APPENDIX 6-C

Hydrology Baseline

June 2016
Report No. 1541520

AGNICO EAGLE

Golder Associates

January 2016

AGNICO EAGLE MINES: MEADOWBANK DIVISION - WHALE TAIL PIT PROJECT

2015 Hydrology Baseline Report

Submitted to:
Agnico Eagle Mines Limited
Ryan Vanengen
Environment Superintendent

REPORT

Report Number: Doc 037-1524321.1300 Ver 1

Distribution:

1 copy: Agnico Eagle Mines Limited
1 copy: Golder Associates Ltd.

Golder Associates

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1.0 INTRODUCTION

Agnico Eagle Mines Limited: Meadowbank Division (Agnico Eagle) is proposing to develop Whale Tail Pit, a satellite deposit on the Amaruq property, in continuation of mine operations and milling of the Meadowbank Mine. The Amaruq Exploration property is a 408 square kilometre (km^2) site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km northwest of the Meadowbank Mine in the Kivalliq region of Nunavut (Figure 1-1). The property was acquired by Agnico Eagle in April 2013 subject to a mineral exploration agreement with Nunavut Tunngavik Incorporated.

The Meadowbank Mine is an approved mining operation and Agnico Eagle is looking to extend the life of the mine by constructing and operating Whale Tail Pit and Haul Road (referred to in this document as the Project), which is located on the Amaruq Exploration property. As an amendment to the existing operations at the Meadowbank mine, it is subject to an environmental review established by Article 12, Part 5 of the *Nunavut Land Claims Agreement* (NLCA). Baseline data have been collected in support of the Environmental Review to document existing conditions and to provide the foundation for a qualitative and quantitative assessment of project operations and the extension of the mine development, to be evaluated in the Environmental Impact Statement (EIS) for the Project.

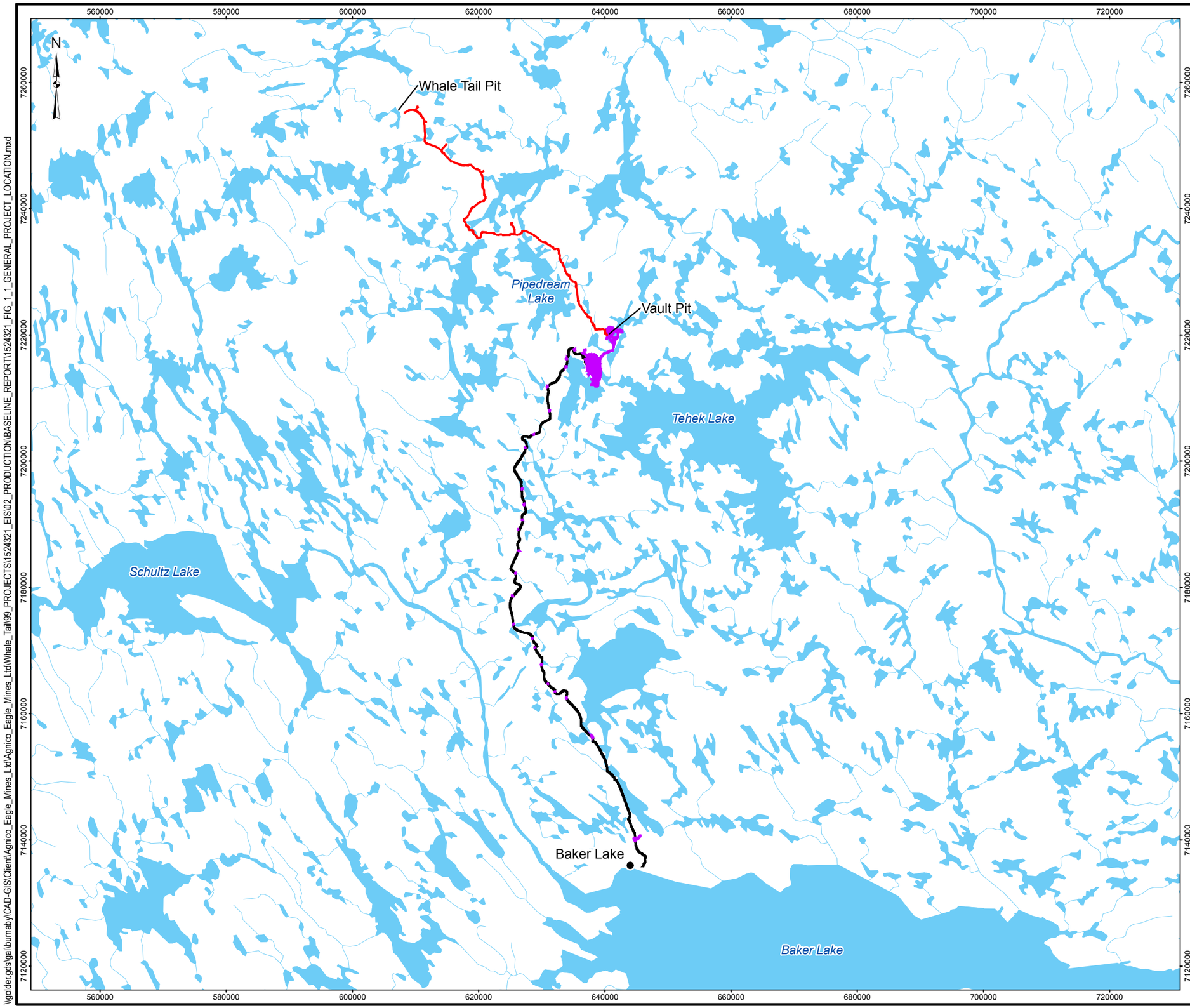
This report presents the results of a baseline hydrology study completed by Golder Associates Ltd. (Golder) for the area associated with the Project. Specifically, this report provides a review of existing hydrology conditions in watersheds potentially affected by the Project.

1.1 Physical Setting

The Project is located at the southern limit of the Northern Arctic terrestrial ecozone, which is one of the coldest and driest regions of Canada, with a Low Arctic ecoclimate. This ecozone extends over most of the non-mountainous areas of the Arctic Islands, northeastern portions of the Kivalliq region of Nunavut, western Baffin Island, and a portion of northern Québec.

1.2 Hydrology Baseline Study Area

The Project is located in the Meadowbank River, Quoich River, and Thelon River watersheds. The hydrology baseline study area (Hydrology BSA) for the Project is the area within which Project activities could potentially have direct or cumulative effects on aquatic biological receptors. The Hydrology BSA consists of the A, B, and C watersheds, and Lake DS1 (i.e., the receiving lake of the A, B, and C watersheds), the outlet of which marks the downstream boundary of the Hydrology BSA. The Hydrology BSA only considers the Whale Tail Pit portion of the Project; the Haul Road was assessed by others. Thus, the Hydrology BSA is solely located in the upper Meadowbank River watershed, which flows north into the Back River prior to draining into the Arctic Ocean. The Hydrology BSA is shown on Figure 1-2.



\\golder.gds\gal\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Agnico_Eagle_Mines_Ltd\Whale_Tail\99_PROJECTS\1524321_EIS\02_PRODUCTION\BASELINE_REPORT\1524321_FIG_1_1_GENERAL_PROJECT_LOCATION.mxd

LEGEND

- COMMUNITY
- PROPOSED HAUL ROAD
- ALL WEATHER ROAD
- MEADOWBANK INFRASTRUCTURE
- WATERCOURSE
- WATERBODY

REFERENCE

1. HAUL ROAD OBTAINED FROM AGNICO EAGLE MINES LIMITED. 2015-10-14 FROM 6103-117-230-200_R0.dwg
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. INSET MAP DATA OBTAINED FROM ESRI

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

12 0 12
KILOMETRES

PROJECT
AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

PROJECT LOCATION

Golder Associates

PROJECT		1524321	FILE No.	
DESIGN	JR	24 Sept. 2015	SCALE AS SHOWN	REV. A
GIS	CD	13 Nov. 2015		
CHECK	JR	16 Dec. 2015		
REVIEW	DRW	16 Dec. 2015		

FIGURE 1-1

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595000 600000 605000 610000

7265000 7260000 7255000 7250000

N

INSET MAP 1

INSET MAP 2

SEE INSET MAP 1

SEE INSET MAP 2

Nemo Lake

Mammoth Lake

Whale Tail Lake

Whale Tail Pit

DS1

A A A B C C C

800 m

LEGEND

- CONTINUOUS STATION
- MANUAL STATION
- PROPOSED HAUL ROAD
- WATERSHED
- STREAM
- WATERCOURSE (CANVEC)
- WATERBODY (CANVEC)

REFERENCE

1. HAUL ROAD OBTAINED FROM AGNICO EAGLE MINES LIMITED. 2015-10-14 FROM 6103-117-230-200_R0.dwg
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

1600 0 1600
METRES

PROJECT
AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

HYDROLOGY BASELINE STUDY AREA

Golder Associates

PROJECT		1524321	FILE No.	
DESIGN	JL	21 Oct. 2015	SCALE AS SHOWN	REV. 0
GIS	CD	21 Oct. 2015		
CHECK	JL	14 Jan. 2016		
REVIEW	DRW	14 Jan. 2016		

FIGURE 1-2

2.0 METHODS

2.1 Data Sources

This report is based on the following data sources:

- potential direct Project aquatic and terrestrial disturbances provided by Agnico Eagle;
- 1 metre (m) Digital Elevation Model (DEM) and 50 centimetre (cm) precision imagery, produced from stereo satellite photos acquired on 28 August 2015 (PhotoSat 2015);
- 1:20,000 scale spatial public watercourse and waterbody datasets (CanVec 2013);
- regional climate data (Government of Canada 2015);
- previous hydrology baseline information available for the Meadowbank Gold Project (AMEC 2003);
- hydrometric data collection by other disciplines and Agnico Eagle on-site in 2015; and
- four site-specific field visits from 28 to 31 May 2015, 8 to 15 June 2015, 4 to 9 August 2015, and 16 to 21 September 2015, respectively.

Inuit Qaujimajatuqangit was collected by field crews from local assistants during their participation in the 2015 field programs, as it was provided. Inuit Qaujimajatuqangit information was only recorded by field crews if permission was granted.

2.2 Watersheds and Drainage Patterns

Watersheds potentially affected by, or relevant to, future effect assessments of the Project, were delineated based on a review of available DEM data and imagery (PhotoSat 2015), and field observations in 2015 (Figure 1-2).

Lakes (i.e., waterbodies with one or several well-defined outlet channels) and ponds (i.e., waterbodies without defined outlet channels), relevant to this report and other environmental studies, were assigned an identifier under the following criteria:

- The downstream extent of the Hydrology BSA is a large lake, and was assigned an identifier of DS1.
- Three distinct watersheds within the Hydrology BSA were defined as:
  - the A watershed (i.e., where Whale Tail and Mammoth Lake are located);
  - the B watershed (i.e., located just north of the A watershed, and west of Nemo Lake); and
  - the C watershed (i.e., where Nemo Lake is located).
- The three distinct watersheds A, B and C each drain to Lake DS1.
- Within each watershed, lakes were assigned a unique alphanumeric identifier, comprised of the name of the watershed (e.g., A), and a unique numeric value. When possible, the unique numeric value was increased in the upstream direction (e.g., Lake A3 drains to Lake A2, which drains to Lake A1).

- Within each watershed, ponds (i.e. a waterbody without defined outlet channels which freezes to the bottom in winter) were assigned a unique alphanumeric identifier, comprised of the name of the watershed (e.g., A), followed by "-P", and a unique numeric value (e.g., A-P1).
- Lake outlets (i.e., streams) were assigned a unique alphanumeric identifier, comprised of the identifier of the upstream (i.e., source) lake, and of the identifier of the lake it is draining to, directly downstream. While this situation was not yet encountered, a prefix of "0" was proposed for cases where a stream does not originate from a lake. This convention is applied in the following examples:
  - Example: For a stream draining from Lake A2 to Lake A1, the stream is identified as Stream A2-A1.
  - Example: For a stream draining to Lake A1 without a source lake, the stream is identified as Stream 0-A1.

2.3 Hydrometry

Two types of hydrometric stations were installed in 2015, including continuous hydrometric stations (i.e., those equipped with data loggers) and manual hydrometric stations (i.e., those without data loggers, and primarily reliant on discrete discharge and water level measurements, and visual observations) (Figure 1-2). Photographs at each station are shown in Appendix A.

2.3.1 Continuous Hydrometric Stations

Six continuous hydrometric stations were installed during the second field visit, between 8 and 15 June 2015, at Lake A15, Lake A17 (Whale Tail Lake), Lake A18, Lake A69, Lake C38 (Nemo Lake), and Lake DS1. Two additional continuous hydrometric stations were installed during the third field visit between 4 and 9 August 2015 at Lake A5 and Lake C8. The locations of the continuous hydrometric stations are shown on Figure 1-2. These stations were equipped with water level loggers. Manual discharge and water level data measurements were also recorded at these stations during each field visit.

Hydrographs for all eight locations were derived using the following methods:

- Onset HOBO U20-001-04 Loggers were installed at each hydrometric station. Each data logger was programmed to record water pressure measurements at 10-minute intervals, and referenced to a local benchmark tied to the geodetic datum established by a mine surveyor.
- Two Onset HOBO U20-001-04 Loggers were installed on land at central locations to all eight sites to provide barometric pressure corrections.
- The data loggers were installed at the start of spring melt, as permitted by ice conditions and site access (excluding A5 and C8 which were installed in August).
- During each site visit, water surface elevations were surveyed using a high accuracy Real Time Kinematic (RTK) GPS Altus APS-3 system, and the pressure transducer readings were recorded during selected data logger downloads.
- Stream discharge measurements were performed during each site visit at stations with flowing water according to the Water Survey of Canada standard described by Terzi et al. (1981). Velocity and depth

measurements, which were used to calculate discharge, were collected using a Swoffer Model 2100™ or using a Marsh McBirney 2000 Flo-Mate™ velocity meter and a top-setting wading rod.

- Data loggers at each station were downloaded during each site visit and pressure transducer readings corresponding to each discharge measurement were recorded.
- Data loggers were removed during the last site visit in September prior to freeze-up.
- A stage-discharge rating curve was derived for each station based on measured water surface elevations and discharges. This rating curve was applied to the continuous record of water surface elevations, as measured and recorded by the water level logger at each station, to derive a continuous record of discharges.

2.3.2 Manual Hydrometric Stations

Following the discharge and water level data collection methods described above, additional discrete discharge and water level measurements were also collected opportunistically at the following 16 locations:

- Lake A12;
- Lake A16;
- Lake A19;
- Lake A21;
- Lake A22;
- Lake A45;
- Lake A53;
- Lake A55;
- Lake A60;
- Lake A62;
- Lake A63;
- Lake A65;
- Lake A72;
- Lake A76;
- Lake A81; and
- Lake B3.

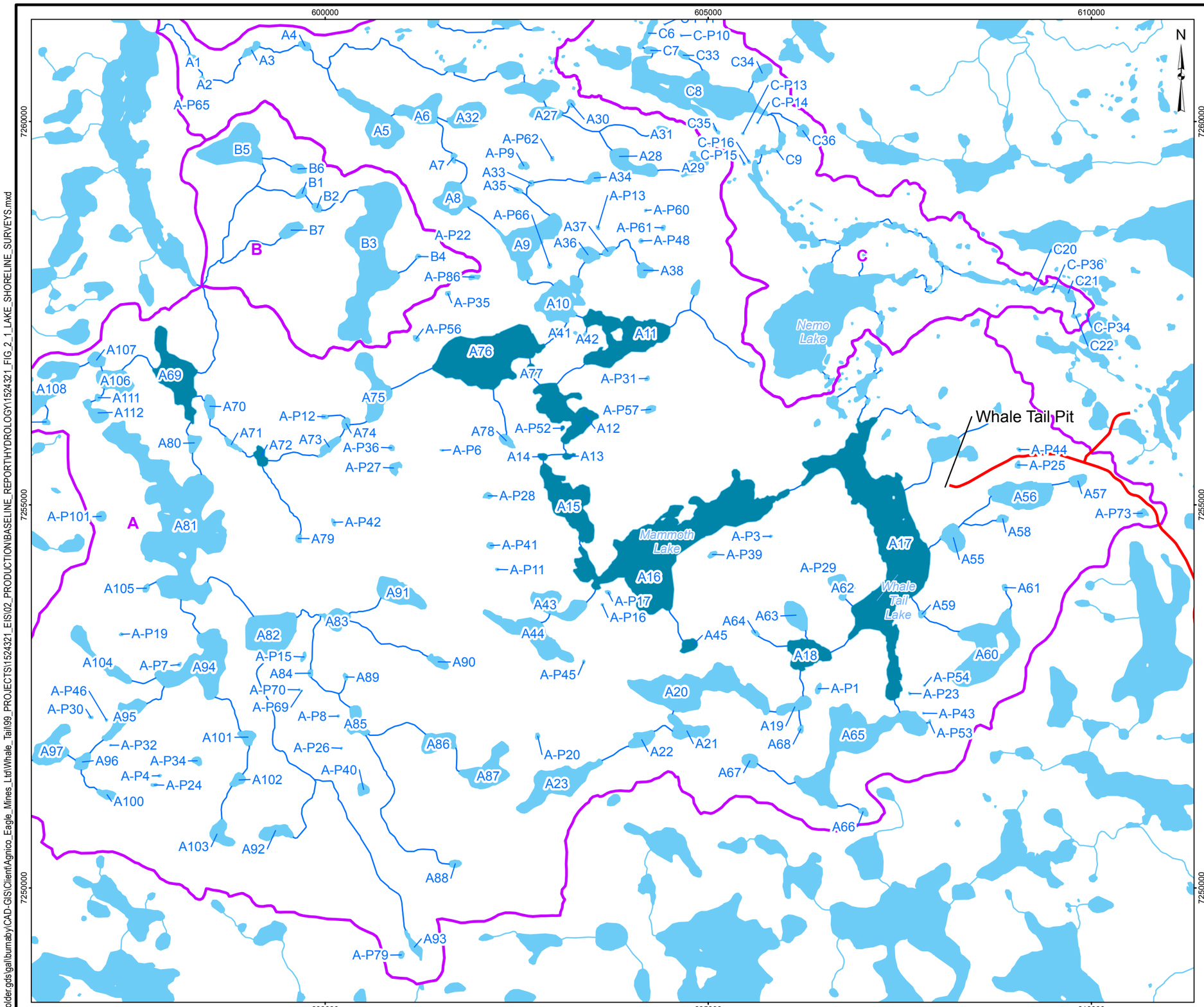
The locations of the manual hydrometric stations are shown on Figure 1-2.

2.4 Lake Shoreline Surveys

A 2015 field survey program was completed to collect geomorphological field data to characterize baseline conditions of the lake shorelines and outlet channels potentially affected by the Project (Figure 2-1). The lake shorelines were surveyed between 16 and 21 September 2015 at those lakes where baseline water levels nearest to the proposed mine operations, including: Lake A12, Lake A15, Lake A16 (Mammoth Lake), Lake A17 (Whale Tail Lake), Lake A18, Lake A45, Lake A69, Lake A72 and Lake A76.. The shorelines were accessed on foot, or by helicopter, depending on the site visit opportunity.

The methods used in the field surveys were as follows:

- For each surveyed lake, shore-normal transects were surveyed to represent typical sections of shoreline with similar slope, soil, and wave exposure.
- Lakeshore survey locations were determined based on information available from the hydrology program field trips, Project information provided by Agnico Eagle, and topographical information for the area at the time of planning (CanVec 2013).



LEGEND

- PROPOSED HAUL ROAD
- WATERSHED
- STREAM
- WATERCOURSE (CANVEC)
- SHORELINE SURVEY
- WATERBODY (CANVEC)

REFERENCE

1. HAUL ROAD OBTAINED FROM AGNICO EAGLE MINES LIMITED. 2015-10-14 FROM 6103-117-230-200_R0.dwg
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

1600 0 1600
METRES

PROJECT
AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

LAKE SHORELINE SURVEYS

Golder Associates

PROJECT		1524321	FILE No.	
DESIGN	JL	21 Oct. 2015	SCALE AS SHOWN	REV. 0
GIS	DC	27 Oct. 2015		
CHECK	JL	14 Jan. 2016		
REVIEW	DRW	14 Jan. 2016		

FIGURE 2-1

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- At each transect, a shore-normal topographic profile was surveyed using a SOKKIA GNSS GSR 2700ISX (Global Navigation Satellite System) with RTK capabilities to provide accurate position and elevation data. The transect profiles typically extended from below the existing water level to above the high water level, estimated based on visual observation while on-site.
- Lake outlet channel cross-sections were also surveyed to provide typical channel geometry data.
- Additional data for the surveyed lakes were derived using GIS software and spatial baseline data (CanVec 2013).
- A more detailed lake shoreline description was prepared based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015).
- The digital elevation data provided by Agnico Eagle (PhotoSat 2015) was used within GIS software to derive a terrain slope dataset.
- Photographic documentation was carried out simultaneously with the field surveys for each homogeneous section of the shoreline. Representative photographs are presented in Appendix B.
- Shoreline sections were delineated in the field based on the visually observable characteristics of aspect, wave exposure (a combination of prevailing wind and fetch length), slope gradient, and terrain and sediment types (gradation and origin). Ice thrust effects (e.g., ice-push berms at the shoreline) were considered as evidence of thermal erosion at existing water level elevations.

The shoreline parameters measured for the lakeshore characterization at each transect were: bank features (elevations, bank height, bank slope), bank materials, and exposure characteristics such as shore orientation and fetch length. A more detailed description of the parameters used in shoreline transect characterization is presented in Table 2-1.

Table 2-1: Shoreline Transect Parameters Description

Parameter	Description
Length	The total length of the surveyed transect
Elevations	Maximum and minimum surveyed elevations
Bank materials	The following materials classes have been used for characterization: - Fines and organics; - Sand; - Gravel; - Cobbles; - Boulders; and - Bedrock. A combination of 2 or more materials may be found at a particular transect location.
Bank height	The average bank height at the transect location
Bank slope	The average bank slope at the transect location, classified for the purposes of this study in the following 3 classes: - <10% as flat to shallow; - 10% to 30% as moderate; and - >30% as steep.
Shoreline geometry	The general shape of the shoreline at the survey location, classified as: - Coves or bays; - Irregular or straight; and - Headland or islands.
Shoreline orientation	The general exposure of the shoreline, in geographic degrees similar to wind direction.
Fetch length	The length of open water perpendicular to the shoreline over which the wind blows generating waves.

2.5 Water Balance Model

A water balance model was developed for the BSA to assess mean characteristics and natural variability of discharge and water levels of lake outlets in the baseline area.

The water balance model was developed using the GoldSim software with a 1-hour time step and input data for the period of 1950 to 2015. Model output results were obtained for all years, with the exception of years with meteorological input data gaps, including years 1951, 1979, 1993, and 2010, which were not modeled. The basic water balance elements for each modeled lake reservoir considered rainfall and snowmelt runoff, lake evaporation, changes in lake storage, and outflow to downstream basins.

The model was calibrated using runoff coefficients for land surfaces, lake outlet stage-discharge rating curves, and degree-day models for snowmelt and formation of ice in outlet channels. Runoff coefficients for land surfaces account for water losses to ground infiltration and summer evapotranspiration. The runoff coefficients were calibrated to the calculated annual water yield of hydrometric stations with available data for most of the 2015 open water season (i.e., stations with a period of record of 97 days or greater). Lake outlet stage-discharge rating curves and degree-day models were calibrated to site-specific data.

The calibrated model was used to generate daily time series datasets of lake stages and lake outlet discharges for the BSA. Frequency analyses were completed for key sites to provide a historical baseline of lake stage and lake outlet discharge regimes.

Further details on the water balance model, including input data, model structure, calibration, and preliminary validation, are presented in Appendix C.

3.0 RESULTS

3.1 Watersheds and Drainage Patterns

Watersheds within the Hydrology BSA comprise an extensive network of lakes, ponds, and interconnecting streams (Figure 1-2).

Characteristics of the A, B, and C watersheds are summarized in Table 3-1. As an example the A watershed has a drainage area of 110 km^2, and lake water surface fraction (i.e., the ratio of lake area to land area) of 16%. Watersheds and general drainage patterns are shown in Figure 3-1 to Figure 3-4.

It should be noted that the boundary separating the A watershed from the C watershed just north of Lake A113 is associated with a degree of uncertainty due to the local flat topography. Field observations noted discharge from Lake A113 both to the north (i.e., within the C watershed) and to the south (i.e., within the A watershed). Based on visual observations, Lake A113 is thought to drain primarily to the south (i.e., within the A watershed) and Lake A113 was included in the A watershed.

Table 3-1: Characteristics of Watersheds in the Hydrology Baseline Study Area

Watershed	Land Surface Area (km^2)	Lake Surface Area (km^2)	Total Area (km^2)	Lake Water Surface Fraction
A	95.6	14.8	110	0.155
B	5.95	1.19	7.14	0.200
C	14.4	3.24	17.6	0.226

km^2 = square kilometre

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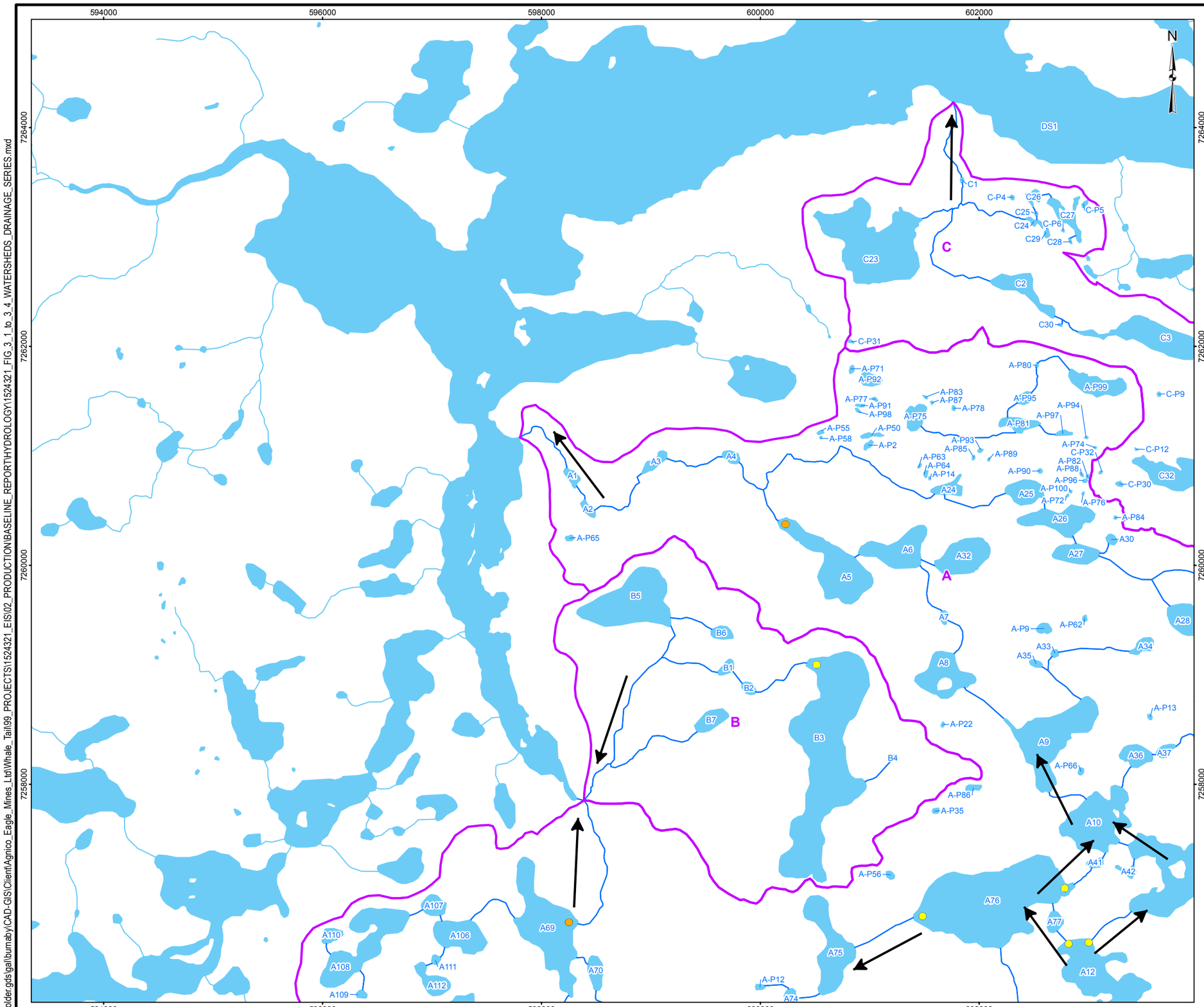

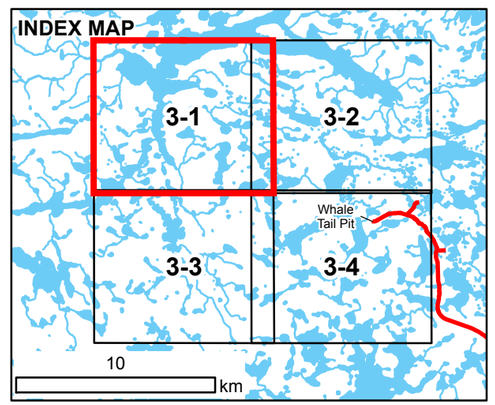

LEGEND

- CONTINUOUS STATION
- MANUAL STATION
- PROPOSED HAUL ROAD
- DRAINAGE PATTERN
- WATERSHED
- STREAM
- WATERCOURSE
- WATERBODY

REFERENCE

1. HAUL ROAD OBTAINED FROM AGNICO EAGLE MINES LIMITED. 2015-10-14 FROM 6103-117-230-200_R0.dwg
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

700 0 700
METRES

PROJECT
AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

WATERSHEDS AND DRAINAGE PATTERNS (NORTH WEST)

Golder Associates

PROJECT		1524321	FILE No.	
DESIGN	JL	21 Oct. 2015	SCALE AS SHOWN	REV. 0
GIS	CD	21 Oct. 2015		
CHECK	JL	14 Jan. 2016		
REVIEW	DRW	14 Jan. 2016		

FIGURE 3-1

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7264000 7262000 7260000 7258000

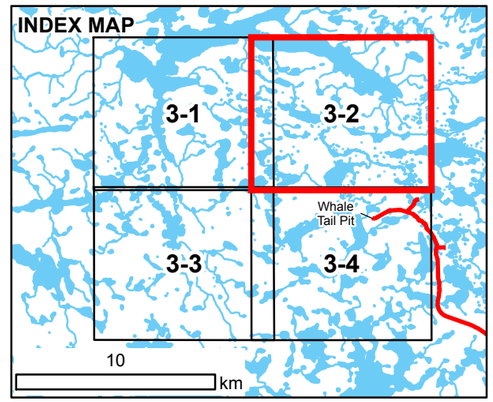
N

DS1 C1 C-P4 C26 C25 C27 C-P5 C24 C-P6 C29 C28 C2 C30 C3 C31 C4 C5 C-P8 C-P7 C-P11 C6 C-P10 C7 C33 C34 C8 C-P9 A-P80 A-P99 A-P83 A-P87 A-P78 A-P95 A-P94 A-P75 A-P81 A-P97 A-P93 A-P85 A-P74 C-P32 C-P12 A-P89 A-P63 A-P64 A-P14 A-P90 A-P82 A-P88 A-P96 C32 C-P30 A24 A25 A-P100 A-P72 A-P76 A26 A-P84 A30 A6 A32 A27 A31 C35 C-P14 C-P13 C36 C9 A7 A-P9 A-P62 A28 A29 C-P16 C-P15 C-P19 A33 A35 A34 C-P17 C-P18 A8 C37 C-P20 C-P22 C-P21 C-P23 C-P24 C-P26 C-P35 C-P29 A-P60 A-P13 A-P61 A-P48 A-P22 C10 C11 C12 C13 C52 C14 C15 C-P38 C-P33 C-P39 C-P25 C-P27 C-P3 C16 C17 C18 C-P28 A9 A36 A37 A-P66 A38 B C A C51 C45 C47 C19 A-P86 A-P35 A10 C48 C49 C50 C20 C21 C-P36 C-P37 C-P34 A39 C38 C46 C43 C-P2 C44 A-P59 C22 A-P47 A41 A42 A11 A76 A77 A12 A113 C41 C42 A-P18 A-P51 C39 A-P38 A48 C40 C-P1 A-P33 A-P237 A47 A-P49 A-P21 A49 A-P68 A50 A-P67 A46 A51 A54 A-P10 A52 A40 A-P31 A-P57 Nemo Lake

LEGEND

- CONTINUOUS STATION
- MANUAL STATION
- PROPOSED HAUL ROAD
- DRAINAGE PATTERN
- WATERSHED
- STREAM
- WATERCOURSE
- WATERBODY

INDEX MAP



REFERENCE

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DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

700 0 700
METRES

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

WATERSHEDS AND DRAINAGE PATTERNS (NORTH EAST)

Golder Associates

PROJECT		1524321	FILE No.	
DESIGN	JL	21 Oct. 2015	SCALE AS SHOWN	REV. 0
GIS	CD	21 Oct. 2015		
CHECK	JL	14 Jan. 2016		
REVIEW	DRW	14 Jan. 2016		

FIGURE 3-2

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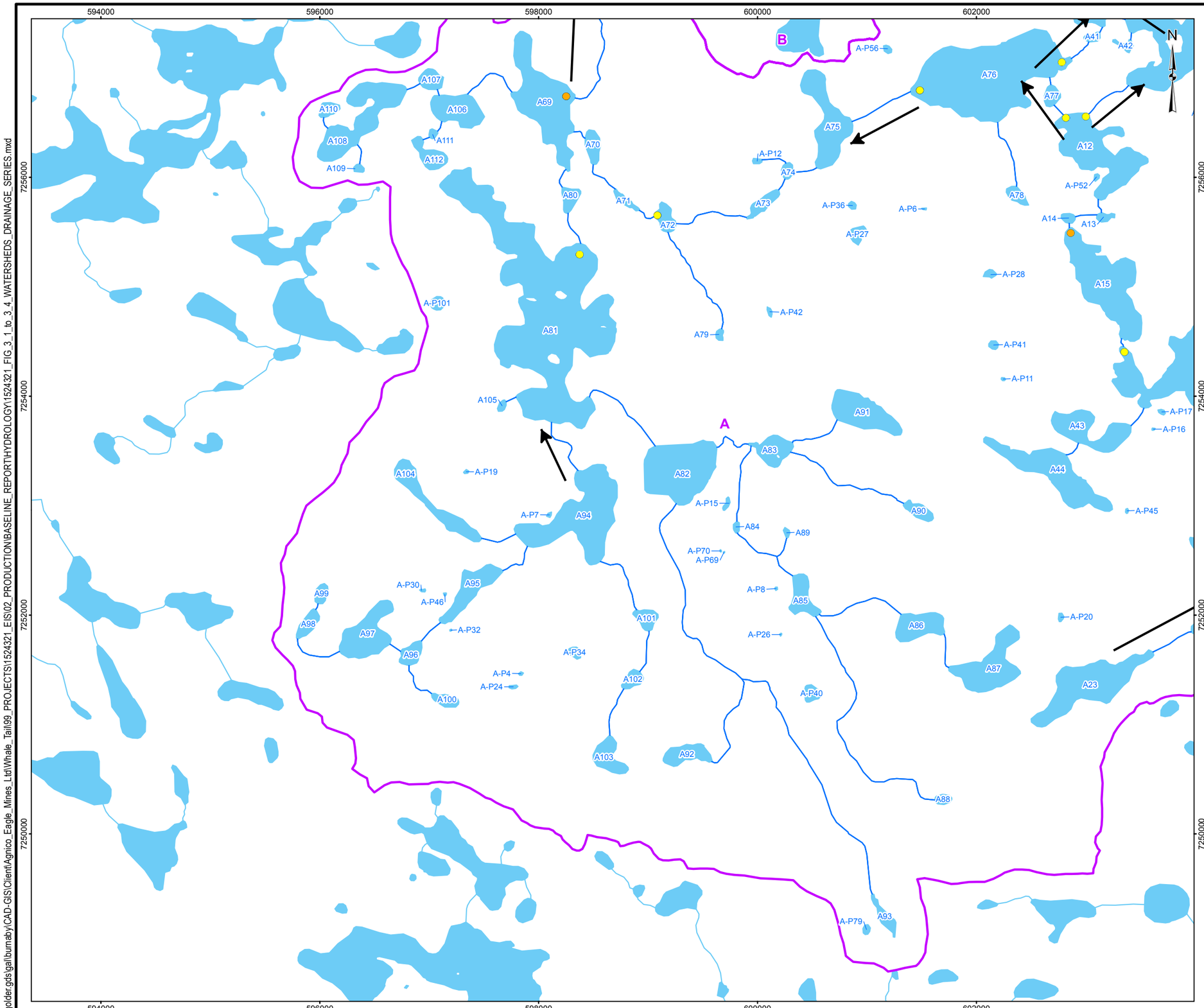

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DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

700 0 700
METRES

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

WATERSHEDS AND DRAINAGE PATTERNS (SOUTH WEST)

Golder Associates

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GIS	CD	21 Oct. 2015		
CHECK	JL	14 Jan. 2016		
REVIEW	DRW	14 Jan. 2016		

FIGURE 3-3

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7256000 7254000 7252000 7250000

Nemo Lake
Mammoth Lake
Whale Tail Lake
Whale Tail Pit

A11 A12 A13 A14 A15 A16 A17 A18 A19 A20 A21 A22 A23
A40 A41 A42 A43 A44 A45 A46 A47 A48 A49 A50 A51 A52 A53 A54 A55 A56 A57 A58 A59 A60 A61 A62 A63 A64 A65 A66 A67 A68
A76 A77 A78 A86 A87 A88 A90
A

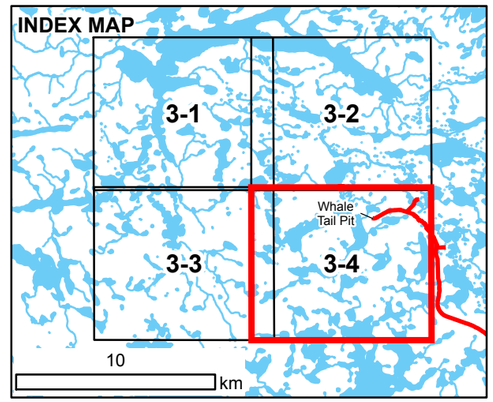
C-P2 C44 C41 C42 C39 C40 C-P1 A113 A-P18 A-P38 A-P51 A-P33 A-P37 A-P49 A-P67 A-P68 A-P10 A-P5 A-P21 A-P47 A-P59 C22
A-P31 A-P57 A-P52 A-P6 A-P28 A-P41 A-P11 A-P17 A-P16 A-P45 A-P3 A-P39 A-P29 A-P44 A-P25 A-P73 A-P1 A-P54 A-P23 A-P43 A-P53 A-P20

N

LEGEND

- CONTINUOUS STATION
- MANUAL STATION
- PROPOSED HAUL ROAD
- DRAINAGE PATTERN
- WATERSHED
- STREAM
- WATERCOURSE
- WATERBODY

INDEX MAP



REFERENCE

1. HAUL ROAD OBTAINED FROM AGNICO EAGLE MINES LIMITED. 2015-10-14 FROM 6103-117-230-200_R0.dwg
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

700 0 700
METRES

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT

TITLE

WATERSHEDS AND DRAINAGE PATTERNS (SOUTH EAST)

Golder Associates

PROJECT		1524321	FILE No.	
DESIGN	JL	21 Oct. 2015	SCALE AS SHOWN	REV. 0
GIS	CD	21 Oct. 2015		
CHECK	JL	14 Jan. 2016		
REVIEW	DRW	14 Jan. 2016		

FIGURE 3-4

\\golder.gds\gal\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Whale_Tail\99_PROJECTS\1524321_EIS\02_PRODUCTION\BASELINE_REPORT\HYDROLOGY\1524321_FIG_3_1_to_3_4_WATERSHEDS_DRAINAGE_SERIES.mxd

3.2 Hydrometry

3.2.1 Continuous Hydrometric Stations

As stated in Section 2.3.1, continuous hydrometric stations were installed at Lake A5, Lake A15, Lake A17 (Whale Tail Lake), Lake A18, Lake A69, Lake C8, Lake C38 (Nemo Lake), and Lake DS1. Hydrographs for all eight locations and field survey results are summarized below. In addition, Appendix A includes factsheets describing the location of each hydrometric station and the equipment installed (when applicable); photographs; measured stage-discharge data; derived stage-discharge rating curve based on data collected in 2015; tabulated mean daily discharge and water level data; manual discharge measurement data; and related calculation sheets for each station.

3.2.1.1 Lake A5

The Lake A5 hydrometric station was visited twice in 2015, and a continuous hydrograph was derived for the period of 6 August to 17 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-2. The hydrographs for Lake A5 are presented in Figure 3-5. The water surface elevation of the lake was also captured by the DEM dataset (PhotoSat 2015) and was added to the table and figure.

It should be noted that the DEM elevation (PhotoSat 2015) is approximately 25 cm higher than the derived water surface elevation. This difference in elevation falls within the accuracy of the DEM data of ± 30 cm (PhotoSat 2015).

Table 3-2: Surveys at Lake A5 Hydrometric Station, 2015

Date	Activities	Lake	Lake Water Surface Elevation (masl)	Outlet	Discharge (m^3/s)
6 Aug	Measured discharge and water surface elevation, and installed data logger.	✓	132.30	✓	0.434
28 Aug	From DEM (PhotoSat 2015)	✓	132.50	-	-
17 Sep	Measured discharge and water surface elevation. Removed and downloaded data logger.	✓	132.16	✓	0.112

masl = metres above sea level, m^3/s = cubic metres per second.

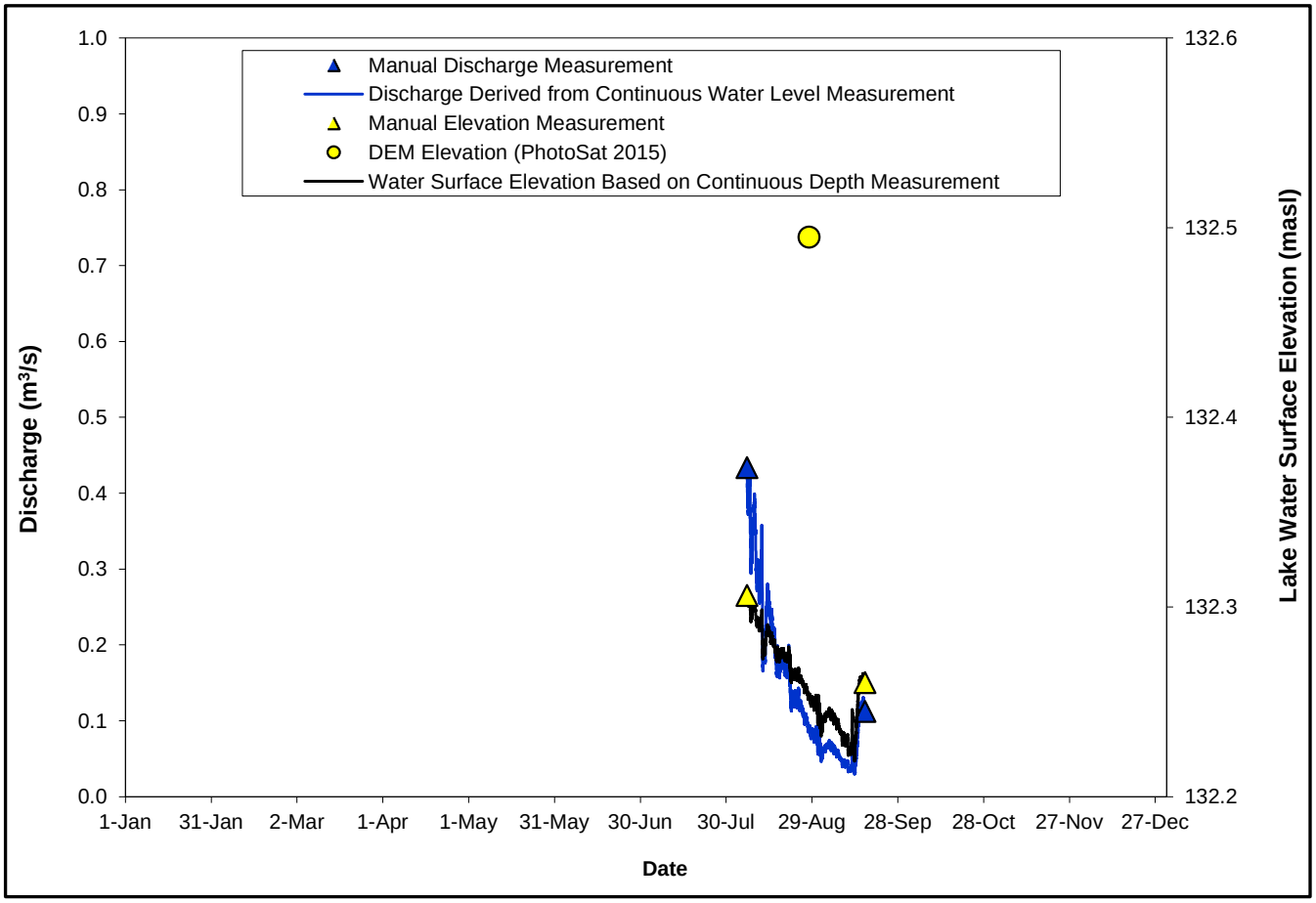


Figure 3-5: Hydrograph for Lake A5 in 2015

3.2.1.2 Lake A15

The Lake A15 hydrometric station was visited six times in 2015, and a continuous hydrograph was derived for the period of 13 June to 18 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-3. The hydrographs for Lake A15 are presented in Figure 3-6. The water surface elevation of the lake was also captured by the DEM dataset (PhotoSat 2015) and was added to the table and figure.

Table 3-3: Surveys at Lake A15 Hydrometric Station, 2015

Date	Activities	Lake	Lake Water Surface Elevation (masl)	Outlet	Discharge (m^3/s)
30 May	None - Lake A15 and outlet frozen.	-	-	-	Frozen
8 Jun	None - Lake A15 and outlet frozen.	-	-	-	Frozen
13 Jun	Installed data logger. Measured water surface elevation.	✓	152.06	-	Trickle (Ice Present)
15 Jun	Measured discharge and water surface elevation.	✓	152.09	✓	5.68
4 Aug	Measured discharge and water surface elevation, and downloaded data logger.	✓	151.65	✓	0.233
28 Aug	From DEM (PhotoSat 2015)	✓	151.46	-	-
18 Sep	Measured discharge and water surface elevation; removed and downloaded data logger.	✓	151.43	-	Not measurable

masl = metres above sea level, m^3/s = cubic metres per second

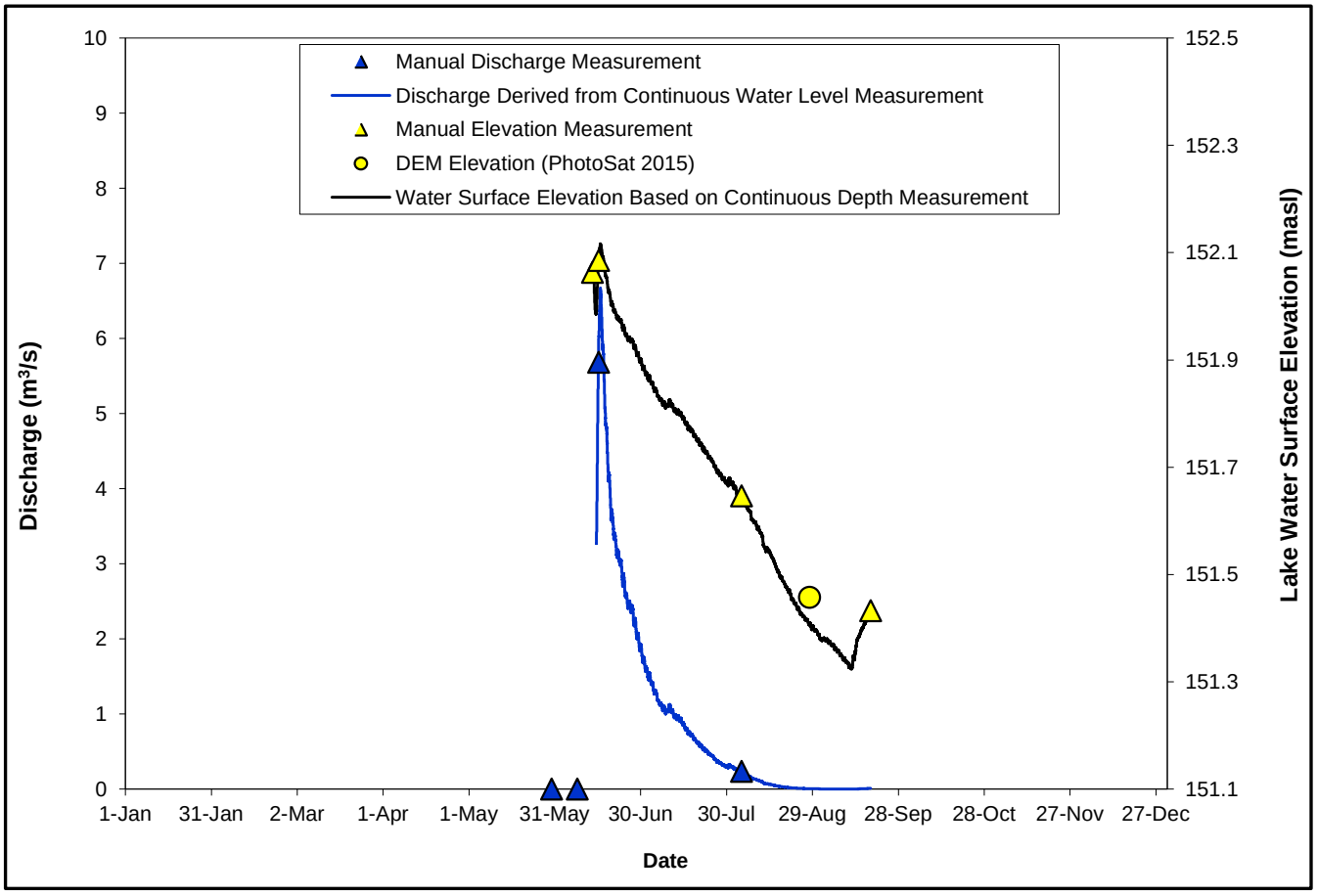


Figure 3-6: Hydrograph for Lake A15 in 2015

3.2.1.3 Lake A17 (Whale Tail Lake)

The Lake A17 (Whale Tail Lake) hydrometric station was visited six times in 2015, and a continuous hydrograph was derived for the period of 12 June to 16 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-4. The hydrographs for Lake A17 and Outlet are presented in Figure 3-7. The water surface elevation of the lake was also captured by the DEM dataset (PhotoSat 2015) and was added to the table and figure.

Table 3-4: Surveys at Lake A17 (Whale Tail Lake) Hydrometric Station, 2015

Date	Activities	Lake	Lake Water Surface Elevation (masl)	Outlet	Discharge (m^3/s)
30 May	None - Lake A17 and outlet are frozen.	-	-	-	Frozen
8 Jun	None - Lake A17 and outlet are frozen.	-	-	-	Frozen
12 Jun	Installed data logger. Measured water surface elevation.	✓	153.11	-	Frozen
14 Jun	Measured discharge and water surface elevation.	✓	153.38	✓	4.23
7 Aug	Measured discharge and water surface elevation, and downloaded data logger.	✓	152.65	✓	0.190
28 Aug	From DEM (PhotoSat 2015)	✓	152.50	-	-
16 Sep	Measured discharge and water surface elevation; removed and downloaded data logger.	✓	152.46	✓	0.012

masl = metres above sea level, m^3/s = cubic metres per second

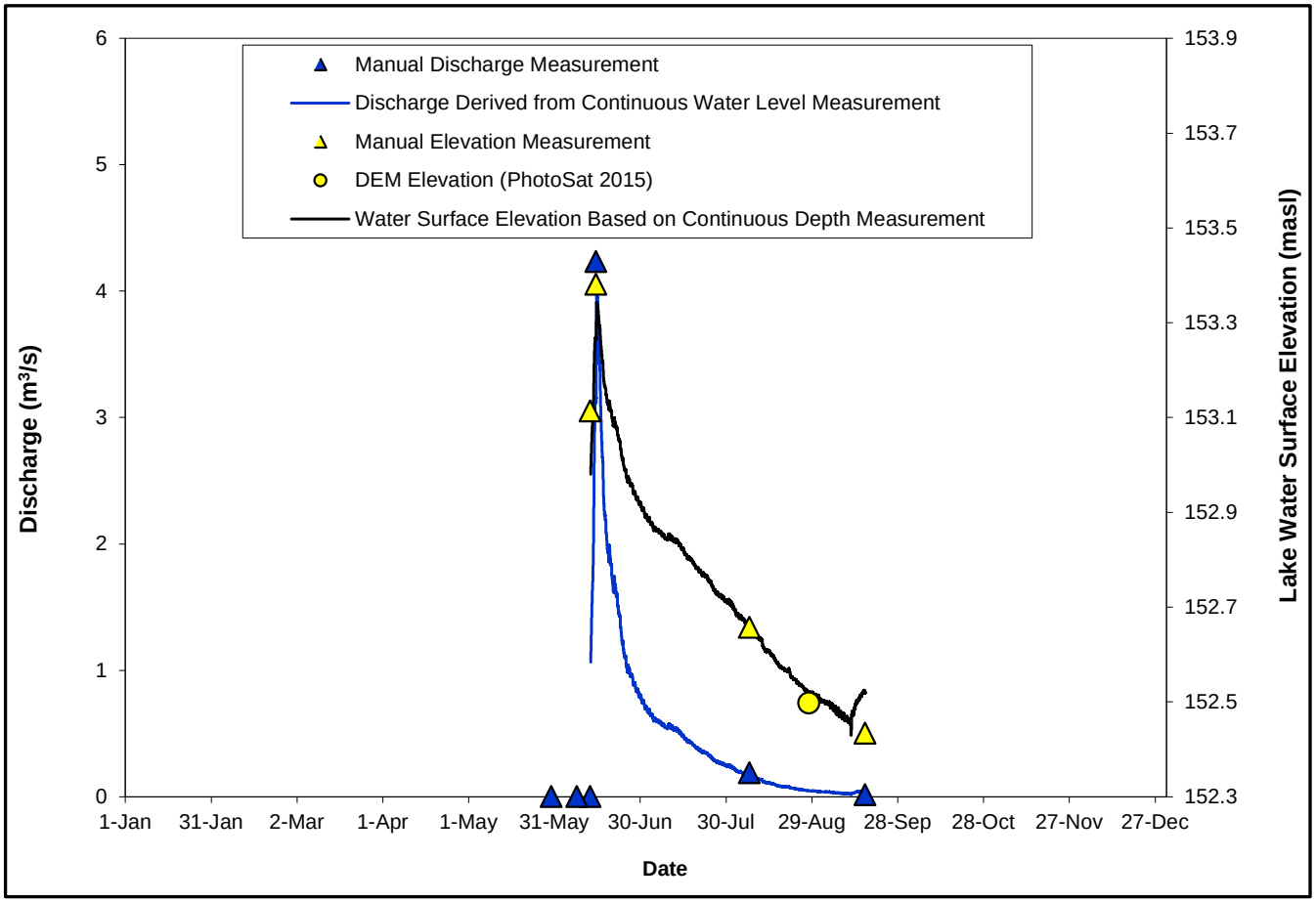


Figure 3-7: Hydrograph for Lake A17 (Whale Tail Lake) in 2015

3.2.1.4 Lake A18

The Lake A18 hydrometric station was visited six times in 2015, and a continuous hydrograph was derived for the period of 11 June to 16 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-5. The hydrographs for Lake A18 and Outlet are presented in Figure 3-8. The water surface elevation of the lake was also captured by the DEM dataset (PhotoSat 2015) and was added to the table and figure.

It should be noted that the DEM elevation (PhotoSat 2015) is approximately 8 cm higher than the derived water surface elevation. This difference in elevation falls within the accuracy of the DEM data of ± 30 cm (PhotoSat 2015).

Table 3-5: Surveys at Lake A18 Hydrometric Station, 2015

Date	Activities	Lake	Lake Water Surface Elevation (masl)	Outlet	Discharge (m^3/s)
30 May	None - Lake A18 and outlet are frozen.	-	-	-	Frozen
8 Jun	None - Lake A18 and outlet are frozen.	-	-	-	Frozen
11 Jun	Installed data logger. Measured water surface elevation.	✓	154.16	-	Frozen
14 Jun	Measured discharge and water surface elevation.	✓	154.22	✓	2.48
4 Aug	Measured discharge and water surface elevation, and downloaded data logger.	✓	153.89	✓	0.129
28 Aug	From DEM (PhotoSat 2015)	✓	153.86	-	-
16 Sep	Measured discharge and water surface elevation; removed and downloaded data logger.	✓	153.81	✓	0.004

masl = metres above sea level, m^3/s = cubic metres per second

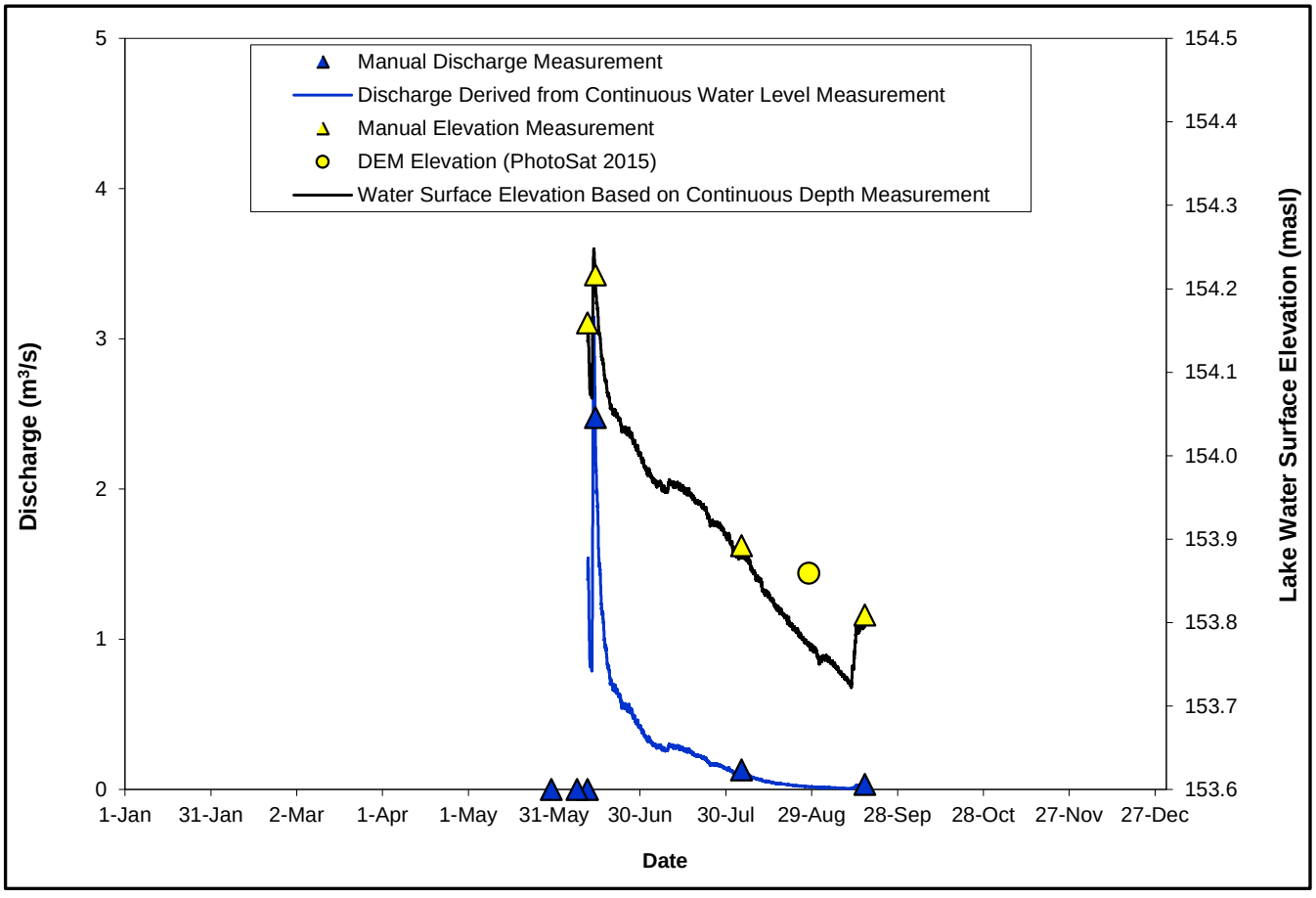


Figure 3-8: Hydrograph for Lake A18 in 2015

3.2.1.5 Lake A69

The Lake A69 hydrometric station was visited six times in 2015, and a continuous hydrograph was derived for the period of 11 June to 16 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-6. The hydrographs for Lake A69 are presented in Figure 3-9. The water surface elevation of the lake was also captured by the DEM dataset (PhotoSat 2015) and was added to the table and figure.

Table 3-6: Surveys at Lake A69 and Outlet Hydrometric Station, 2015

Date	Activities / Data Source	Lake	Lake Water Surface Elevation (masl)	Outflow	Discharge (m^3/s)
30 May	None - Lake A69 and outlet are frozen.	-	-	-	Frozen
8 Jun	None - Lake A69 and outlet are frozen.	-	-	-	Frozen
11 Jun	Installed data logger. Measured discharge and water surface elevation.	✓	112.47	✓	3.00
15 Jun	Measured discharge and water surface elevation.	✓	112.60	✓	6.73
4 Aug	Measured discharge and water surface elevation, and downloaded data logger.	✓	112.21	✓	0.398
28 Aug	From DEM (PhotoSat 2015)	✓	112.21	-	-
16 Sep	Measured discharge and water surface elevation; removed and downloaded data logger.	✓	112.17	✓	0.206

masl = metres above sea level, m^3/s = cubic metres per second

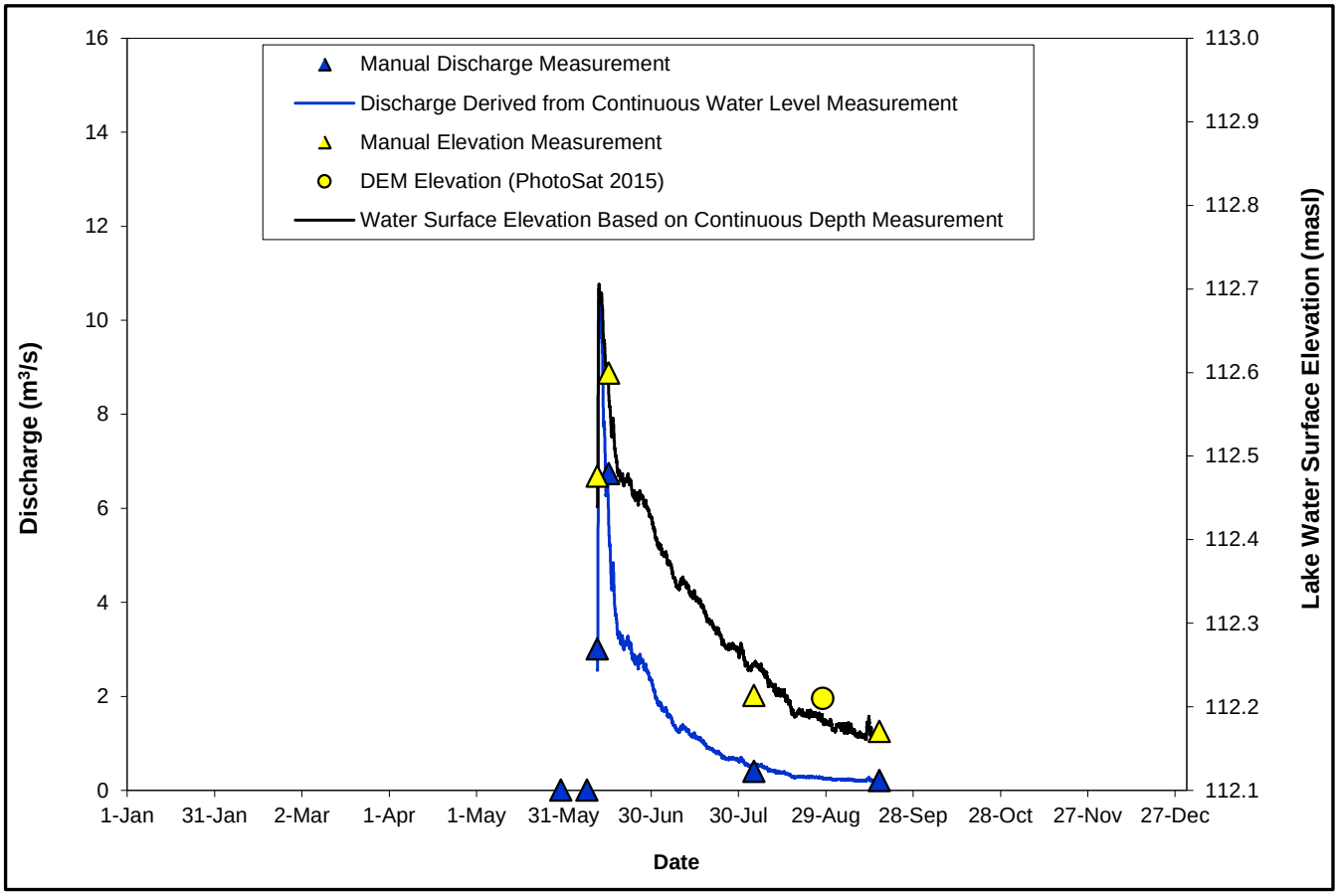


Figure 3-9: Hydrograph for Lake A69 in 2015

3.2.1.6 Lake C8

The Lake C8 hydrometric station was visited twice in 2015, and a continuous hydrograph was derived for the period of 8 August to 16 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-7. The hydrographs for Lake C8 are presented in Figure 3-10. The water surface elevation of the lake was also captured by the DEM dataset (PhotoSat 2015) and was added to the table and figure.

It should be noted that the DEM elevation (PhotoSat 2015) is approximately 25 cm lower than the derived water surface elevation. This difference in elevation falls within the accuracy of the DEM data of ± 30 cm (PhotoSat 2015).

Table 3-7: Surveys at Lake C8 Hydrometric Station, 2015

Date	Activities	Lake	Lake Water Surface Elevation (masl)	Outlet	Discharge (m^3/s)
8 Aug	Measured discharge and water surface elevation, and installed data logger.	✓	139.02	✓	0.087
28 Aug	From DEM (PhotoSat 2015)	✓	138.74	-	-
16 Sep	Measured discharge and water surface elevation; removed and downloaded data logger.	✓	139.02	✓	0.101

masl = metres above sea level, m^3/s = cubic metres per second

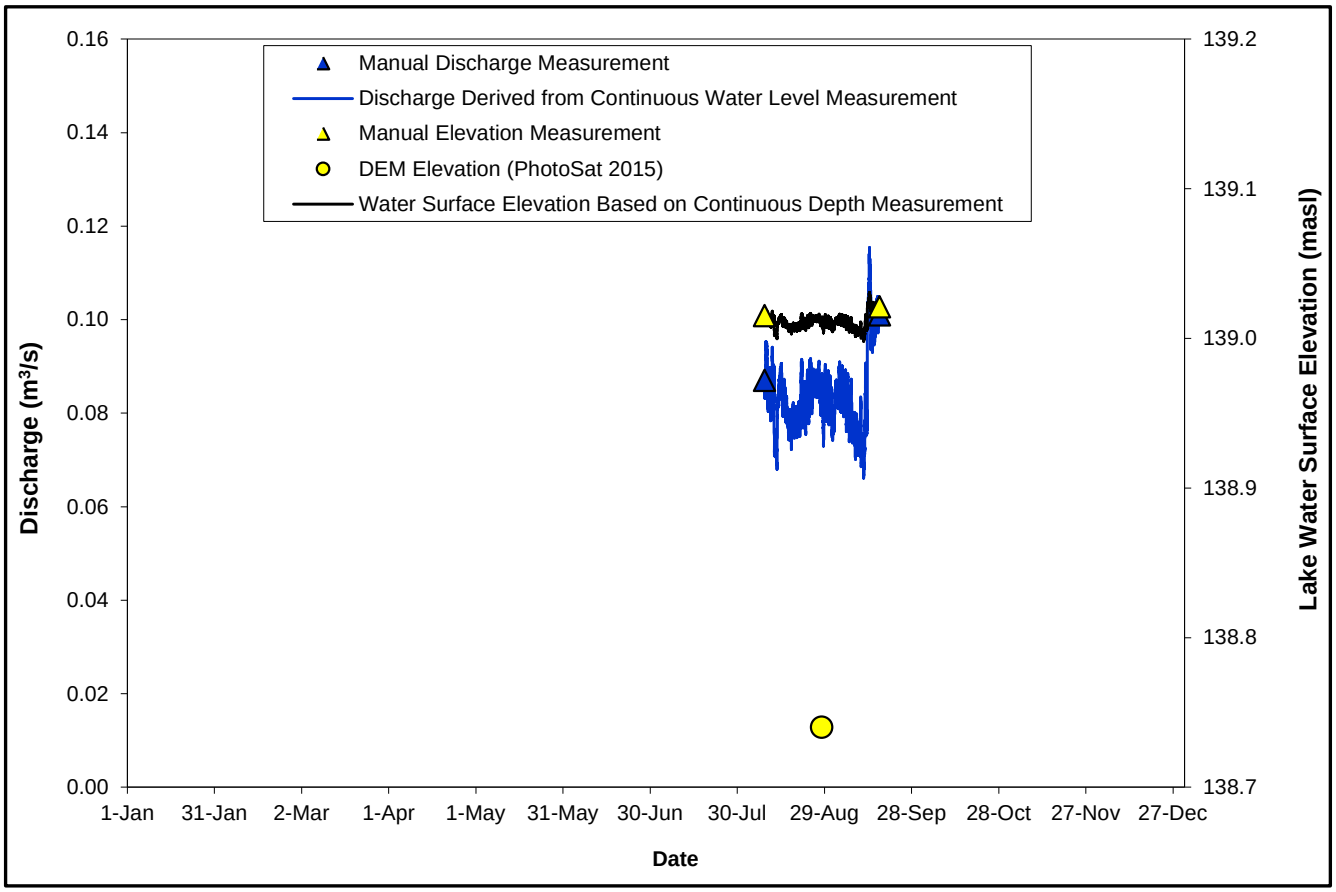


Figure 3-10: Hydrograph for Lake C8 in 2015

3.2.1.7 Lake C38 (Nemo Lake)

The Lake C38 (Nemo Lake) hydrometric station was visited six times in 2015, and a continuous hydrograph was derived for the period of 13 June to 17 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-8. The hydrographs for Lake C38 (Nemo Lake) are presented in Figure 3-11. The water surface elevation of the lake was also captured by the DEM dataset (PhotoSat 2015) and was added to the table and figure.

Table 3-8: Surveys at Lake C38 (Nemo Lake) Hydrometric Station, 2015

Date	Activities	Lake	Lake Water Surface Elevation (masl)	Outlet	Discharge (m^3/s)
30 May	None - Lake C38 and outlet are frozen.	-	-	-	Frozen
8 Jun	None - Lake C38 and outlet are frozen.	-	-	-	Frozen
13 Jun	Installed data logger. Measured water surface elevation.	✓	155.99	-	Frozen
14 Jun	Measured discharge and water surface elevation.	✓	156.01	✓	0.046
4 Aug	Measured discharge and water surface elevation, and downloaded data logger.	✓	155.85	✓	0.019
28 Aug	From DEM (PhotoSat 2015)	✓	155.70	-	-
17 Sep	Measured discharge and water surface elevation; removed and downloaded data logger.	✓	155.69	✓	0.007

masl = metres above sea level, m^3/s = cubic metres per second

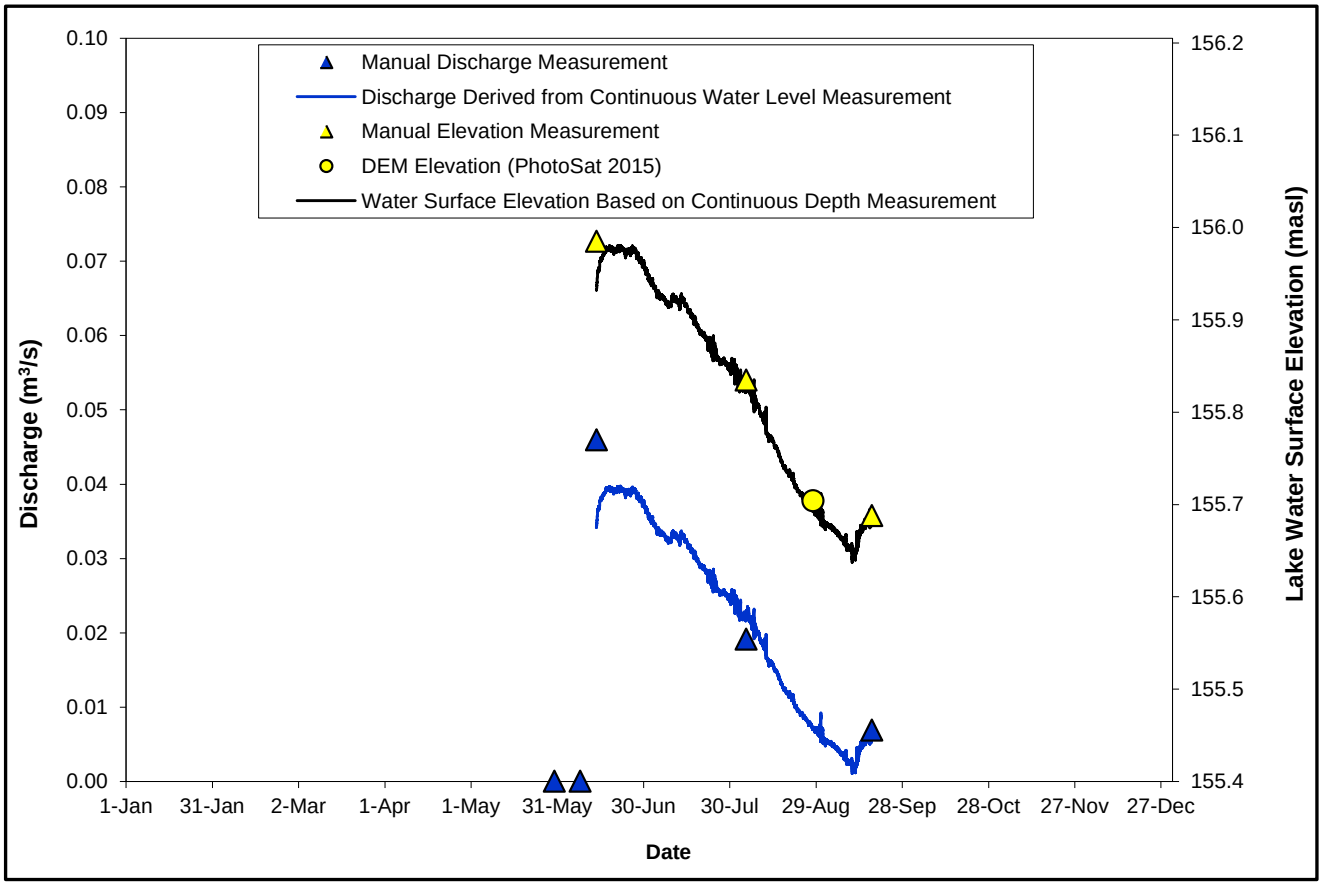


Figure 3-11: Hydrograph for Lake C38 (Nemo Lake) in 2015

3.2.1.8 Lake DS1

The Lake DS1 hydrometric station was visited three times in 2015, and a continuous hydrograph was derived for the period of 12 June to 16 September 2015, based on continuous logger data. Details of each site visit are provided in Table 3-9. The hydrographs for Lake DS1 are presented in Figure 3-12.

No discharge was measured on 12 June 2015 due to unsafe wading conditions. The estimate provided was based on velocity measurements along wadeable sections near the banks, and estimated wetted width. DEM data did not extend to the Lake DS1 hydrometric station.

Table 3-9: Surveys at Lake DS1 and Outlet Hydrometric Station, 2015

Date	Activities	Lake	Lake Water Surface Elevation (masl)	Outlet	Discharge (m^3/s)
12 Jun	Installed data logger. Measured water surface elevation and estimated discharge due to unsafe wading conditions.	✓	99.66	-	-
5 Aug	Measured discharge and water surface elevation, and downloaded data logger.	✓	99.47	✓	12.3
16 Sep	Measured discharge and water surface elevation; removed and downloaded data logger.	✓	99.21	✓	4.82

masl = metres above sea level, m^3/s = cubic metres per second

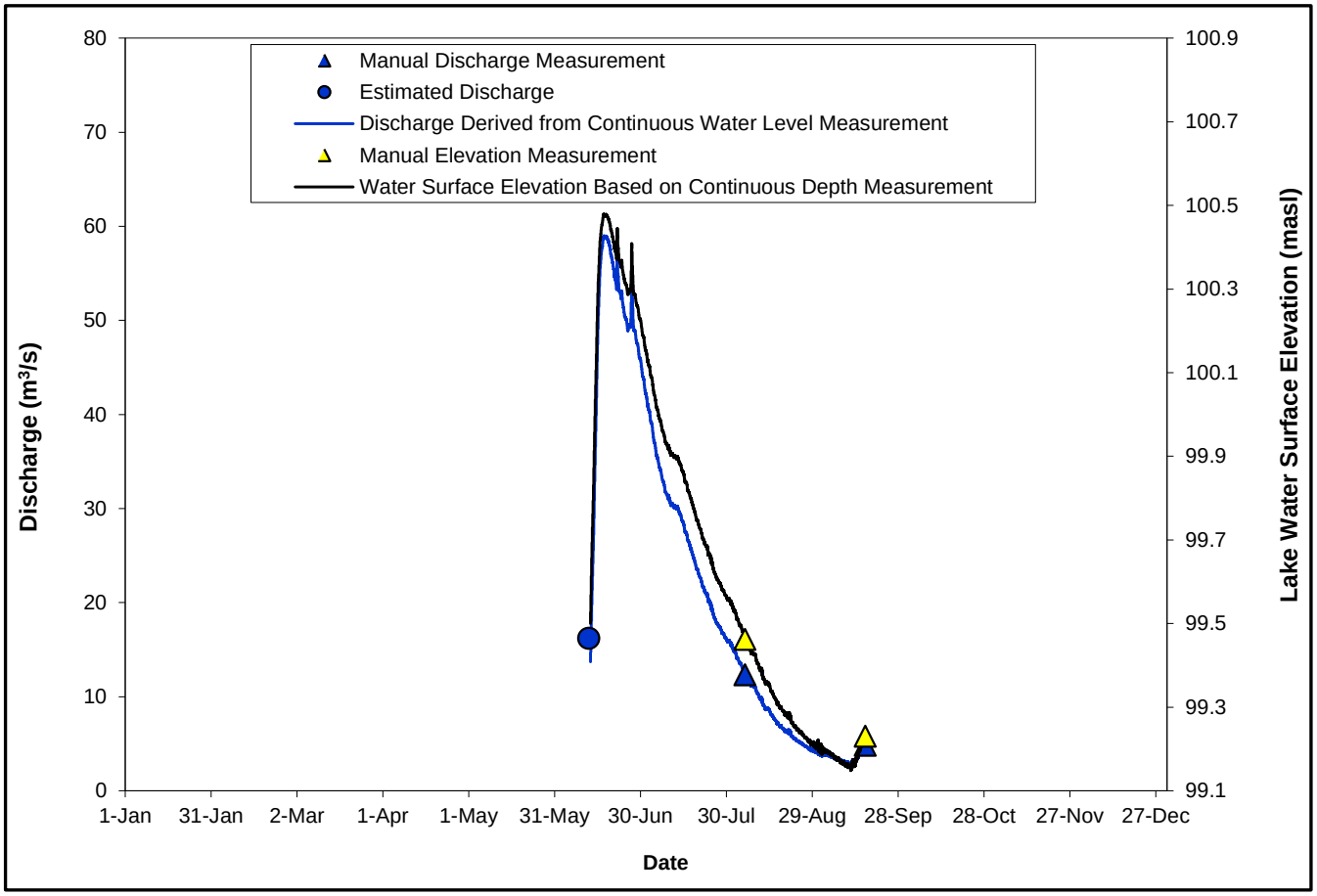


Figure 3-12: Hydrograph for Lake DS1 in 2015

3.2.1.9 Water Yields

Water yields for the open water season were calculated based on derived daily discharge values for stations with continuous hydrographs, and are presented in Table 3-10.

Derived water yields for lakes with similar periods of record (i.e., with 97 and 98 days of record) varied between 52.3 mm (Lake C38 [Nemo Lake]) and 267 mm (Lake A18). The lower water yields at Lake A17 and Lake C38 may be attributed to proportions of ineffective areas in the watersheds, and the potential for shallow subsurface flow to convey water outside of the assumed drainage boundaries. Tributaries of Lake A17 (Whale Tail Lake) and Lake C38 (Nemo Lake) were opportunistically observed to drain poorly, with ponded water.

Lake A5 and Lake 69 are both located downstream of Lake A76. As shown on the drainage pattern map (Figure 1-2), Lake A12 and Lake A76 each have two lake outlets. Based on field observations (with further information on the elevations of each lake outlet provided in Section 3.3), Lake A12 primarily drains to Lake A11, and its secondary outlet drains to Lake A77. Lake A76 primarily drains to Lake A41, and its secondary outlet to Lake A75. It was therefore assumed that Lake A76 only drained to Lake A41 during periods of record for water yields derived for Lake A5 and Lake A69.

Table 3-10: Water Yield Values for the Continuous Stations over the Period of Record in 2015

Sub-Watershed	Watershed Area (km^2)	Hydrograph Period and Duration (number of days)	Runoff Volume (m^3)	Water Yield (mm)
Lake A5	57.6[a]	6 August to 16 September 2015 (42)	518,000	9.0[a,c]
Lake A15	40.8	13 June to 18 September 2015 (98)	7,880,000	193
Lake A17 (Whale Tail Lake)	28.1	12 June to 16 September 2015 (97)	4,290,000	152
Lake A18	8.89	11 June to 15 September 2015 (97)	2,380,000	267
Lake A69	43.4[b]	11 June to 16 September 2015 (98)	11,400,000	276[b]
Lake C8	11.8	8 August to 16 September 2015 (40)	283,000	24.0[c]
Lake C38 (Nemo Lake)	3.54	13 June to 17 September 2015 (97)	185,000	52.3
Lake DS1	897.6	12 June to 16 September 2015 (97)	179,000,000	199.2

[a] inclusive of the Lake A76 sub-watershed (i.e., over the period of the record, it was assumed that all runoff from Lake A76 drained to Lake A41)

[b] exclusive of the Lake A76 sub-watershed (i.e., over the period of the record, it was assumed that all runoff from Lake A76 drained to Lake A41)

[c] late open-water season flows only; does not include freshet

km^2 = square kilometres; m^3 = cubic metres; mm = millimetres

3.2.2 Manual Hydrometric Stations

Manual hydrometric measurements are summarized in Table 3-11.

Table 3-11: Manual Hydrometric Measurements

Lake Name	Date	Discharge (m^3/s)	Water Level (masl)	Comment
Lake A12-A11	06-Aug-15	0.316	148.82	northeast outlet of Lake A12
	28-Aug-15	-	148.61	PhotoSat 2015
	18-Sep-15	(a)	148.73	northeast outlet of Lake A12
Lake A12-A77	06-Aug-15	0.133	148.82	northwest outlet of Lake A12
	28-Aug-15	-	148.61	PhotoSat 2015
	18-Sep-15	(a)	148.73	northwest outlet of Lake A12
Lake A16	13-Jun-15	2.07	152.61	
	28-Aug-15	-	152.24	PhotoSat 2015
	18-Sep-15	-	152.09	
Lake A19	08-Aug-15	(a)	154.69	
	28-Aug-15	-	154.62	PhotoSat 2015
Lake A21	06-Aug-15	0.015	157.77	Water level measured on 8 August 2015
	28-Aug-15	-	154.63	PhotoSat 2015
Lake A22	08-Aug-15	(a)	154.92	
	28-Aug-15	-	154.79	PhotoSat 2015
Lake A45	28-Aug-15	-	156.27	PhotoSat 2015
	19-Sep-15	(a)	156.42	
Lake A53	12-Jul-15	0.048	-	Measured by Agnico Eagle
	7-Aug-15	0.005	161.655	
	28-Aug-15	-	161.73	PhotoSat 2015

Table 3-11: Manual Hydrometric Measurements (continued)

Lake Name	Date	Discharge (m^3/s)	Water Level (masl)	Comment
Lake A55	12-Jul-15	0.110	-	Measured by Agnico Eagle
	07-Aug-15	0.020	155.00	
	28-Aug-15	-	155.01	PhotoSat 2015
	17-Sep-15	0.042	154.97	
Lake A60	12-Jul-15	0.077	170.67	Measured by Agnico Eagle; discharge measured downstream of Lake A26
	09-Aug-15	0.004	170.51	
	28-Aug-15	-	170.44	PhotoSat 2015
	17-Sep-15	0.002	-	
Lake A62	12-Jul-15	-	-	Sheet flow observed by Agnico Eagle
	08-Aug-15	0	155.29	
	28-Aug-15	-	155.41	PhotoSat 2015
Lake A63	08-Aug-15	(a)	154.41	
	28-Aug-15	-	154.45	PhotoSat 2015
Lake A65	12-Jul-15	-	-	Observed flow by Agnico Eagle
	09-Aug-15	(a)	154.38	
	28-Aug-15	-	154.79	PhotoSat 2015
Lake A72	28-Aug-15	-	117.36	PhotoSat 2015
	18-Sep-15	0.117	117.39	
Lake A76-A41	06-Aug-15	0.079	147.69	East outlet of Lake A76; water level measured on 5 August 2015
	28-Aug-15	-	147.56	PhotoSat 2015
	18-Sep-15	(a)	147.48	East outlet of Lake A76
Lake A76-A75	12-Jul-15	(a)	-	Measured by Agnico Eagle
	06-Aug-15	(a)	147.69	West outlet of Lake A76; water level measured on 5 August 2015
	28-Aug-15	-	147.56	PhotoSat 2015
	18-Sep-15	(a)	147.48	West outlet of Lake A76
Lake A81	12-Jul-15	1.09	119.92	Measured by Agnico Eagle
	08-Aug-15	0.124	119.86	
	28-Aug-15	-	119.31	PhotoSat 2015
Lake B3	12-Jul-15	0	-	Measured by Agnico Eagle
	08-Aug-15	0.036	-	
	28-Aug-15	-	161.73	PhotoSat 2015

masl = metres above sea level, m^3/s = cubic metres per second, (a) = discharge too low to measure, - = not available

3.3 Lake Shoreline Surveys

Shorelines were surveyed at those lakes where baseline water levels are anticipated to be affected by mine operations, including: Lake A12, Lake A15, Lake A16 (Mammoth Lake), Lake A17 (Whale Tail Lake), Lake A18, Lake A45, Lake A69, Lake A72 and Lake A76 (Figure 2-1; Appendix B). The shorelines were accessed on foot, or by helicopter, depending on the site visit opportunity. The surveys were completed using the methods described in Section 2.4.

The majority of the shorelines surveyed exhibit a consistent terrain type related to shorelines that have developed in morainal material. These morainal shorelines were observed at all lakes visited during the field survey. Limited areas of bedrock and shallowly sloped sandy shorelines were also observed. As a general characteristic for the surveyed shorelines, the predominant materials are boulder gardens mixed with cobble with very limited soils or organic materials on top. The outlet channels exhibit the same characteristics for streambed materials, which results in interstitial flow through large boulders or below the surface and likely close to the bedrock, making flow difficult to observe and measure.

3.3.1 Lake A12

The survey of Lake A12 focused on the lake shoreline and outlet channel. Lake A12 has a surface area of approximately 28.9 ha, and drains into Lake A11 through a main outlet at average and below average water levels. At water levels above average, Lake A12 has a secondary outlet that drains into Lake A77. The proportion of flow to each outlet may also be influenced by outlet channel ice conditions during freshet. Section 3.1 provides further details on the drainage patterns.

The field surveys at Lake A12 included: outlet channel cross-section, outlet channel water surface slope, lake shore normal transects and existing and ordinary high lake water levels.

Both outlet channel cross-sections were surveyed. The main outlet channel is approximately 35 m wide and the secondary outlet channel is approximately 40 m wide (Figure 3-13). The outlet channels are similar, with a poorly defined channel, mainly comprised of a boulder field. The water flows mostly through the boulders for almost the entire width of the main outlet channels. Further downstream, the flow becomes entirely subsurface and is only visible at times through the boulders. No flowing water was observed in the secondary outlet channel at the time of visit.

The slope of the water surface in the main outlet channel could not be measured during the survey because no water was observed and the flow was determined to be interstitial flow (through the boulders and below the surface).

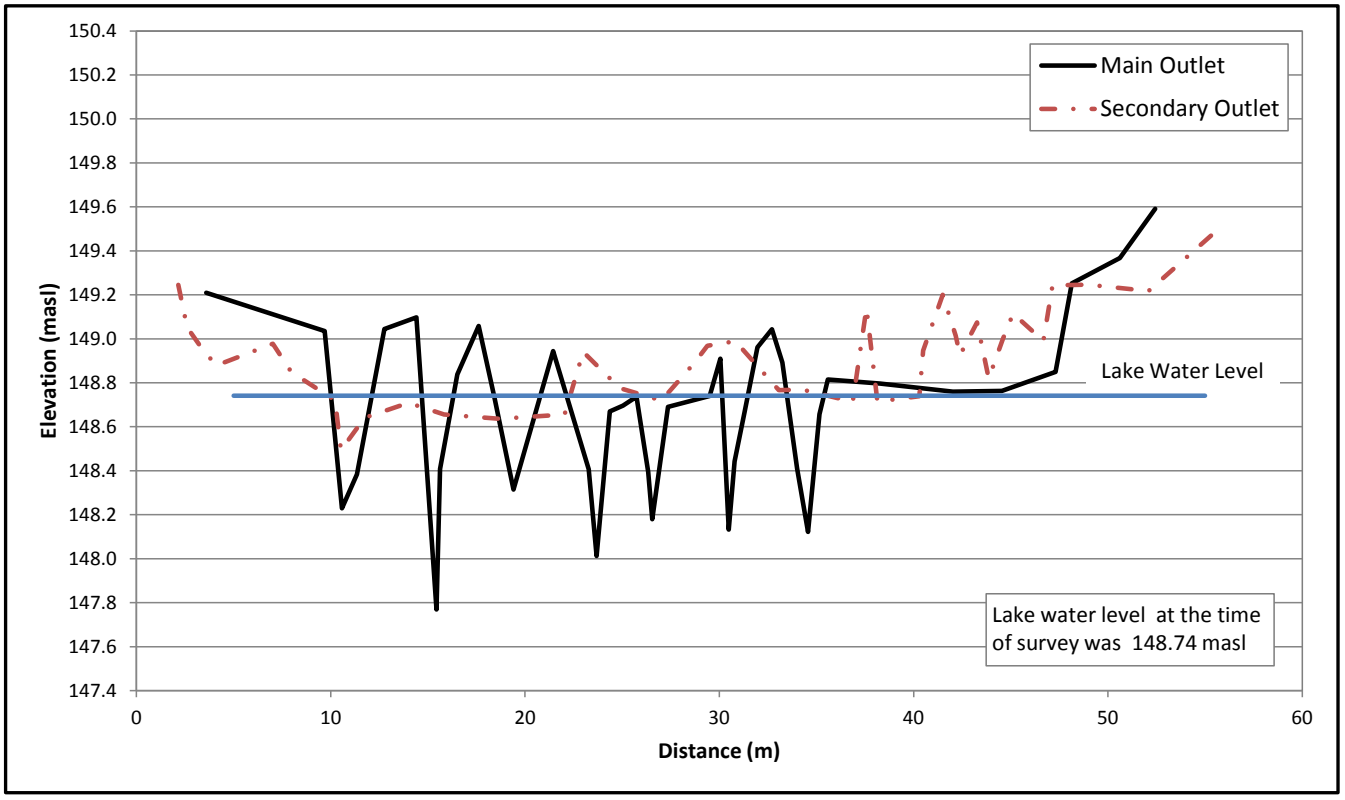


Figure 3-13: Lake A12 Main and Secondary Outlet Channel Cross-Sections, 2015

The water surface elevation at Lake A12 at the time of survey (i.e., 18 September 2015) was measured as 148.74 masl, and the ordinary high water level was estimated at 149.01 masl. A more detailed description of the lake shoreline is presented in Table 3-12, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A12 shoreline are shown in Figure 3-14.

Table 3-12: Lake A12 Shoreline Description

Criteria	Description
Bank materials	The majority of the shoreline is composed of large boulders and cobble. Bedrock is present as well on the northwest shore in a shallow area.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 5% gradient. Several small sections on the west shoreline have higher slopes between 10% and 30% gradient. The bedrock shore from the northwest is abrupt with slope gradients greater than 100%.
Typical shoreline geometry	Mostly irregular shoreline with several smaller and shallow bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 0.85 km, on a northwest – southeast direction.

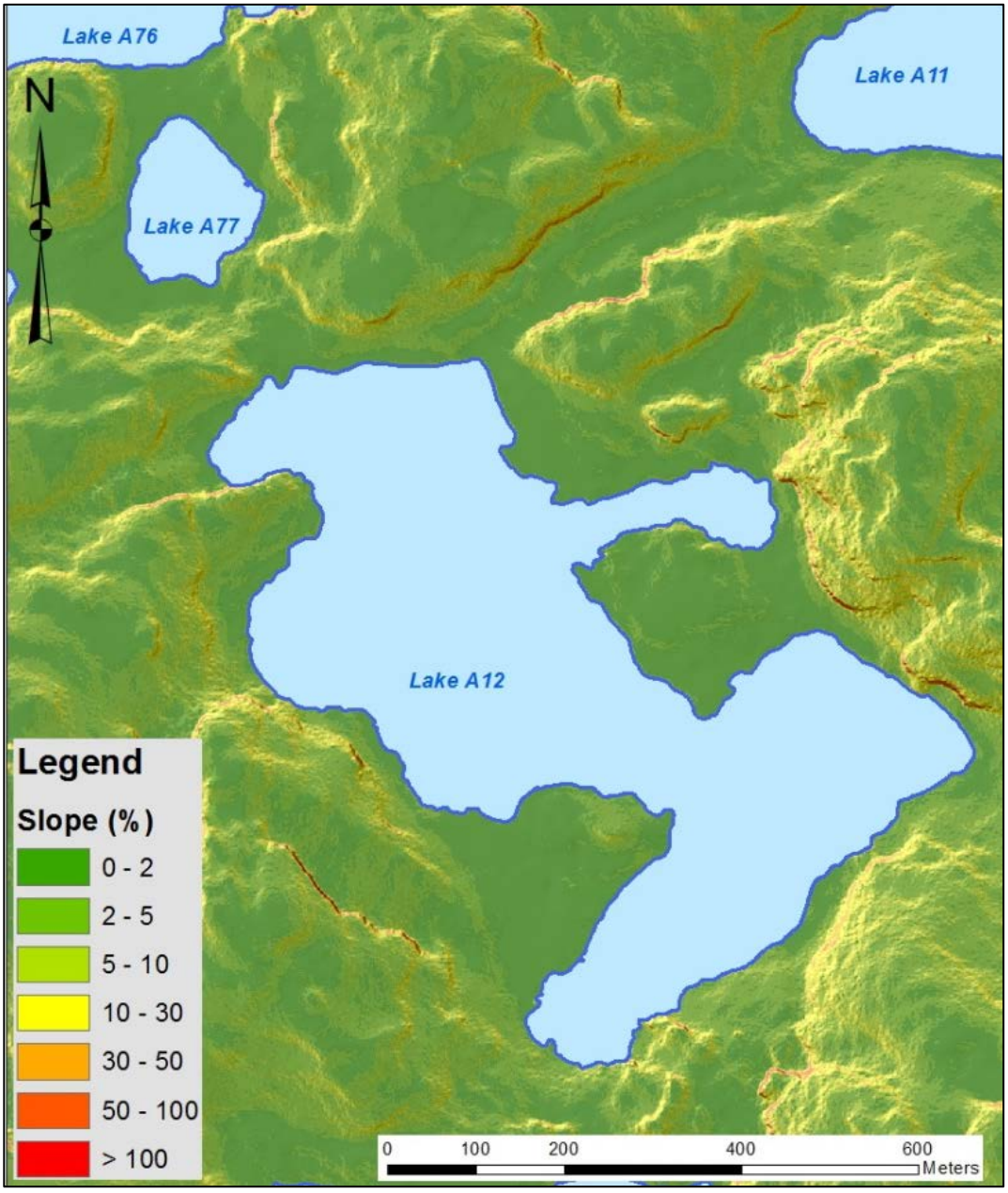


Figure 3-14: Lake A12 Shoreline Slopes (Based on available DEM data [PhotoSat 2015])

Two shore-normal transects were surveyed, one closer to the lake inlet (South Transect), and a second one closer to the lake outlet (North Transect) (Figure 3-15). At both locations, the shoreline is composed of boulders intercalated (cobble inserted between boulders) with cobble. The terrain slopes are similar, at typically less than 5% gradient.

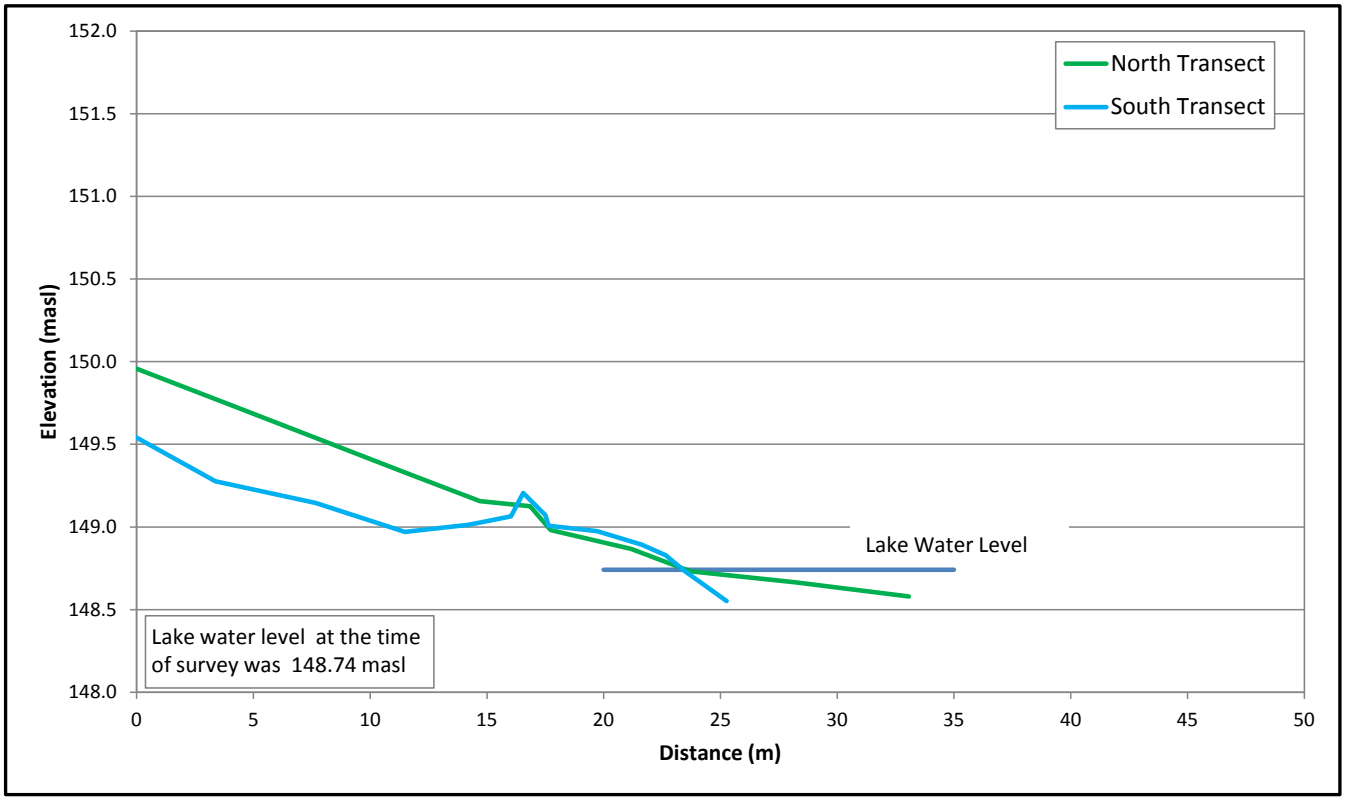


Figure 3-15: Cross-section Profiles of the Surveyed Transects, Lake A12

3.3.2 Lake A15

The survey of Lake A15 focused on the lake shoreline and outlet channel. Lake A15 has a surface area of approximately 33.3 ha, and drains into Lake A14. The Lake A15 field surveys included: outlet channel cross-section, outlet channel water surface slope, lake shore normal transects and existing and ordinary high lake water levels.

The outlet channel is approximately 50 m wide (Figure 3-16), with a poorly defined channel that is mainly comprised of large boulders. The water flows through or under the boulders for almost the entire width of the channel. The slope of the water surface in the channel could not be measured because no water was observed and the flow was determined to be through the boulders and below the surface.

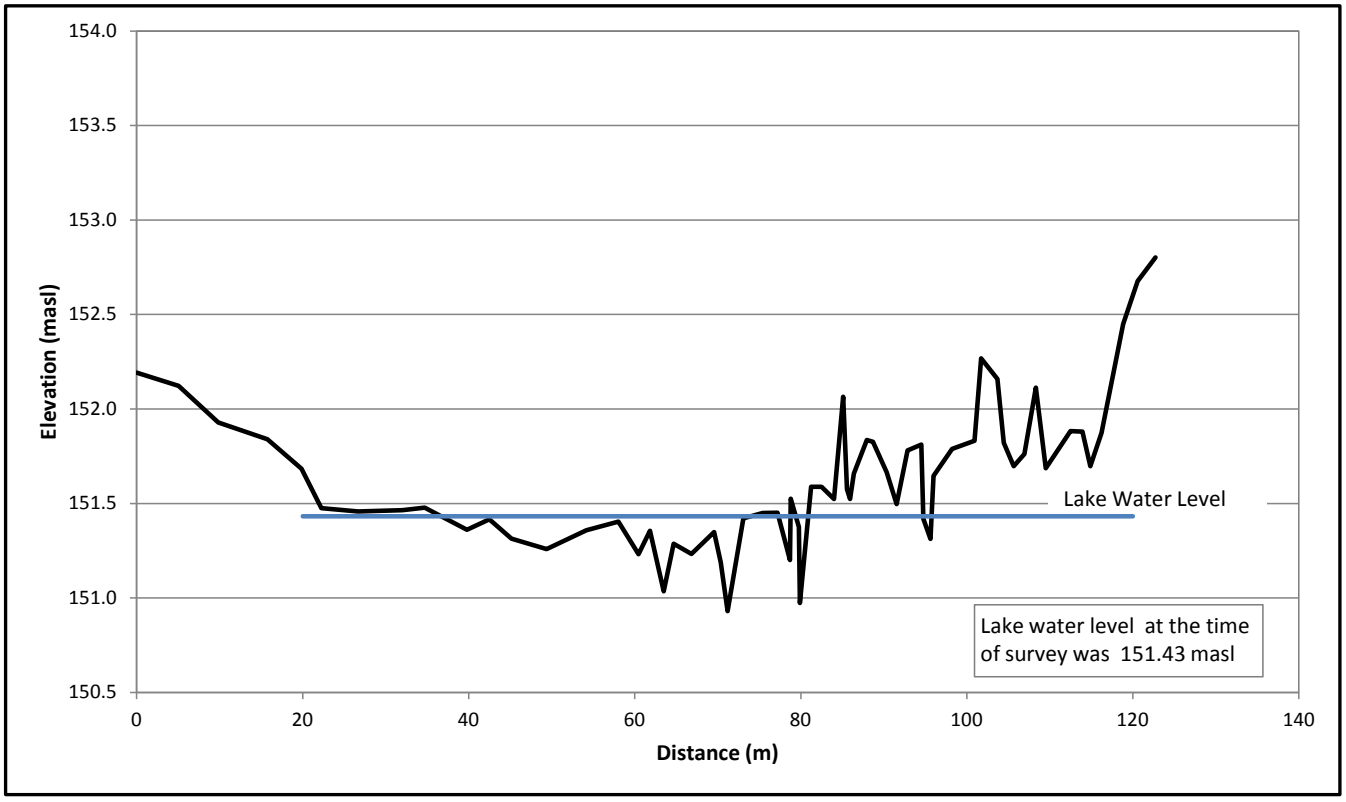


Figure 3-16: Lake A15 Outlet Channel Cross-Section, 2015

The water surface elevation at Lake A15 at the time of survey (i.e., 18 September 2015) was measured as 151.43 masl, and the ordinary high water level was estimated as 151.71 masl. A more detailed description of the lake shoreline is presented in Table 3-13, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A15 shoreline are shown in Figure 3-17.

Table 3-13: Lake A15 Shoreline Description

Criteria	Description
Bank materials	Almost the entire shoreline is composed of large boulders and coble.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 5% gradient. Only two small sections on the west shoreline have slopes between 10% and 30% gradient.
Typical shoreline geometry	Mostly straight shoreline with several smaller bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 1.2 km, on an approximate north – south direction.

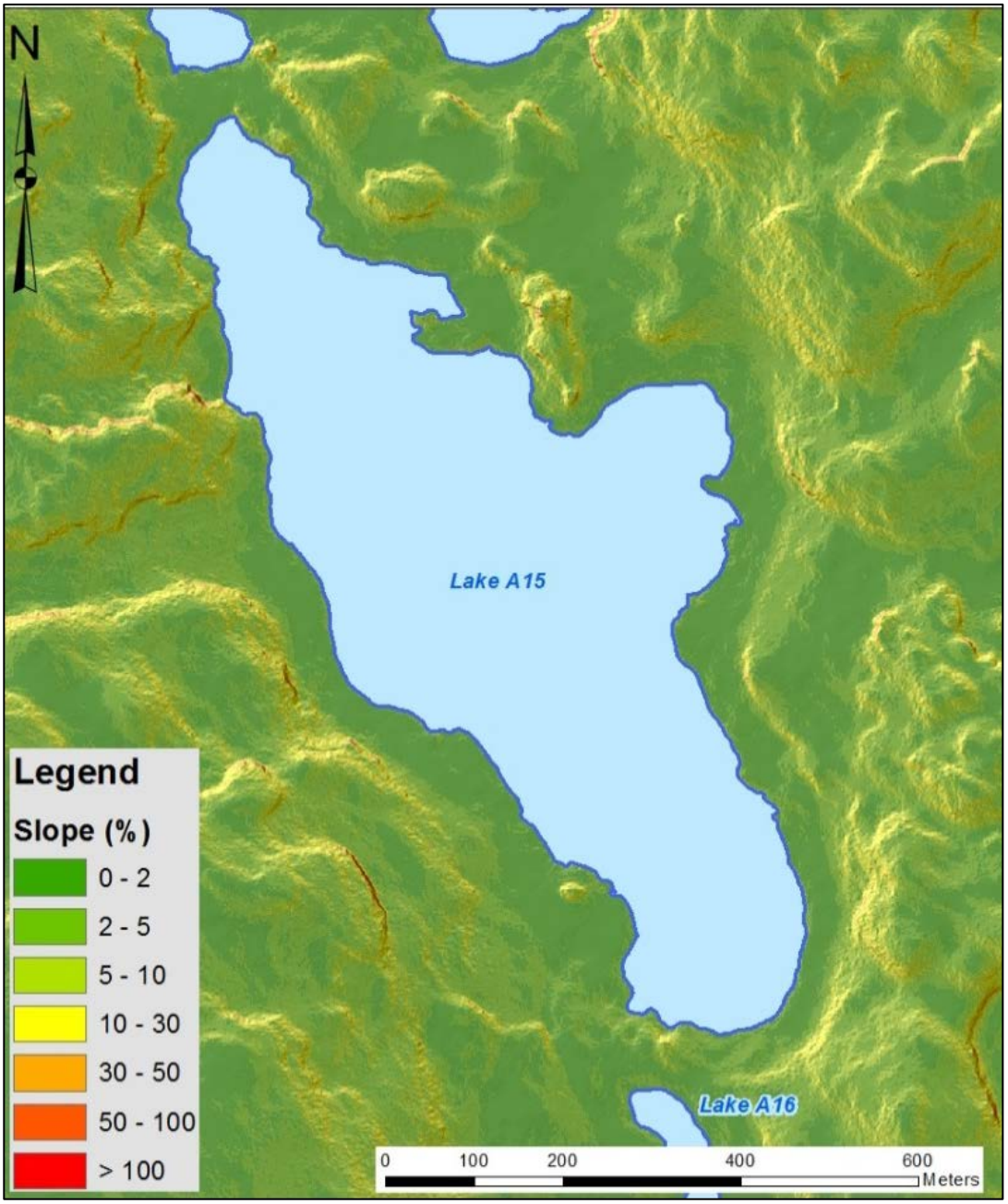


Figure 3-17: Lake A15 Shoreline Slope (Based on available DEM data [PhotoSat 2015])

Two shore-normal transects were surveyed, one closer to the lake inlet (South Transect), and a second one closer to the lake outlet (North Transect). For both locations the shoreline is composed of boulders intercalated with cobble. The terrain slopes are similar, at typically less than 5% gradient (Figure 3-18).

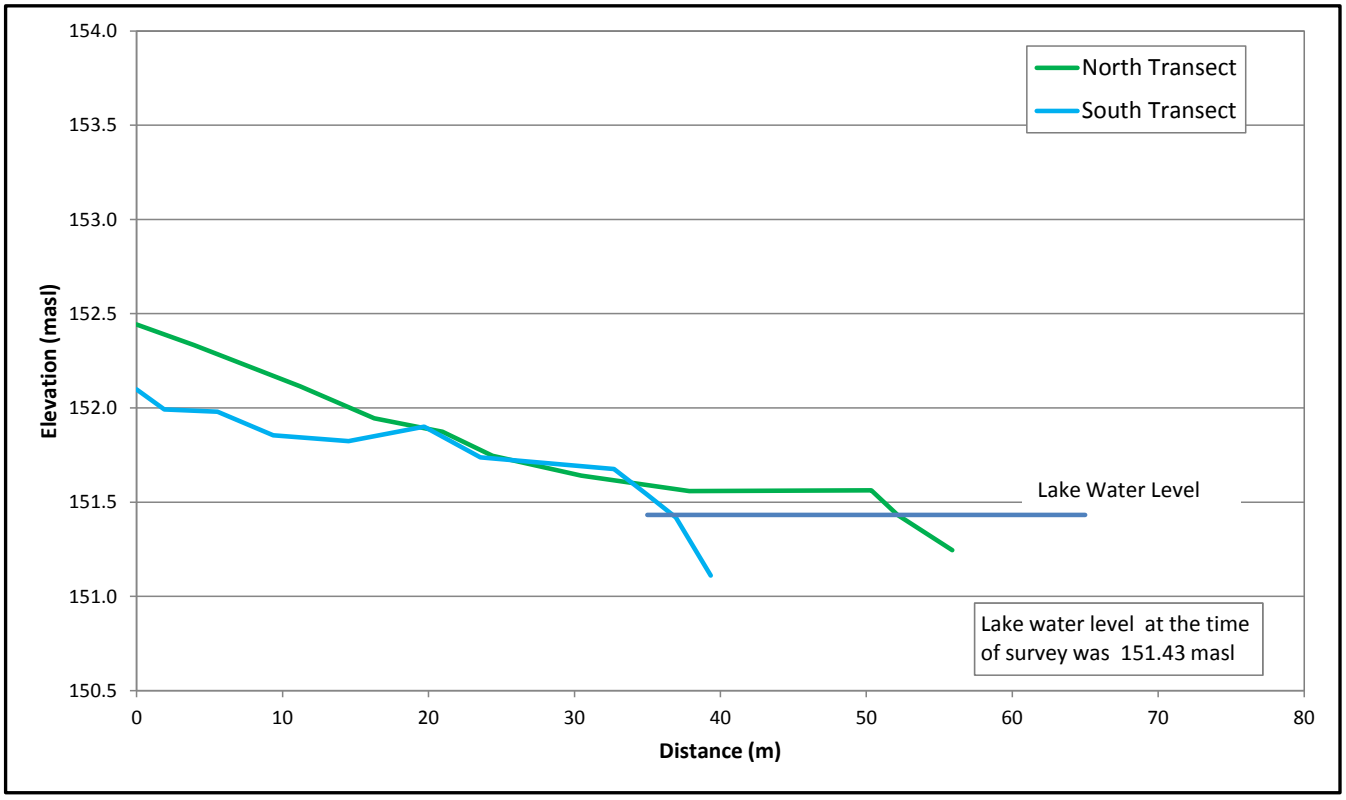


Figure 3-18: Cross-section Profiles of the Surveyed Transects, Lake A15

3.3.3 Lake A16 (Mammoth Lake)

The survey of Lake A16 (Mammoth Lake) focused on the lake outlet channel. Lake A16 has a surface area of approximately 148 ha, and drains into Lake A15. At this location, the field surveys included: outlet channel cross-section, outlet channel water surface slope, and existing and ordinary high lake water levels.

The outlet channel is approximately 45 m wide (Figure 3-19), with a poorly defined channel that is mainly comprised of large boulders. The water flows through or under the boulders for almost the entire length of the channel. A secondary channel was observed to the west of the main channel and it appears to function only during the high water levels, with the flow mostly through boulders and below surface. The slope of the water surface in the channel could not be measured because no water was observed. It was determined that the flow was through the boulders and below the surface.

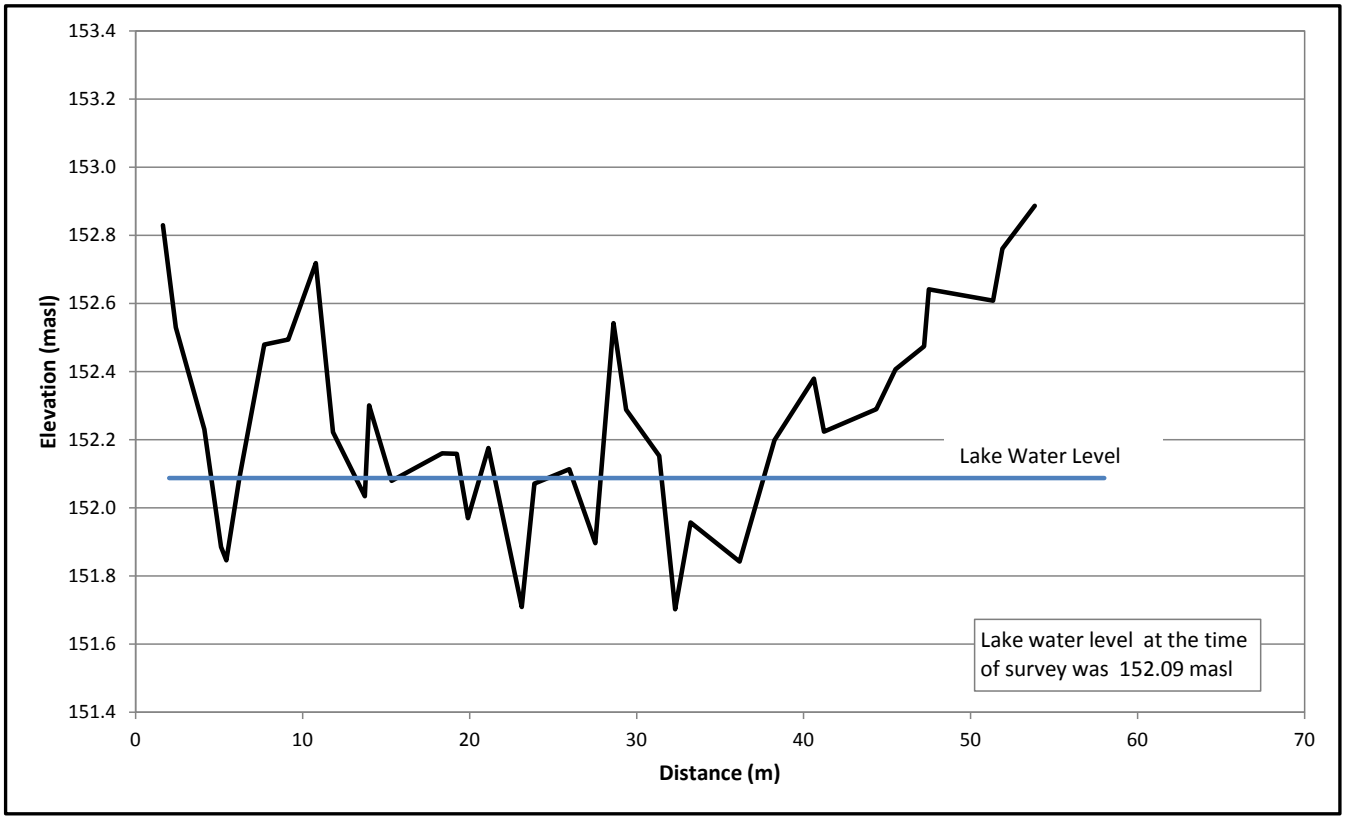


Figure 3-19: Lake A16 (Mammoth Lake) Outlet Channel Cross-Section, 2015

The water surface elevation at Lake A16 at the time of survey (i.e., 18 September 2015) was measured as 152.09 masl, and the ordinary high water level was estimated as 152.49 masl. A more detailed description of the lake shoreline is presented in Table 3-14, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A16 shoreline are shown in Figure 3-20.

Table 3-14: Lake A16 (Mammoth Lake) Shoreline Description

Criteria	Description
Bank materials	Mostly large boulders and cobble with very limited vegetation.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 2%. Only the northeast and southeast shoreline show some sections with slopes between 5% and 10%.
Typical shoreline geometry	Mostly straight shoreline with sections with smaller bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 2.8 km, on a southwest – northeast direction.

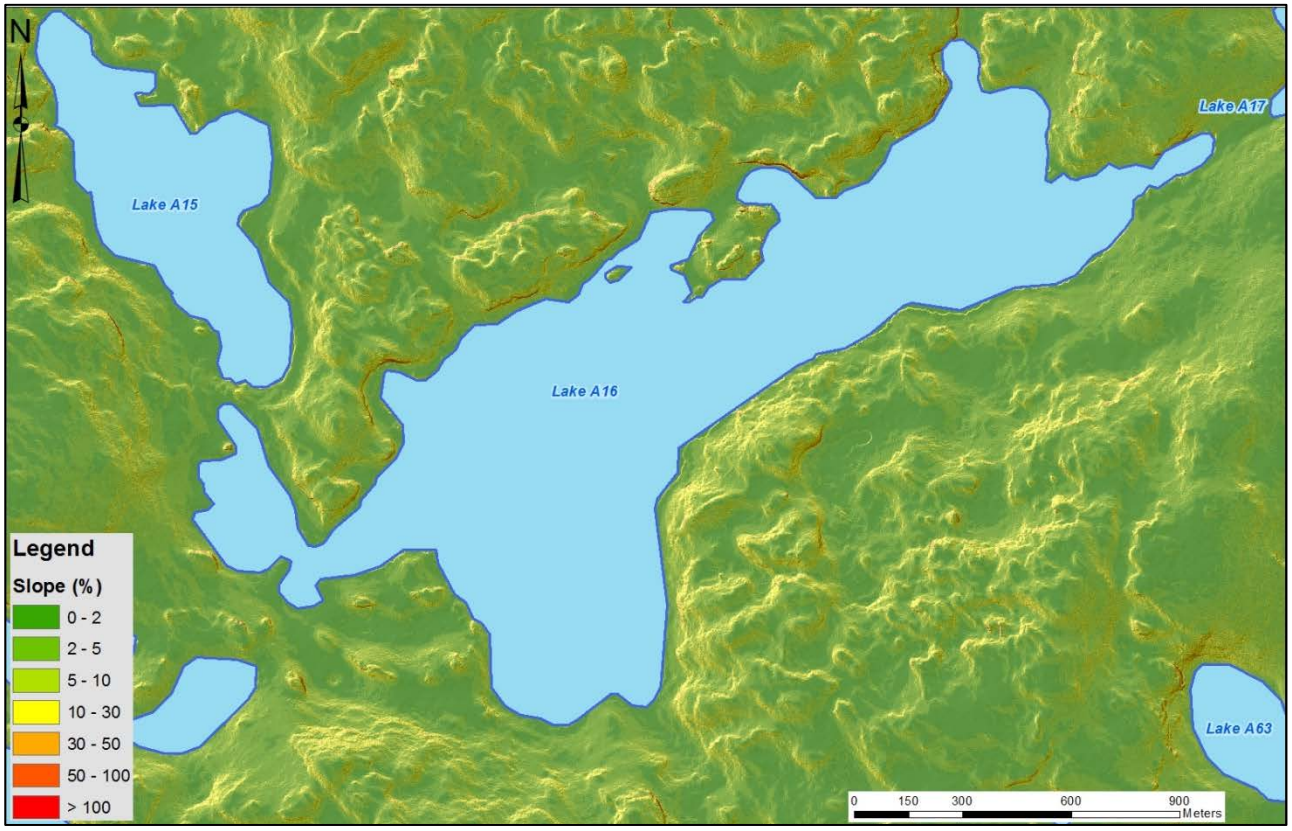


Figure 3-20: Lake A16 (Mammoth Lake) Shoreline Slope (Based on available DEM data [PhotoSat 2015])

3.3.4 Lake A17 (Whale Tail Lake)

The survey of Lake A17 focused on the lake outlet channel. Lake A17 has a surface area of approximately 166 ha, and drains into Lake A16 (Mammoth Lake). The Lake A17 field surveys included: outlet channel cross-section, outlet channel water surface slope, and existing and ordinary high lake water levels.

The outlet channel is approximately 60 m wide (Figure 3-21), with a poorly defined channel that is mainly comprised of boulders. The water flows through or under the boulders for almost the entire length of the channel. The slope of the water surface in the channel was measured and indicated a typical gradient of 0.18%.

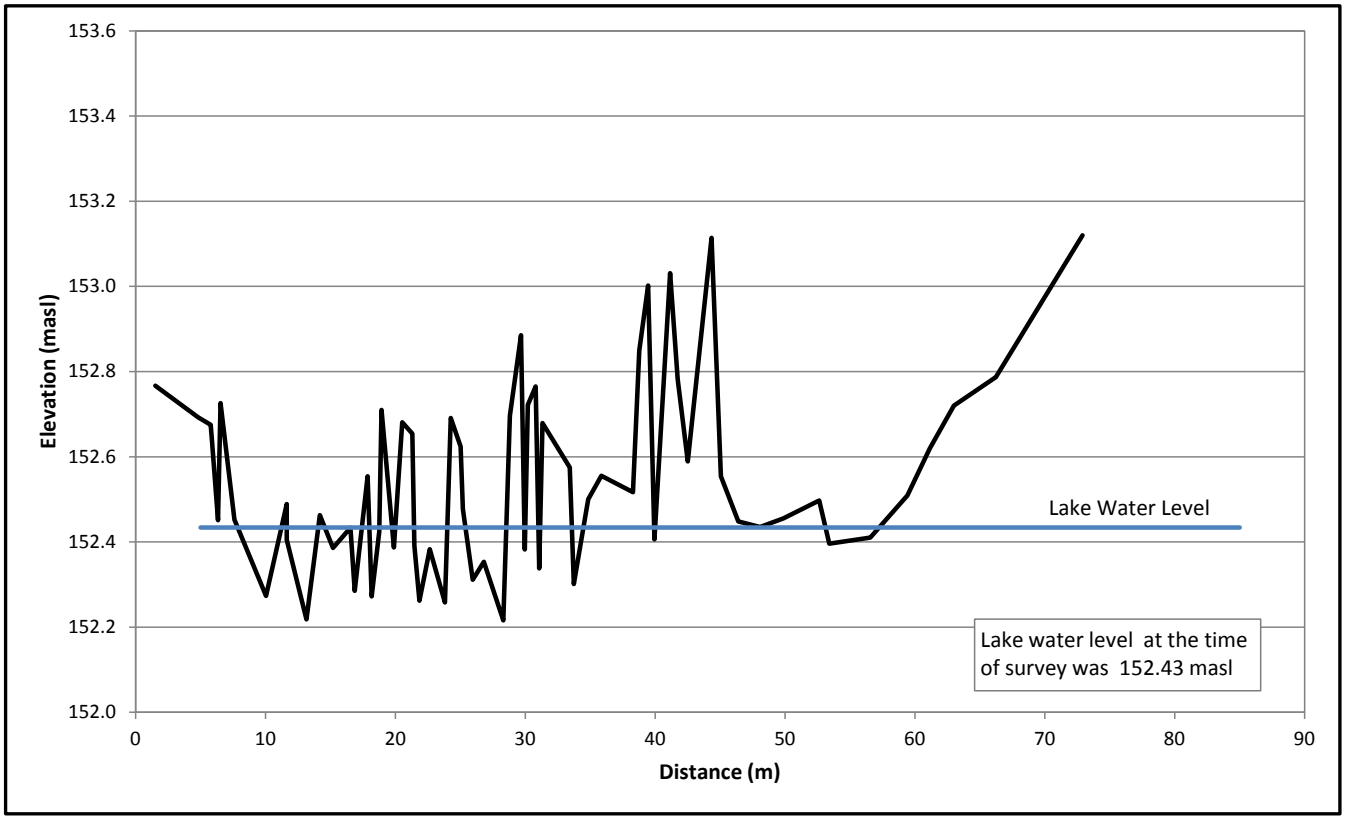


Figure 3-21: Lake A17 Outlet Channel Cross-Section, 2015

The water surface elevation at Lake A17 at the time of survey (i.e., 16 September 2015) was measured as 152.43 masl, and the ordinary high water level was estimated as 153.38 masl. A more detailed description of the lake shoreline is presented in Table 3-15, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A17 shoreline are shown in Figure 3-22.

Table 3-15: Lake A17 (Whale Tail Lake) Shoreline Description

Criteria	Description
Bank materials	Mostly boulders and cobble with limited vegetation. Vegetation along the shoreline is present only at the inlet from the smaller Lake A62, A59, A55, A53, A50, and A46.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 2%. Only the northeast and southeast shorelines include some sections with slopes between 5% and 10%.
Typical shoreline geometry	Relatively straight shoreline with little sections with small and narrow bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 2.3 km, on an approximate north – south direction.

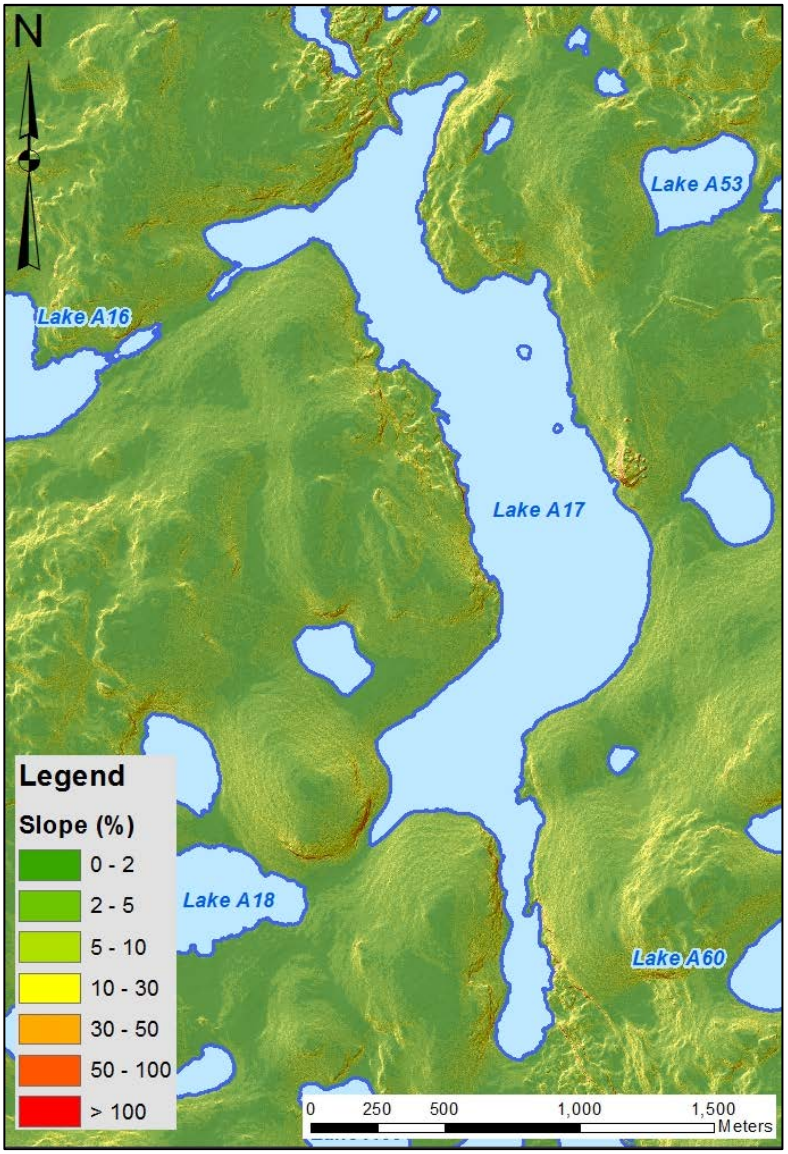


Figure 3-22: Lake A17 (Whale Tail Lake) Shoreline Slope (Based on available DEM data [PhotoSat 2015])

3.3.5 Lake A18

The survey of Lake A18 focused on the lake outlet channel. Lake A18 has a surface area of approximately 15.8 ha, and drains into Lake A17 (Whale Tail Lake). At this location, the field surveys included: outlet channel cross-section, outlet channel water surface slope, and existing and ordinary high lake water levels.

The outlet channel is approximately 45 m wide (Figure 3-23), with a poorly defined channel mainly comprised of boulders. The water flows through or under the boulders for almost the entire length of the channel. The slope of the water surface in the channel was measured and indicated a typical gradient of 0.42%.

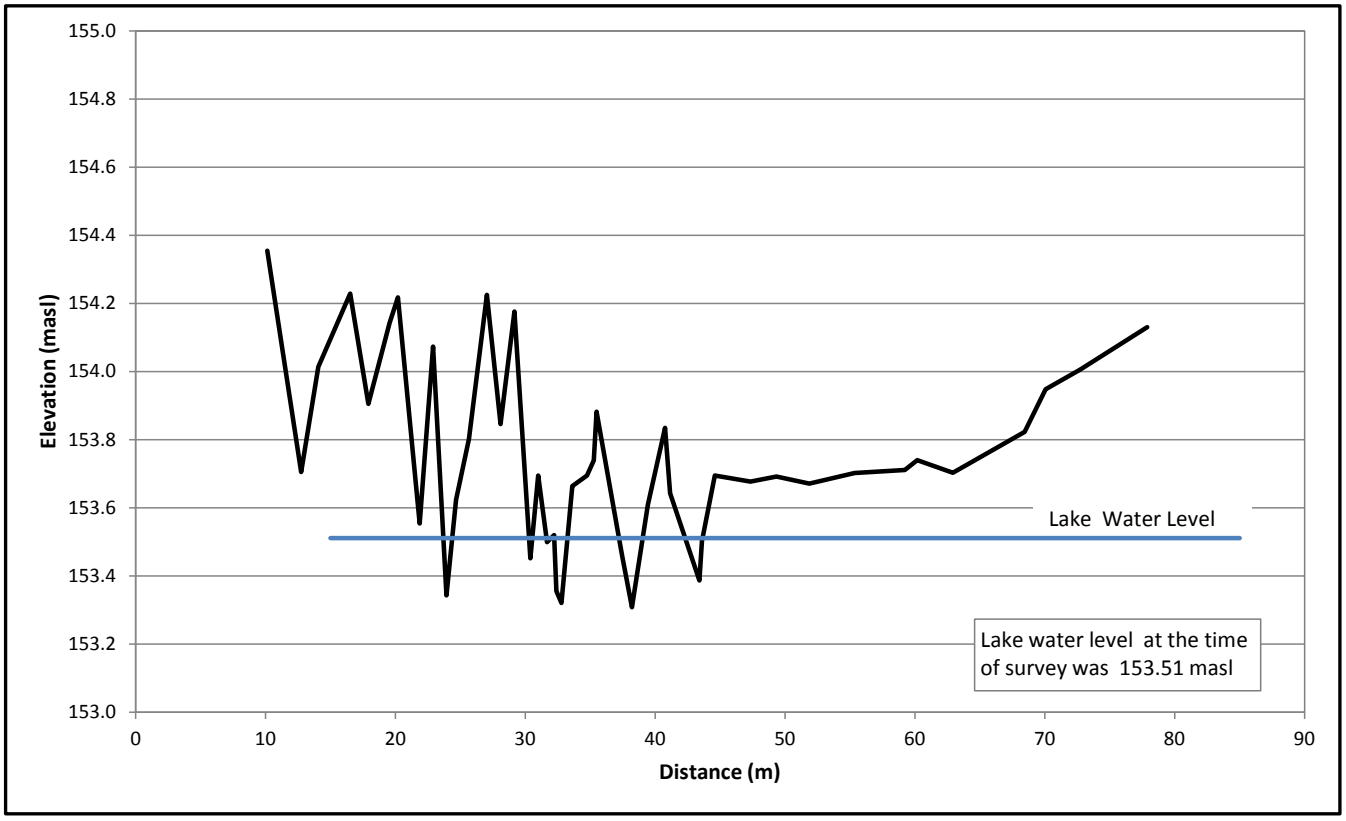


Figure 3-23: Lake A18 Outlet Channel Cross-Section, 2015

The water surface elevation at Lake A18 at the time of survey (i.e., 16 September 2015) was measured as 153.71 masl, and the ordinary high water level was estimated as 153.97 masl. A more detailed description of the lake shoreline is presented in Table 3-16, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A18 shoreline are shown in Figure 3-24.

Table 3-16: Lake A18 Shoreline Description

Criteria	Description
Bank materials	Mostly boulders and cobble with limited vegetation. The northeast shoreline and the inlet channel from Lake A63 have vegetation.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 2%. Only the northeast and southeast shorelines show some sections with slopes between 5% and 10%.
Typical shoreline geometry	Irregular shoreline with little sections with small bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 0.6 km, on an east-west direction.

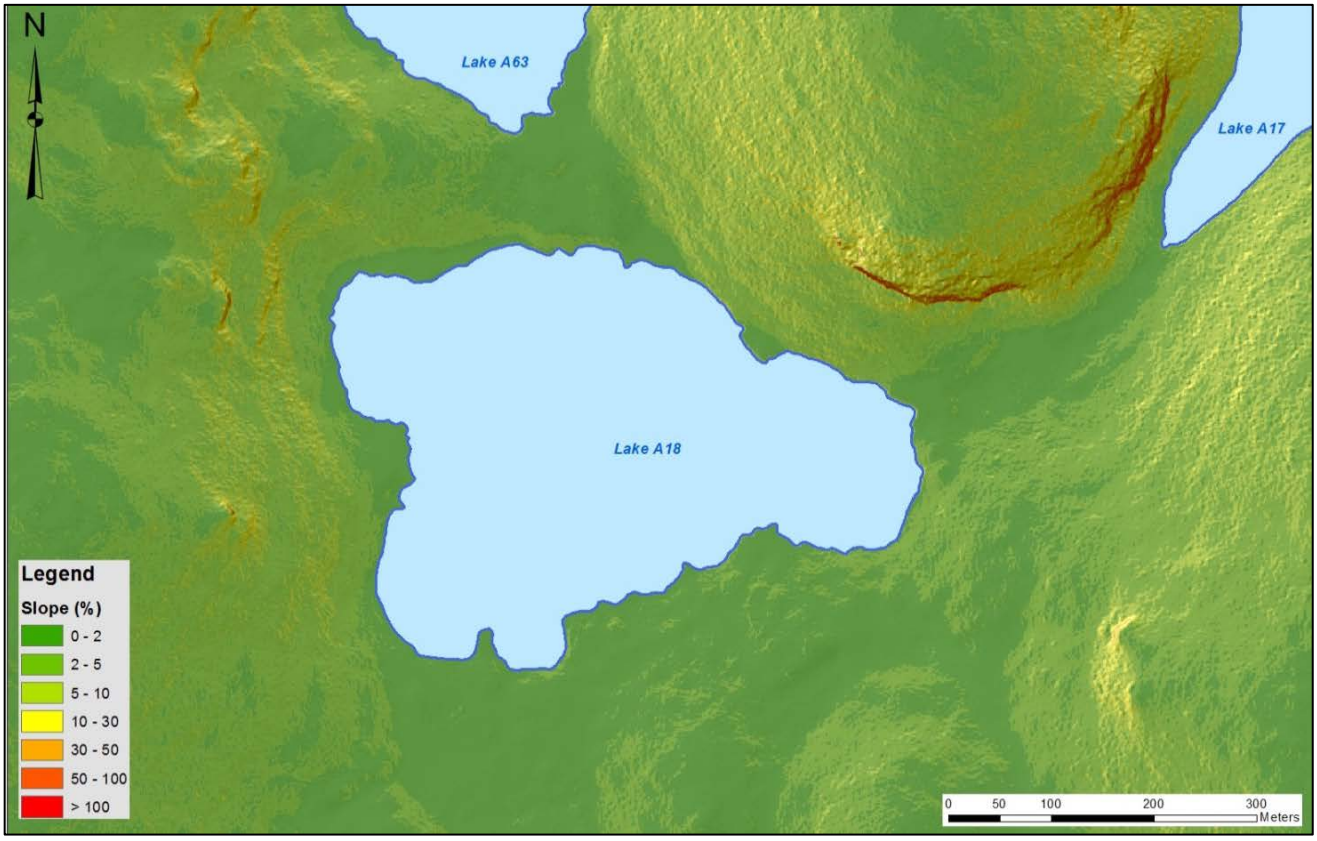


Figure 3-24: Lake A18 Shoreline Slope (Based on available DEM data [PhotoSat 2015])

3.3.6 Lake A45

The survey of Lake A45 focused on the lake outlet channel. Lake A45 has a surface area of approximately 2.9 ha, and drains into Lake A16. The Lake A45 field surveys included outlet channel cross-section, outlet channel water surface slope, and existing and ordinary high lake water levels.

The lake outlet channel is approximately 35 m wide, poorly defined and composed of a boulder garden. Its banks have organic materials with vegetation on top of the boulders Figure 3-25. The slope of the water surface in the outlet channel could not be measured because no water was observed and the flow was determined to be through the boulders and below the surface.

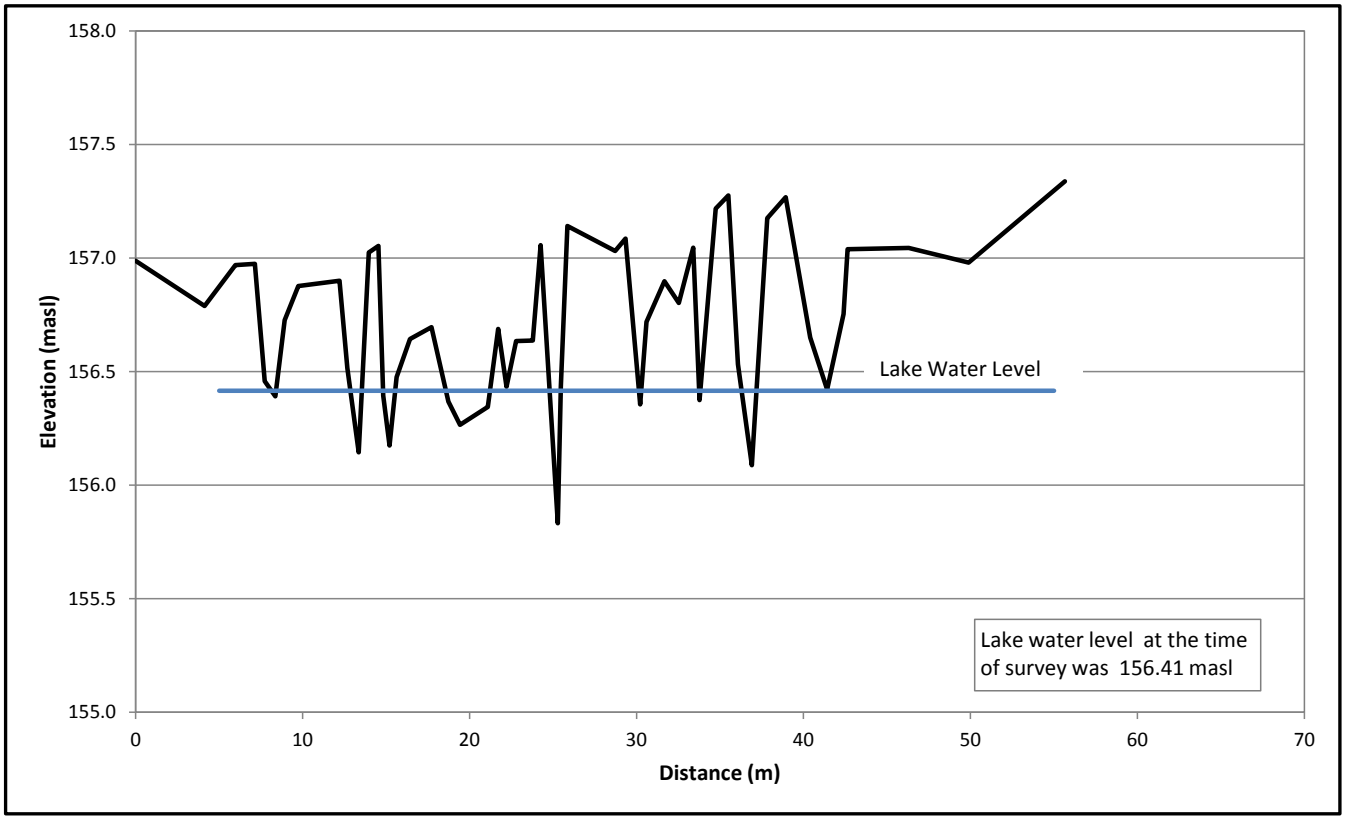


Figure 3-25: Lake A45 Outlet Channel Cross-Section, 2015

The water surface elevation at Lake A45 at the time of survey (i.e., 19 September 2015) was measured as 156.42 masl, and the ordinary high water level was estimated as 156.50 masl. A more detailed description of the lake shoreline is presented in Table 3-17, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A45 shoreline are shown in Figure 3-26.

Table 3-17: Lake A45 Shoreline Description

Criteria	Description
Bank materials	The majority of the shoreline is made of large boulders and cobble.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 5%.
Typical shoreline geometry	Relatively straight shoreline with small and shallow bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 0.26 km, on an approximate northeast – southwest direction.

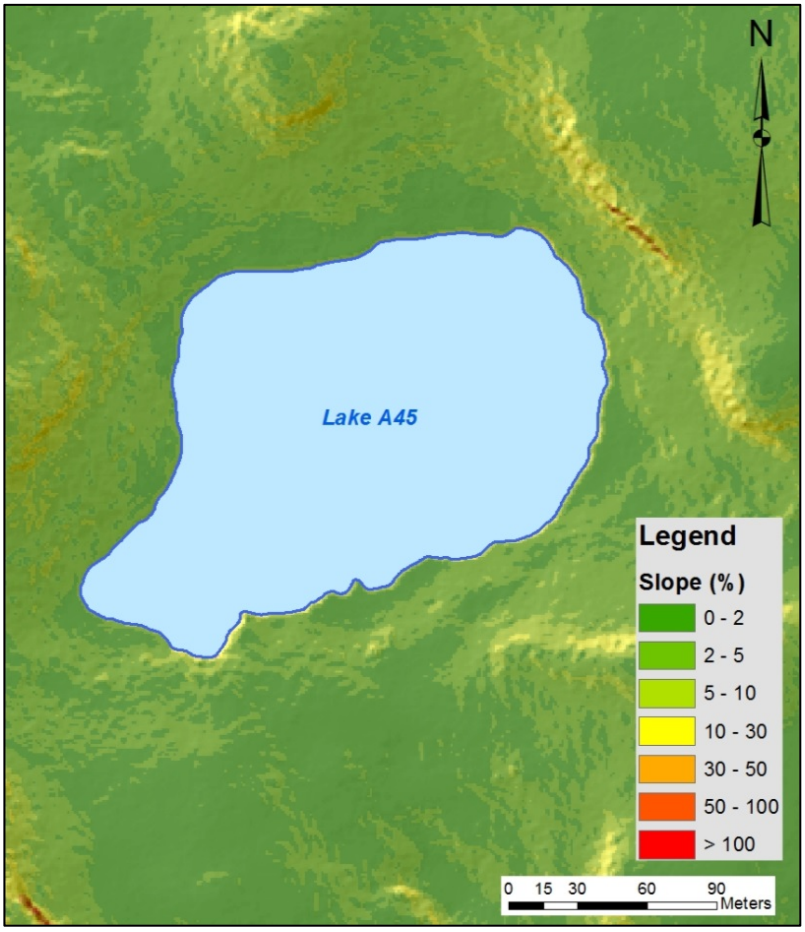


Figure 3-26: Lake A45 Shoreline Slope (Based on available DEM data [PhotoSat 2015])

3.3.7 Lake A69

The survey of Lake A69 focused on the lake outlet channel. Lake A69 has a surface area of approximately 31.8 ha, and drains into Lake DS1. At this location, the field surveys included outlet channel cross-section, and outlet channel water surface slope.

The lake outlet channel is approximately 35 m wide, well defined with mostly cobble and some boulders as streambed materials and with soils and organics on both banks Figure 3-27. The water surface slope in the outlet channel was estimated from the PhotoSat (2015) elevation data as 0.85%.

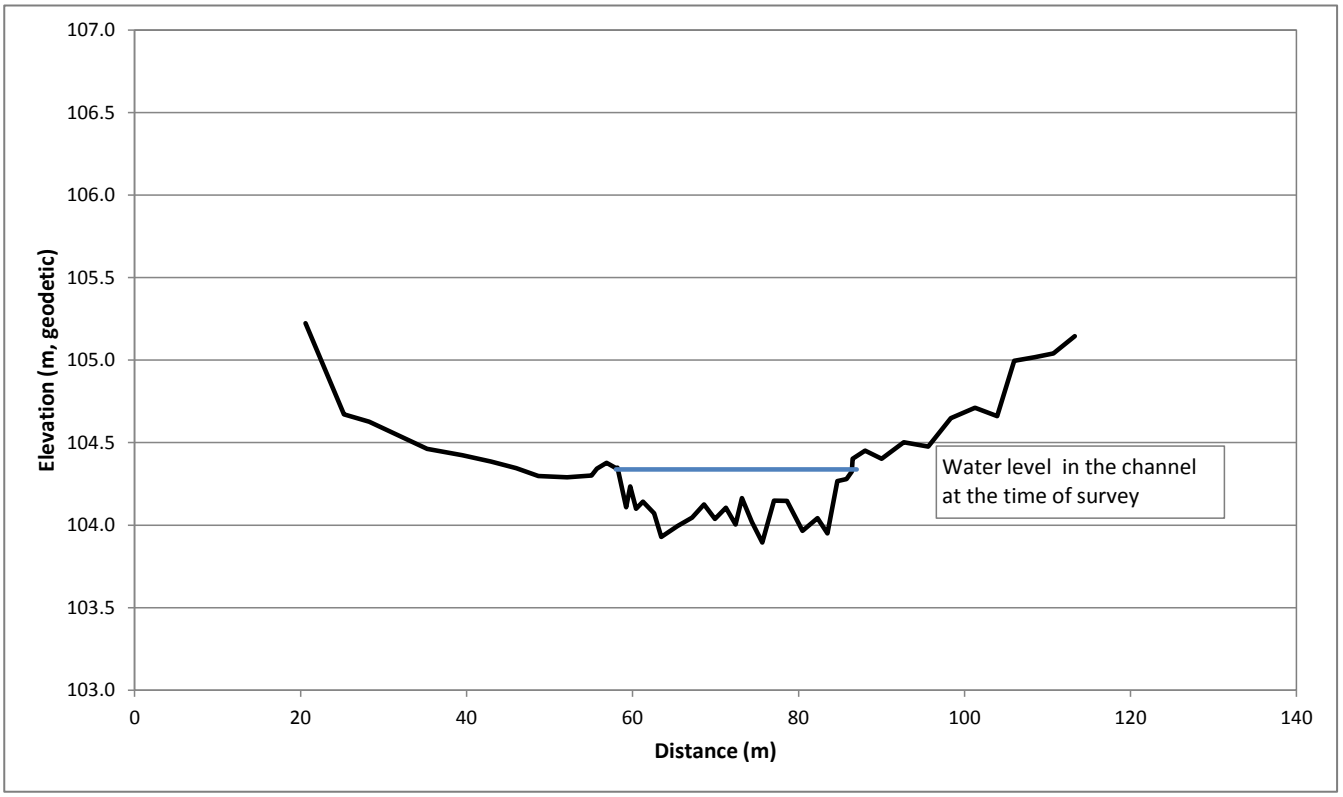


Figure 3-27: Lake A69 Outlet Channel Cross-Section, 2015

A more detailed description of the lake shoreline is presented in Table 3-18, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A69 shoreline are partially shown in Figure 3-28 based on available DEM data (PhotoSat 2015) (i.e., only partial DEM data were available for Lake A69).

Table 3-18: Lake A69 Shoreline Description

Criteria	Description
Bank materials	A mix of sand and gravel intercalated with smaller sections of cobble and boulders. Soils and vegetation are present on top of the bank, above the typical high water level elevation.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 5%.
Typical shoreline geometry	Irregular shoreline with small and shallow bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 1.3 km, on an approximate north – south direction.

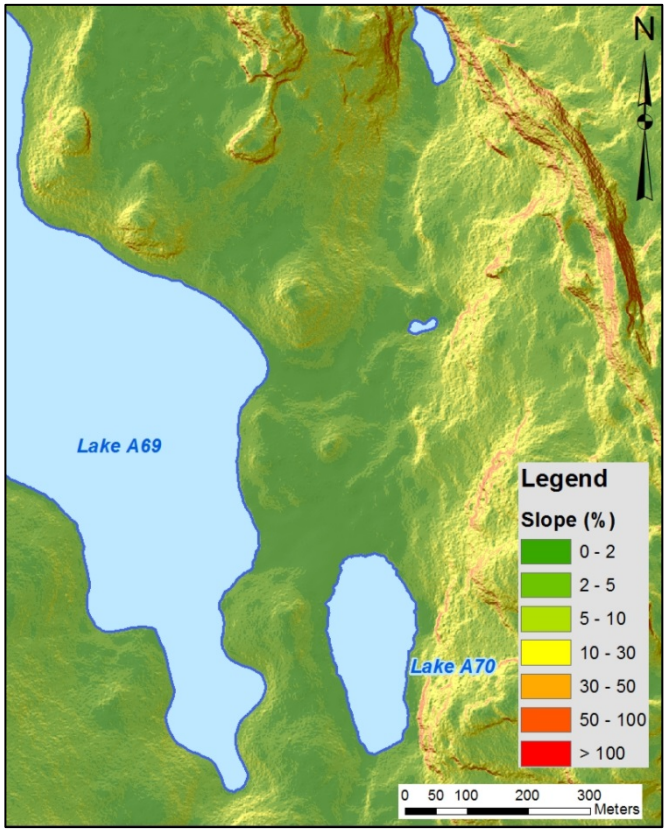


Figure 3-28: Lake A69 Shoreline Slope (Based on available DEM data [PhotoSat 2015])

3.3.8 Lake A72

The survey of Lake A72 focused on the lake outlet channel. Lake A72 has a surface area of approximately 3.2 ha, and drains into Lake A71. At this location, the field surveys included outlet channel cross-section, and outlet channel water surface slope.

The lake outlet channel is approximately 15 m wide, well defined with mostly sand and fines as streambed materials, and with soils and organics on both banks Figure 3-29. The measured water surface slope was 0.03%.

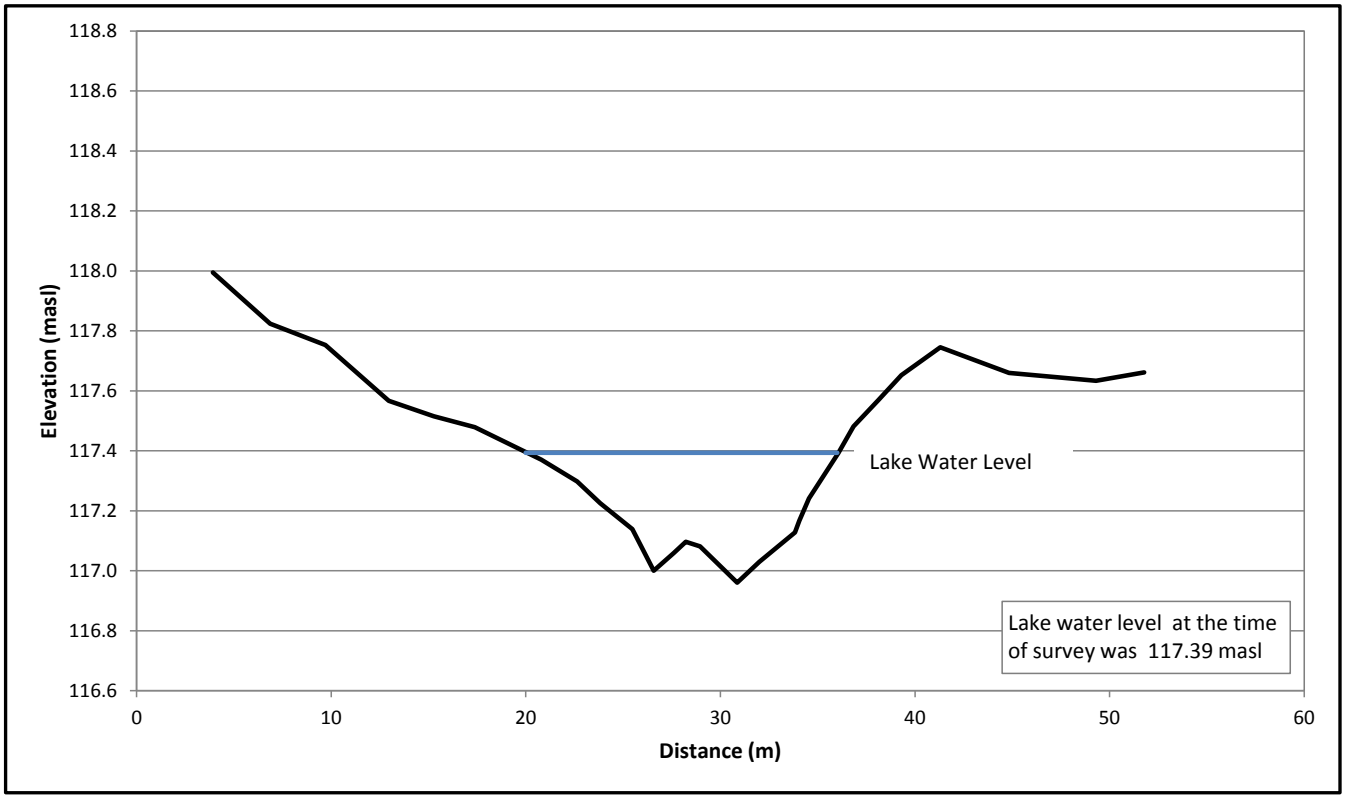


Figure 3-29: Lake A72 Outlet Channel Cross-Section, 2015

A more detailed description of the lake shoreline is presented in Table 3-19, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A72 shoreline are shown in Figure 3-30.

Table 3-19: Lake A72 Shoreline Description

Criteria	Description
Bank materials	Mostly sand and fines with vegetation on top. The inlet channel from upstream Lake A73 is comprised of boulders and cobble.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 2%.
Typical shoreline geometry	Relatively straight shoreline with small sections of small and shallow bays.
Fetch	Maximum fetch length was estimated in GIS at approximately 0.3 km, on an approximate north – south direction.

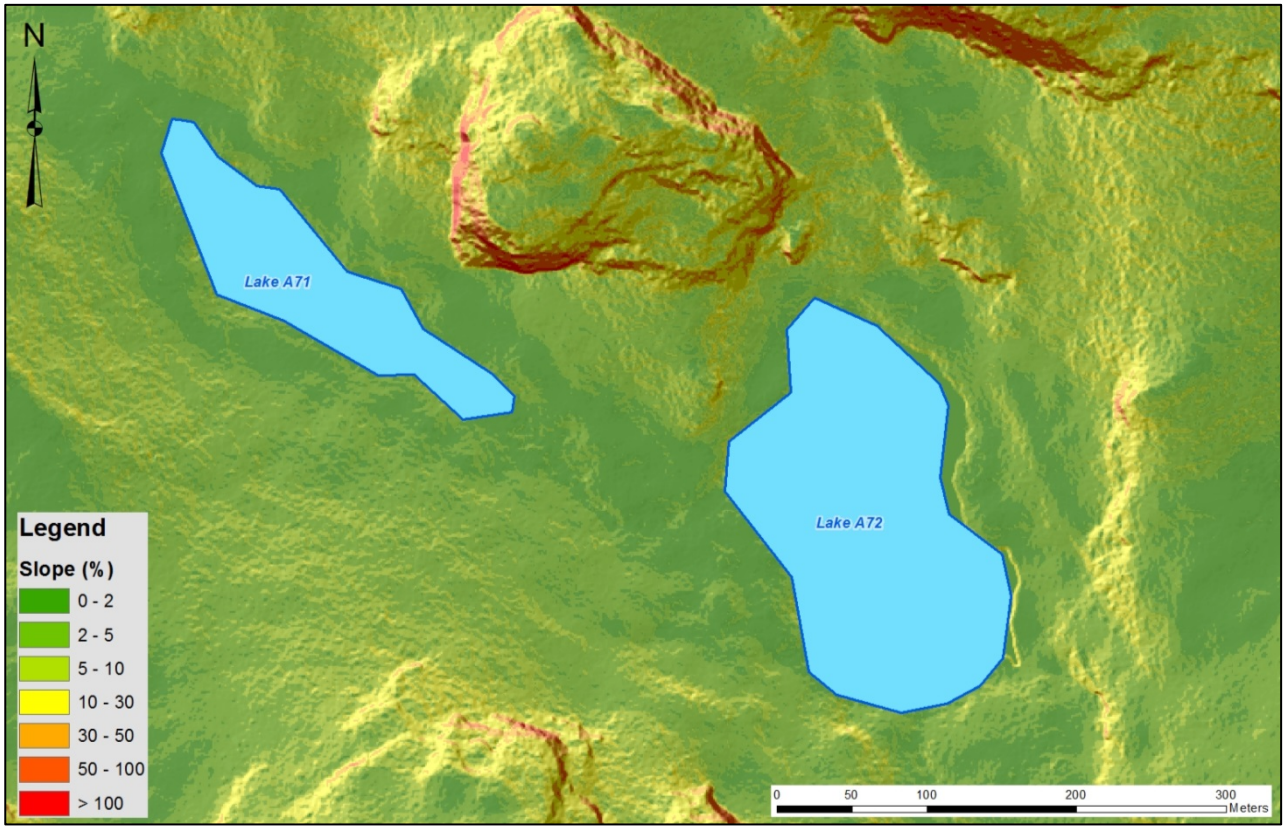


Figure 3-30: Lake A72 Shoreline Slope (Based on available DEM data [PhotoSat 2015])

3.3.9 Lake A76

The survey of Lake A76 focused on the lake shoreline and outlet channel. Lake A76 has a surface area of approximately 71 ha, and drains into Lake A10 through a main outlet at average and below average water levels. At water levels above average, Lake A12 has a secondary outlet that drains into Lake A75. Section 3.1 provides further details regarding these drainage patterns. The Lake A76 field surveys included: outlet channel cross-section, outlet channel water surface slope, lake shore normal transects and existing and ordinary high lake water levels.

The cross-section data for the main outlet was obtained from the RTK survey, and the cross-section data for the secondary channel was obtained from the PhotoSat (2015) elevation data. The main outlet channel is approximately 55 m wide and flows east, and the secondary outlet channel is approximately 35 m wide and flows west (Figure 3-31). The main outlet channel comprises a boulder garden with the majority of the flow through the boulders or below the surface. Further downstream, the flow becomes almost entirely subsurface with only higher flows reaching the surface. During the site visit, the flow was below the surface and no discharge measurement was possible.

The secondary channel flows west and is located at the opposite side of the lake. The channel was visually surveyed. The channel is a boulder garden with very large boulders. No signs of flow (neither low nor high flows) were visible and it was assumed that the flow occurs only at high lake water levels and only below the surface.

This may be confirmed by additional investigations during the high water season. The secondary channel is approximately 580 m long to Lake A75. It should be noted that the profile shown on Figure 3-31 is based on available DEM data (PhotoSat 2015), representative of the top of boulders rather than the actually channel bed.

The slope of the water surface in the main outlet channel could not be measured because no water was observed and the flow was determined to be through the boulders and below the surface. The next lake downstream along the main outlet channel is Lake A41, with the water surface elevation measured as 146.36 masl.

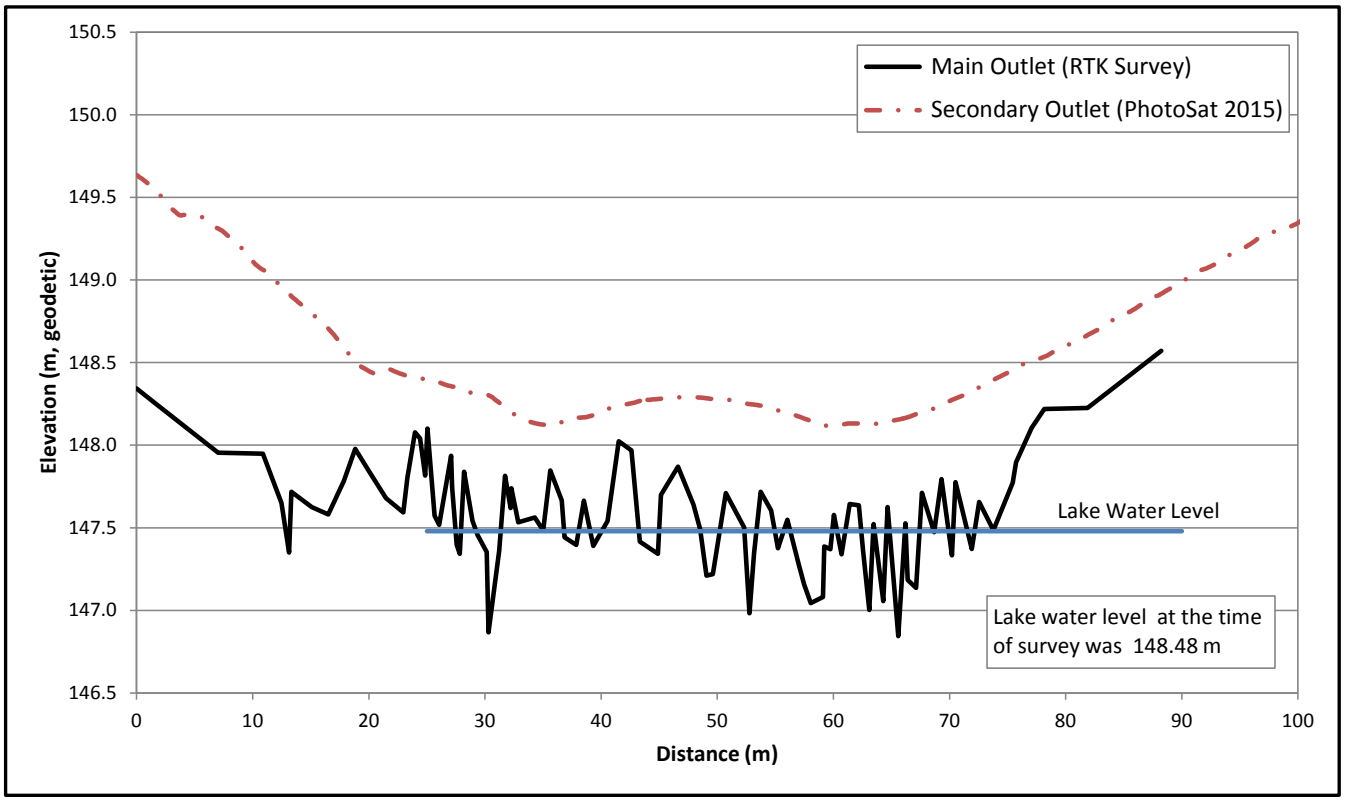


Figure 3-31: Lake A76 Main and Secondary Outlet Channel Cross-Sections, 2015

The water surface elevation at Lake A76 at the time of survey (i.e., 18 September 2015) was measured as 147.48 masl, and the ordinary high water level was estimated as 147.70 masl. A more detailed description of the lake shoreline is presented in Table 3-20, and is based on the field reconnaissance and satellite imagery provided by Agnico Eagle (PhotoSat 2015). Terrain slopes calculated for the Lake A76 shoreline are shown in Figure 3-32.

Table 3-20: Lake A76 Shoreline Description

Criteria	Description
Bank materials	The majority of the shoreline is comprised of large boulders and cobble. Limited areas at the west part of the lake have sections with organic materials on top of the boulders and cobble. Small sections of bedrock are found at the main outlet, on the east side of the lake.
Typical bank slopes	Most of the shoreline has shallow slopes, typically less than 5% gradient. Several small sections on the west shoreline have higher slopes between 10% and 30% gradient. The bedrock shore from the east side is abrupt with slope gradients greater than 100% and near-vertical at some locations (limited visibility on Figure 3-32 due to figure scale).
Typical shoreline geometry	Mostly straight shoreline.
Fetch	Maximum fetch length was estimated in GIS at approximately 1.4 km, on a northeast – southwest direction.

Two shore-normal transects were surveyed on the south shoreline, one closer to the lake inlet (East Transect), and a second one closer to the secondary outlet (West Transect) (Figure 3-33). At both locations, the shoreline is composed of boulders intercalated with cobble. The terrain slopes at the transects are similar, typically less than 5% gradient.

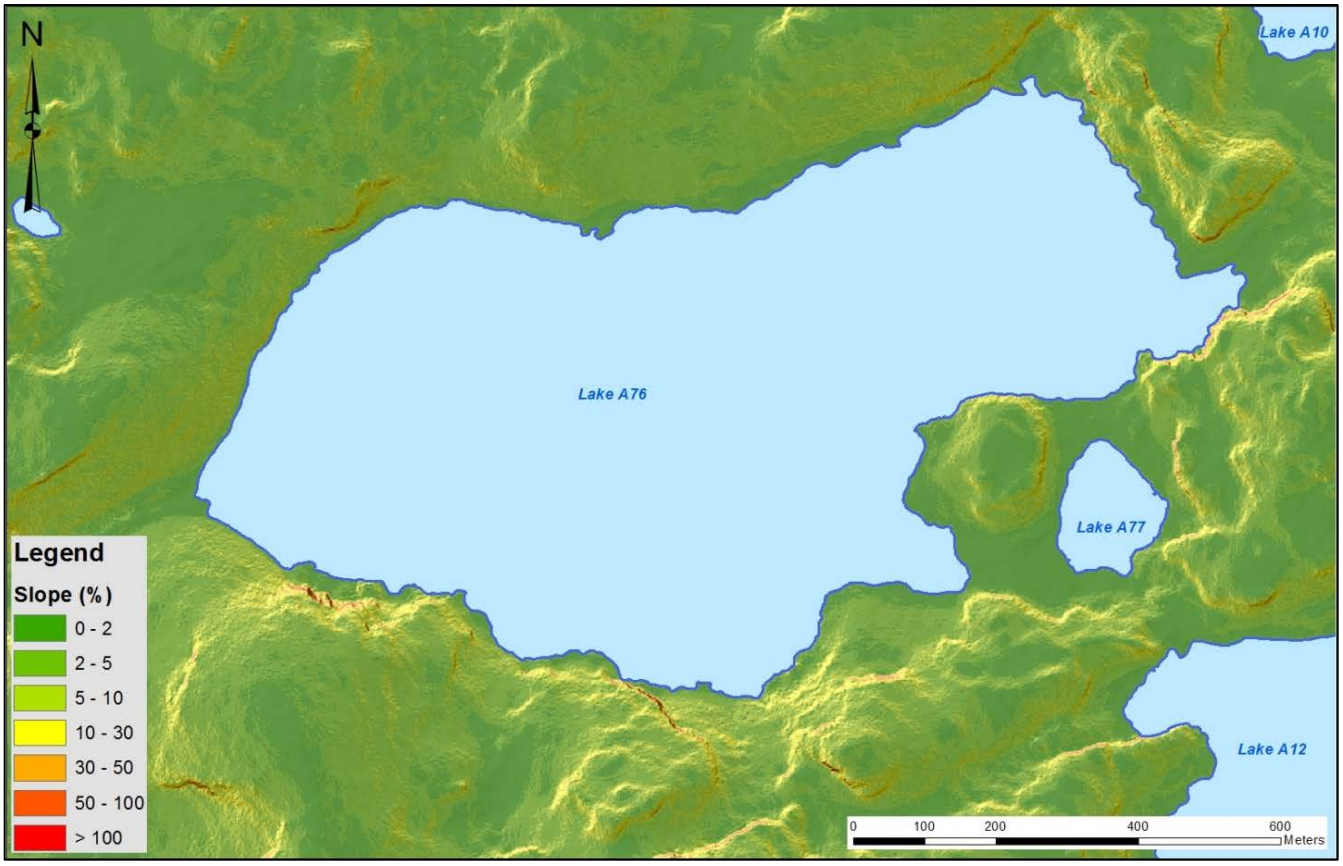


Figure 3-32: Lake A76 Shoreline Slope (Based on available DEM data [PhotoSat 2015])

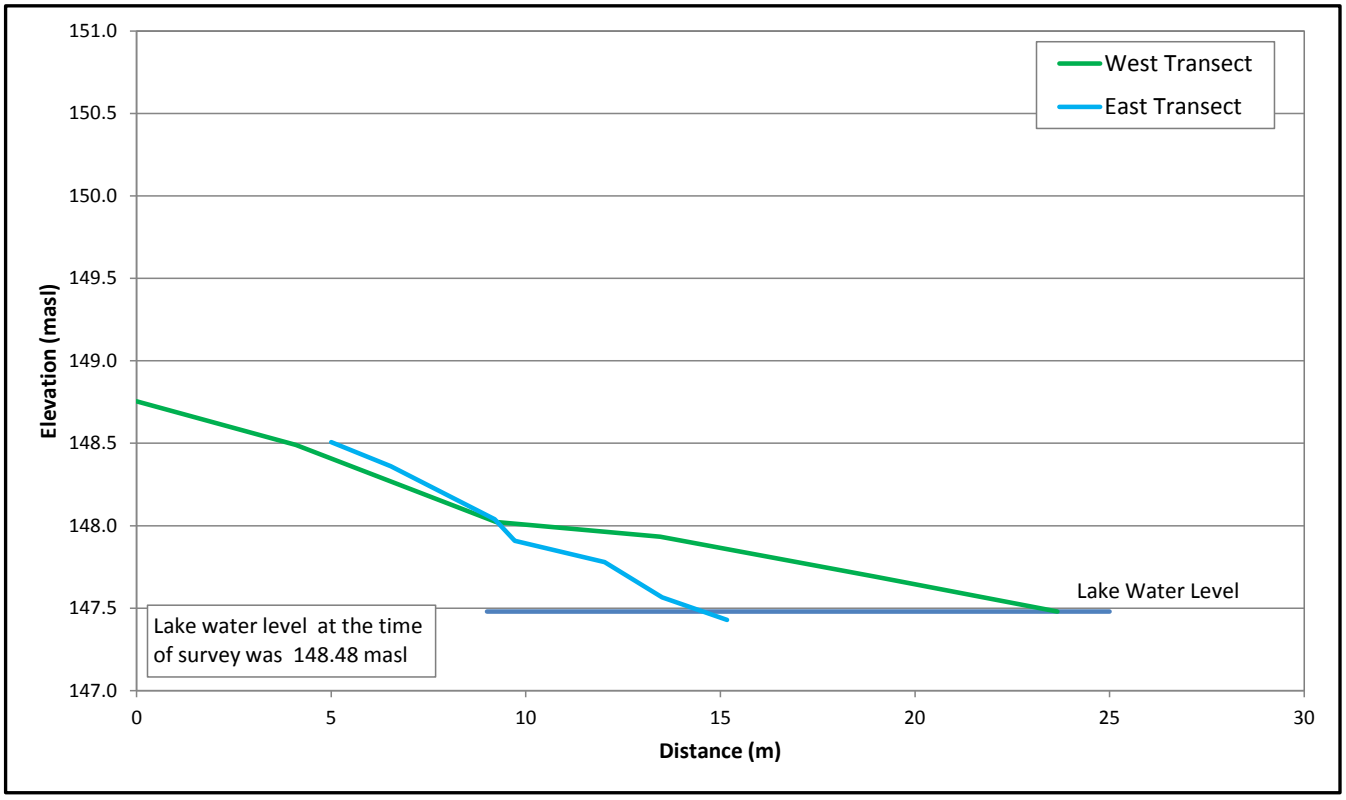


Figure 3-33: Cross-section Profiles of the Surveyed Transects, Lake A76

3.4 Water Balance Model

Frequency analyses of the hydrology model results (floods and droughts) were completed for key lakes in the Hydrology BSA to provide a basis for environmental impact assessment and engineering design. The following parameters were examined:

- maximum and mean daily outflow volumes for open water months, and corresponding stages;
- annual 7-day and 14-day flood discharges, and corresponding stages; and
- annual 30-day, 60-day, and 90-day low flow discharges for the period of July, August, and September, and corresponding stages.

While results are available at all modeled lakes (Appendix B), results are only presented herein at key locations, including Lake A5, Lake A15, Lake A17 (Whale Tail Lake), Lake A18, Lake A69, Lake C8, Lake C38, and Lake DS1.

3.4.1 Lake A5

Results for Lake A5 are presented in Table 3-21 (monthly mean discharges), Table 3-22 (peak and low flow discharges), Table 3-23 (monthly mean stages), and Table 3-24 (peak and low flow stages). Results are summarized in Figure 3-34 (flow regimes) and Figure 3-35 (stage regimes).

Table 3-21: Monthly Mean Discharges at the Lake A5 Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	56,200	271,000	148,000	84,700	108,000	55,100
	50	44,700	254,000	128,000	77,100	97,800	49,900
	20	30,300	228,000	102,000	66,200	82,700	42,500
	10	20,200	205,000	82,900	56,900	70,300	36,200
	5	10,800	177,000	64,300	46,400	56,500	29,100
Median	2	122	128,000	41,100	29,000	34,400	17,400
Dry	5	0	84,400	30,100	15,800	18,800	8,680
	10	0	65,500	27,600	10,900	13,400	5,420
	20	0	52,400	26,500	7,800	10,200	3,410
	50	0	40,600	25,900	5,350	7,750	1,820
	100	0	34,400	25,800	4,220	6,700	1,090

m^3/d= cubic metres per day.

Table 3-22: Peak and Low Flow Discharges at the Lake A5 Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	15.8	828,000	566,000	65,400	70,400	84,700
	50	13.8	757,000	521,000	57,200	65,100	78,500
	20	11.3	655,000	456,000	46,700	57,200	69,600
	10	9.5	570,000	401,000	38,900	50,500	61,900
	5	7.73	474,000	338,000	31,200	42,500	53,100
Median	2	5.27	315,000	233,000	20,100	28,600	38,100
Dry	5	3.59	197,000	153,000	12,300	17,100	26,200
	10	2.91	154,000	122,000	9,120	12,400	21,500
	20	2.42	127,000	102,000	6,810	9,190	18,500
	50	1.94	106,000	86,700	4,500	6,460	16,000
	100	1.65	96,900	79,400	3,110	5,100	14,800

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-23: Monthly Mean Stages at the Lake A5 Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.368	0.571	0.482	0.413	0.442	0.366
	50	0.345	0.561	0.463	0.402	0.430	0.356
	20	0.309	0.544	0.435	0.385	0.410	0.340
	10	0.276	0.529	0.410	0.369	0.392	0.325
	5	0.232	0.507	0.382	0.349	0.368	0.306
Median	2	0.066	0.463	0.337	0.306	0.321	0.265
Dry	5	-	0.412	0.309	0.258	0.271	0.218
	10	-	0.384	0.301	0.232	0.246	0.191
	20	-	0.361	0.298	0.212	0.228	0.168
	50	-	0.336	0.296	0.190	0.211	0.141
	100	-	0.321	0.296	0.178	0.203	0.122

m= metres.

Table 3-24: Peak and Low Flow Stages at the Lake A5 Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	0.899	0.781	0.702	0.384	0.392	0.413
	50	0.865	0.762	0.686	0.370	0.383	0.404
	20	0.818	0.732	0.661	0.349	0.370	0.391
	10	0.779	0.704	0.638	0.332	0.357	0.378
	5	0.736	0.668	0.608	0.312	0.340	0.362
Median	2	0.661	0.596	0.548	0.276	0.304	0.330
Dry	5	0.594	0.523	0.487	0.240	0.264	0.297
	10	0.560	0.488	0.457	0.221	0.241	0.281
	20	0.531	0.462	0.435	0.204	0.221	0.269
	50	0.500	0.439	0.415	0.181	0.201	0.259
	100	0.477	0.428	0.405	0.164	0.188	0.253

m= metres.

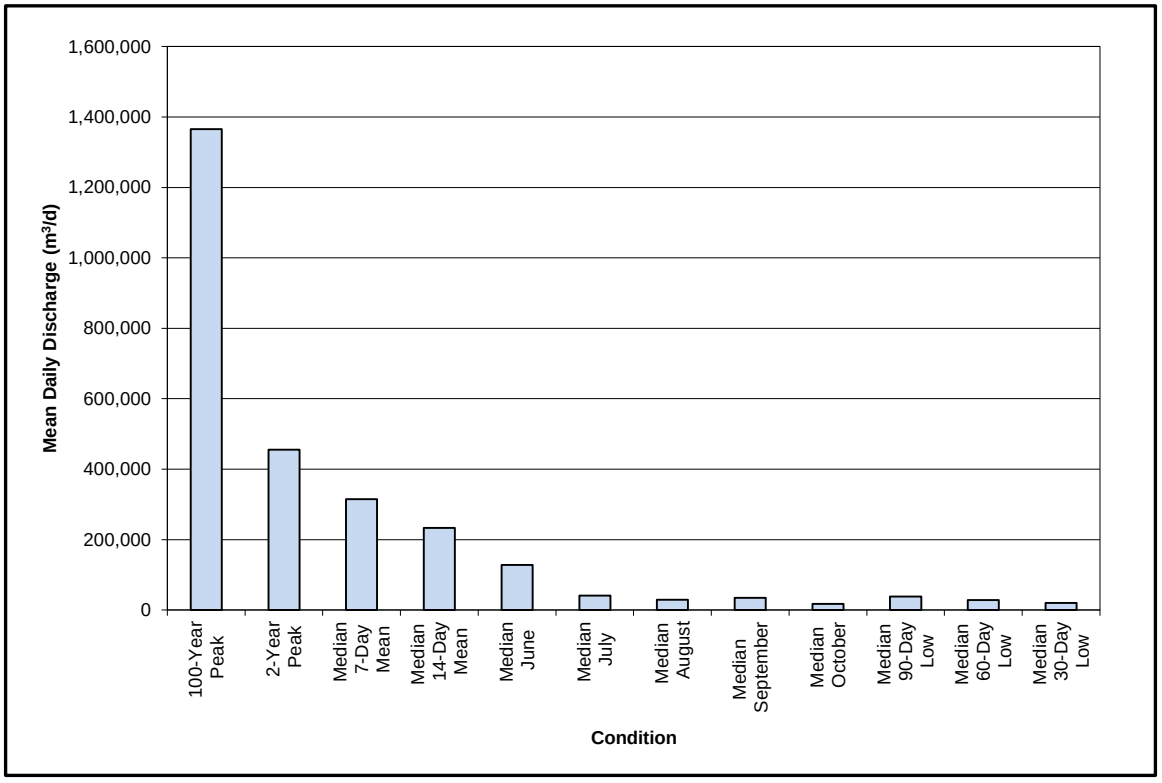


Figure 3-34: Derived Flow Regimes at Lake A5

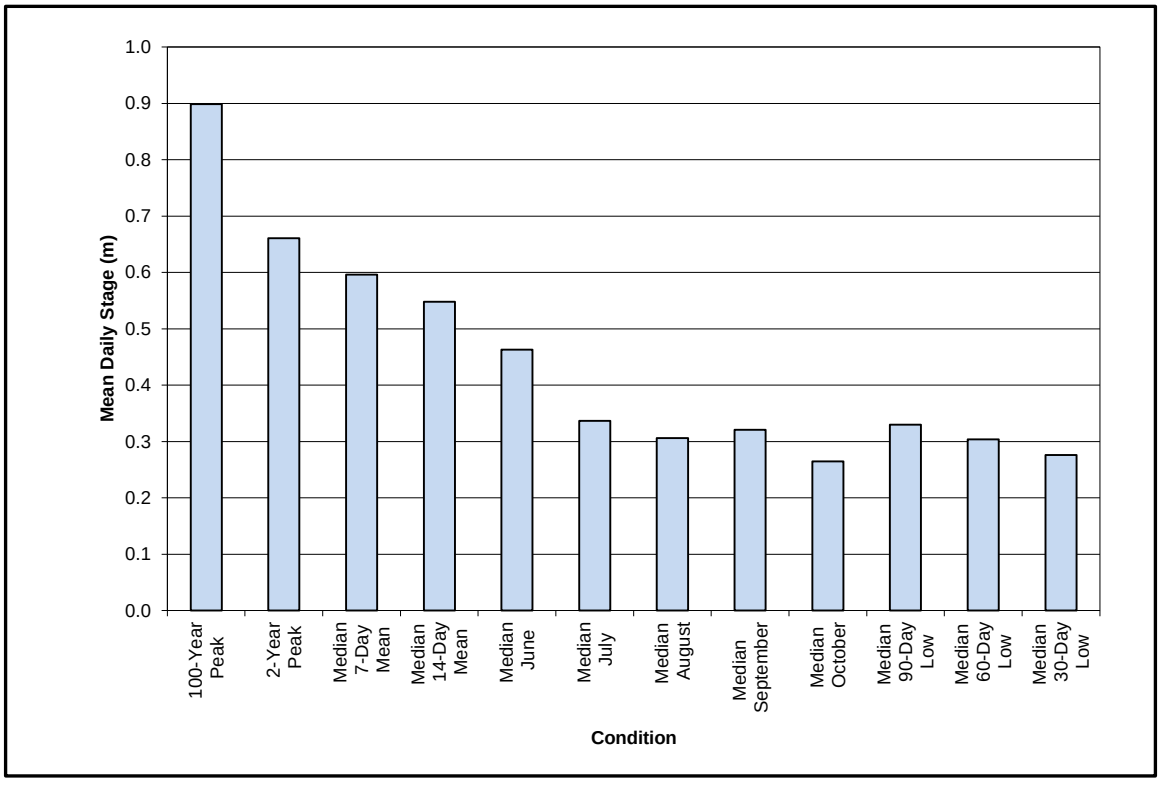


Figure 3-35: Derived Stage Regimes at Lake A5

3.4.2 Lake A15

Results for Lake A15 are presented in Table 3-25 (monthly mean discharges), Table 3-26 (peak and low flow discharges), Table 3-27 (monthly mean stages), and Table 3-28 (peak and low flow stages). Results are summarized in Figure 3-36 (flow regimes) and Figure 3-37 (stage regimes).

Table 3-25: Monthly Mean Discharges at the Lake A15 Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	29,700	201,000	127,000	65,700	85,100	44,800
	50	23,200	188,000	109,000	59,500	76,700	40,600
	20	15,300	169,000	86,400	50,800	64,700	34,700
	10	9,940	152,000	69,700	43,400	54,800	29,600
	5	5,120	132,000	53,800	35,200	43,900	23,900
Median	2	0	95,400	34,500	21,800	26,400	14,300
Dry	5	0	62,800	25,900	11,900	14,000	7,030
	10	0	48,400	24,100	8,390	9,630	4,290
	20	0	38,400	23,300	6,240	7,070	2,580
	50	0	29,200	23,000	4,570	5,130	1,220
	100	0	24,300	22,800	3,830	4,290	583

m^3/d= cubic metres per day.

Table 3-26: Peak and Low Flow Discharges at the Lake A15 Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	9.37	593,000	414,000	51,800	54,600	68,300
	50	8.51	541,000	380,000	45,300	50,500	63,200
	20	7.29	467,000	332,000	37,000	44,400	55,800
	10	6.26	405,000	291,000	30,800	39,200	49,500
	5	5.11	334,000	245,000	24,700	33,000	42,400
Median	2	3.22	218,000	168,000	16,000	22,200	30,300
Dry	5	1.82	131,000	110,000	9,840	13,300	20,900
	10	1.32	98,700	88,000	7,320	9,530	17,300
	20	1.01	78,900	74,500	5,500	7,040	15,100
	50	0.77	63,300	63,700	3,690	4,890	13,200
	100	0.66	56,200	58,700	2,590	3,810	12,400

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-27: Monthly Mean Stages at the Lake A15 Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.485	0.731	0.663	0.575	0.608	0.530
	50	0.460	0.721	0.641	0.563	0.595	0.519
	20	0.421	0.704	0.610	0.544	0.573	0.502
	10	0.384	0.689	0.583	0.526	0.553	0.485
	5	0.333	0.668	0.551	0.503	0.528	0.463
Median	2	-	0.623	0.501	0.454	0.473	0.415
Dry	5	-	0.570	0.471	0.399	0.413	0.356
	10	-	0.539	0.464	0.370	0.381	0.320
	20	-	0.513	0.461	0.347	0.357	0.287
	50	-	0.483	0.459	0.325	0.333	0.245
	100	-	0.465	0.458	0.313	0.320	0.209

m= metres.

Table 3-28: Peak and Low Flow Stages at the Lake A15 Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	0.986	0.922	0.854	0.547	0.553	0.580
	50	0.966	0.904	0.838	0.531	0.544	0.570
	20	0.934	0.876	0.814	0.509	0.529	0.555
	10	0.904	0.850	0.792	0.489	0.515	0.541
	5	0.866	0.815	0.763	0.466	0.496	0.524
Median	2	0.784	0.744	0.704	0.425	0.456	0.487
Dry	5	0.694	0.667	0.642	0.383	0.408	0.450
	10	0.647	0.628	0.612	0.359	0.380	0.432
	20	0.611	0.598	0.591	0.338	0.356	0.420
	50	0.576	0.571	0.571	0.310	0.329	0.408
	100	0.557	0.556	0.561	0.287	0.312	0.402

m= metres.

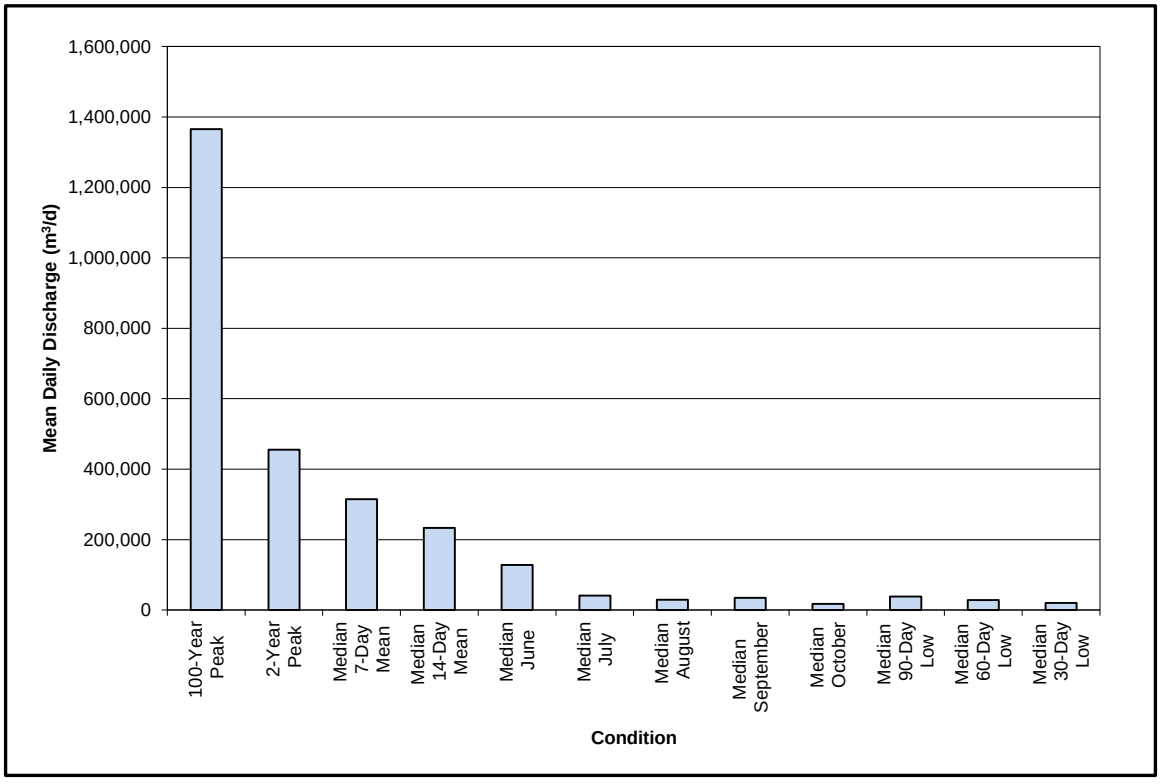


Figure 3-36: Derived Flow Regimes at Lake A15

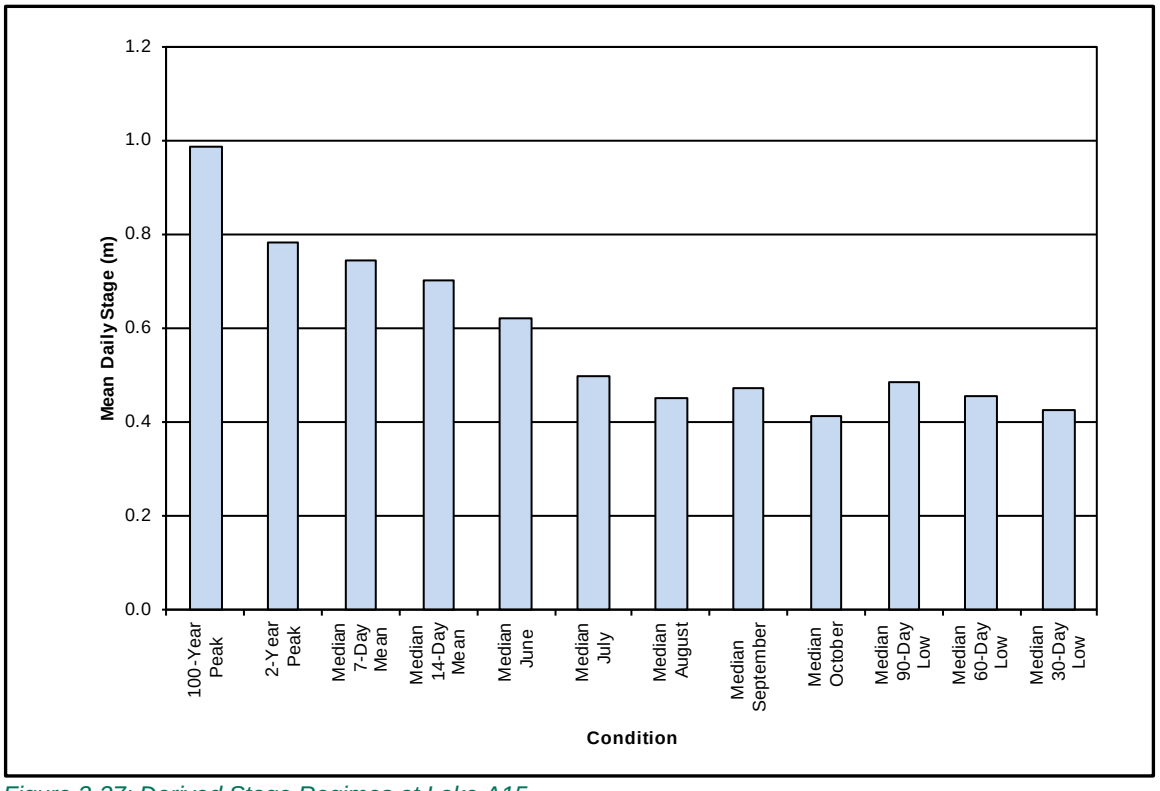


Figure 3-37: Derived Stage Regimes at Lake A15

3.4.3 Lake A17 (Whale Tail Lake)

Results for Lake A17 (Whale Tail Lake) are presented in Table 3-29 (monthly mean discharges), Table 3-30 (peak and low flow discharges), Table 3-31 (monthly mean stages), and Table 3-32 (peak and low flow stages). Results are summarized in Figure 3-38 (flow regimes) and Figure 3-39 (stage regimes).

Table 3-29: Monthly Mean Discharges at the Lake A17 (Whale Tail Lake) Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	14,400	122,000	75,200	39,500	56,700	30,200
	50	11,100	114,000	63,700	35,600	49,500	26,900
	20	7,070	102,000	50,200	29,900	40,100	22,300
	10	4,420	92,300	41,100	25,200	33,100	18,500
	5	2,140	80,200	32,600	19,900	25,900	14,300
Median	2	0	57,800	21,600	11,400	15,400	8,090
Dry	5	0	37,700	14,600	5,280	7,810	4,100
	10	0	28,700	11,900	3,090	4,660	2,780
	20	0	22,400	9,980	1,780	2,360	2,030
	50	0	16,600	8,140	784	59	1,450
	100	0	13,400	7,050	343	0	1,200

m^3/d= cubic metres per day.

Table 3-30: Peak and Low Flow Discharges at the Lake A17 (Whale Tail Lake) Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	6.17	355,000	250,000	31,100	32,100	40,800
	50	5.58	324,000	230,000	26,500	29,500	37,700
	20	4.74	281,000	202,000	20,900	25,700	33,200
	10	4.04	245,000	177,000	16,900	22,500	29,300
	5	3.26	203,000	150,000	13,000	18,600	24,900
Median	2	2.01	134,000	104,000	7,790	11,900	17,400
Dry	5	1.10	81,700	68,600	4,280	6,320	11,500
	10	0.78	62,000	55,200	2,880	4,020	9,210
	20	0.59	49,700	46,900	1,890	2,480	7,750
	50	0.44	39,900	40,200	906	1,150	6,550
	100	0.38	35,400	37,100	320	489	5,980

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-31: Monthly Mean Stages at the Lake A17 (Whale Tail Lake) Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.458	0.847	0.737	0.612	0.679	0.566
	50	0.424	0.831	0.702	0.594	0.653	0.548
	20	0.373	0.804	0.656	0.565	0.615	0.519
	10	0.326	0.782	0.619	0.538	0.582	0.492
	5	0.264	0.751	0.579	0.502	0.542	0.457
Median	2	-	0.683	0.514	0.428	0.466	0.387
Dry	5	-	0.604	0.459	0.343	0.384	0.319
	10	-	0.558	0.433	0.294	0.331	0.285
	20	-	0.520	0.412	0.250	0.272	0.260
	50	-	0.477	0.388	0.198	0.094	0.236
	100	-	0.448	0.372	0.156	-	0.224

m= metres.

Table 3-32: Peak and Low Flow Stages at the Lake A17 (Whale Tail Lake) Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	1.296	1.152	1.042	0.571	0.576	0.618
	50	1.259	1.122	1.017	0.545	0.563	0.604
	20	1.201	1.077	0.979	0.509	0.541	0.582
	10	1.147	1.035	0.943	0.479	0.520	0.561
	5	1.078	0.981	0.899	0.444	0.493	0.536
Median	2	0.938	0.870	0.809	0.383	0.433	0.483
Dry	5	0.788	0.755	0.717	0.323	0.361	0.429
	10	0.714	0.697	0.674	0.288	0.317	0.402
	20	0.659	0.654	0.643	0.255	0.276	0.383
	50	0.606	0.614	0.615	0.206	0.221	0.365
	100	0.579	0.593	0.601	0.153	0.173	0.355

m= metres.

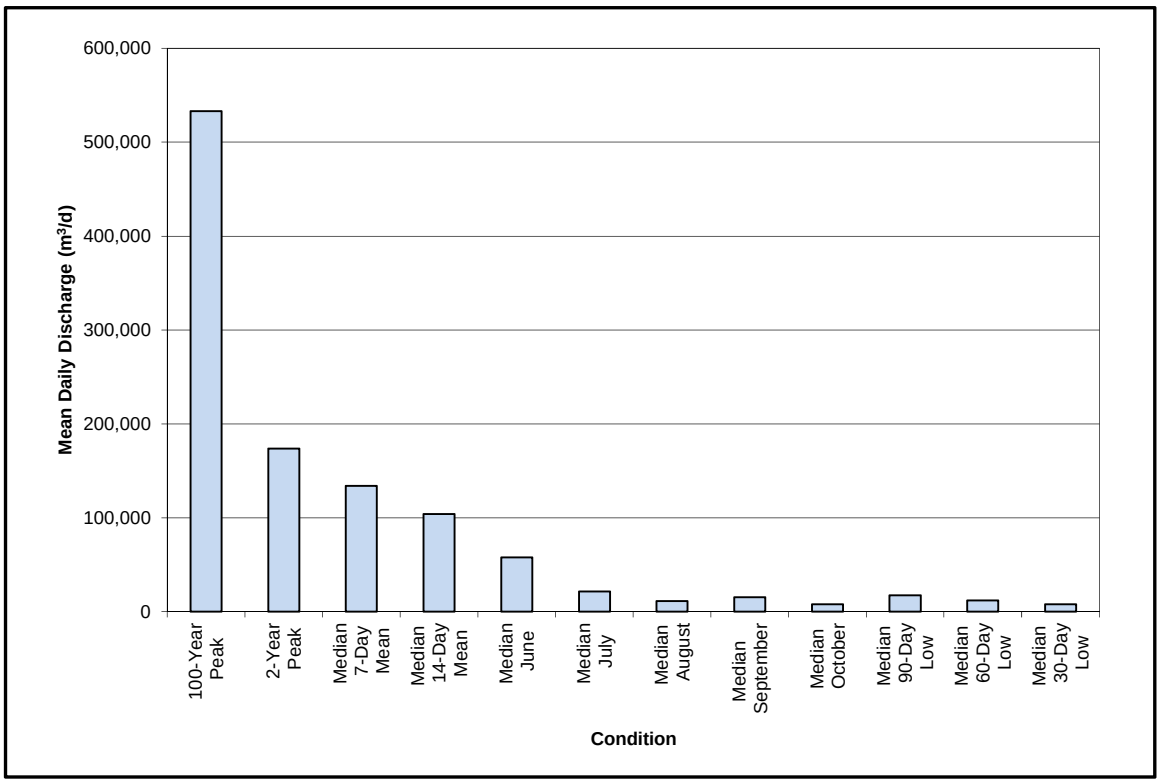


Figure 3-38: Derived Flow Regimes at Lake A17 (Whale Tail Lake)

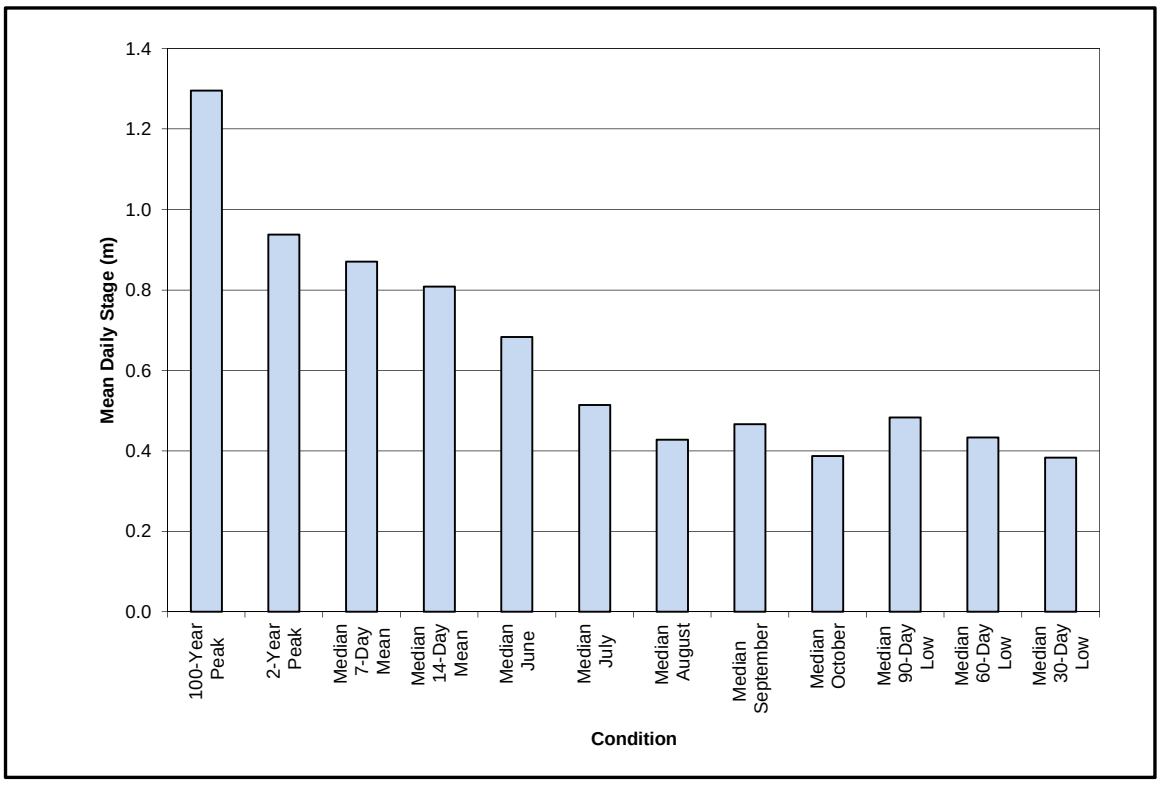


Figure 3-39: Derived Stage Regimes at Lake A17 (Whale Tail Lake)

3.4.4 Lake A18

Results for Lake A18 are presented in Table 3-33 (monthly mean discharges), Table 3-34 (peak and low flow discharges), Table 3-35 (monthly mean stages), and Table 3-36 (peak and low flow stages). Results are summarized in Figure 3-40 (flow regimes) and Figure 3-41 (stage regimes).

Table 3-33: Monthly Mean Discharges at the Lake A18 Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	12,200	57,000	32,600	23,000	24,900	13,700
	50	9,870	53,500	28,300	20,200	22,700	11,600
	20	6,910	48,200	22,700	16,600	19,500	9,080
	10	4,760	43,500	18,700	13,700	16,700	7,300
	5	2,700	38,100	14,600	10,700	13,600	5,580
Median	2	190	28,400	8,930	6,220	8,310	3,230
Dry	5	0	20,100	5,150	2,870	4,160	0
	10	0	16,700	3,720	1,440	2,540	0
	20	0	14,300	2,750	388	1,510	0
	50	0	12,100	1,840	0	662	0
	100	0	11,100	1,330	0	261	0

m^3/d= cubic metres per day.

Table 3-34: Peak and Low Flow Discharges at the Lake A18 Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	3.38	146,000	112,000	12,000	16,700	18,400
	50	2.92	135,000	103,000	10,500	15,200	17,200
	20	2.36	119,000	91,400	8,570	13,000	15,300
	10	1.97	106,000	81,200	7,090	11,200	13,700
	5	1.61	90,300	69,700	5,560	9,160	11,800
Median	2	1.11	64,400	50,700	3,300	5,840	8,490
Dry	5	0.81	44,600	36,300	1,650	3,130	5,680
	10	0.70	37,100	30,900	953	1,920	4,500
	20	0.63	32,300	27,600	446	997	3,710
	50	0.57	28,500	25,000	0	42	3,020
	100	0.54	26,700	23,800	0	0	2,670

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-35: Monthly Mean Stages at the Lake A18 Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.405	0.549	0.492	0.459	0.466	0.415
	50	0.389	0.543	0.478	0.448	0.458	0.401
	20	0.362	0.531	0.458	0.431	0.444	0.382
	10	0.336	0.521	0.441	0.415	0.431	0.366
	5	0.301	0.507	0.420	0.395	0.414	0.347
Median	2	0.178	0.479	0.381	0.355	0.376	0.312
Dry	5	-	0.447	0.342	0.304	0.328	-
	10	-	0.431	0.320	0.266	0.297	-
	20	-	0.418	0.302	0.205	0.268	-
	50	-	0.405	0.279	-	0.228	-
	100	-	0.398	0.262	-	0.190	-

m= metres.

Table 3-36: Peak and Low Flow Stages at the Lake A18 Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	0.759	0.662	0.628	0.404	0.431	0.439
	50	0.737	0.651	0.617	0.393	0.423	0.434
	20	0.707	0.635	0.603	0.378	0.410	0.424
	10	0.682	0.621	0.589	0.364	0.398	0.415
	5	0.655	0.602	0.572	0.347	0.383	0.403
Median	2	0.609	0.563	0.537	0.313	0.350	0.377
Dry	5	0.572	0.523	0.503	0.273	0.310	0.348
	10	0.555	0.505	0.487	0.245	0.281	0.333
	20	0.544	0.491	0.476	0.211	0.247	0.320
	50	0.533	0.479	0.467	-	0.132	0.308
	100	0.527	0.473	0.462	-	-	0.300

m= metres.

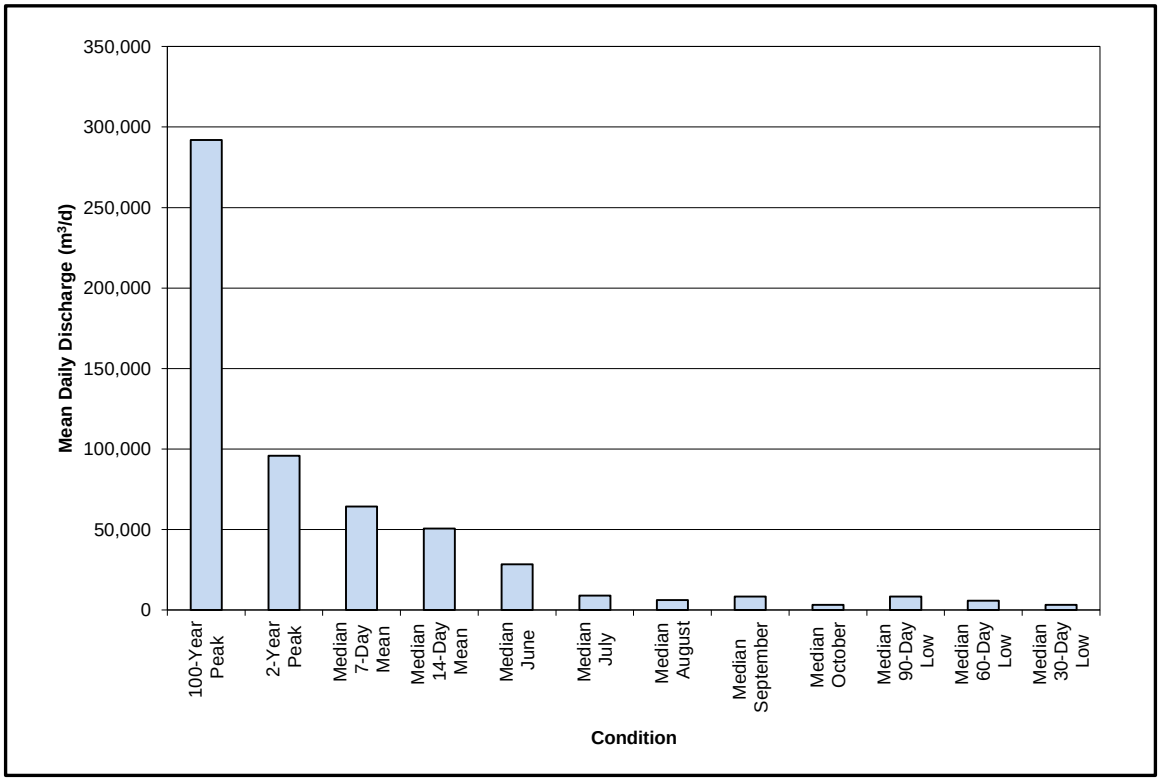


Figure 3-40: Derived Flow Regimes at Lake A18

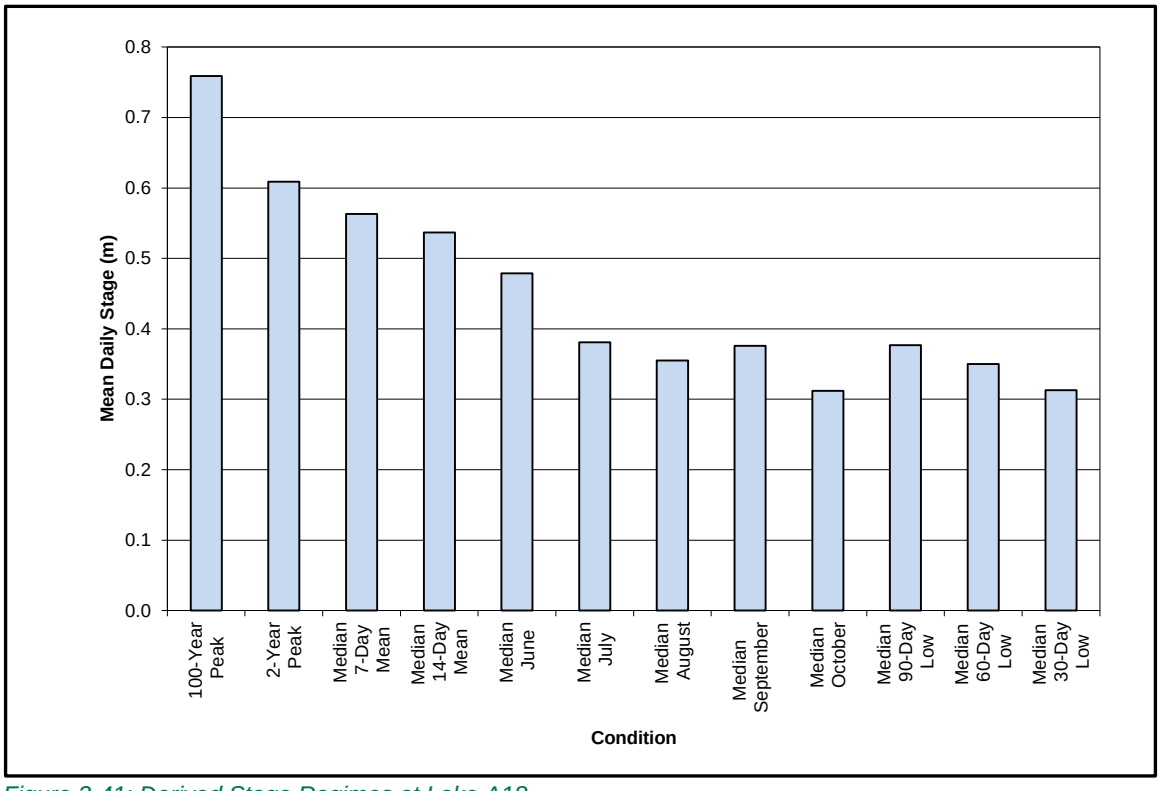


Figure 3-41: Derived Stage Regimes at Lake A18

3.4.5 Lake A69

Results for Lake A69 are presented in Table 3-37 (monthly mean discharges), Table 3-38 (peak and low flow discharges), Table 3-39 (monthly mean stages), and Table 3-40 (peak and low flow stages). Results are summarized in Figure 3-42 (flow regimes) and Figure 3-43 (stage regimes).

Table 3-37: Monthly Mean Discharges at the Lake A69 Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	65,000	285,000	182,000	109,000	129,000	69,300
	50	53,300	269,000	159,000	99,700	118,000	59,400
	20	38,000	245,000	127,000	86,600	102,000	46,900
	10	26,600	224,000	103,000	75,200	87,700	38,000
	5	15,600	199,000	78,900	61,900	71,900	29,300
Median	2	1,570	151,000	46,600	38,300	44,900	17,200
Dry	5	0	107,000	29,800	18,500	23,800	8,940
	10	0	86,700	25,500	10,200	15,500	5,620
	20	0	72,200	23,500	4,580	10,200	3,240
	50	0	58,600	22,300	0	5,910	883
	100	0	51,200	21,900	0	3,840	0

m^3/d= cubic metres per day.

Table 3-38: Peak and Low Flow Discharges at the Lake A69 Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	14.5	710,000	571,000	65,100	86,000	99,100
	50	13.3	659,000	529,000	57,900	79,600	92,500
	20	11.6	584,000	468,000	48,200	70,100	82,800
	10	10.1	521,000	417,000	40,700	61,800	74,400
	5	8.58	448,000	359,000	32,700	52,000	64,600
Median	2	6.15	327,000	264,000	20,500	34,400	47,300
Dry	5	4.51	233,000	192,000	11,300	19,300	32,700
	10	3.95	196,000	165,000	7,400	12,900	26,600
	20	3.64	174,000	149,000	4,500	8,540	22,600
	50	3.41	155,000	136,000	1,550	4,650	19,000
	100	3.31	146,463	129,974	0	2,655	17,263

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-39: Monthly Mean Stages at the Lake A69 Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.383	0.580	0.511	0.443	0.464	0.390
	50	0.362	0.570	0.492	0.432	0.453	0.374
	20	0.330	0.556	0.462	0.415	0.435	0.350
	10	0.298	0.542	0.436	0.399	0.417	0.330
	5	0.257	0.524	0.404	0.378	0.394	0.306
Median	2	0.135	0.485	0.349	0.330	0.345	0.264
Dry	5	-	0.441	0.308	0.269	0.289	0.220
	10	-	0.415	0.295	0.228	0.256	0.193
	20	-	0.395	0.288	0.182	0.228	0.165
	50	-	0.372	0.284	-	0.196	0.115
	100	-	0.358	0.282	-	0.173	-

m= metres.

Table 3-40: Peak and Low Flow Stages at the Lake A69 Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	0.877	0.748	0.704	0.383	0.414	0.431
	50	0.857	0.733	0.689	0.371	0.405	0.423
	20	0.824	0.709	0.666	0.352	0.391	0.410
	10	0.793	0.686	0.645	0.336	0.378	0.398
	5	0.758	0.658	0.618	0.316	0.360	0.382
Median	2	0.690	0.602	0.567	0.277	0.321	0.350
Dry	5	0.633	0.548	0.519	0.235	0.273	0.316
	10	0.610	0.522	0.497	0.208	0.244	0.298
	20	0.596	0.505	0.483	0.181	0.217	0.285
	50	0.585	0.489	0.471	0.135	0.183	0.271
	100	0.580	0.481	0.465	-	0.156	0.264

m = metres.

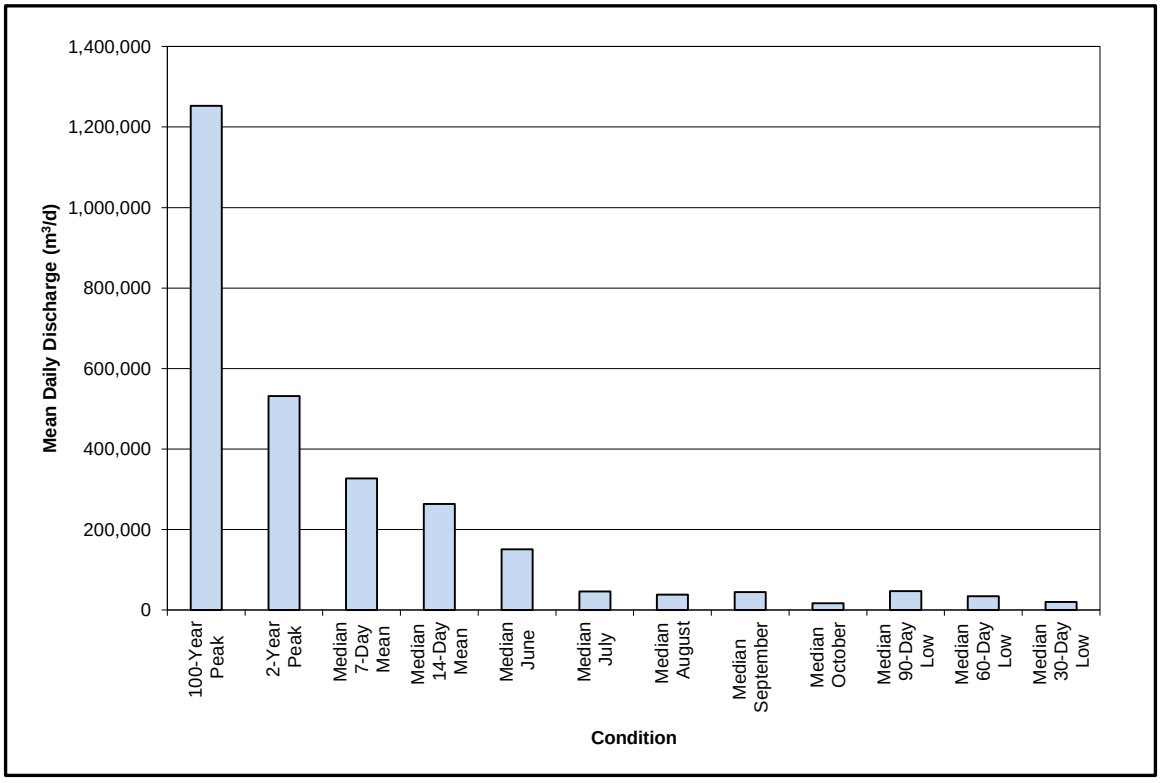


Figure 3-42: Derived Flow Regimes at Lake A69

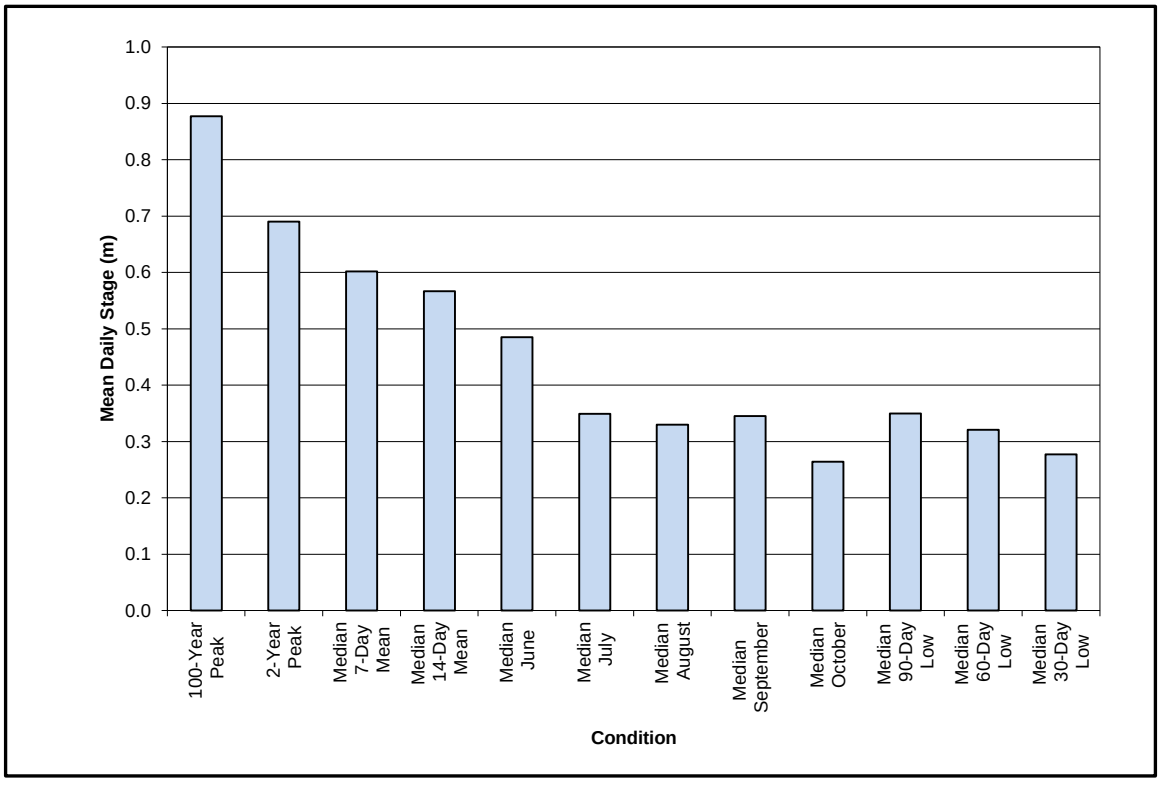


Figure 3-43: Derived Stage Regimes at Lake A69

3.4.6 Lake C8

Results for Lake C8 are presented in Table 3-41 (monthly mean discharges), Table 3-42 (peak and low flow discharges), Table 3-43 (monthly mean stages), and Table 3-44 (peak and low flow stages). Results are summarized in Figure 3-44 (flow regimes) and Figure 3-45 (stage regimes).

Table 3-41: Monthly Mean Discharges at the Lake C8 Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	22,500	56,400	22,200	20,600	24,100	13,500
	50	18,200	53,300	19,700	19,000	22,200	11,900
	20	12,600	48,600	16,400	16,600	19,400	9,690
	10	8,610	44,300	13,800	14,400	17,000	8,040
	5	4,810	39,100	11,200	11,900	14,200	6,350
Median	2	241	29,100	7,180	7,420	9,240	3,870
Dry	5	0	19,400	4,240	3,560	5,150	2,070
	10	0	14,800	3,030	1,910	3,460	1,320
	20	0	11,300	2,170	784	2,340	770
	50	0	7,920	1,320	0	1,370	218
	100	0	6,000	831	0	890	0

m^3/d= cubic metres per day.

Table 3-42: Peak and Low Flow Discharges at the Lake C8 Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	5.33	202,000	120,000	11,600	16,100	17,600
	50	4.80	190,000	113,000	10,600	14,900	16,300
	20	4.09	170,000	101,000	9,130	13,100	14,500
	10	3.53	154,000	91,300	7,870	11,600	13,000
	5	2.94	134,000	79,700	6,420	9,740	11,300
Median	2	2.09	99,500	59,300	3,950	6,410	8,290
Dry	5	1.60	69,700	42,200	1,980	3,520	5,690
	10	1.45	57,100	35,000	1,210	2,280	4,460
	20	1.38	48,500	30,200	711	1,420	3,500
	50	1.33	40,900	26,100	296	648	2,490
	100	1.31	37,000	24,000	98	249	1,850

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-43: Monthly Mean Stages at the Lake C8 Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.457	0.548	0.456	0.449	0.463	0.413
	50	0.438	0.542	0.445	0.442	0.456	0.403
	20	0.408	0.532	0.430	0.431	0.444	0.387
	10	0.378	0.523	0.415	0.419	0.433	0.373
	5	0.337	0.510	0.398	0.403	0.417	0.356
Median	2	0.187	0.481	0.365	0.367	0.384	0.323
Dry	5	-	0.444	0.329	0.318	0.342	0.285
	10	-	0.421	0.308	0.281	0.316	0.261
	20	-	0.399	0.288	0.236	0.292	0.235
	50	-	0.372	0.261	-	0.263	0.183
	100	-	0.352	0.238	-	0.242	-

m= metres.

Table 3-44: Peak and Low Flow Stages at the Lake C8 Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	0.830	0.705	0.636	0.401	0.428	0.436
	50	0.813	0.697	0.629	0.394	0.421	0.429
	20	0.788	0.682	0.615	0.383	0.411	0.419
	10	0.765	0.669	0.603	0.372	0.401	0.410
	5	0.738	0.650	0.587	0.357	0.388	0.399
Median	2	0.690	0.613	0.554	0.324	0.357	0.375
Dry	5	0.654	0.572	0.518	0.283	0.317	0.349
	10	0.642	0.550	0.499	0.257	0.291	0.332
	20	0.636	0.532	0.485	0.231	0.265	0.317
	50	0.631	0.515	0.471	0.194	0.227	0.296
	100	0.629	0.504	0.463	0.156	0.188	0.279

m= metres.

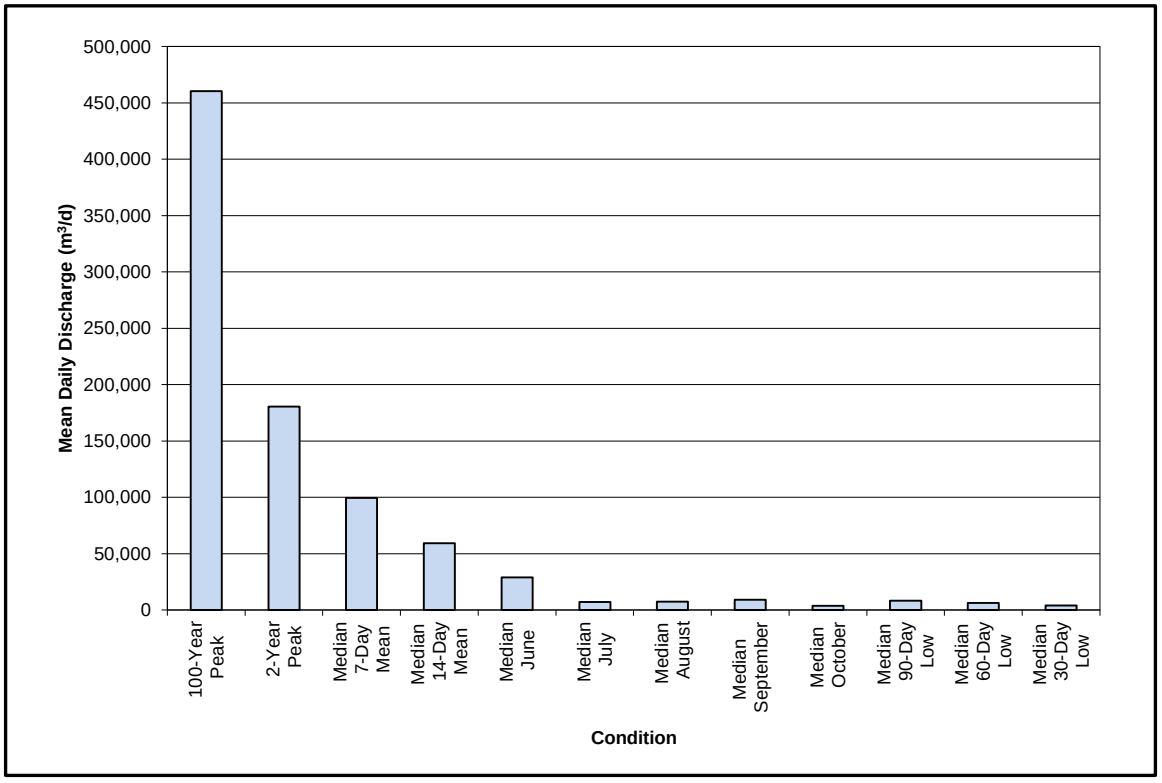


Figure 3-44: Derived Flow Regimes at Lake C8

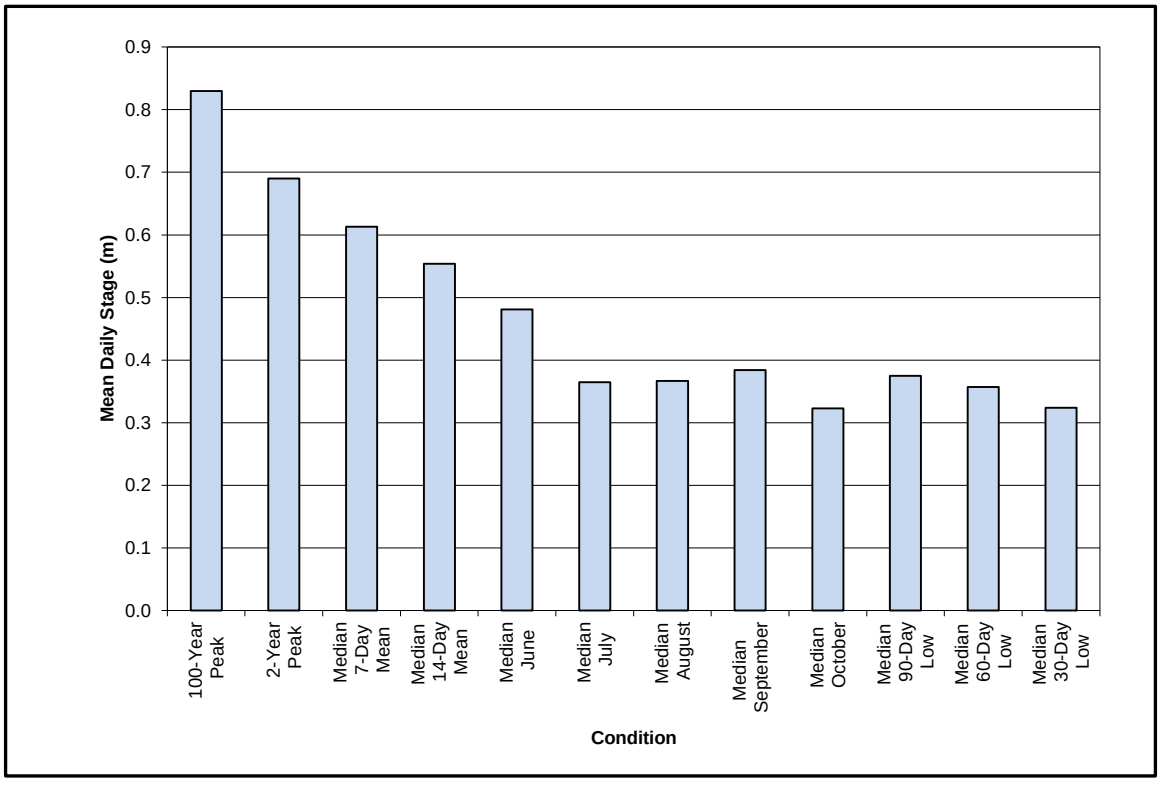


Figure 3-45: Derived Stage Regimes at Lake C8

3.4.7 Lake C38 (Nemo Lake)

Results for Lake C38 (Nemo Lake) are presented in Table 3-45 (monthly mean discharges), Table 3-46 (peak and low flow discharges), Table 3-47 (monthly mean stages), and Table 3-48 (peak and low flow stages). Results are summarized in Figure 3-46 (flow regimes) and Figure 3-47 (stage regimes).

Table 3-45: Monthly Mean Discharges at the Lake C38 (Nemo Lake) Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	396	4,380	5,330	4,100	3,800	2,520
	50	305	4,140	4,960	3,820	3,560	2,340
	20	199	3,780	4,430	3,410	3,190	2,080
	10	131	3,450	3,990	3,060	2,880	1,850
	5	72	3,050	3,490	2,650	2,510	1,580
Median	2	3	2,270	2,650	1,920	1,840	1,070
Dry	5	0	1,470	1,910	1,250	1,210	621
	10	0	1,050	1,570	929	898	421
	20	0	692	1,300	672	645	280
	50	0	288	1,020	393	368	151
	100	0	17	847	215	188	82

m^3/d= cubic metres per day.

Table 3-46: Peak and Low Flow Discharges at the Lake C38 (Nemo Lake) Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	0.075	6,380	6,200	3,560	3,870	4,310
	50	0.072	6,050	5,880	3,340	3,610	4,030
	20	0.066	5,570	5,400	3,000	3,240	3,610
	10	0.061	5,150	4,990	2,700	2,920	3,260
	5	0.055	4,650	4,500	2,350	2,550	2,860
Median	2	0.044	3,730	3,610	1,700	1,870	2,150
Dry	5	0.034	2,850	2,760	1,070	1,240	1,510
	10	0.029	2,410	2,330	743	921	1,200
	20	0.025	2,060	1,990	481	670	953
	50	0.020	1,670	1,620	190	396	690
	100	0.017	1,410	1,370	0	219	523

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-47: Monthly Mean Stages at the Lake C38 (Nemo Lake) Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.041	0.447	0.543	0.418	0.388	0.258
	50	0.032	0.422	0.506	0.390	0.364	0.239
	20	0.021	0.386	0.452	0.348	0.326	0.213
	10	0.014	0.352	0.407	0.313	0.294	0.190
	5	0.007	0.312	0.356	0.271	0.257	0.162
Median	2	0.000	0.232	0.271	0.197	0.189	0.110
Dry	5	-	0.151	0.196	0.128	0.124	0.064
	10	-	0.108	0.161	0.096	0.092	0.043
	20	-	0.071	0.133	0.069	0.066	0.029
	50	-	0.030	0.105	0.041	0.038	0.016
	100	-	0.002	0.087	0.022	0.020	0.009

m= metres.

Table 3-48: Peak and Low Flow Stages at the Lake C38 (Nemo Lake) Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	0.660	0.649	0.631	0.364	0.395	0.440
	50	0.633	0.616	0.599	0.341	0.369	0.411
	20	0.581	0.567	0.550	0.307	0.331	0.369
	10	0.537	0.525	0.509	0.276	0.298	0.333
	5	0.485	0.474	0.459	0.241	0.261	0.292
Median	2	0.388	0.381	0.369	0.174	0.192	0.220
Dry	5	0.300	0.291	0.282	0.110	0.127	0.155
	10	0.256	0.247	0.238	0.077	0.095	0.123
	20	0.221	0.211	0.204	0.050	0.069	0.098
	50	0.177	0.171	0.166	0.020	0.041	0.071
	100	0.151	0.145	0.141	-	0.023	0.054

m= metres.

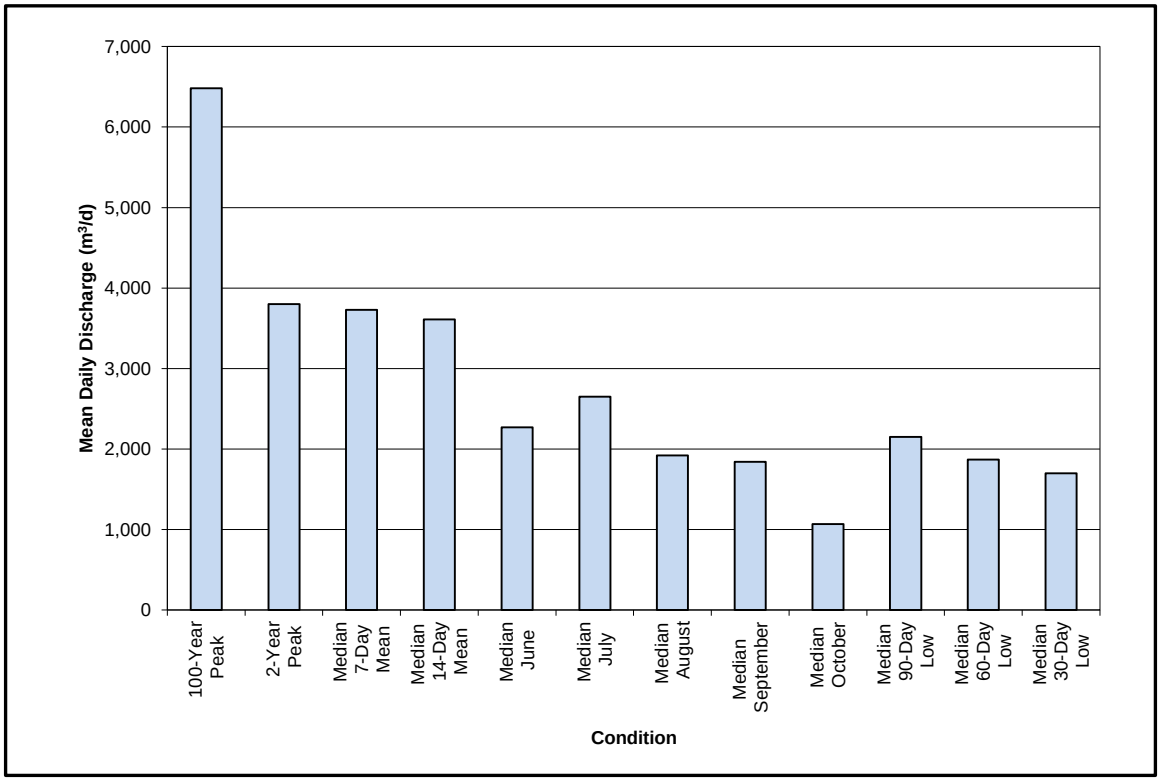


Figure 3-46: Derived Flow Regimes at Lake C38 (Nemo Lake)

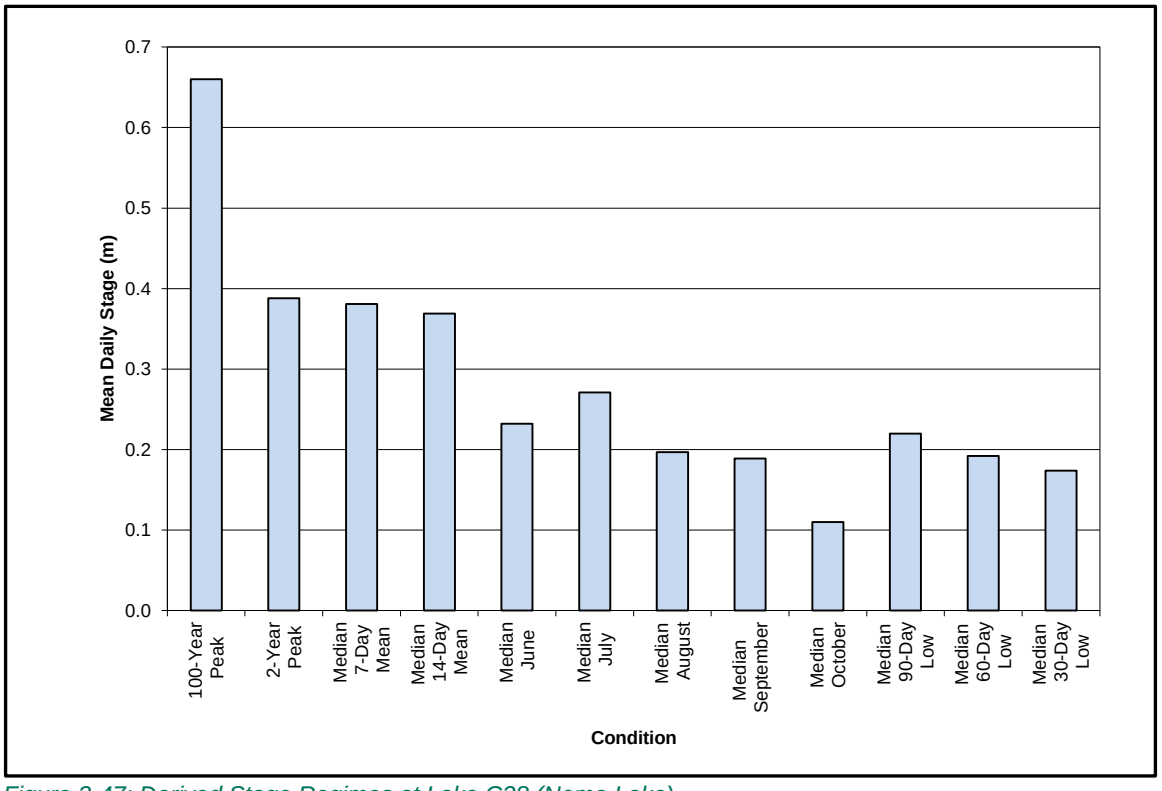


Figure 3-47: Derived Stage Regimes at Lake C38 (Nemo Lake)

3.4.8 Lake DS1

Results for Lake DS1 are presented in Table 3-49 (monthly mean discharges), Table 3-50 (peak and low flow discharges), Table 3-51 (monthly mean stages), and Table 3-52 (peak and low flow stages). Results are summarized in Figure 3-48 (flow regimes) and Figure 3-49 (stage regimes).

Table 3-49: Monthly Mean Discharges at the Lake DS1 Outlet

Condition	Return Period (years)	Monthly Mean Discharge (m^3/d)					
		May	June	July	August	September	October
Wet	100	329,000	3,510,000	5,120,000	1,890,000	2,280,000	1,980,000
	50	224,000	3,230,000	4,390,000	1,720,000	2,100,000	1,810,000
	20	130,000	2,810,000	3,500,000	1,480,000	1,830,000	1,560,000
	10	82,800	2,450,000	2,860,000	1,270,000	1,600,000	1,360,000
	5	48,500	2,040,000	2,250,000	1,020,000	1,330,000	1,140,000
Median	2	15,800	1,320,000	1,390,000	604,000	874,000	780,000
Dry	5	1,090	716,000	816,000	266,000	485,000	491,000
	10	0	436,000	584,000	130,000	306,000	363,000
	20	0	221,000	419,000	42,300	169,000	266,000
	50	0	0	256,000	0	24,400	165,000
	100	0	0	158,000	0	0	103,000

m^3/d= cubic metres per day.

Table 3-50: Peak and Low Flow Discharges at the Lake DS1 Outlet

Condition	Return Period (years)	Peak Daily Q (m^3/s)	7-Day Mean Peak Q (m^3/d)	14-Day Mean Peak Q (m^3/d)	30-Day Low Flow Q (m^3/d)	60-Day Low Flow Q (m^3/d)	90-Day Low Flow Q (m^3/d)
Wet	100	80.8	6,870,000	6,540,000	1,640,000	1,720,000	2,340,000
	50	73.6	6,260,000	5,960,000	1,410,000	1,570,000	2,150,000
	20	63.8	5,420,000	5,160,000	1,120,000	1,350,000	1,880,000
	10	56.0	4,750,000	4,530,000	906,000	1,160,000	1,660,000
	5	47.6	4,050,000	3,850,000	693,000	956,000	1,420,000
Median	2	34.7	2,950,000	2,810,000	388,000	623,000	1,010,000
Dry	5	24.8	2,100,000	2,010,000	174,000	353,000	686,000
	10	20.5	1,740,000	1,660,000	86,100	233,000	540,000
	20	17.3	1,470,000	1,410,000	22,800	142,000	431,000
	50	14.0	1,190,000	1,140,000	0	48,100	317,000
	100	12.0	1,020,000	984,000	0	0	246,000

Q= discharge; m^3/s= cubic metres per second; m^3/d= cubic metres per day.

Table 3-51: Monthly Mean Stages at the Lake DS1 Outlet

Condition	Return Period (years)	Monthly Mean Stage (m)					
		May	June	July	August	September	October
Wet	100	0.193	1.122	1.485	0.708	0.814	0.733
	50	0.145	1.054	1.324	0.660	0.766	0.686
	20	0.097	0.951	1.119	0.590	0.691	0.614
	10	0.069	0.859	0.963	0.527	0.626	0.554
	5	0.047	0.749	0.806	0.448	0.545	0.486
Median	2	0.020	0.542	0.563	0.303	0.399	0.367
Dry	5	0.003	0.344	0.379	0.165	0.258	0.260
	10	-	0.238	0.296	0.097	0.183	0.208
	20	-	0.144	0.231	0.042	0.118	0.165
	50	-	-	0.160	-	0.028	0.116
	100	-	-	0.112	-	-	0.081

m= metres.

Table 3-52: Peak and Low Flow Stages at the Lake DS1 Outlet

Condition	Return Period (years)	Peak Daily Stage (m)	7-Day Mean Peak Stage (m)	14-Day Mean Peak Stage (m)	30-Day Low Flow Stage (m)	60-Day Low Flow Q Stage (m)	90-Day Low Flow Stage (m)
Wet	100	1.869	1.847	1.781	0.637	0.660	0.830
	50	1.744	1.724	1.662	0.569	0.617	0.779
	20	1.568	1.549	1.493	0.480	0.551	0.705
	10	1.424	1.404	1.356	0.410	0.493	0.643
	5	1.262	1.247	1.201	0.336	0.427	0.572
Median	2	0.998	0.986	0.951	0.218	0.310	0.444
Dry	5	0.777	0.766	0.741	0.120	0.203	0.333
	10	0.675	0.666	0.643	0.071	0.149	0.279
	20	0.595	0.587	0.569	0.027	0.103	0.236
	50	0.508	0.502	0.486	-	0.046	0.188
	100	0.453	0.448	0.436	-	-	0.156

m= metres.

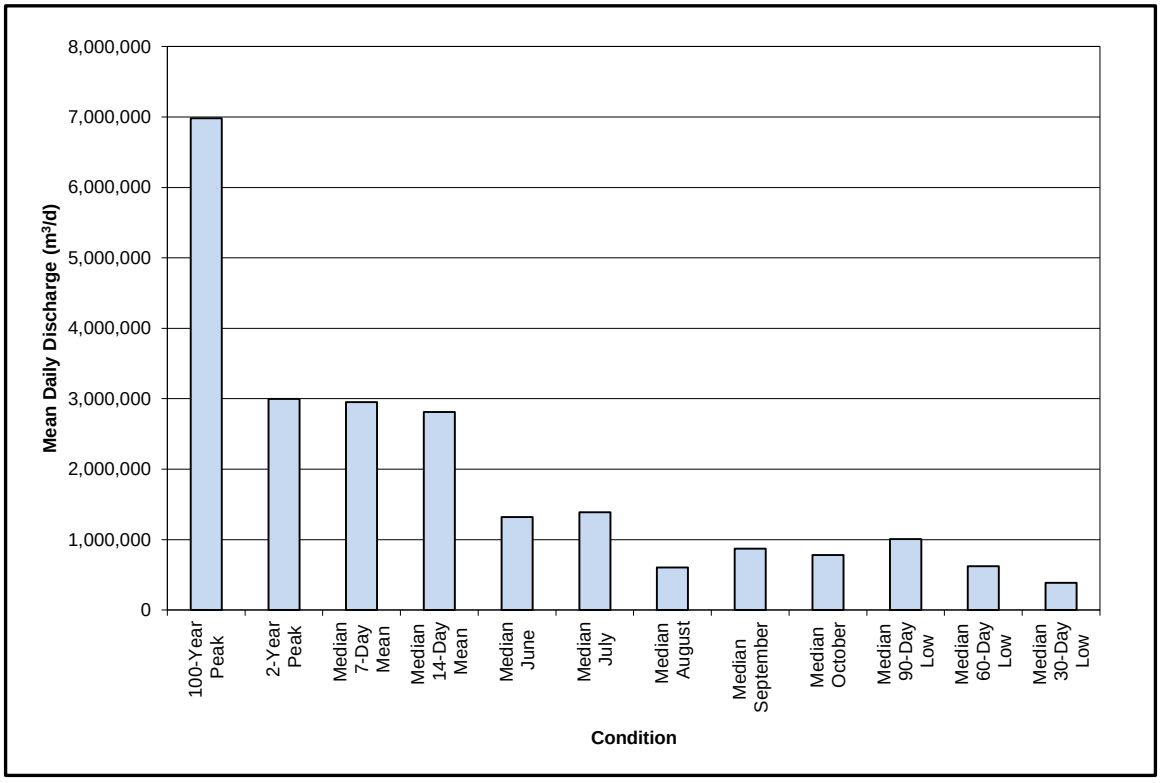


Figure 3-48: Derived Flow Regimes at Lake DS1

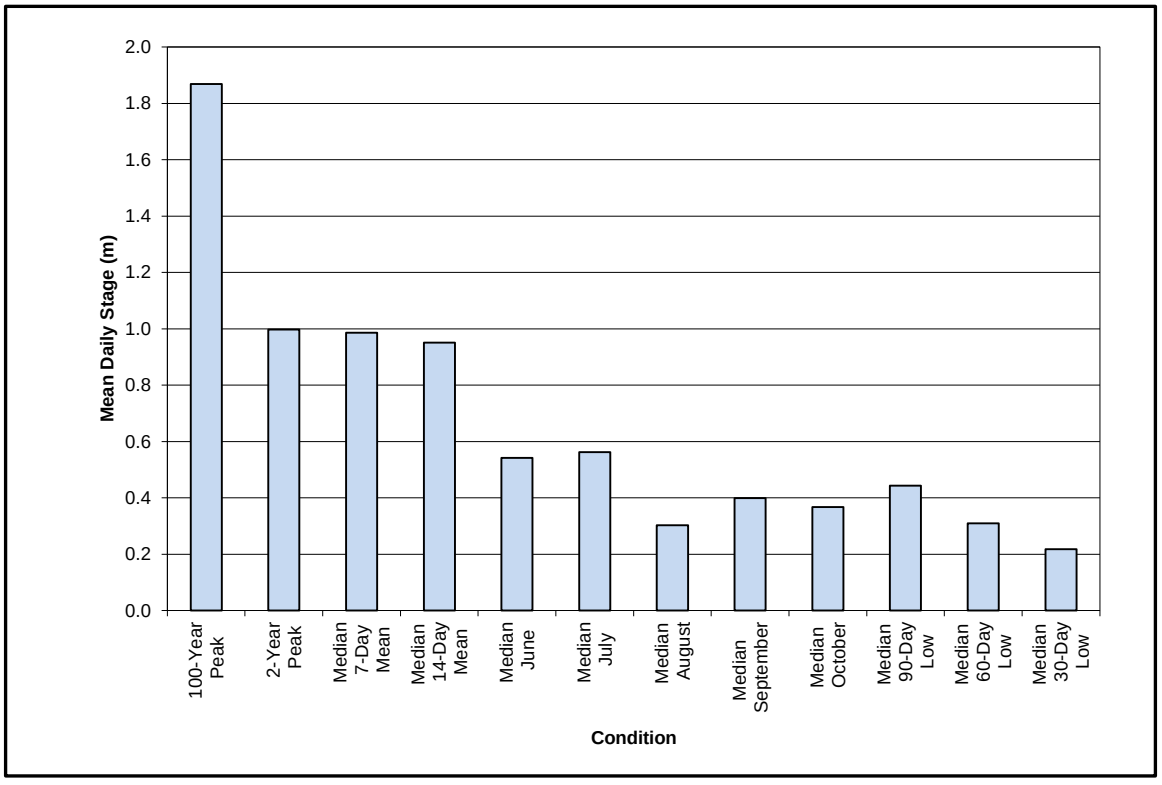


Figure 3-49: Derived Stage Regimes at Lake DS1

4.0 CONCLUSION

This study provides a review of existing hydrology conditions in watersheds potentially affected by the Project, based on available Project information. The Study included characterization of local watersheds and drainage patterns, flow regimes, and lake shoreline and outlet channel geomorphology, based on a review of available desktop data and four field visits in 2015 spanning from early June (during frozen conditions), to July, August and finishing in September, and is intended to provide a basis for future impact assessments of the Project.

Three distinct watersheds within the Hydrology BSA were defined as the A watershed (i.e., where Whale Tail and Mammoth Lake are located), the B watershed (i.e., located just north of the A watershed, and west of Nemo Lake), and the C watershed (i.e., where Nemo Lake is located); these three watersheds each drain into Lake DS1. Drainage patterns were initially defined based on a desktop exercise and refined and/or validated on the ground. In general, ground-truthed drainage patterns were in agreement with those derived from the desktop exercise, with the exception of Lake A12 and Lake A76, which were found to discharge through two lake outlets. Lake A12 was found to discharge northward to Lake A77, and eastward to Lake A11. Lake A76 was found to discharge westward to Lake A75, and eastward to Lake A41. The proportion of flow through each outlet of Lake A12 and Lake A76 was only assessed during low flow conditions, and may vary during high flow conditions. Derived water yields for lakes with similar periods of record (i.e., with 97 and 98 days of record) varied between 52 mm (i.e., Lake C38 [Nemo Lake]) and 267 mm (Lake A18). The lower water yields at Lake A17 and Lake C38 may be attributed to proportions of ineffective areas in the watersheds, and the potential for shallow subsurface flow to convey water outside of the assumed drainage boundaries.

The majority of the shorelines surveyed exhibit a consistent terrain type related to shorelines that have developed in morainal material. These morainal shorelines were observed at all lakes visited during the field survey. Limited areas of bedrock and shallowly sloped sandy shorelines were also observed. As a general characteristic for the surveyed shorelines, the predominant materials are boulder gardens mixed with cobble with very limited soils or organic materials on top. The outlet channels exhibit the same characteristics for streambed materials, which results in interstitial flow through large boulders or below the surface likely close to the bedrock, making flow difficult to observe and measure.

Report Signature Page

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APPENDIX A

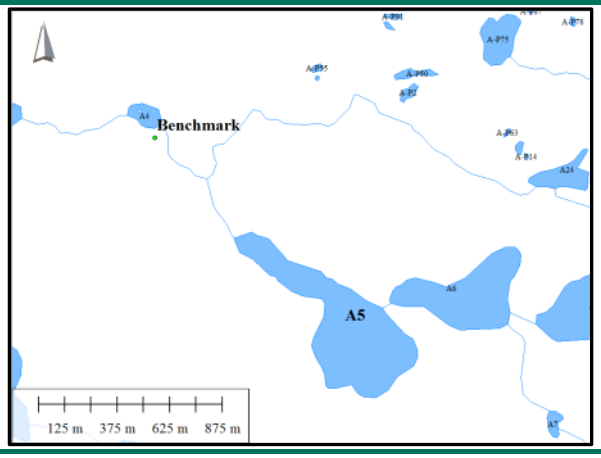
Hydrometric Stations

Table of Contents

FIGURES

A1.0 LAKE A5 & OUTLET (STREAM A5-A4)

Parameter	Value	Note
Drainage Area (km^2)	57.6	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	65	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.4	Measured in the field, based on vegetation
Wetted Width (m)	59.0	Measured in the field on 6 August 2015
Max. Wetted Depth (m)	0.26	Measured in the field on 6 August 2015
Channel Length (km)	0.70	Measured from CanVec data
Outlet Channel Slope (m/m)	0.026	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	599782 m E, 7260885 m N, 129.77 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	598325 m E, 7256756 m N	
Comment	Poorly defined boulder channel. Sub-surface flow present. Cross-sectional data are available in discharge calculation sheets.	



Lake A5: Benchmark location.

6 August 2015. View looking east at Lake A5 and staff gauge.

6 August 2015. View from watercourse at Lake A5 (southeast).

6 August 2015. Downstream view of the watercourse (northwest).

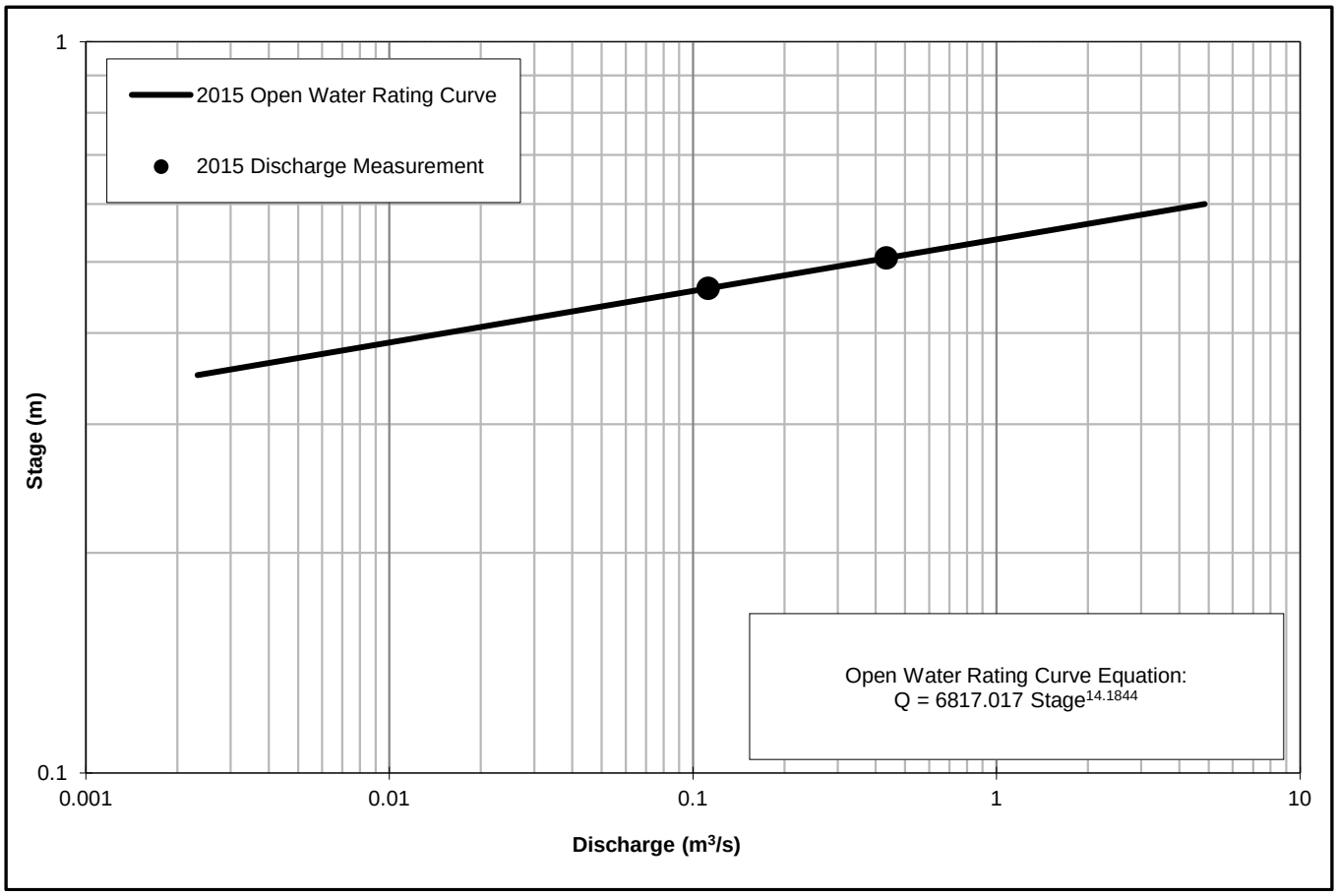


Figure 1: 2015 Stage-Discharge Rating Curve (Lake A5)

Lake A5 - 2015

MEAN DAILY DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	-	-	0.06	-	-	-
2	-	-	-	-	-	-	-	-	0.06	-	-	-
3	-	-	-	-	-	-	-	-	0.07	-	-	-
4	-	-	-	-	-	-	-	-	0.07	-	-	-
5	-	-	-	-	-	-	-	-	0.06	-	-	-
6	-	-	-	-	-	-	-	0.39 P	0.06	-	-	-
7	-	-	-	-	-	-	-	0.38	0.06	-	-	-
8	-	-	-	-	-	-	-	0.35	0.05	-	-	-
9	-	-	-	-	-	-	-	0.34	0.04	-	-	-
10	-	-	-	-	-	-	-	0.28	0.04	-	-	-
11	-	-	-	-	-	-	-	0.28	0.04	-	-	-
12	-	-	-	-	-	-	-	0.19	0.05	-	-	-
13	-	-	-	-	-	-	-	0.25	0.05	-	-	-
14	-	-	-	-	-	-	-	0.24	0.09	-	-	-
15	-	-	-	-	-	-	-	0.22	0.12	-	-	-
16	-	-	-	-	-	-	-	0.19	0.12 P	-	-	-
17	-	-	-	-	-	-	-	0.18	-	-	-	-
18	-	-	-	-	-	-	-	0.18	-	-	-	-
19	-	-	-	-	-	-	-	0.17	-	-	-	-
20	-	-	-	-	-	-	-	0.17	-	-	-	-
21	-	-	-	-	-	-	-	0.15	-	-	-	-
22	-	-	-	-	-	-	-	0.13	-	-	-	-
23	-	-	-	-	-	-	-	0.13	-	-	-	-
24	-	-	-	-	-	-	-	0.13	-	-	-	-
25	-	-	-	-	-	-	-	0.12	-	-	-	-
26	-	-	-	-	-	-	-	0.10	-	-	-	-
27	-	-	-	-	-	-	-	0.10	-	-	-	-
28	-	-	-	-	-	-	-	0.09	-	-	-	-
29	-	-	-	-	-	-	-	0.08	-	-	-	-
30	-	-	-	-	-	-	-	0.08	-	-	-	-
31	-	-	-	-	-	-	-	0.07	-	-	-	-
MIN	-	-	-	-	-	-	-	0.072	0.036	-	-	-
MEAN	-	-	-	-	-	-	-	0.191	0.064	-	-	-
MAX	-	-	-	-	-	-	-	0.393	0.119	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	518,371	429,907	88,464
Water Yield (mm) =	9.0	83%	17%

Lake A5 - 2015

MEAN DAILY WATER SURFACE ELEVATION (masl) BASED ON BENCHMARK ELEVATION 129.77 masl

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	-	-	132.238	-	-	-
2	-	-	-	-	-	-	-	-	132.241	-	-	-
3	-	-	-	-	-	-	-	-	132.243	-	-	-
4	-	-	-	-	-	-	-	-	132.244	-	-	-
5	-	-	-	-	-	-	-	-	132.242	-	-	-
6	-	-	-	-	-	-	-	132.302 P	132.240	-	-	-
7	-	-	-	-	-	-	-	132.301	132.238	-	-	-
8	-	-	-	-	-	-	-	132.298	132.232	-	-	-
9	-	-	-	-	-	-	-	132.297	132.230	-	-	-
10	-	-	-	-	-	-	-	132.291	132.229	-	-	-
11	-	-	-	-	-	-	-	132.290	132.224	-	-	-
12	-	-	-	-	-	-	-	132.277	132.232	-	-	-
13	-	-	-	-	-	-	-	132.286	132.231	-	-	-
14	-	-	-	-	-	-	-	132.285	132.254	-	-	-
15	-	-	-	-	-	-	-	132.282	132.261	-	-	-
16	-	-	-	-	-	-	-	132.277	132.262 P	-	-	-
17	-	-	-	-	-	-	-	132.275	-	-	-	-
18	-	-	-	-	-	-	-	132.275	-	-	-	-
19	-	-	-	-	-	-	-	132.274	-	-	-	-
20	-	-	-	-	-	-	-	132.273	-	-	-	-
21	-	-	-	-	-	-	-	132.269	-	-	-	-
22	-	-	-	-	-	-	-	132.264	-	-	-	-
23	-	-	-	-	-	-	-	132.265	-	-	-	-
24	-	-	-	-	-	-	-	132.265	-	-	-	-
25	-	-	-	-	-	-	-	132.261	-	-	-	-
26	-	-	-	-	-	-	-	132.257	-	-	-	-
27	-	-	-	-	-	-	-	132.256	-	-	-	-
28	-	-	-	-	-	-	-	132.252	-	-	-	-
29	-	-	-	-	-	-	-	132.251	-	-	-	-
30	-	-	-	-	-	-	-	132.249	-	-	-	-
31	-	-	-	-	-	-	-	132.245	-	-	-	-
MIN	-	-	-	-	-	-	-	132.245	132.224	-	-	-
MEAN	-	-	-	-	-	-	-	132.274	132.240	-	-	-
MAX	-	-	-	-	-	-	-	132.302	132.262	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

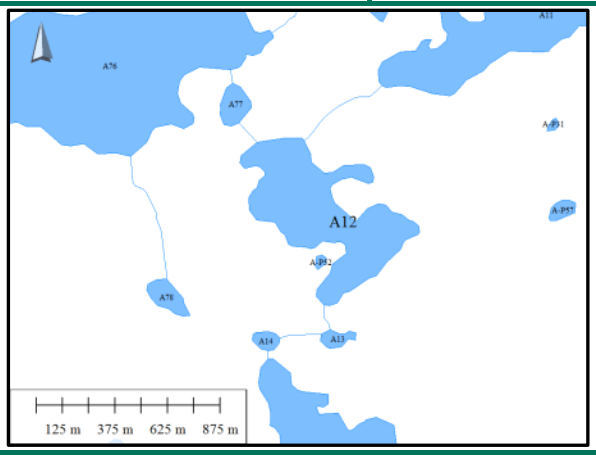
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - trip 2			**Date**		06-Aug-15	
Waterbody:		A5			**Start Time**		9:45	
Crossing ID:		A5-A4			**End Time**		10:05	
Left Downstream Bank (LDB) UTM Location		**Survey**			**Datalogger SN:**			
East	600184	BM_read			**Transducer SN:**			
North	7260409	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL & JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.10		0.00				**0.180**
2	1.50	0.14		0.06			**0.011**	**0.084**
3	2.70	0.00		0.00			**0.000**	**0.000**
4	3.70	0.00		0.00			**0.000**	**0.032**
5	4.50	0.08		0.12			**0.011**	**0.090**
6	6.00	0.04		0.15			**0.009**	**0.098**
7	7.50	0.09		0.23			**0.031**	**0.143**
8	9.00	0.10		0.10			**0.014**	**0.060**
9	10.20	0.00		0.00			**0.000**	**0.000**
10	11.10	0.00		0.00			**0.000**	**0.099**
11	12.00	0.22		0.03			**0.006**	**0.110**
12	13.00	0.00		0.00			**0.000**	**0.000**
13	13.50	0.00		0.00			**0.000**	**0.015**
14	13.70	0.15		0.10			**0.011**	**0.202**
15	15.00	0.16		0.26			**0.042**	**0.056**
16	15.70	0.00		0.00			**0.000**	**0.000**
17	17.00	0.00		0.00			**0.000**	**0.020**
18	17.20	0.20		0.10			**0.015**	**0.169**
19	18.50	0.06		0.11			**0.008**	**0.030**
20	19.50	0.00		0.00			**0.000**	**0.000**
21	19.80	0.00		0.00			**0.000**	**0.040**
22	20.20	0.20		0.20			**0.034**	**0.286**
23	21.50	0.24		0.17			**0.055**	**0.168**
24	22.90	0.00		0.00			**0.000**	**0.000**
25	23.40	0.00		0.00			**0.000**	**0.132**
26	24.50	0.24		0.03			**0.009**	**0.255**
27	26.00	0.10		0.21			**0.032**	**0.263**
28	27.50	0.25		0.15			**0.056**	**0.330**
29	29.00	0.19		0.11			**0.031**	**0.203**
30	30.50	0.08		0.09			**0.011**	**0.060**
31	32.00	0.00		0.00			**0.000**	**0.000**
32	32.30	0.00		0.00			**0.000**	**0.012**
33	32.50	0.12		0.05			**0.002**	**0.018**
34	32.80	0.00		0.00			**0.000**	**0.000**
35	33.10	0.00		0.00			**0.000**	**0.040**
36	33.50	0.20		0.03			**0.006**	**0.345**
37	35.00	0.26		0.00			**0.000**	**0.140**
38	35.70	0.14		0.04			**0.007**	**0.198**
39	37.50	0.08		0.06			**0.033**	**0.484**
40	49.60	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.434**	
						A(m2)	**4.36**	
						B(m)	**49.6**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**	16-Sep-15	
Waterbody:		A5			**Start Time**	12:45	
Crossing ID:		A5-A4			**End Time**	13:05	
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	600182	BM_read			**Transducer SN:**		
North	7260409	WL_read			**Meter Type/SN:**		
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC	
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)	Qi (m3/s)	Ai (m2)
1	0.00	0.00		0			**0.030**
2	0.50	0.12		0.02		**0.001**	**0.030**
3	1.00	0.00		0		**0.000**	**0.000**
4	1.00	0.15		0.01		**0.001**	**0.105**
5	1.70	0.15		0.01		**0.001**	**0.001**
6	1.71	0.00		0		**0.000**	**0.000**
7	1.71	0.10		0.06		**0.001**	**0.025**
8	1.96	0.10		0.06		**0.001**	**0.001**
9	1.97	0.00		0		**0.000**	**0.000**
10	1.97	0.08		0.02		**0.000**	**0.024**
11	2.27	0.08		0.02		**0.000**	**0.000**
12	2.28	0.00		0		**0.000**	**0.000**
13	2.28	0.13		0.16		**0.006**	**0.078**
14	2.88	0.13		0.16		**0.006**	**0.001**
15	2.89	0.00		0		**0.000**	**0.000**
16	2.89	0.06		0.15		**0.002**	**0.021**
17	3.24	0.06		0.15		**0.002**	**0.000**
18	3.25	0.00		0.00		**0.000**	**0.000**
19	3.25	0.10		0.01		**0.000**	**0.040**
20	3.65	0.10		0.01		**0.000**	**0.000**
21	3.65	0.00		0.00		**0.000**	**0.000**
22	3.65	0.00		0.00		**0.000**	**0.018**
23	3.85	0.18		0.15		**0.011**	**0.060**
24	4.45	0.02		0.01		**0.000**	**0.060**
25	5.45	0.10		0.06		**0.007**	**0.119**
26	6.85	0.07		0.03		**0.003**	**0.063**
27	8.65	0.00		0.00		**0.000**	**0.000**
28	8.65	0.00		0.00		**0.000**	**0.064**
29	9.45	0.16		0.03		**0.004**	**0.153**
30	10.35	0.18		0.05		**0.009**	**0.216**
31	11.55	0.18		0.03		**0.006**	**0.176**
32	12.45	0.21		0.07		**0.014**	**0.105**
33	13.45	0.00		0.00		**0.000**	**0.000**
34	13.45	0.20		0.08		**0.006**	**0.150**
35	14.20	0.20		0.08		**0.006**	**0.001**
36	14.21	0.00		0.00		**0.000**	**0.000**
37	14.21	0.10		0.15		**0.003**	**0.040**
38	14.61	0.10		0.15		**0.003**	**0.000**
39	14.62	0.00		0.00		**0.000**	**0.000**
40	14.62	0.08		0.11		**0.002**	**0.032**
41	15.02	0.08		0.11		**0.002**	**0.000**
42	15.03	0.00		0.00		**0.000**	**0.000**
43	15.03	0.07		0.08		**0.000**	**0.014**
44	15.23	0.07		0.08		**0.001**	**0.000**
45	15.24	0.00		0.00		**0.000**	**0.000**
46	15.24	0.12		0.02		**0.001**	**0.108**
47	16.14	0.12		0.02		**0.001**	**0.001**
48	16.15	0.00		0.00		**0.000**	**0.000**
49	16.15	0.12		0.03		**0.001**	**0.048**
50	16.55	0.12		0.03		**0.001**	**0.000**
51	16.55	0.00		0.00		**0.000**	**0.040**
52	17.35	0.10		0.02		**0.002**	**0.110**
53	18.45	0.10		0.06		**0.006**	**0.040**
54	19.25	0.00		0.00		**0.000**	**0.035**
55	19.95	0.10		0.01		**0.001**	**0.030**
56	20.55	0.00		0.00		**0.000**	**0.000**
57	20.55	0.08		0.02		**0.000**	**0.040**
58	21.05	0.08		0.02		**0.000**	**0.000**
59	21.06	0.00		0.00		**0.000**	**0.000**
60	21.06	0.06		0.07		**0.001**	**0.030**
61	21.56	0.06		0.07		**0.001**	**0.000**

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		16-Sep-15	
Waterbody:		A5			**Start Time**		12:45	
Crossing ID:		A5-A4			**End Time**		13:05	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	600182	BM_read			**Transducer SN:**			
North	7260409	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION	DISTANCE		Velocity		Optional			
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW		Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)		(m3/s)	(m2)
62	21.57	0.00		0.00			**0.000**	**0.000**
NOTES:	Discharge measurement was separated into sections that contained flow. In some cases, sections were estimated as an average depth and velocity. Therefore, the distance from LDB, A and B values are not applicable to this measurement. RDB un-measurable low flow area accounting for ~5% of flow				**RESULTS:**	**Q (m3/s)**	**0.112**	
						A(m2)	**2.11**	
						B(m)	**21.6**	

A2.0 LAKE A12 & NORTHWEST OUTLET (STREAM A12-A11)

Parameter	Value	Note
Drainage Area (km^2)	42.4	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	44	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.9	Measured in the field, based on vegetation and high water marks
Wetted Width (m)	42.0	Measured in the field August 6, 2015
Max. Wetted Depth (m)	0.31	Measured in the field August 6, 2015
Channel Length (km)	0.50	Measured from CanVec data
Outlet Channel Slope (m/m)	0.004	Average slope, based on DEM (PhotoSat 2015)
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	N/A	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined boulder channel. Sub surface flows present. Cross-sectional data are available in discharge calculation sheets and Section 3.3.	



Lake A12.

6 August 2015. Looking north from Lake A12 to Lake A77 and Lake A11.

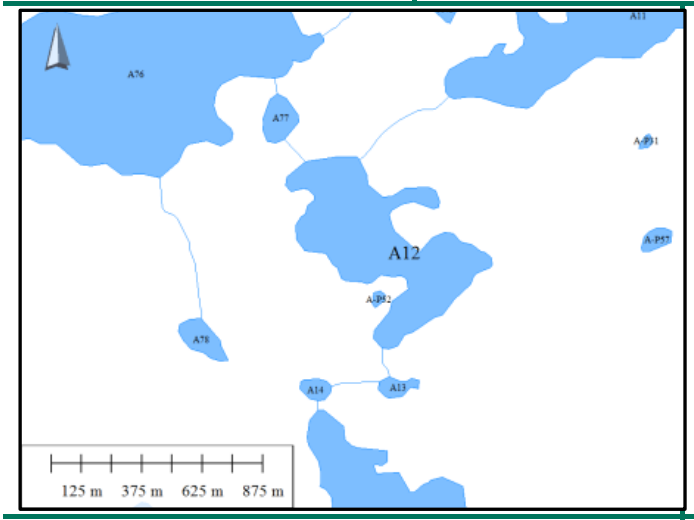
6 August 2015. Upstream view from the watercourse towards Lake A12 (southwest).

19 September 2015. Downstream view of the watercourse (northeast).

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		06-Aug-15	
Waterbody:		A12			**Start Time**		12:05	
Crossing ID:		A12-A11			**End Time**		12:40	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	603052	BM_read			**Transducer SN:**			
North	7256600	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	156, 14W	WL_Elev			**Crew:**	JRL & JN		
STATION	DISTANCE		Velocity		Optional			
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW		Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)		(m3/s)	(m2)
1	0.00	0.00		0.00				**0.114**
2	1.20	0.19		0.00			**0.000**	**0.148**
3	2.00	0.18		0.02			**0.004**	**0.353**
4	3.50	0.29		0.02			**0.008**	**0.358**
5	4.80	0.26		0.00			**0.000**	**0.442**
6	6.50	0.26		0.00			**0.000**	**0.195**
7	8.00	0.00		0.00			**0.000**	**0.044**
8	8.40	0.22		0.06			**0.013**	**0.176**
9	10.00	0.00		0.00			**0.000**	**0.038**
10	11.90	0.04		0.23			**0.009**	**0.002**
11	12.00	0.00		0.00			**0.000**	**0.027**
12	12.60	0.09		0.02			**0.001**	**0.018**
13	13.00	0.00		0.00			**0.000**	**0.117**
14	14.30	0.18		0.00			**0.000**	**0.180**
15	15.50	0.12		0.16			**0.016**	**0.030**
16	16.00	0.00		0.00			**0.000**	**0.600**
17	22.00	0.20		0.09			**0.059**	**0.050**
18	22.50	0.00		0.00			**0.000**	**0.078**
19	23.00	0.31		0.00			**0.000**	**1.785**
20	31.50	0.11		0.02			**0.011**	**0.083**
21	33.00	0.00		0.00			**0.000**	**0.162**
22	35.70	0.12		0.36			**0.194**	**0.378**
23	42.00	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.316**	
						A(m2)	**5.38**	
						B(m)	**42.0**	

A3.0 LAKE A12 & NORTHEAST OUTLET (STREAM A12-A77)

Parameter	Value	Note
Drainage Area (km^2)	42.4	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	45	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.45	Measured in the field, based on vegetation
Wetted Width (m)	16.8	Measured in the field on 6 August 2015
Max. Wetted Depth (m)	0.39	Measured in the field on 6 August 2015
Channel Length (km)	0.12	Measured from CanVec data
Outlet Channel Slope (m/m)	0.020	Average slope, based on DEM (PhotoSat 2015)
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass, bushes	
Benchmark Coordinates	N/A	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined braid-like boulder channels. Cross-sectional data are available in discharge calculation sheets and Section 3.3.	



Lake A12.

6 August 2015. Upstream view from Lake A76 to Lake A12 (south).

6 August 2015. Upstream view at Lake A12 to A77 outlet (south).

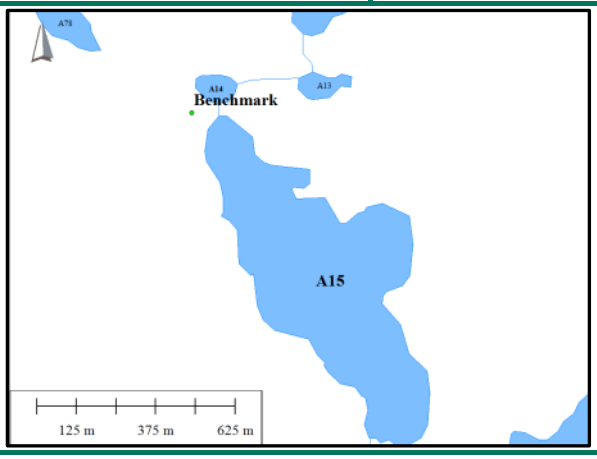
OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		Amaruq - Trip 2			**Date**		06-Aug-15
Waterbody:		A12			**Start Time**		11:20
Crossing ID:		A12-A77			**End Time**		11:45
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	602772	BM_read			**Transducer SN:**		
North	7256632	WL_read			**Meter Type/SN:**		Marsh McBirney
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN	

STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)	Qi (m3/s)	Ai (m2)
1	1.60	0.00		0.00			**0.011**
2	1.90	0.07		0.13		**0.003**	**0.074**
3	2.30	0.30		0.18		**0.030**	**0.203**
4	3.00	0.28		0.27		**0.064**	**0.235**
5	4.00	0.19		0.02		**0.003**	**0.099**
6	4.60	0.14		0.10		**0.007**	**0.052**
7	5.00	0.12		0.02		**0.003**	**0.120**
8	7.00	0.00		0.00		**0.000**	**0.000**
9	7.01	0.00		0.00		**0.000**	**0.000**
10	10.00	0.00		0.00		**0.000**	**0.002**
11	10.01	0.36		0.11		**0.010**	**0.176**
12	10.50	0.36		0.11		**0.010**	**0.002**
13	10.51	0.12		0.11		**0.003**	**0.047**
14	10.90	0.12		0.04		**0.001**	**0.001**
15	10.91	0.00		0.00		**0.000**	**0.000**

NOTES:	**RESULTS:**	**Q (m3/s)**	**0.133**
		A(m2)	**1.02**
		B(m)	**9.3**

A4.0 LAKE A15 & OUTLET (STREAM A15-A14)

Parameter	Value	Note
Drainage Area (km^2)	40.8	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	100	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.95	Measured in the field, based on vegetation
Wetted Width (m)	87.7	Measured in the field on 15 June 2015
Max. Wetted Depth (m)	0.55	Measured in the field on 15 June 2015
Channel Length (km)	0.35	Measured from CanVec data
Outlet Channel Slope (m/m)	0.002	Average slope, based on DEM (PhotoSat 2015)
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	603366 m E 7254484 m N, 153.67 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	603151 m E 7255313 m N	
Comment	Poorly defined boulder channel. During spring freshet, Lake A14 and Lake A15 have similar water elevations and may form one lake. Discharges were measured between Lake A14 and Lake A13. Cross-sectional data are available in discharge calculation sheets and Section 3.3.	



Lake A14: Benchmark location.

13 June 2015. View looking west of Lake A15 and staff gauge.

18 September 2015. View looking west of Lake 15 and staff gauge.

4 August 2015. Upstream view of the watercourse (west).

13 June 2015. Downstream view of the watercourse (east).

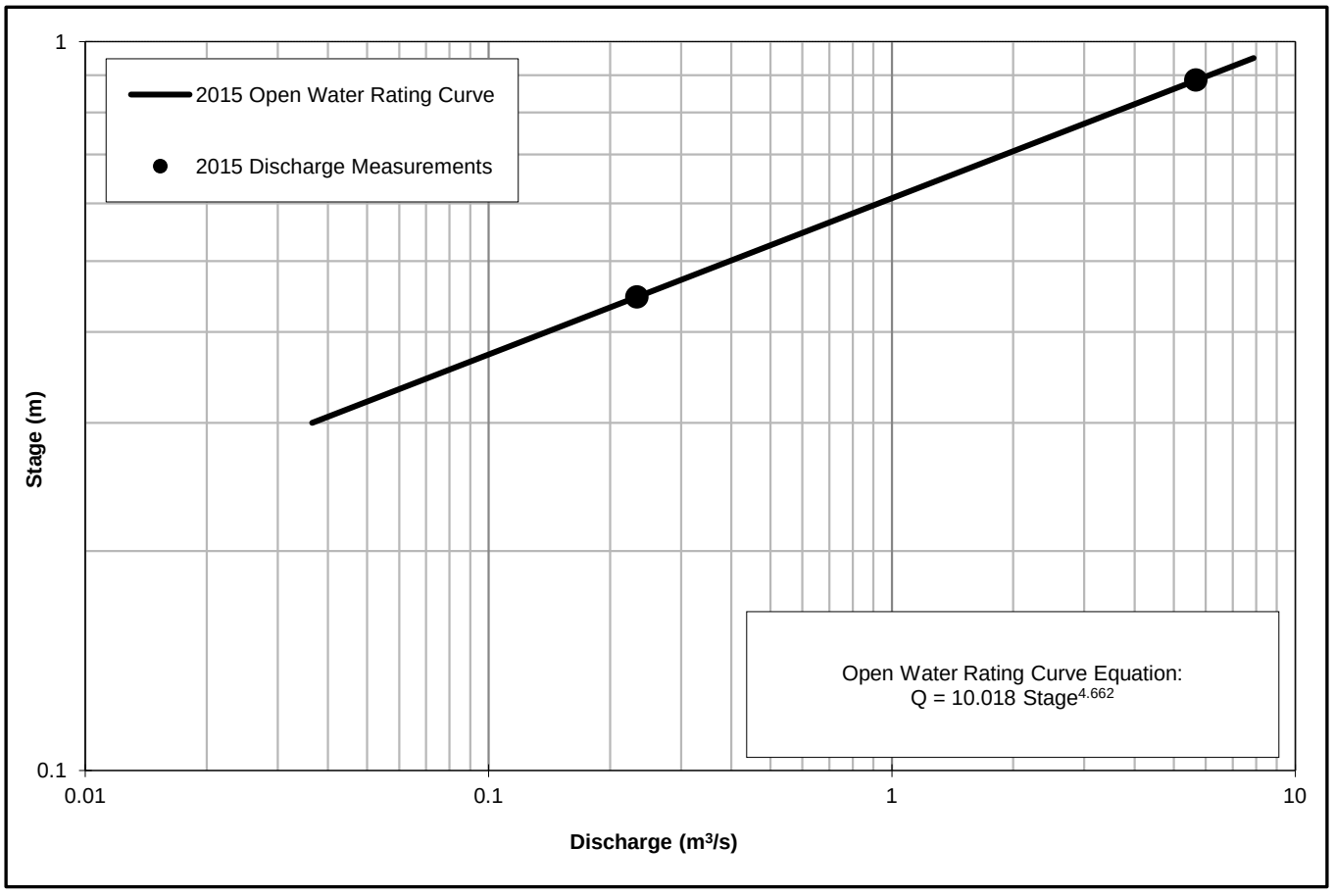


Figure 2: 2015 Stage-Discharge Rating Curve (Lake A15)

Lake A15 - 2015

MEAN DAILY DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	1.68	0.29	0.00	-	-	-
2	-	-	-	-	-	-	1.55	0.26	0.00	-	-	-
3	-	-	-	-	-	-	1.48	0.24	0.00	-	-	-
4	-	-	-	-	-	-	1.36	0.22	0.00	-	-	-
5	-	-	-	-	-	-	1.29	0.20	0.00	-	-	-
6	-	-	-	-	-	-	1.16	0.18	0.00	-	-	-
7	-	-	-	-	-	-	1.10	0.16	0.00	-	-	-
8	-	-	-	-	-	-	1.06	0.14	0.00	-	-	-
9	-	-	-	-	-	-	1.04	0.13	0.00	-	-	-
10	-	-	-	-	-	-	1.09	0.11	0.00	-	-	-
11	-	-	-	-	-	-	1.02	0.10	0.00	-	-	-
12	-	-	-	-	-	-	0.96	0.08	0.00	-	-	-
13	-	-	-	-	-	5.01 P	0.94	0.07	0.00	-	-	-
14	-	-	-	-	-	3.52	0.90	0.06	0.00	-	-	-
15	-	-	-	-	-	5.68	0.84	0.06	0.01	-	-	-
16	-	-	-	-	-	6.30	0.78	0.05	0.01	-	-	-
17	-	-	-	-	-	5.38	0.73	0.04	0.01	-	-	-
18	-	-	-	-	-	4.54	0.70	0.03	0.01 P	-	-	-
19	-	-	-	-	-	3.93	0.64	0.03	-	-	-	-
20	-	-	-	-	-	3.53	0.60	0.02	-	-	-	-
21	-	-	-	-	-	3.26	0.57	0.02	-	-	-	-
22	-	-	-	-	-	3.11	0.53	0.02	-	-	-	-
23	-	-	-	-	-	2.92	0.50	0.01	-	-	-	-
24	-	-	-	-	-	2.72	0.46	0.01	-	-	-	-
25	-	-	-	-	-	2.50	0.43	0.01	-	-	-	-
26	-	-	-	-	-	2.43	0.39	0.01	-	-	-	-
27	-	-	-	-	-	2.33	0.36	0.01	-	-	-	-
28	-	-	-	-	-	2.14	0.34	0.01	-	-	-	-
29	-	-	-	-	-	1.97	0.31	0.01	-	-	-	-
30	-	-	-	-	-	1.83	0.30	0.00	-	-	-	-
31	-	-	-	-	-	-	0.31	0.00	-	-	-	-
MIN	-	-	-	-	-	1.825	0.303	0.004	0.001	-	-	-
MEAN	-	-	-	-	-	3.506	0.821	0.083	0.003	-	-	-
MAX	-	-	-	-	-	6.296	1.685	0.286	0.010	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	7,878,483	5,452,441	2,197,845	222,881	5,316
Water Yield (mm) =	193.1	69%	28%	3%	0.05%

Lake A15 - 2015

MEAN DAILY WATER SURFACE ELEVATION (masl) BASED ON BENCHMARK ELEVATION 155.17 masl

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	151.882	151.666	151.379	-	-	-
2	-	-	-	-	-	-	151.870	151.657	151.380	-	-	-
3	-	-	-	-	-	-	151.863	151.647	151.377	-	-	-
4	-	-	-	-	-	-	151.851	151.642	151.372	-	-	-
5	-	-	-	-	-	-	151.844	151.634	151.367	-	-	-
6	-	-	-	-	-	-	151.830	151.624	151.361	-	-	-
7	-	-	-	-	-	-	151.823	151.613	151.355	-	-	-
8	-	-	-	-	-	-	151.818	151.600	151.347	-	-	-
9	-	-	-	-	-	-	151.816	151.593	151.341	-	-	-
10	-	-	-	-	-	-	151.821	151.583	151.335	-	-	-
11	-	-	-	-	-	-	151.812	151.572	151.328	-	-	-
12	-	-	-	-	-	-	151.805	151.550	151.340	-	-	-
13	-	-	-	-	-	152.061 P	151.802	151.547	151.368	-	-	-
14	-	-	-	-	-	151.999	151.797	151.539	151.386	-	-	-
15	-	-	-	-	-	152.084	151.787	151.528	151.398	-	-	-
16	-	-	-	-	-	152.105	151.778	151.514	151.409	-	-	-
17	-	-	-	-	-	152.075	151.771	151.502	151.423	-	-	-
18	-	-	-	-	-	152.044	151.764	151.492	151.428 P	-	-	-
19	-	-	-	-	-	152.018	151.755	151.482	-	-	-	-
20	-	-	-	-	-	151.999	151.747	151.472	-	-	-	-
21	-	-	-	-	-	151.986	151.740	151.462	-	-	-	-
22	-	-	-	-	-	151.978	151.732	151.451	-	-	-	-
23	-	-	-	-	-	151.968	151.725	151.442	-	-	-	-
24	-	-	-	-	-	151.956	151.717	151.434	-	-	-	-
25	-	-	-	-	-	151.943	151.708	151.425	-	-	-	-
26	-	-	-	-	-	151.938	151.697	151.419	-	-	-	-
27	-	-	-	-	-	151.931	151.690	151.413	-	-	-	-
28	-	-	-	-	-	151.918	151.683	151.405	-	-	-	-
29	-	-	-	-	-	151.905	151.676	151.400	-	-	-	-
30	-	-	-	-	-	151.894	151.672	151.395	-	-	-	-
31	-	-	-	-	-	-	151.675	151.385	-	-	-	-
MIN	-	-	-	-	-	151.894	151.672	151.385	151.328	-	-	-
MEAN	-	-	-	-	-	151.983	151.773	151.519	151.372	-	-	-
MAX	-	-	-	-	-	152.105	151.882	151.666	151.428	-	-	-

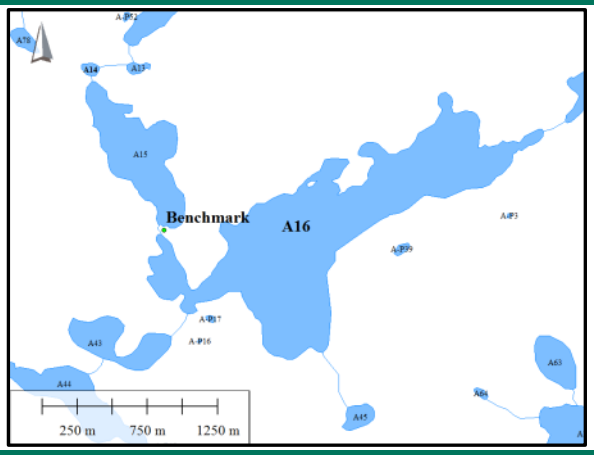
NOTES: P - PARTIAL DAILY AVERAGE

OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		1524321 - Amaruq			**Date**	15-Jun-15	
Waterbody:		A15			**Start Time**	14:10	
Crossing ID:		A14-A13			**End Time**	1520	
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	603046	BM_read			**Transducer SN:**		
North	7255689	WL_read			**Meter Type/SN:**	Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	CJ, JRL	
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)	Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00			**0.036**
2	0.60	0.12		0.27		**0.028**	**0.198**
3	1.70	0.24		0.10		**0.032**	**0.341**
4	3.25	0.20		0.03		**0.009**	**0.320**
5	4.85	0.20		0.01		**0.003**	**0.566**
6	8.75	0.09		0.04		**0.011**	**0.341**
7	10.95	0.22		0.00		**0.000**	**0.851**
8	15.55	0.15		0.25		**0.111**	**0.156**
9	16.85	0.09		0.16		**0.023**	**0.314**
10	18.75	0.24		0.09		**0.029**	**0.136**
11	19.55	0.10		0.17		**0.015**	**0.145**
12	20.55	0.19		0.07		**0.015**	**0.202**
13	21.85	0.12		0.12		**0.017**	**0.175**
14	22.85	0.23		0.23		**0.071**	**0.408**
15	24.55	0.25		0.13		**0.057**	**0.621**
16	26.35	0.44		0.08		**0.062**	**0.544**
17	28.05	0.20		0.09		**0.026**	**0.264**
18	29.25	0.24		0.08		**0.030**	**0.527**
19	31.20	0.30		0.34		**0.186**	**0.476**
20	32.90	0.26		0.36		**0.220**	**0.990**
21	35.90	0.40		0.06		**0.058**	**0.657**
22	37.70	0.33		0.20		**0.139**	**0.696**
23	40.10	0.25		0.46		**0.270**	**0.518**
24	42.40	0.20		0.36		**0.119**	**0.215**
25	43.40	0.23		0.30		**0.090**	**0.248**
26	45.00	0.08		0.45		**0.049**	**0.280**
27	46.10	0.43		0.23		**0.168**	**1.024**
28	48.40	0.46		0.21		**0.164**	**0.440**
29	49.50	0.34		0.37		**0.157**	**0.553**
30	50.90	0.45		0.37		**0.241**	**0.563**
31	52.40	0.30		0.25		**0.101**	**0.510**
32	53.60	0.55		0.56		**0.755**	**1.628**
33	57.30	0.33		0.33		**0.283**	**0.510**
34	58.80	0.35		0.65		**0.432**	**0.713**
35	61.10	0.27		0.68		**0.376**	**0.576**
36	62.90	0.37		0.30		**0.266**	**1.155**
37	65.90	0.40		0.35		**0.350**	**0.720**
38	67.90	0.32		0.26		**0.146**	**0.353**
39	69.40	0.15		0.06		**0.012**	**0.186**
40	70.60	0.16		0.32		**0.056**	**0.130**
41	71.60	0.10		0.49		**0.129**	**0.213**
42	75.85	0.00		0.00	end main channel	**0.000**	**0.000**
43	76.00	0.00		0.00	start side channel	**0.000**	**0.028**
44	76.80	0.07		0.25		**0.025**	**0.221**
45	78.90	0.14		0.48		**0.155**	**0.275**
46	81.40	0.08		0.46		**0.155**	**0.325**
47	87.30	0.03		0.42		**0.040**	**0.006**
48	87.70	0.00		0.00		**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**5.680**
						A(m2)	**20.35**
						B(m)	**87.7**

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - trip 2			**Date**		04-Aug-15	
Waterbody:		A15			**Start Time**		11:45	
Crossing ID:		A14-A13			**End Time**		12:10	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	6030112	BM_read			**Transducer SN:**			
North	7255650	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.885**
2	35.40	0.05		0.00			**0.000**	**0.015**
3	35.50	0.25		0.06			**0.002**	**0.013**
4	35.60	0.00		0.00			**0.000**	**0.000**
5	36.10	0.00		0.00			**0.000**	**0.000**
6	36.10	0.20		0.00			**0.000**	**0.020**
7	36.20	0.20		0.00			**0.000**	**0.000**
8	36.20	0.00		0.00			**0.000**	**0.000**
9	36.80	0.00		0.00			**0.000**	**0.020**
10	37.00	0.20		0.06			**0.002**	**0.020**
11	37.20	0.00		0.00			**0.000**	**0.000**
12	37.90	0.00		0.00			**0.000**	**0.009**
13	38.00	0.17		0.04			**0.004**	**0.185**
14	39.00	0.20		0.04			**0.008**	**0.210**
15	40.00	0.22		0.07			**0.015**	**0.170**
16	41.00	0.12		0.04			**0.003**	**0.012**
17	41.20	0.00		0.00			**0.000**	**0.000**
18	41.70	0.00		0.00			**0.000**	**0.024**
19	42.00	0.16		0.01			**0.001**	**0.140**
20	43.00	0.12		0.10			**0.009**	**0.030**
21	43.50	0.00		0.00			**0.000**	**0.000**
22	44.40	0.00		0.00			**0.000**	**0.105**
23	45.00	0.35		0.05			**0.007**	**0.035**
24	45.20	0.00		0.00			**0.000**	**0.000**
25	46.80	0.00		0.00			**0.000**	**0.021**
26	47.00	0.21		0.06			**0.003**	**0.021**
27	47.20	0.00		0.00			**0.000**	**0.000**
28	47.50	0.00		0.00			**0.000**	**0.053**
29	48.00	0.21		0.10			**0.016**	**0.305**
30	49.00	0.40		0.05			**0.020**	**0.345**
31	50.00	0.29		0.05			**0.015**	**0.375**
32	51.00	0.46		0.11			**0.051**	**0.380**
33	52.00	0.30		0.14			**0.032**	**0.075**
34	52.50	0.00		0.00			**0.000**	**0.000**
35	53.60	0.00		0.00			**0.000**	**0.076**
36	54.00	0.38		0.10			**0.011**	**0.043**
37	54.20	0.05		0.14			**0.004**	**0.144**
38	55.00	0.31		0.03			**0.008**	**0.300**
39	56.00	0.29		0.05			**0.015**	**0.180**
40	57.00	0.07		0.11			**0.005**	**0.010**
41	57.30	0.00		0.00			**0.000**	**0.000**
42	58.00	0.00		0.00			**0.000**	**0.003**
43	58.10	0.06		0.06			**0.000**	**0.072**
44	58.90	0.12		0.09			**0.005**	**0.006**
45	59.00	0.00		0.00			**0.000**	**0.000**
46	59.01	0.05		0.00			**0.000**	**0.650**
47	85.01	0.00		0.00			**0.000**	**0.000**
NOTES:	First and last row approximated. Depth <5cm.				**RESULTS:**	**Q (m3/s)**	**0.233**	
						A(m2)	**4.95**	
						B(m)	**85.0**	

A5.0 LAKE A16 (MAMMOTH LAKE) & OUTLET (STREAM A16-A15)

Parameter	Value	Note
Drainage Area (km^2)	38.7	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	45	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.95	Measured in the field, based on vegetation
Wetted Width (m)	39.3	Measured in the field on 13 June 2015
Max. Wetted Depth (m)	0.48	Measured in the field on 13 June 2015
Channel Length (km)	0.07	Measured from CanVec data
Outlet Channel Slope (m/m)	0.009	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	602765 m E, 7255549 m N, 155.17 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined boulder channel. Subsurface flow present. Cross-sectional data are available in discharge calculation sheets and Section 3.3.	



18 September 2015. View looking southeast towards Lake A16 and outlet.

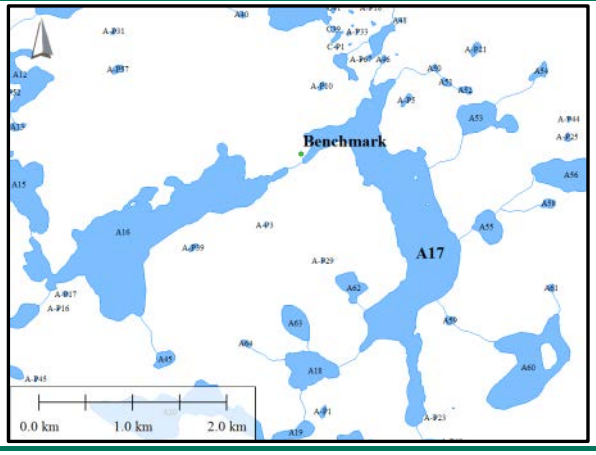
13 June 2015. Upstream view of the watercourse (south).

18 September 2015. Downstream view from watercourse towards Lake A15 (northeast).

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		154321			**Date**		13-Jun-15	
Waterbody:		A16			**Start Time**		1245	
Crossing ID:		A16-A15			**End Time**		1305	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	6023386	BM_read			**Transducer SN:**			
North	7254474	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	CJ, JRL		
STATION	DISTANCE		Velocity		Optional			
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW		Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)		(m3/s)	(m2)
1	0.00	0.00		0.00				**0.052**
2	0.80	0.13		0.05			**0.006**	**0.225**
3	1.80	0.32		0.20			**0.256**	**1.645**
4	8.80	0.15		0.11			**0.067**	**0.220**
5	9.90	0.25		0.22			**0.099**	**0.638**
6	12.40	0.26		0.40			**0.182**	**0.210**
7	13.40	0.16		0.15			**0.029**	**0.196**
8	14.80	0.12		0.42			**0.055**	**0.124**
9	15.60	0.19		0.55			**0.157**	**0.297**
10	17.80	0.08		0.40			**0.054**	**0.222**
11	19.00	0.29		0.00			**0.000**	**0.308**
12	20.40	0.15		0.35			**0.118**	**0.496**
13	23.50	0.17		0.40			**0.221**	**0.561**
14	26.90	0.16		0.36			**0.282**	**1.408**
15	33.30	0.28		0.40			**0.423**	**0.236**
16	34.45	0.13		0.42			**0.055**	**0.157**
17	35.30	0.24		0.30			**0.031**	**0.000**
18	35.30	0.09		0.11			**0.007**	**0.188**
19	36.80	0.16		0.05			**0.028**	**0.440**
20	42.30	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**2.070**	
						A(m2)	**7.62**	
						B(m)	**42.3**	

A6.0 LAKE A17 (WHALE TAIL LAKE) & OUTLET (STREAM A17-A16)

Parameter	Value	Note
Drainage Area (km^2)	28.1	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	75	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.80	Measured in the field, based on vegetation
Wetted Width (m)	75.3	Measured in the field on 14 June 2015
Max. Wetted Depth (m)	0.80	Measured in the field on 14 June 2015
Channel Length (km)	0.50	Measured from CanVec data
Outlet Channel Slope (m/m)	0.002	Average slope, measured with DEM
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	606209 m E, 7255347 m N, 156.35 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	606646 m E, 7255513 m N	
Comment	Poorly defined boulder channel. Cross-sectional data are available in discharge calculation sheets and Section 3.3.	



Lake H17: Benchmark location.

14 June 2015. View looking north at Lake A17.

7 August 2015. Upstream view of the watercourse (northwest).

14 June 2015. Downstream view of the watercourse (southwest).

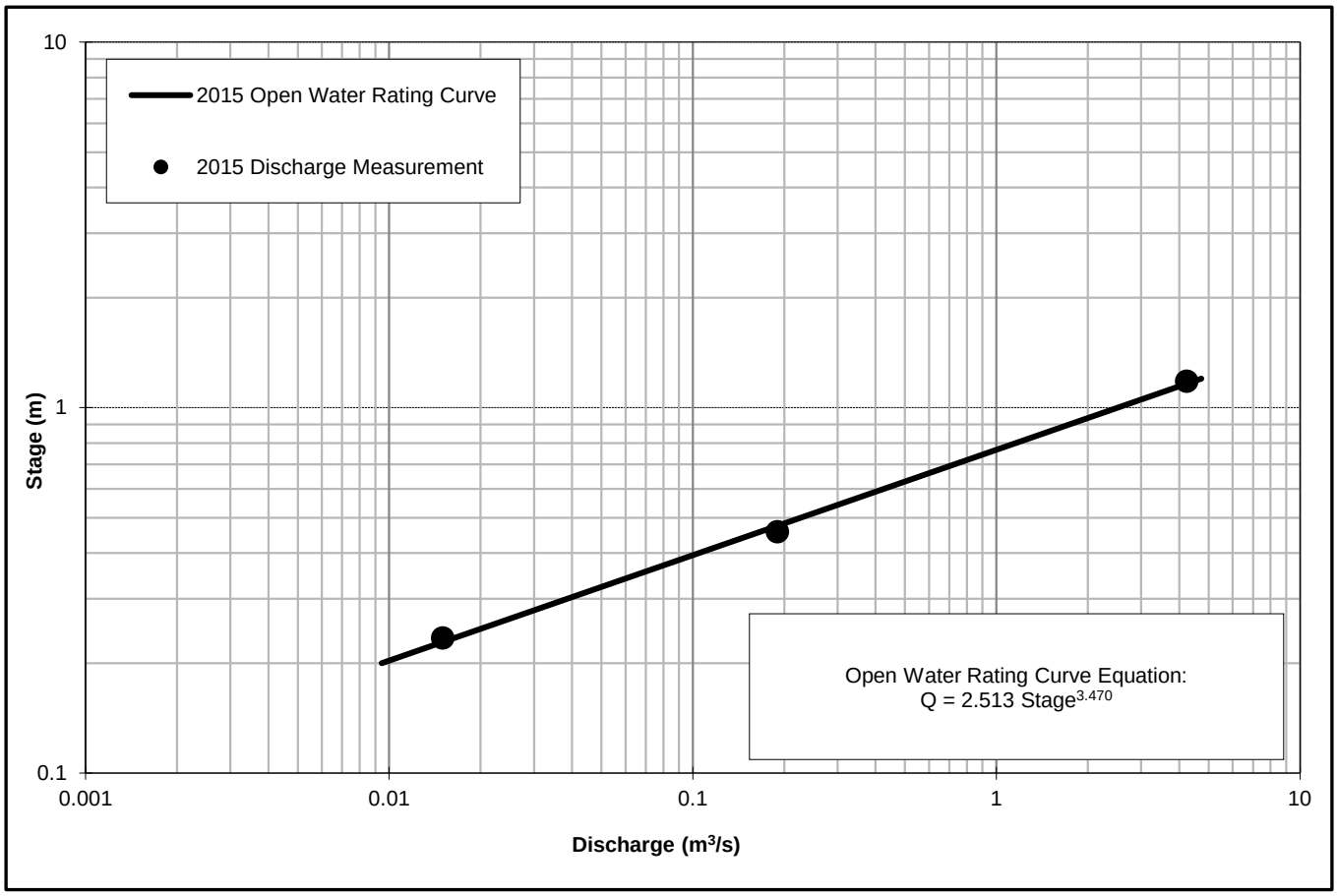


Figure 3: 2015 Stage-Discharge Rating Curve (Lake A17)

Lake A17 - 2015

MEAN DAILY DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	0.72	0.23	0.04	-	-	-
2	-	-	-	-	-	-	0.69	0.21	0.04	-	-	-
3	-	-	-	-	-	-	0.66	0.20	0.04	-	-	-
4	-	-	-	-	-	-	0.62	0.19	0.04	-	-	-
5	-	-	-	-	-	-	0.61	0.18	0.03	-	-	-
6	-	-	-	-	-	-	0.59	0.17	0.03	-	-	-
7	-	-	-	-	-	-	0.58	0.16	0.03	-	-	-
8	-	-	-	-	-	-	0.56	0.16	0.03	-	-	-
9	-	-	-	-	-	-	0.55	0.15	0.03	-	-	-
10	-	-	-	-	-	-	0.56	0.14	0.02	-	-	-
11	-	-	-	-	-	-	0.54	0.13	0.02	-	-	-
12	-	-	-	-	-	1.26 P	0.53	0.11	0.03	-	-	-
13	-	-	-	-	-	2.04	0.52	0.11	0.04	-	-	-
14	-	-	-	-	-	3.47	0.49	0.11	0.04	-	-	-
15	-	-	-	-	-	3.56	0.46	0.10	0.05	-	-	-
16	-	-	-	-	-	2.82	0.44	0.09	0.05 P	-	-	-
17	-	-	-	-	-	2.26	0.43	0.08	-	-	-	-
18	-	-	-	-	-	1.98	0.41	0.08	-	-	-	-
19	-	-	-	-	-	1.88	0.39	0.08	-	-	-	-
20	-	-	-	-	-	1.67	0.38	0.08	-	-	-	-
21	-	-	-	-	-	1.62	0.36	0.07	-	-	-	-
22	-	-	-	-	-	1.45	0.35	0.07	-	-	-	-
23	-	-	-	-	-	1.26	0.34	0.06	-	-	-	-
24	-	-	-	-	-	1.12	0.32	0.06	-	-	-	-
25	-	-	-	-	-	1.02	0.30	0.06	-	-	-	-
26	-	-	-	-	-	0.98	0.28	0.05	-	-	-	-
27	-	-	-	-	-	0.91	0.27	0.05	-	-	-	-
28	-	-	-	-	-	0.86	0.26	0.05	-	-	-	-
29	-	-	-	-	-	0.81	0.25	0.05	-	-	-	-
30	-	-	-	-	-	0.77	0.25	0.04	-	-	-	-
31	-	-	-	-	-	-	0.24	0.04	-	-	-	-
MIN	-	-	-	-	-	0.768	0.241	0.042	0.023	-	-	-
MEAN	-	-	-	-	-	1.671	0.450	0.108	0.035	-	-	-
MAX	-	-	-	-	-	3.563	0.723	0.226	0.049	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	4,285,347	2,742,373	1,205,254	289,947	47,773
Water Yield (mm) =	152.3	64%	28%	7%	1%

Lake A17 - 2015

MEAN DAILY WATER SURFACE ELEVATION (masl) BASED ON BENCHMARK ELEVATION 156.35 masl

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	152.898	152.699	152.502	-	-	-
2	-	-	-	-	-	-	152.888	152.688	152.500	-	-	-
3	-	-	-	-	-	-	152.880	152.681	152.498	-	-	-
4	-	-	-	-	-	-	152.869	152.676	152.493	-	-	-
5	-	-	-	-	-	-	152.863	152.670	152.489	-	-	-
6	-	-	-	-	-	-	152.860	152.663	152.483	-	-	-
7	-	-	-	-	-	-	152.854	152.656	152.479	-	-	-
8	-	-	-	-	-	-	152.848	152.650	152.472	-	-	-
9	-	-	-	-	-	-	152.846	152.640	152.467	-	-	-
10	-	-	-	-	-	-	152.848	152.634	152.463	-	-	-
11	-	-	-	-	-	-	152.843	152.626	152.457	-	-	-
12	-	-	-	-	-	153.018 P	152.840	152.611	152.479	-	-	-
13	-	-	-	-	-	153.138	152.834	152.608	152.498	-	-	-
14	-	-	-	-	-	153.296	152.825	152.602	152.508	-	-	-
15	-	-	-	-	-	153.305	152.815	152.595	152.517	-	-	-
16	-	-	-	-	-	153.233	152.806	152.585	152.522 P	-	-	-
17	-	-	-	-	-	153.169	152.801	152.577	-	-	-	-
18	-	-	-	-	-	153.133	152.793	152.572	-	-	-	-
19	-	-	-	-	-	153.119	152.784	152.568	-	-	-	-
20	-	-	-	-	-	153.089	152.778	152.566	-	-	-	-
21	-	-	-	-	-	153.081	152.771	152.557	-	-	-	-
22	-	-	-	-	-	153.054	152.767	152.549	-	-	-	-
23	-	-	-	-	-	153.020	152.761	152.544	-	-	-	-
24	-	-	-	-	-	152.992	152.752	152.538	-	-	-	-
25	-	-	-	-	-	152.970	152.739	152.533	-	-	-	-
26	-	-	-	-	-	152.962	152.731	152.527	-	-	-	-
27	-	-	-	-	-	152.947	152.726	152.522	-	-	-	-
28	-	-	-	-	-	152.933	152.722	152.518	-	-	-	-
29	-	-	-	-	-	152.922	152.716	152.517	-	-	-	-
30	-	-	-	-	-	152.911	152.712	152.513	-	-	-	-
31	-	-	-	-	-	-	152.709	152.508	-	-	-	-
MIN	-	-	-	-	-	152.922	152.709	152.508	152.457	-	-	-
MEAN	-	-	-	-	-	153.060	152.803	152.593	152.489	-	-	-
MAX	-	-	-	-	-	153.305	152.898	152.699	152.522	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

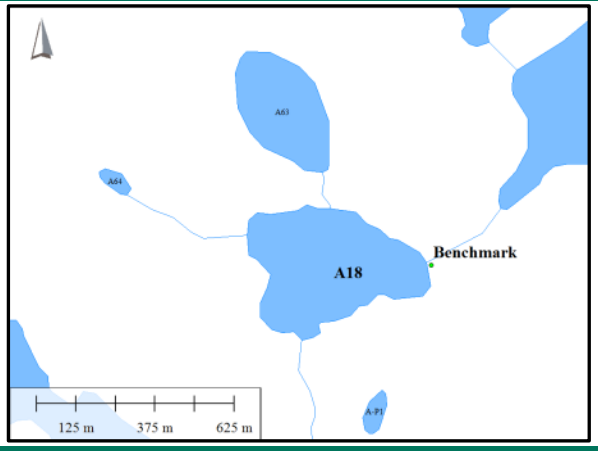
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - 154321			**Date**		14-Jun-15	
Waterbody:		A17			**Start Time**		1538	
Crossing ID:		A17-A16			**End Time**		1613	
LDB UTM Location					**Datalogger SN:**			
East	606273	BM_read			**Transducer SN:**			
North	7255251	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	CJ, JRL		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	2.50	0.00		0.00				**0.018**
2	3.00	0.07		0.01			**0.000**	**0.063**
3	3.60	0.14		0.01			**0.001**	**0.171**
4	4.50	0.24		0.10			**0.023**	**0.300**
5	5.50	0.36		0.14			**0.050**	**0.370**
6	6.50	0.38		0.11			**0.063**	**0.830**
7	8.50	0.45		0.22			**0.149**	**0.325**
8	9.50	0.20		0.24			**0.048**	**0.335**
9	10.50	0.47		0.18			**0.085**	**0.485**
10	11.50	0.50		0.27			**0.135**	**0.485**
11	12.50	0.47		0.26			**0.122**	**0.475**
12	13.50	0.48		0.22			**0.106**	**0.485**
13	14.50	0.49		0.30			**0.147**	**0.465**
14	15.50	0.44		0.38			**0.167**	**0.450**
15	16.50	0.46		0.28			**0.129**	**0.530**
16	17.50	0.60		0.34			**0.204**	**0.620**
17	18.50	0.64		0.26			**0.166**	**0.685**
18	19.50	0.73		0.31			**0.226**	**0.720**
19	20.50	0.71		0.35			**0.249**	**0.685**
20	21.50	0.66		0.36			**0.238**	**0.705**
21	22.50	0.75		0.31			**0.233**	**0.745**
22	23.50	0.74		0.31			**0.229**	**0.720**
23	24.50	0.70		0.31			**0.217**	**0.715**
24	25.50	0.73		0.41			**0.299**	**0.715**
25	26.50	0.70		0.33			**0.231**	**0.665**
26	27.50	0.63		0.45			**0.284**	**0.615**
27	28.50	0.60		0.38			**0.228**	**0.585**
28	29.50	0.57		0.36			**0.205**	**0.555**
29	30.50	0.54		0.00			**0.000**	**0.135**
30	31.00	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**4.233**	
						A(m2)	**14.65**	
						B(m)	**28.5**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		07-Aug-15	
Waterbody:		A17 (Whale Tail Lake)			**Start Time**		8:35	
Crossing ID:		A17-A15			**End Time**		8:55	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606301	BM_read			**Transducer SN:**			
North	7255289	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.05		0.00				**0.240**
2	3.00	0.11		0.01			**0.003**	**0.364**
3	5.80	0.15		0.01			**0.005**	**0.624**
4	9.00	0.24		0.01			**0.007**	**0.870**
5	12.00	0.34		0.00			**0.000**	**0.810**
6	15.00	0.20		0.00			**0.000**	**0.528**
7	17.40	0.24		0.01			**0.007**	**0.576**
8	21.00	0.08		0.00			**0.000**	**0.120**
9	24.00	0.00		0.00			**0.000**	**0.065**
10	25.30	0.10		0.00			**0.000**	**0.323**
11	27.00	0.28		0.01			**0.007**	**0.555**
12	30.00	0.09		0.00			**0.000**	**0.451**
13	32.65	0.25		0.00			**0.000**	**0.504**
14	34.75	0.23		0.00			**0.000**	**0.570**
15	36.75	0.34		0.01			**0.009**	**1.500**
16	39.75	0.66		0.02			**0.040**	**1.845**
17	42.75	0.57		0.01			**0.017**	**1.470**
18	45.75	0.41		0.05			**0.062**	**1.440**
19	48.75	0.55		0.01			**0.017**	**1.335**
20	51.75	0.34		0.00			**0.000**	**0.810**
21	54.75	0.20		0.03			**0.018**	**0.450**
22	57.75	0.10		0.00			**0.000**	**0.450**
23	62.25	0.10		0.00			**0.000**	**3.113**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.190**	
						A(m2)	**19.01**	
						B(m)	**62.3**	

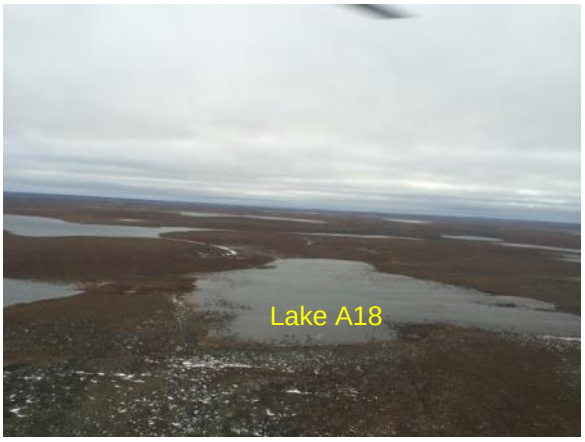
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		16-Sep-15	
Waterbody:		A17			**Start Time**		17:00	
Crossing ID:		A17-A16			**End Time**		17:25	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606189	BM_read			**Transducer SN:**			
North	7255256	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.012**
2	0.30	0.08		0.04			**0.001**	**0.013**
3	0.50	0.05		0.05			**0.001**	**0.005**
4	0.70	0.00		0.00			**0.000**	**0.002**
5	0.90	0.02		0.02			**0.000**	**0.001**
6	1.00	0.00		0.00			**0.000**	**0.000**
7	1.00	0.05		0.10			**0.001**	**0.020**
8	1.40	0.05		0.10			**0.001**	**0.000**
9	1.41	0.00		0.00			**0.000**	**0.000**
10	1.41	0.06		0.09			**0.001**	**0.030**
11	1.91	0.06		0.09			**0.001**	**0.000**
12	1.92	0.00		0.00			**0.000**	**0.000**
13	1.92	0.06		0.04			**0.000**	**0.018**
14	2.22	0.06		0.04			**0.000**	**0.000**
15	2.23	0.00		0.00			**0.000**	**0.000**
16	2.23	0.10		0.09			**0.001**	**0.030**
17	2.53	0.10		0.09			**0.001**	**0.000**
18	2.54	0.00		0.00			**0.000**	**0.000**
19	2.54	0.10		0.06			**0.001**	**0.040**
20	2.94	0.10		0.06			**0.001**	**0.001**
21	2.95	0.00		0.00			**0.000**	**0.000**
NOTES:	Discharge measurement was separated into sections that contained flow. In some cases, sections were estimated as an average depth and velocity. Therefore, the distance from LDB, A and B values are not applicable to this measurement. 20-40% of flow not measurable between boulders.				**RESULTS:**	**Q (m3/s)**	**0.012**	
						A(m2)	**0.17**	
						B(m)	**3.0**	

A7.0 LAKE A18 & OUTLET (STREAM A18-A17)

Parameter	Value	Note
Drainage Area (km^2)	8.9	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	45	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.6	Measured in the field, based on vegetation
Wetted Width (m)	50	Measured in the field on 14 June 2015
Max. Wetted Depth (m)	0.56	Measured in the field on 14 June 2015
Channel Length (km)	0.35	Measured from Canvec data
Outlet Channel Slope (m/m)	0.004	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass, bushes	
Benchmark Coordinates	606615 m E, 7253064 m N, 154.60 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	606599 m E, 7253067 m N	
Comment	Poorly defined boulder channel. Cross-sectional data are available in discharge calculation sheets and Section 3.3.	



Lake A18: Benchmark location.



17 September 2015. View looking east at Lake A18.

7 August 2015. Upstream view of the watercourse and Lake (southwest).

16 September 2015. Downstream view of the watercourse (north).

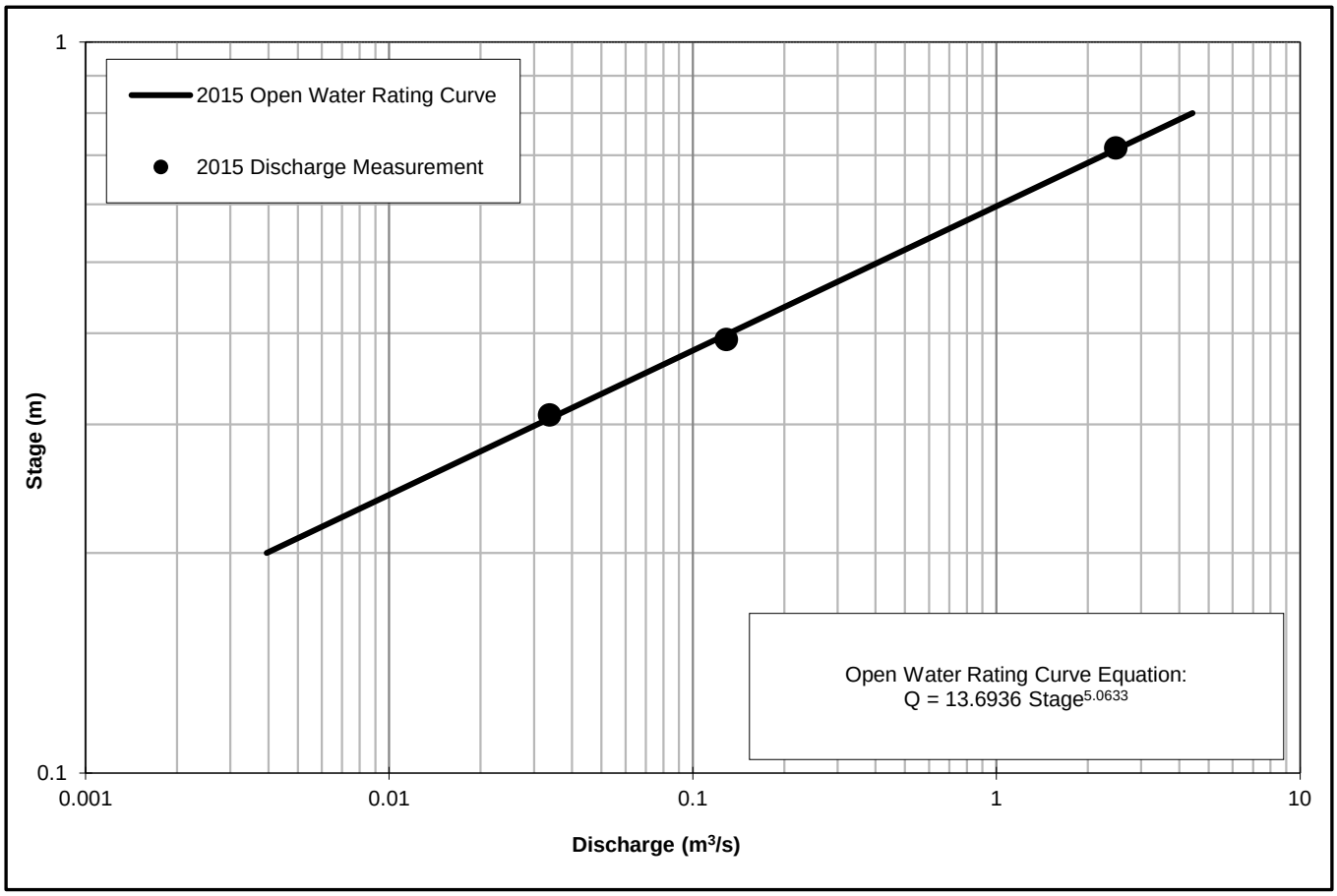


Figure 4: 2015 Stage-Discharge Rating Curve (Lake A18)

Lake A18 - 2015

MEAN DAILY DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	0.36	0.11	0.01	-	-	-
2	-	-	-	-	-	-	0.34	0.10	0.01	-	-	-
3	-	-	-	-	-	-	0.33	0.10	0.01	-	-	-
4	-	-	-	-	-	-	0.30	0.10	0.01	-	-	-
5	-	-	-	-	-	-	0.29	0.10	0.01	-	-	-
6	-	-	-	-	-	-	0.29	0.10	0.01	-	-	-
7	-	-	-	-	-	-	0.28	0.09	0.01	-	-	-
8	-	-	-	-	-	-	0.27	0.08	0.01	-	-	-
9	-	-	-	-	-	-	0.27	0.07	0.01	-	-	-
10	-	-	-	-	-	-	0.29	0.07	0.01	-	-	-
11	-	-	-	-	-	1.45 P	0.29	0.06	0.01	-	-	-
12	-	-	-	-	-	0.92	0.28	0.06	0.01	-	-	-
13	-	-	-	-	-	2.18	0.28	0.05	0.02	-	-	-
14	-	-	-	-	-	2.25	0.27	0.05	0.03	-	-	-
15	-	-	-	-	-	1.62	0.27	0.05	0.03 P	-	-	-
16	-	-	-	-	-	1.24	0.26	0.04	-	-	-	-
17	-	-	-	-	-	1.01	0.25	0.04	-	-	-	-
18	-	-	-	-	-	0.85	0.24	0.04	-	-	-	-
19	-	-	-	-	-	0.74	0.23	0.04	-	-	-	-
20	-	-	-	-	-	0.68	0.22	0.03	-	-	-	-
21	-	-	-	-	-	0.67	0.22	0.03	-	-	-	-
22	-	-	-	-	-	0.63	0.21	0.03	-	-	-	-
23	-	-	-	-	-	0.57	0.19	0.03	-	-	-	-
24	-	-	-	-	-	0.56	0.17	0.02	-	-	-	-
25	-	-	-	-	-	0.54	0.17	0.02	-	-	-	-
26	-	-	-	-	-	0.53	0.17	0.02	-	-	-	-
27	-	-	-	-	-	0.49	0.16	0.02	-	-	-	-
28	-	-	-	-	-	0.46	0.16	0.02	-	-	-	-
29	-	-	-	-	-	0.43	0.14	0.02	-	-	-	-
30	-	-	-	-	-	0.40	0.14	0.02	-	-	-	-
31	-	-	-	-	-	-	0.13	0.01	-	-	-	-
MIN	-	-	-	-	-	0.398	0.130	0.014	0.008	-	-	-
MEAN	-	-	-	-	-	0.911	0.240	0.052	0.015	-	-	-
MAX	-	-	-	-	-	2.249	0.362	0.115	0.029	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	2,376,562	1,574,018	643,735	139,983	18,826
Water Yield (mm) =	267.2	66%	27%	6%	1%

Lake A18 - 2015

MEAN DAILY WATER SURFACE ELEVATION (masl) BASED ON BENCHMARK ELEVATION 154.60 masl

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	153.988	153.889	153.757	-	-	-
2	-	-	-	-	-	-	153.981	153.882	153.758	-	-	-
3	-	-	-	-	-	-	153.978	153.880	153.757	-	-	-
4	-	-	-	-	-	-	153.970	153.880	153.753	-	-	-
5	-	-	-	-	-	-	153.967	153.880	153.751	-	-	-
6	-	-	-	-	-	-	153.967	153.876	153.747	-	-	-
7	-	-	-	-	-	-	153.963	153.869	153.742	-	-	-
8	-	-	-	-	-	-	153.959	153.861	153.738	-	-	-
9	-	-	-	-	-	-	153.961	153.854	153.734	-	-	-
10	-	-	-	-	-	-	153.968	153.852	153.731	-	-	-
11	-	-	-	-	-	154.142 P	153.966	153.844	153.727	-	-	-
12	-	-	-	-	-	154.086	153.965	153.837	153.751	-	-	-
13	-	-	-	-	-	154.183	153.964	153.834	153.787	-	-	-
14	-	-	-	-	-	154.199	153.962	153.829	153.793	-	-	-
15	-	-	-	-	-	154.155	153.959	153.825	153.797 P	-	-	-
16	-	-	-	-	-	154.122	153.957	153.819	-	-	-	-
17	-	-	-	-	-	154.098	153.954	153.815	-	-	-	-
18	-	-	-	-	-	154.078	153.949	153.812	-	-	-	-
19	-	-	-	-	-	154.062	153.945	153.808	-	-	-	-
20	-	-	-	-	-	154.053	153.944	153.803	-	-	-	-
21	-	-	-	-	-	154.051	153.941	153.798	-	-	-	-
22	-	-	-	-	-	154.045	153.937	153.794	-	-	-	-
23	-	-	-	-	-	154.034	153.930	153.791	-	-	-	-
24	-	-	-	-	-	154.031	153.920	153.786	-	-	-	-
25	-	-	-	-	-	154.029	153.919	153.782	-	-	-	-
26	-	-	-	-	-	154.027	153.919	153.778	-	-	-	-
27	-	-	-	-	-	154.018	153.916	153.775	-	-	-	-
28	-	-	-	-	-	154.011	153.913	153.772	-	-	-	-
29	-	-	-	-	-	154.005	153.907	153.768	-	-	-	-
30	-	-	-	-	-	153.997	153.904	153.765	-	-	-	-
31	-	-	-	-	-	-	153.898	153.755	-	-	-	-
MIN	-	-	-	-	-	153.997	153.898	153.755	153.727	-	-	-
MEAN	-	-	-	-	-	154.067	153.947	153.823	153.755	-	-	-
MAX	-	-	-	-	-	154.199	153.988	153.889	153.797	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

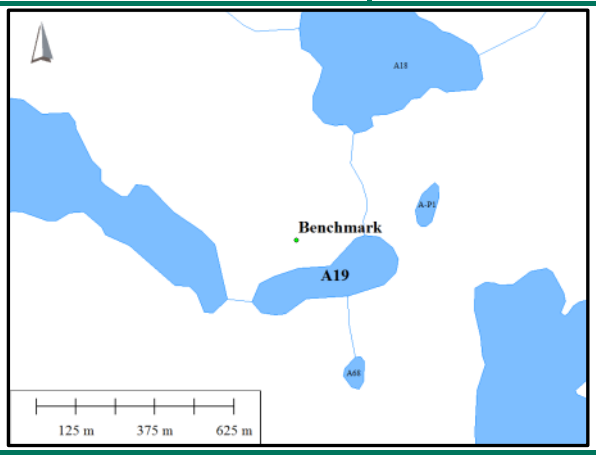
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - 154321			**Date**		14-Jun-15	
Waterbody:		A18			**Start Time**		1148	
Crossing ID:		A18-A17			**End Time**		1213	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606650	BM_read			**Transducer SN:**			
North	7253107	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	CJ, JRL		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	3.00	0.00		0.00				**0.072**
2	3.60	0.24		0.20			**0.055**	**0.519**
3	5.30	0.37		0.12			**0.062**	**0.309**
4	6.40	0.19		0.10			**0.034**	**0.442**
5	8.85	0.17		0.08			**0.027**	**0.256**
6	10.40	0.16		0.23			**0.056**	**0.263**
7	11.90	0.19		0.34			**0.126**	**0.648**
8	14.30	0.35		0.65			**0.489**	**0.599**
9	16.20	0.28		0.44			**0.253**	**0.649**
10	18.40	0.31		0.50			**0.357**	**0.768**
11	20.80	0.33		0.16			**0.092**	**0.302**
12	21.90	0.22		0.41			**0.153**	**0.621**
13	24.20	0.32		0.30			**0.163**	**0.308**
14	25.30	0.24		0.10			**0.037**	**0.340**
15	27.30	0.10		0.37			**0.085**	**0.533**
16	29.90	0.31		0.21			**0.153**	**0.536**
17	32.00	0.20		0.16			**0.077**	**0.581**
18	34.70	0.23		0.19			**0.098**	**0.450**
19	36.50	0.27		0.14			**0.089**	**0.725**
20	39.40	0.23		0.10			**0.054**	**0.387**
21	41.20	0.20		0.04			**0.011**	**0.185**
22	42.20	0.17		0.01			**0.003**	**0.196**
23	44.50	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**2.475**	
						A(m2)	**9.69**	
						B(m)	**41.5**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - trip 2			**Date**		04-Aug-15	
Waterbody:		A18			**Start Time**		13:20	
Crossing ID:		A18-A17			**End Time**		13:45	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606637	BM_read			**Transducer SN:**			
North	7253084	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.000**
2	3.00	0.00		0.00			**0.000**	**0.018**
3	4.20	0.03		0.00			**0.000**	**0.033**
4	5.30	0.03		0.00			**0.000**	**0.198**
5	7.10	0.19		0.08			**0.015**	**0.019**
6	7.30	0		0.00			**0.000**	**0.055**
7	8.40	0.1		0.00			**0.000**	**0.125**
8	10.90	0		0.00			**0.000**	**0.006**
9	11.00	0.12		0.12			**0.013**	**0.255**
10	12.70	0.18		0.02			**0.005**	**0.112**
11	13.50	0.1		0.04			**0.007**	**0.336**
12	16.30	0.14		0.08			**0.020**	**0.091**
13	17.00	0.12		0.21			**0.014**	**0.046**
14	17.40	0.11		0.07			**0.007**	**0.158**
15	18.90	0.1		0.07			**0.009**	**0.132**
16	20.00	0.14		0.03			**0.006**	**0.221**
17	21.70	0.12		0.11			**0.030**	**0.280**
18	24.50	0.08		0.03			**0.004**	**0.020**
19	25.00	0		0.00			**0.000**	**0.000**
20	37.00	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.129**	
						A(m2)	**2.10**	
						B(m)	**37.0**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		16-Sep-15	
Waterbody:		A18			**Start Time**		16:10	
Crossing ID:		A18-A17			**End Time**		16:20	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606635	BM_read			**Transducer SN:**			
North	7253081	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.03		0.01				**0.009**
2	0.30	0.03		0.01			**0.000**	**0.000**
3	0.31	0.00		0.00			**0.000**	**0.000**
4	0.31	0.01		0.02			**0.000**	**0.005**
5	0.81	0.01		0.02			**0.000**	**0.000**
6	0.82	0.00		0.00			**0.000**	**0.000**
7	0.82	0.10		0.02			**0.001**	**0.085**
8	1.67	0.10		0.02			**0.001**	**0.001**
9	1.68	0.00		0.00			**0.000**	**0.000**
10	1.68	0.12		0.02			**0.001**	**0.096**
11	2.48	0.12		0.02			**0.001**	**0.001**
12	2.49	0.00		0.00			**0.000**	**0.000**
NOTES:	Discharge measurement was separated into sections that contained flow. In some cases, sections were estimated as an average depth and velocity. Therefore, the distance from LDB, A and B values are not applicable to this measurement.				**RESULTS:**	**Q (m3/s)**	**0.004**	
						A(m2)	**0.20**	
						B(m)	**2.5**	

A8.0 LAKE A19 & OUTLET (STREAM A19-A18)

Parameter	Value	Note
Drainage Area (km^2)	7.4	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	N/A	
Max. Bankfull Depth (m)	N/A	
Wetted Width (m)	0	Observed no flow in field 8 August 2015
Max. Wetted Depth (m)	0	Observed no flow in field 8 August 2015
Channel Length (km)	0.35	Measured from CanVec data
Outlet Channel Slope (m/m)	0.004	Not measured in the field or covered by DEM
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	606023 m E, 7252491 m N, 157.51 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Boulder channel. No observed flow in August 2015.	

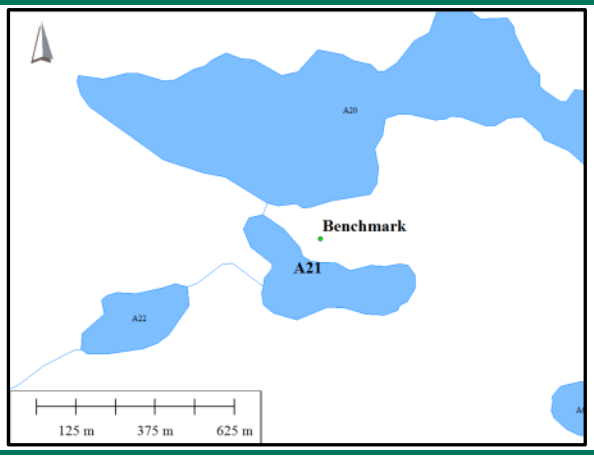


Lake A19: Benchmark location.

8 August 2015. Looking northwest at Lake A18.

A9.0 LAKE A21 & OUTLET (STREAM A21-A20)

Parameter	Value	Note
Drainage Area (km^2)	5.1	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	20	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.45	Measured in the field, based on vegetation
Wetted Width (m)	17.3	Measured in the field 3 August 2015
Max. Wetted Depth (m)	0.32	Measured in the field 3 August 2015
Channel Length (km)	0.05	Measured from CanVec data
Outlet Channel Slope (m/m)	0.001	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	604715 m E, 7252196 m N, 155.95 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined boulder channel. Cross-sectional data are available in discharge calculation sheets.	



Lake A21: Benchmark location.

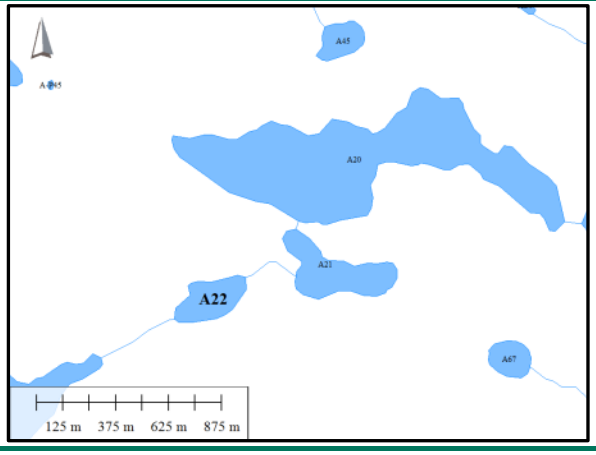
8 August 2015. Downstream view of the watercourse (north).

8 August 2015. View looking east of the watercourse.

OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		Amaruq - trip 2			**Date**	06-Aug-15	
Waterbody:		A21			**Start Time**	14:00	
Crossing ID:		A21-A20			**End Time**	14:25	
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	604557	BM_read			**Transducer SN:**		
North	7252299	WL_read			**Meter Type/SN:**	Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN	
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)	Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00			**0.048**
2	0.40	0.24		0.00		**0.000**	**0.042**
3	0.70	0.04		0.00		**0.000**	**0.041**
4	1.60	0.05		0.01		**0.001**	**0.096**
5	2.80	0.11		0.02		**0.002**	**0.017**
6	3.10	0.00		0.00		**0.000**	**0.000**
7	9.30	0.00		0.00		**0.000**	**0.015**
8	9.60	0.10		0.00		**0.000**	**0.120**
9	10.80	0.10		0.00		**0.000**	**0.100**
10	12.80	0.00		0.00		**0.000**	**0.000**
11	13.50	0.00		0.00		**0.000**	**0.076**
12	14.30	0.19		0.02		**0.003**	**0.255**
13	15.30	0.32		0.02		**0.010**	**0.580**
14	17.30	0.26		0.00		**0.000**	**0.001**
15	17.29	0.00		0.00		**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.015**
						A(m2)	**1.39**
						B(m)	**17.3**

A10.0 LAKE A22 & OUTLET (STREAM A22-A21)

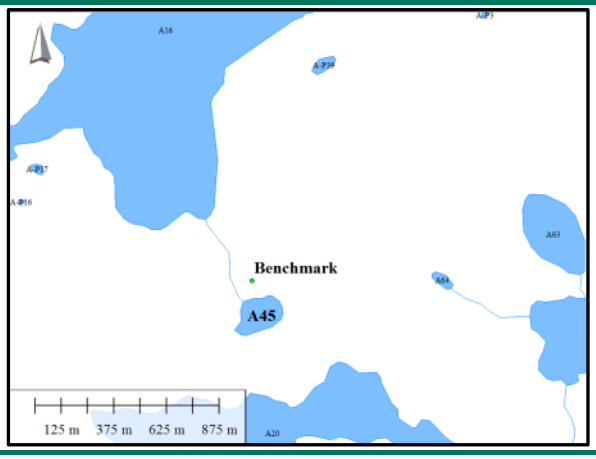
Parameter	Value	Note
Drainage Area (km^2)	4.0	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	N/A	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	N/A	Measured in the field, based on vegetation
Wetted Width (m)	0	Observed in the field 3 August 2015
Max. Wetted Depth (m)	0	Observed in the field 3 August 2015
Channel Length (km)	0.3	Measured from CanVec data
Outlet Channel Slope (m/m)	0.001	Not measured in the field or covered by DEM
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	N/A	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined boulder channel. No observed flow in August 2015.	



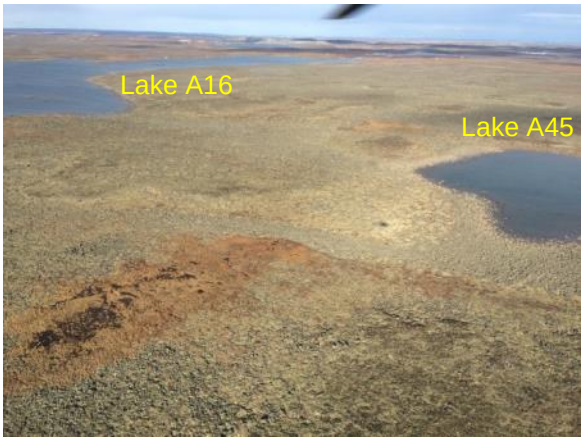
Lake A22.

A11.0 LAKE A45 & OUTLET (STREAM A45-A16)

Parameter	Value	Note
Drainage Area (km^2)	0.2	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	35	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	N/A	Not measureable; deep boulder garden
Wetted Width (m)	0	Observed no surface flow in field 8 August 2015
Max. Wetted Depth (m)	0	Observed no surface flow in field 8 August 2015
Channel Length (km)	0.45	Measured from CanVec data
Outlet Channel Slope (m/m)	0.009	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	604716 m E, 7253325 m N, 159.66 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Deep boulder garden channel with predominantly subsurface flows especially later in the open water season. Cross-sectional data are available in Section 3.3.	



Lake A45: Benchmark location.

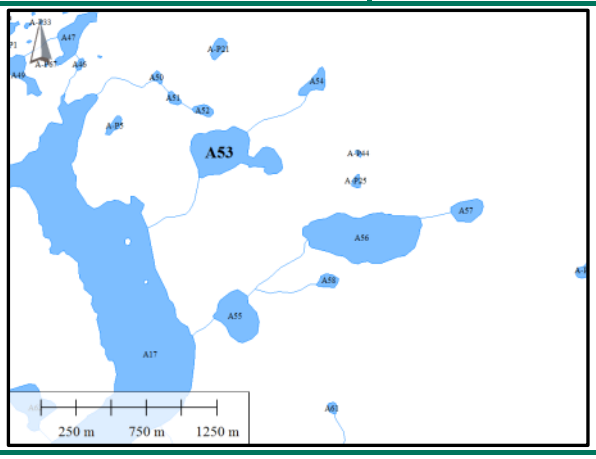


19 September 2015. View looking north towards Lake A45 (right) and outlet.

8 August 2015. Upstream view of outlet to Lake A45 (southeast).

A12.0 LAKE A53 & OUTLET (STREAM A53-A17)

Parameter	Value	Note
Drainage Area (km^2)	1.3	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	N/A	Poorly defined channel, no visible bankfull dimensions
Max. Bankfull Depth (m)	N/A	Poorly defined channel, no visible bankfull dimensions
Wetted Width (m)	3.5	Measured in the field on 6 August 2015
Max. Wetted Depth (m)	0.16	Measured in the field on 6 August 2015
Channel Length (km)	0.60	Measured from CanVec data
Outlet Channel Slope (m/m)	0.017	Average slope, measured in the field
Bed Material	Cobbles, sand, silt, organics	
Bank Material	Grass, sand, silt, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	N/A	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Well defined channel, with a high width to depth ratio. Cross-sectional data are available in discharge calculation sheets.	



Lake A53.

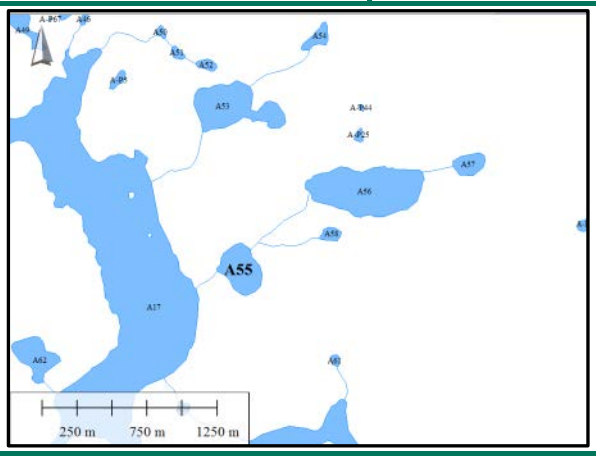
7 August 2015. Upstream view of the watercourse (north).

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq			**Date**		12-Jul-15	
Waterbody:		A53			**Start Time**		11:30	
Crossing ID:		A53-A17			**End Time**			
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	607754	BM_read			**Transducer SN:**			
North	725526	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	AEM: RV, RD, JM		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.008**
2	0.20	0.08		0.35			**0.005**	**0.018**
3	0.40	0.10		0.33			**0.007**	**0.021**
4	0.60	0.11		0.33			**0.007**	**0.031**
5	0.80	0.20		0.70			**0.028**	**0.037**
6	1.00	0.17		0.01			**0.000**	**0.016**
7	1.10	0.15		0.00			**0.000**	**0.015**
8	1.20	0.14		0.02			**0.000**	**0.028**
9	1.40	0.14		0.00			**0.000**	**0.025**
10	1.75	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.048**	
						A(m2)	**0.20**	
						B(m)	**1.8**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		07-Aug-15	
Waterbody:		A53			**Start Time**		9:00	
Crossing ID:		A53-A17			**End Time**		9:20	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	607914	BM_read			**Transducer SN:**			
North	7255484	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.08		0.00				**0.090**
2	1.00	0.10		0.00			**0.000**	**0.132**
3	2.10	0.14		0.01			**0.001**	**0.030**
4	2.30	0.16		0.04			**0.001**	**0.032**
5	2.50	0.16		0.04			**0.002**	**0.042**
6	2.80	0.12		0.03			**0.001**	**0.022**
7	3.00	0.10		0.02			**0.001**	**0.027**
8	3.30	0.08		0.00			**0.000**	**0.008**
9	3.50	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.005**	
						A(m2)	**0.38**	
						B(m)	**3.5**	

A13.0 LAKE A55 & OUTLET (STREAM A55-A17)

Parameter	Value	Note
Drainage Area (km^2)	4.2	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	15	No visible bankfull dimensions
Max. Bankfull Depth (m)	0.3	No visible bankfull dimensions
Wetted Width (m)	8.9	Measured in the field 7 August 2015
Max. Wetted Depth (m)	0.14	Measured in the field 7 August 2015
Channel Length (km)	0.23	Measured from CanVec data
Outlet Channel Slope (m/m)	0.011	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	N/A	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Well defined channel. Cross-sectional data are available in discharge calculation sheets.	



Lake A55.

17 September 2015. Aerial view looking north towards Lake A55 (right) and Lake A17 (Whale Tail Lake) (left)

17 September 2015. Upstream view of the watercourse and Lake A55 (northeast).

17 September 2015. Downstream view of the watercourse (southwest).

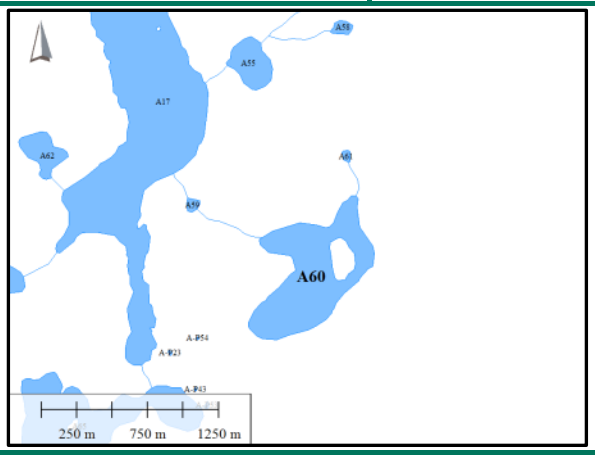
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq			**Date**		12-Jul-15	
Waterbody:		A55			**Start Time**		11:00	
Crossing ID:		A55-A17			**End Time**		11:10	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	607990	BM_read			**Transducer SN:**			
North	7254505	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	AEM: RV, LG		
STATION	DISTANCE		Velocity		Optional			
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW		Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)		(m3/s)	(m2)
1	0.00	0.00		0.00				**0.030**
2	0.50	0.12		0.01			**0.000**	**0.063**
3	1.00	0.13		0.00			**0.000**	**0.063**
4	1.50	0.12		0.00			**0.000**	**0.065**
5	2.00	0.14		0.19			**0.013**	**0.070**
6	2.50	0.14		0.19			**0.013**	**0.068**
7	3.00	0.13		0.20			**0.013**	**0.068**
8	3.50	0.14		0.27			**0.019**	**0.070**
9	4.00	0.14		0.24			**0.017**	**0.066**
10	4.50	0.13		0.36			**0.023**	**0.051**
11	5.00	0.08		0.28			**0.011**	**0.020**
12	5.50	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.110**	
						A(m2)	**0.63**	
						B(m)	**5.5**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		07-Aug-15	
Waterbody:		A55			**Start Time**		15:30	
Crossing ID:		A55-A17			**End Time**		15:50	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	608009	BM_read			**Transducer SN:**			
North	7254529	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.60	0.00		0.00				**0.017**
2	0.90	0.11		0.00			**0.000**	**0.038**
3	1.20	0.14		0.05			**0.003**	**0.081**
4	1.80	0.13		0.06			**0.004**	**0.020**
5	2.10	0.00		0.00			**0.000**	**0.012**
6	2.30	0.12		0.06			**0.005**	**0.143**
7	3.60	0.10		0.02			**0.002**	**0.099**
8	4.50	0.12		0.05			**0.004**	**0.060**
9	5.00	0.12		0.00			**0.000**	**0.070**
10	5.70	0.08		0.01			**0.002**	**0.152**
11	9.50	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.020**	
						A(m2)	**0.69**	
						B(m)	**8.9**	

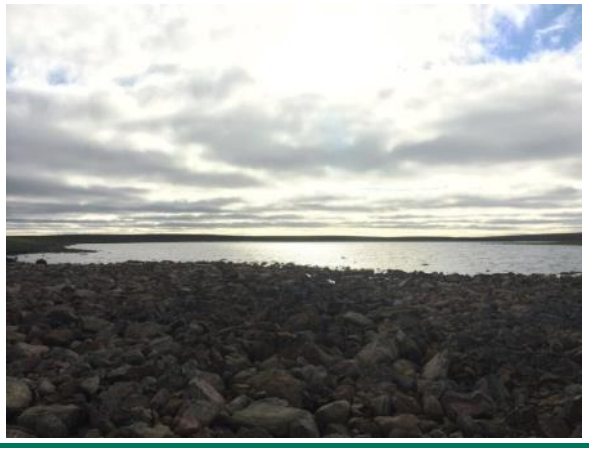
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		17-Sep-15	
Waterbody:		A55			**Start Time**		15:00	
Crossing ID:		A55-A17			**End Time**		15:10	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	607986	BM_read			**Transducer SN:**			
North	7254508	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.008**
2	0.20	0.08		0.20			**0.003**	**0.020**
3	0.40	0.12		0.08			**0.002**	**0.020**
4	0.60	0.08		0.29			**0.005**	**0.014**
5	0.80	0.06		0.27			**0.003**	**0.012**
6	1.00	0.06		0.18			**0.002**	**0.016**
7	1.20	0.10		0.25			**0.005**	**0.022**
8	1.40	0.12		0.16			**0.005**	**0.021**
9	1.75	0.00		0.00			**0.000**	**0.000**
10	2.10	0.00		0.00			**0.000**	**0.008**
11	2.30	0.08		0.35			**0.007**	**0.018**
12	2.60	0.04		0.21			**0.003**	**0.020**
13	3.00	0.06		0.24			**0.006**	**0.015**
14	3.50	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.042**	
						A(m2)	**0.19**	
						B(m)	**3.5**	

A14.0 LAKE A60 & OUTLET (STREAM A60-A59)

Parameter	Value	Note
Drainage Area (km^2)	2.1	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	30	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.45	Measured in the field
Wetted Width (m)	20.4	Measured in the field on 8 August 2015
Max. Wetted Depth (m)	0.23	Measured in the field on 8 August 2015
Channel Length (km)	0.50	Measured from CanVec data
Outlet Channel Slope (m/m)	0.040	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	N/A	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined boulder channel. Cross-sectional data are available in discharge calculation sheets.	



Lake A60.



8 August 2015. Upstream view of the watercourse and Lake A60 (east).

17 September 2015. Downstream view of the watercourse (west).

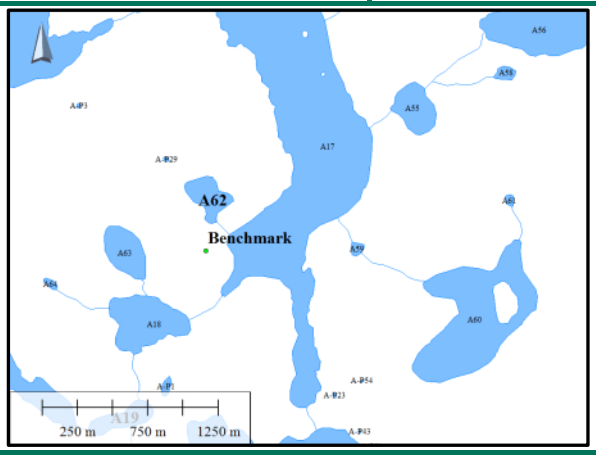
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq			**Date**		12-Jul-15	
Waterbody:		A60			**Start Time**		-	
Crossing ID:		A60-A59			**End Time**		-	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	608264	BM_read			**Transducer SN:**			
North	72537278	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	AEM: RV, LG, RD		
STATION	DISTANCE		Velocity		Optional			
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW		Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)		(m3/s)	(m2)
1	0.00	0.000		0.00				**0.016**
2	0.20	0.155		0.15			**0.005**	**0.031**
3	0.40	0.150		0.12			**0.004**	**0.030**
4	0.60	0.150		0.23			**0.007**	**0.030**
5	0.80	0.150		0.19			**0.006**	**0.030**
6	1.00	0.150		0.31			**0.007**	**0.016**
7	1.10	0.160		0.25			**0.004**	**0.016**
8	1.20	0.160		0.27			**0.006**	**0.032**
9	1.40	0.160		0.29			**0.009**	**0.034**
10	1.60	0.175		0.29			**0.010**	**0.033**
11	1.80	0.150		0.30			**0.009**	**0.024**
12	2.00	0.090		0.21			**0.004**	**0.018**
13	2.20	0.090		0.07			**0.001**	**0.020**
14	2.40	0.110		0.00			**0.000**	**0.025**
15	2.60	0.135		0.13			**0.004**	**0.025**
16	2.80	0.115		0.06			**0.001**	**0.020**
17	3.00	0.080		0.04			**0.000**	**0.004**
18	3.10	0.000		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.077**	
						A(m2)	**0.40**	
						B(m)	**3.1**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		09-Aug-15	
Waterbody:		A60			**Start Time**		8:20	
Crossing ID:		A60-A59			**End Time**		8:40	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	608143	BM_read			**Transducer SN:**			
North	7253354	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	1.40	0.00		0.00				**0.014**
2	1.60	0.14		0.04			**0.001**	**0.022**
3	1.80	0.08		0.04			**0.001**	**0.018**
4	2.00	0.10		0.00			**0.000**	**0.015**
5	2.20	0.05		0.06			**0.001**	**0.009**
6	2.40	0.04		0.05			**0.000**	**0.004**
7	2.60	0.00		0.00			**0.000**	**0.000**
8	2.95	0.00		0.00			**0.000**	**0.017**
9	3.10	0.23		0.01			**0.000**	**0.040**
10	3.30	0.17		0.02			**0.001**	**0.026**
11	3.50	0.09		0.03			**0.001**	**0.023**
12	3.70	0.14		0.00			**0.000**	**0.007**
13	3.80	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.004**	
						A(m2)	**0.20**	
						B(m)	**2.4**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		17-Sep-15	
Waterbody:		A60			**Start Time**		9:20	
Crossing ID:		A60-A59			**End Time**		9:25	
BM UTM Location		**Survey**			**Datalogger SN:**			
East	608143	BM_read			**Transducer SN:**			
North	7253354	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.006**
2	0.20	0.06		0.02			**0.000**	**0.014**
3	0.40	0.08		0.02			**0.000**	**0.014**
4	0.60	0.06		0.02			**0.000**	**0.022**
5	0.80	0.16		0.03			**0.001**	**0.026**
6	1.00	0.10		0.01			**0.000**	**0.023**
7	1.20	0.13		0.01			**0.000**	**0.031**
8	1.40	0.18		0.00			**0.000**	**0.022**
9	1.60	0.04		0.02			**0.000**	**0.004**
10	1.80	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.002**	
						A(m2)	**0.16**	
						B(m)	**1.8**	

A15.0 LAKE A62 & OUTLET (STREAM A62-A17)

Parameter	Value	Note
Drainage Area (km^2)	0.7	Measured with DEM
Bankfull Width (m)	N/A	No defined channel
Max. Bankfull Depth (m)	N/A	No defined channel
Wetted Width (m)	0	Observed no flow in the field 7 August 2015
Max. Wetted Depth (m)	0	Observed no flow in the field 7 August 2015
Channel Length (km)	0.13	Measured from CanVec data
Outlet Channel Slope (m/m)	0.020	Average slope, measured in the field
Bed Material	Boulders, cobbles, grass	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	606719 m E, 7253561 m N, 165.43 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	No defined channel. No flow in August 2015.	



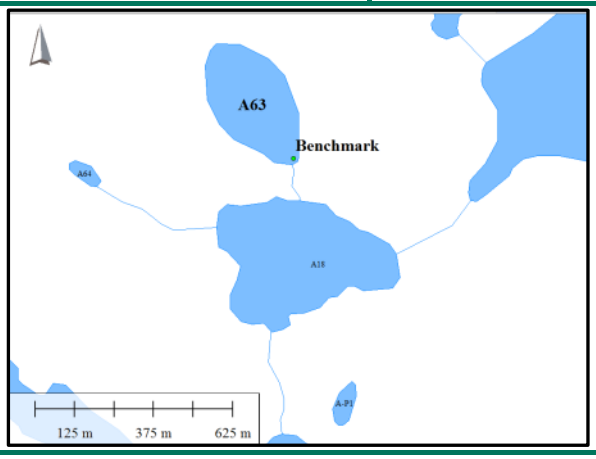
Lake A62: Benchmark location.

7 August 2015. View looking upstream towards Lake A62 (northwest).

7 August 2015. View looking southeast towards Lake A17 (Whale Tail Lake) from the watercourse.

A16.0 LAKE A63 & OUTLET (STREAM A63-A18)

Parameter	Value	Note
Drainage Area (km^2)	0.5	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	N/A	Not measured
Max. Bankfull Depth (m)	N/A	Not measured
Wetted Width (m)	0	Observed no surface flow in the field 7 August 2015
Max. Wetted Depth (m)	0	Observed no surface flow in the field 7 August 2015
Channel Length (km)	0.14	Measured from CanVec data
Outlet Channel Slope (m/m)	0.005	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	606276 m E, 7253375 m N, 155.24 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined boulder channel. No observed surface flow in August 2015.	



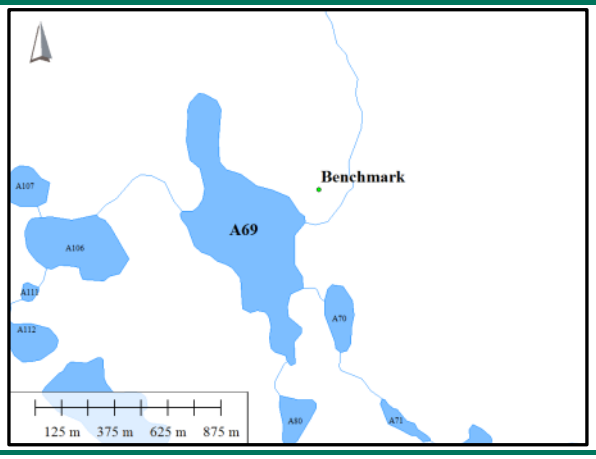
Lake A63.

7 August 2015. Looking west towards Lake A63 (right) and Lake A18 (left). The channel had no surface flow at the time of this photo.

17 September 2015. View looking east at Lake A18 and A19

A17.0 LAKE A69 & OUTLET (STREAM A69-DS1)

Parameter	Value	Note
Drainage Area (km^2)	41.4	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	30 to 60	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	1.0	Measured in the field, based on vegetation
Wetted Width (m)	47.5	Measured in the field on 11 June 2015
Max. Wetted Depth (m)	0.98	Measured in the field on 11 June 2015
Channel Length (km)	1.35	Measured from CanVec data
Outlet Channel Slope (m/m)	0.0085	Average slope, measured with DEM
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	598399 m E, 7256880 m N, 115.62 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Well defined boulder channel. Cross-sectional data are available in discharge calculation sheets and Section 3.3.	



Lake A69: Benchmark location.

11 June 2015. View looking west at Lake A69.

11 June 2015. West view of Lake A69.

11 June 2015. Upstream view of the watercourse (west).

5 August 2015. Looking south towards right downstream bank.

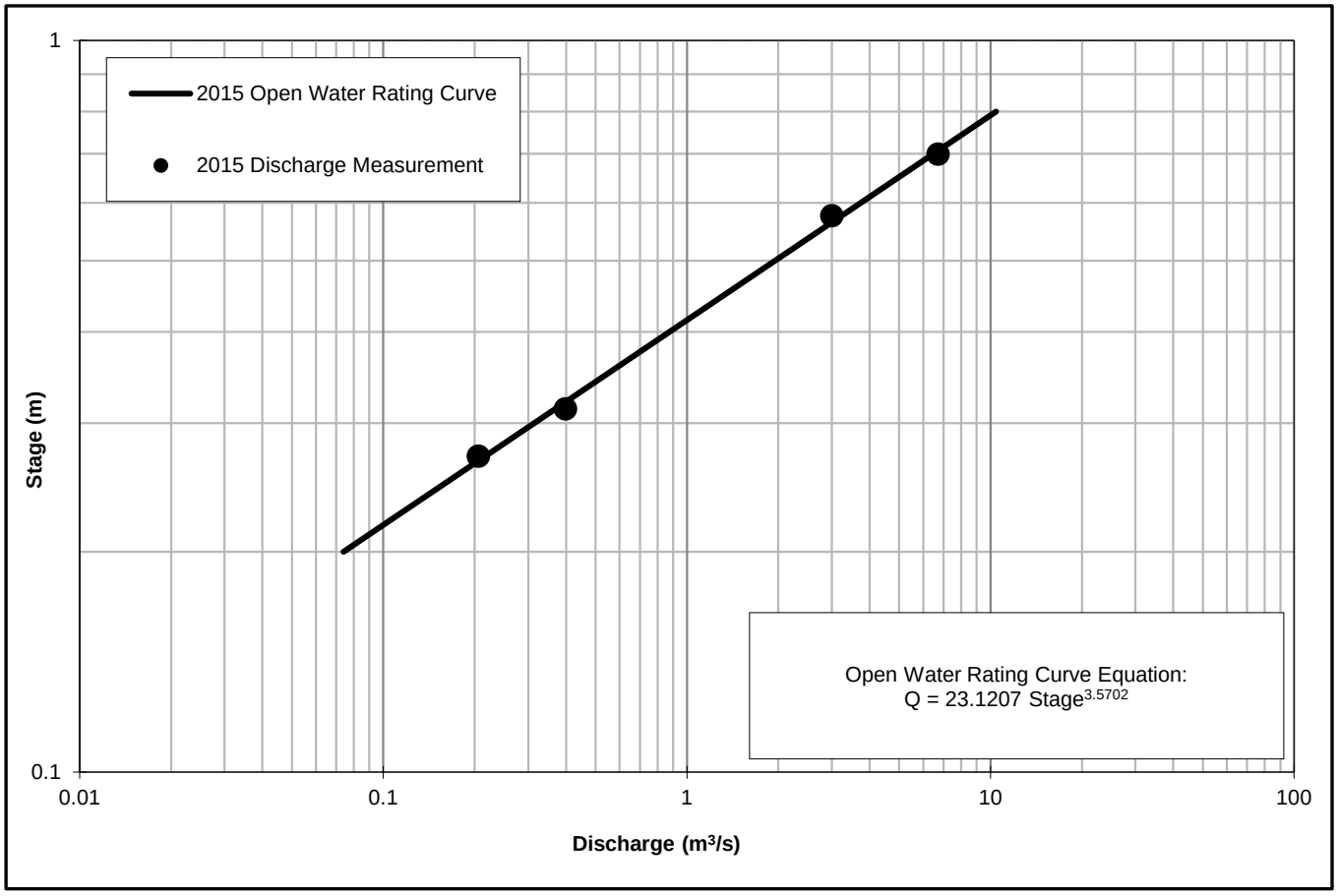


Figure 5: 2015 Stage-Discharge Rating Curve (Lake A69)

Lake A69 - 2015

MEAN DAILY WATER DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	2.03	0.56	0.23	-	-	-
2	-	-	-	-	-	-	1.86	0.53	0.24	-	-	-
3	-	-	-	-	-	-	1.80	0.53	0.23	-	-	-
4	-	-	-	-	-	-	1.72	0.55	0.23	-	-	-
5	-	-	-	-	-	-	1.66	0.54	0.23	-	-	-
6	-	-	-	-	-	-	1.58	0.53	0.23	-	-	-
7	-	-	-	-	-	-	1.44	0.51	0.22	-	-	-
8	-	-	-	-	-	-	1.33	0.48	0.21	-	-	-
9	-	-	-	-	-	-	1.26	0.44	0.21	-	-	-
10	-	-	-	-	-	-	1.34	0.42	0.20	-	-	-
11	-	-	-	-	-	4.96 P	1.33	0.40	0.20	-	-	-
12	-	-	-	-	-	10.12	1.28	0.38	0.24	-	-	-
13	-	-	-	-	-	8.76	1.19	0.38	0.22	-	-	-
14	-	-	-	-	-	6.82	1.18	0.38	0.20	-	-	-
15	-	-	-	-	-	5.83	1.14	0.35	0.20	-	-	-
16	-	-	-	-	-	4.59	1.11	0.33	0.21 P	-	-	-
17	-	-	-	-	-	4.13	1.06	0.29	-	-	-	-
18	-	-	-	-	-	3.44	0.99	0.28	-	-	-	-
19	-	-	-	-	-	3.23	0.91	0.29	-	-	-	-
20	-	-	-	-	-	3.13	0.89	0.29	-	-	-	-
21	-	-	-	-	-	3.14	0.85	0.28	-	-	-	-
22	-	-	-	-	-	3.14	0.82	0.28	-	-	-	-
23	-	-	-	-	-	2.91	0.79	0.28	-	-	-	-
24	-	-	-	-	-	2.81	0.73	0.28	-	-	-	-
25	-	-	-	-	-	2.73	0.68	0.28	-	-	-	-
26	-	-	-	-	-	2.78	0.67	0.27	-	-	-	-
27	-	-	-	-	-	2.66	0.68	0.27	-	-	-	-
28	-	-	-	-	-	2.57	0.68	0.25	-	-	-	-
29	-	-	-	-	-	2.41	0.67	0.25	-	-	-	-
30	-	-	-	-	-	2.25	0.64	0.25	-	-	-	-
31	-	-	-	-	-	-	0.64	0.23	-	-	-	-
MIN	-	-	-	-	-	2.25	0.64	0.23	0.20	-	-	-
MEAN	-	-	-	-	-	4.12	1.13	0.37	0.22	-	-	-
MAX	-	-	-	-	-	10.12	2.03	0.56	0.24	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	11,424,733	7,119,611	3,017,150	985,455	302,517
Water Yield (mm) =	276.1	62%	26%	9%	3%

Lake A69 - 2015

MEAN DAILY WATER SURFACE ELEVATION (masl) BASED ON BENCHMARK ELEVATION 115.62 masl

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	112.406	112.253	112.174	-	-	-
2	-	-	-	-	-	-	112.394	112.248	112.178	-	-	-
3	-	-	-	-	-	-	112.389	112.247	112.176	-	-	-
4	-	-	-	-	-	-	112.383	112.251	112.176	-	-	-
5	-	-	-	-	-	-	112.378	112.250	112.175	-	-	-
6	-	-	-	-	-	-	112.372	112.248	112.174	-	-	-
7	-	-	-	-	-	-	112.359	112.243	112.171	-	-	-
8	-	-	-	-	-	-	112.349	112.237	112.167	-	-	-
9	-	-	-	-	-	-	112.343	112.229	112.167	-	-	-
10	-	-	-	-	-	-	112.350	112.226	112.166	-	-	-
11	-	-	-	-	-	112.537 P	112.349	112.221	112.164	-	-	-
12	-	-	-	-	-	112.693	112.344	112.216	112.179	-	-	-
13	-	-	-	-	-	112.661	112.336	112.217	112.171	-	-	-
14	-	-	-	-	-	112.610	112.335	112.216	112.165	-	-	-
15	-	-	-	-	-	112.579	112.330	112.210	112.166	-	-	-
16	-	-	-	-	-	112.536	112.327	112.205	112.167 P	-	-	-
17	-	-	-	-	-	112.517	112.322	112.194	-	-	-	-
18	-	-	-	-	-	112.486	112.314	112.190	-	-	-	-
19	-	-	-	-	-	112.476	112.304	112.193	-	-	-	-
20	-	-	-	-	-	112.471	112.301	112.193	-	-	-	-
21	-	-	-	-	-	112.471	112.296	112.192	-	-	-	-
22	-	-	-	-	-	112.472	112.292	112.192	-	-	-	-
23	-	-	-	-	-	112.460	112.289	112.192	-	-	-	-
24	-	-	-	-	-	112.454	112.279	112.191	-	-	-	-
25	-	-	-	-	-	112.450	112.273	112.191	-	-	-	-
26	-	-	-	-	-	112.453	112.271	112.189	-	-	-	-
27	-	-	-	-	-	112.446	112.272	112.187	-	-	-	-
28	-	-	-	-	-	112.441	112.272	112.182	-	-	-	-
29	-	-	-	-	-	112.431	112.270	112.181	-	-	-	-
30	-	-	-	-	-	112.420	112.266	112.181	-	-	-	-
31	-	-	-	-	-	-	112.266	112.174	-	-	-	-
MIN	-	-	-	-	-	112.420	112.266	112.174	112.164	-	-	-
MEAN	-	-	-	-	-	112.498	112.324	112.211	112.171	-	-	-
MAX	-	-	-	-	-	112.693	112.406	112.253	112.179	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - 154321			**Date**		11-Jun-15	
Waterbody:		A69			**Start Time**		1148	
Crossing ID:		A69-DS1			**End Time**		1213	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	598584	BM_read			**Transducer SN:**			
North	7257210	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	CJ, JRL		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.70	0.00		0.00				**0.154**
2	2.10	0.22		0.25			**0.077**	**0.294**
3	3.50	0.20		0.15			**0.045**	**0.440**
4	5.10	0.35		0.20			**0.151**	**0.851**
5	7.80	0.28		0.60			**0.336**	**0.358**
6	9.10	0.27		0.64			**0.233**	**0.350**
7	10.50	0.23		0.45			**0.145**	**0.385**
8	11.90	0.32		0.34			**0.152**	**0.392**
9	13.30	0.24		0.10			**0.037**	**0.442**
10	15.00	0.28		0.60			**0.235**	**0.286**
11	16.10	0.24		0.28			**0.084**	**0.455**
12	17.50	0.41		0.24			**0.138**	**0.574**
13	18.90	0.41		0.45			**0.258**	**0.469**
14	20.30	0.26		0.14			**0.051**	**0.364**
15	21.70	0.26		0.50			**0.182**	**0.406**
16	23.10	0.32		0.53			**0.237**	**0.413**
17	24.50	0.27		0.50			**0.189**	**0.441**
18	25.90	0.36		0.70			**0.353**	**0.329**
19	27.30	0.11		0.70			**0.100**	**0.126**
20	28.50	0.10		0.00			**0.000**	**0.020**
21	28.90	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**3.004**	
						A(m2)	**7.55**	
						B(m)	**28.2**	

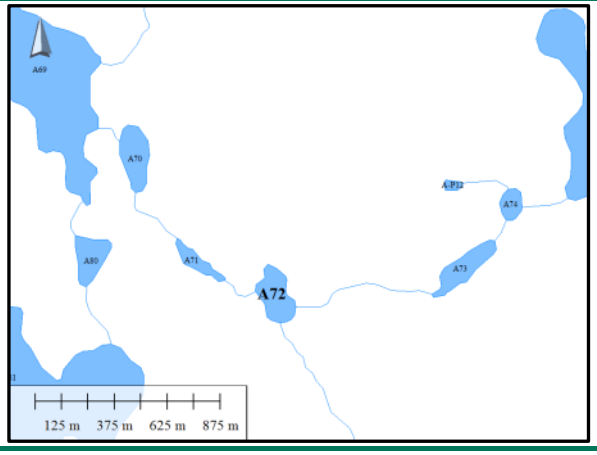
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - 154321			**Date**		15-Jun-15	
Waterbody:		A69			**Start Time**		1040	
Crossing ID:		A69-DS1			**End Time**		1106	
LDB UTM Location					**Datalogger SN:**			
East	598497	BM_read			**Transducer SN:**			
North	7256995	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	CJ, JRL		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	3.10	0.00		0.00				**0.098**
2	4.60	0.13		0.10			**0.048**	**0.767**
3	10.50	0.13		0.16			**0.067**	**0.083**
4	11.00	0.20		0.37			**0.052**	**0.162**
5	11.90	0.16		0.40			**0.051**	**0.130**
6	12.60	0.21		0.77			**0.081**	**0.074**
7	12.90	0.28		0.57			**0.080**	**0.235**
8	13.60	0.39		0.56			**0.126**	**0.155**
9	14.05	0.30		0.88			**0.323**	**0.530**
10	16.05	0.23		0.69			**0.286**	**0.440**
11	17.65	0.32		0.94			**0.526**	**0.637**
12	19.55	0.35		1.15			**0.785**	**0.774**
13	21.55	0.42		0.96			**0.814**	**0.714**
14	23.55	0.29		0.35			**0.178**	**0.428**
15	25.05	0.28		0.93			**0.326**	**0.195**
16	26.05	0.11		0.27			**0.027**	**0.148**
17	26.85	0.26		0.81			**0.211**	**0.198**
18	28.05	0.07		0.00			**0.000**	**0.132**
19	29.25	0.15		0.85			**0.223**	**0.564**
20	31.55	0.34		0.31			**0.221**	**0.561**
21	33.45	0.25		0.72			**0.450**	**0.542**
22	36.55	0.10		0.45			**0.113**	**0.295**
23	38.45	0.21		0.20			**0.084**	**0.462**
24	40.55	0.23		0.58			**0.260**	**0.387**
25	42.35	0.20		0.42			**0.143**	**0.384**
26	43.95	0.28		0.52			**0.262**	**0.570**
27	45.95	0.29		0.52			**0.309**	**0.535**
28	48.05	0.22		0.61			**0.242**	**0.285**
29	49.55	0.16		0.49			**0.098**	**0.125**
30	50.55	0.09		0.49			**0.119**	**0.682**
31	54.95	0.22		0.22			**0.230**	**0.561**
32	60.05	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**6.732**	
						A(m2)	**11.85**	
						B(m)	**57.0**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - trip 2			**Date**		04-Aug-15	
Waterbody:		A69			**Start Time**		9:20	
Crossing ID:		A69-DS1			**End Time**		9:45	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	598452	BM_read			**Transducer SN:**			
North	7256756	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.025**
2	1.00	0.05		0.00			**0.000**	**0.050**
3	2.00	0.05		0.00			**0.000**	**0.025**
4	2.50	0.05		0.08			**0.003**	**0.075**
5	3.50	0.10		0.12			**0.012**	**0.050**
6	4.50	0.00		0.00			**0.000**	**0.090**
7	5.50	0.18		0.15			**0.027**	**0.190**
8	6.50	0.20		0.11			**0.022**	**0.200**
9	7.50	0.20		0.22			**0.044**	**0.245**
10	8.50	0.29		0.00			**0.000**	**0.073**
11	9.00	0.00		0.00			**0.000**	**0.000**
12	9.40	0.00		0.00			**0.000**	**0.013**
13	9.50	0.25		0.16			**0.022**	**0.270**
14	10.50	0.29		0.09			**0.026**	**0.295**
15	11.50	0.30		0.09			**0.027**	**0.270**
16	12.50	0.24		0.10			**0.023**	**0.234**
17	13.40	0.28		0.10			**0.028**	**0.281**
18	14.50	0.23		0.05			**0.012**	**0.245**
19	15.50	0.26		0.04			**0.010**	**0.245**
20	16.50	0.23		0.04			**0.009**	**0.280**
21	17.50	0.33		0.03			**0.010**	**0.320**
22	18.50	0.31		0.02			**0.006**	**0.250**
23	19.50	0.19		0.06			**0.011**	**0.165**
24	20.50	0.14		0.15			**0.021**	**0.095**
25	21.50	0.05		0.14			**0.007**	**0.125**
26	22.50	0.20		0.15			**0.030**	**0.160**
27	23.50	0.12		0.12			**0.014**	**0.120**
28	24.50	0.12		0.11			**0.013**	**0.085**
29	25.50	0.05		0.14			**0.007**	**0.050**
30	26.50	0.05		0.11			**0.006**	**0.065**
31	27.50	0.08		0.07			**0.006**	**0.065**
32	28.50	0.05		0.00			**0.000**	**0.008**
33	28.80	0.00		0.00			**0.000**	**0.021**
34	29.50	0.06		0.04			**0.001**	**0.015**
35	30.00	0.00		0.00			**0.000**	**0.000**
36	35.00	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.398**	
						A(m2)	**4.70**	
						B(m)	**35.0**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		16-Sep-15	
Waterbody:		A69			**Start Time**		9:30	
Crossing ID:		A69-DS1			**End Time**		9:50	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	598438	BM_read			**Transducer SN:**			
North	7256752	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.000				**0.060**
2	2.00	0.06		0.070			**0.006**	**0.070**
3	3.00	0.08		0.079			**0.006**	**0.095**
4	4.00	0.11		0.073			**0.008**	**0.085**
5	5.00	0.06		0.101			**0.006**	**0.075**
6	6.00	0.09		0.070			**0.006**	**0.120**
7	7.00	0.15		0.061			**0.009**	**0.155**
8	8.00	0.16		0.076			**0.012**	**0.185**
9	9.00	0.21		0.052			**0.011**	**0.195**
10	10.00	0.18		0.046			**0.008**	**0.165**
11	11.00	0.15		0.073			**0.011**	**0.150**
12	12.00	0.15		0.101			**0.015**	**0.200**
13	13.00	0.25		0.061			**0.009**	**0.025**
14	13.20	0.00		0.000			**0.000**	**0.000**
15	13.21	0.00		0.000			**0.000**	**0.100**
16	14.21	0.20		0.021			**0.004**	**0.190**
17	15.21	0.18		0.055			**0.010**	**0.190**
18	16.21	0.20		0.061			**0.012**	**0.190**
19	17.21	0.18		0.061			**0.011**	**0.210**
20	18.21	0.24		0.034			**0.008**	**0.205**
21	19.21	0.17		0.058			**0.010**	**0.175**
22	20.21	0.18		0.070			**0.013**	**0.165**
23	21.21	0.15		0.055			**0.008**	**0.175**
24	22.21	0.20		0.052			**0.010**	**0.190**
25	23.21	0.18		0.049			**0.005**	**0.009**
26	23.31	0.00		0.000			**0.000**	**0.000**
27	23.32	0.00		0.000			**0.000**	**0.027**
28	23.62	0.18		0.073			**0.004**	**0.027**
29	23.92	0.00		0.000			**0.000**	**0.000**
30	23.93	0.00		0.000			**0.000**	**0.020**
31	24.73	0.05		0.046			**0.002**	**0.020**
32	25.53	0.00		0.000			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.206**	
						A(m2)	**3.47**	
						B(m)	**25.5**	

A18.0 LAKE A72 & OUTLET (STREAM A72-D71)

Parameter	Value	Note
Drainage Area (km^2)	7.1	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	15	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.75	Measured in the field, based on vegetation
Wetted Width (m)	14.2	Measured in the field on 11 June 2015
Max. Wetted Depth (m)	0.40	Measured in the field on 11 June 2015
Channel Length (km)	0.19	Measured from CanVec data
Outlet Channel Slope (m/m)	0.003	Average slope, measured in the field 18 September 2015
Bed Material	Sand, silt, organics	
Bank Material	Sand, silt, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	N/A	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Well defined channel. Cross-sectional data are available in discharge calculation sheets.	



Lake A72.

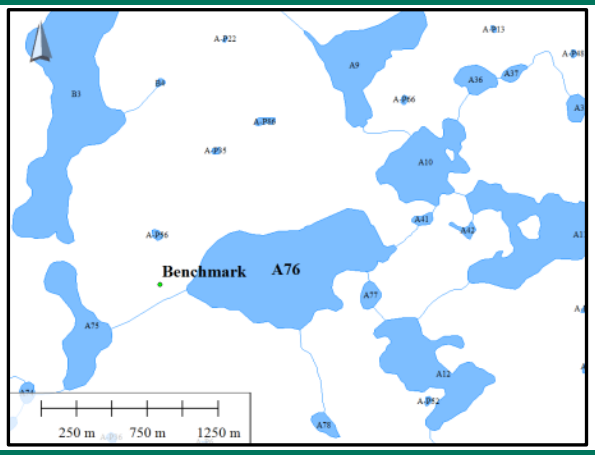
OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**	18-Sep-15	
Waterbody:		A72			**Start Time**	14:30	
Crossing ID:		A72-A71			**End Time**	14:50	
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	598988	BM_read			**Transducer SN:**		
North	7255622	WL_read			**Meter Type/SN:**		
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC	

STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)	Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00			**0.112**
2	1.60	0.14		0.00		**0.000**	**0.111**
3	2.20	0.23		0.03		**0.003**	**0.068**
4	2.50	0.22		0.04		**0.003**	**0.065**
5	2.80	0.21		0.03		**0.002**	**0.068**
6	3.10	0.24		0.02		**0.001**	**0.072**
7	3.40	0.24		0.04		**0.003**	**0.071**
8	3.70	0.23		0.03		**0.002**	**0.072**
9	4.00	0.25		0.02		**0.002**	**0.086**
10	4.30	0.32		0.03		**0.003**	**0.101**
11	4.60	0.35		0.03		**0.003**	**0.083**
12	4.90	0.20		0.01		**0.001**	**0.089**
13	5.20	0.39		0.03		**0.004**	**0.113**
14	5.50	0.36		0.04		**0.004**	**0.108**
15	5.80	0.36		0.05		**0.005**	**0.097**
16	6.10	0.29		0.05		**0.004**	**0.087**
17	6.40	0.29		0.06		**0.005**	**0.083**
18	6.70	0.26		0.05		**0.004**	**0.084**
19	7.00	0.30		0.03		**0.003**	**0.090**
20	7.30	0.30		0.02		**0.002**	**0.096**
21	7.60	0.34		0.05		**0.006**	**0.148**
22	8.00	0.40		0.04		**0.006**	**0.156**
23	8.40	0.38		0.01		**0.002**	**0.150**
24	8.80	0.37		0.04		**0.006**	**0.150**
25	9.20	0.38		0.03		**0.005**	**0.152**
26	9.60	0.38		0.04		**0.006**	**0.144**
27	10.00	0.34		0.04		**0.005**	**0.136**
28	10.40	0.34		0.04		**0.005**	**0.140**
29	10.80	0.36		0.04		**0.006**	**0.136**
30	11.20	0.32		0.02		**0.003**	**0.124**
31	11.60	0.30		0.05		**0.006**	**0.104**
32	12.00	0.22		0.04		**0.004**	**0.092**
33	12.40	0.24		0.02		**0.002**	**0.072**
34	12.80	0.12		0.03		**0.001**	**0.042**
35	13.20	0.09		0.03		**0.001**	**0.030**
36	13.60	0.06		0.01		**0.000**	**0.018**
37	14.20	0.00		0.00		**0.000**	**0.000**

NOTES:		**RESULTS:**	**Q (m3/s)**	**0.117**
			A(m2)	**3.55**
			B(m)	**14.2**

A19.0 LAKE A76 & EAST OUTLET (STREAM A76-A11)

Parameter	Value	Note
Drainage Area (km^2)	2.9	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	65	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	1.0	Measured in the field, based on vegetation
Wetted Width (m)	60.0	Measured in the field 6 August 2015
Max. Wetted Depth (m)	0.31	Measured in the field 6 August 2015
Channel Length (km)	0.28	Measured from CanVec data
Outlet Channel Slope (m/m)	0.0035	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	601213 m E, 7256820 m N, 154.00 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Boulder channel. Cross-sectional data are available in discharge calculation sheets and Section 3.3. See Stream A12 for more photos relating to Lake A76.	



Lake A76: Benchmark location.

6 August 2015. Downstream view of the watercourse (northeast).

19 September 2015. Upstream view of the watercourse and Lake A76 (southwest)

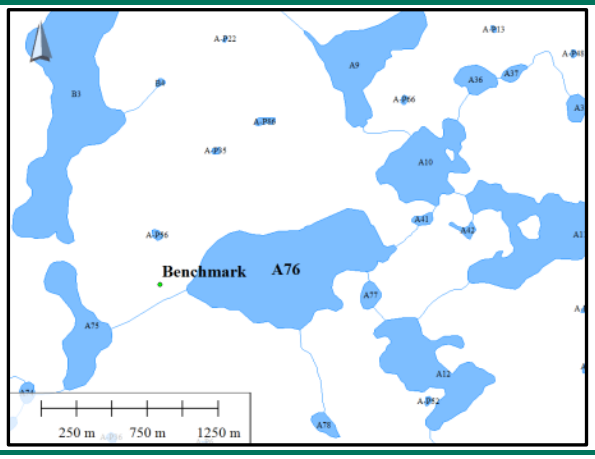
OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		Amaruq - Trip 2			**Date**		06-Aug-15
Waterbody:		A76			**Start Time**		1:15
Crossing ID:		A76-A41			**End Time**		1:45
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	602921	BM_read			**Transducer SN:**		
North	7257158	WL_read			**Meter Type/SN:**		Marsh McBirney
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN	

STATION	DISTANCE		Velocity		Optional		
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW	Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)	(m3/s)	(m2)
1	0.00	0.00		0.00			**0.051**
2	0.60	0.17		0.00		**0.000**	**0.243**
3	1.50	0.37		0.00		**0.000**	**0.123**
4	2.00	0.12		0.00		**0.000**	**0.036**
5	2.60	0.00		0.00		**0.000**	**0.000**
6	3.40	0.00		0.00		**0.000**	**0.027**
7	4.00	0.09		0.00		**0.000**	**0.014**
8	4.30	0.00		0.00		**0.000**	**0.000**
9	6.00	0.00		0.00		**0.000**	**0.007**
10	6.10	0.15		0.00		**0.000**	**0.030**
11	6.50	0.00		0.00		**0.000**	**0.000**
12	6.90	0.00		0.00		**0.000**	**0.012**
13	7.00	0.24		0.00		**0.000**	**0.495**
14	8.50	0.42		0.00		**0.000**	**0.750**
15	10.00	0.58		0.02		**0.017**	**0.855**
16	11.50	0.56		0.02		**0.011**	**0.112**
17	11.90	0.00		0.00		**0.000**	**0.000**
18	12.70	0.00		0.00		**0.000**	**0.074**
19	13.00	0.49		0.00		**0.000**	**0.264**
20	13.60	0.39		0.03		**0.012**	**0.560**
21	15.00	0.41		0.01		**0.006**	**1.029**
22	16.70	0.80		0.01		**0.012**	**0.722**
23	18.00	0.31		0.02		**0.009**	**0.330**
24	19.50	0.13		0.00		**0.000**	**0.323**
25	21.00	0.30		0.00		**0.000**	**0.488**
26	22.50	0.35		0.01		**0.005**	**0.503**
27	24.00	0.32		0.01		**0.005**	**0.360**
28	25.50	0.16		0.01		**0.001**	**0.008**
29	25.60	0.00		0.00		**0.000**	**0.000**
30	26.90	0.00		0.00		**0.000**	**0.064**
31	27.70	0.16		0.01		**0.001**	**0.232**
32	28.50	0.42		0.00		**0.000**	**0.380**
33	29.60	0.27		0.00		**0.000**	**0.054**
34	30.00	0.00		0.00		**0.000**	**0.000**

NOTES:	15 m of no/low depth wetted width on RDB & LDB	**RESULTS:**	**Q (m3/s)**	**0.079**
			A(m2)	**8.14**
			B(m)	**30.0**

A20.0 LAKE A76 & WEST OUTLET (STREAM A76-A75)

Parameter	Value	Note
Drainage Area (km^2)	2.9	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	35	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	N/A	Measured in the field, based on vegetation
Wetted Width (m)	N/A	Observed no surface flow in the field 5 August 2015
Max. Wetted Depth (m)	0	Observed no surface flow in the field 5 August 2015
Channel Length (km)	0.58	Measured from CanVec data
Outlet Channel Slope (m/m)	0.017	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	601213 m E, 7256820 m N, 154.00 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Boulder channel. Some visible flow through boulders but not measureable. See Section 3.3 and discharge sheets for cross-sections, and Stream A12 for more photos relating to Lake A76.	



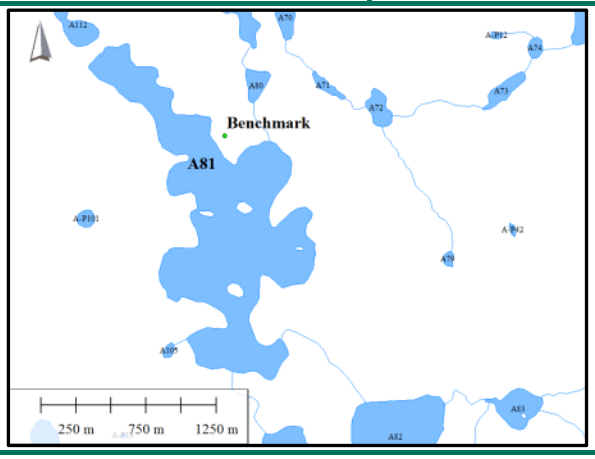
Lake A76: Benchmark location.

6 August 2015. Downstream view of watercourse (west). No visible flow through channel at time of photo.

17 September 2015. View looking west towards Lake A76 and watercourse.

A21.0 LAKE A81 & OUTLET (STREAM A81-A80)

Parameter	Value	Note
Drainage Area (km^2)	30.1	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	50	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.5	Measured in the field, based on vegetation
Wetted Width (m)	48.7	Measured in the field 8 August 2015
Max. Wetted Depth (m)	0.42	Measured in the field 8 August 2015
Channel Length (km)	0.30	Measured from CanVec data
Outlet Channel Slope (m/m)	0.011	Average slope, based on DEM (PhotoSat 2015)
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	598067 m E, 7255436 m N, 129.65 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined boulder channel. See discharge sheets for cross-sections.	



Lake A81: Benchmark location.

8 August 2015. Downstream view of the watercourse (north).

17 September 2015. View looking east at Lake A81 and watercourse.

OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		1524321 - Amaruq			**Date**	12-Jul-15	
Waterbody:		A81			**Start Time**		
Crossing ID:		A81-A80			**End Time**		
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	598366	BM_read			**Transducer SN:**		
North	7255457	WL_read			**Meter Type/SN:**	Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	AEM: RV, LG, RD	
STATION	DISTANCE		Velocity		Optional		
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW	Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)	(m3/s)	(m2)
1	0.00	0.00		0.00			**0.000**
2	0.50	0.00		0.00		**0.000**	**0.013**
3	1.00	0.05		0.18		**0.005**	**0.030**
4	1.50	0.07		0.26		**0.009**	**0.025**
5	2.00	0.03		0.15		**0.002**	**0.015**
6	2.50	0.03		0.15		**0.002**	**0.058**
7	3.00	0.20		0.40		**0.040**	**0.050**
8	3.50	0.00		0.00		**0.000**	**0.030**
9	4.00	0.12		0.39		**0.023**	**0.055**
10	4.50	0.10		0.41		**0.021**	**0.068**
11	5.00	0.17		0.14		**0.012**	**0.073**
12	5.50	0.12		0.62		**0.037**	**0.043**
13	6.00	0.05		0.25		**0.006**	**0.065**
14	6.50	0.21		0.44		**0.046**	**0.078**
15	7.00	0.10		0.37		**0.019**	**0.071**
16	7.50	0.19		0.10		**0.009**	**0.116**
17	8.00	0.28		0.44		**0.062**	**0.120**
18	8.50	0.20		0.41		**0.041**	**0.163**
19	9.00	0.45		0.12		**0.027**	**0.173**
20	9.50	0.24		0.26		**0.031**	**0.105**
21	10.00	0.18		0.42		**0.038**	**0.100**
22	10.50	0.22		0.37		**0.041**	**0.100**
23	11.00	0.18		0.05		**0.005**	**0.100**
24	11.50	0.22		0.25		**0.028**	**0.105**
25	12.00	0.20		0.02		**0.002**	**0.100**
26	12.50	0.20		0.00		**0.000**	**0.105**
27	13.00	0.22		0.28		**0.031**	**0.090**
28	13.50	0.14		0.02		**0.001**	**0.073**
29	14.00	0.15		0.00		**0.000**	**0.088**
30	14.50	0.20		0.06		**0.006**	**0.095**
31	15.00	0.18		0.27		**0.024**	**0.075**
32	15.50	0.12		0.12		**0.007**	**0.068**
33	16.00	0.15		0.43		**0.032**	**0.080**
34	16.50	0.17		0.65		**0.055**	**0.043**
35	17.00	0.00		0.00		**0.000**	**0.000**
36	17.50	0.00		0.00		**0.000**	**0.000**
37	18.00	0.00		0.00		**0.000**	**0.000**
38	18.50	0.00		0.00		**0.000**	**0.025**
39	19.00	0.10		0.00		**0.000**	**0.100**
40	19.50	0.30		0.57		**0.086**	**0.113**
41	20.00	0.15		0.12		**0.009**	**0.058**
42	20.50	0.08		0.23		**0.000**	**0.060**
43	21.00	0.16		0.71		**0.000**	**0.040**
44	21.50	0.00		0.00		**0.000**	**0.000**
45	22.00	0.00		0.00		**0.000**	**0.000**
46	22.50	0.00		0.00		**0.000**	**0.038**
47	23.00	0.15		0.41		**0.031**	**0.075**
48	23.50	0.15		0.22		**0.017**	**0.038**
49	24.00	0.00		0.00		**0.000**	**0.025**
50	24.50	0.10		0.33		**0.017**	**0.038**
51	25.00	0.05		0.01		**0.000**	**0.013**
52	25.50	0.00		0.00		**0.000**	**0.030**
53	26.00	0.12		0.08		**0.005**	**0.030**
54	26.50	0.00		0.00		**0.000**	**0.040**
55	27.00	0.16		0.39		**0.031**	**0.085**
56	27.50	0.18		0.33		**0.030**	**0.083**
57	28.00	0.15		0.19		**0.014**	**0.038**

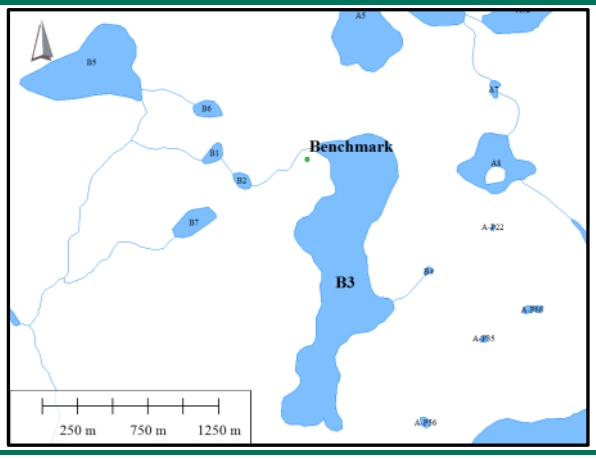
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq			**Date**		12-Jul-15	
Waterbody:		A81			**Start Time**			
Crossing ID:		A81-A80			**End Time**			
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	598366	BM_read			**Transducer SN:**			
North	7255457	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	AEM: RV, LG, RD		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
58	28.50	0.00		0.00			**0.000**	**0.000**
59	29.00	0.00		0.00			**0.000**	**0.000**
60	29.50	0.00		0.00			**0.000**	**0.000**
61	30.00	0.00		0.00			**0.000**	**0.020**
62	30.50	0.08		0.22			**0.044**	**0.180**
63	31.00	0.00		0.00			**0.000**	**0.000**
64	31.50	0.10		0.15			**0.008**	**0.025**
65	32.00	0.00		0.00			**0.000**	**0.000**
66	33.00	0.08		0.10			**0.136**	**1.320**
67	34.00	0.00		0.00			**0.000**	**0.000**
68	35.00	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**1.088**	
						A(m2)	**5.04**	
						B(m)	**35.0**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET							
Project Name, Number:		Amaruq - Trip 2			**Date**	08-Aug-15	
Waterbody:		A81			**Start Time**	11:51	
Crossing ID:		A81-A80			**End Time**	12:20	
LDB UTM Location		**Survey**			**Datalogger SN:**		
East	598343	BM_read			**Transducer SN:**		
North	7255414	WL_read			**Meter Type/SN:**	Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JL, Laren (wildlife monitor took notes)	
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)	Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00			**0.000**
2	2.50	0.00		0.00		**0.000**	**0.006**
3	2.60	0.12		0.13		**0.002**	**0.006**
4	2.70	0.00		0.00		**0.000**	**0.000**
5	5.60	0.00		0.00		**0.000**	**0.002**
6	5.70	0.04		0.10		**0.000**	**0.002**
7	5.80	0.00		0.00		**0.000**	**0.000**
8	6.70	0.00		0.00		**0.000**	**0.003**
9	6.90	0.03		0.08		**0.000**	**0.001**
10	7.00	0.00		0.00		**0.000**	**0.000**
11	7.30	0.00		0.00		**0.000**	**0.002**
12	7.40	0.04		0.00		**0.000**	**0.004**
13	7.60	0.00		0.00		**0.000**	**0.000**
14	7.70	0.00		0.00		**0.000**	**0.002**
15	7.80	0.04		0.08		**0.000**	**0.001**
16	7.85	0.00		0.00		**0.000**	**0.000**
17	10.20	0.00		0.00		**0.000**	**0.003**
18	10.40	0.03		0.12		**0.001**	**0.036**
19	11.00	0.09		0.01		**0.001**	**0.057**
20	11.60	0.10		0.11		**0.012**	**0.165**
21	13.10	0.12		0.16		**0.017**	**0.018**
22	13.40	0.00		0.00		**0.000**	**0.004**
23	13.80	0.02		0.02		**0.000**	**0.022**
24	14.20	0.09		0.09		**0.002**	**0.000**
25	14.20	0.00		0.00		**0.000**	**0.010**
26	15.20	0.02		0.09		**0.001**	**0.003**
27	15.50	0.00		0.00		**0.000**	**0.000**
28	15.80	0.00		0.00		**0.000**	**0.010**
29	16.00	0.10		0.00		**0.000**	**0.063**
30	16.70	0.08		0.10		**0.004**	**0.008**
31	16.90	0.00		0.00		**0.000**	**0.000**
32	18.50	0.00		0.00		**0.000**	**0.004**
33	18.70	0.04		0.22		**0.004**	**0.096**
34	19.50	0.20		0.06		**0.009**	**0.080**
35	20.20	0.03		0.17		**0.003**	**0.009**
36	20.80	0.00		0.00		**0.000**	**0.000**
37	21.90	0.00		0.00		**0.000**	**0.006**
38	22.10	0.06		0.10		**0.002**	**0.040**
39	22.60	0.10		0.05		**0.002**	**0.005**
40	22.70	0.00		0.00		**0.000**	**0.000**
41	26.50	0.00		0.00		**0.000**	**0.030**
42	27.50	0.06		0.05		**0.000**	**0.035**
43	28.20	0.04		0.22		**0.000**	**0.006**
44	28.50	0.00		0.00		**0.000**	**0.000**
45	28.80	0.00		0.00		**0.000**	**0.003**
46	28.90	0.06		0.10		**0.001**	**0.006**
47	29.10	0.00		0.00		**0.000**	**0.000**
48	31.70	0.00		0.00		**0.000**	**0.006**
49	31.80	0.12		0.01		**0.000**	**0.018**
50	32.10	0.00		0.00		**0.000**	**0.000**
51	32.50	0.00		0.00		**0.000**	**0.004**
52	32.60	0.08		0.16		**0.009**	**0.098**
53	33.90	0.07		0.01		**0.001**	**0.084**
54	35.10	0.07		0.17		**0.011**	**0.042**
55	35.70	0.07		0.01		**0.000**	**0.049**
56	36.40	0.07		0.18		**0.009**	**0.036**
57	37.20	0.02		0.00		**0.000**	**0.018**
58	37.80	0.04		0.11		**0.018**	**0.370**
59	45.20	0.06		0.06		**0.014**	**0.015**
60	45.70	0.00		0.00		**0.000**	**0.000**

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		08-Aug-15	
Waterbody:		A81			**Start Time**		11:51	
Crossing ID:		A81-A80			**End Time**		12:20	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	598343	BM_read			**Transducer SN:**			
North	7255414	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JL, Laren (wildlife monitor took notes)		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.124**	
						A(m2)	**1.49**	
						B(m)	**45.7**	

A22.0 LAKE B3 & OUTLET (STREAM B3-B2)

Parameter	Value	Note
Drainage Area (km^2)	2.8	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	15	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.3	Measured in the field, based on vegetation
Wetted Width (m)	12.8	Measured in the field 8 August 2015
Max. Wetted Depth (m)	0.25	Measured in the field 8 August 2015
Channel Length (km)	0.38	Measured from CanVec data
Outlet Channel Slope (m/m)	0.007	Average slope, based on DEM (PhotoSat 2015)
Bed Material	Boulders, cobbles, with some gravel, sand	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	600357 m E, 7259028 m N, 144.86 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Poorly defined, braided bouldery channel. Cross-sectional data are available in discharge calculation sheets.	



Lake B3: Benchmark location.

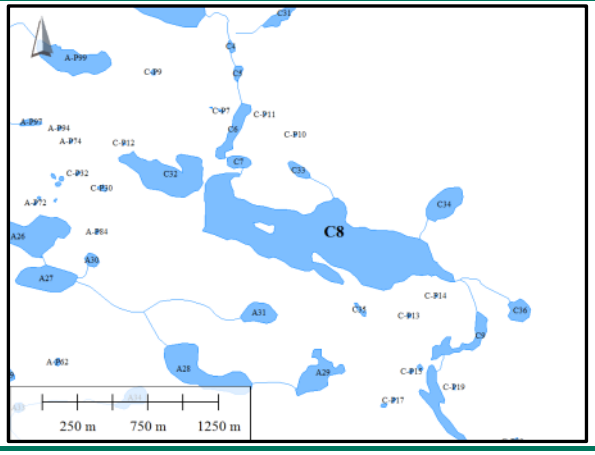
8 August 2015. Upstream view of the Lake B3 outlet (east).

8 August 2015. Downstream view of the Lake B3 outlet (west).

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - trip 2			**Date**		08-Aug-15	
Waterbody:		B3			**Start Time**		7:45	
Crossing ID:		B3-B2			**End Time**		8:05	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	600126	BM_read			**Transducer SN:**			
North	7258966	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION	DISTANCE		Velocity		Optional			
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW		Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)		(m3/s)	(m2)
1	0.00	0.00		0.00				**0.135**
2	1.50	0.18		0.04			**0.006**	**0.009**
3	1.60	0.00		0.00			**0.000**	**0.000**
4	2.00	0.00		0.00			**0.000**	**0.008**
5	2.10	0.15		0.03			**0.001**	**0.023**
6	2.40	0.00		0.00			**0.000**	**0.000**
7	3.10	0.00		0.00			**0.000**	**0.011**
8	3.30	0.11		0.04			**0.001**	**0.054**
9	3.70	0.16		0.03			**0.002**	**0.068**
10	4.20	0.11		0.09			**0.006**	**0.092**
11	5.00	0.12		0.06			**0.005**	**0.058**
12	5.50	0.11		0.02			**0.001**	**0.098**
13	6.20	0.17		0.03			**0.003**	**0.026**
14	6.50	0.00		0.00			**0.000**	**0.000**
15	7.80	0.00		0.00			**0.000**	**0.008**
16	7.90	0.16		0.05			**0.003**	**0.087**
17	8.50	0.13		0.02			**0.001**	**0.058**
18	9.00	0.10		0.02			**0.001**	**0.058**
19	9.50	0.13		0.09			**0.004**	**0.013**
20	9.70	0.00		0.00			**0.000**	**0.000**
21	11.10	0.00		0.00			**0.000**	**0.012**
22	11.20	0.24		0.01			**0.001**	**0.048**
23	11.60	0.00		0.00			**0.000**	**0.000**
24	12.60	0.00		0.00			**0.000**	**0.008**
25	12.70	0.16		0.03			**0.000**	**0.008**
26	12.80	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.036**	
						A(m2)	**0.88**	
						B(m)	**12.8**	

A23.0 LAKE C8 & OUTLET (STREAM C8-C7)

Parameter	Value	Note
Drainage Area (km^2)	11.2	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	30	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.3	Measured in the field, based on vegetation
Wetted Width (m)	16.6	Measured in the field on 8 August 2015
Max. Wetted Depth (m)	0.14	Measured in the field on 8 August 2015
Channel Length (km)	0.05	Measured from CanVec data
Outlet Channel Slope (m/m)	0.005	Average slope, measured in the field
Bed Material	Cobbles, gravel, sand	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	604219 m E, 7260840 m N	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	N/A	
Comment	Well defined channel. Cross-sectional data are available in discharge calculation sheets.	



Lake C8.

8 August 2015. Southwest view of Lake C8 flowing into C7.

8 August 2015. Upstream view of the watercourse (southwest).

8 August 2015. View looking south at Lake C8.

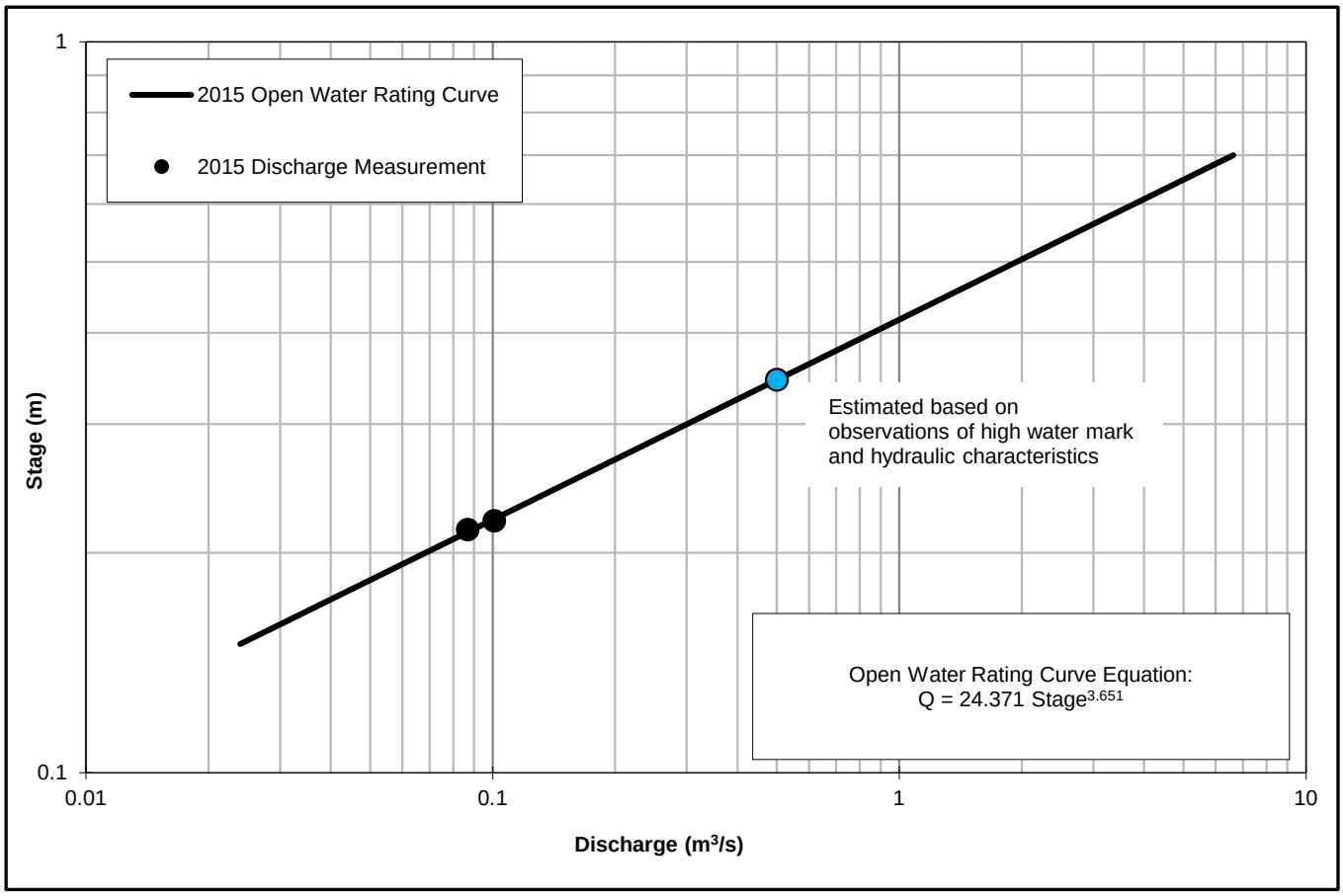


Figure 6: 2015 Stage-Discharge Rating Curve (Lake C8)

Lake C8 - 2015

MEAN DAILY DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	-	-	0.08	-	-	-
2	-	-	-	-	-	-	-	-	0.08	-	-	-
3	-	-	-	-	-	-	-	-	0.09	-	-	-
4	-	-	-	-	-	-	-	-	0.09	-	-	-
5	-	-	-	-	-	-	-	-	0.08	-	-	-
6	-	-	-	-	-	-	-	-	0.08	-	-	-
7	-	-	-	-	-	-	-	-	0.08	-	-	-
8	-	-	-	-	-	-	-	0.09 P	0.08	-	-	-
9	-	-	-	-	-	-	-	0.09	0.08	-	-	-
10	-	-	-	-	-	-	-	0.08	0.08	-	-	-
11	-	-	-	-	-	-	-	0.09	0.07	-	-	-
12	-	-	-	-	-	-	-	0.07	0.08	-	-	-
13	-	-	-	-	-	-	-	0.08	0.08	-	-	-
14	-	-	-	-	-	-	-	0.09	0.08	-	-	-
15	-	-	-	-	-	-	-	0.08	0.08	-	-	-
16	-	-	-	-	-	-	-	0.08	0.08 P	-	-	-
17	-	-	-	-	-	-	-	0.08	-	-	-	-
18	-	-	-	-	-	-	-	0.08	-	-	-	-
19	-	-	-	-	-	-	-	0.08	-	-	-	-
20	-	-	-	-	-	-	-	0.08	-	-	-	-
21	-	-	-	-	-	-	-	0.08	-	-	-	-
22	-	-	-	-	-	-	-	0.08	-	-	-	-
23	-	-	-	-	-	-	-	0.08	-	-	-	-
24	-	-	-	-	-	-	-	0.09	-	-	-	-
25	-	-	-	-	-	-	-	0.09	-	-	-	-
26	-	-	-	-	-	-	-	0.09	-	-	-	-
27	-	-	-	-	-	-	-	0.09	-	-	-	-
28	-	-	-	-	-	-	-	0.08	-	-	-	-
29	-	-	-	-	-	-	-	0.08	-	-	-	-
30	-	-	-	-	-	-	-	0.08	-	-	-	-
31	-	-	-	-	-	-	-	0.08	-	-	-	-
MIN	-	-	-	-	-	-	-	0.073	0.072	-	-	-
MEAN	-	-	-	-	-	-	-	0.083	0.080	-	-	-
MAX	-	-	-	-	-	-	-	0.089	0.086	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	282,794	171,934	110,860
Water Yield (mm) =	24.0	61%	39%

Lake C8 - 2015
MEAN DAILY WATER SURFACE ELEVATION (masl)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	-	-	139.008	-	-	-
2	-	-	-	-	-	-	-	-	139.012	-	-	-
3	-	-	-	-	-	-	-	-	139.013	-	-	-
4	-	-	-	-	-	-	-	-	139.012	-	-	-
5	-	-	-	-	-	-	-	-	139.011	-	-	-
6	-	-	-	-	-	-	-	-	139.010	-	-	-
7	-	-	-	-	-	-	-	-	139.009	-	-	-
8	-	-	-	-	-	-	-	139.014 P	139.006	-	-	-
9	-	-	-	-	-	-	-	139.015	139.005	-	-	-
10	-	-	-	-	-	-	-	139.012	139.005	-	-	-
11	-	-	-	-	-	-	-	139.012	139.003	-	-	-
12	-	-	-	-	-	-	-	139.004	139.009	-	-	-
13	-	-	-	-	-	-	-	139.012	139.025	-	-	-
14	-	-	-	-	-	-	-	139.013	139.020	-	-	-
15	-	-	-	-	-	-	-	139.011	139.021	-	-	-
16	-	-	-	-	-	-	-	139.008	139.022 P	-	-	-
17	-	-	-	-	-	-	-	139.007	-	-	-	-
18	-	-	-	-	-	-	-	139.008	-	-	-	-
19	-	-	-	-	-	-	-	139.007	-	-	-	-
20	-	-	-	-	-	-	-	139.009	-	-	-	-
21	-	-	-	-	-	-	-	139.011	-	-	-	-
22	-	-	-	-	-	-	-	139.010	-	-	-	-
23	-	-	-	-	-	-	-	139.011	-	-	-	-
24	-	-	-	-	-	-	-	139.013	-	-	-	-
25	-	-	-	-	-	-	-	139.013	-	-	-	-
26	-	-	-	-	-	-	-	139.013	-	-	-	-
27	-	-	-	-	-	-	-	139.013	-	-	-	-
28	-	-	-	-	-	-	-	139.010	-	-	-	-
29	-	-	-	-	-	-	-	139.011	-	-	-	-
30	-	-	-	-	-	-	-	139.011	-	-	-	-
31	-	-	-	-	-	-	-	139.010	-	-	-	-
MIN	-	-	-	-	-	-	-	139.004	139.003	-	-	-
MEAN	-	-	-	-	-	-	-	139.011	139.012	-	-	-
MAX	-	-	-	-	-	-	-	139.015	139.025	-	-	-

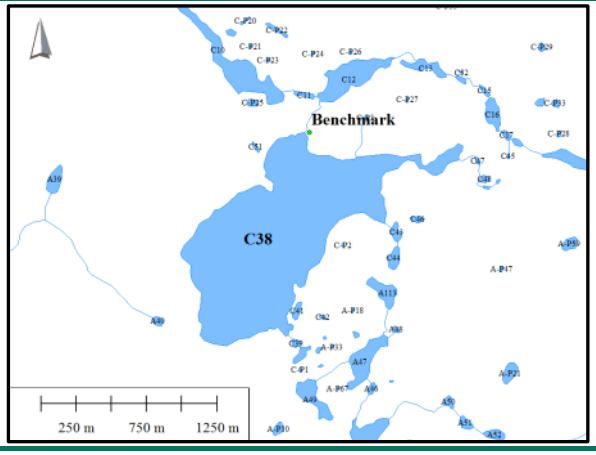
NOTES: P - PARTIAL DAILY AVERAGE

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		08-Aug-15	
Waterbody:		C8			**Start Time**		9:45	
Crossing ID:		C8-C7			**End Time**		10:00	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	604259	BM_read			**Transducer SN:**			
North	7260865	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.40	0.00		0.00				**0.002**
2	0.50	0.04		0.00			**0.000**	**0.028**
3	1.20	0.04		0.00			**0.000**	**0.066**
4	2.40	0.07		0.01			**0.001**	**0.065**
5	3.40	0.06		0.05			**0.003**	**0.084**
6	4.60	0.08		0.06			**0.006**	**0.132**
7	5.80	0.14		0.08			**0.013**	**0.150**
8	7.00	0.11		0.07			**0.009**	**0.138**
9	8.20	0.12		0.08			**0.012**	**0.144**
10	9.40	0.12		0.07			**0.010**	**0.144**
11	10.60	0.12		0.04			**0.006**	**0.108**
12	11.80	0.06		0.07			**0.005**	**0.096**
13	13.00	0.10		0.05			**0.006**	**0.102**
14	14.20	0.07		0.05			**0.004**	**0.114**
15	15.40	0.12		0.08			**0.012**	**0.108**
16	16.60	0.06		0.01			**0.000**	**0.012**
17	17.00	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.087**	
						A(m2)	**1.49**	
						B(m)	**16.6**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		16-Sep-15	
Waterbody:		C8			**Start Time**		11:40	
Crossing ID:		C8-C7			**End Time**		11:50	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	604255	BM_read			**Transducer SN:**			
North	7260877	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0				**0.100**
2	2.00	0.10		0.02			**0.003**	**0.080**
3	3.00	0.06		0.06			**0.004**	**0.090**
4	4.00	0.12		0.1			**0.012**	**0.135**
5	5.00	0.15		0.07			**0.011**	**0.135**
6	6.00	0.12		0.07			**0.008**	**0.145**
7	7.00	0.17		0.05			**0.009**	**0.180**
8	8.00	0.19		0.02			**0.004**	**0.195**
9	9.00	0.20		0.04			**0.008**	**0.180**
10	10.00	0.16		0.06			**0.010**	**0.160**
11	11.00	0.16		0.04			**0.006**	**0.150**
12	12.00	0.14		0.07			**0.010**	**0.130**
13	13.00	0.12		0.07			**0.008**	**0.125**
14	14.00	0.13		0.05			**0.007**	**0.115**
15	15.00	0.10		0.03			**0.002**	**0.030**
16	15.60	0.00		0			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.101**	
						A(m2)	**1.95**	
						B(m)	**15.6**	

A24.0 LAKE C38 (NEMO LAKE) & OUTLET (STREAM C38-C12)

Parameter	Value	Note
Drainage Area (km^2)	3.5	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	3	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	0.2	Measured in the field, based on vegetation
Wetted Width (m)	1.4	Measured in the field 4 August 2015
Max. Wetted Depth (m)	0.12	Measured in the field 4 August 2015
Channel Length (km)	0.22	Measured from CanVec data
Outlet Channel Slope (m/m)	0.024	Average slope, measured in the field
Bed Material	Boulders, cobble, gravel	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	606646 m E, 7258165 m N, 157.42 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	606615 m E, 7258148 m N	
Comment	Poorly defined boulder channel with some well-defined portions. Cross-sectional data are available in discharge calculation sheets.	



Lake C38: Benchmark location.

14 June 2015. View from outlet looking south at Lake C38.

17 September 2015. Upstream view of the watercourse and Lake C38 (south)

4 August 2015. Upstream view of the watercourse and Lake C38 (south).

4 August 2015. Downstream view of the watercourse (north).

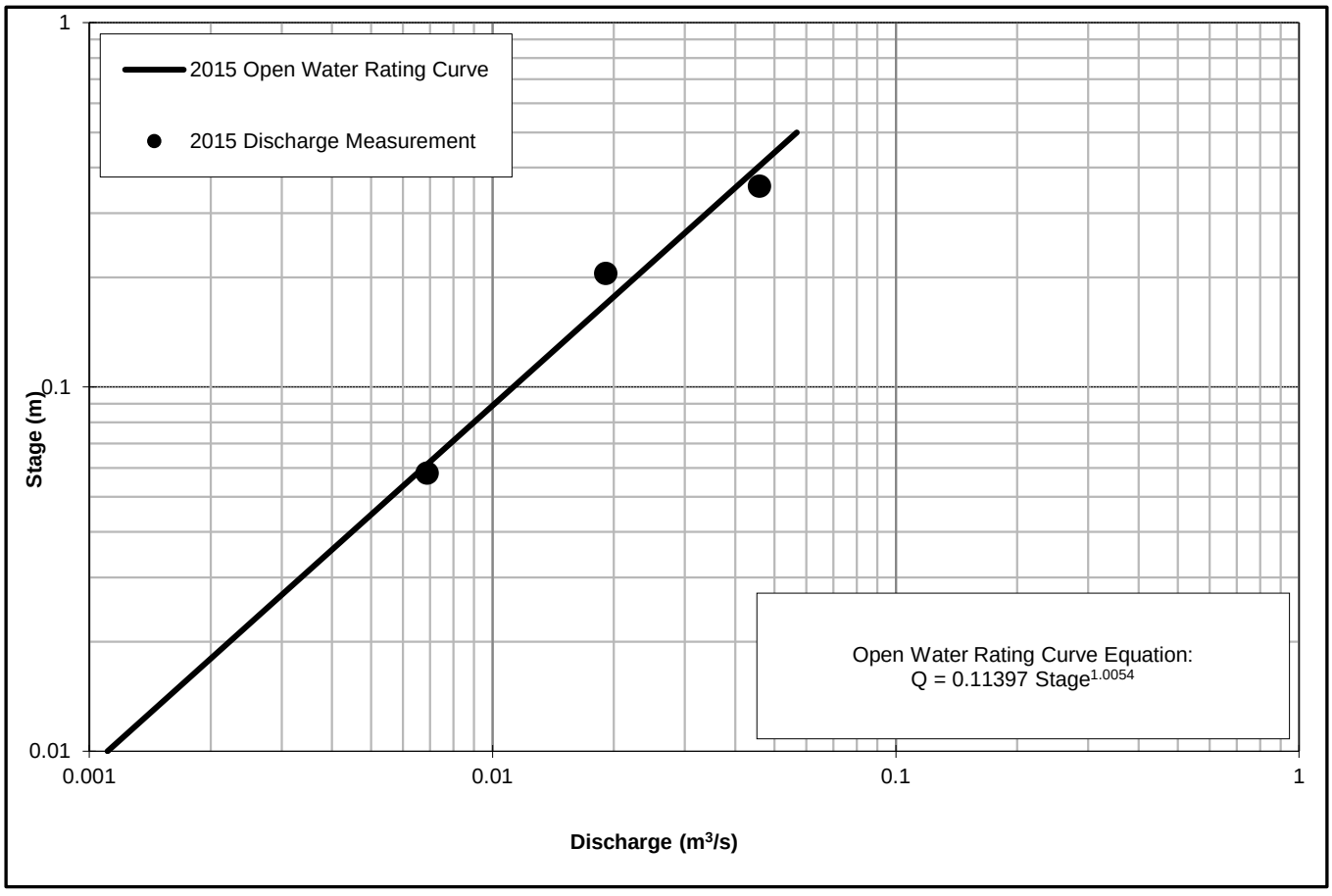


Figure 7: 2015 Stage-Discharge Rating Curve (Lake C38)

Lake C38 (Nemo Lake) - 2015

MEAN DAILY DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	0.04	0.02	0.01	-	-	-
2	-	-	-	-	-	-	0.04	0.02	0.01	-	-	-
3	-	-	-	-	-	-	0.03	0.02	0.01	-	-	-
4	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
5	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
6	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
7	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
8	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
9	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
10	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
11	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
12	-	-	-	-	-	-	0.03	0.02	0.00	-	-	-
13	-	-	-	-	-	0.04	0.03	0.02	0.00	-	-	-
14	-	-	-	-	-	0.04	0.03	0.02	0.01	-	-	-
15	-	-	-	-	-	0.04	0.03	0.01	0.01	-	-	-
16	-	-	-	-	-	0.04	0.03	0.01	0.01	-	-	-
17	-	-	-	-	-	0.04	0.03	0.01	0.01	-	-	-
18	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
19	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
20	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
21	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
22	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
23	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
24	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
25	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
26	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
27	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
28	-	-	-	-	-	0.04	0.03	0.01	-	-	-	-
29	-	-	-	-	-	0.04	0.02	0.01	-	-	-	-
30	-	-	-	-	-	0.04	0.02	0.01	-	-	-	-
31	-	-	-	-	-	-	0.02	0.01	-	-	-	-
MIN	-	-	-	-	-	0.035	0.025	0.006	0.002	-	-	-
MEAN	-	-	-	-	-	0.038	0.030	0.014	0.004	-	-	-
MAX	-	-	-	-	-	0.039	0.036	0.024	0.006	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	185,489	59,834	81,074	38,325	6,256
Water Yield (mm) =	52.3	32%	44%	21%	3%

Lake C38 (Nemo Lake) - 2015

MEAN DAILY WATER SURFACE ELEVATION (masl) BASED ON BENCHMARK ELEVATION 157.42 masl

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	155.949	155.841	155.677	-	-	-
2	-	-	-	-	-	-	155.942	155.833	155.677	-	-	-
3	-	-	-	-	-	-	155.938	155.827	155.675	-	-	-
4	-	-	-	-	-	-	155.930	155.827	155.672	-	-	-
5	-	-	-	-	-	-	155.928	155.828	155.669	-	-	-
6	-	-	-	-	-	-	155.925	155.821	155.664	-	-	-
7	-	-	-	-	-	-	155.921	155.815	155.661	-	-	-
8	-	-	-	-	-	-	155.917	155.808	155.657	-	-	-
9	-	-	-	-	-	-	155.918	155.800	155.654	-	-	-
10	-	-	-	-	-	-	155.924	155.794	155.650	-	-	-
11	-	-	-	-	-	-	155.922	155.787	155.647	-	-	-
12	-	-	-	-	-	-	155.918	155.773	155.660	-	-	-
13	-	-	-	-	-	155.940 P	155.923	155.772	155.671	-	-	-
14	-	-	-	-	-	155.957	155.917	155.765	155.676	-	-	-
15	-	-	-	-	-	155.967	155.911	155.760	155.679	-	-	-
16	-	-	-	-	-	155.973	155.906	155.750	155.683	-	-	-
17	-	-	-	-	-	155.977	155.901	155.743	155.684 P	-	-	-
18	-	-	-	-	-	155.977	155.895	155.738	-	-	-	-
19	-	-	-	-	-	155.976	155.888	155.734	-	-	-	-
20	-	-	-	-	-	155.976	155.885	155.730	-	-	-	-
21	-	-	-	-	-	155.978	155.881	155.723	-	-	-	-
22	-	-	-	-	-	155.977	155.876	155.716	-	-	-	-
23	-	-	-	-	-	155.973	155.873	155.712	-	-	-	-
24	-	-	-	-	-	155.974	155.866	155.709	-	-	-	-
25	-	-	-	-	-	155.974	155.860	155.705	-	-	-	-
26	-	-	-	-	-	155.977	155.856	155.700	-	-	-	-
27	-	-	-	-	-	155.972	155.855	155.696	-	-	-	-
28	-	-	-	-	-	155.966	155.853	155.692	-	-	-	-
29	-	-	-	-	-	155.962	155.849	155.691	-	-	-	-
30	-	-	-	-	-	155.956	155.847	155.690	-	-	-	-
31	-	-	-	-	-	-	155.847	155.683	-	-	-	-
MIN	-	-	-	-	-	155.940	155.847	155.683	155.647	-	-	-
MEAN	-	-	-	-	-	155.969	155.898	155.757	155.668	-	-	-
MAX	-	-	-	-	-	155.978	155.949	155.841	155.684	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

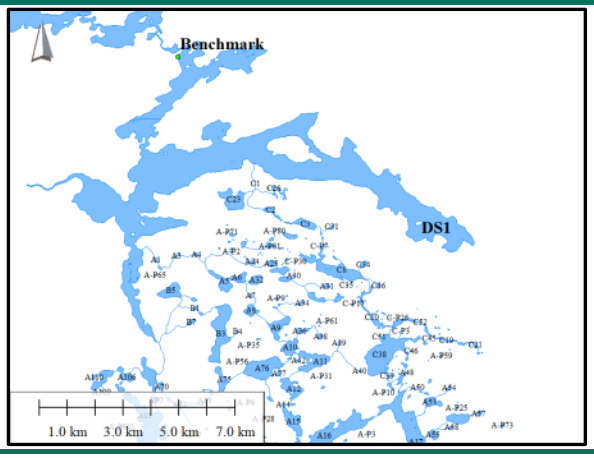
OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq			**Date**		14-Jun-15	
Waterbody:		C38			**Start Time**		13:00	
Crossing ID:		C38-C12			**End Time**		13:30	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606634	BM_read			**Transducer SN:**			
North	7258188	WL_read			**Meter Type/SN:**		Swoffer	
Elevation, Zone	14W	WL_Elev			**Crew:**	CJ, JRL		
STATION	DISTANCE		Velocity		Optional			
Start	FROM LDB	DEPTH	0.2 DEPTH	0.6/0.8 DEPTH	ANGLE OF FLOW		Qi	Ai
LDB	(m)	(m)	(m/s)	(m/s)	(º)		(m3/s)	(m2)
1	1.40	0.00		0.00				**0.016**
2	1.60	0.16		0.23			**0.007**	**0.026**
3	1.80	0.10		0.38			**0.008**	**0.018**
4	2.00	0.08		0.40			**0.006**	**0.017**
5	2.20	0.09		0.05			**0.001**	**0.034**
6	2.60	0.08		0.30			**0.007**	**0.014**
7	2.80	0.06		0.20			**0.003**	**0.018**
8	3.05	0.08		0.30			**0.005**	**0.014**
9	3.20	0.10		0.30			**0.005**	**0.021**
10	3.40	0.11		0.03			**0.001**	**0.024**
11	3.60	0.13		0.09			**0.002**	**0.024**
12	3.80	0.11		0.00			**0.000**	**0.022**
13	4.00	0.11		0.01			**0.000**	**0.017**
14	4.30	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.046**	
						A(m2)	**0.26**	
						B(m)	**2.9**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - trip 2			**Date**		04-Aug-15	
Waterbody:		C38			**Start Time**		16:45	
Crossing ID:		C38-C12			**End Time**		17:00	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606635	BM_read			**Transducer SN:**			
North	7258187	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.003**
2	0.15	0.04		0.00			**0.000**	**0.011**
3	0.30	0.10		0.17			**0.003**	**0.022**
4	0.50	0.12		0.02			**0.000**	**0.015**
5	0.70	0.03		0.00			**0.000**	**0.000**
6	0.71	0.00		0.00			**0.000**	**0.010**
7	0.90	0.10		0.36			**0.005**	**0.010**
8	1.00	0.10		0.36			**0.005**	**0.020**
9	1.20	0.10		0.36			**0.004**	**0.001**
10	1.21	0.09		0.07			**0.001**	**0.017**
11	1.40	0.09		0.07			**0.001**	**0.000**
12	1.41	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.019**	
						A(m2)	**0.11**	
						B(m)	**1.4**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		17-Sep-15	
Waterbody:		C38			**Start Time**		9:20	
Crossing ID:		C38-C12			**End Time**		9:25	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	606634	BM_read			**Transducer SN:**			
North	7258188	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.002**
2	0.20	0.02		0.11			**0.001**	**0.006**
3	0.50	0.02		0.12			**0.001**	**0.006**
4	0.80	0.02		0.12			**0.001**	**0.007**
5	1.00	0.05		0.17			**0.003**	**0.012**
6	1.40	0.01		0.15			**0.001**	**0.009**
7	1.70	0.05		0.13			**0.002**	**0.007**
8	2.00	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**0.007**	
						A(m2)	**0.05**	
						B(m)	**2.0**	

A25.0 LAKE DS1 & OUTLET (STREAM DS1)

Parameter	Value	Note
Drainage Area (km^2)	898	Based on DEM (PhotoSat 2015)
Bankfull Width (m)	77	Measured in the field, based on vegetation
Max. Bankfull Depth (m)	1.4	Measured in the field, based on vegetation
Wetted Width (m)	45.5	Measured in the field 5 August 2015
Max. Wetted Depth (m)	0.74	Measured in the field 5 August 2015
Channel Length (km)	0.10	Measured from CanVec data
Outlet Channel Slope (m/m)	0.006	Average slope, measured in the field
Bed Material	Boulders, cobbles	
Bank Material	Boulders, cobbles, organics	
Bank Vegetation	Grass	
Benchmark Coordinates	599092 m E, 7268034 m N, 107.31 masl	NAD83 Zone 14
Logger/ Staff Gauge Coordinates	599253 m E, 7268300 m N	
Comment	Well defined boulder channel. Cross-sectional data are available in discharge calculation sheets.	



Lake DS1: Benchmark location.

12 June 2015. View looking east at Lake DS1 and staff gauge.

16 September 2015. View looking south east at Lake DS1 and outlet.

5 August 2015. Looking north-west at the watercourse.

5 August 2015. Looking north at the watercourse.

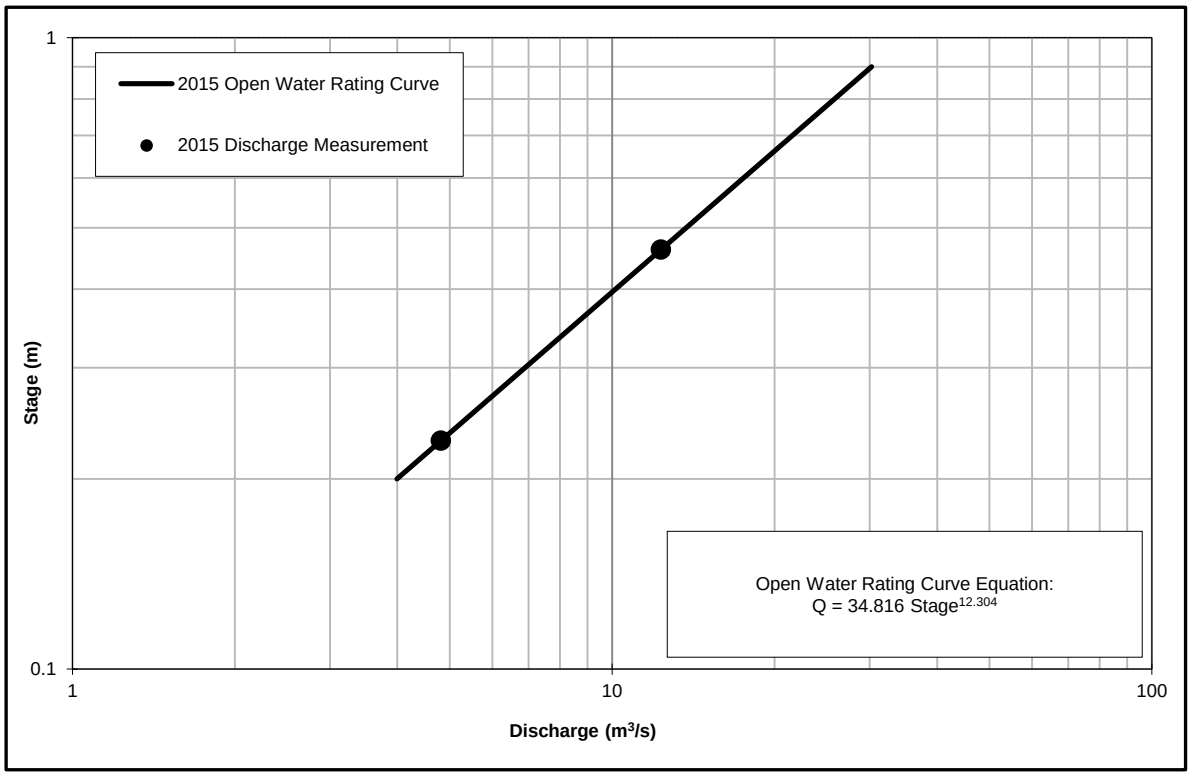


Figure 8: 2015 Stage-Discharge Rating Curve (Lake DS1)

Lake DS1 - 2015

MEAN DAILY DISCHARGE (m^3/s)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	43.03	15.09	3.96	-	-	-
2	-	-	-	-	-	-	41.25	14.46	3.88	-	-	-
3	-	-	-	-	-	-	39.73	13.75	3.81	-	-	-
4	-	-	-	-	-	-	37.94	13.23	3.67	-	-	-
5	-	-	-	-	-	-	36.10	12.65	3.54	-	-	-
6	-	-	-	-	-	-	34.74	12.12	3.41	-	-	-
7	-	-	-	-	-	-	33.49	11.52	3.32	-	-	-
8	-	-	-	-	-	-	32.25	11.12	3.17	-	-	-
9	-	-	-	-	-	-	31.35	10.68	3.07	-	-	-
10	-	-	-	-	-	-	30.68	10.03	2.99	-	-	-
11	-	-	-	-	-	-	30.33	9.57	2.89	-	-	-
12	-	-	-	-	-	15.99 P	30.14	8.88	3.04	-	-	-
13	-	-	-	-	-	24.84	29.74	8.73	3.31	-	-	-
14	-	-	-	-	-	38.71	28.90	8.29	3.83	-	-	-
15	-	-	-	-	-	51.45	27.87	7.83	4.41	-	-	-
16	-	-	-	-	-	57.22	26.89	7.36	4.82 P	-	-	-
17	-	-	-	-	-	58.86	25.93	7.00	-	-	-	-
18	-	-	-	-	-	58.67	24.91	6.73	-	-	-	-
19	-	-	-	-	-	57.53	23.87	6.42	-	-	-	-
20	-	-	-	-	-	55.81	23.02	6.28	-	-	-	-
21	-	-	-	-	-	54.29	22.12	6.08	-	-	-	-
22	-	-	-	-	-	54.06	21.29	5.64	-	-	-	-
23	-	-	-	-	-	52.48	20.62	5.40	-	-	-	-
24	-	-	-	-	-	50.73	19.84	5.20	-	-	-	-
25	-	-	-	-	-	49.52	18.82	5.03	-	-	-	-
26	-	-	-	-	-	50.07	18.00	4.79	-	-	-	-
27	-	-	-	-	-	50.95	17.50	4.59	-	-	-	-
28	-	-	-	-	-	48.21	16.93	4.42	-	-	-	-
29	-	-	-	-	-	46.60	16.44	4.32	-	-	-	-
30	-	-	-	-	-	44.89	15.97	4.24	-	-	-	-
31	-	-	-	-	-	-	15.66	4.14	-	-	-	-
MIN	-	-	-	-	-	15.988	15.661	4.140	2.888	-	-	-
MEAN	-	-	-	-	-	48.468	26.947	8.245	3.570	-	-	-
MAX	-	-	-	-	-	58.864	43.030	15.093	4.821	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

Water Yield (m^3) =	178,758,458	79,565,618	72,173,563	22,083,501	4,935,776
Water Yield (mm) =	199.2	45%	40%	12%	3%

Lake DS1 - 2015

MEAN DAILY WATER SURFACE ELEVATION (m) BASED ON BENCHMARK ELEVATION 107.31 masl

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	-	-	-	-	-	100.170	99.537	99.199	-	-	-
2	-	-	-	-	-	-	100.134	99.520	99.196	-	-	-
3	-	-	-	-	-	-	100.102	99.501	99.193	-	-	-
4	-	-	-	-	-	-	100.065	99.487	99.188	-	-	-
5	-	-	-	-	-	-	100.027	99.471	99.183	-	-	-
6	-	-	-	-	-	-	99.998	99.456	99.178	-	-	-
7	-	-	-	-	-	-	99.971	99.439	99.174	-	-	-
8	-	-	-	-	-	-	99.944	99.428	99.168	-	-	-
9	-	-	-	-	-	-	99.925	99.415	99.164	-	-	-
10	-	-	-	-	-	-	99.910	99.397	99.161	-	-	-
11	-	-	-	-	-	-	99.902	99.383	99.157	-	-	-
12	-	-	-	-	-	99.560 P	99.898	99.362	99.163	-	-	-
13	-	-	-	-	-	99.776	99.889	99.357	99.174	-	-	-
14	-	-	-	-	-	100.080	99.870	99.344	99.194	-	-	-
15	-	-	-	-	-	100.336	99.847	99.330	99.215	-	-	-
16	-	-	-	-	-	100.446	99.825	99.315	99.230 P	-	-	-
17	-	-	-	-	-	100.477	99.803	99.303	-	-	-	-
18	-	-	-	-	-	100.473	99.779	99.295	-	-	-	-
19	-	-	-	-	-	100.452	99.755	99.285	-	-	-	-
20	-	-	-	-	-	100.419	99.735	99.280	-	-	-	-
21	-	-	-	-	-	100.390	99.713	99.273	-	-	-	-
22	-	-	-	-	-	100.386	99.694	99.259	-	-	-	-
23	-	-	-	-	-	100.356	99.677	99.250	-	-	-	-
24	-	-	-	-	-	100.322	99.658	99.243	-	-	-	-
25	-	-	-	-	-	100.299	99.633	99.237	-	-	-	-
26	-	-	-	-	-	100.309	99.612	99.229	-	-	-	-
27	-	-	-	-	-	100.326	99.599	99.222	-	-	-	-
28	-	-	-	-	-	100.273	99.585	99.216	-	-	-	-
29	-	-	-	-	-	100.241	99.572	99.212	-	-	-	-
30	-	-	-	-	-	100.207	99.560	99.209	-	-	-	-
31	-	-	-	-	-	-	99.552	99.205	-	-	-	-
MIN	-	-	-	-	-	99.560	99.552	99.205	99.157	-	-	-
MEAN	-	-	-	-	-	100.265	99.820	99.337	99.184	-	-	-
MAX	-	-	-	-	-	100.477	100.170	99.537	99.230	-	-	-

NOTES: P - PARTIAL DAILY AVERAGE

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		Amaruq - Trip 2			**Date**		05-Aug-15	
Waterbody:		DS1			**Start Time**		13:10	
Crossing ID:					**End Time**		13:45	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	599152	BM_read			**Transducer SN:**			
North	7268331	WL_read			**Meter Type/SN:**		Marsh McBirney	
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, JN		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**1.000**
2	8.00	0.25		0.25			**0.297**	**0.293**
3	9.50	0.14		0.44			**0.092**	**0.330**
4	11.00	0.30		0.50			**0.225**	**0.488**
5	12.50	0.35		0.65			**0.341**	**0.578**
6	14.00	0.42		0.80			**0.504**	**0.765**
7	15.50	0.60		1.06			**0.954**	**0.915**
8	17.00	0.62		0.87			**0.809**	**0.953**
9	18.50	0.65		0.95			**0.926**	**0.968**
10	20.00	0.64		0.87			**0.835**	**0.945**
11	21.50	0.62		0.95			**0.884**	**0.990**
12	23.00	0.70		1.00			**1.050**	**1.080**
13	24.50	0.74		1.00			**1.110**	**0.960**
14	26.00	0.54		1.08			**0.875**	**0.885**
15	27.50	0.64		1.00			**0.960**	**0.810**
16	29.00	0.44		0.85			**0.561**	**0.630**
17	30.50	0.40		0.80			**0.480**	**0.698**
18	32.00	0.53		0.50			**0.331**	**0.470**
19	33.00	0.41		0.60			**0.308**	**0.660**
20	34.50	0.47		0.51			**0.360**	**0.615**
21	36.00	0.35		0.55			**0.289**	**0.375**
22	37.50	0.15		0.40			**0.090**	**0.150**
23	39.00	0.05		0.22			**0.017**	**0.068**
24	40.50	0.04		0.12			**0.016**	**0.100**
25	45.50	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**12.313**	
						A(m2)	**15.72**	
						B(m)	**45.5**	

OPEN WATER DISCHARGE CALCULATION SPREADSHEET								
Project Name, Number:		1524321 - Amaruq Trip 3			**Date**		16-Sep-15	
Waterbody:		DS1			**Start Time**		14:10	
Crossing ID:					**End Time**		14:35	
LDB UTM Location		**Survey**			**Datalogger SN:**			
East	599158	BM_read			**Transducer SN:**			
North	7268338	WL_read			**Meter Type/SN:**			
Elevation, Zone	14W	WL_Elev			**Crew:**	JRL, DC		
STATION Start LDB	DISTANCE FROM LDB (m)	DEPTH (m)	Velocity 0.2 DEPTH (m/s)	Velocity 0.6/0.8 DEPTH (m/s)	Optional ANGLE OF FLOW (º)		Qi (m3/s)	Ai (m2)
1	0.00	0.00		0.00				**0.110**
2	1.00	0.22		0.34			**0.075**	**0.250**
3	2.00	0.28		0.37			**0.104**	**0.270**
4	3.00	0.26		0.59			**0.153**	**0.320**
5	4.00	0.38		0.56			**0.213**	**0.375**
6	5.00	0.37		0.71			**0.263**	**0.350**
7	6.00	0.33		0.43			**0.142**	**0.370**
8	7.00	0.41		0.60			**0.246**	**0.435**
9	8.00	0.46		0.61			**0.281**	**0.470**
10	9.00	0.48		0.60			**0.288**	**0.530**
11	10.00	0.58		0.61			**0.354**	**0.590**
12	11.00	0.60		0.70			**0.420**	**0.605**
13	12.00	0.61		0.75			**0.458**	**0.585**
14	13.00	0.56		0.56			**0.314**	**0.570**
15	14.00	0.58		0.58			**0.336**	**0.540**
16	15.00	0.50		0.50			**0.250**	**0.460**
17	16.00	0.42		0.42			**0.176**	**0.440**
18	17.00	0.46		0.46			**0.212**	**0.440**
19	18.00	0.42		0.42			**0.176**	**0.405**
20	19.00	0.39		0.39			**0.152**	**0.350**
21	20.00	0.31		0.31			**0.096**	**0.270**
22	21.00	0.23		0.23			**0.053**	**0.215**
23	22.00	0.20		0.20			**0.040**	**0.155**
24	23.00	0.11		0.11			**0.012**	**0.105**
25	24.00	0.10		0.10			**0.008**	**0.030**
26	24.60	0.00		0.00			**0.000**	**0.000**
NOTES:					**RESULTS:**	**Q (m3/s)**	**4.821**	
						A(m2)	**9.24**	
						B(m)	**24.6**	

APPENDIX B

Shoreline Baseline Characterization

B1.0 LAKE A12

Figure B-1: Shoreline with boulders (looking southwest)

Figure B-2: Lake A12 main outlet channel with boulder gardens (looking northeast)

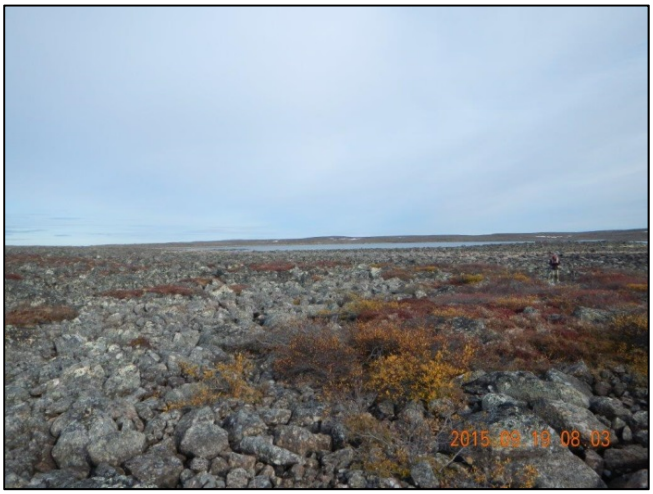


Figure B-3: Lake A12 main outlet towards Lake A11, mostly subsurface (looking northeast)

Figure B-4: Shoreline at the lake outlet with shallow and bouldery beach (looking west)

B2.0 LAKE A15

Figure B-5: Shoreline with boulder garden beaches (looking south)

Figure B-6: Eastern shoreline with boulder garden beaches (looking north)

Figure B-7: Lake A15 outlet channel, right bank looking downstream

Figure B-8: Shoreline with boulder gardens at the lake inlet (looking north)

B3.0 LAKE A16 (MAMMOTH LAKE)

Figure B-9: Lake A16 outlet channel, left bank looking upstream

Figure B-10: Lake A16 outlet channel, large boulders with the flow through the boulders, looking downstream

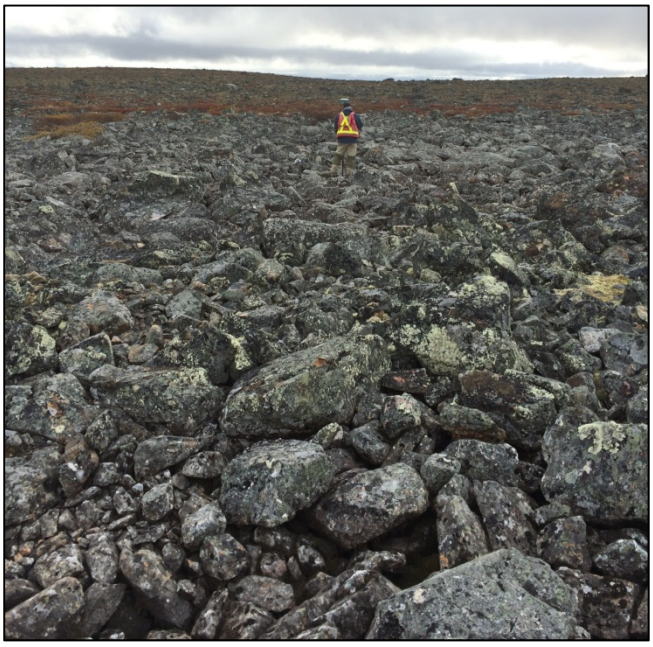


Figure B-11: Lake A16 outlet channel, with boulder gardens, view towards right bank

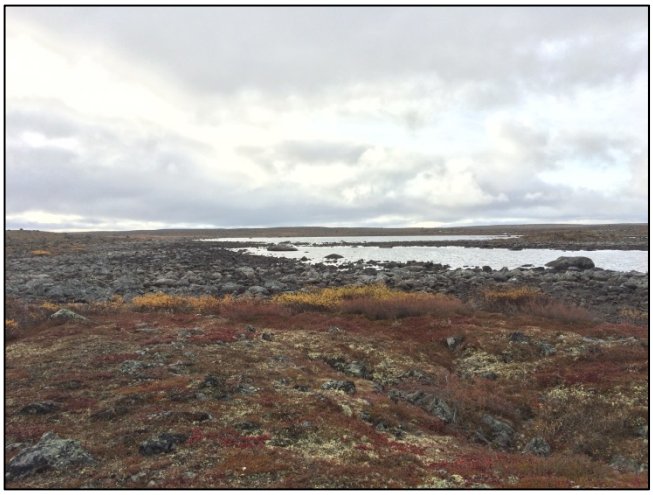


Figure B-12: Shallow shoreline extending into the lake with large boulders as the main material (looking south)

B4.0 LAKE A17 (WHALE TAIL LAKE)

Figure B-13: Shallow shoreline with gravel and cobble beach inserted with large boulders (looking northeast)

Figure B-14: Shallow shoreline with gravel and cobble beach inserted with large boulders (looking south)

Figure B-15: Lake A17 (Whale Tail Lake) outlet channel looking upstream

Figure B-16: Lake A17 (Whale Tail Lake) outlet channel aerial view looking upstream

B5.0 LAKE A18

Figure B-17: Lake A18 outlet channel with a boulder garden, looking downstream

Figure B-18: Lake A18 outlet channel with a boulder garden, looking upstream

Figure B-19: Shoreline with boulder materials partially covered by soils and organics (looking north)

Figure B-20: Lake A18 left bank floodplain (looking south)

B6.0 LAKE A45

Figure B-21: Lake A45 outlet channel looking upstream from the left bank

Figure B-22: Shoreline with large boulders relatively shallow (looking south)

Figure B-23: Shoreline with boulder garden at the lake outlet (looking north)

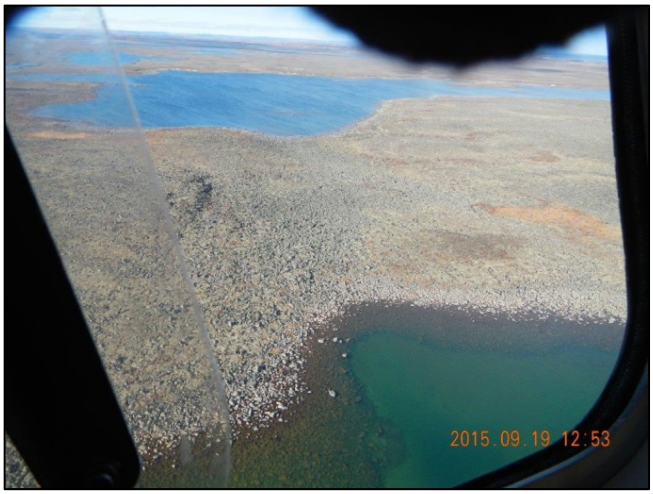


Figure B-24: Aerial view of Lake A45 outlet channel looking downstream. Undefined channel with boulder garden (looking north)

B7.0 LAKE A72

Figure B-25: Lake A72 Outlet channel, right bank looking upstream

Figure B-26: Lake A72 Outlet channel, left bank looking upstream

Figure B-27: Lake A72 Outlet channel view towards left bank at the cross section location

Figure B-28: Lake A72 Outlet channel view downstream

B8.0 LAKE A69

Figure B-29: Shoreline with large boulders (looking north)

Figure B-30: Shoreline with boulders in the shallow area (looking southeast)

Figure B-31: Shallow shoreline with larger boulders (looking west)

Figure B-32: Lakebed shoreline with gravel and cobble at the lake outlet

B9.0 LAKE A76

Figure B-33:Shoreline with large boulders and bedrock outcrop above the high water mark (looking northwest)

Figure B-34: Shoreline with boulder gardens (looking east)

Figure B-35: Shallow shoreline with cobble and boulders covered with soils and vegetation (south shore)

Figure B-36: Lake A76 main outlet channel looking upstream. Boulder gardens with shallow areas

Figure B-37: Lake A76 main outlet channel looking downstream. Boulder gardens with shallow areas and with the majority of the flow subsurface

Figure B-38: Lake A76 secondary outlet channel looking towards the right bank. Boulder gardens with no visible flow across the entire channel

APPENDIX C

Water Balance Model

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TABLES

FIGURES

C1.0 INTRODUCTION

A water balance model was developed for the baseline study area (BSA) to assess mean characteristics and natural variability of discharge and water levels of lake outlets in the baseline area. This appendix describes the water balance model including input data, model structure, calibration, preliminary validation, and results.

The water balance model was developed using GoldSim software with a 1-hour time step and input data for the period of 1950 to 2015. Model output results were obtained for all years, with the exception of years with meteorological input data gaps, including years 1951, 1979, 1993, and 2010, which were not modeled. The basic water balance elements for each modeled lake reservoir considered rainfall and snowmelt runoff, lake evaporation, changes in lake storage, and outflow to downstream watersheds.

The model was calibrated using runoff coefficients for land surfaces, lake outlet stage-discharge rating curves, and degree-day models for snowmelt and formation of ice in outlet channels. Runoff coefficients for land surfaces account for water losses to storage and summer evapotranspiration. The runoff coefficients were calibrated to the calculated annual water yield of hydrometric stations with available data for most of the 2015 open water season (i.e., stations with a period of record of 97 days or greater). Lake outlet stage-discharge rating curves and degree-day models were calibrated to site-specific data.

The calibrated model was used to generate daily time series data sets of lake stages and lake outlet discharges for the BSA. Frequency analyses were completed for key sites to provide a derived historical baseline of lake stage and lake outlet discharge regimes.

C2.0 MODEL STRUCTURE

Each lake in the BSA with a surface area greater than 20 hectares (ha) was modeled as a reservoir as described in the schematic diagrams (Figure C-1; Figure C-2). Inflows to the reservoir consisted of inflows from upstream watersheds and local watershed rainfall and snowmelt, including a runoff coefficient to account for storage and evapotranspiration losses. Snow-water equivalents (SWE) were calculated based on a sublimation adjustment to account for snowpack losses, and snowmelt rates were calculated using a degree-day model. Outflows consisted of lake outlet discharges and evaporative losses. Modeled lakes accounted for differences between inputs and outputs by calculating corresponding changes in lake stages and storage volumes.

A key assumption of the model is that losses to deep groundwater and changes to shallow groundwater storage are not significant due to the local permafrost regime and the associated low connectivity of shallow and deep groundwater systems.

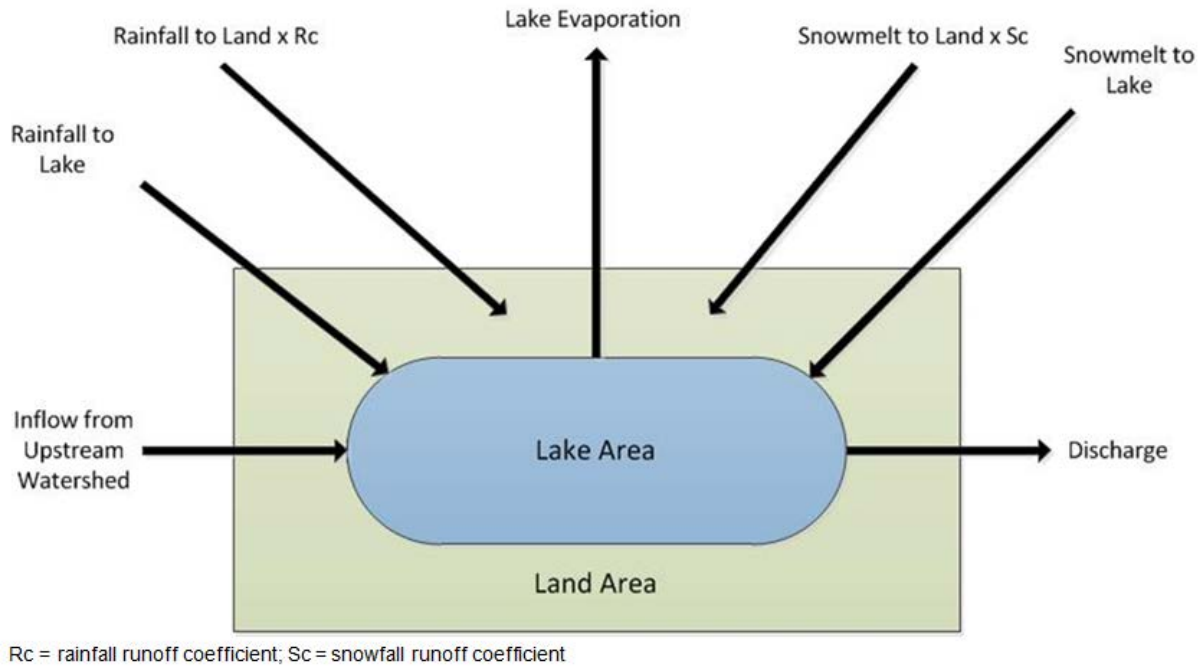
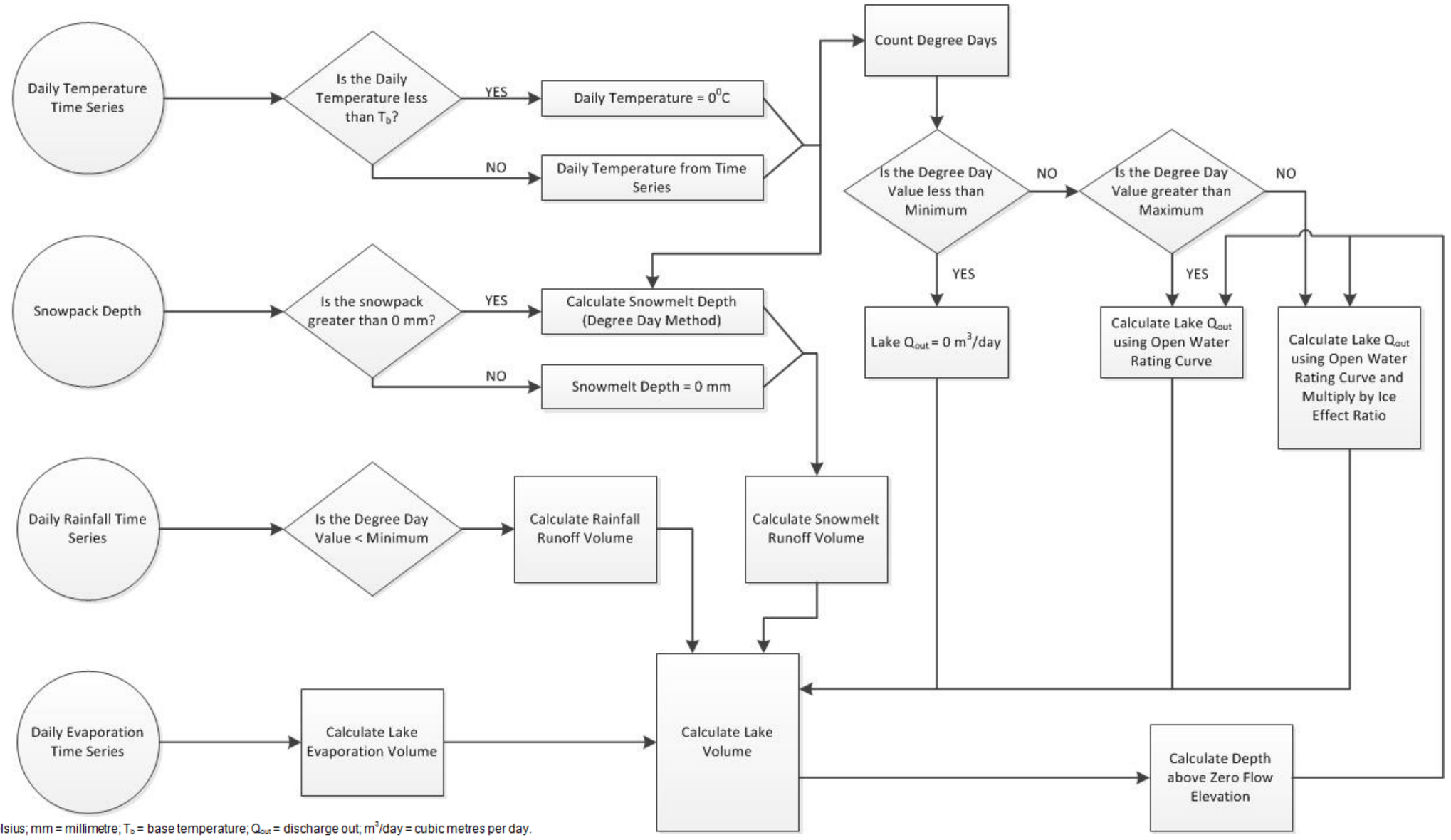


Figure C-1: Schematic of Typical Lake Reservoir Model



°C = degrees Celsius; mm = millimetre; T_b = base temperature; Q_{out} = discharge out; m^3/day = cubic metres per day.

Figure C-2: Water Balance Model Flowchart

C2.1 Meteorological Data

Meteorological data were available from the Baker Lake A meteorological station (Station ID 2300500) operated by the Government of Canada (2015) from 1946 to 2015, and from the Meadowbank Gold Mine (Meadowbank) from 1997 to 2003 (AMEC 2003) and from 2013 to 2015 (provided by Agnico Eagle).

Meteorological data were based on the following datasets:

- Temperature and precipitation from 1950 to 2013 were based on mean daily data available from Baker Lake A. Years with large data gaps (for the purpose of this model, defined as 20 or more days of missing data), including years 1946 to 1949, 1951, 1979, 1993, and 2010, were not considered in the model.

  Temperature was based on mean daily temperature, spatially adjusted using the following equation (AMEC 2003):

  *Mean Daily Temperature (Local) = 1.01 * Mean Daily Temperature (Baker Lake) – 0.63*

  Precipitation was based on mean daily rainfall and mean daily (SWE) derived from the difference between daily precipitation and mean daily rainfall. Precipitation was adjusted for undercatch as follows (AMEC 2003):

  *Adjusted Rainfall = Rainfall * 1.15*

  *Adjusted Snowfall = Snowfall * 1.55*

  *Adjusted Precipitation = Precipitation * 1.38*

  Temperature and rainfall data were only partially available from 1997 to 2003 at Meadowbank (AMEC 2003), and were not considered in the model.

- Temperature and precipitation from 2014 to 2015 were based on mean daily data available from Meadowbank. While data were also available for Year 2013, Year 2013 contains large data gaps (with 159 days missing) and was not considered in the model. Temperature was based on mean daily temperature data. Precipitation is collected by a rain gauge and a canister. Snowfall collected in the canister is melted at room temperature and poured into the rain gauge, and both rainfall and snowfall are recorded as precipitation. As such, the precipitation record was split between rainfall and SWE based on concurrent mean daily temperature data. Rainfall was assumed when mean daily temperatures were greater than 0ºC, and SWE was assumed when mean daily temperatures were equal to or less than 0ºC. Recorded trace events were assigned a value of 0 millimetres (mm) of precipitation. The precipitation record includes “large” (i.e., defined, for the purpose of this section, as exceeding 10 days per month) data gaps in November 2014 (13 days missing), January (16 days missing) and June (14 days missing) 2015. Gaps were assigned a value of 0 mm. Precipitation was adjusted for undercatch using the adjustment factors presented above.

- Evaporation was based on mean monthly evaporation derived from previous baseline studies (AMEC 2003), and was applied as a constant daily value for each month.

C2.2 Watershed Characteristics

Watershed delineation and analysis were based on available DEM data (PhotoSat 2015), as discussed in Section 2.2.

C2.2.1 Land and Lake Areas

Seventy-four lakes with surface areas greater than 20 ha were modeled, including 54 lakes in the A watershed, four lakes in the B watershed, 15 lakes in the C watershed, and Lake DS1. Lake DS1 has a large and complex watershed and the lake was modeled using a lumped area for its tributaries, other than the A, B, and C watersheds, which were modeled explicitly. Local watershed, lake, tributary, and land areas are presented in Table C-1 for each modeled lake.

Table C-1: Local Watershed, Lake, Tributary, and Land Areas of Modeled Lakes (km^2)

Name	Local Watershed	Lake	Tributary	Land	Name	Local Watershed	Lake	Tributary	Land
A10	0.578	0.230	0.00921	0.339	**A63**	0.480	0.0792	0	0.401
A103	0.692	0.0583	0	0.634	**A65**	3.28	0.589	0.0378	2.65
A104	1.44	0.108	0	1.33	**A69**	7.88	0.464	0.0313	7.38
A106	0.73	0.107	0.0820	0.541	**A75**	1.81	0.180	0.000553	1.63
A108	0.854	0.221	0.0241	0.609	**A76**	2.94	0.710	0.0471	2.18
A11	4.18	0.430	0.0385	3.71	**A8**	0.896	0.118	0.000992	0.777
A12	1.58	0.289	0.0211	1.27	**A81**	6.08	1.31	0.0191	4.75
A15	2.12	0.333	0.0114	1.77	**A82**	6.02	0.292	0.109	5.62
A16	7.45	1.48	0.00904	5.96	**A83**	2.98	0.0644	0.100	2.81
A17	6.14	1.66	0.0478	4.43	**A85**	2.64	0.0589	0.0111	2.57
A18	0.985	0.158	0.0111	0.816	**A86**	0.636	0.0878	0	0.548
A19	0.609	0.0553	0.00483	0.549	**A87**	1.04	0.176	0	0.860
A20	1.72	0.530	0	1.19	**A9**	2.21	0.278	0.049	1.88
A21	1.06	0.0874	0	0.972	**A91**	0.903	0.145	0	0.758
A22	0.730	0.0496	0	0.680	**A94**	2.33	0.366	0.0512	1.92
A23	3.31	0.273	0.00292	3.03	**A95**	3.75	0.0985	0.0649	3.59
A24	2.58	0.0266	0.162	2.39	**A97**	1.60	0.144	0.0471	1.41
A25	0.322	0.0574	0.00500	0.259	**B1**	0.388	0.0128	0.0108	0.364
A26	0.342	0.109	0.000609	0.232	**B3**	2.78	0.824	0.00262	1.96
A27	1.05	0.0576	0.00700	0.980	**B5**	1.26	0.282	0.0186	0.956
A28	0.791	0.102	0	0.690	**B7**	0.382	0.0388	0	0.343
A29	0.563	0.0492	0	0.514	**C1**	1.42	0.00116	0.0578	1.37
A31	0.204	0.0269	0	0.177	**C10**	1.84	0.134	0.0202	1.68
A32	0.721	0.117	0	0.604	**C12**	0.663	0.0743	0.000831	0.588
A36	1.45	0.0429	0.0451	1.36	**C13**	0.463	0.0173	0.00597	0.440

Table C-1: Local Watershed, Lake, Tributary, and Land Areas of Modeled Lakes (km^2) (continued)

Name	Local Watershed	Lake	Tributary	Land	Name	Local Watershed	Lake	Tributary	Land
A43	0.802	0.140	0.000864	0.661	**C16**	0.198	0.0170	0.00612	0.175
A44	2.30	0.229	0.000933	2.07	**C19**	0.611	0.0389	0.0101	0.562
A45	0.535	0.0295	0	0.505	**C2**	0.738	0.0707	0.000687	0.667
A47	1.23	0.0445	0.0359	1.15	**C20**	0.230	0.0232	0.00042	0.207
A49	0.252	0.0294	0.0048	0.218	**C21**	0.240	0.0268	0.00521	0.208
A5	1.24	0.234	0	1.01	**C23**	1.42	0.438	0	0.979
A53	1.34	0.141	0.0180	1.18	**C3**	2.61	0.200	0.0392	2.37
A55	1.37	0.0764	0.0111	1.28	**C34**	0.372	0.0406	0	0.332
A56	2.79	0.228	0.0427	2.52	**C38**	3.55	1.18	0.0451	2.32
A6	0.967	0.128	0.00633	0.832	**C8**	2.81	0.610	0.127	2.07
A60	2.11	0.427	0.00396	1.68	**C9**	0.222	0.0344	0	0.187
A62	0.737	0.0597	0.000867	0.676	**DS1**	766	24.2	115	627

C2.2.2 Outlet Rating Curves

Lake outlet stage-discharge rating curves were assigned for each modeled lake using one of the following five methods, with applicability as described:

1) Stage-discharge rating curves for lake outlets with available stage-discharge relationships for most of the 2015 open water season (i.e., for a period of record of 97 days or greater) were based on site-specific stage-discharge rating curves (Section 3.2.1; Appendix A). These include the lake outlets of Lake A15, Lake A17 (Whale Tail Lake), Lake A18, Lake A69, Lake C38 (Nemo Lake), and Lake DS1.

2) The stage-discharge rating curve for Lake A5 was based on the 2015 stage-discharge rating curve for Lake A69 which is similar to the stage-discharge rating curve of Lake A5 over the monitored period.

3) Lake A12 has two outlets. In the absence of site-specific stage-discharge data, both outlets were modeled using a single rating curve based on the stage-discharge rating curve of Lake A18. The outlet discharging to Lake A11 was assigned 60% of the discharge, and the remaining portion (40%) was assigned to discharge to Lake A77. These proportions were based on instantaneous discharge measurements from August 2015 (Section 3.2.2).

4) Lake A76 has two outlets which were modeled based on field observations using two separate stage-discharge rating curves to assign most of the discharge to Lake A41, while allowing discharge to Lake A75 at high flows. In the absence of continuous site-specific stage-discharge data at both outlets, the stage-discharge rating curve of the outlet discharging to Lake A41 is based on the stage-discharge rating curve of Lake A15. The stage-discharge rating curve of the outlet discharging to Lake A75 was assumed, and was calibrated to match measured water yields at Lake A69, located downstream of Lake A76. Stage-discharge rating curves of Lake A76 are presented in Figure C-3.

5) Stage-discharge rating curves for other lakes (with the exception of upstream lakes and lakes from the C watershed) were based on the stage-discharge rating curve of the closest upstream lake with a site-specific stage-discharge rating curve (e.g., the stage-discharge rating curve of Lake A16 was based on that of Lake A17; the stage-discharge rating curve of Lake A12 was based on that of Lake A15). Stage-discharge of upstream lakes and lakes from the C watershed (other than Lake C38 [Nemo Lake]) were based on the stage-discharge rating curve of Lake A18.

The method used to develop rating curves at each modeled lake is summarized in Table C-2.

Table C-2: Outlet Stage-Discharge Rating Curves

Modeled Lake	Method Used to Develop Outlet Rating Curve
Lake A5	Lake A69
Lake A12-A11	Lake A15*0.6
Lake A12-A77	Lake A15*0.4
Lake A15	Lake A15
Lake A17 (Whale Tail Lake)	Lake A17
Lake A18	Lake A18
Lake A69	Lake A69
Lake A76-A41	Lake A15 (Figure C-3)
Lake A76-A75	Assumed (Figure C-3)
Lake C38	Lake C38
Lake DS1	Lake DS1
All other lakes	Stage-discharge rating curve from the closest upstream lake with a site-specific stage-discharge rating curve, or Lake A18 for upstream lakes and lakes from the C watershed

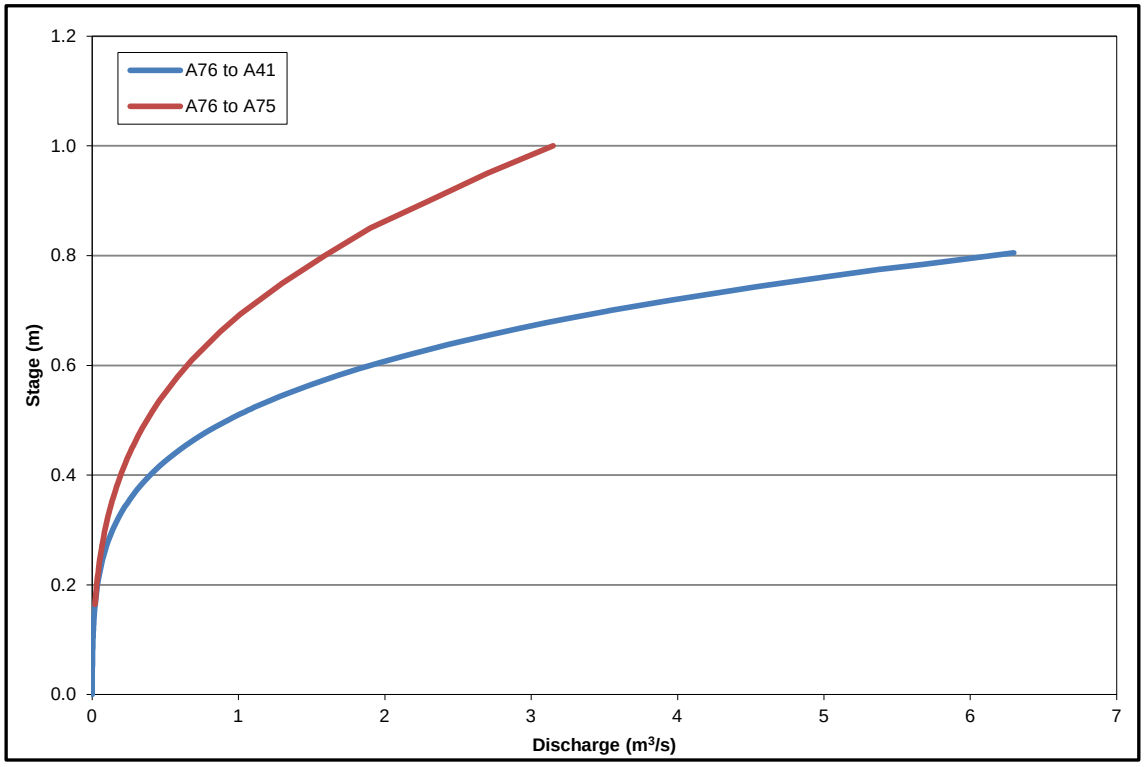


Figure C-3: Stage-Discharge Rating Curves for Lake A76

C2.3 Ice Effects on Lake Outlets

Based on field observations and general experience in the North, the opening of lake outlets during spring is generally a rapid process. This process is related to snowmelt runoff into the lake upstream of the outlet, as well as thaw of ice in the lake outlet. Flowing water provides additional thermal input, and melted or saturated snow on the outlet channel surface has a lower albedo and higher absorption of solar energy, which further accelerates melting. The change from frozen solid to fully open conditions has been observed to occur over a span of up to about four days. Lake outlets and borders are generally the first areas of open water during spring melt, while a floating ice cover may persist in the body of the lake for days or weeks after the outlet opens.

The formation of ice in winter constricts outflow channels and reduces lake discharge rates. The outlets for small lakes become constricted with ice and eventually freeze completely from approximately late October to early June each year.

A numerical relationship between lake outlet discharge and cumulative degree days was developed to account for ice effects during the freezing period in water balance modeling.

C2.3.1 Observations of Ice Formation and Degradation

Ice degradation was observed at several lake outlets during the 2015 baseline program, including outlets of Lake A15, Lake A17 (Whale Tail Lake), Lake A18, and Lake A69, as follows:

- Outlets of Lake A18 and Lake A69 were both observed to start discharging on 10 June 2015, followed by the outlet of Lake A17 on 11 June 2015, and the outlet of Lake A15 on 12 June 2015. It was noted that outlets of Lake A15 and Lake A17 may have started discharging earlier under the ice.
- The outlet of Lake A69 was free of ice on 11 June 2015. This was followed by the outlets of Lake A17 and A18 on 14 June 2015, and Lake A15 on 15 June 2015.

Ice formation was also observed by Agnico Eagle and was described in previous baseline studies (AMEC 2003) as follows:

- full ice cover was observed on small lakes on 2 October 2015;
- partial ice cover was observed on large lakes (e.g., Lake A16 [Mammoth Lake]; Lake A17 [Whale Tail]) on 2 October 2015;
- full ice cover was observed on large lakes on 12 October 2015; and
- previous baseline studies report ongoing discharge to the end of October, and to the end of November at larger lakes (AMEC 2003).

Ice formation and degradation depends on local meteorological conditions, with natural variability from year to year, but is most strongly linked to air temperature. Solar radiation also contributes to ice degradation, but historical data was not available, and air temperature may serve as a partial proxy.

C2.3.2 Method and Results

A degree-day method was developed to simulate the effect of ice conditions on discharge at each lake outlet. Degree-days were added above a base temperature of 0 degrees Celsius (°C) based on daily mean temperatures, which typically begin to exceed 0°C in early June.

The effect of ice on discharge was quantified by the following ratio:

$$\text{Ice Effect Ratio} = Q_{actual} / Q_{predicted}$$

where

Q_{actual} = Discharge measured at the outlet under ice conditions; and

$Q_{predicted}$ = Discharge predicted using an open-water rating curve for the specific outlet.

Thus, an ice effect ratio of 0 implies a frozen outlet, with no discharge, while an ice effect ratio of 1 implies an open outlet, free of ice, and fully discharging.

Ice effect ratios were developed for all modeled lakes, with the exception of Lake DS1 which was assumed to flow continuously over the winter, as follows based on observations of ice formation and ice degradation summarized in Section C2.3.1:

- For Lake A69, ice was assumed to start degrading when cumulative degree-days reach 7.8ºCd (i.e., corresponding to 10 June 2015), and the outlet was assumed to be free of ice when cumulative degree-

days reach 10.4ºCd (i.e., corresponding to 11 June 2015). This ice effect ratio is summarized in Table C-3 and shown on Figure C-4.

- For other lakes, ice was assumed to start degrading when cumulative degree-days reach 7.8ºCd (i.e., corresponding to 10 June 2015), and the outlet was assumed to be free of ice when cumulative degree-days reach 24.3ºCd (i.e., corresponding to 14 June 2015). This ice effect ratio is summarized in Table C-3 and shown on Figure C-4.
- Ice was assumed to start forming once mean daily temperatures fall below 0ºC, and outlets were assumed to be completely frozen at the end of October. As such, the ice effect ratio of 1 was assigned a negative degree day of 1ºCd, and the ice effect ratio of 0 was assigned a negative degree days of 270ºCd (corresponding to 31 October 2015), during the ice formation period. This ice effect ratio is summarized in Table C-3 and shown on Figure C-5.

Table C-3: Ice Effect Ratio Parameters

Parameter	Value
Outlet break-up – closed (Lake A69) (Ice effect ratio of 0)	7.8
Outlet break-up – open (Lake A69) (Ice effect ratio of 1)	10.4
Outlet break-up – closed (all other lakes) (Ice effect ratio of 0)	7.8
Outlet break-up – open (all other lakes) (Ice effect ratio of 1)	24.3
Outlet freeze-up – open (Ice effect ratio of 1)	1.0
Outlet freeze-up – closed (Ice effect ratio of 0)	270

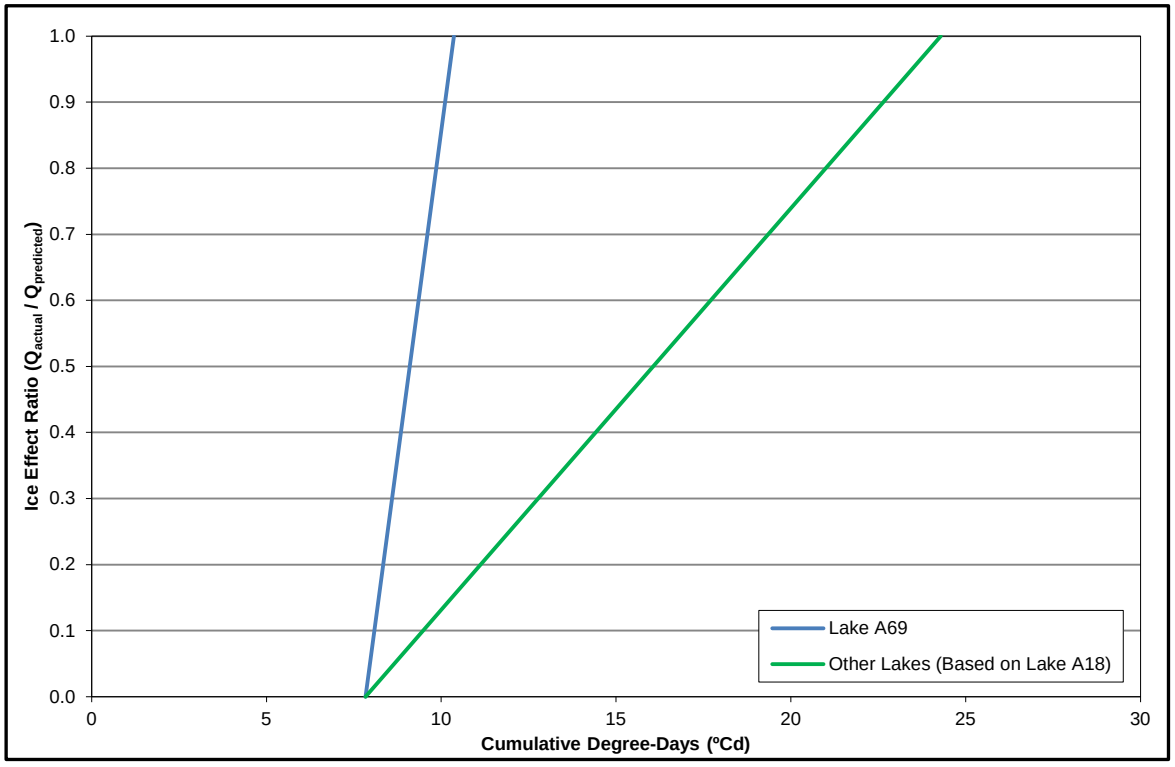


Figure C-4: Ice Degradation Period: Ice Effect Ratios and Cumulative Degree-Days

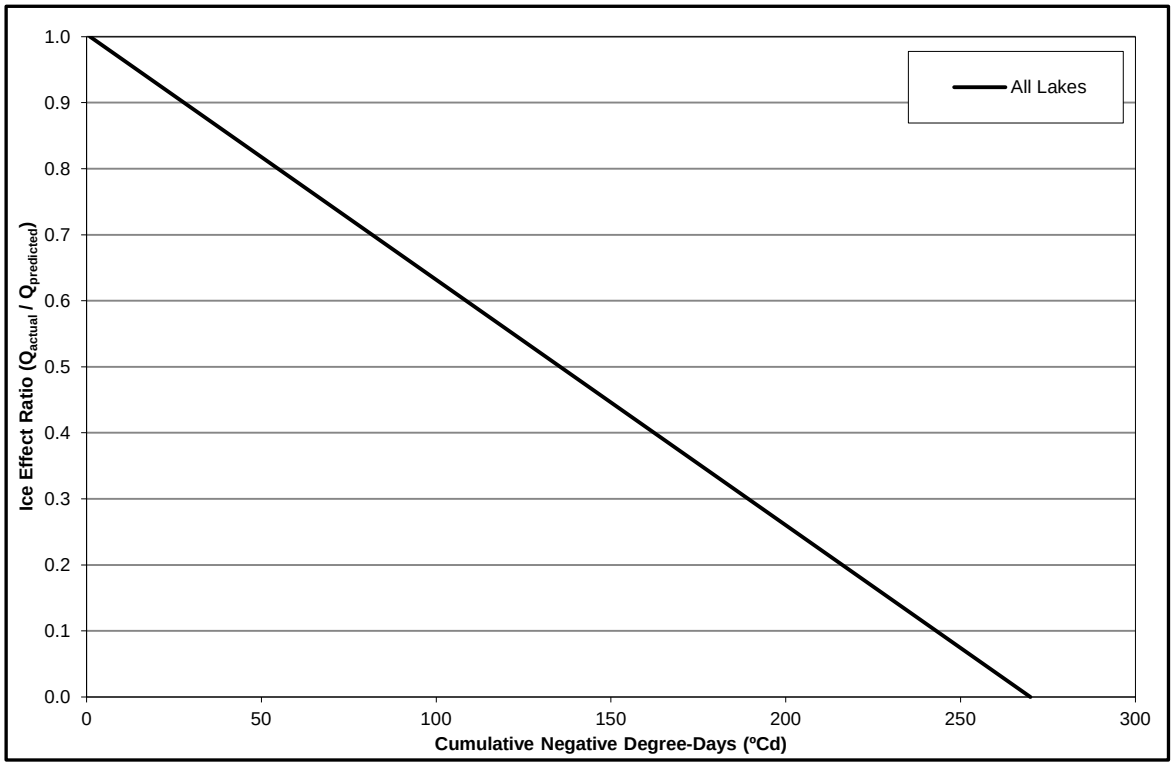


Figure C-5: Ice Formation Period: Ice Effect Ratios and Cumulative Degree-Days

C2.4 Snowmelt

Snowmelt is generated predominantly by the melting of the accumulated snowpack during the period of spring freshet. Based on experience, the spring freshet occurs over a period of several weeks and is a major contributor of overall annual precipitation and lake inflows in northern environments.

C2.4.1 Observations of Snowmelt

Snowmelt was observed during the first hydrometric field visit (from 8 to 15 June 2015). By 15 June 2015, most of the snow had melted, with any snow remaining largely located along steep slopes with lesser exposure to sunlight.

C2.4.2 Method

In the model, snowfall from the derived climate data accumulates as snowpack during fall and winter when temperatures are below freezing. A 26% reduction was applied to the modeled snowpack to represent sublimation losses based on previous baseline studies (AMEC 2003).

Snowmelt begins when the daily average temperature rises above the base temperature (T_b). The snowmelt rate is determined by Equation 1.

Equation 1: Snowmelt Equation

$$\text{Daily Snowmelt Runoff} = R_{cs} \times M_f \times (T - T_b)$$

Where

R_{cs}= Snowmelt runoff coefficient (dimensionless);

M_f = Melt factor (mm/°C);

T = Mean daily air temperature (°C); and

T_b = Base temperature (°C).

For consistency with observed snowmelt, the melt factor was set at 4.0 millimetres per degree Celsius (mm/ºC) and the base temperature at -1.0°C,. The snowmelt runoff coefficient R_{cs} was calibrated to expected freshet and annual watershed yields, and is further discussed in Section C2.5. These values resulted in a completely melted snowpack by 18 June 2015, consistent with field observations, and modeled peak discharges consistent with measured hydrographs, as shown in Section C2.5. Snowpack accumulation and melt are shown in Figure C-6 for the 2015 hydrological year (i.e., 1 October of the previous year to 30 September of the current year, as defined by previous baseline studies [AMEC 2003]).

A dispersed delay of 20 days was applied to the lumped tributaries of Lake DS1 to account for attenuations.

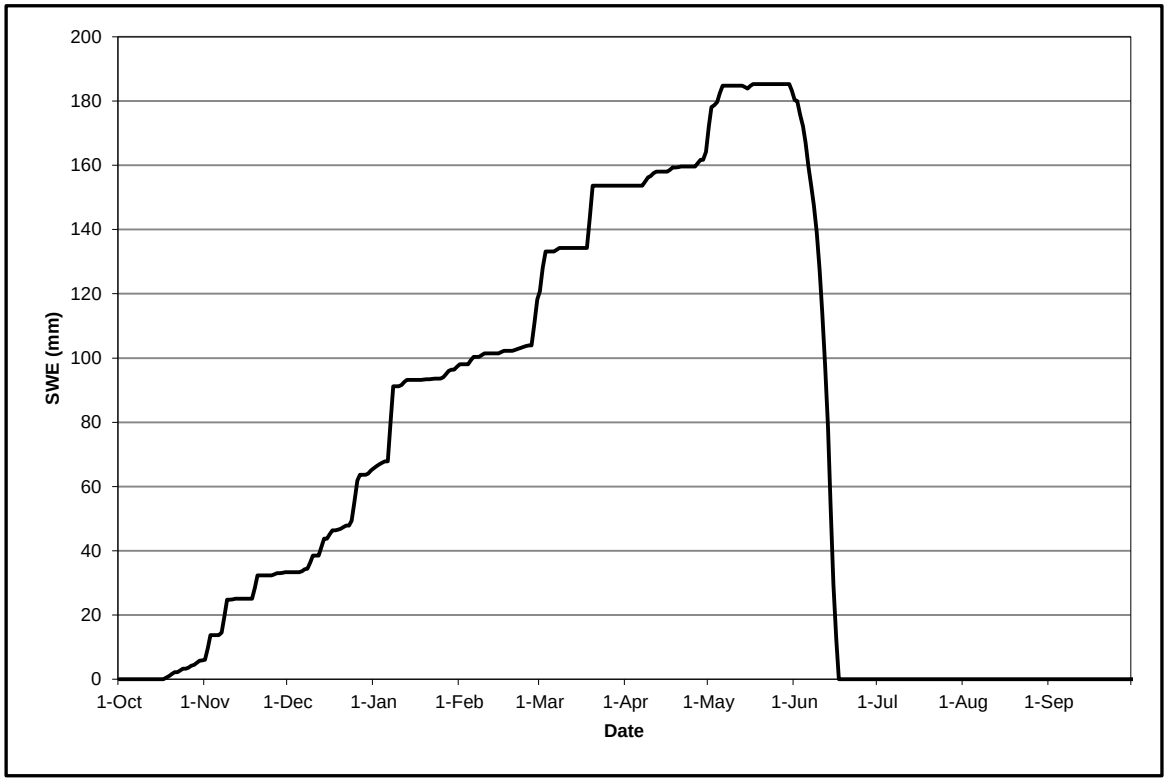


Figure C-6: 2015 Modeled Snowpack

C2.5 Model Calibration and Validation

Each modeled lake has a consistent structure and logic in the water balance. Physical characteristics of each modeled lake include local contributing lake and land areas, total discharge areas, and connectivity with other lakes.

The volume and timing of lake discharges are the predominant model outputs. The key calibration variables for the volume of water discharged are runoff coefficients, including rainfall and snowmelt runoff coefficients:

- Rainfall runoff coefficients were applied to rainfall runoff, separated by runoff on land and runoff on lake areas (i.e., direct runoff) to account for evapotranspiration and storage losses. Direct runoff coefficients were assigned a value of 1.0.
- Snowmelt runoff coefficients were applied to snowmelt runoff, separated by runoff on land and runoff on lake areas (i.e., direct runoff) to account for storage losses. Snowmelt runoff coefficients were considered separately from sublimation losses. Direct runoff coefficients were assigned a value of 1.0.

C2.5.1 Method

Rainfall and snowmelt runoff coefficients for land areas were calibrated to measured hydrographs and annual water yields. The snowmelt runoff coefficient primarily affects peak discharges, and was calibrated to measured hydrographs. The rainfall runoff coefficient was adjusted to reach measured annual water yields. There were three days of rainfall prior to peak discharges, which were considered during the calibration of the rainfall runoff coefficient.

The calibration process was as follows:

- **Calibration:** The model was run on a 1-hour time-step from 1950 to 2015 (exclusive of years 1951, 1979, 1993, and 2010) using the derived climate data set as input values. Both rainfall and snowmelt runoff coefficients were initially set to 1.0 and reduced incrementally to match the measured hydrograph and annual water yields at Lake A18 (i.e., the most upstream lake with a continuous data set).

  Derived annual water yields of Lake A17 (Whale Tail Lake) and Lake C38 (Nemo Lake) (Section 3.2.1.9) were significantly lower than those derived for Lake A18, Lake A15, Lake A69, and Lake DS1, and runoff coefficients of these local watersheds and local tributaries were reduced from those applied for Lake A18. As noted in Section 3.2.1.9, this reduction may be related to a proportion of ineffective drainage area in both local watersheds. Tributaries of Lake A17 (Whale Tail Lake) and Lake C38 (Nemo Lake) were opportunistically observed to drain poorly, with ponded water, and the potential exists for shallow subsurface flow to convey water outside of the assumed watershed boundaries.

- **Validation:** Runoff coefficients applied to Lake A18 were applied to all modeled lakes (other than Lake A17 [Whale Tail Lake] and local tributaries, and Lake C38 [Nemo Lake] and tributaries), and were verified by comparing modeled hydrographs and annual water yields to measured continuous data sets.

C2.5.2 Results

Rainfall runoff coefficients were calibrated as 1.0 for lake areas, 0.35 for land areas of local watersheds of Lake A17 (Whale Tail Lake), Lake C38 (Nemo Lake), and their tributaries, and 0.70 for land areas of all other lakes. Snowmelt runoff coefficients were calibrated as 1.0 for lake areas, 0.50 for land areas of local watersheds of Lake A17 (Whale Tail Lake), Lake C38 (Nemo Lake), and their tributaries, and 1.0 for land areas of all other lakes. A snowmelt coefficient of 1.0 is consistent with frozen ground conditions and low evaporation during the melt period; however, it may indicate that additional precipitation may not have been captured by the local climate station, or that sublimation losses may be slightly overestimated. This may only be confirmed with additional monitoring data.

The calibrated runoff coefficients result in good agreement between modeled and measured discharges, water levels, and annual water yields. Uncertainties are discussed below:

- Lake A5 appears to be well estimated at low flows; however, additional field data during the high flow period are required to validate the timing and magnitude of the peaks, and improve its stage-discharge rating curve, which, is based on that of Lake A69 in the model. Thus, peak discharges generated by the model at Lake A5 are associated with a degree of uncertainty.

- The model appears to slightly overestimate lake surface elevations of Lake A15 at low flows. This may result from its stage-discharge rating curve, which was based on two discharge measurements at high and lower flows, and a discharge estimate during the low flow season in September, which was not measurable.

- Local watersheds and tributaries of Lake A17 (Whale Tail Lake), Lake C38 (Nemo Lake) and their tributaries were assumed to be poorly drained with proportions of ineffective areas, and the potential for shallow subsurface flow to convey water outside of the assumed watershed boundaries. While consistent

with opportunistic field observations, areas of potential ineffective flows could be refined with additional observations and specifically targeted with lower runoff coefficients to improve the model.

- Stage-discharge rating curves of Lake A12 and Lake A76 were based on assumptions and calibration of water yields at Lake A69. Both lakes are comprised of two lake outlets, and assumed rating curves could be improved, and further validated, with additional field measurements.
- Recession discharges and water levels at Lake A69 are associated with a degree of uncertainty related to the timing of snowmelt runoff of upstream lakes. Thus, the recession period may be improved with additional field data at upstream lakes. Peak and low flows appear to be well matched.
- Lake DS1 was modeled coarsely with lumped tributary areas (other than the A, B, and C watersheds, which were modelled explicitly) based on physical parameters derived from available desktop data. Due its large watershed, Lake DS1 hydrology is complex and cannot accurately be reproduced by this baseline model; however the model results are considered fit for the purpose of this baseline study. Annual water yields are reasonably matched which further validate calibrated parameters. Finer scale parameters such as the timing of peaks and response to rainfall events may not be accurately estimated and should be used with caution.

Resulting runoff coefficients are presented in Table C-4.

Measured discharge data are plotted along with model output for qualitative comparison in Figure C-7 (Lake A5), Figure C-9 (Lake A15), Figure C-11 (Lake A17 [Whale Tail Lake]), Figure C-13 (Lake A18), Figure C-15 (Lake A69), Figure C-17 (Lake C8), Figure C-19 (Lake C38 [Nemo Lake]), and Figure C-21 (Lake DS1).

Comparisons of measured and modeled lake water surface elevations are presented in Figure C-8 (Lake A5), Figure C-10 (Lake A15), Figure C-12 (Lake A17 [Whale Tail Lake]), Figure C-14 (Lake A18), Figure C-16 (Lake A69), Figure C-18 (Lake C8), Figure C-20 (Lake C38 [Nemo Lake]), and Figure C-22 (Lake DS1) over the discharge period.

Comparisons of measured and modeled annual water yields are presented in Figure C-23.

Table C-4: Calibrated Runoff Coefficients

Lake	Rainfall Runoff Coefficient		Snowfall Runoff Coefficient	
	Land	Lake (Direct)	Land	Lake (Direct)
Lake A17 (Whale Tail Lake), Lake C38 (Nemo Lake)	0.35	1.0	0.50	1.0
All other lakes	0.70	1.0	1.0	1.0

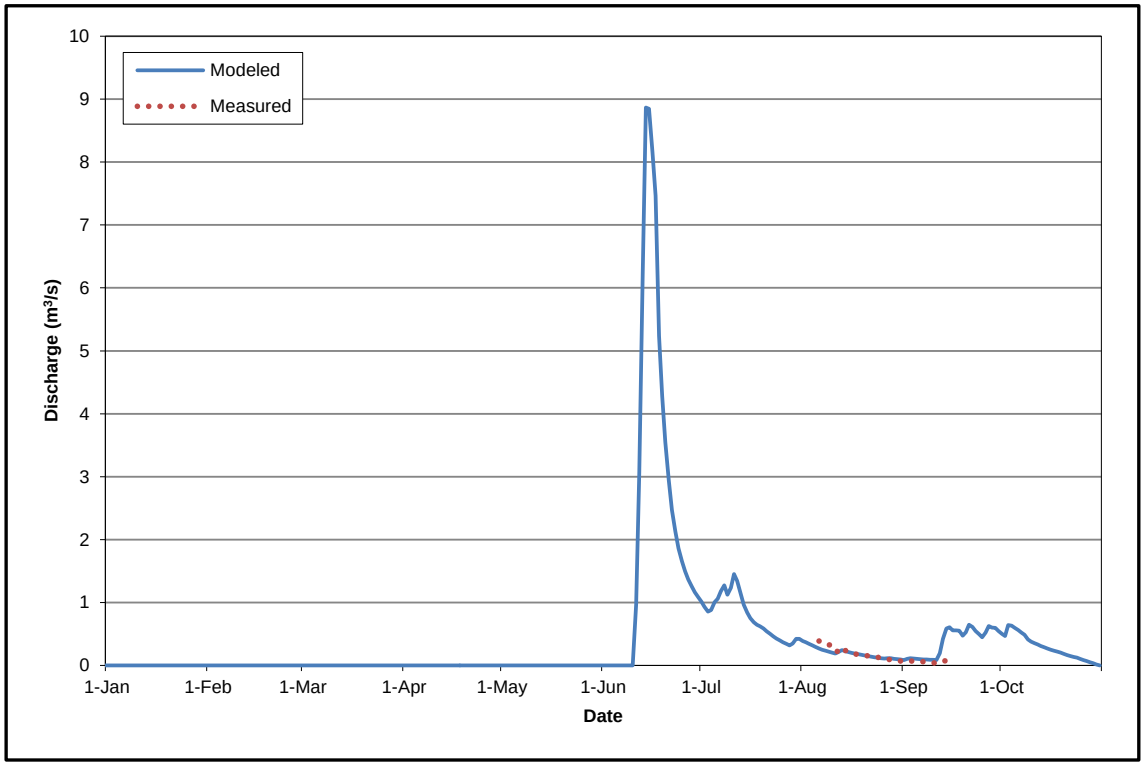


Figure C-7: Comparison of Modeled and Measured Discharge at Lake A5 in 2015

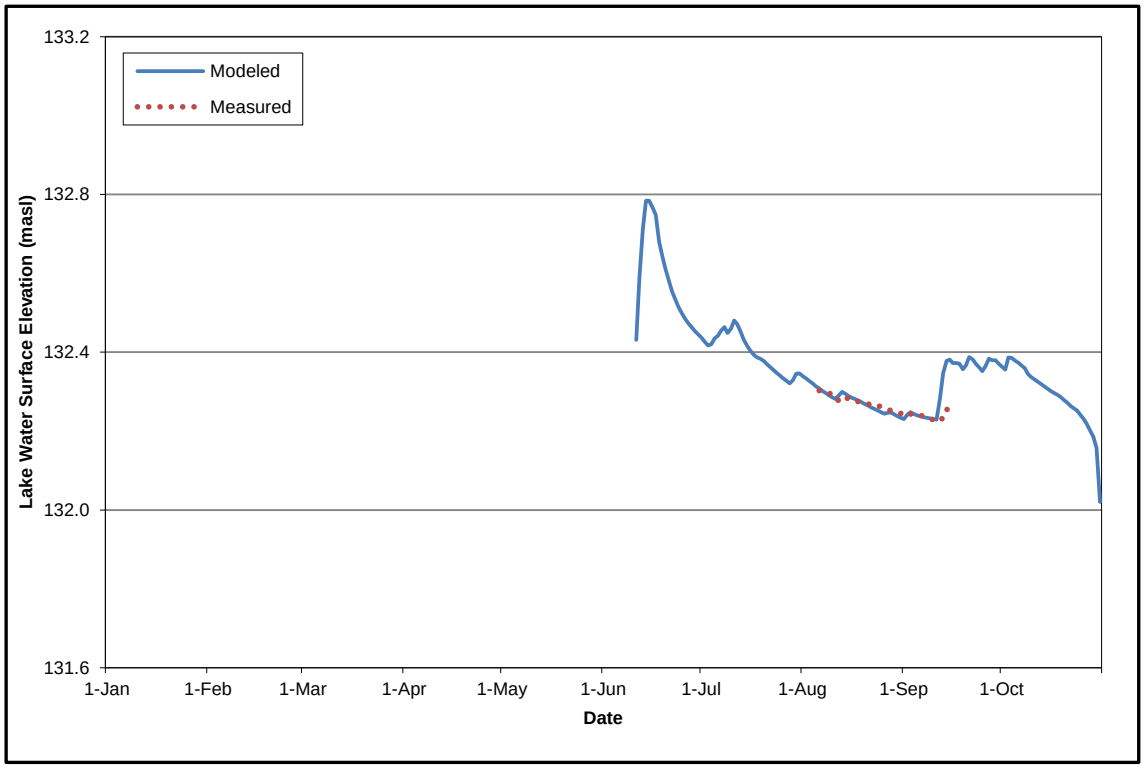


Figure C-8: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake A5 in 2015

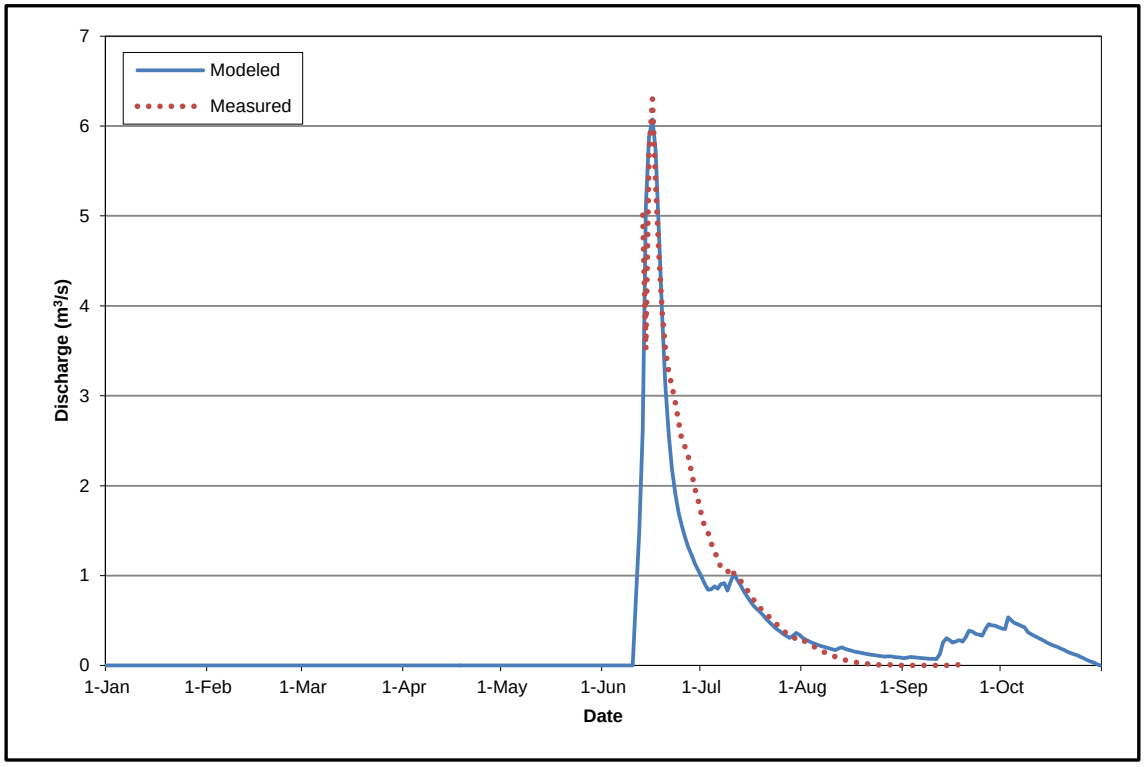


Figure C-9: Comparison of Modeled and Measured Discharge at Lake A15 in 2015

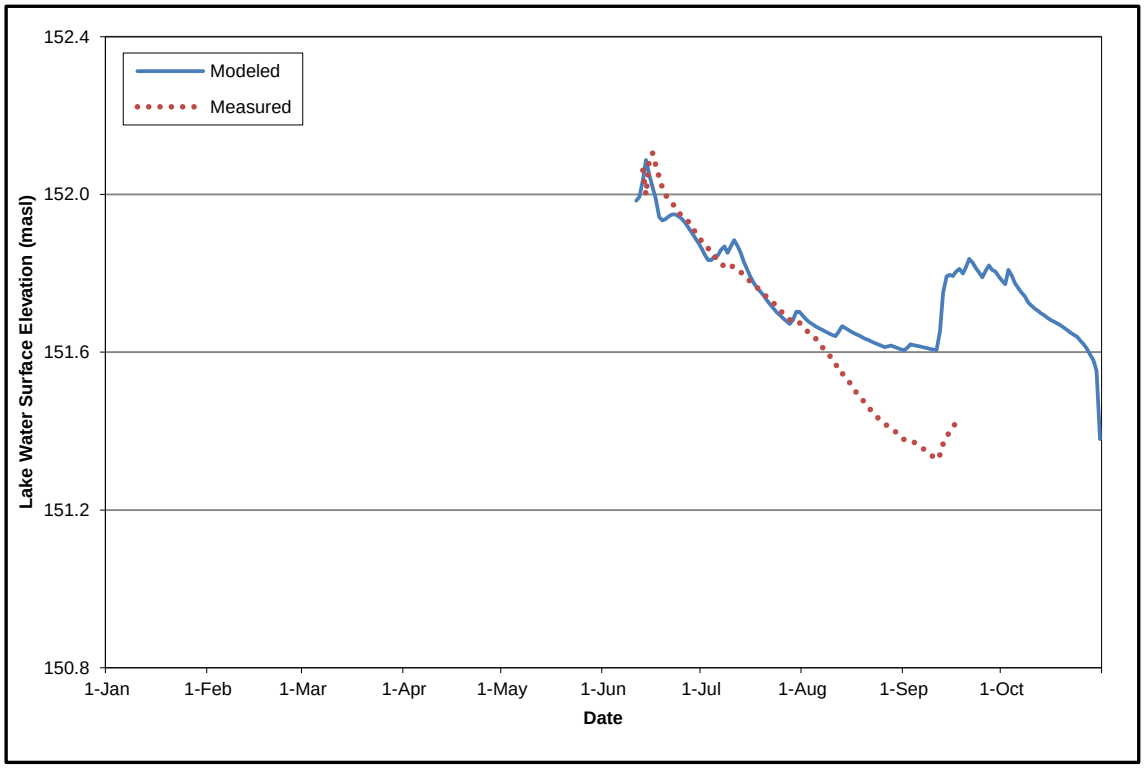


Figure C-10: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake A15 in 2015

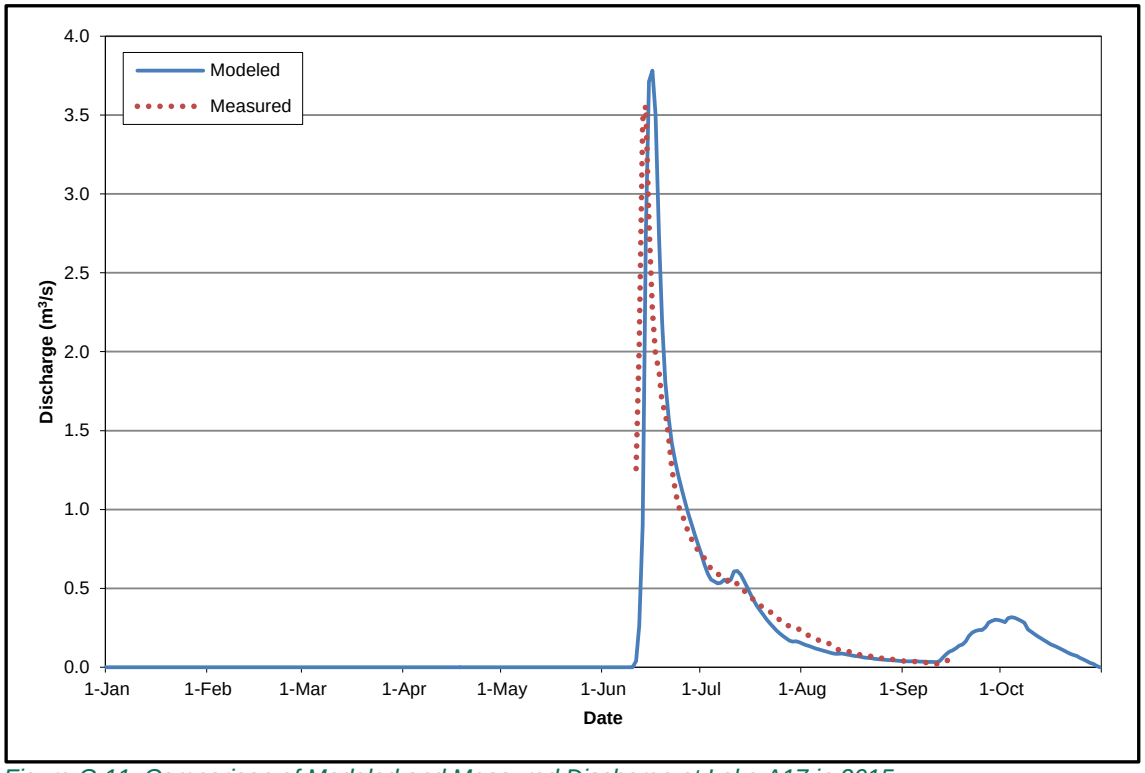


Figure C-11: Comparison of Modeled and Measured Discharge at Lake A17 in 2015

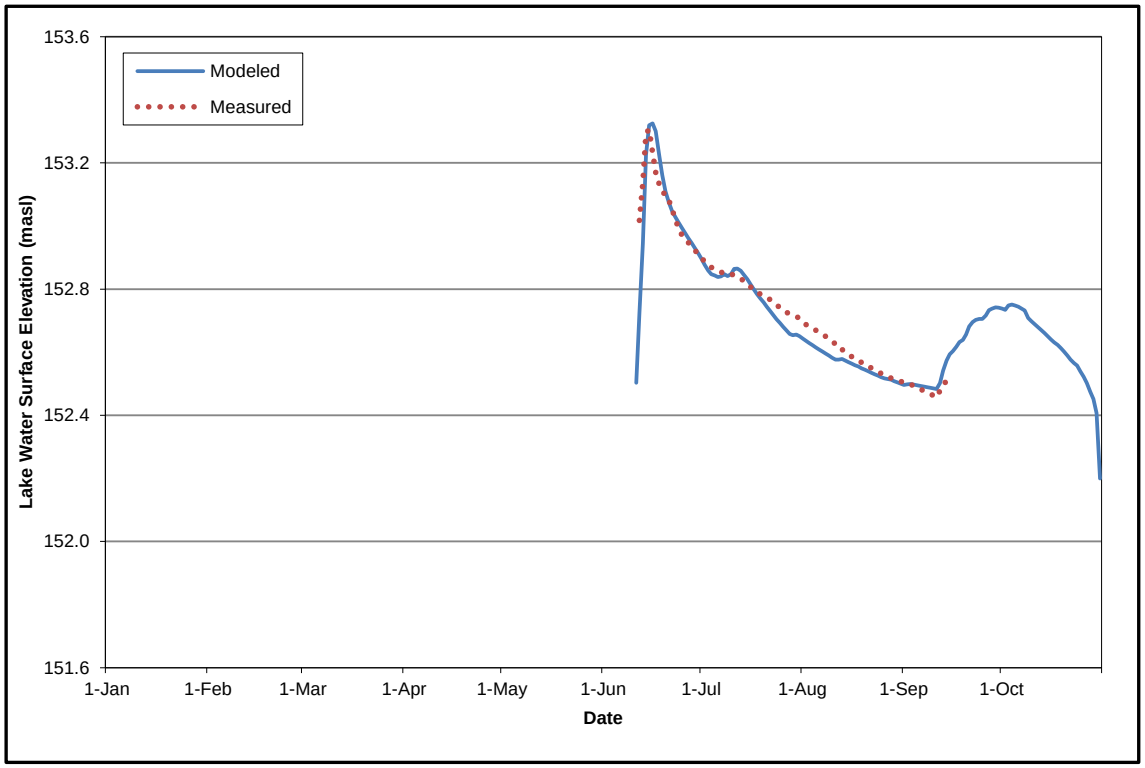


Figure C-12: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake A17 in 2015

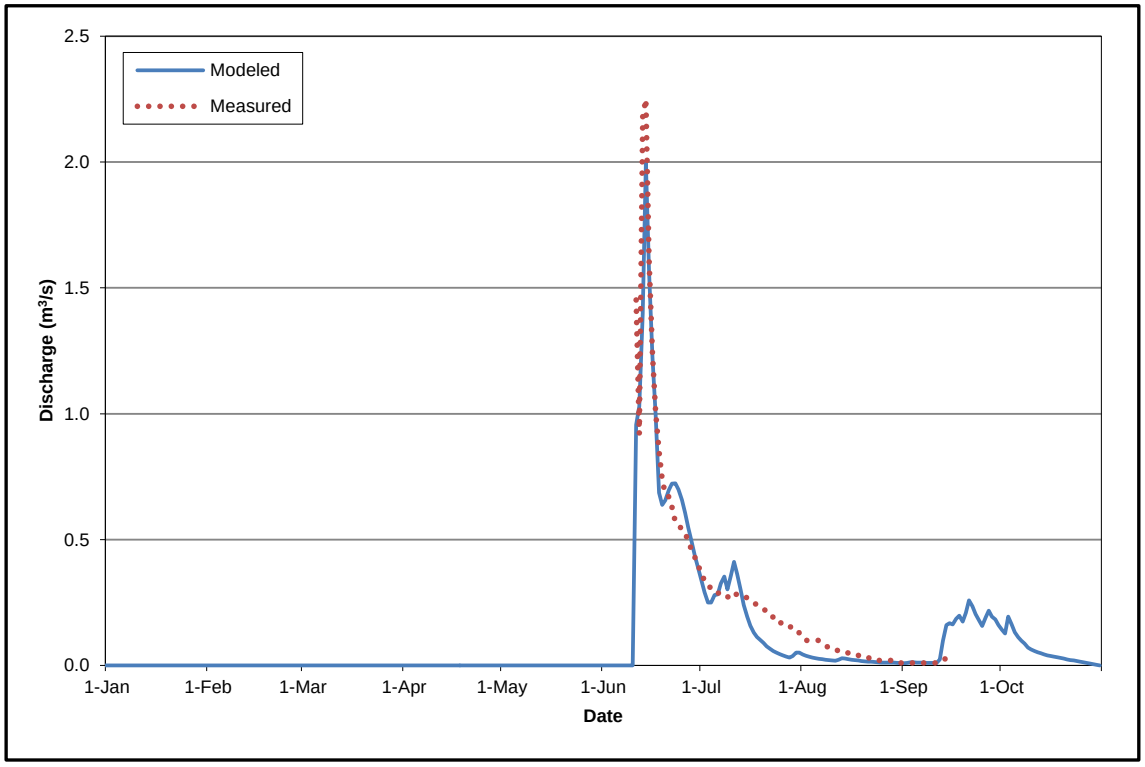


Figure C-13: Comparison of Modeled and Measured Discharge at Lake A18 in 2015

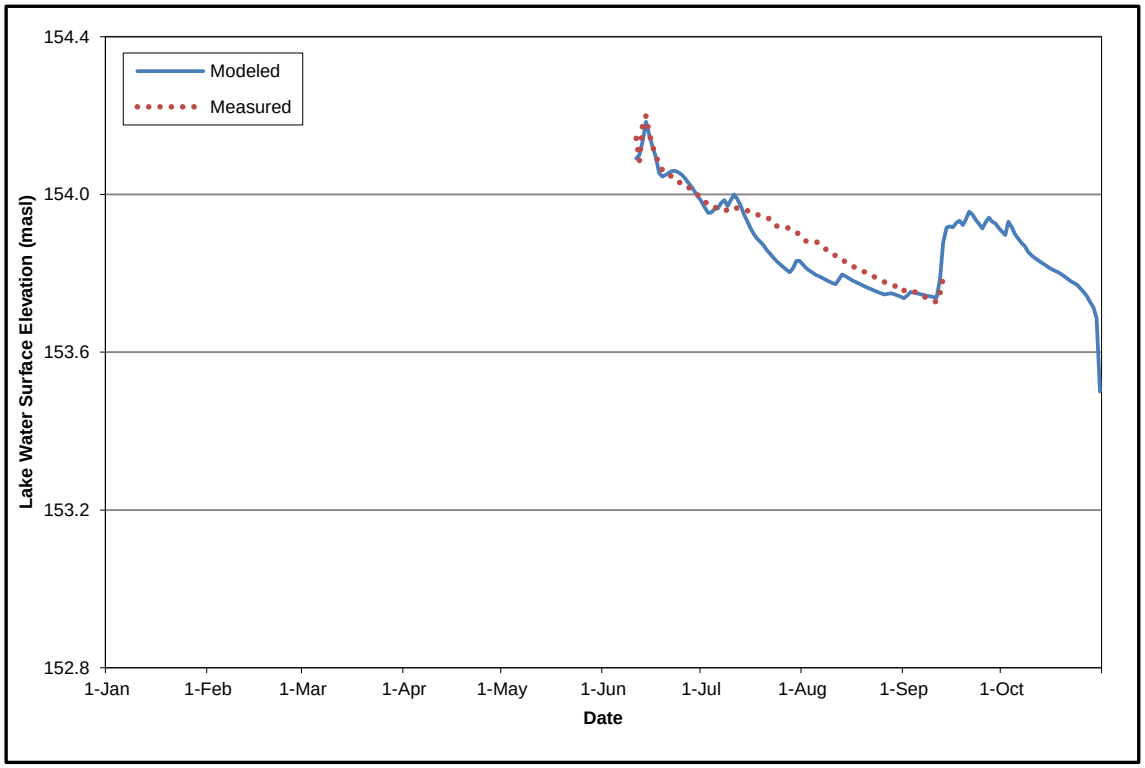


Figure C-14: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake A18 in 2015

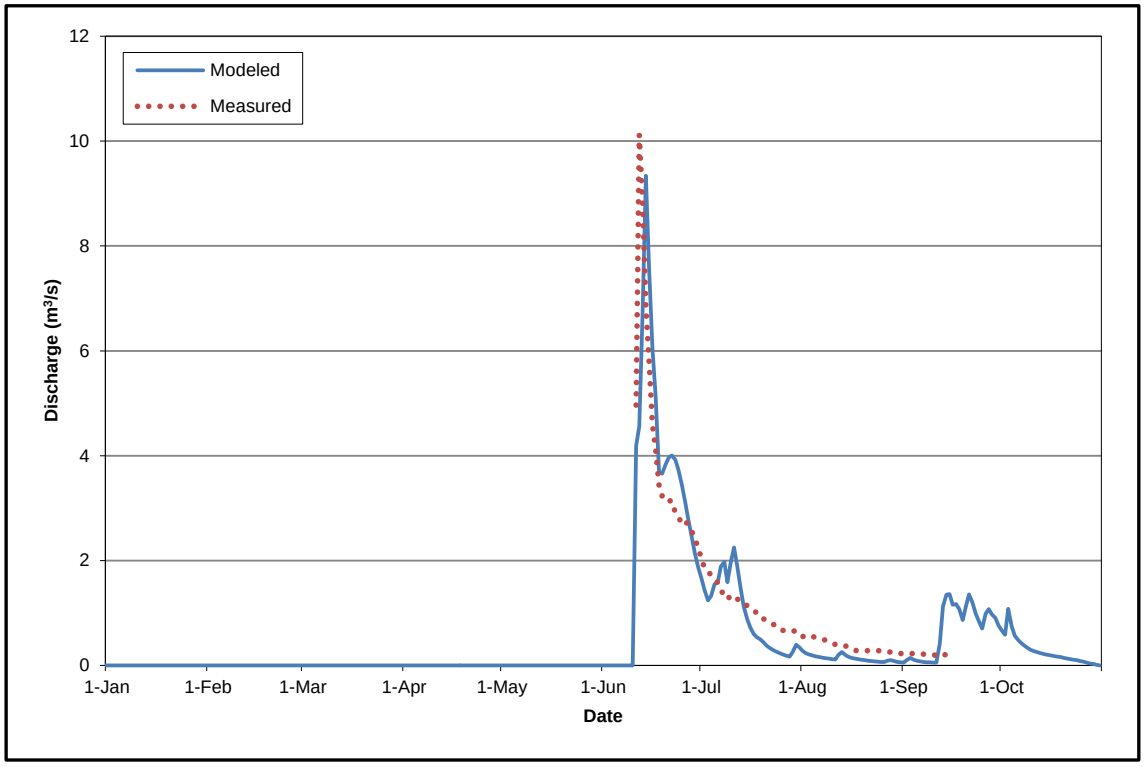


Figure C-15: Comparison of Modeled and Measured Discharge at Lake A69 in 2015

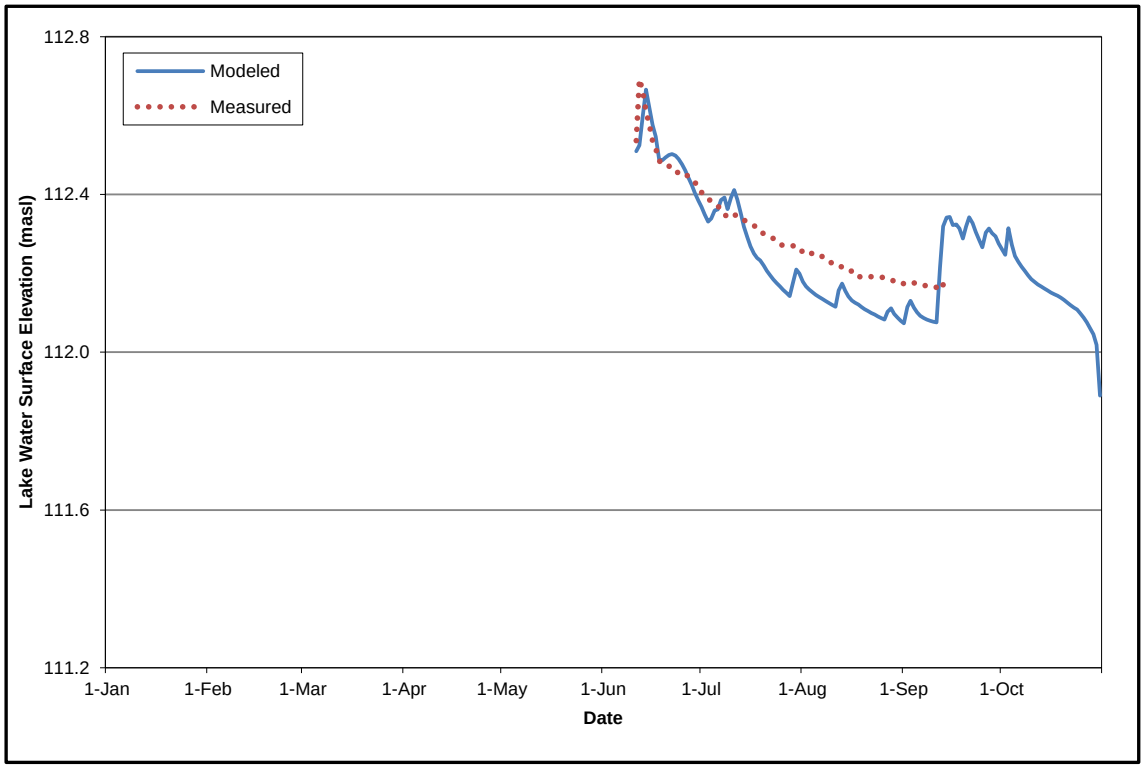


Figure C-16: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake A69 in 2015

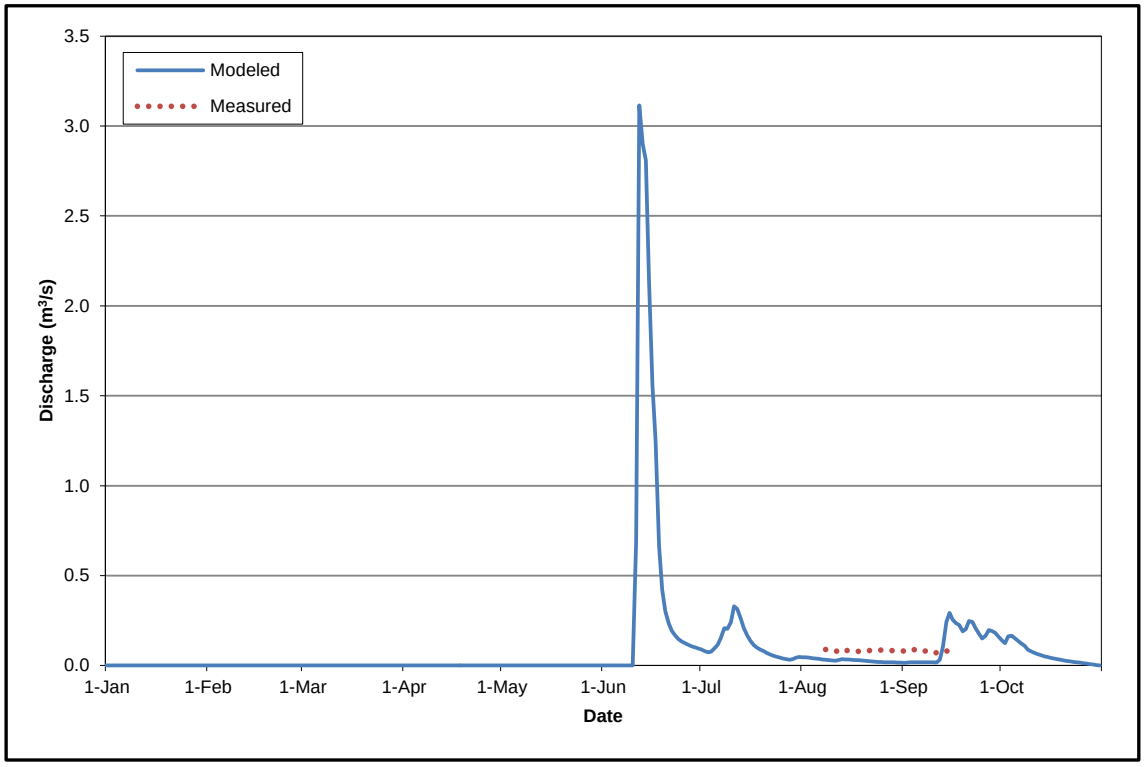


Figure C-17: Comparison of Modeled and Measured Discharge at Lake C8 in 2015

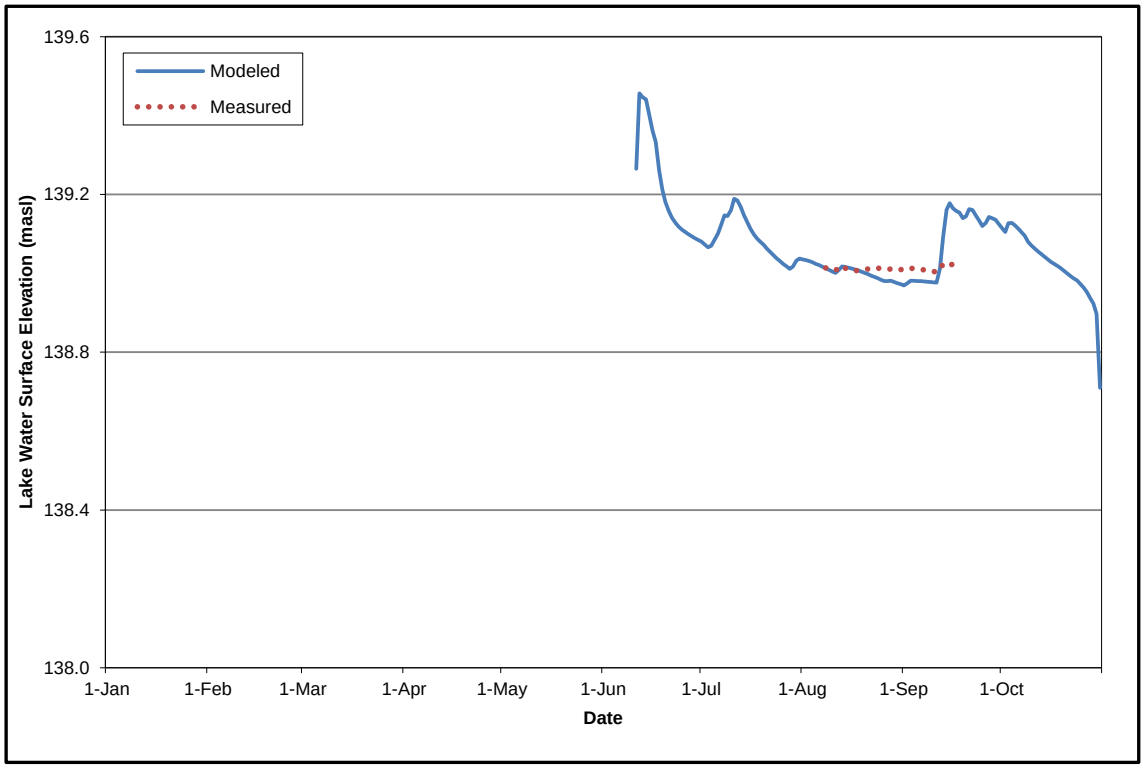


Figure C-18: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake C8 in 2015

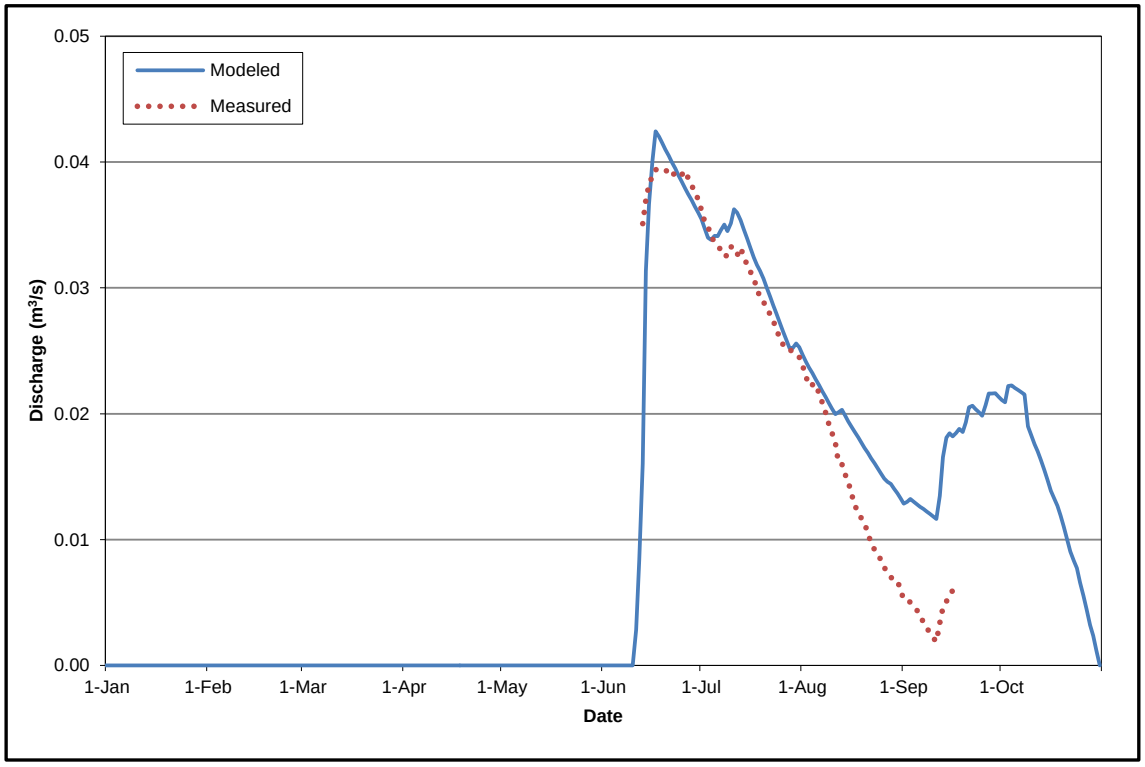


Figure C-19: Comparison of Modeled and Measured Discharge at Lake C38 in 2015

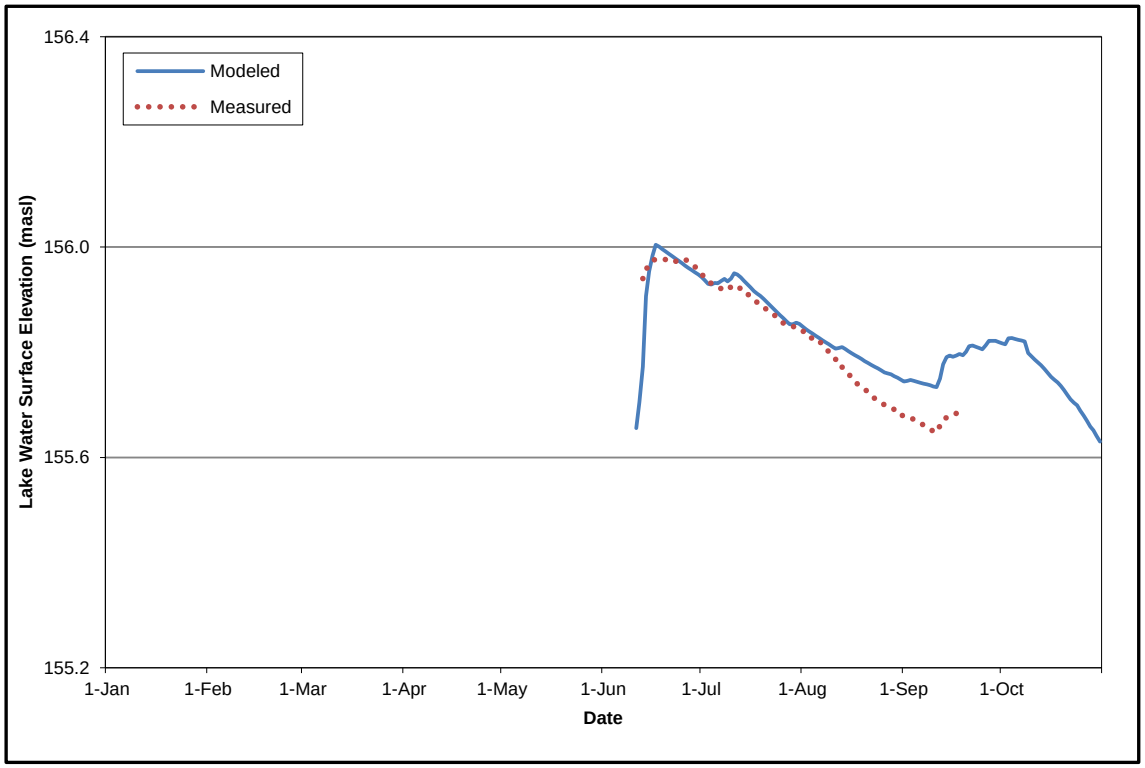


Figure C-20: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake C38 in 2015

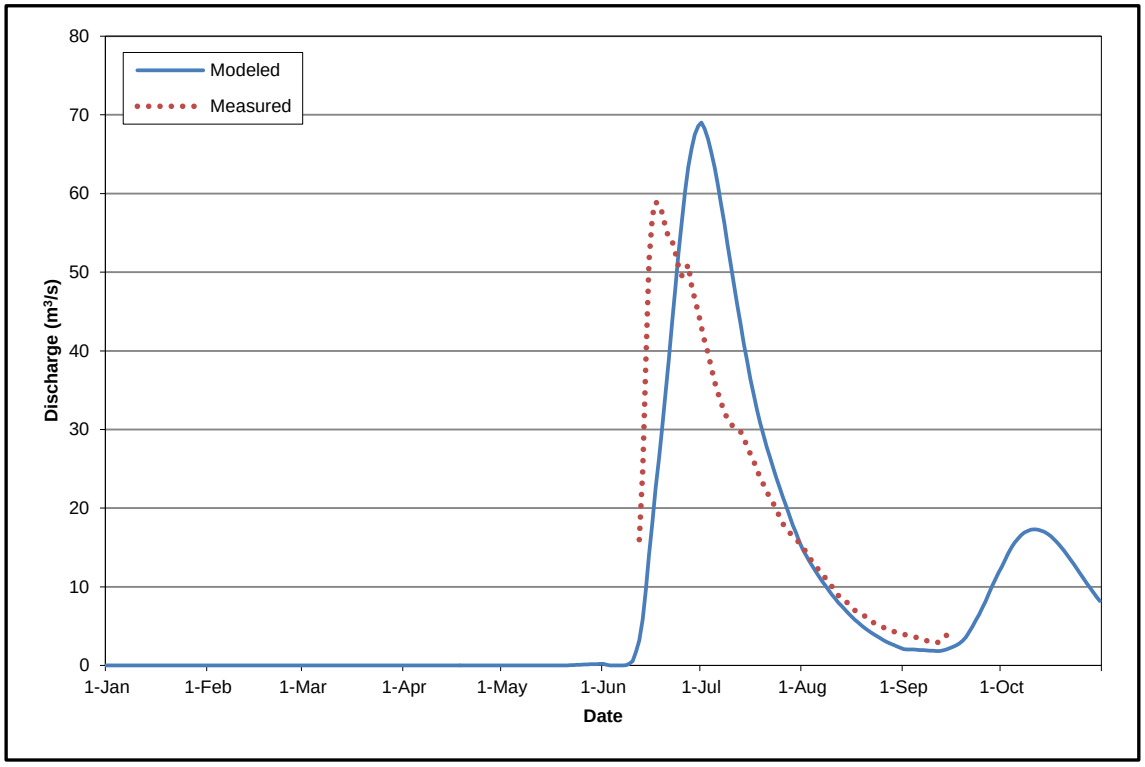


Figure C-21: Comparison of Modeled and Measured Discharge at Lake DS1 in 2015

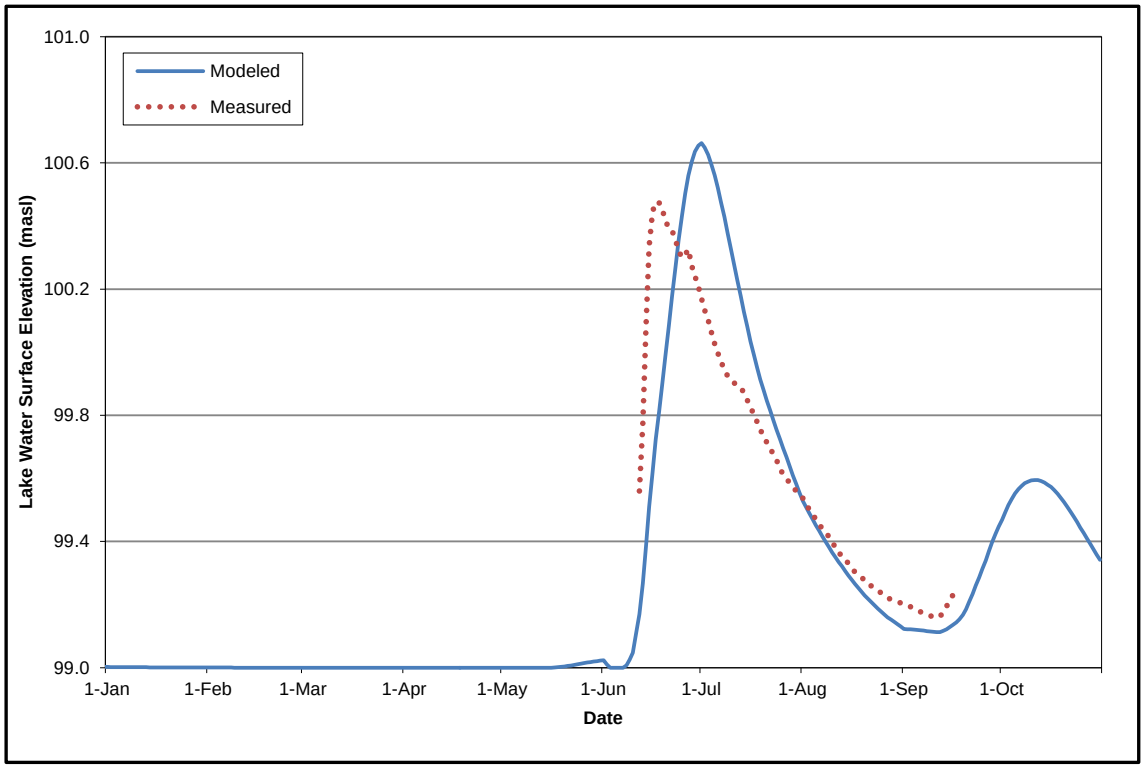


Figure C-22: Comparison of Modeled and Measured Lake Water Surface Elevation at Lake DS1 in 2015

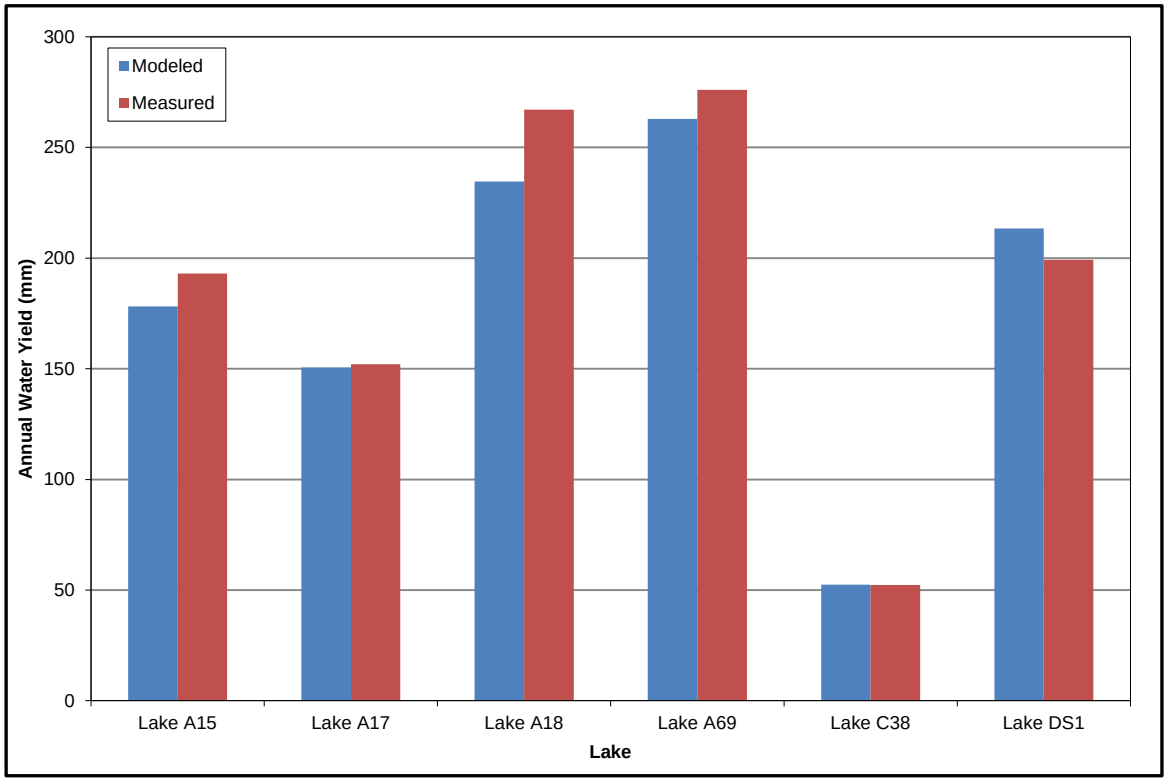


Figure C-23: Comparison of Modeled and Measured Water Yields in 2015

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