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To: koneill@nlh.nl.ca; janinemccarthy@nalcenergy.com
Cc: [Ed Bush](#); [Gilbert Bennett](#); [James Meaney](#); [Robert Woolgar](#)
Subject: Re: Update Q & As from OC
Date: Sunday, December 7, 2014 1:27:51 PM
Attachments: [_png](#)
[OC questions- Nalcor responses updated Dec 7th.docx](#)

Karen/janine

Here are my suggested responses. I am trying to lift the discussion on costs away from the details that will only bog the OC down in endless debates of no consequence on minor issues

Jim

Can you pls collate the responses and get to Craig on Monday

Robert

pls review especially the North Spur question regarding 2015 to 2017 River management etc- respond back to all on this note- feel free to correct any inaccurate statements

All

Feel free to adjust the responses- respond back to all on this email



OC questions- Nalcor responses updated Dec 7th.docx

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Karen O'Neill---12/05/2014 10:18:27 AM---Hey Folks, I've taken another look at the Q&As from the OC.

From: Karen O'Neill/NLHydro

To: [Gilbert Bennett/NLHydro@NLHydro](#), [Paul Harrington/NLHydro@NLHydro](#), [James Meaney/NLHydro@NLHYDRO](#), [Ed Bush/NLHydro@NLHYDRO](#),

Date: 12/05/2014 10:18 AM

Subject: Update Q & As from OC

Hey Folks,

I've taken another look at the Q&As from the OC.

I've updated the messages in most of these from what we sent over earlier this week. In some I've tweaked the wording and some I've added more (the North Spur mitigation measures).

The answers on the cost questions need a lot of work. Can someone spearhead adding the appropriate level of messages and detail in these answers.

Thanks

Karen

[attachment "Oversight Committee Questions - updated Dec 5 2014.docx" deleted by Paul Harrington/NLHydro]



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Draft for Discussion

Committee Questions

1. Progress on Powerhouse & Intake and the Spillway & Gates

The Committee observed that as of the end of September there is slippage from the planned vs. actual progress with respect to the work on the Powerhouse & Intake and the Spillway & Gates. Planned progress on the Powerhouse and Intake was 12.1% complete as compared to actual of 9.2% and planned progress on the Spillway and gates was 20.0% complete as compared to actual progress of 17.8% completion.

- a) Do these progress delays on the Powerhouse & Intake and the Spillway & Gates impact the Milestone Schedule or Project budget?

Overall, the Muskrat Falls Project remains on schedule and construction progress for the Muskrat Falls generating facility work is generally where we anticipated it to be at this point. The slippage in project schedule is largely due to a slower than anticipated mobilization and start up by Astaldi Canada. Nalcor is working closely with the contractor and measures have been put in place between Nalcor and Astaldi to address issues affecting progress. Based on the completed work to date, there are no impacts on the milestone schedule or the project budget and first power is on target for late 2017.

- b) What actions are being undertaken to address these delays?

Nalcor is working closely with Astaldi to address their work progress. Astaldi is responsible to take all necessary actions to address any variances between planned and actual progress on the Powerhouse and Intake and Spillway Gates (Contract CH0007). The contract format requires Astaldi to meet certain milestones or pay liquidated damages, this only could occur if/when a milestone is not achieved.

There are mitigating measures being taken on a number of fronts with Contract CH0007. These include:

- Regular dialogue between Nalcor and Astaldi leadership to address issues affecting progress.*
- Astaldi is mobilizing additional management resources and Nalcor is supporting the Astaldi initiatives to improve performance.*
- Astaldi has mobilized additional plant material and equipment.*
- Additional equipment being procured where required.*
- Working groups have been formed to address key focus areas including the Integrated Cover System (ICS), Powerhouse/Intakes, Winterization, Spillway, and Productivity.*

- *Review of methods to capitalize on opportunities i.e., combining pours, prefabrication opportunities, more work in the winter months than planned.*

These actions taken by both Nalcor and Astaldi are designed to improve production, productivity and regain the schedule to ensure there is no impact on the first power milestone date.

2. Integrated Cover Systems at Muskrat Falls Site

Nalcor has reported that the construction of the full Integrated Cover Systems will not be concluded prior to the onset of this winter 2014/15. What impact will this delay have on the progress at site during this season and the overall Project Schedule?

The construction and in service date of the Integrated Cover System (ICS) does not impact the overall schedule for the Muskrat Falls Project and it is not a requirement for the Muskrat Falls Project construction.

Work on the ICS is ongoing and it is a priority by Astaldi. Work is ongoing on pouring the concrete at the spillway, and progress is being made on the powerhouse. It's important to note that concrete can be poured throughout the winter regardless of the weather.

The construction of the ICS is being executed in accordance with Astaldi's baseline schedule for the project. The contractor has already commenced installation of structural steel for the portion of the ICS covering the intake and powerhouse for unit #3. The foundations and backfill work required to facilitate the installation of the structure across the remaining units has already been completed. Work is underway to provide a temporary wall between units #2 and #3 to facilitate the commencement of work for units #1 and #2.

Concrete work has commenced on the intakes for units #1, #2, #3 and #4 as well as the South Service Bay.

Timelines may change for individual work within the overall project, such as on the cover structure; however, this has not impacted the end date.

~~*Nalcor continues to monitor Astaldi's progress—the cover is a piece of that work. They are making progress on that and we're not seeing an impact on project schedule.*~~

In addition, the majority of the work on the hydroelectric generating facility is currently taking place in the spillway and not in the powerhouse. This work is taking place outside as planned. ~~The work will transition to the powerhouse in the coming~~

months as the ICS work is finalized. The Integrated Cover System is one way to provide shelter from the winter conditions, Astaldi are also using other equally successful methods of weather protection on the spillway construction using hoarding, temporary cover systems and heating, Astaldi and Nalcor will assess how best to achieve the weather protection for the powerhouse and achieve the schedule milestones.

3. Milestone Date Change for North Spur Ready for Diversion date

- a) Why was the schedule changed from the original Milestone date for the “North Spur Works Ready for Diversion”?

The change in the North Spur Ready for Diversion milestone date has been changed from 2015 to 2016. While the completion date for the North Spur works ready diversion has shifted later in the project work schedule from the original milestone schedule, this shift does not impact the schedule for first power from Muskrat Falls. This change will actually lower the project cost and reduce risk and it will provide the contractor with more time to complete the stabilization work. This change was made to allow the project team to take the appropriate time necessary to ensure that maximum value was derived for the project.

- b) Please clarify what work is planned for 2017 given the Planned Milestone date of November 2016.

The work planned to be completed in 2017 consists of the remaining work, above the winter headpond, that is required to be completed by the time that full reservoir impoundment occurs in fall of 2017. This takes the water level in the Churchill River reservoir from elevation 25m to full supply level of elevation 39m. ANSWER NEEDS MORE WORK FROM NALCOR

In order to understand the work which is planned to be carried out after the North Spur Milestone of November 2016 it is important to discuss the river management strategy during the construction of the Muskrat Falls facilities. This is a complex issue but can be summarized as follows:

- In November 2016 the plan is to divert the river through the Spillway, hence the spillway is on the project schedule critical path.
- Following diversion of the river through the spillway the spillway gates can be operated to control the flow
- The plan is to use the spillway gates to create a partial impoundment by creating a headpond upstream of Muskrat Falls elevation 25 mtrs commencing in November 2016
- The 25 mtrs headpond will create a stable ice cover upstream of MF
- The upstream stable ice cover will prevent the generation of the hanging ice dam downstream of Muskrat Falls which will lower the downstream river elevations and will facilitate the construction of the remaining structures at

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Muskrat Falls planned to be carried out from November 2016 to November 2017.

- The North Spur stabilization work is therefore synchronized to the river management plan. The partial impoundment in 2016 of 25 mtrs is required to create a headpond upstream of Muskrat Falls, avoid the downstream ice dam, negate the ice generating phenomena of the Muskrat upper falls by creating a stable upstream ice cover.
- The North Spur stabilization work required to be complete by November 2016 is to allow the impoundment to 25 mtrs which is only part of the full scope and the full scope of the North Spur stabilization work is required to be complete prior to full impoundment which is planned to be carried out November 2017. Therefore the stabilization work planned to be carried out between the partial impoundment November 2016 and the full impoundment November 2017 is above the 25 mtr elevation (plus a two mtr buffer) of the North Spur and the Full Supply Level of 39 mtrs

c) What impact does this change in plan have on the Project's critical path and delivery of power by the dates outlined in the Milestone schedule?

The Project Critical Path, including delivery of first power, is not impacted as a result of this change.

d) Does this change introduce risk that the other Milestone dates may not be achieved?

The planned three-season construction approach will reduce project ~~cost and~~ risk.

As noted above, the Project Critical Path, including delivery of first power, is not impacted as a result of this change.

4. Variances from Planned vs. Incurred Costs table

The Committee observed that the cumulative costs to September 2014 are tracking slightly higher than planned with an expenditure variance of 0.5 per cent higher than planned.

a) The committee asked Nalcor to provide an explanation with respect to the Project-to-date variances in incurred planned expenditures to September 2014. Nalcor has responded as follows:

The variances noted in the tables are within normal reasonable planning tolerances for the expenditures. The actual incurred amounts are closely aligned with the planned incurred costs for the respective assets. NALCOR NEEDS TO ADD ADDITIONAL INFO TO THIS ANSWER

Commented [PH1]: I suggest the questions concerning variances between planned vs actual incurred costs sare rolled into a single question because the answer will be the same for the overall, MF,LIL and LTA

The net actual incurred costs are less than 1% higher than planned and are not unusual in large projects and are not a cause for concern. There are many factors which can effect the incurring of costs on a project of such magnitude, some activities can be brought forward and costs incurred earlier than planned and other activities deferred because of changes to the original plan. These adjustments in incurring costs are perfectly normal and indeed are prudent in Project Management execution. The net variance between planned and actual incurred costs are well within normal reasonable planning tolerances.

b) Muskrat Falls, LIL and LTA Budget versus Project Final Costs

The Committee asked Nalcor to provide explanation with respect to the individual variances in Project Forecast Costs from Budget. Nalcor has responded as follows:

Commented [PH2]: I suggest the question b, c and d are rolled into a single question because the answer will be the same

The Final Forecast Costs for Muskrat Falls, LTA and LIL have not changed from the approved Budgeted amounts. It is normal and prudent Project Management practice to adjust costs between the line items that make up the overall project budgets for MF, LIL and LTA as the projects develop and costs are saved in some areas and costs increased in other areas. Contingency is allocated to each of the MF, LTA and LIL projects and if the cost savings within a project do not cover the cost increases then contingency is used to cover the cost delta. It is important to note that there has not been a drawdown on contingency. Since there has been no contingency drawdown and the final forecast costs for each project are aligned with the approved budgeted amount the individual variances are not significant and should not be a cause for concern.

The variances noted in the tables are within normal reasonable planning tolerances for the expenditures. The actual incurred amounts are closely aligned with the planned incurred costs for the respective assets. NALCOR NEEDS TO ADD ADDITIONAL INFO TO THIS ANSWER

The Committee observed that the cumulative costs to September 2014 are tracking higher than planned with an expenditure variance of 5.04 per cent higher than anticipated.

e) LIL

The Committee asked Nalcor to provide explanation with respect to the Project to-date variances in planned vs. incurred expenditures to September 2014. Nalcor has responded as follows:

~~The variances noted in the tables are within normal reasonable planning tolerances for the expenditures. The actual incurred amounts are closely aligned with the planned incurred costs for the respective assets. NALCOR NEEDS TO ADD ADDITIONAL INFO TO THIS ANSWER~~

~~d) LIL~~

~~The Committee asked Nalcor to provide explanation with respect to the individual variances in the Project Forecast Costs from Budget. Nalcor has responded as follows:~~

~~The variances noted in the tables are within normal reasonable planning tolerances for the expenditures. The actual incurred amounts are closely aligned with the planned incurred costs for the respective assets. NALCOR NEEDS TO ADD ADDITIONAL INFO TO THIS ANSWER~~

~~—— LTA~~

~~The Committee observed that the cumulative costs to September 2014 are tracking lower than planned with an expenditure variance of 5.8 per cent lower than planned.~~

~~e) The Committee asked Nalcor to provide an explanation with respect to the Project to date variances in incurred versus planned expenditures to September 2014. Nalcor has responded as follows:~~

~~The variances noted in the tables are within normal reasonable planning tolerances for the expenditures. The actual incurred amounts are closely aligned with the planned incurred costs for the respective assets. NALCOR NEEDS TO ADD ADDITIONAL INFO TO THIS ANSWER~~

f) The Committee asked Nalcor to provide an explanation with respect to the individual variances in Project Forecast Costs from Budget. Nalcor has responded as follows:

The variances noted in the tables are within normal reasonable planning tolerances for the expenditures. The actual incurred amounts are closely aligned with the planned incurred costs for the respective assets. NALCOR NEEDS TO ADD ADDITIONAL INFO TO THIS ANSWER

PROJECT RISKS

5. North Spur stabilization works

There have been some recent concerns raised locally with respect to clay formations at the North Spur and the potential impacts of these formations on the stability of the North Spur. North Spur Stability also continues to be a risk identified and monitored by Nalcor.

a) *Has Nalcor considered this issue of these clay formations in its design of the North Spur stabilization works?*

The North Spur is a 1,000m long, 500m wide and 45 to 60m high ridge that connects the Muskrat Falls rock knoll to the north bank of the river. When the reservoir is impounded this feature will form a natural dam and become a major part of the river impoundment system.

The feature is composed of unconsolidated mixed sand and marine silt/clay sediments. The depth to bedrock underneath the spur is in the range of 200 to 250m. It contains a significant amount of glacio-marine silt/clay sediments, including horizons of highly sensitive clay strata, mixed with some sandy layers. The upstream and down-stream slopes of this feature are subject to ongoing river erosion and mass wasting. This has contributed to local slope over-steepening of the slope, which triggers rotational sliding on both the downstream and upstream sides of the spur.

As part of the water retention system, the importance of stabilizing the north spur has been an underlying design criterion for several decades.

The solution for the North Spur has been addressed in numerous engineering studies and investigations by competent and qualified geotechnical engineers. The geotechnical conditions at the North Spur are well understood by Nalcor and its

engineering consultants. The design has been based on the results of site investigations and the properties of the materials comprising the North Spur.

Nalcor's project engineers and designers have incorporated special features to ensure long-term stability. These include slope modifications, the installation of a cutoff wall under the upstream slope, a drilled well system, special drainage measures and the placement protective zones to protect against erosion.

The type of clay on the North Spur is "sensitive clay" and the design has taken all geotechnical and other factors into account in the design of the North Spur stabilization scope.

The engineering design for stabilization of the North Spur has been undertaken by qualified geotechnical engineers, and extensive field investigations have been completed to support the engineering design. The design for the North Spur has been further validated through independent reviews by MWH Canada (the project's independent engineer) as well as Hatch Ltd.

The Independent Engineer has reviewed Nalcor's design in detail and commented as follows:

"Concerns have been raised during earlier project reviews about potential liquefaction of the sensitive silt/clay strata during the design earthquake. In the fall of 2013 the IE and other reviewers commented that the stability studies had not considered the special liquefaction and strength loss strength properties under earthquake loadings and that further studies were needed to deal with this issue. New studies to address these issues were subsequently carried out during the first half of 2014. Nalcor and SNC presented the results of the studies in a meeting on July 20, 2014. This presentation was based on the following reports, which were submitted to the IE at that time.

- Report No. 1: "Earthquake Hazard Analysis - Muskrat Damsite, Lower Churchill, Labrador", issued by Gail M. Atkinson Ph. D., on May 22, 2014.
- Report No. 2: "Three Dimensional (3D) Hydrogeological Study for the North Spur", Report no. H346252-0000-00-124-0001, Rev A, issued by Hatch on June 16, 2014.
- Report No. 3: "North Spur Stabilization Works - Dynamic Analysis Study - Phase 2", Nalcor Doc No. MFA-SN-CD-2800-GT-RP-0007-01, Rev A1, issued by SNC-Lavalin in May 2014.

Report No. 1, the Atkinson earthquake hazard analysis, consisted of a site specific earthquake hazard analysis of The Muskrat Falls damsite. This report concluded that the 1/10,000 year maximum design earthquake would produce a Peak Ground Acceleration value (PGA) 0.06 g at the site. This could be generated by an event of M6.1 to M6.5 at a distance of about 90 to 100 km or an event of approximately M7.3 at a distance of 350 to 450 km. The new 0.06 PGA is a significant reduction of the previously assumed PGA 0.09g that was extrapolated from an earlier seismic hazard analysis for the Gull Island Project. The new PGA value would result in significantly reduced earthquake shaking than had been earlier assumed. The report also established earthquake spectral ground motions for use in dynamic stability analyses.

Report No. 2, by Hatch, consists of a finite element seepage analysis of the North Spur. This report established the initial North Spur seepage patterns and then determined the impact of the planned stabilization works of piezometric levels through-out the Spur at various reservoir levels. This established the validity of the planned stabilization works and provided a monitoring tool for forecasting hydrogeologic changes that would occur during construction, impoundment and operation.

Report No. 3, by SNC Lavalin, presents the results of a geotechnical assessment and 2-dimensional (2-D) finite element dynamic stability analysis of the North Spur. The study used scaled ground motions from various earthquake records, scaled in accordance with the ground motion parameters set out in the Anderson seismic hazard report. Groundwater seepage and piezometric levels were input from the Hatch study (Report No. 2). Liquefaction criteria were established for the critical soil units based on cone penetration tests and other data from the geotechnical site investigations. 2-D dynamic analyses computed ground motions throughout the sour and established dynamic stress levels. These established ground deformations, pore water increases, cyclic stress strength losses and established if true liquefaction would occur during design earthquake events. The analyses concluded that the design earthquake ground motions did not destabilize the North Spur slopes and 9 October 20, 2014 25501457 Lower Churchill Project Site Visit Report that there is no liquefaction hazard. The analyses validated the remedial designs. It was considered that ongoing geotechnical observations and monitoring during construction will be calibrated with the expected conditions to ensure the accuracy of the analyses.

The geotechnical assessments and dynamic studies were reviewed by Professor Idriss and Dr. Serge Leroueil. Professor Idriss is an internationally renowned expert of seismic hazard analyses and dynamic analyses of earthworks and civil structures. Dr. Leroueil is recognized for his expertise in dealing with sensitive soils, particularly the slopes of the St. Lawrence Valley in Quebec. With the involvement of these two experts, Nalcor can rest assured that analytical work of the North Spur has been done to a world class standard.

The IE considers that the various geotechnical concerns for the North Spur have generally been satisfied by the studies de-scribed above. These studies confirm that the designed remediation and stabilization works are adequate and that there is no significant hazard from stability problem-related seepage, strength loses in sensitive soils and/or earthquake shaking during construction or operation of the project. The IE also agrees with the plan that further geotechnical observations will be made as the remedial works progress and as new geotechnical monitoring is performed. These observations will be calibrated against the expectations of the various analysis reports. Designs will be amended if any significant surprises or discrepancies are encountered".

- b) What actions, if any, has Nalcor undertaken to mitigate risk relating to the North Spur Stability?

The North Spur design has been implemented by qualified and competent engineering consultants and has been subjected to multiple 'cold eyes' reviews to ensure the adequacy of the design to meet its intended objectives. The planned work has also been reviewed by the Independent Engineer.

As noted above in comments from the Independent Engineer following its July 2014 site visit report, "The IE considers that the various geotechnical concerns for the North Spur have generally been satisfied by the studies de-scribed above. These studies confirm that the designed remediation and stabilization works are adequate and that there is no significant hazard from stability problem-related seepage, strength loses in sensitive soils and/or earthquake shaking during construction or operation of the project. The IE also agrees with the plan that further geotechnical observations will be made as the remedial works progress and as new geotechnical monitoring is performed. These observations will be calibrated against the expectations of the various analysis reports. Designs will be amended if any significant surprises or discrepancies are encountered".

Feasibility investigations in 1979-80 showed the Muskrat Falls site is a viable site for a hydroelectric development, although stabilization measures would be necessary to prevent continued landsliding from breaching the spur under existing conditions. In 1982, an interim system of 22 pump wells were installed on the spur to lower the groundwater table and prevent continued regression of the slopes due to landslide activity. The interim pump well system has performed well and no landslides have occurred at Muskrat Falls in the last 17 years. However, in 2010, a landslide did occur further upstream at Edward's Brook.

Engineering and Stabilization work on the North Spur

The Muskrat Falls North Spur has been investigated from a geotechnical perspective in previous field programs and has undergone multiple studies. The information gathered in those programs supported the design, installation and operation of a well point system that helped maintain the north spurs stability for the last 30 years and provided information that helped the development of a conceptual long-term solution. The conceptual design was used to inform Decision Gate 3. The plan for geotechnical work on the North Spur has been deemed to be reliable and cost effective. Following Decision Gate 3, Nalcor Energy with SNC-Lavalin commenced detailed engineering on the North Spur to refine the conceptual solution. The information gathered in this program has been used as input into the detailed design.