SOBI Decision Recommendation

12 October 2010

Boundless Energy

nalcor energy
LOWER CHURCHILL PROJECT

Background

- Two options for crossing of the SOBI have been diligently pursued.
  - Option 1 – Seabed Crossing
  - Option 2 – Tunnel / Conduit Crossing
- To achieve a technically sound crossing solution, implementation of various technologies including the cables, installation, and protection was required.

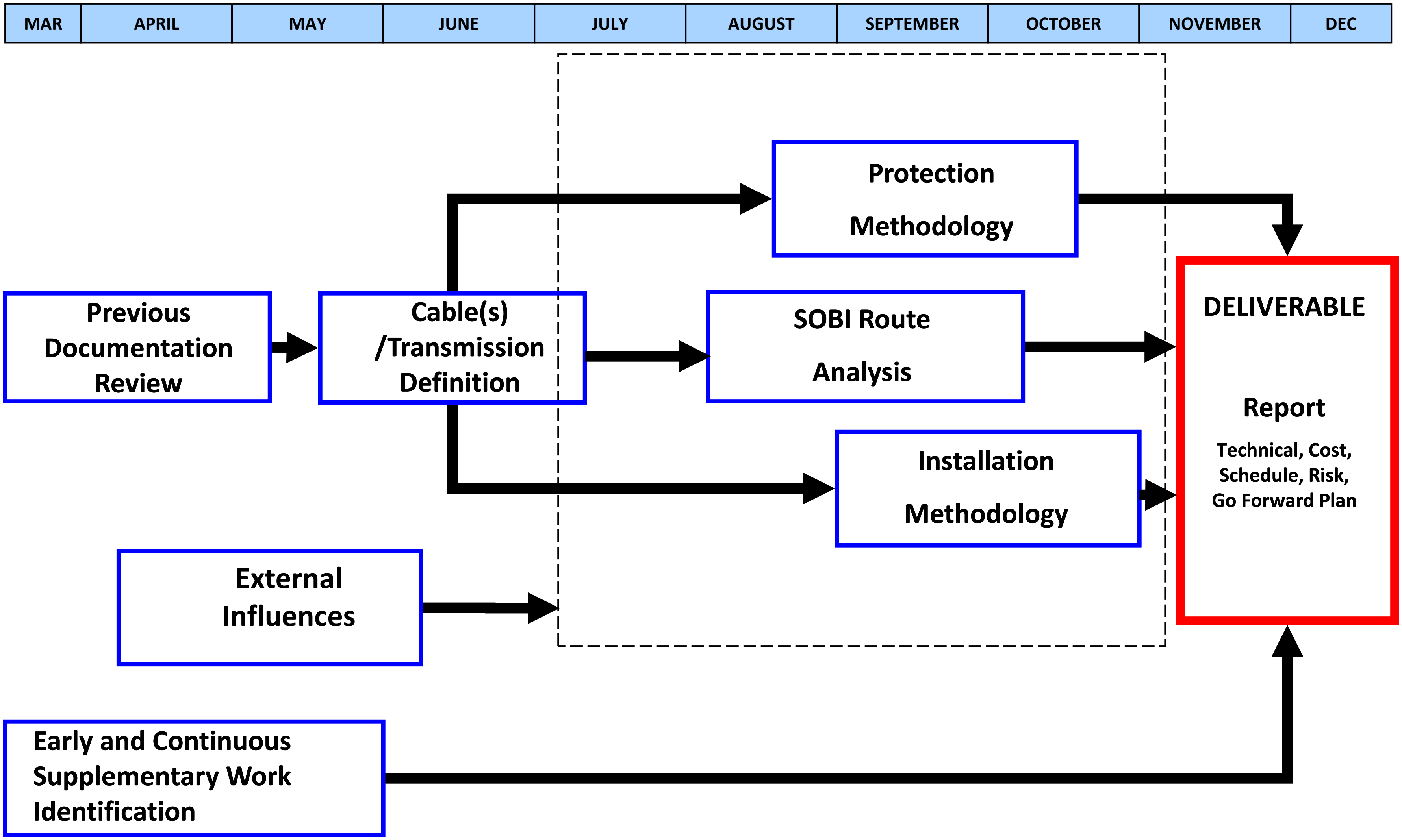
Key Points

- Significant technical uncertainties previously existed for both options.
- Extensive site investigations and engagement of national / international experts have resulted in acquisition of the data required to make this recommendation.
- The SOBI has been identified as the greatest technical challenge which presents the greatest technical risk to the project.

Conceptual Design Methodology

- Built team from local East Coast resource pool with marine mega-project experience.
- Developed plan for execution of the design taking into account all influencing factors.
- Mandate was to exhaust all potential solutions and technical alternatives for a subsea cable crossing in the Strait.
- Engage world class companies / vendors / specialists to understand all influences and technologies.
- Assess alternatives (technical, environmental, safety, cost, schedule) to select the conceptual design.

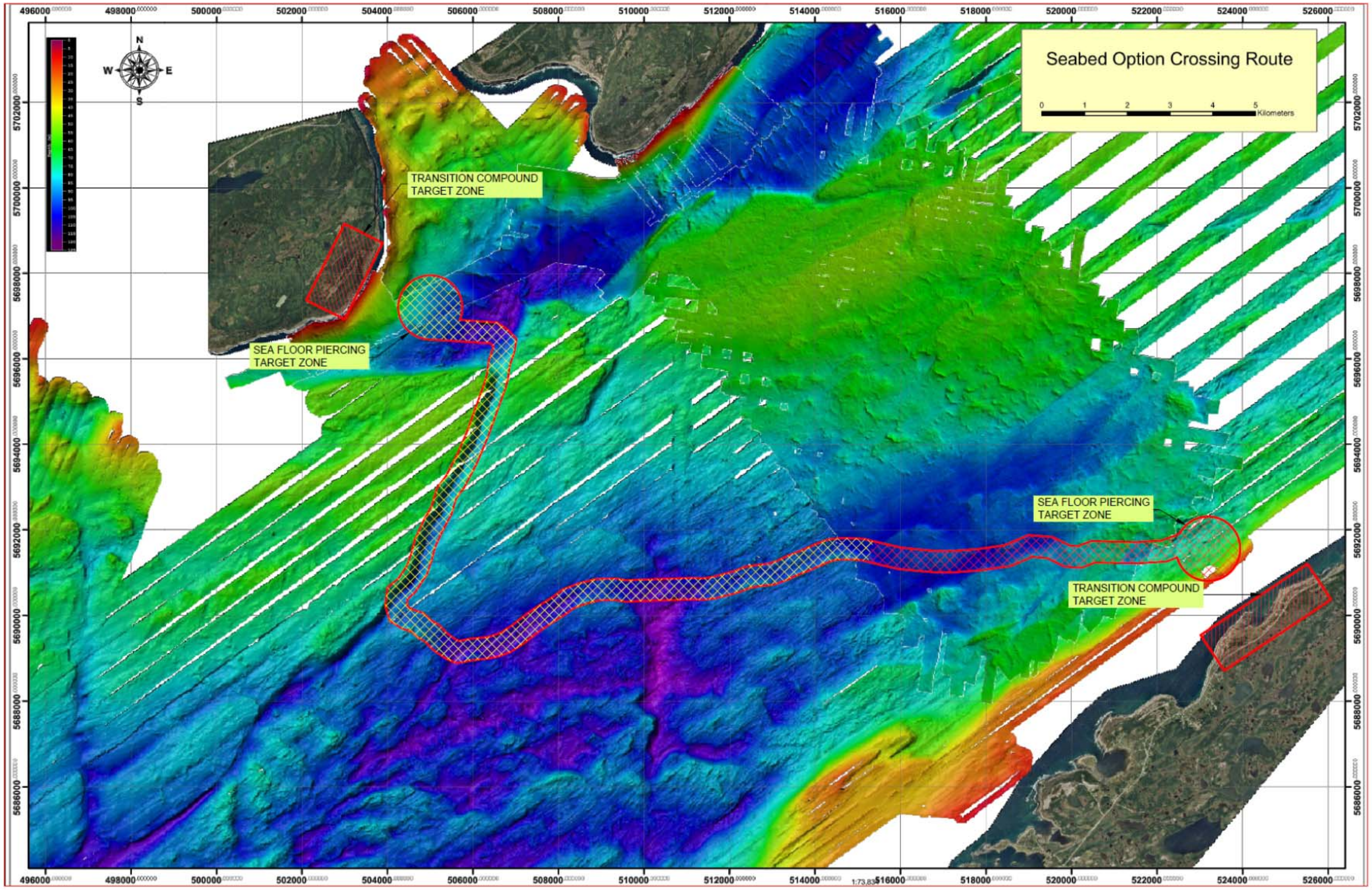
Option 1 – Seabed Crossing



Seabed Conceptual Design

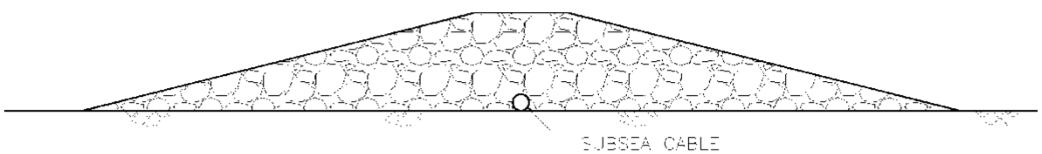
- Three (2 plus one spare) Mass Impregnated (MI) cables – each nominally 34 km in length (102 km in total).
- Route selected to avoid iceberg scour on seabed and minimize impact of external influences.
- Dedicated ~ 2 km horizontal directionally drilled (HDD) hole to nominally 75 m water depth for each cable at both shorelines (NL and LAB) – 6 HDD holes (12 km in total).
- Each cable protected by a dedicated rock berm (30 km long) between bore hole exit locations – nominally 1 million tonnes of rock (90 km in total length).

Conceptual Seabed Routing

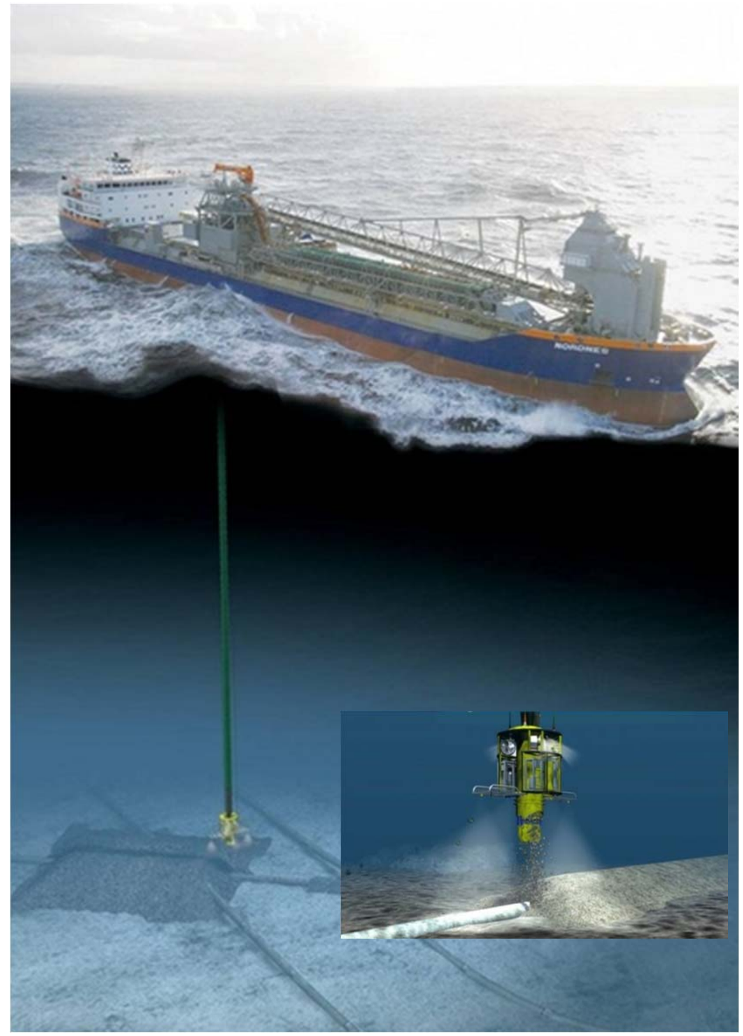


Horizontal Direction Drilling (HDD)

Rock Placement



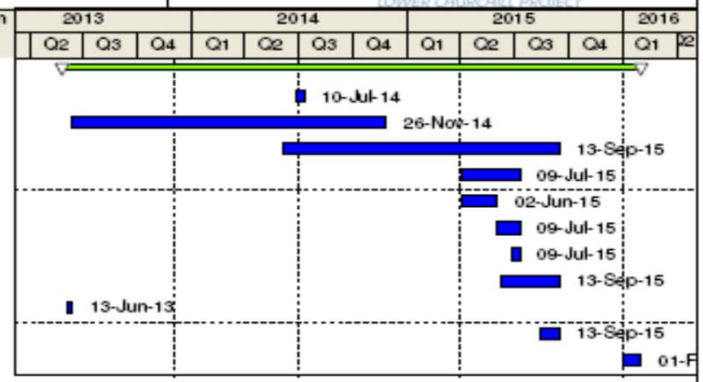
TYPICAL ROCKBERM CROSS SECTION



Seabed – Installation Schedule

SOBI SEABED INSTALLATION SCHEDULE

WBS Name	Start	Finish	Duration (Days)
SOBI, SEABED INSTALLATION SCHEDULE	27-May-13	01-Feb-16	990
LEVELING (INCL. PRE/POST SURVEY)	26-Jun-14	10-Jul-14	15
HORIZONTAL DIRECTIONAL DRILLING (INCL. PRE-WORKS)	13-Jun-13	26-Nov-14	530
ROCK CRUSHING	05-Jun-14	13-Sep-15	375
CABLE INSTALLATION	01-Apr-15	09-Jul-15	63
MOBILIZATION (EUROPE & NL)	01-Apr-15	02-Jun-15	25
INSTALLATION CAMPAIGN	03-Jun-15	09-Jul-15	23
DE-MOBILIZATION	25-Jun-15	09-Jul-15	15
ROCK BERM (TWO VESSELS)	08-Jun-15	13-Sep-15	95
TRANSITION COMPOUNDS PRE-HDD	03-Jun-13	13-Jun-13	10
TRANSITION COMPOUNDS POST- ROCK DUMPING	14-Aug-15	13-Sep-15	30
COMMISSIONING	01-Jan-16	01-Feb-16	30



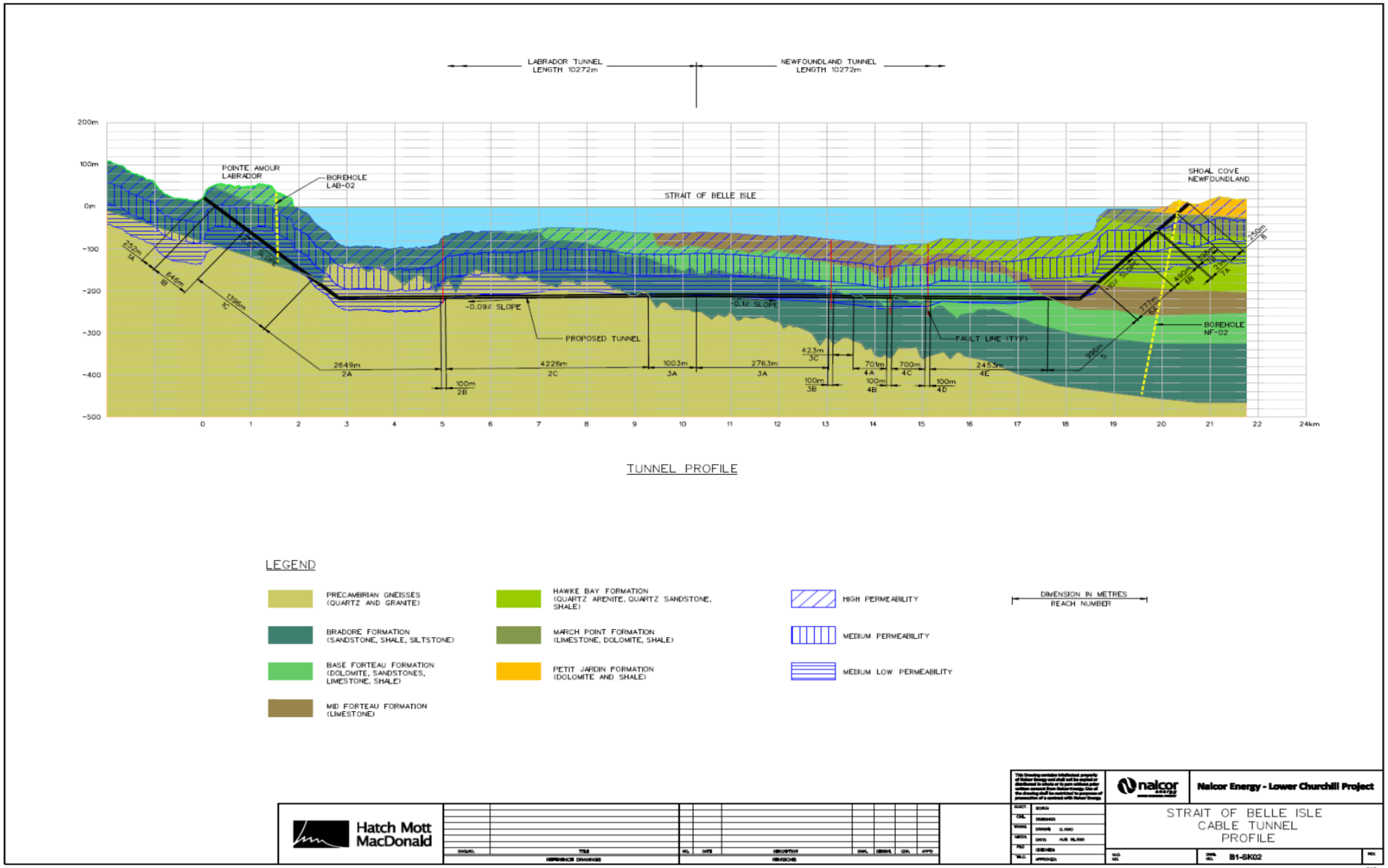
Summary
WBS Elements below Project

Date	Revision	Checked	Approved	(c) Primavera Systems, Inc.
14-Sep-10	SOBI SEABED INSTALLATION SCHEDULE	CWF		

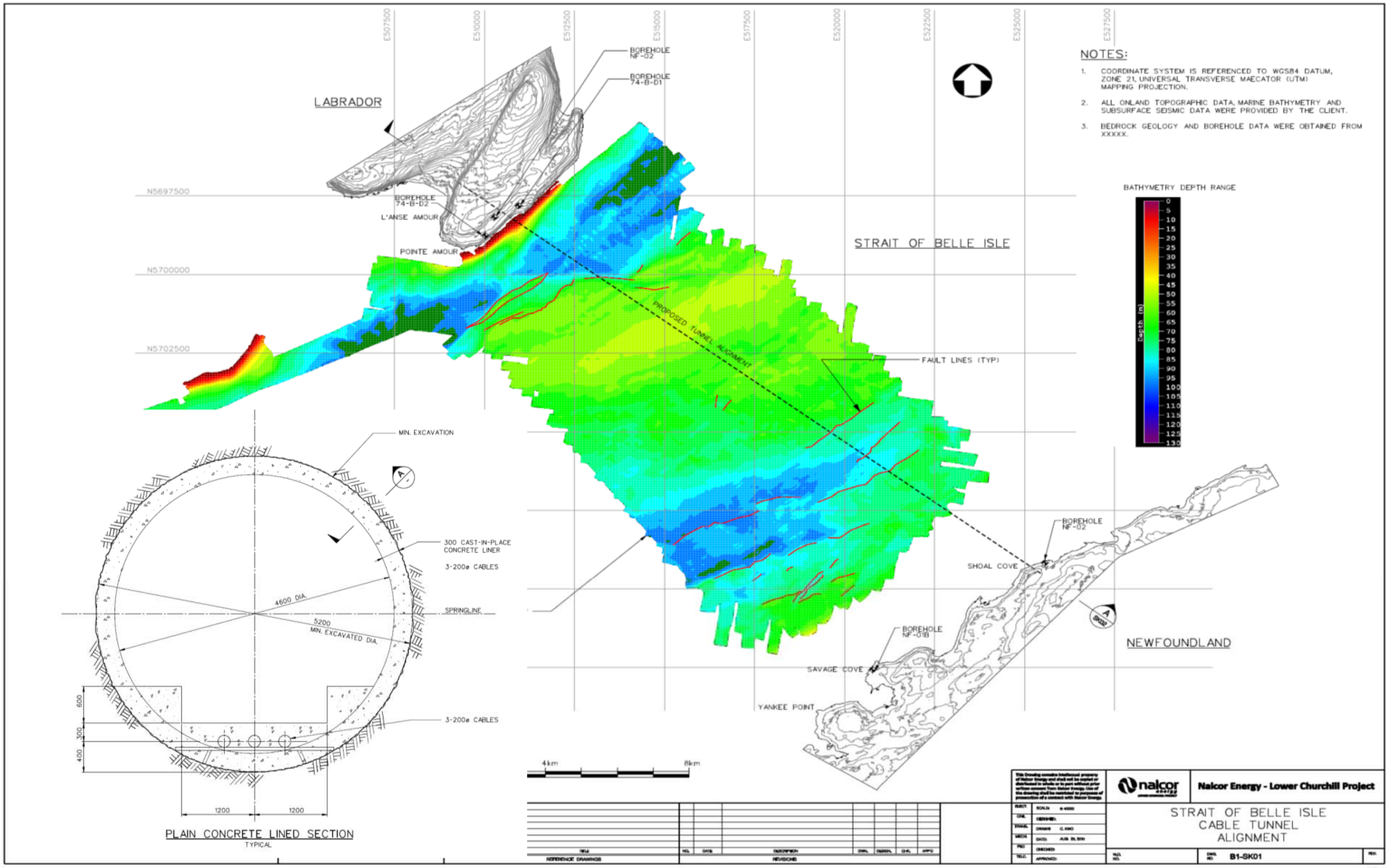
Option 2 - Cable Tunnel / Conduit

- Three (2 plus one spare) Mass Impregnated (MI) cables – each nominally 21 km in length (63 km in total).
- ~20.5 km long tunnel (with ~17.5 km subsea).
- Tunnel depth at ~200 m below sea level.
- 5.2 m outside diameter using a tunnel boring machine
- Fully lined (necessary for water ingress management and long-term tunnel stability) with a 4.6 m inside diameter.
- Base case for tunnel to be flooded after cable installation.
- De-watered duration is ~ 90 days, if required.

Tunnel Conceptual Profile



Plan View & Cross Section of Tunnel



Option Comparison

- To determine the best possible way forward for Nalcor based on technical, cost, schedule, and strategic positioning, a comparison was performed.
- Both options were evaluated using a risk register with key risk areas that include technical feasibility, safety, cost, schedule, contingency planning, and geological complexity.
- After reasonable mitigation the severity level and likelihood of occurrence of each major risk was determined as per the Nalcor Risk Matrix.
- Risks which fall into the **red** category are deemed unacceptable and considered as showstoppers.

Nalcor Risk Matrix

				IMPACT*				
				Insignificant	Minor	Moderate	Major	Extreme
				1	2	3	4	5
				An event that has virtually no impact.	An event that could be considered as minor and of no lasting consequence.	An event that causes a disruption in performance levels without suspending operations	An event that results in substantial losses and that forces a suspension of certain operations for a period of time, or that permanently compromises the ability to realize one or more Corporate goals.	A catastrophic event that forces the suspension of all operations over a sustained time frame, perhaps permanently.
LIKELIHOOD: Almost Certain	5	>90%	Almost inevitable that this event will occur unless circumstances change	Low	Medium	High	High	High
LIKELIHOOD: Likely	4	>50% to 90%	Likely to occur in most circumstances	Low	Medium	Medium	High	High
LIKELIHOOD: Possible	3	1% to 50%	Might occur under certain circumstances	Low	Low	Medium	Medium	High
LIKELIHOOD: Unlikely	2	0.01% to < 1%	Remote possibility of occurrence	Low	Low	Medium	Medium	Medium
LIKELIHOOD: Rare	1	< 0.01%	Rare or Extremely Improbable - An unusual combination of factors would be required for the event to occur	Low	Low	Low	Low	Medium

* For further guidance in the assessment of impact, refer to the Impact Measurement Tool and also the Financial Impact Matrix.

Risk Analysis Summary

- **Option 1 Seabed** – There were no risks after mitigation which were identified as red.

- **Option 2 Tunnel / Conduit**– There were 5 risks identified as red, even after mitigation, in key risk areas.

*The following slides discuss these 5 key risk areas for both options.

Risk Results

Criteria	Tunnel	Seabed
Technical Feasibility		
Safety		
Cost Certainty		
Schedule Certainty		
Fall-back Options		
Geological Risk		

Low Risk | Moderate Risk | Severe Risk

- Risk identification has yielded 5 key risks with the tunnel option that cannot be mitigated below red.

Option 2 Tunnel - Showstoppers

- **Geological Risk** - Seismic work has identified 4 major faults, rock formations with various degrees of permeability, and areas of geological uncertainty - impact is the potential for significant water ingress / flooding potentially leading to cost increase and schedule delay. This is difficult to engineer-out prior to construction.
- **Schedule** - Construction schedule is on the critical path with no flexibility. Worldwide tunnel construction experience indicates that tunnel construction has a high degree of schedule uncertainty, with major delays common.
- **Cost and Schedule Overrun Exposure** - The experience with subsea tunnels and tunnels in general is that geological faults and unknown conditions often result in significant cost overruns.
- **Safety During Construction** - The design of the tunnel is such that water ingress rates have potential to exceed pumping capacity and may result in the tunnel egress becoming flooded – potentially endangering the lives of construction personnel.
- **Fall Back Options** – If during tunnel construction geological complications that cannot be managed are encountered and tunnel abandonment is necessary, there is ***no*** fall back option other than reverting to implementation of the seabed option.

Option 1 Seabed – No Showstoppers

- **Technical Feasibility** – HDD technology well proven. Significant East Coast marine installation experience and expertise in-house wrt rock placement and cable laying.
- **Geological Risk** – Minor – low cost impact on HDD. Many drilling techniques available to overcome risks.
- **Schedule** – Construction schedule is relatively short with considerable execution float / tolerance for schedule delays and interdependencies.
- **Cost and Schedule Overrun Exposure** – High confidence in the seabed cost certainty and schedule.
- **Safety During Construction** – Standard construction techniques that are regularly employed globally with well known safety risks and mitigations.
- **Fall Back Options** – Various fallback options both technically and for the schedule.

Potential Capital Cost Increases

Seabed

- Uncertainty in rock quarry and quay location could result in an increase of up to ***$35 MM.***
- If fallback options are required, cost impact could nominally be ***$25 MM*** with potential to roll into 2016 campaign but not affect first power.
- Geological uncertainty worst case impact on HDD would be schedule delays and requirement of one extra hole per side, nominally ***$15 MM.***
- Cable installation methodology is well understood, however, complications could be encountered during long HDD pull-in, cost impact would nominally be ***$5 MM.***

Tunnel

- Tunnel liner costs preliminary – cost exposure up to additional ***$25 - 50 MM.***
- Could be upwards of ***$100 MM*** for each year of overrun.
- If only option for fallback is the seabed, subsea cables would need to be ordered as base case for the tunnel and would increase installation complexity and increase cost by ***$50 MM***.
- Seabed fallback option would then cost ***$250 MM*** plus mark-up for vessels on short notice and major schedule delays.
- Cable installation methodology is complex and not completely understood. Cost impact of nominally ***$20 MM***.

Summary

- The previous SOBI crossing option studies were assessed and have proven to be unfounded from good design, safety or technical feasibility perspectives.
- Recent technology advancements in Horizontal Directional Drilling (HDD) have made the current seabed option technically and economically feasible.
- The seismic and drilling work for the tunnel option has identified faults, areas of geological uncertainty and variable rock permeability conditions across the tunnel length.
- Risk identification has yielded 5 key risks with the tunnel option that cannot be mitigated below red.

Recommendation

As based on the solutions outlined and the risk comparison performed the **Seabed Option** it is the recommended option and will be carried forward into the Environmental Assessment and detailed design. The following are key reasons in support of this decision:

- The seabed option has a lower capital cost with less upside risk potential and a more attractive spending profile with less cash exposure risk early in the project.
- The seabed option utilizes existing proven technology that has been implemented previously on numerous other global interconnector projects.
- The implementation schedule for the seabed option is extremely flexible and provides sufficient time in 2011 through 2013 to complete detailed design and understand and mitigate any risks.
- The construction schedule for the seabed option is relatively short with an earliest start date of spring 2014, hence having the ability to tolerate early project approval delays including the EA and permitting.
- The seabed option strategically builds internal competence and confidence that can be leveraged for future SOBI or other interconnector projects (Cabot Strait).