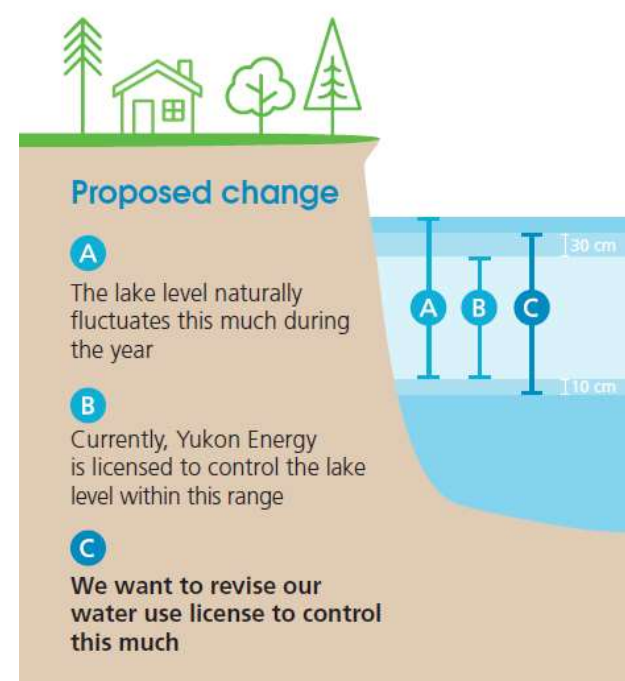


THE SOUTHERN LAKES ENHANCED STORAGE PROJECT: UNDERSTANDING POTENTIAL GROUNDWATER EFFECTS ON SURROUNDING PROPERTIES IN OLD CONSTABULARY

Throughout 2016 and into 2017, Yukon Energy worked with Yukoners on a plan to address the territory's electricity needs to the year 2035. The resulting 2016 Resource Plan identified the Southern Lakes Enhanced Storage Project (SLESP) as a priority of its action plan.

SLESP is a hydroelectricity enhancement project that would provide additional water for winter power production at the Whitehorse Rapids Generating Station, when that electricity is needed most. The SLESP would involve a change in Yukon Energy's water license to increase their Full Supply Level (FSL) on the Southern Lakes by 30cm (12") and lower their Low Supply Level (LSL) by 10cm (4"). An increase in FSL would result in higher water levels in the Southern Lakes during autumn and early winter, and a decrease in LSL would result in lower water levels in spring. Yukon Energy would continue to not influence lake water levels between May 15 and August 15 – the "all gates open" period on the Marsh Lake Dam.



Lake levels are related to groundwater levels in many near-shore areas of the Southern Lakes so Yukon Energy retained Hemmera to complete a detailed analysis to understand if increasing the FSL by up to 30cm in the late fall/early winter could increase groundwater levels and might affect properties or infrastructure around the lakes. Initial surveys and previous investigations suggested that changes to near-shore groundwater levels associated with the proposed increase in FSL could affect some low-lying properties with sub-surface infrastructure. The three main objectives were to identify all potentially affected properties and their mitigation needs, estimate the costs for those mitigation needs, and gain an understanding of the acceptability of landowners to the proposed mitigations and the SLESP as a whole.

This cover page summarises the groundwater research and studies undertaken by Hemmera. The attached maps show the results of those studies.

Groundwater Investigation

The first step taken to compile an inventory of properties potentially affected by SLESP-related groundwater rise, was to build a GIS-based groundwater screening tool designed to identify any low-lying

properties with ground areas (>2m²) within 3.5m of altitude of the proposed FSL (656.53 masl). A depth of 3.5m was chosen based on the range of sub-surface infrastructure depth measurements taken during previous property surveys, and it was assumed that no properties would have sub-surface infrastructure deeper than 3.5m. The model conservatively identified 457 of the 1338 properties in the study area as potentially affected by groundwater rise with an increase in FSL. Further observation and inspection of these properties removed 304 from consideration, with 153 potentially affected properties remaining for further investigation through landowner engagement and infrastructure geodetic surveys.

A comprehensive landowner engagement program was launched to understand potentially affected properties and incorporate additional local knowledge into the analysis. Some information was already known about 78 of the properties from previous work, so this was incorporated into the study. The engagement program included phone calls and letters to landowners, as well as in-person meetings. Property geodetic surveys and geotechnical assessments were undertaken when required.

The most common types of sub-surface infrastructure measured were septic fields and septic tanks. Basements/crawl spaces and sumps were also surveyed. Mitigation measures recommended for this infrastructure included: raising the septic field, septic tank anchoring, sump pump installation and compensation. Many low-lying properties already experience groundwater issues related to their subsurface infrastructure during natural peak summer Southern Lakes' water levels. If the property survey results indicated that these effects would be prolonged by SLESP-related groundwater levels, mitigation measures were discussed between Yukon Energy and the landowner.

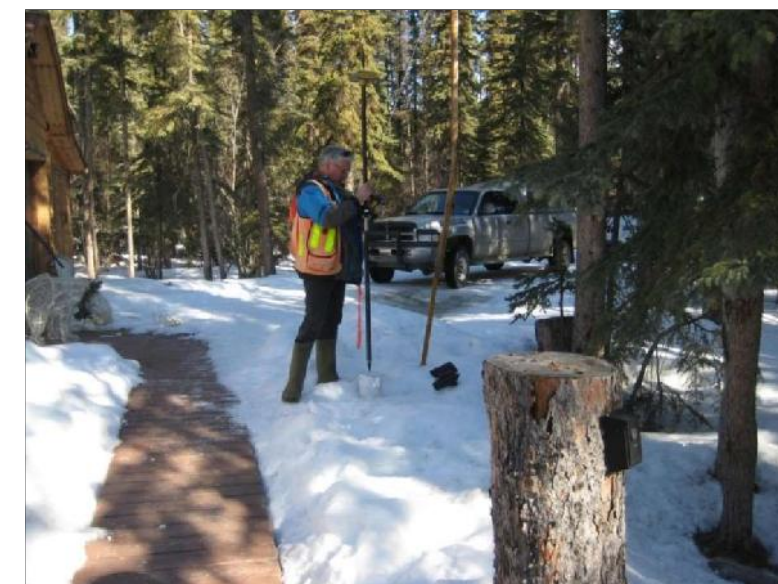
In 2015, 53 properties were identified to have infrastructure that could be potentially affected by SLESP-related groundwater rise and were recommended for mitigation. Of the 53 properties, six were included as "likely affected" pending confirmation of infrastructure with the landowner. Subdivisions of land parcels since then have increased that number to 57 properties.

Septic system upgrades were the most common recommended mitigation measure for affected properties. If SLESP proceeds to a YESAB assessment and water licensing, mitigation measures determined from this study will be included in project planning and assessment.

Mapping of Properties Potentially Affected by SLESP-related Groundwater Rise

Properties potentially affected by SLESP-related groundwater rise are located in South McClintock, Army Beach, McClintock Place, Old Constabulary, Judas Creek, Tagish and Carcross. On the following maps, properties surveyed and likely to be affected are indicated by solid-green lot lines. Those properties not surveyed but likely to be affected by the SLESP are represented by dashed-green lot lines. Properties initially identified at risk from SLESP-related groundwater rise that were surveyed and determined to be unaffected are indicated by the solid-purple lot lines. The remaining properties that were considered to be at a very low risk of being affected and were not surveyed are indicated by black lot lines. If you have any questions, or would like more information, please contact Travis Ritchie, Project Lead at Yukon Energy.

Travis.Ritchie@yec.yk.ca.



Measuring the Elevation of a Septic Tank Access Pipe on a Southern Lakes Property in March 2015.

Marsh Lake

OLD
CONSTABULARY
BEACH

(9077)
LOT 266
GROUP 80

(9078)
LOT 265A
GROUP 804

(9079)
LOT 265B
GROUP 804

(9080)
LOT 735
GROUP 804

(9081)
LOT 736
GROUP 804

(9082)
LOT 737A
GROUP 804

(9083)
LOT 738
GROUP 804

(9084)
LOT 739
GROUP 804

(9085)
LOT 740
GROUP 804

(15901)
YUKON HWY NO 1
(ALASKA HWY)
ALASKA HIGHWAY

BURNT
ROAD

JOHNSTON ROAD



Southern Lakes Enhanced Storage Project, Yukon

Potential interactions between groundwater and Southern Lakes properties

Legend

- Lot Boundary
- Lot Survey Status**
- Surveyed and affected
- Not surveyed and unaffected
- First Nations Settlement Land (Surveyed)

Sources

- Lot boundary: Yukon Government, 2012
- Elevation data: Yukon Government, 2012 September
- Road alignment Yukon Government, 2012 (Minor catagraphic edits)
- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:2,000

0 50 100

Metres

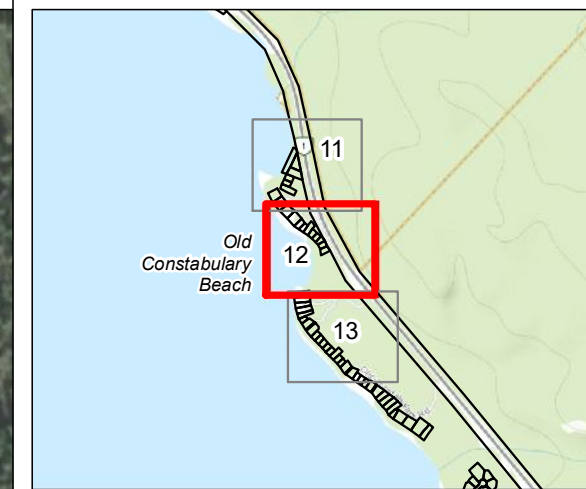
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yukon
energy

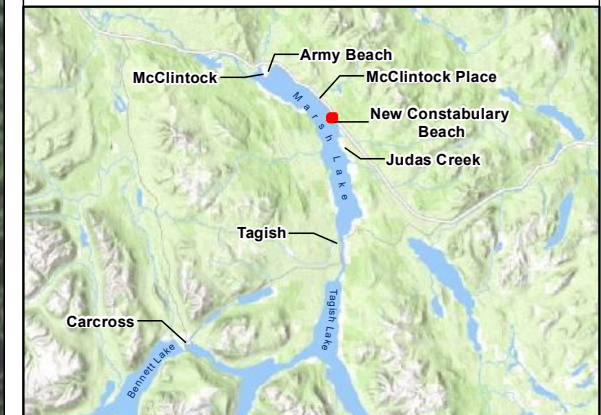


Southern Lakes Enhanced Storage Project, Yukon

Potential interactions between groundwater and Southern Lakes properties

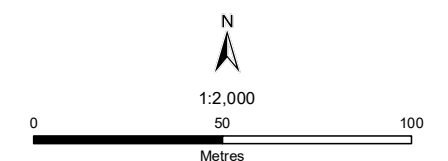
Legend

-  Lot Boundary
- Lot Survey Status**
-  Surveyed and affected
-  Surveyed and unaffected
-  Not surveyed and unaffected
-  First Nations Settlement Land (Surveyed)



Sources

- Lot boundary: Yukon Government, 2012
- Elevation data: Yukon Government, 2012 September
- Road alignment Yukon Government, 2012 (Minor cartographic edits)
- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map



NAD 1983 UTM Zone 8N

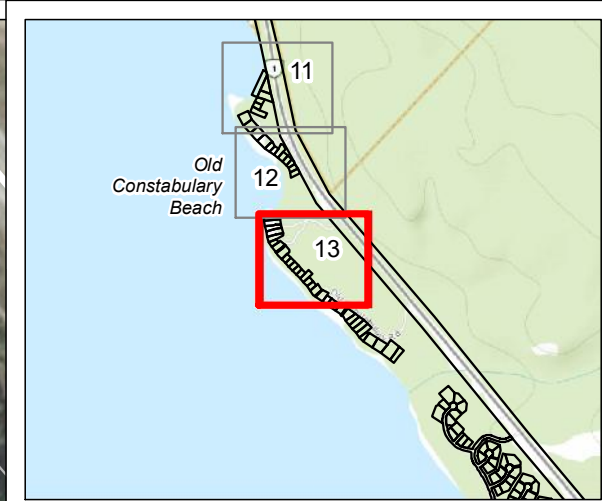
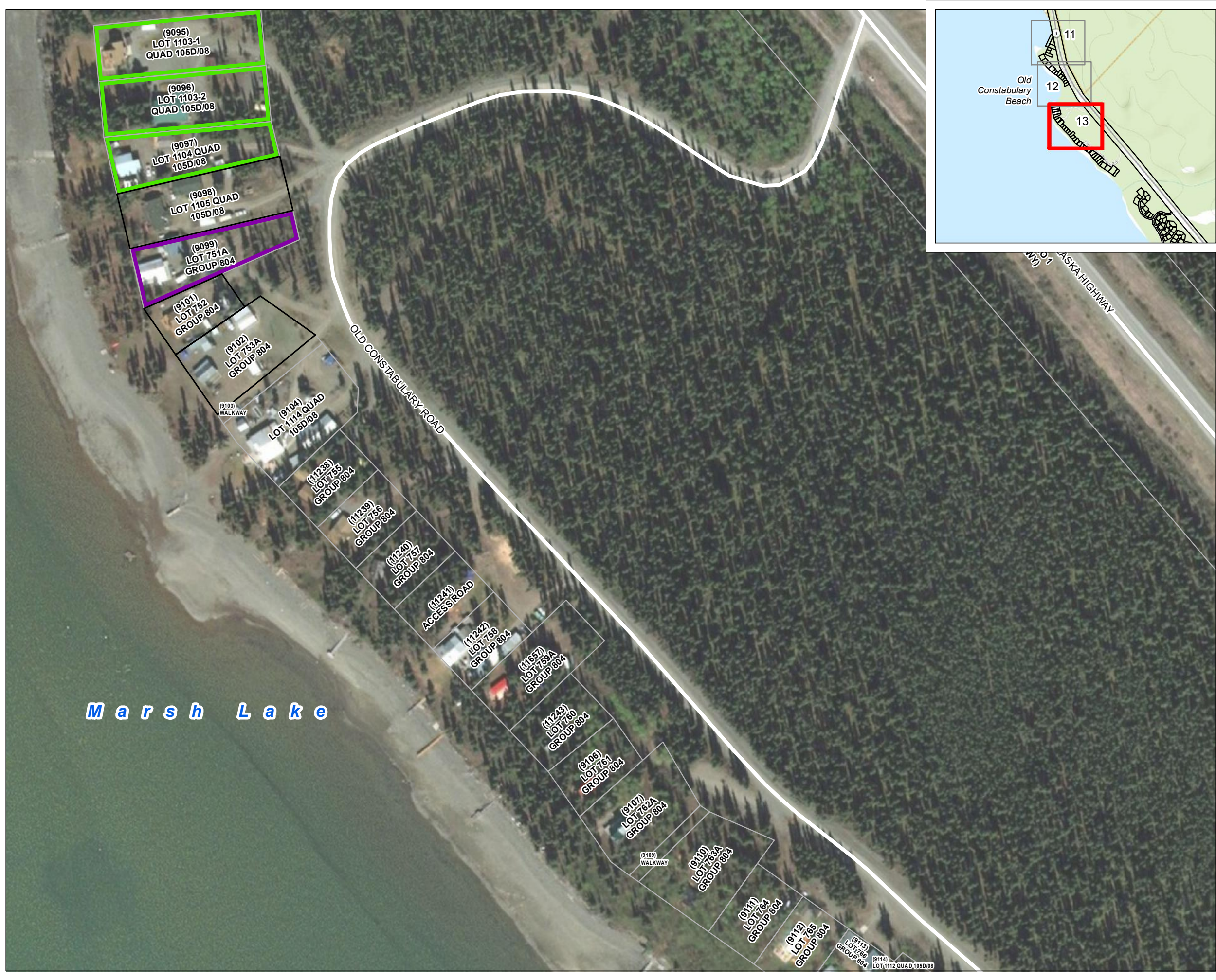
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Production Date: Aug 06, 2019

Map 12

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Southern Lakes Enhanced Storage Project, Yukon

Potential interactions between groundwater and Southern Lakes properties

Legend

- Lot Boundary
- Lot Survey Status
 - Surveyed and affected
 - Surveyed and unaffected
 - Not surveyed and unaffected
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Metres

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Creation Date: Jan 10, 2015
Production Date: Aug 06, 2019

Map 13

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