Summary Findings

- Skilled Labour Availability Risk Exposure

- The current estimate is based on labour rates agreed for the Hebron project. It is likely this project will compete with Western Canada for labour. The proposed wage rates are lower, but have larger union benefits than Western Canada resulting in lower take-home compensation. In addition, completion bonuses are being planned in Western Canada.

Conclusions

The Lower Churchill Project, if sanctioned late Q3 2012, should be slightly ahead of a planned high volume construction activity in Canada / North America. It is also primarily a construction project with minimal engineering and procurement required prior to effective start. A timely start and quick work ramp-up could mitigate risk exposure.

The sheer size of the project and volume of work are in and of themselves a strategic risk exposure with respect to the availability of the skills required.

The current schedule is aggressive, given the northern location and the sustained concrete placement production rates required.

Construction productivity has been on a steady decline for twenty-five years. A key element of this is the availability of front line supervision. This project likely has significant performance risk exposure. On the positive side, there has been significant effort to secure a Project Labor Agreement (PLA) that will minimize exposure to labor excesses. While negotiation is not complete, positive concepts like “work teams” have been accepted.

Potential Strategic Risk Exposure and Risk Adjusted Capital Costs (2012 Cdn$)

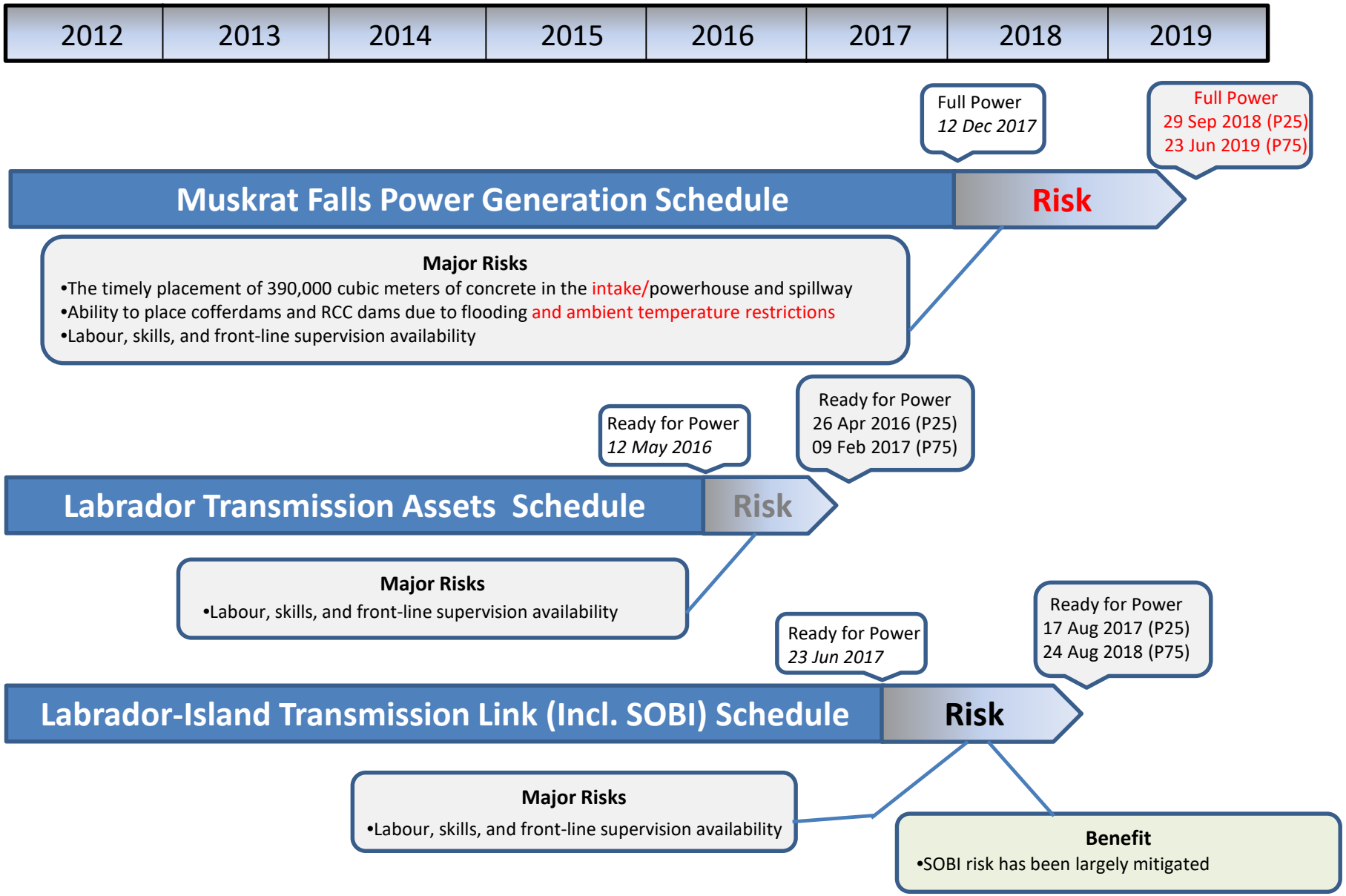
Expected Cost excl. Strategic Risk Exposure: $5,841 MM

Estimate	$5,473 MM
Estimating Contingency	$368 MM
Expected	$5,841 MM

Strategic Risk Exposure (Mean Impacts of Risks)	Potential Impact (Millions)
≈ Potential Schedule Risk – Time Extension	$184
≈ Potential Performance Risk – Productivity	$161
≈ Potential Skilled Labour – Completion Bonus	$82
≈ Potential Skilled Labour – Wage Rate	$70
Total of Mean Values:	$497

Risk Exposure Adjusted Capital Cost From Monte Carlo Simulation → (P25 to P75) = $5,946 MM - $6,737 MM

Risk Adjusted Schedule



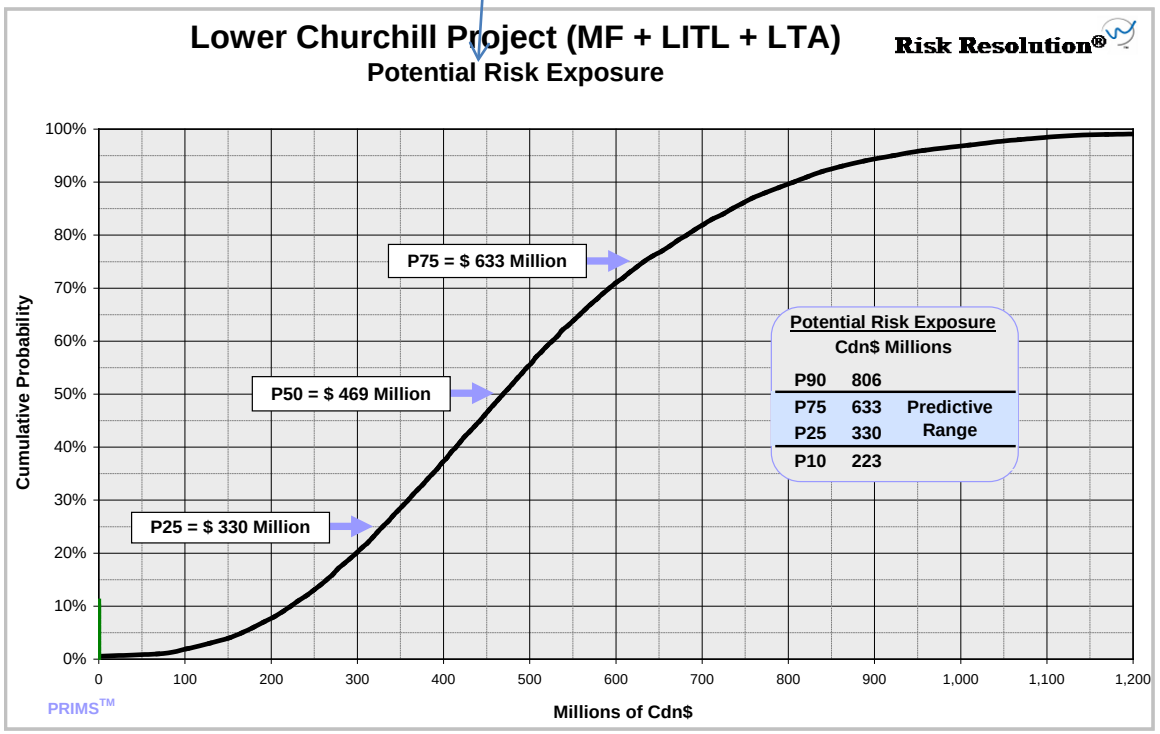
Supporting Materials

Potential Strategic Risk Exposure

Strategic

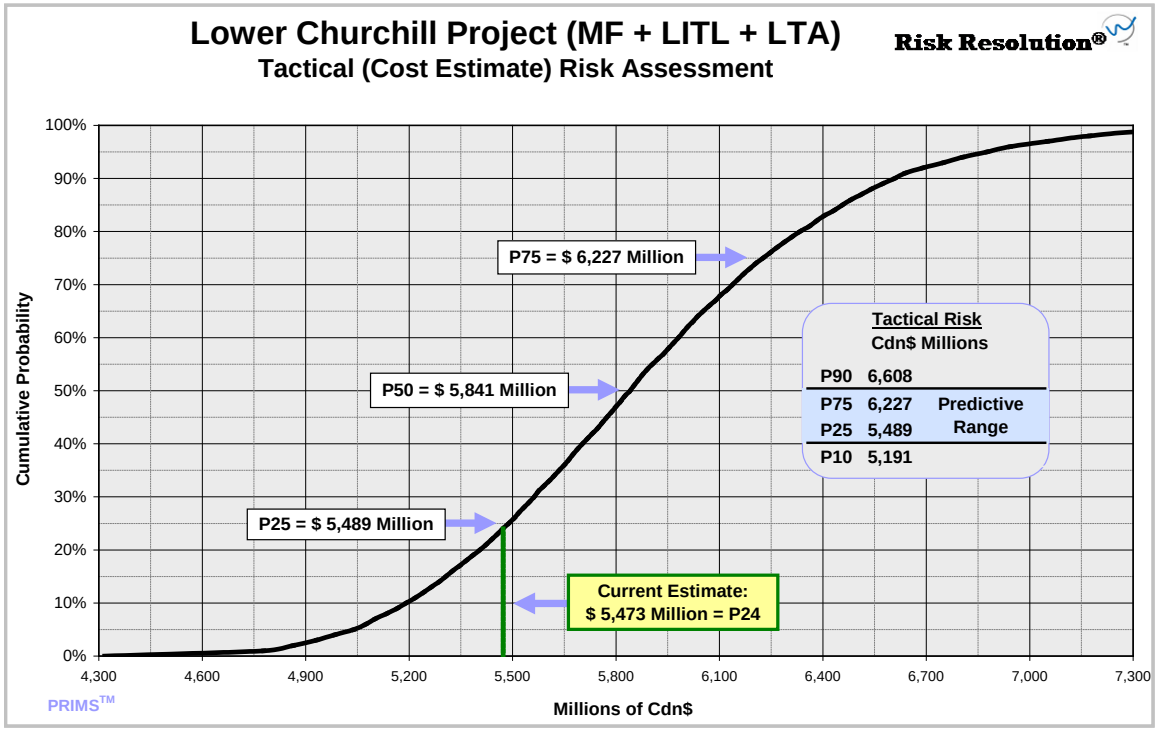
The Predictive Range (P25 – P75) for the potential Strategic Risk Exposure beyond the Estimate Contingency is $330 MM - $633 MM. These results are mostly influenced by:

- *Schedule Risk – Time Extension*
- *Performance Risk – Productivity*



Tactical Risk Assessment Results from the LCP Estimate Accuracy Analysis

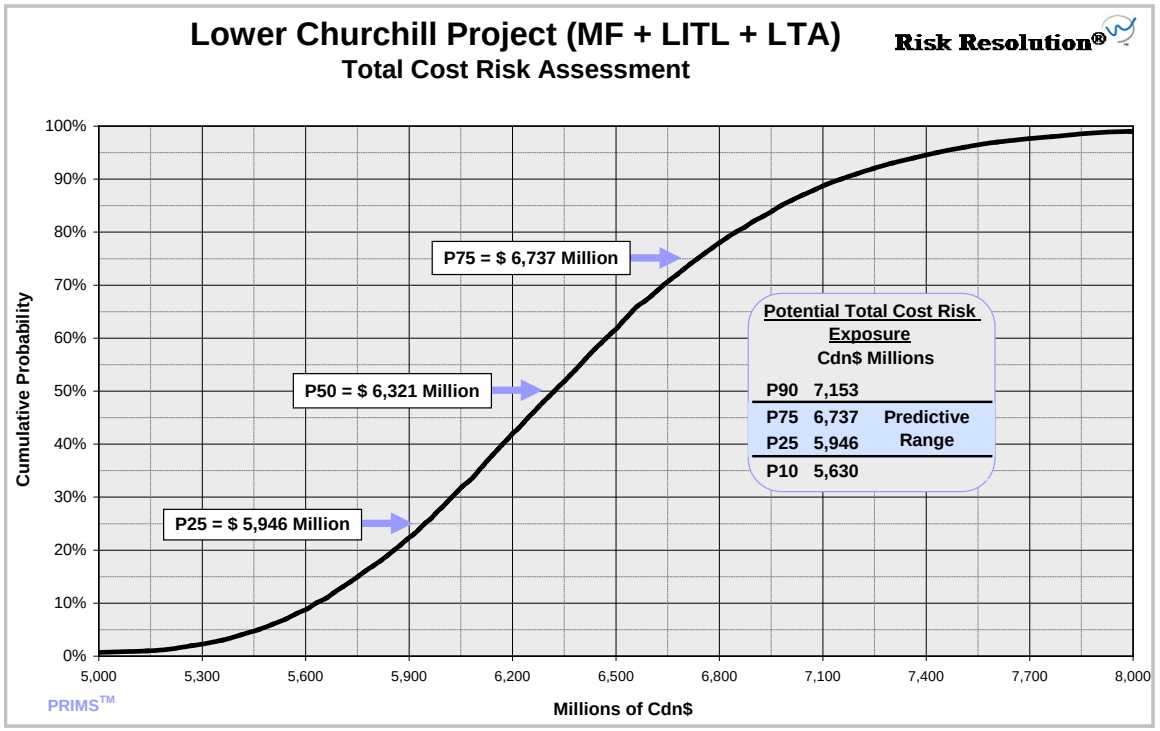
The Predictive Range (P25 – P75) of the Tactical Risk Assessment for the Lower Churchill Project is $5,489 MM - $6,227 MM. At a P50 value, the project contingency would be $368 million ($5,841 million minus $5,473 million), which equates to 7% of the estimate.



Total Cost Risk Exposure

The Predictive Range (P25 – P75) of the Total Cost Risk Assessment for the Lower Churchill Project is $5,946 MM - $6,737 MM. These results reflect the full impact of both the Tactical Risk Assessment and the potential Strategic Risk Exposure.

Please note that, due to the nature of probabilistic analyses, the Tactical Risk Assessment results and the potential Strategic Risk Exposure are not directly additive to the Total Cost Risk Exposure.



Potential Strategic Risk Exposure

Description	Impact	Unmitigated (millions)	Mitigated (millions)	Cost of Mitigation (millions)
Availability of Skilled Labour				
• Payment of Completion Bonuses – It is known the Western Canada projects are planning to pay completion bonuses of $10 per work-hour. Assuming not all workers would achieve the required hours, $8 is used for impact calculation purposes.	Project Completion Bonus	$ 50 M to $ 120 M		
• Wage Rate – The Hebron wage rates used in the estimate are roughly $5 per hour to the person less than the Western Canada rates. The mining projects in the west of the province are currently paying Alberta rates.	Pay Alberta / BC wage rates	$ 0 M to $ 150 M		

Potential Strategic Risk Exposure

Description *Performance*	Impact	Unmitigated (millions)	Mitigated (millions)	Cost of Mitigation (millions)
• Productivity – The Long Harbour and western Province projects are experiencing poor productivity and some jurisdictional problems. The weather is problematic at this site, compounding the productivity issue.	More work-hours than estimated required to complete the work	$ 0 M to $ 350 M		

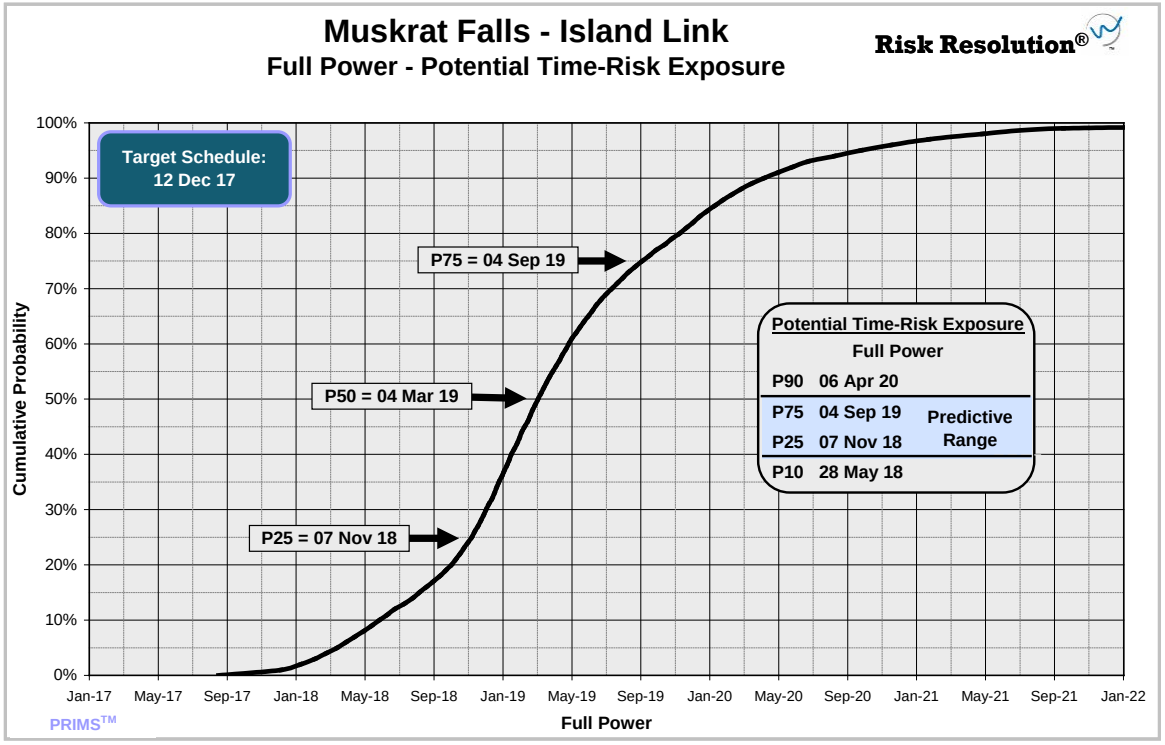
Potential Strategic Risk Exposure

Description	Impact	Unmitigated (millions)	Mitigated (millions)	Cost of Mitigation (millions)
Schedule / Time Risk				
• Schedule Extension – If weather, logistics, and / or productivity reduce the production rates required to meet the current schedule, a time extension will be the most economical solution to the issue due to the labour concerns in recovery or acceleration scenarios.	Time Extension	$ 0 M to $ 400 M		

Risk Adjusted Schedule Suggests Potential for an 11 to 21 Month Delay for Full Power

Results are largely driven by timing of Muskrat Falls Generation Facility. Major risks for facility are:

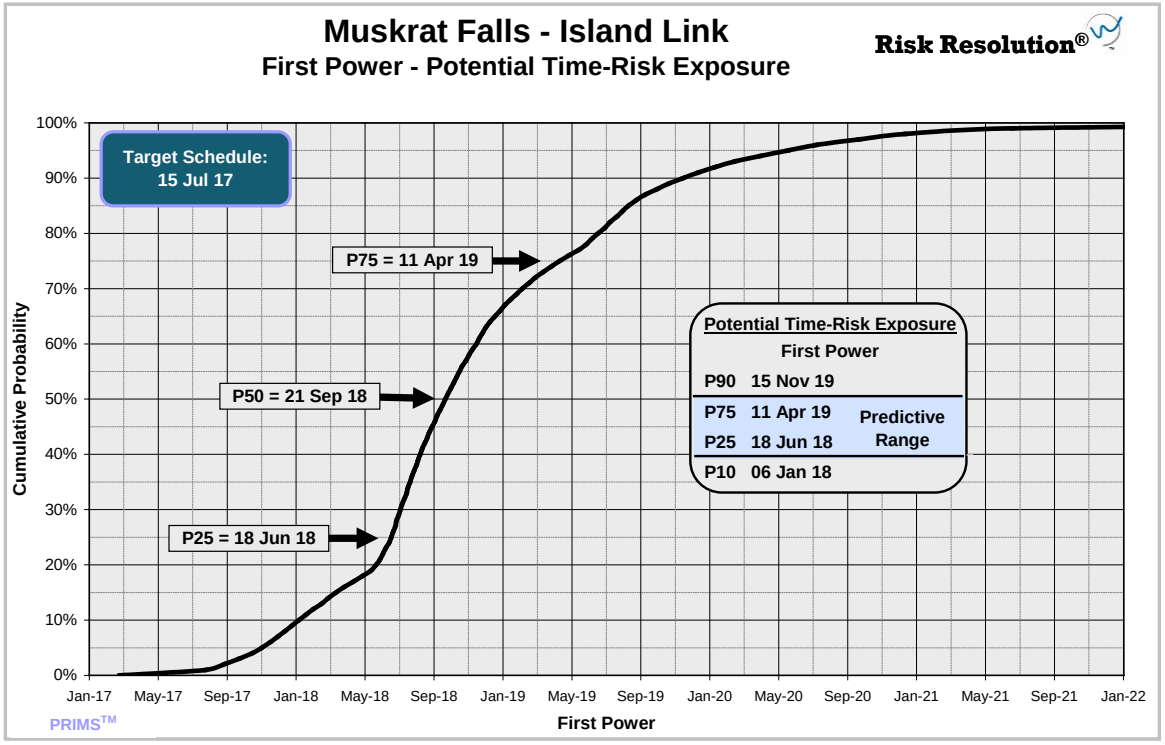
- *timely placement of concrete in powerhouse*
- *ability to place cofferdams and RCC dams while avoiding flooding*
- *availability of labour, skills, and front-line supervision*
- *weather windows*



Risk Adjusted Schedule Suggests Potential for an 11 to 21 Month Delay for First Power

Results are still largely driven by timing of Muskrat Falls Generation Facility. Major risks for facility are:

- *timely placement of concrete in powerhouse*
- *ability to place cofferdams and RCC dams while avoiding flooding*
- *availability of labour, skills, and front-line supervision*
- *weather windows*

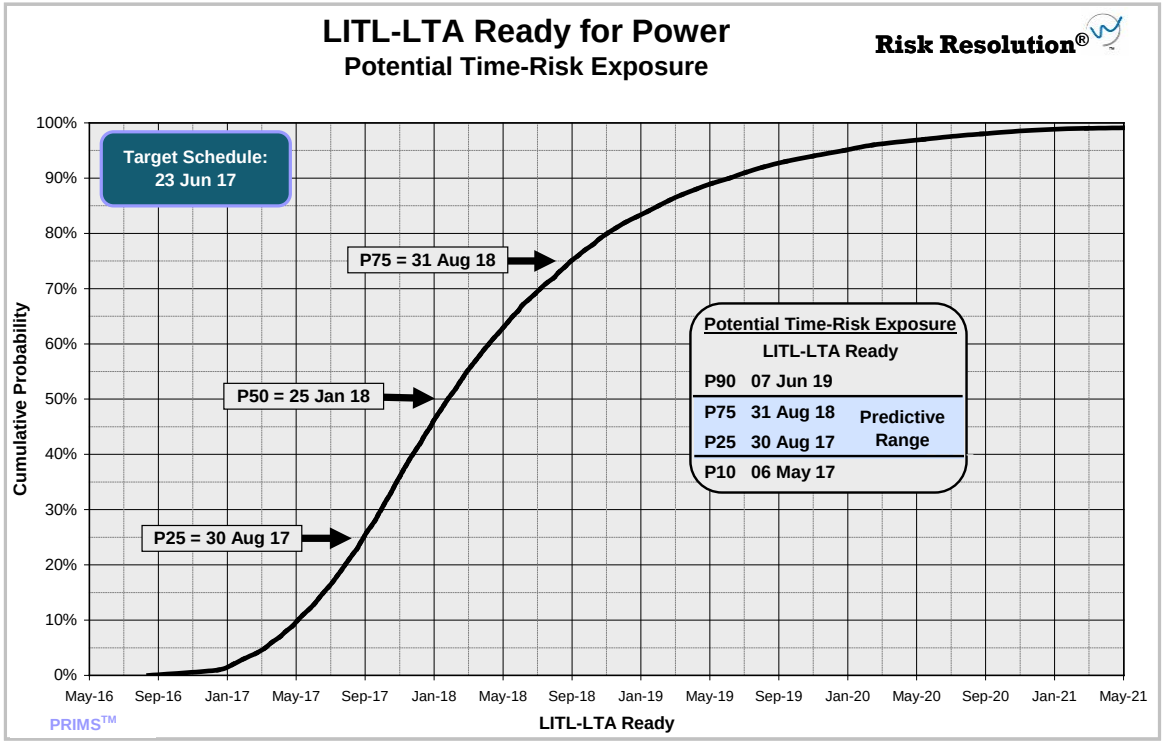


Risk Adjusted Schedule Suggests Potential for a 2 to 14 Month Delay for Transmission Capability

Results are driven by timing of Labrador – Island Transmission Link (including SOBI Crossing). Major risks for transmission capability are:

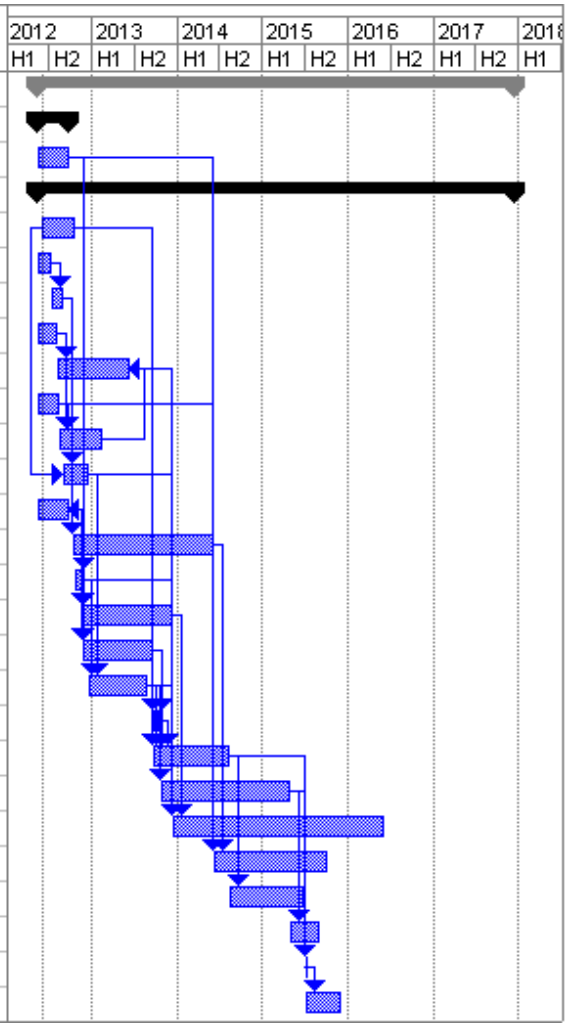
- *availability of labour, skills, and front-line supervision*
- *weather windows*

Note: Key risks associated with SOBI Crossing have been largely mitigated.



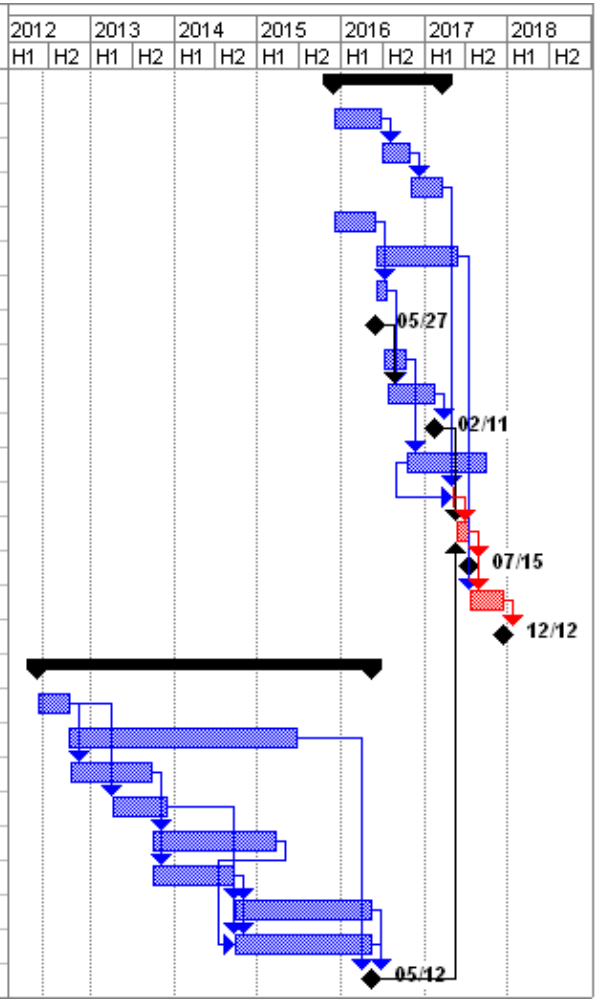
Time-risk Model

ID	Name	Duration	Start	Finish
0	**Nalcor Energy - Lower Churchill Project - May 2012**	**2039 d**	**05/14/12**	**12/12/17**
1	**Management**	**131 d**	**05/14/12**	**09/21/12**
2	Project Sanction	131 d	05/14/12	09/21/12
3	**Muskrat Falls**	**2039 d**	**05/14/12**	**12/12/17**
4	Southside Access Road (to PH)	142 d	06/01/12	10/20/12
5	Contract Award for Accomodations Complex	58 d	05/14/12	07/10/12
6	Manufacturing/Delivery Starter Accomodations	47 d	07/11/12	08/26/12
7	FE Analysis & PH Reinforcing Design (Prelim)	80 d	05/14/12	08/01/12
8	Contracting for Main Civil (CH0007) - from RFI	313 d	08/02/12	06/10/13
9	Selection of Preferred TG Bidder (CH0030)	94 d	05/14/12	08/15/12
10	Update CATIA & FE Analysis, Complete Reinforcing Design	180 d	08/16/12	02/11/13
11	Accomodations & Utilities - Starter Camp (150 Person)	110 d	08/30/12	12/17/12
12	Award Contract for Bulk Excavation (CH006)	131 d	05/14/12	09/21/12
13	T/Gs - Design & Fabrication	600 d	10/14/12	06/05/14
14	Construction Power (Post Road Construction)	35 d	10/21/12	11/24/12
15	Bulk Excavation - Powerhouse & Related Structures	385 d	11/20/12	12/09/13
16	Bulk Excavation - Spillway & Prep Foundation for Riverside Cofferdam	299 d	11/20/12	09/14/13
17	Accomodations & Utilities (Manuf/Del/Inst/comm) - Ph 2 (Complete)	250 d	12/18/12	08/24/13
18	Riverside (RCC) Cofferdam to El 16m (Seasonal)	30 d	09/15/13	10/14/13
19	Spillway Structure/concreting	330 d	09/15/13	08/10/14
20	North Spur (Pre-Headpond)	550 d	10/24/13	04/26/15
21	Concreting & Embedments - Service Bay & Unit 1	900 d	12/10/13	05/27/16
22	T/Gs - Manufacturing & Delivery - Unit 1	480 d	06/06/14	09/28/15
23	Spillway Hydromechanical	315 d	08/11/14	06/21/15
24	North Spur (Completion)	120 d	04/27/15	08/24/15
25	Start of Upstream Main Cofferdam (Seasonal)	1 d	07/01/15	07/01/15
26	Upstream Main Cofferdam (Seasonal)	150 d	07/02/15	11/28/15



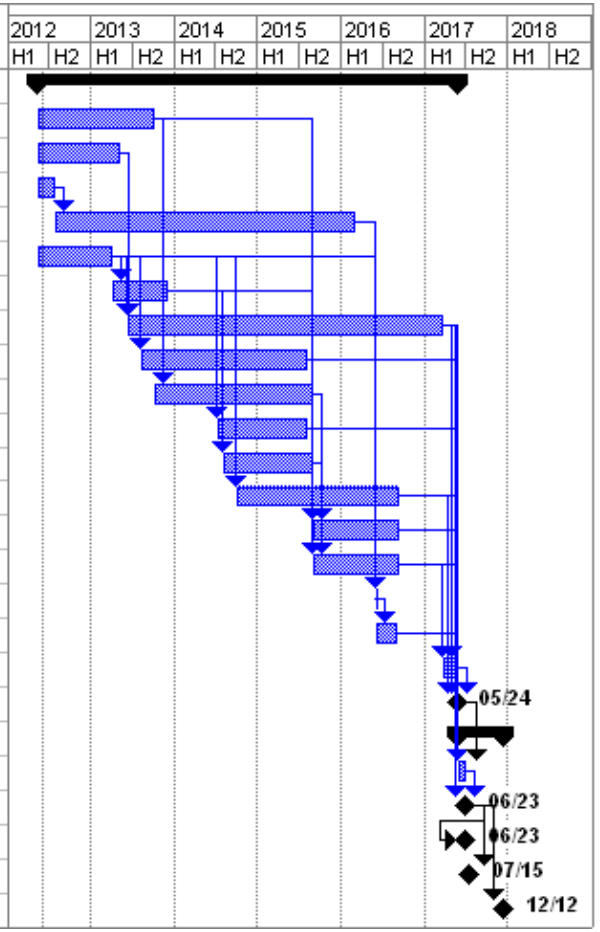
Time-risk Model (cont.)

ID	Name	Duration	Start	Finish
27	**North RCC Dam c/w CVC Face**	**480 d**	**11/29/15**	**03/22/17**
28	Foundation Prep & Mud Slab	210 d	11/29/15	06/25/16
29	RCC Placement (Seasonal)	120 d	06/26/16	10/23/16
30	CVC Cap and Downstream Face	150 d	10/24/16	03/22/17
31	Powerhouse Superstructure (For crane)	180 d	11/30/15	05/27/16
32	Units 2-4 (Remainder of Primary & secondary Concrete + unit assembly)	360 d	05/28/16	05/22/17
33	Main Powerhouse Crane Installation - Unit 1	50 d	05/28/16	07/16/16
34	Pit Free Unit 1	0 d	05/27/16	05/27/16
35	Install Spillway Bay - Rollways #1 & 2 (Seasonal)	105 d	07/01/16	10/13/16
36	Turbine & Generator Assembly - Unit 1	210 d	07/17/16	02/11/17
37	Ready to Turn - Unit 1	0 d	02/11/17	02/11/17
38	Install Spillway Bay - Rollways #3, 4 & 5 (Seasonal)	125 d	10/14/16	09/30/17
39	Impound Reservoir	16 d	05/01/17	05/16/17
40	Wet Testing - Unit 1	60 d	05/17/17	07/15/17
41	Ready for Commerical Power - Unit 1 (First Power)	0 d	07/15/17	07/15/17
42	Wet Testing & Commissioning - Units 2-4	150 d	07/16/17	12/12/17
43	Ready for Commerical Power - Units 2-4 (Full Power)	0 d	12/12/17	12/12/17
44	**Labrador Transmission Assets**	**1460 d**	**05/14/12**	**05/12/16**
45	Design of Hvac Switchyards (to RFI)	140 d	05/14/12	09/30/12
46	Hvac Overland Constr. Labrador Seg 1 + Seg 2 (incl. clearing & infra.)	1000 d	09/24/12	06/20/15
47	Procurement Process to Contract Award - Switchyard Components	360 d	10/01/12	09/25/13
48	Earthworks at MF & CF Switchyards	240 d	04/08/13	12/03/13
49	Vendor Design, Fabrication & Delivery - Transformer	540 d	09/26/13	03/19/15
50	Vendor Design, Fabrication & Delivery - Switchgear, etc	360 d	09/26/13	09/20/14
51	Hvac Switchyard - Muskrat Falls	600 d	09/21/14	05/12/16
52	Hvac Switchyard - Churchill Falls	600 d	09/21/14	05/12/16
53	LTA Ready for Power transmission	0 d	05/12/16	05/12/16



Time-risk Model (cont.)

ID	Name	Duration	Start	Finish
54	**Labrador - Island Transmission Link**	**1837 d**	**05/14/12**	**05/24/17**
55	Engineering, Contracting & Proc. for Converter Stations (to award)	510 d	05/14/12	10/05/13
56	Engineering & Procurment - HVdc Tower Steel (to First Deliveries)	360 d	05/14/12	05/08/13
57	SOBI Cable Award	78 d	05/14/12	07/30/12
58	SOBI Cable Design & Supply	1310 d	07/31/12	03/01/16
59	LITL EA Release	323 d	05/14/12	04/01/13
60	Earthworks for LITL Conv Stns & SY	246 d	04/02/13	12/03/13
61	HVdc TL Overland Construction - Island + Labrador	1380 d	06/11/13	03/21/17
62	SOBI Shoreline Protection (HDD)	727 d	08/05/13	08/01/15
63	Vendor Design, Procurement, Fab. & Delivery for Converter Stations	690 d	10/06/13	08/26/15
64	Transition Compounds (Labrador & Island)	390 d	07/07/14	07/31/15
65	Converter Stations - Bldgs, etc (non-equipment)	390 d	08/01/14	08/25/15
66	Soldier's Pond Switchyard & Sync Condeners	705 d	10/01/14	09/04/16
67	Converter Station - Muskrat Falls (INCL site Dynamic Comm)	375 d	08/27/15	09/04/16
68	Converter Station - Soldier's Pond (EXCL site Dynamic Comm)	375 d	08/27/15	09/04/16
69	Start of SOBI Cable Installation	1 d	06/01/16	06/01/16
70	SOBI Cable Install. (all 3 cables - protection not complete) & Testing	92 d	06/02/16	09/01/16
71	Dynamic Comm of SP CS (Need dc TX)	64 d	03/22/17	05/24/17
72	LITL System Ready for Overall System Commissioning	0 d	05/24/17	05/24/17
73	**Ready for Operations**	**202 d**	**05/25/17**	**12/12/17**
74	LITL System Testing & Commissioning	30 d	05/25/17	06/23/17
75	Labrador-Island Transmission Link In-Service	0 d	06/23/17	06/23/17
76	Power Transmission to Island via LITL-LTA	0 d	06/23/17	06/23/17
77	Power Transmission to Island via LITL-MF (First Power)	0 d	07/15/17	07/15/17
78	Power Transmission to Island via LITL-MF (Full Power)	0 d	12/12/17	12/12/17



Time-risk ranging sheet

Lower Churchill Project Time-Risk Assessment
Ranging Sheet

		Time-Risk Model			Task Duration	
ID	Task Description	Duration	Start	Finish	Best	Worst
01	**Management**	**131 d**	**14-May-12**	**21-Sep-12**		
02	Project Sanction	131 d	14-May-12	21-Sep-12	131	191
03	**Muskrat Falls**	**2039 d**	**14-May-12**	**12-Dec-17**		
04	Southside Access Road (to PH)	142 d	1-Jun-12	20-Oct-12	135	172
05	Contract Award for Accomodations Complex	58 d	14-May-12	10-Jul-12	118	178
06	Manufacturing/Delivery Starter Accomodations	47 d	11-Jul-12	26-Aug-12	40	61
07	FE Analysis & PH Reinforcing Design (Prelim)	80 d	14-May-12	1-Aug-12		
08	Contracting for Main Civil (CH0007) - from RFI	313 d	2-Aug-12	10-Jun-13	313	403
09	Selection of Preferred TG Bidder (CH0030)	94 d	14-May-12	15-Aug-12	87	120
10	Update CATIA & FE Analysis, Complete Reinforcing Design	180 d	16-Aug-12	11-Feb-13	150	220
11	Accomodations & Utilities - Starter Camp (150 Person)	110 d	30-Aug-12	17-Dec-12	89	150
12	Award Contract for Bulk Excavation (CH006)	131 d	14-May-12	21-Sep-12	116	161
13	T/Gs - Design & Fabrication	600 d	14-Oct-12	5-Jun-14	480	660
14	Construction Power (Post Road Construction)	35 d	21-Oct-12	24-Nov-12	28	42
15	Bulk Excavation - Powerhouse & Related Structures	385 d	20-Nov-12	9-Dec-13	325	475
16	Bulk Excavation - Spillway & Prep Foundation for Riverside Cofferdam	299 d	20-Nov-12	14-Sep-13	269	389
17	Accomodations & Utilities (Manuf/Del/Inst/comm) - Ph 2 (Complete)	250 d	18-Dec-12	24-Aug-13	220	320
18	Riverside (RCC) Cofferdam to El 16m (Seasonal)	30 d	15-Sep-13	14-Oct-13	25	40
19	Spillway Structure/concreting	330 d	15-Sep-13	10-Aug-14	285	450
20	North Spur (Pre-Headpond)	550 d	24-Oct-13	26-Apr-15	490	640
21	Concreting & Embedments - Service Bay & Unit 1	900 d	10-Dec-13	27-May-16	810	1,300
22	T/Gs - Manufacturing & Delivery - Unit 1	480 d	6-Jun-14	28-Sep-15	420	540
23	Spillway Hydromechanical	315 d	11-Aug-14	21-Jun-15	270	360
24	North Spur (Completion)	120 d	27-Apr-15	24-Aug-15	105	150

Time-risk ranging sheet

Lower Churchill Project Time-Risk Assessment
Ranging Sheet

		Time-Risk Model			Task Duration	
ID	Task Description	Duration	Start	Finish	Best	Worst
25	**Start of Upstream Main Cofferdam (Seasonal)**	**1 d**	**1-Jul-15**	**1-Jul-15**		
26	Upstream Main Cofferdam (Seasonal)	150 d	2-Jul-15	28-Nov-15	100	150
27	**North RCC Dam c/w CVC Face**	**480 d**	**29-Nov-15**	**22-Mar-17**		
28	Foundation Prep & Mud Slab	210 d	29-Nov-15	25-Jun-16	180	240
29	RCC Placement (Seasonal)	120 d	26-Jun-16	23-Oct-16	90	150
30	CVC Cap and Downstream Face	150 d	24-Oct-16	22-Mar-17	60	180
31	Powerhouse Superstructure (For crane)	180 d	30-Nov-15	27-May-16	150	210
32	Units 2-4 (Remainder of Primary & secondary Concrete + unit assembly)	360 d	28-May-16	22-May-17	330	420
33	Main Powerhouse Crane Installation - Unit 1	50 d	28-May-16	16-Jul-16	43	57
34	**Pit Free Unit 1**	**0 d**	**27-May-16**	**27-May-16**		
35	Install Spillway Bay - Rollways #1 & 2 (Seasonal)	105 d	1-Jul-16	13-Oct-16	90	135
36	Turbine & Generator Assembly - Unit 1	210 d	17-Jul-16	11-Feb-17	165	255
37	**Ready to Turn - Unit 1**	**0 d**	**11-Feb-17**	**11-Feb-17**		
38	Install Spillway Bay - Rollways #3, 4 & 5 (Seasonal)	125 d	14-Oct-16	30-Sep-17	110	170
39	Impound Reservoir	16 d	1-May-17	16-May-17	9	23
40	Wet Testing - Unit 1	60 d	17-May-17	15-Jul-17	30	90
41	**Ready for Commerical Power - Unit 1 (First Power)**	**0 d**	**15-Jul-17**	**15-Jul-17**		
42	Wet Testing & Commissioning - Units 2-4	150 d	16-Jul-17	12-Dec-17	120	210
43	**Ready for Commerical Power - Units 2-4 (Full Power)**	**0 d**	**12-Dec-17**	**12-Dec-17**		

Time-risk ranging sheet

Lower Churchill Project Time-Risk Assessment
Ranging Sheet

		Time-Risk Model			Task Duration	
ID	Task Description	Duration	Start	Finish	Best	Worst
44	**Labrador Transmission Assets**	**1460 d**	**14-May-12**	**12-May-16**		
45	Design of Hvac Switchyards (to RFI)	140 d	14-May-12	30-Sep-12	140	200
46	Hvac Overland Construction Labrador Seg 1 + Seg 2 (Incl Clearing & infrastruc	1000 d	24-Sep-12	20-Jun-15	960	1,100
47	Procurement Process to Contract Award - Switchyard Components	360 d	1-Oct-12	25-Sep-13	300	420
48	Earthworks at MF & CF Switchyards	240 d	8-Apr-13	3-Dec-13	150	270
49	Vendor Design, Fabrication & Delivery - Transformer	540 d	26-Sep-13	19-Mar-15	390	720
50	Vendor Design, Fabrication & Delivery - Switchgear, etc	360 d	26-Sep-13	20-Sep-14	300	450
51	Hvac Switchyard - Muskrat Falls	600 d	21-Sep-14	12-May-16	420	690
52	Hvac Switchyard - Churchill Falls	600 d	21-Sep-14	12-May-16	420	690
53	**LTA Ready for Power transmission**	**0 d**	**12-May-16**	**12-May-16**		

Time-risk ranging sheet

Lower Churchill Project Time-Risk Assessment
Ranging Sheet

		Time-Risk Model			Task Duration	
ID	Task Description	Duration	Start	Finish	Best	Worst
54	**Labrador - Island Transmission Link**	**1837 d**	**14-May-12**	**24-May-17**		
55	Engineering, Contracting & Procurement for Converter Stations (to award)	510 d	14-May-12	5-Oct-13	330	600
56	Engineering & Procurment - HVdc Tower Steel (to First Deliveries)	360 d	14-May-12	8-May-13	300	480
57	SOBI Cable Award	78 d	14-May-12	30-Jul-12	18	138
58	SOBI Cable Design & Supply	1310 d	31-Jul-12	1-Mar-16	1,160	1,370
59	LITL EA Release	323 d	14-May-12	1-Apr-13	293	413
60	Earthworks for LITL Conv Stns & SY	246 d	2-Apr-13	3-Dec-13	186	306
61	HVdc TL Overland Construction - Island + Labrador	1380 d	11-Jun-13	21-Mar-17	1,200	1,745
62	SOBI Shoreline Protection (HDD)	727 d	5-Aug-13	1-Aug-15	667	907
63	Vendor Design, Procurement, Fabrication & Delivery for Converter Stations	690 d	6-Oct-13	26-Aug-15	600	810
64	Transition Compounds (Labrador & Island)	390 d	7-Jul-14	31-Jul-15	330	480
65	Converter Stations - Bldgs, etc (non-equipment)	390 d	1-Aug-14	25-Aug-15	300	450
66	Soldier's Pond Switchyard & Sync Condeners	705 d	1-Oct-14	4-Sep-16	525	765
67	Converter Station - Muskrat Falls (INCL site Dynamic Comm)	375 d	27-Aug-15	4-Sep-16	315	435
68	Converter Station - Soldier's Pond (EXCL site Dynamic Comm)	375 d	27-Aug-15	4-Sep-16	315	435
69	**Start of SOBI Cable Installation**	**1 d**	**1-Jun-16**	**1-Jun-16**		
70	SOBI Cable Install. (all 3 cables - protection not complete) & Testing	92 d	2-Jun-16	1-Sep-16	62	137
71	Dynamic Comm of SP CS (Need dc TX)	64 d	22-Mar-17	24-May-17	54	94
72	**LITL System Ready for Overall System Commissioning**	**0 d**	**24-May-17**	**24-May-17**		
73	**Ready for Operations**	**202 d**	**25-May-17**	**12-Dec-17**		
74	LITL System Testing & Commissioning	30 d	25-May-17	23-Jun-17	20	90
75	**Labrador-Island Transmission Link In-Service**	**0 d**	**23-Jun-17**	**23-Jun-17**		
76	**Power Transmission to Island via LITL-LTA**	**0 d**	**23-Jun-17**	**23-Jun-17**		
77	**Power Transmission to Island via LITL-MF (First Power)**	**0 d**	**15-Jul-17**	**15-Jul-17**		
78	**Power Transmission to Island via LITL-MF (Full Power)**	**0 d**	**12-Dec-17**	**12-Dec-17**		

It is important to note that the scope of work for Westney Consulting Group was for Westney to guide and facilitate the Risk Resolution® Process, using the consultants' experience to ask the right questions and, where appropriate, challenge the Nalcor Energy participant's thinking. This resulted in an outcome of the analysis that represented the best thinking and efforts of both the Nalcor Energy participants and the consultants from Westney.