

**From:** Carter, Paul  
**To:** [gbennett@nalcorenergy.com](mailto:gbennett@nalcorenergy.com)  
**Cc:** ["StevePellerin@lowerchurchillproject.ca"](mailto:StevePellerin@lowerchurchillproject.ca)  
**Subject:** North Spur  
**Date:** Friday, March 31, 2017 2:28:16 PM  
**Attachments:** [.png](#)  
[Letter to Nalcor - North Spur March 2017.pdf](#)

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Gilbert,

Please see attached letter on behalf of the Oversight Committee in reference to North Spur stabilization works. Original to follow by mail. Please feel free to give me a call if you wish to discuss.

Kindest,

Paul

Paul Q. Carter

Executive Director - Muskrat Oversight Committee

Cabinet Secretariat, Executive Council

Government of Newfoundland and Labrador

PO Box 8700

St. John's, NL

A1B 2Z8

Phone: 709-729-3681

Email: [paulcarter@gov.nl.ca](mailto:paulcarter@gov.nl.ca)

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Government of Newfoundland and Labrador  
Executive Council

March 31, 2017

Mr. Gilbert Bennett  
Lower Churchill Management Corporation  
Corporate Office, 500 Columbus Drive  
P.O. Box 12800  
St. John's, NL  
A1B 0C9

Attention: Mr. Gilbert Bennett, Vice President

**RE. North Spur Stability**

Dear Mr. Bennett:

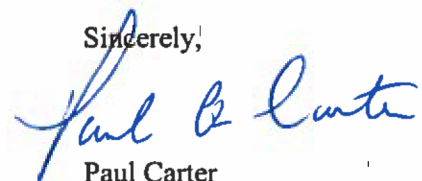
Please provide the Muskrat Falls Oversight Committee (the Committee):

1. copies of all of the Project's Engineer of Record (SNC-Lavalin) engineering stamped design documents for North Spur stabilization;
2. confirmation from SNC-Lavalin that all stabilization work completed to date on the North Spur has been in accordance with design requirements as per the requisite engineer stamped documents;
3. when complete, copies of SNC-Lavalin's engineering stamped as built documents for North Spur stabilization;
4. confirmation from Hatch that all recommendations originating from Hatch's 2014 "Cold Eye Review of Design and Technical Specifications, North Spur Stabilization Works" report have been appropriately documented and followed up on by Nalcor; and
5. confirmation from SNC-Lavalin and from Hatch that the North Spur design criteria stabilization work performed to date and dam safety management procedures and practices conform with applicable Canadian Dam Association (CDA) Dam Safety Guidelines.

Also attached is correspondence received by the Committee from David Vardy and Ronald Penney in which a "List of Issues" regarding stability of the North Spur is identified. Please ensure that Nalcor officials and your consultants (where appropriate) communicate with Mr. Vardy and Mr. Penney to respond to perceived concerns identified. Please copy the Committee on any written responses. The Committee will be responding to Mr. Vardy and Mr. Penney indicating that Nalcor will be communicating with them on these matters.

Please provide this information as expeditiously as possible. I will serve as the point of contact for the Committee on this matter. I am available to discuss if you require any further clarification at 729-3681.

Sincerely,



Paul Carter  
Executive Director –  
Muskrat Falls Oversight  
Committee

c. Stephen Pellerin, Lower Churchill Project

## Attachment

Ronald Penney  
[REDACTED]

St. John's, NL [REDACTED]

David Vardy  
[REDACTED]

St. John's, NL [REDACTED]

January 16, 2017

Bern Coffey  
Chair Muskrat Falls Oversight Committee  
Clerk of the Executive Council  
Government of Newfoundland and Labrador  
Confederation Building, East Block  
St. John's, NL

Dear Bern

We are writing to you in your capacity as Chair of the Oversight Committee to request that you consider the attached list of issues relating to the North Spur, compiled by retired engineer Jim Gordon, in collaboration with the undersigned and with other colleagues.

The North Spur is a hill 1,000m long which comprises part of the natural dam at Muskrat Falls, a dam which is both an advantage of the site, as well as its Achilles Heel. When the Muskrat reservoir is filled, this hill will form a natural dam containing the reservoir. The hill consists of two layers of sand, and two layers of quick clay, sloping downstream, on a deep foundation of quick clay, extending down to far below tidewater. Quick clay is similar to quicksand. It liquefies when disturbed or when it becomes saturated with water. There are numerous quick clay slides on the North shore upstream and downstream of Muskrat, including three large slides on the downstream slope of the North Spur.

NALCOR intends to increase these factors by flattening the slopes, adding a downstream berm, adding pump wells, placing an upstream impervious blanket to close off the upper sand layer, and building a cut-off wall filled with an impervious material to close off the lower sand layer. This means that the two layers of quick clay will remain within the body of the dam. To our knowledge, quick clay has never before been used to form part of a dam structure, nor has a dam been built on a quick clay foundation.

If the North Spur dam fails, there is a risk of loss of life in Goose Bay and Happy Valley. If the North Spur fails, the Muskrat Hydro facility would be left high and dry, and become a stranded asset, with a repair cost well over several billions. Power would be interrupted for several years. Since the design of the North Spur dam is without precedent, it is imperative to have the design reviewed by an independent panel of experts – a Review Board, to provide added assurance that the design is safe.

There has been no public forum for reviewing the North Spur and to test the research and remedial measures advanced by Nalcor's geo-technical experts. The engineering design work had not been completed when the joint panel undertook its review so the panel could not test the effectiveness of the remedial measures that have been taken since the panel's report of August 2011.

When public health and safety are at issue such critical independent assessment must be in public view, through a fully transparent process and conducted by a panel of geo-technical experts. It must be fully independent of the proponents and its engineering consultants. The "precautionary principle" requires that when a project imposes a potential risk to the public and the environment, and there is no demonstrated scientific consensus to refute such risk, then the proponent must provide evidence that the project will not be harmful. This applies in particular where extensive scientific knowledge on the matter is lacking. There is a social responsibility to protect the public from exposure to harm. The exercise of the principle calls for further scientific research and inquiry to provide sound evidence that no harm will result.

I am sure you share our concern that every measure possible must be taken to reduce risk, following the precautionary principle, even if it leads to an excess of caution over incaution by the project proponent. Not only is a huge financial investment at stake but, more importantly, failure of the dam has the potential to place people and communities at risk, through life-threatening unpredictable events! Better to err on the side of safety, when lives are in the balance!

We have been told that Nalcor has mitigated all the risks and that we should trust Nalcor to do the right thing. Is there any basis on which the public can have trust that Nalcor has left no stone unturned in its quest to maximize public safety and to minimize the risk of a devastating dam failure or earth slide? Sadly we do not think there is!

We are all familiar with the egregious cost overruns which have increased estimated project cost from \$6.2 billion in 2011 to \$11.7 billion in 2017. We are all familiar with the delay for full power from 2017 to the second quarter of 2020.

We are all familiar with egregious lapses in quality control on this project, including the leaking coffer dam, the "popped" transmission strand and the collapsing concrete cribbing. These lapses, and others, make it clear that quality control has been weak and, furthermore, that Nalcor is not capable of being its own project manager.

The performance of Nalcor is far from exemplary and provides no basis for trust that everything has been executed in accordance with the highest quality standards. It is not clear to us that the new CEO has instigated a "root and branch" transformation which will make Nalcor more open, transparent and accountable. From the outside there is little evidence of structural change, other than the separation of generation from transmission, and little change in senior personnel. In our opinion major changes in structure and senior personnel are essential. We are disappointed that the new CEO has chosen not to initiate an independent review of the design plan for remediation. We believe government must undertake such an independent review and that it should be expedited.

The undersigned wrote to your predecessor, Julia Mullaly, and to the Deputy Minister of Environment and Conservation, Jamie Chippett, on November 22, 2014, providing a copy of the PowerPoint presentation made by Dr. Stig Bernander at the LSPU Hall on October 30, 2014.

In our covering letter we made the following statements:

*If Dr. Bernander is correct and the right engineering research and associated mitigation measures are not undertaken, assuming that mitigation is even possible, the risks of a catastrophic failure of the North Spur, which include the loss of the project and downstream flooding, are significant.*

*The Joint Environmental Panel concluded that the loss of the Muskrat Falls dam would result in the "inundation" of Mud Lake and the lower part of Happy Valley Goose Bay, with only two hours of notice, causing immense property damage. Two hours' notice would not provide sufficient time to evacuate all those who would be in the path of a wall of water and there would likely be loss of life.*

*If we were in your position we would want to know that we took all necessary measures to ensure that the risks of such an eventuality are reduced to the extent possible and urge you both to exercise your responsibilities by getting the best independent advice possible.*

The attached list provides a compelling case for the appointment of such a review panel independent of Nalcor. It delineates the risks which remain outstanding and complements the work done by Dr. Stig Bernander, whose most recent research has been presented to the Public Utilities Board and can be viewed at [http://www.pub.nl.ca/applications/IslandInterconnectedSystem/phase2w/chronologically\\_grandriverkeeper.php](http://www.pub.nl.ca/applications/IslandInterconnectedSystem/phase2w/chronologically_grandriverkeeper.php).

*Jim Gordon concludes as follows: It is essential that the dam design be reviewed by a panel of geotechnical experts. It is not too late to undertake such a review, since any changes resulting from the review can still be built. If there are no changes required, then there is the added assurance that the dam is safe.*

An independent review of the geo-technical research and remediation for the North Spur should be embraced openly as a prudent course of action. This review should be initiated by government, given Nalcor's defensive posture and its failure to take action on its own.

The undersigned would be pleased to meet with you to discuss this matter. We also recommend that you invite Jim Gordon to meet with your committee to explore his concerns, along with options to deal with this major problem.

You are now the most senior official in the government. Because of our own personal experience we know what an immense responsibility that is. You have both the opportunity and the responsibility to recommend that government take the prudent steps we suggest. We look forward to your response.

Respectfully,

*David Vardy*

David Vardy and Ron Penney

*Ron Penney*

**LIST OF ISSUES ON THE NORTH SPUR – January 2017.****Not in any order of importance.**

1. This is the first use of a "natural dam" containing quick clay in a hydro facility. Other precedents at Ontario hydro and Hydro Quebec are far smaller, and have a totally different dam section with far flatter slopes, constructed with selected materials, and therefore are not "natural".
2. The recent comment by Phil Helwig in the use of the same safety criteria as a dam constructed with selected materials all compacted and tested to CDA standards is very pertinent. The natural dam materials have not been compacted nor tested sufficiently to warrant the same safety factor - it should be higher.
3. The Canadian Dam Association was contacted to comment on the application of their guidelines to a "natural dam". They replied within 24 hours advising that at a director's meeting over the phone they had come to the conclusion that the CDA publications are "Guidelines" only, to be interpreted as required by geotechnical engineers. This means the guidelines may not be relevant to the North Spur.
4. The North Spur strata are all sloping slightly downstream. The clay surfaces slope downstream. Water will accumulate on the top of the clay strata, reducing the friction and inducing a slide. This is why Phil Helwig's comments are so pertinent. A constructed dam does not have sloping downstream surfaces.
5. Experts such as Dr. Bernander, a professor at Luleå Technical University, Luleå, (Sweden), with extensive experience investigating quick clay slides, has criticised the design, but has been dismissed almost as a crackpot for questioning the design. Instead, his opinions should be thoroughly investigated to determine whether his different approach to the calculation of the dam stability factor is correct, requiring a different design or whether it verifies the current design.
6. Dr. Bernander has indicated that the use of cut-off walls where the horizontal force will be concentrated, may have a detrimental effect on the stability. This has not been investigated.
7. The upstream slope is too steep as demonstrated by the "slips" detected during construction. At 2.5:1, it has the same slope as the downstream face, but there are no clear photos of the downstream face to determine whether it also has "slips". Yes, the lower half of the upstream face is flatter at 3:1, but it is not known whether this is flat enough.
8. The "slips" should have been used to back-calculate the average friction angle used in the dam design. It is suspected that it will result in a lower friction, requiring flatter slopes.
9. The west slope in the deep hole downstream of the Spur is very steep, at a slope of 1.5:1, is steeper than the downstream natural slopes in the Spur where the factor of



safety is about 1.0. No geotechnical analysis of this West slope has been undertaken. Any failure in this slope is likely to migrate upstream into the Spur.

10. Below the low-drawdown reservoir level, the upstream slope in the re-shaped North Spur increases from 3:1 to 2.5:1, where it is not necessary to design for a "rapid drawdown". This indicates that the designer lacks experience - a steeper lower slope is never used - it reduces the safety factor.
11. There is no mention of any pump tests to determine whether the lower aquifer is not connected to the upstream reservoir. In at least one Upstream-Downstream cross section through the Spur, the lower aquifer slopes upward in the upstream direction, indicating that a connection to the upstream river water is likely. Several pump tests at different locations are required to verify the assumed lack of a connection. It is essential for the safety of the dam that there is no connection.
12. The AMEC report on the test holes undertaken by a vibratory drill across the North Spur indicated that the drill casing dropped under its own weight through very soft clay in several holes. This is very troubling. Yet, there is no mention of the implications in the dam design document prepared by SNC.
13. The geotechnical investigation relies, in part, on past data extending back to 1965. This data should have been verified since test equipment and methodologies may have changed over the last 50 years. Also, according to Dr. Bernander, several types of tests were not undertaken, all necessary in determining dam safety.
14. In the geotechnical data there is an anomaly in the relationship between tested shear strength and the liquidity index, as discovered by Maurice Adams. This relationship is well outside the normal range, indicating that one or the other is incorrect. This anomaly needs to be investigated since any incorrect data will affect the dam safety. If the liquidity index is correct, then the shear strength should be lower by about one magnitude. If the shear strength is correct, then the liquidity index is too high by about one magnitude.
15. There have been at least three designs for the dam, including a downstream groin extending out into the water and infilling of the deep downstream hole. Why should the current design not address these issues and particularly the slope of the Spur as it extends to the bottom of the hole
16. Acres, now Hatch, have reviewed the geotechnical design. Their main concern was found to be the natural water table level as it changes with the introduction of the upstream reservoir. Apparently, the water table affects the stability more than expected and Hatch had to develop a 3D computer model to calculate the new water table levels. This effect of the water level was verified by Dr. Bernander in his report. The water table problem was so complex, that the work was undertaken by geotechnical engineers with postgraduate degrees. There has been no review of this very complex work.

17. Quick clay has been detected at two locations on the downstream slope. But the extent has not been determined. If extensive, it will have serious implications for the dam safety. This will require more drilling of boreholes.
18. NALCOR insist that the geotechnical design has been reviewed by two independent experts, namely Dr. Leroueil and Dr. Idriss.  
Dr. Leroueil is currently a professor at Laval University in Quebec City. He advised that he is not qualified to undertake such a review since he is not an expert in dynamic analysis, was not provided with all the data (no report appendices) and hence confined his review to only Chapter 2 in the voluminous geotechnical report. His conclusions, on less than two pages, were that "the stabilization works increase the factor of safety from about 1.0 to 1.6, which is very significant". Not a full endorsement of the design.  
Dr. Idriss is a retired earthquake specialist, from the University of California at Davis, who attended several meetings, made some comments, but never issued a report.
19. There is a reference (NALCOR 2016 report on the spur design, page 120) to the Independent Engineer (MWH) having reviewed and approved the design of the North Spur – quote - The Independent Engineer commented that "the stabilization works have been designed in accordance with currently accepted geotechnical design practices and effectively stabilizes the North Spur when the reservoir is impounded". – end quote. An email to the Independent engineer asking for confirmation of this statement resulted in the following reply - "MWH have never at any stage been involved in the design of the North Spur. We act as Lender's Engineer to the Federal Government and have never at any point been actively involved in the design of any of the project components". This contradiction needs to be resolved.
20. Finally, there is the question of insurance for the dam. This can be purchased, but if there is a failure, the insurance company will deny payment since this was a known and unacceptable risk assumed by NALCOR.

**It is essential that the dam design be reviewed by a panel of geotechnical experts. It is not too late to undertake such a review, since any changes resulting from the review can still be built. If there are no changes required, then there is the added assurance that the dam is safe.**

By Jim Gordon with input from Maurice Adams and Phil Helwig.