CONTRACTOR		
SITE OFFICE		
LINE CONSTRUCTION		

Attachment B.3

Construction Fleet Rates used in the CCE

Attachment B.3 Construction Fleet Rates used in CCE

ID	Description	Hourly Rate
8ABATCH150	BATCH PLANT CONCRETE 150 CY	$ 375.00
8ACONV01	PORT CONVEYOR 50 FEET - 300	$ -
8ACR200	CRUSHER 200 MT/HR	$ 275.00
8AGRIZZLY1	GRIZZLY FEEDERS VIBRATORY	$ 61.87
8ATJH60	Jackhammer 60#	$ 2.00
8ATRB30	Rivet Buster 30#	$ 2.00
8BC	Bomag Compactor	$ 75.00
8BCT1	Cable Breaker Timberland	$ 35.00
8BH225B	Backhoe C/W cat 225B	$ 92.00
8BH325B	BACKHOE C/W CAT 325B	$ 112.90
8BH345B	BACKHOE C/W CAT 345B	$ 176.71
8BH365B	BACKHOE CAT 365B	$ 240.31
8BH375CL	BACKHOE CAT 375CL	$ 284.71
8BH385CL	BACKHOE CAT 385CL	$ 358.28
8CCCONCT10	TRUCK CONCRETE 8M3	$ 115.29
8CCONCB2	Concrete Bucket 2cy	$ 4.00
8CCONCB3	Concrete Bucket 3cy	$ 6.00
8CCONCB4	Concrete Bucket 4cy Air	$ 15.00
8CCONCCT36	Concrete Trowel 36"	$ 3.00
8CCONCGM16	Grout Mixer 16cf	$ 7.00
8CCONCHCGEN	Concrete Hi-Cycle Generator	$ 5.00
8CCONCHCVIB	Concrete Hi-Cycle Vibrator	$ 2.00
8CCONCP2	TRUCK CONCRETE PUMP RATED 85	$ 115.29
8CCONCP42	Concrete Pump Boom 42m	$ 160.00
8CCONCP52	Concrete Pump Boom 52m	$ 240.00
8CCONCP61	Concrete Pump Boom 61m	$ 260.00
8CCONCPTC	Concrete Pump Truck Chassis	$ 80.00
8CCONCRS	Concrete Roller Screed	$ 50.00
8CCONCVIB	Concrete Vibrator	$ 5.00
8CCV	Concrete Vibrator SE	$ 10.00
8CMPD0185	Compressor Diesel 185 C.F.M.	$ 20.00
8CMPD075	COMPRESSOR DIESEL 750 C.F.M.	$ 55.97
8CMPD090	COMPRESSOR DIESEL 900 C.F.M.	$ 64.31
8CMPD090-S	COMPRESSOR DIESEL 900- STAND	$ 64.31
8CMPD120	COMPRESSOR DIESEL 1200 C.F.M	$ 105.32
8CMPD150	Compressor 150 pcm	$ 10.00
8CMPD650	Compressor 650 C.F.M	$ 45.00
8COB	Compactor Cat 563	$ 66.23
8COB213PD	VIBRATOR PAD FOOT BOMAG BW17	$ 39.77
8COB850T	VIBRATOR SINGLE DRUM BOMAG B	$ 9.74
8CPT1.8	Cable Puller Timberland P20	$ 24.00
8CRANE20	Crane 20 ton RT-58D	$ 75.00
8CRHYDC50	CRANE HYDRAULIC 50 TON	$ 148.31
8CRMOB100	CRANE MOBILE 100 TON	$ 201.98
8CRTC050	CRANE ROUGH TERRAIN 50 TON	$ 124.38
8CRTC100	Crane Rough Terrain 100 Ton	$ 200.00
8CRW100	Crane Crawler 100 Ton	$ 200.00
8CRW150	CRANE CRAWLER 150 TON	$ 233.80
8CRW200	Crane Crawler 200 Ton	$ 300.00
8CRW250	CRANE CRAWLER 250 TON	$ 331.64
8CRW300	Crane Crawler 300 Ton	$ 430.00
8CRWTC	Tower Crane	$ 250.00
8CSB16	Chainsaw 16" blade	$ 2.80
8CT18T BOOM	BOOM TRUCK 18 TON	$ 90.80

Attachment B.3 Construction Fleet Rates used in CCE

ID	Description	Hourly Rate
8CUTTO	Cutting Torch	$ 2.00
8DD05	Dozer D-5	$ 58.91
8DD05W	Dozer D-5 With Winch	$ 77.00
8DD08N	DOZER C/W U-BLADE CAT D8N	$ 150.22
8DD09R	DOZER C/W U-BLADE CAT D9R	$ 199.20
8DD10R	DOZER C/W U-BLADE CAT D10R	$ 297.49
8DRCHYD7	HYDRAULIC DRILL ROC D7	$ 146.28
8DRCHYDR47	HYDRAULIC CRAWLER DRILL DM25	$ 266.00
8DRCHYDR6	DRIL HYDRAULIC C/W	$ 270.71
8DRDIAMEC	DRIL HYDRAULIC C/W	$ 270.71
8DRM	Drill Manuel	$ 5.00
8DRRO601	Drill Rock 601	$ 45.00
8EQPFS	Equipment for fuison	$ 50.00
8FEBARGE10	BARGE MATERIAL 45'X120'X800'	$ -
8FETUG0250	TUGBOAT 250 HP	$ -
8GEN020	GENERATOR DIESEL 20 KW	$ 13.87
8GEN05	Generator 5 kw	$ 5.00
8GEN060	Generator Diesel 60 KW	$ 30.00
8GEN150	GENERATOR DIESEL 150 KW	$ 62.84
8GEN500	GENERATOR DIESEL 500 KW	$ 174.84
8GEN750	GENERATOR DIESEL 750 KW	$ 253.05
8GR14H	GRADER 14H CAT	$ 115.80
8GR16H	GRADER 16H CAT	$ 154.43
8GROUT	Grout Plant	$ 20.00
8GROUT55	GROUT PLANT 5.5M3/HR	$ 53.16
8HFWFORK05	FORKLIFT 5 TON	$ 44.13
8HFWFORKRT	Forklift RT 5 Ton	$ 80.00
8HFWML18	Manlift 18m	$ 50.00
8HFWML30	Manlift 30m	$ 90.00
8HFWSCISS	SCISSORLIFT RUBBER TIRED	$ 4.39
8HFWWINCH06	WINCH ELECTRIC 60 TON	$ 31.11
8JACKHR	Jackhammer	$ 5.00
8JACKLEG	JACK LEG	$ 15.00
8LIGHT4	LIGHT TOWER 4 LIGHTS	$ 10.20
8LIGHT6	LIGHT TOWER 6 LIGHTS	$ 15.69
8LO966F	LOADER CAT 966 3.3 M3	$ 76.44
8LO988F	LOADER CAT 966 5.4 M3	$ 150.78
8LO992K	Loader Cat 992k 7.0 BCM	$ 434.90
8LOLBOBCAT	BOB CAT LIGHT	$ 27.66
8LOTCIT38	Tool Carrier IT38 35,000#	$ 80.00
8MISCSE	Misc Tools Spillway	$ 10.00
8PDHR	Pile Driving Hammer	$ 15.00
8PILE10	PILE HAMMER DELMAG DIESEL D3	$ 70.44
8POHT	Propane Heater	$ 2.00
8PUMP03	Water pump 3"	$ 3.50
8PUMP04	PUMP SUBMERSIBLE 4"-6"	$ 6.91
8PUMP06	PUMP SUBMERSIBLE 6"-8"	$ 8.72
8PUMP100	100 Ton Pressure pump	$ 10.00
8PW050	Pressure Washer 5000psi	$ 15.00
8SC651ES	SCRAPER CAT 651 33 M3	$ 316.21
8SHOTCR12	SHOTCRETE EQUIP 0.6 M3 TO 12	$ 30.28
8SOSA	Soldering Station	$ 13.00
8SVBUS38	BUS 38 SEATER	$ 35.00
8SVBUS44	BUS 44 SEATER	$ 40.00

Attachment B.3 Construction Fleet Rates used in CCE

ID	Description	Hourly Rate
8TB	Test Bench	$ 25.00
8TD725D	TRUCK DUMP CAT 725D 25T	$ 118.25
8TD769D	TRUCK DUMP CAT 769D 36T	$ 153.39
8TD773D	TRUCK DUMP CAT 773D 52T	$ 177.44
8TD777D	TRUCK DUMP CAT 777D 97T	$ 255.55
8TDRILL	TRUCK DRILL	$ 80.00
8TDT10W	Dump Truck 10 Wheel	$ 63.29
8TDYN	Truck Dynamite	$ 50.00
8TINJ	TRUCK FOR INJECTION INCL QUI	$ 80.00
8TPUP001	TRUCK PICK UP 3/4 TON	$ 28.44
8TPUP002	TRUCK PICK UP 3/4 TON 4X3	$ 19.82
8TR01	Tractor	$ 70.00
8TRLTRL18	Trailer Flat Deck 20 Ton	$ 6.00
8TRLTRL35	TRAILER LOWBOY 35 TON	$ 15.76
8TSP	Truck Snow Plow	$ 62.05
8TTRUCK05	TRUCK FLAT BED 5 TON	$ 38.91
8TTRUCK12	TRUCK FLAT BED 12 TON	$ 50.68
8TWAT4	TRUCK WATER 4000 GAL	$ 62.05
8VACUUM	TRUCK VACCUM	$ 200.00
8VTT44	VTT 4x4	$ 12.00
8WCBUS14	Bus 14 Passenger	$ 40.00
8WCCD	Caravan-Diner	$ 1.00
8WCCS	Chain Saw	$ 1.63
8WCDL322	Delimber 322D FM for RC	$ 145.00
8WCFB	Feller Buncher	$ 136.00
8WCFB2	Feller Buncher for RC	$ 233.00
8WCFT	Fuel Tanker Truck	$ 62.05
8WCL320D	Loader 320D FM for RC	$ 113.00
8WCMK	Muskeg	$ 15.00
8WCMKOR	Muskeg Off Road	$ 52.00
8WCML	Mulcher	$ 150.00
8WCNW	Nodwell	$ 67.00
8WCSH2000	Shear 2000	$ 32.00
8WCSK	Skidder 610c	$ 51.00
8WCSK2	Skidder 610c for RC	$ 201.00
8WCTT50	50TN Truck Tractor	$ 71.00
8WCTTT	Truck Tractor Trailer for RC	$ 135.00
8WCWT	Walki Talki	$ 2.00
8WELDD50	Welder Diesel 500 Amp	$ 12.00
8WELDE40	WELDER ELECTRIC 400 AMP	$ 5.96
8WT1	Wild T-1 & Tripod	$ 3.00
	BOOM TRUCK 12 TON	$ 41.75
	Dozer D-6	$ 93.54
	ART CAT 740 - 40T	$ 177.44
	Rigid Frame 60T (SLI 75T)	$ 203.25
	Rigid Frame 40T (SLI 52T)	$ 177.44

Attachment B.4

Technical Note: System Upgrades – Island Interconnected Transmission System

Purpose

To provide an overview of the history of the proposed upgrades to the Island Interconnected Transmission System associated with the addition of the Labrador Island HVdc Transmission Link.

History

May 2008

The first listing of Island Interconnected Transmission System upgrades was identified in integration studies completed by TransGrid Solutions (TGS) and summarized in report "DC1020 – HVdc System Integration Study". At this point the Island Interconnected Transmission System base cases included a new 175 MW oil refinery in Placentia Bay, an 83 MW nickel processing plant near Long Harbour, a second 54 MW combustion turbine at Hardwoods and five 50 MW combustion turbines at Holyrood to support the new industrial loads until the HVdc infeed to the Island was completed. The new oil refinery was to be connected to a new 230 kV station called Piper's Hole. As well, the HVdc system under consideration was a 1600 MW multi-terminal scheme with converter stations at Gull Island, Soldiers Pond and Salisbury, NB. Volume 1 – Summary Report provides a listing of the required system upgrades at that time:

- Three units at Holyrood converted to permanent synchronous condenser operation to support the Equivalent Short Circuit Ratio (ESCR) requirements of the Soldiers Pond converter;
- Transmission line work including
    - Thermal upgrades to TL202 and TL206;
    - Rebuild of TL203;
    - Investigation of thermal limits TL207 and TL237; and
    - Rebuild TL201;
- Addition of six 300 MVAR high inertia synchronous condensers (two each in service at Soldiers Pond and Pipers Hole at all times);
- 50% series compensation of transmission lines between Bay d'Espoir and Sunnyside; and
- Circuit Breaker replacements at:
    - Stony Brook 138 kV;
    - Bay d'Espoir 230 kV;
    - and Holyrood 230 kV.

November 2008

By 2008 the addition of the new 175 MW oil refinery became very questionable. System Planning reviewed the proposed Island Interconnected Transmission System additions based upon ongoing work by TGS, assuming no new oil refinery, the subsequent removal of the Piper's Hole Terminal Station and acceptance of the potential for system collapse should there be a permanent three phase fault on the 230 kV bus at Bay d'Espoir. The resultant Island upgrades were provided in a memo to LCP Electrical Engineering dated November 5, 2008. The upgrades include:

- Three 300 MVAR high inertia synchronous condensers at Soldiers Pond;
- Conversion of all Holyrood units to permanent synchronous condenser capability;
- New 230 kV transmission line Bay d'Espoir to Western Avalon;
- 50% series compensation on all three 230 kV transmission lines Bay d'Espoir east (i.e. TL202, TL206 and the new BDE – WAV circuit);
- Circuit breaker replacements at:
    - Bay d'Espoir 230 kV (1);
    - Holyrood 230 kV (9); and
    - Hardwoods 66 kV (4)
    - Note no breaker replacements at Stony Brook or Sunnyside 138 kV
- Thermal overloads on TL201 were discovered in future peak load cases and not in the 2016 in service base case. Therefore TL201 rebuild was excluded from the list of system additions;
- Overloads on TL201, TL202, TL203 and TL206 during transmission line contingencies were managed through redispatch of HVdc imports and operation of loal combustion turbines; and
- Rebuild of TL203 was deemed to not be required prior to the proposed 2016 in service date of the Soldiers Pond converter.

July 2010

In July 2010 TGS had completed its HVdc Sensitivity Studies and issued the report "DC1210 – HVdc Sensitivity Studies Summary Report". The report identified the following additions:

- The studies assumed synchronous condenser conversion at Holyrood;
- Three 150 MVAR high inertia synchronous condensers at Soldiers Pond (two in service at all times); and
- Either
  - 200 MVAR SVC at Sunnyside and 50% series compensation on the Bay d'Espoir – Sunnyside lines (TL202 and TL206); or
  - New 230 kV transmission line Bay d'Espoir – Western Avalon Line with no series compensation on any 230 kV transmission line.

The studies had been conducted assuming that Island system collapse for the three phase fault at the Bay d'Espoir 230 kV bus was acceptable. As no final decision or agreement had been reached on the point the following system upgrades had been considered for DG2:

- Conversion of Holyrood units to synchronous condenser capability;
- Three 300 MVAR high inertia synchronous condensers at Soldiers Pond (rationale was to provide sufficient inertia in the event system collapse for the Bay d'Espoir three phase fault was unacceptable);
- New 230 kV transmission line Bay d'Espoir to Western Avalon (Station congestion at Sunnyside makes installation of an SVC impossible therefore requires new 230 kV terminal station such as Pipers Hole. The new circuit removes the need to rebuild TL203 until end of its useful life); and
- Circuit breaker replacements at:
  - Bay d'Espoir 230 kV (1);
  - Holyrood 230 kV (9); and
  - Hardwoods 66 kV (4)

Late 2010 - Early 2011

Analysis completed by System Planning indicated that the 230 kV transmission line between Bay d'Espoir and Western Avalon would be required for both the Isolated and Interconnected Island Alternatives. As a result the new 230 kV transmission line was removed from the list of Island Interconnected Transmission System upgrades associated with the Labrador Island HVdc Transmission Link and added to the NLH 2012 Capital Budget and Five Year plan as part of the Phase III submission.

December 2011

In December 2011 SLI completed studies with respect to the existing ±350 kV HVdc system between Muskrat Falls and Soldiers Pond. The document Nalcor Doc. No. LCP-SN-CD-8000-EL-RP-0001-01 (SLI Doc. No. 505573-480A-47ER-0004) entitled Stability Studies incorporates the following Island Interconnected Transmission System additions:

- Conversion of Holyrood units to synchronous condenser capability; and
- Three 150 MVAR high inertia synchronous condensers at Soldiers Pond.

In addition the following circuit breaker replacements were required:

- Bay d'Espoir 230 kV (1);
- Holyrood 230 kV (9); and
- Hardwoods 66 kV (4).

The study assumed the new 230 kV transmission line between Bay d'Espoir and Western Avalon had been completed. The line cost is not carried in the upgrade requirements due to the Labrador Island HVdc Transmission Link as the cost is common to both the Isolated and Interconnected Island Alternatives.

July 2012

In2012 System Planning undertook a review of the synchronous condenser requirements for the integration of the Labrador Island HVdc Transmission Link with a view to develop technically viable alternatives considering combinations of high inertia synchronous condensers located at either Soldiers Pond or Holyrood in conjunction with varying the number of existing Holyrood units converted to synchronous condenser capability. The final report entitled "Review of Synchronous Condenser Requirements For The Lower Churchill Project" identified eight technically viable combinations of high inertia synchronous condensers ranging in rating from 125 MVAR to 300 MVAR with the number of Holyrood synchronous condenser conversions ranging from 3 to 1 to none. The report recommended a detailed CPW analysis to determine the least overall cost option.

Given the initial capital cost to convert Holyrood Units 1 and 2 to synchronous condenser capability versus the incremental cost to increase the rating of the Soldiers Pond synchronous condenser rating from 150 MVAR to 175 MVAR, the project VP directed that the preference would be to operate only Holyrood Unit 3 as a synchronous condenser and install three 175 MVAR synchronous condensers at Soldiers Pond.

October 2012

A review of short circuit levels were conducted in light of the proposed changes to the Soldiers Pond synchronous condenser size and the relocation of the proposed Hardwoods 50 MW combustion turbine to Holyrood. The following Island Interconnected Transmission System upgrades were identified:

- Operation of only Holyrood Unit 3 as a synchronous condenser;
- Three 175 MVAR high inertia synchronous condensers at Soldiers Pond; and
- circuit breaker replacements at:
- Bay d'Espoir 230 kV (1);
- Holyrood 230 kV (9); and
- Hardwoods 66 kV (3).

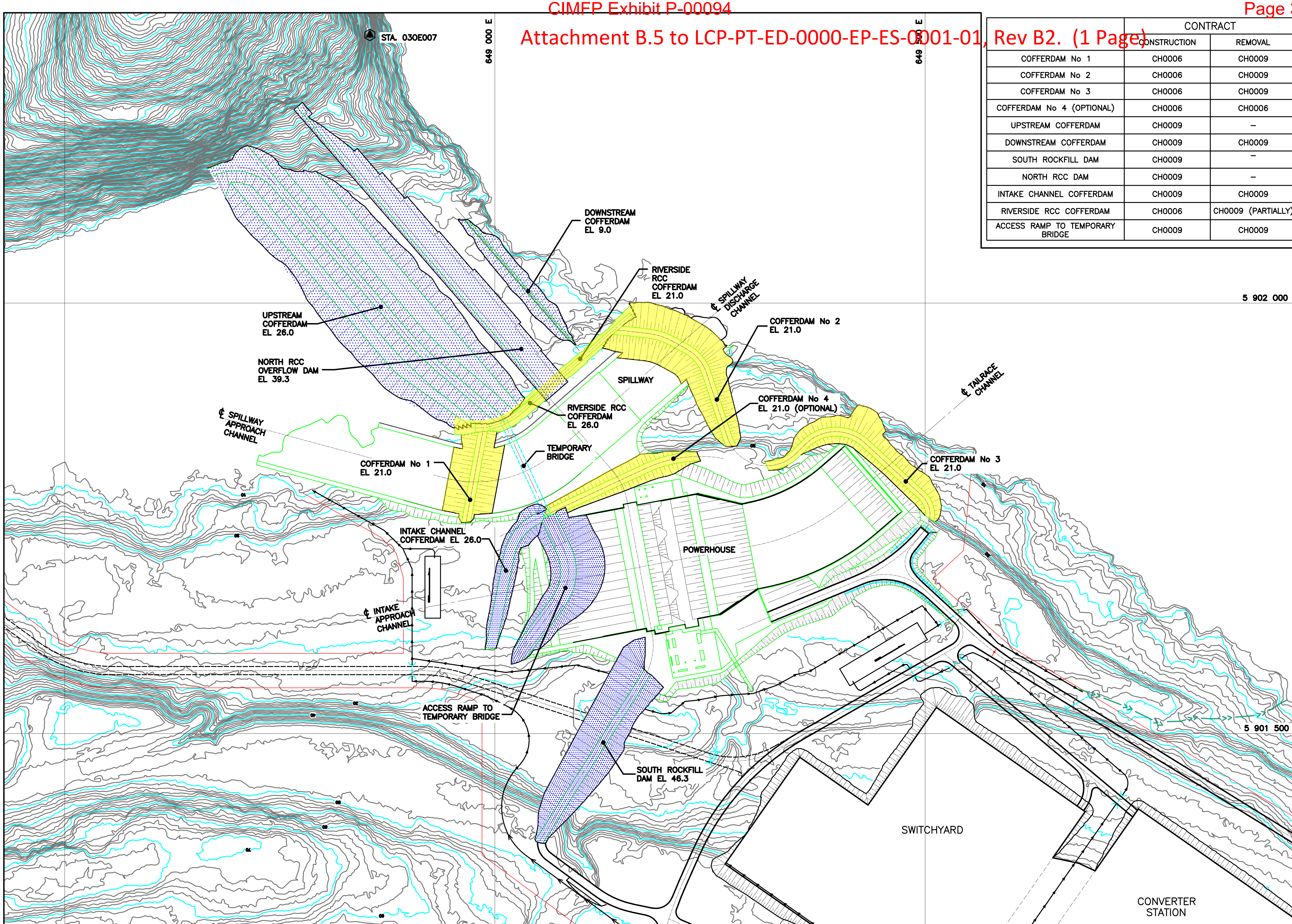
Outside the identified upgrades is the construction of the new 230 kV transmission line Bay d'Espoir to Western Avalon.

Attachment B.5

Key Plan of Cofferdams and Dams

Attachment B.5 to LCP-PT-ED-0000-EP-ES-0001-01, Rev B2. (1 Page)

	CONTRACT	
	CONSTRUCTION	REMOVAL
COFFERDAM No 1	CH0006	CH0009
COFFERDAM No 2	CH0006	CH0009
COFFERDAM No 3	CH0006	CH0009
COFFERDAM No 4 (OPTIONAL)	CH0006	CH0006
UPSTREAM COFFERDAM	CH0009	–
DOWNSTREAM COFFERDAM	CH0009	CH0009
SOUTH ROCKFILL DAM	CH0009	–
NORTH RCC DAM	CH0009	–
INTAKE CHANNEL COFFERDAM	CH0009	CH0009
RIVERSIDE RCC COFFERDAM	CH0006	CH0009 (PARTIALLY)
ACCESS RAMP TO TEMPORARY BRIDGE	CH0009	CH0009



Attachment B.6

Manpower Loading for Soils and Concrete Laboratory Scope

Muskrat falls - Manpower forecast and vehicules for Soil and Concrete Laboratory base on Schedule December 2011

2012

Titre	fonction	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Resident engineer (D)											
Deputy engineer (D)											
Main staff coordinator (D)			1	1	1	1	1	1	1	1	0.5
Secretary (D)											
Office clerk (D)			1	1	1	1	1	1	1	1	0.5
Staff coordinator (D)											
Staff coordinator (N)											
Concrete	Concrete										
Technician (D)	Batch plant						1	1	1		
Technician (D)	Field						1	1	1		
Technician (D)	Sampling					1	2	2	2		
Technician (D)	Lab					1	1	1	1		
	Aggregates										
Technician (D)	Lab										
Technician (D)	Sampling										
Technician (D) 450 samples	Lab (cement)										
Earthfill											
Technician (D)	Slurry wall										
Technician (D)	Field										
Technician (D)	Lab										
Roads & camp											
Technician (D)	Field		1	1	1	2	2	2	2	1	
Technician (D)	Field / Sampling		1	1	1	1	1	1	1	1	
Technician (D)	Lab		1	1	1	1	1	1	1	1	
Concrete											
Technician (N)	Concrete										
Technician (N)	Batch plant						1	1	1		
Technician (N)	Field						1	1	1		
Technician (N)	Sampling						2	2	2		
Technician (N)	Lab						1	1	1		
Technician (N)	Aggregates										
Technician (N)	Lab										
Technician (N)	Sampling										
Earthfill											
Technician (D)	Field										
Technician (D)	Lab										
	Sub-total	0	5	5	5	8	16	16	16	5	0
	Rotation 20 %	0	1	1	1	2	3	3	3	1	0
1574	Total	0	6	6	6	10	19	19	19	6	0
											76

2013

Titre	fonction	Jan.	Feb.	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Resident engineer (D)			1	1	1	1	1	1	1	1	1	1	1
Deputy engineer (D)					1	1	1	1	1	1	1	1	1
Main staff coordinator (D)			1	1	1	1	1	1	1	1	1	1	1
Secretary (D)			1	1	1	1	1	1	1	1	1	1	1
Office clerk (D)							1	1	1	1	1	1	1
Staff coordinator (D)					1	1	1	1	1	1	1	1	1
Staff coordinator (N)					1	1	1	1	1	1	1	1	1
Concrete	Concrete												
Technician (D)	Batch plant				1	1	2	2	2	2	2	1	1
Technician (D)	Field				1	7	8	9	9	9	9	9	9
Technician (D)	Sampling		1	1	1	2	2	2	2	2	2	2	2
Technician (D)	Lab		1	1	1	3	3	3	3	3	3	3	3
	Aggregates												
Technician (D)	Lab			1	2	2	2	2	2	2	2	2	1
Technician (D)	Sampling												
Technician (D) 450 samples	Lab (cement)							1	1	1	1	1	1
Earthfill													
Technician (D)	Slurry wall							1	1	1	1		
Technician (D)	Field					2	4	4	4	4	2		
Technician (D)	Lab					3	3	3	3	3	3		
Roads & camp													
Technician (D)	Field												
Technician (D)	Field / Sampling												
Technician (D)	Lab												
Concrete													
Technician (N)	Concrete												
Technician (N)	Batch plant				1	1	2	2	2	2	2	1	1
Technician (N)	Field				1	5	6	7	7	7	7	7	6
Technician (N)	Sampling				1	2	2	2	2	2	2	2	2
Technician (N)	Lab				1	2	2	2	2	2	2	2	2
Technician (N)	Aggregates												
Technician (N)	Lab			1	2	2	2	2	2	2	2	2	1
Technician (N)	Sampling												
Earthfill													
Technician (D)	Field					2	2	2	2	2	2		
Technician (D)	Lab					2	2	2	2	2	2		
	Sub-total	0	5	7	18	42	49	53	53	53	51	39	36
	Rotation 20 %	0	1	1	4	8	10	11	11	11	10	8	7
1574	Total	0	6	8	22	50	59	64	64	64	61	47	43
													406

2014

Titre	fonction	Jan.	Feb.	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Resident engineer (D)		1	1	1	1	1	1	1	1	1	1	1	1
Deputy engineer (D)		1	1	1	1	1	1	1	1	1	1	1	1
Main staff coordinator (D)		1	1	1	1	1	1	1	1	1	1	1	1
Secretary (D)		1	1	1	1	1	1	1	1	1	1	1	1
Office clerk (D)		0,5	1	1	1	1	1	1	1	1	1	1	1
Staff coordinator (D)		1	1	1	1	1	1	1	1	1	1	1	1
Staff coordinator (N)		1	1	1	1	1	1	1	1	1	1	1	1
Concrete	Concrete												
Technician (D)	Batch plant	1	1	1	1	1	1	1	1	1	1	1	1
Technician (D)	Field	5	5	5	5	5	5	5	5	5	5	5	4
Technician (D)	Sampling	2	2	2	2	2	2	2	2	2	2	2	2
Technician (D)	Lab	3	3	3	3	3	3	3	3	3	3	3	3
	Aggregates												
Technician (D)	Lab												
Technician (D)	Sampling												
Technician (D) 450 samples	Lab (cement)	1	1	1	1	1	1	1	1	1	1	1	1
Earthfill													
Technician (D)	Slurry wall						1	1	1	1			
Technician (D)	Field					2	4	4	4	4	2		
Technician (D)	Lab					3	3	3	3	3	3		
Roads & camp													
Technician (D)	Field												
Technician (D)	Field / Sampling												
Technician (D)	Lab												
Concrete													
Technician (N)	Concrete												
Technician (N)	Batch plant	1	1	1	1	1	1	1	1	1	1	1	1
Technician (N)	Field	4	4	4	4	4	4	4	4	4	4	4	3
Technician (N)	Sampling	2	2	2	2	2	2	2	2	2	2	2	2
Technician (N)	Lab	2	2	2	2	2	2	2	2	2	2	2	2
Technician (N)	Aggregates												
Technician (N)	Lab												
Technician (N)	Sampling												
Earthfill													
Technician (D)	Field					2	2	2	2	2	2		
Technician (D)	Lab					2	2	2	2	2	2		
	Sub-total	28	28	28	28	37	40	40	40	40	37	28	26
	Rotation 20 %	6	6	6	6	7	8	8	8	8	7	6	5
1574	Total	34	34	34	34	44	48	48	48	48	44	34	31
													400

2015

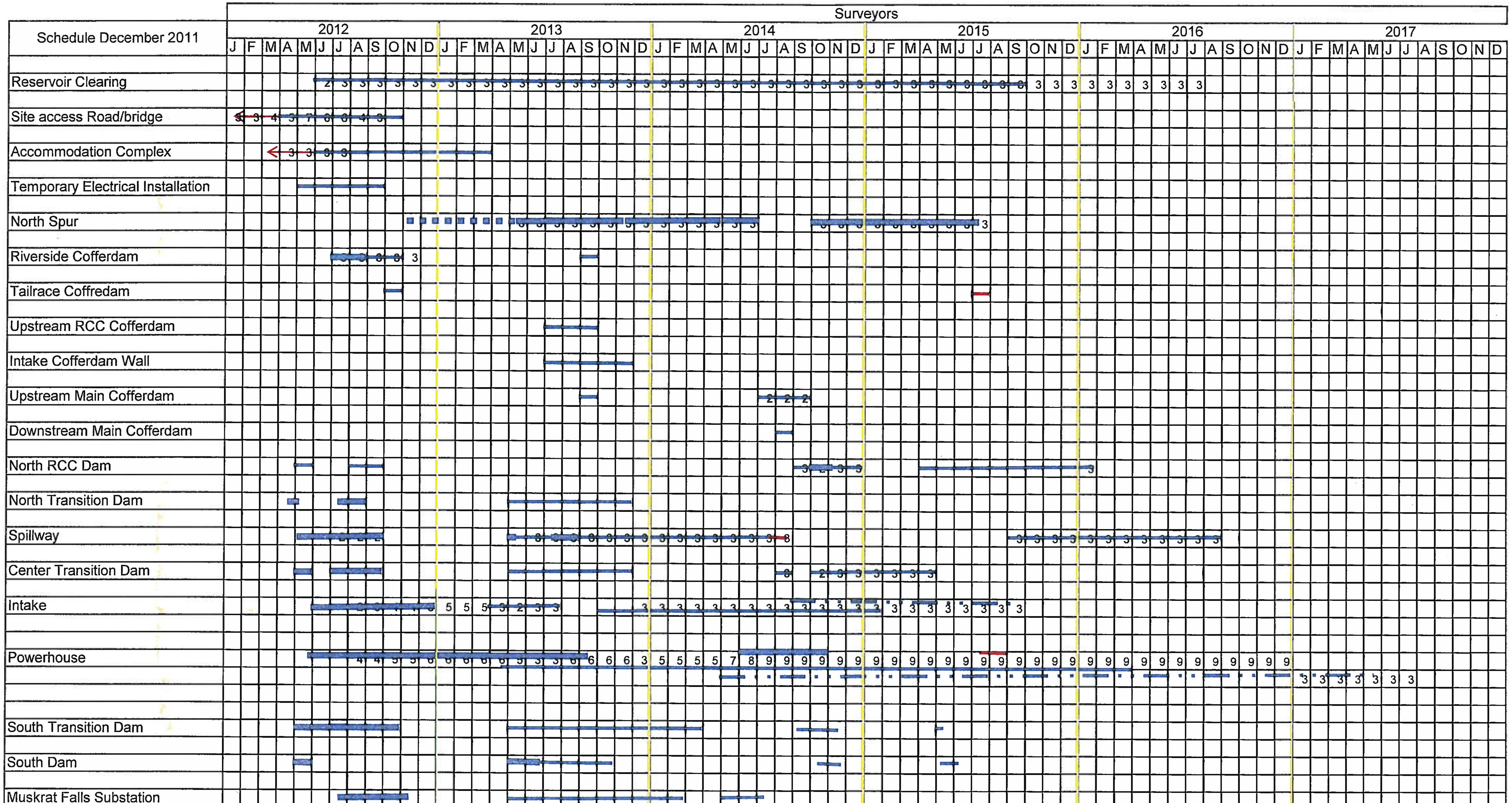
Titre	fonction	Jan.	Feb.	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Resident engineer (D)		1	1	1	1	1	1	1	1	1	1	1	1
Deputy engineer (D)		1	1	1	1	1	1	1	1	1	1	1	1
Main staff coordinator (D)		1	1	1	1	1	1	1	1	1	1	1	1
Secretary (D)		1	1	1	1	1	1	1	1	1	1	1	1
Office clerk (D)		0,5	1	1	1	1	1	1	1	1	1	1	1
Staff coordinator (D)		1	1	1	1	1	1	1	1	1	1	1	1
Staff coordinator (N)		1	1	1	1	1	1	1	1	1	1	1	1
Concrete	Concrete												
Technician (D)	Batch plant			1	1	2	2	2	2	2	2	2	2
Technician (D)	Field	1	1	2	3	4	4	4	4	4	4	4	4
Technician (D)	Sampling			2	2	2	2	2	2	2	2	2	2
Technician (D)	Lab		1	1	1	2	3	3	3	3	3	2	2
	Aggregates												
Technician (D)	Lab												
Technician (D)	Sampling												
Technician (D) 450 samples	Lab (cement)		1	1	1	1	1	1	1	1	1	1	1
Earthfill													
Technician (D)	Slurry wall												
Technician (D)	Field												
Technician (D)	Lab												
Roads & camp													
Technician (D)	Field												
Technician (D)	Field / Sampling												
Technician (D)	Lab												
Concrete													
Technician (N)	Concrete												
Technician (N)	Batch plant			1	1	2	2	2	2	2	2	2	2
Technician (N)	Field	1	1	2	3	3	3	3	3	3	3	3	3
Technician (N)	Sampling			2	2	2	2	2	2	2	2	2	2
Technician (N)	Lab		1	1	1	2	2	2	2	2	2	2	2
Technician (N)	Aggregates												
Technician (N)	Lab												
Technician (N)	Sampling												
Earthfill													
Technician (D)	Field												
Technician (D)	Lab												
	Sub-total	9	12	20	22	27	28	28	28	28	28	27	27
	Rotation 20 %	2	2	4	4	5	6	6	6	6	6	5	5
1574	Total	11	14	24	26	32	34	34	34	34	34	32	32
													284

2016

Titre	fonction	Jan.	Feb.	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Somme
Resident engineer (D)		1	1	1	1	1	1	1	1	1	1	1	1	47
Deputy engineer (D)		1	1	1	1	1	1	1	1	1	1	1	1	45
Main staff coordinator (D)		1	1	1	1	1	1	1	1	1	1	1	1	55
Secretary (D)		1	1	1	1	1	1	1	1	1	1	1	1	47
Office clerk (D)		0,5	1	1	1	1	1	1	1	1	1	0,5		48
Staff coordinator (D)		1	1	1	1	1	1	1	1					41
Staff coordinator (N)		1	1	1										36
Concrete	Concrete													
Technician (D)	Batch plant	2	2	2	1	1	1	1	1					58
Technician (D)	Field	3	3	3	1	1	1	1	1					185
Technician (D)	Sampling	2	2	2	1	1	1	1	1					81
Technician (D)	Lab	2	2	2										97
	Aggregates													
Technician (D)	Lab													18
Technician (D)	Sampling													
Technician (D) 450 samples	Lab (cement)		1	1	1	1	1	1	1					36
Earthfill														
Technician (D)	Slurry wall													8
Technician (D)	Field													40
Technician (D)	Lab													36
Roads & camp														
Technician (D)	Field													12
Technician (D)	Field / Sampling													8
Technician (D)	Lab													8
Concrete														
Technician (N)	Concrete													
Technician (N)	Batch plant	2	2	2										53
Technician (N)	Field	3	3	3										143
Technician (N)	Sampling	2	2	2										73
Technician (N)	Lab	2	2	2										69
Technician (N)	Aggregates													
Technician (N)	Lab													18
Technician (N)	Sampling													
Earthfill														
Technician (D)	Field													24
Technician (D)	Lab													24
	Sub-total	25	26	26	10	10	10	10	10	5	5	5	4	1310
	Rotation 20 %	5	5	5	2	2	2	2	2	1	1	1	1	264
1574	Total	30	31	31	12	12	12	12	12	6	6	6	5	
													145	

Attachment B.7

Manpower Loading for Survey Services Scope



947

	J	F	M	A	M	J	J	A	S	O	N	D
2012 Number on payroll	3	3	4	8	10	13	19	18	18	15	15	14
2012 Present on site	2	2	3	5	7	9	13	12	12	10	10	9
2013 Number on payroll	14	14	14	14	13	15	15	15	15	15	15	15
2013 Present on site	9	9	9	9	9	10	10	10	10	10	10	10

	J	F	M	A	M	J	J	A	S	O	N	D
2014 Number on payroll	17	17	17	17	19	20	20	23	20	22	24	24
2014 Present on site	11	11	11	11	13	13	13	15	13	15	16	16
2015 Number on payroll	21	21	21	21	18	18	18	15	18	15	15	15
2015 Present on site	14	14	14	14	12	12	12	10	12	10	10	10

	J	F	M	A	M	J	J	A	S	O	N	D
2016 Number on payroll	18	15	15	15	15	15	15	12	9	9	9	9
2016 Present on site	12	10	10	10	10	10	10	8	6	6	6	6
2017 Number on payroll	3	3	3	3	3	3	3	0	0	0	0	0
2017 Present on site	2	2	2	2	2	2	2	0	0	0	0	0