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9 July 2017

SLI REFERENCE No.: 505573-0000-30CC-I-1500
LC Ref. No: S011-L010-200-170330-00274

Lower Churchill Management Corporation
350 Torbay Road, Suite 2
St. John's, NL, A1A 4E1 CANADA

Attention: Scott O'Brien

**Subject: Lower Churchill, Phase 1 Development
Agreement LC-G-002
Engineering Procurement and Construction Management (EPCM) Services
Muskrat Falls – R. Dury Thesis on North Spur**

Dear Scott:

SNC is aware of the works of Dr. S. Bernander and has done calculations on the initiation of downhill progress failures at the North Spur with the support of well-known world experts in the field of landslides in sensitive clay. These analysis and conclusions have been presented in peer reviewed papers and at international conferences on sensitive clays and landslides.

SNC has undertaken a preliminary review of the thesis by the student, Robin Dury. As Mr. Dury said in his thesis: "This work is mainly based on rough assumptions as concerns the mechanics and geometric properties of the slope studied. That we cannot claim that the study gives an entirely accurate analysis." (Section 1.4). From what we see in the thesis, it appears that the "rough assumptions" used are not complete and field information collected shows that the assumptions are not in accordance with the data, geometry, groundwater and soil properties at the North Spur.

Below are some specific examples of assumptions that are oversimplifications, or not correct. We will continue reviewing and note any further discrepancies from the factual data that is available.

- The figures used in the analysis show the assumption that the stratigraphy is gently sloping from upstream to downstream, with some assumed divisions between layers. These assumptions are not consistent with actual conditions as determined from field investigation results, mapping, geological and the sedimentation process.
- On these figures, the cut-off wall is shown as a vertical wall extending to the top of the Spur. The actual cut-off wall is vertical to el 17 m and then intersects with a till blanket sloped at 2H:1V. This would change the resultant of the forces acting on it.
- The thesis references a concrete dam on the North Spur (page 17). There is no concrete dam as part of the North Spur works.





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- There is also reference to the tailwater level being lower post-project (page 17). This is not correct, the tailwater levels are unaffected by the project, and will vary from el 2.5 m to el 6.5 m, depending on time of year, and flow in the river.
- In the thesis, the assumption is made that the watertable downstream of the cut-off wall will fall to that of the tailwater level (page 38). This is not correct, the downstream of the wall will continue to exist at close to its present level with a maximum anticipated drop of about 2 m. This has shown by instrumentation installed to monitor the watertable and confirmed by hydrogeologic modelling.
- The thesis uses the assumption of a large differential across the cut-off wall as the trigger for a landslide. Since there is actually not a significant differential, this triggering mechanism does not exist.
- The author comments (page 42) that traditional calculation methods are not applicable if the clays have high porosity. This indicates a misinterpretation of the concept. All clays show high porosity and the void ratio of the upper clay at the North Spur is in the same order of magnitude as other eastern Canadian clay. It appears that the author applied the concept of porosity developed for sand which is not applicable to clays.
- The author indicates pile driving as an investigative tool and a mitigative measure. Bernander's thesis (Bernander 2000), page 5 of this thesis, and standard practise recommends strongly against "vibratory activity" (ie pile driving) in the presence of sensitive clays as it is a known trigger for landslides. This recommendation is inconsistent Bernander's recommendations and with the project approach, and cannot be considered for the North Spur.
- In addition to the above, throughout the document there are hypotheses, judgements, assessments, and statements that are not supported by scientific references and research or not supported by the data and geotechnical information available. The following are some examples of these:
 - Abstract: "In order to provide a more reliable study" This is not supported by scientific evidence which considers the approach used as standard approach for this situation.
 - Abstract: the current approach by Nalcor, "which is very optimistic and rather unrealistic" is a judgment by the author and this is not correct.
 - Page 1: "With ongoing climate changes it is likely that the risk for landslides will increase". No reference or support indicating how landslides are linked to climate change and why this is relevant.
 - Page 20: "The main issue (using LEM calculation) is that this procedure is not justifiable for soils having such a high porosity" This is not correct and not supported by documentation, or considerable body of scientific research.

The above preliminary review indicates that there are numerous examples of oversimplification and incorrect assumptions. The parameters used are not consistent with geotechnical data





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which has been collected and is publicly available on the Nalcor website. SNC remains confident that the approach taken in the design of the North Spur is correct and is scientifically supported and justified as attested to by numerous independent peer reviews that have taken place. SNC will continue to review the thesis by Dury and will highlight any additional issues that may come to light.

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