Hope Bay Mining Limited

DORIS NORTH GOLD MINE PROJECT
Hydrology Compliance Report 2011

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DORIS NORTH GOLD MINE PROJECT
HYDROLOGY COMPLIANCE REPORT 2011

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NEWMONT™ NORTH AMERICA

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Executive Summary

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Executive Summary

The purpose of this report is to present the results from the Hydrology Compliance Monitoring Program completed in 2011 for the Doris North Project. Lake and stream water levels were monitored at stations TL-2 (Doris Creek upstream location), TL-3 (Doris Creek downstream location), Doris Lake, and Tail Lake in order to comply with the Doris North Project Certificate (NIRB No. 003 2006) and the Type A Water License requirements ((NWB No. 2AM-DOH0713 2007).

As part of the hydrologic requirements for the Type A Water Licence and the Project Certificate, additional monitoring was also conducted in 2011 at the established Windy Lake, Roberts Hydro, and Roberts Bay hydrometric stations. This was completed in support of work required by the Tail Lake Outflow Fisheries Authorization (NU-02-0117.3), the Roberts Bay Jetty Authorization (NU-02-0117), and the No Net Loss Plan Updates (Rescan 2010).

The hydrology monitoring program commenced in early-June and continued until mid-October when the Station TL-2 (Doris Creek upstream location) station was demobilized for the winter. The hydrometric stations at Doris and Tail lakes remain in operation and will continue recording data through the 2011/2012 winter season.

The lake water level variation for Doris Lake was 0.737 m, ranging from a minimum of 97.725 m to a maximum of 98.462 m. Two distinct high water levels were measured in Doris Lake in 2011. The first occurred on June 22^{nd} as result of snow and ice melt during freshet conditions. The second and the maximum for the year, occurred on July 5^{th} in response to 32 mm of rain that was produced by storms between June 30^{th} and July 1st. After July 5^{th}, lake water levels decreased steadily and were recharged by precipitation events that occurred in early September.

At Tail Lake the water levels ranged from 94.545 m to 95.171 m, for a total variation of 0.626 m. A single peak water level was observed on July 9^{th} at this lake. After that date, water levels remained elevated but declined steadily. The lake were recharged by rainfall that occurred between September 5^{th} and 7^{th}.

At Windy Lake water levels ranged from 95.386 m to 95.621 m for a total variation of 0.235 m. A single peak water level was observed on July 5^{th} at this lake. After that date, water levels declined steadily. The lake was recharged by rainfall that occurred between September 5^{th} and 7^{th}.

Tidal fluctuations were recorded by an automated station located approximately 90 m east of the existing jetty. The tides in Roberts Bay were microtidal (less than 2 m in tide range). Daily tide ranges were generally between 0.25 m and 0.35 m, with an average of 0.30 m ± 0.07 m.

The maximum tidal range is defined by the difference between high and low water levels in one tidal cycle. During the monitoring period, the maximum tidal range was 0.33 m occurred during a spring tide on September 20, 2011.

Calculated runoff values for the period of record in 2011 were 184 mm for station TL-2, 183 mm for station TL-3, and 144 mm for Roberts Hydro. Calculated mean flows for 2011 were 1.58 m^3/s for Station TL-2, 1.58 m^3/s for Station TL-3, and 1.68 m^3/s for Roberts Hydro station. Comparatively, 2011 was a wetter year in terms of annual runoff and mean flow discharge. In 2010, the calculated annual runoff values were 121 mm and 137 mm for stations TL-2 and Roberts Hydro, respectively. Calculated mean flows for 2010 were 1.15 m^3/s for station TL-2 and 1.00 m^3/s for station Roberts Hydro.

Frequency analysis results reported for the Doris Watershed (Rescan 2009) show that the mean annual runoff (1-in-2-year recurrence interval) for this watershed is 99 mm. In terms of annual runoff, the 2011 results are consistent with wetter hydrologic conditions associated with a 1-in-100 year return period interval.

The onset of the spring freshet occurred in early June. By June 22nd water levels reached a high as a result of melting of ice and snow associated with freshet conditions. Discharges receded from that point, until July 5th when discharges reached the annual peak as a result of 32 mm of rain produced by storms that occurred between June 30th and July 1st. Daily peak flows were 5.77 m^3/s at Station TL-2, 5.86 m^3/s at Station TL-3, and 7.34 m^3/s at Roberts Hydro station.

Frequency analysis results reported for the Doris Watershed (Rescan 2009) showed that the mean annual peak flow (1-in-2-year recurrence interval) for this watershed is 1.68 m^3/s. In 2011, calculated peak flows exceeded the wetter hydrologic conditions associated with a 1-in-100 year return period interval.

Following the freshet period, flows steadily decreased until early September when they reached the lowest flow discharge conditions. Low flows were 0.400 m^3/s at Station TL-2, 0.365 m^3/s at Station TL-3, and 0.116 m^3/s at Roberts Hydro station. After July 5th, flows were augmented by rainfall bursts between September 5th and September 7th.

Acknowledgements

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Glossary and Abbreviations

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

ADCP	Acoustic Doppler current profiler
Calculated runoff for period of record	Calculated runoff for the period of record is a measure of the hydrologic response of a watershed. It is often presented as a depth, in mm, over an entire watershed allowing direct comparison with precipitation totals.
Flood frequency	The frequency that a flood of a specified magnitude occurs, inversely related to flood return period (see Return Period).
Freshet	In channels, the relatively high annual peak water discharge period resulting from spring/summer meltwater runoff of the snowpack accumulated over the winter.
HBML	Hope Bay Mining Limited
Hydrograph	A graphical plot of water discharge versus time.
ISO	International Organization for Standardization
NAD 83	North American Datum 1983. A datum is a reference system for computing or correlating the results of a survey. The NAD83 datum is based on the spheroid (GRS80).
NWB	Nunavut Water Board
Return Period	The average interval at which an event occurs, calculated from the probability of its occurrence in a given year.
RMS	Root Mean Square
Stage	The depth of water in a water course or channel
Stage Discharge Curve	A curve derived from concurrently measured stage and discharge data that is used to estimate the discharge for any given observed stage. Often referred to as a rating curve for a hydrometric station.
UTM	Universal Transverse Mercator. A mathematical transformation (map projection) of the earth's surface to create a flat map sheet.

1. Introduction

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1. Introduction

The purpose of this report is to present the results from the hydrology compliance monitoring program that was completed in 2011 at the Doris North Project.

During the Hydrology Compliance Monitoring Program, water level data were collected in order to comply with the following regulatory requirements:

- Doris North Project Type A Water Licence (NWB No. 2AM-DOH0713; issued September 19, 2007):
  - Part F, Item 1a: "(the Water Management Plan should include) A requirement to continuously monitor Doris Lake levels and outflow during the two (2) years of mining and beyond to confirm water balance model predictions."
  - Part G, Item 29. "The Licensee shall ensure that water within the Tailings Impoundment Area is maintained at an elevation of least 28.3 metres above sea level such that a minimum of four (4) metres of water cover is maintained over the tailings at all times."
  - Part G, Item 30. "The Licensee shall ensure that the flow from the Tailings Impoundment Area into Doris Creek at monitoring station TL-4 does not exceed 10% of the background flow in Doris Creek as measured at monitoring station TL-2 at the time of discharge."
  - Part J, Item 2: "The Licensee shall install appropriate instrumentation in Doris Creek at Monitoring Station TL-2, to monitor flow when ice conditions allow for such measurements to be taken, on a real time and continuous basis."
  - Part J, Item 3. "The Licensee shall undertake the Water Monitoring Program detailed in the Tables of Schedule J."

- Doris North Project Certificate (NIRB No. 003, issued September 15, 2006):
  - "Hope Bay Mining Limited will monitor stage and discharge in Doris Outflow both upstream and downstream of the decant discharge point to provide information that can be used in assessing the accuracy of the impact predictions relating to fish habitat downstream."

In addition to the hydrometric monitoring required for the Type A Water Licence and Project Certificate, monitoring was also conducted in 2011 at the Windy Lake, Roberts Hydro, and Roberts Bay stations to support work required by the Tail Lake Outflow Fisheries Authorization (NU-02-0117.3), the Roberts Bay Jetty Authorization (NU-02-0117), and the No Net Loss Plan Updates (Golder 2007, Rescan 2010).

The construction of the North Dam for the future Tailings Impoundment Area commenced in January 2011 and continued throughout the spring and summer seasons. The dam is not yet completed, and construction is scheduled to resume during the winter of 2011/2012.

In July 2011, high spring runoff and impounded water levels on the upstream side of the North Dam became a concern with respect to the integrity of the structure during the construction period. As a result, Hope Bay Mining Limited (HBML) obtained permission to transfer fresh waters that were contained by the dam downstream to Doris Creek. In response, a daily hydrology compliance monitoring program was carried out at station TL-2 in order to assure compliance with Part 6, Item 3 of the Type A Water Licence.

The daily hydrology monitoring program along Doris Creek consisted of converting the continually recorded surface water elevations at station TL-2 and converting them to equivalent water discharge estimates. From this, the maximum amount of stored water volume that could be transferred downstream from the North Dam to Doris Creek were determined so that daily water transfer rate did not exceed 10% of the determined background flow discharges along Doris Creek. Details of the hydrology monitoring program at compliance station TL-2 are provided in Appendix D of this report.

Chapter 2 of this report presents the methods used to collect and analyze hydrometric data. Chapter 3 presents the results from the 2011 monitoring program for the following seven stations:

- Station TL-2 (Doris Creek upstream);
- Station TL-3 (Doris Creek downstream);
- Doris Lake;
- Tail Lake;
- Windy Lake;
- Roberts Lake; and
- Roberts Bay.

2. Methods

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2. Methods

Methods from the 2011 Hydrology Compliance Monitoring Program are presented as follows: 1) description of the monitoring network, 2) hydrometric station setups, 3) hydrometric levelling surveys, 4) discharge measurements, 5) rating curve development, 6) hydrograph generation, and 7) calculation of hydrological indices.

2.1 HYDROLOGY COMPLIANCE MONITORING NETWORK

In 2011 the hydrology compliance monitoring network consisted of seven stations that operated in the Doris North Mine area (Figure 2.1-1 and Table 2.1-1).

Table 2.1-1. Compliance Hydrometric Monitoring Stations, Doris North Project, 2011

Hydrometric Station	Geographic Location	UTM Coordinates (Zone 13 W)		Drainage Area (km^2)	Period of Operation	Hydrometric Monitoring	Purpose
		Easting	Northing				
Tail Lake	Northwest shore of Doris Lake	434,899	7,558,494	4.2	January 1-September 24	Continuous monitoring of water levels	Monitoring required for Type A Water Licence
Doris Lake	Northwest shore of Doris Lake	433,512	7,558,452	94.6	January 1-September 24	Continuous monitoring of water levels	Monitoring required for Type A Water Licence
TL-2 (Doris Creek, upstream location)	Doris Lake Outflow, downstream of new bridge	434,059	7,559,504	94.6	June 9-October 17	Real-time continuous monitoring of water levels ; Periodic flow measurements	Gauge flow required for Type A Water Licence
TL-3 (Doris Creek, downstream location)	Doris Creek, downstream of Doris Falls	434,204	7,559,985	95.3	July 22-September 25	Continuous monitoring of water levels ; Periodic flow measurements	Gauge flow required for Type A Water Licence
Roberts Hydro	Roberts Lake Outflow	435,310	7,562,560	97.9	June 21-September 25	Continuous monitoring of water levels; Periodic flow measurements	Support requirements for Fisheries Authorization (NU-02-0117)
Windy Lake	Northwest shore of Windy Lake	431,481	7,555,089	14.1	June 21-September 22	Continuous monitoring of water levels; Periodic flow measurements	Water level data will support habitat compensation project as required by Fisheries Authorization (NU-02-0117.3)
Tide Gauge (Roberts Bay)	Roberts Bay, approximately 90 m east of existing jetty	432,612	7,563,336	n/a	July 24-September 28	Continuous monitoring of water levels	Monitor tidal range near proposed port sites; support bathymetry requirements for (NU-02-0117) and for the proposed Roberts Bay Diffuser

N/a- not applicable.

The automated monitoring stations located at Doris and Tail lakes were partially operated through 2004 at temporary locations, before they were permanently installed at their current locations in 2005. These stations operated through the 2010/2011 winter season and remained in operation as of the last site visit in September 24, 2011.

The monitoring stations TL-2 (Doris Creek upstream location), Roberts Hydro, and Windy Lake were remobilized at the onset of freshet between June 9 and June 21, 2011. The monitoring station TL-3 (Doris Creek downstream location) and the tide gauge located at Roberts Bay were remobilized on July 22^{nd} and July 24^{th} respectively.

All stations, with the exception of the two stations located at Doris and Tail lakes, were demobilized in either late September or mid-October. The stations were demobilized to prevent damage to the pressure transducers due to freezing conditions.

2.2 HYDROMETRIC STATION SETUP

All the automatic hydrometric stations consisted of a pressure transducer and data logger combination. The instrumentation recorded water level data, or stage, at specific time intervals. The station setup varied among the different stations operating within the project area. The following is a description of the setups used in the 2011 monitoring program.

The stations located at Doris and Tail lakes consisted of a 10 psi vented KPSI 730-series solid-state pressure transducer (Measurement Specialties Inc.) paired with a DD-320 data logger (Optimum Instruments Inc.). The data logger recorded lake water levels every 15 minutes. The pressure transducer and cabling were inserted through a 10 cm diameter steel pipe anchored to an on-shore bedrock outcrop; the pipe was set in the lake to a depth below 5 m to prevent freezing during the winter months. The data logger was housed in a steel enclosure located along the lake shoreline above the high water mark.

The hydrometric station TL-2 (Doris Creek upstream) instrumentation package consisted of a 0-5 psi vented PS-9800® pressure transducer (Instrumentation Northwest Inc.) paired with an HOBO® Energy Pro Datalogger (Onset Computer Corp). It also included a Solarstream™ solar-powered Iridium® satellite transceiver (Upward Innovations Inc.). Every two hours the system automatically sent the recorded water level data to a secure Internet server. Data were then available for viewing or downloading over a secure 256-bit encrypted connection. The pressure transducer and cabling were inserted into a flexible aluminum conduit with one end of the conduit attached to a piece of angle iron 1.5 m long. The angle iron assembly was weighed down and placed flat on the streambed, close to the banks. The assembly was installed as deep as possible in the water to allow for monitoring of low stream levels. The sensor, datalogger, and satellite transceiver were housed in a polycarbonate waterproof enclosure. Power to the station was supplied by a 12 Volt battery connected to a backup solar panel. All the instrumentation was mounted to a 3.0 m-tall galvanized steel tripod located along the adjacent channel bank above the high water mark (see Plate 2.2-1).

The stations TL-3 (Doris Creek downstream), Roberts Hydro, and Windy Hydro were standard hydrometric stations. The setup at these stations consisted of a 0-5 psi vented Aquistar PT-2X Smart Sensor® (Instrumentation Northwest Inc.). This sensor combines the pressure transducer and data logger in a small diameter unit. The unit recorded water level at 10 minute intervals. The sensor and cabling were inserted into a flexible aluminum conduit with one end of the conduit attached to a piece of angle iron 1.5 m long. In rocky substrates the angle iron was placed directly on the lakebed or streambed, whereas in fine-grained substrates the angle iron was attached to a wooden frame to spread the weight evenly and prevent the assembly from sinking into the substrate.

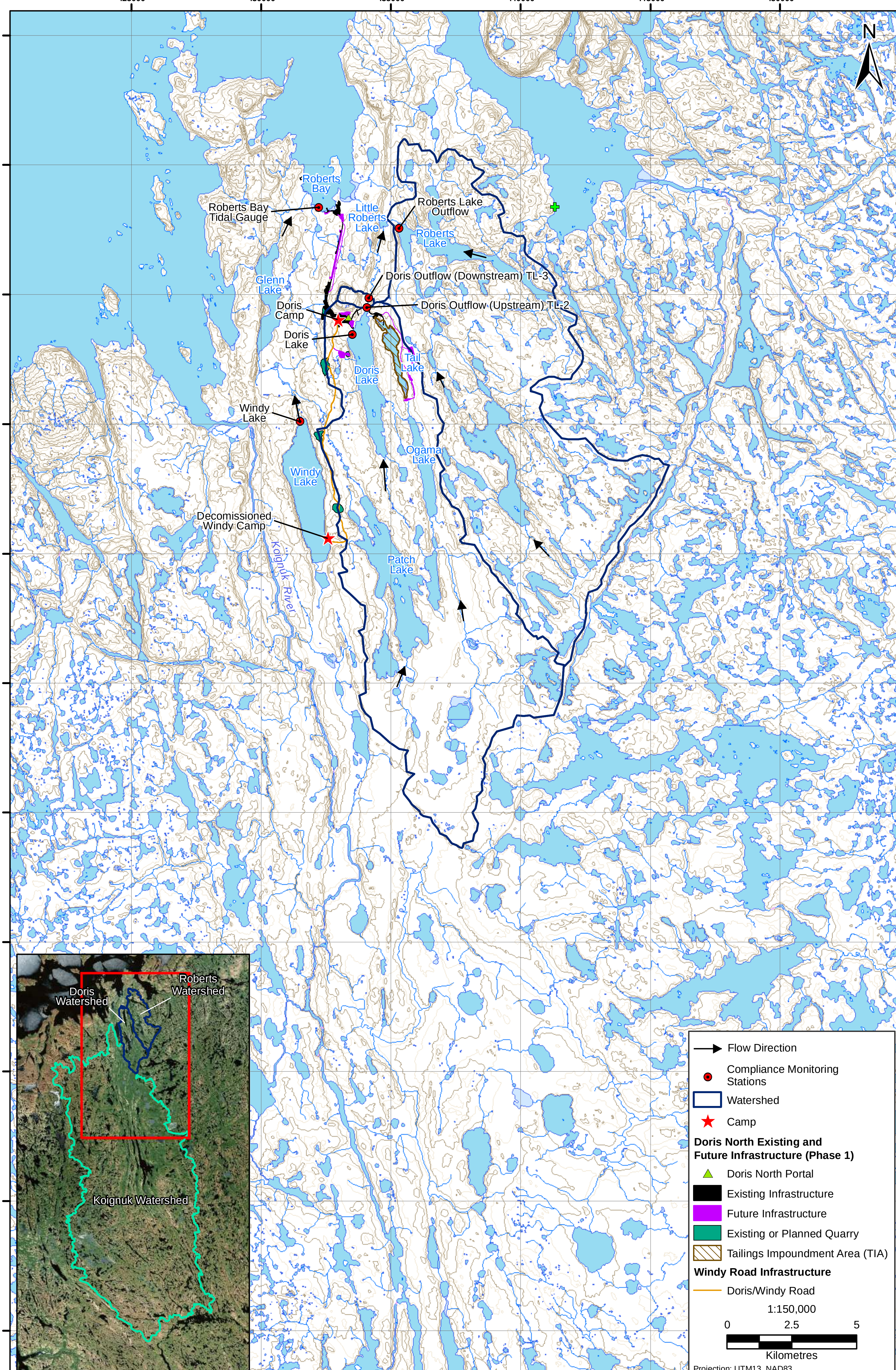

Figure 2.1-1

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2011 Compliance Monitoring Stations, Doris North Project

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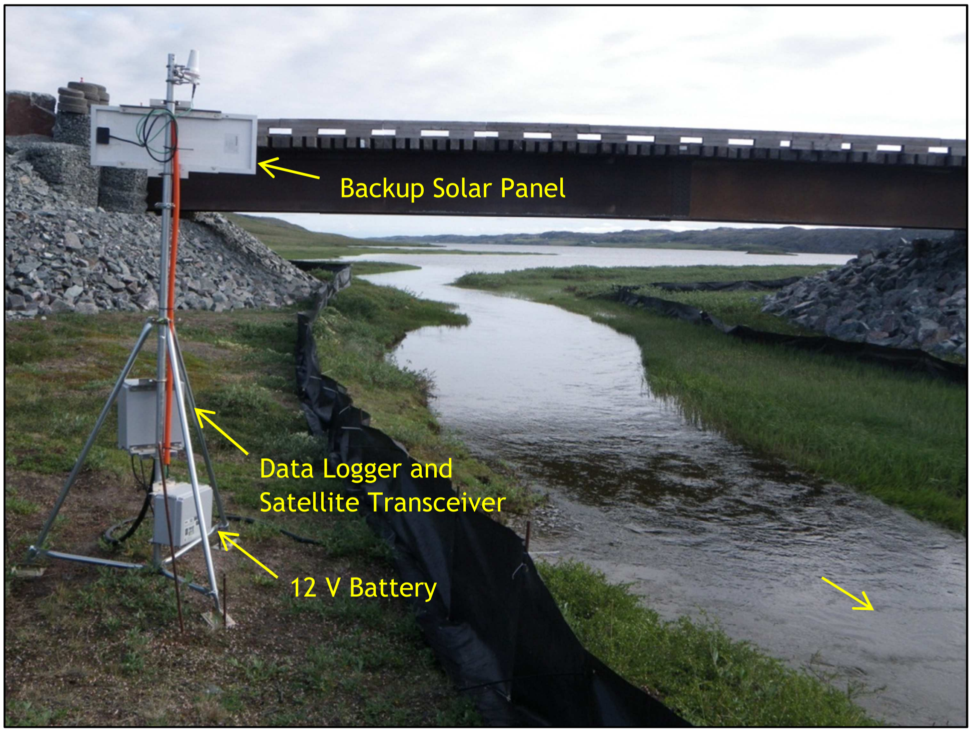


Plate 2.2-1. Low angle oblique photograph looking upstream along Doris Creek showing the instrumentation package that was used at Doris Creek Hydrometric Station TL-2. July 24, 2011.

The station operated at Roberts Bay consisted of a Levelogger® M-10 pressure transducer/data logger combination (Solinst Canada Ltd.). The Levelogger® was attached to a floating marker and anchored to the ocean bottom. The unit recorded water levels every 10 minutes. A Barologger® (Solinst Canada Ltd.) was installed on shore and recorded atmospheric pressure to correct the Levelogger absolute pressure readings.

2.3 HYDROMETRIC LEVELLING SURVEYS

2.3.1 Water Level Elevation Surveys

Benchmarks established in 2009 were used as survey control points along the channel banks and lake shores at each of the monitoring stations that were re-established in 2011. At most sites the local datum was assumed to have an elevation of 0.0 m and the main benchmark an arbitrary elevation of 100 m relative to the datum. The exception was at Roberts Bay, where the elevation of the tide gauge was surveyed relative to a pre-established geodetic benchmark. At all stations, the elevations of the pressure transducer and water level relative to the station datum were surveyed using an engineer's rod and level.

Survey control points were also established at station TL-3, which was a new addition to the hydrometric monitoring network in 2011. Pressure transducer and water level elevations relative to the station datum were also surveyed. During subsequent site visits, additional hydrometric levelling surveys were carried out at each station to check and verify pressure transducer readings, as well as to determine the reliability of the water level data that were recorded between site visits.

2.3.2 Shoreline Profile Surveys

Shoreline profile surveys were conducted at the three lake level monitoring stations and at the tide gauge located in Roberts Bay. In these surveys the topography of the shoreline was recorded along a transect that started at the location of the transducer in the water and extended through to the shoreline (beyond the location of the water mark at the time of the survey). The purpose of the surveys is to show how the fluctuations of the water levels relate to the local topography along the shoreline of the monitored water bodies. All shoreline transects were surveyed using an engineer's level and stadia rod.

2.4 DISCHARGE MEASUREMENTS

At hydrometric stations TL-2 (Doris Creek upstream location), TL-3 (Doris Creek downstream location), and Roberts Hydro current velocity measurements were performed so that discharges could be determined. Measurements were taken throughout the open water season (June to September) to obtain a range of discharges under different flow conditions. In all cases the adopted methods followed standard Water Survey of Canada operating procedures (Lane 1999).

At most stations, water discharge measurements involved wading across the channel and measuring current velocities using a Marsh-McBirney Flo-Mate 2000® handheld electromagnetic current velocity meter (Hach Company). The exception was station TL-3 during spring freshet conditions. At this time of year, the water depth and current velocities were too high to allow field personnel to safely wade the stream and measure discharge with a handheld current velocity meter. As a result, water discharges were measured by means of a Teledyne RD Instruments StreamPro® acoustic Doppler current profiler (ADCP).

All water discharges determined from handheld current velocity measurements were computed using the velocity-area method. The ADCP unit determined flow discharges in real-time, based on the measured water current velocities per segment. As a result, no additional calculations were necessary. A description of the velocity-area method is provided below, followed by a description of the ADCP method used.

The velocity-area method assumes that the velocity sampled at each vertical section across the channel represents the mean velocity. The segment area extends laterally from half the distance from the preceding vertical segment to half the distance to the next, and vertically from the water surface to the sounded depth at the channel bed. The partial discharges across the channel are then summed to obtain the estimated total discharge measurement for the gauged channel section.

At each vertical section, the water current velocity was measured over a 40 to 70 second time interval in order to obtain the mean velocity for that vertical section. At each sounding point across the channel, if the observed water depth was less than 0.75 m, the current water velocities were measured at 60% of the flow depth of water. The measurement was assumed to be the mean velocity for the vertical water section. When water depths were greater than 0.75 m, current velocities were measured at 20 and 80% of the flow depth of water and the average of the two readings was taken as the mean velocity for the vertical. A minimum of 20 current velocity measurements were taken across the width of the channel, with the aim of having each sounding or measurement interval account for less than 10% of the total discharge.

The ADCP unit was mounted onto a tethered floating platform and deployed across the stream by means of a temporary cableway. Measurements of current velocity, water depth, and the position of the unit across the channel section were automatically recorded. A single channel section or transect produced one measurement of mean discharge. At least four valid transects were collected during each site visit to reduce the effects of turbulence, directional bias, or other random errors. Results were considered valid if they were within 5% of the observed mean flow average. The resulting mean discharge value was reported as the estimated discharge for the river. The range of individual measurements was used as the error associated with the average discharge. The employed ADCP methods followed standard operating procedures (Oberg et al. 2005; Water Survey of Canada 2004).

2.5 RATING CURVE DEVELOPMENT

Unlike water level or stage, discharge is not typically monitored on a continuous basis at most hydrometric stations. To provide a continuous record of the discharge at a monitoring site, a relationship between recorded stages and associated measured discharges is developed. This empirical relationship is referred to as rating curve (ISO 2010). Once the rating curve is established for a monitoring site, water level data can be converted into a continuous discharge time series or hydrograph.

The quality of a rating curve depends on the number and accuracy of the individual data points used to generate the curve as well as the hydraulic characteristics of the monitoring location. Although a rating curve can be developed with as few as three points, hydrometric standards recommend as a minimum between 5 and 15 discharge measurements per year depending whether an existing rating is being maintained or a new rating is being established (Anderson 1999; ISO 2010). Each additional point increases the range and robustness of the rating curve at varying discharge levels. High discharge measurements are especially important as they help define the upper end of the rating curve. This is important as high discharges often require extrapolation beyond the range of the observed data used to generate the rating curve. Further, depending on channel geometry the rating relationship can change between low and high flow periods.

In the absence of a stage–discharge measurement corresponding to high flow conditions, the rating curve is often extrapolated to a high flow value that is beyond the range of the observed data used to generate the curve. The stage-discharge relationships in this report were extrapolated to values equal to 1.5 times the greatest measured discharge. Any discharge extrapolation beyond that limit is not recommended as the resulting value will have a high uncertainty associated with it (ISO 2010).

Rating curves were developed using Aquarius™ Time Series Hydrologic Software (Aquatics Informatics Inc.). The software uses standard methods outlined by the United States Geological Survey and the International Organization for Standardization (ISO; Kennedy 1984; ISO 2010). Plotted on a logarithmic scale, a least-squares regression procedure was used to produce a line of best fit and logarithmic equation for the concurrently measured water level (stage) and discharge data. Taking the antilogarithmic transformation, discharge was determined by a power function of the form:

$$Q = C\ (H - a)^{b} \qquad (1)$$

Where Q is the discharge [m^3/s], C and b are regression coefficients, H is the stage (water level; m), and a is the stage at zero flow (datum correction; m). The stage at zero flow was determined by subtracting the depth of water over the lowest point on the control from the stage indicated by the pressure transducer reading. A cross-sectional channel survey provided an approximation to the location of the lowest point on the control; however, the location was further refined using estimating techniques built into Aquarius™ Software.

2.6 HYDROGRAPH GENERATION

The developed rating curves for each site were used to convert water level data (stage) recorded continually by the automated stations into continuous discharge time-series or hydrographs.

The station TL-3 (Doris Creek downstream) was installed in late July 2011 after the need for transferring water from behind the North Dam to Doris Creek was identified by HBML; therefore, water discharges associated with the freshet period were not available for the period of record. To compensate for the data gap daily discharges at TL-3 were estimated using a simple linear regression model. The model was built using a period of concurrent daily discharge data (July 22nd to September 25th) from stations TL-2 and TL-3. Manual discharges measured on June 19th and June 22nd at station TL-3 were also incorporated into the linear regression model.

It is important to note that the procedure used to generate the discharge hydrograph for station TL-2 was different than the procedure used for stations TL-3 and Roberts Hydro. The hydrograph at TL-2 was updated on a daily basis with the most recent data downloaded via satellite transmissions. Daily discharge data were then sent (via email) to HBML personnel to support the water transfer activities from behind the North Dam to Doris Creek. Details for the procedure used for the hydrograph generation for the station TL-2 are provided in Appendix D.

2.7 HYDROLOGIC INDICES

Calculated annual runoff, mean flow for the period of record, peak flows, and low flows are important hydrologic indices that provide useful information when undertaking a hydrologic assessment for engineering design of mine project infrastructure as well as when managing the water resources once a mine has entered operations.

2.7.1 Calculated Runoff and Mean Flow

Calculated annual runoff (as a depth) represents the difference between annual precipitation, snowmelt, and evaporation. It is valuable for obtaining gross estimates of the water available from a basin. Because it is standardized by drainage area, it is a useful index when comparing the hydrological response of drainage basins of various sizes.

The mean flow was computed as an average discharge over the period of record. This is an additional parameter that provides an indication of the relative magnitude of water produced as a function of the hydroclimatic conditions, drainage basin size, as well as the range between recorded miniumum and maximum or peak flows.

Peak flows represent the maximum flow rate from a basin during a year, and typically occur in response to precipitation and snowmelt events. Peak flows are used in combination with flood frequency analysis techniques in order to estimate design discharges that are often employed in the sizing of open channel ditches, diversion channels, or drainage structures at channel crossings. For 2011, the maximum instantaneous and daily flow values were determined from the generated hydrographs.

In contrast, low flows provide an estimate of the normal base flow conditions during the open water season, which is important to the sustained health of a stream's aquatic community. Low flows were determined from the generated hydrographs for the period between July and September 2011.

3. Results and Observations

3. Results and Observations

Results from the 2011 Hydrology Compliance Monitoring Program are presented as follows: 1) completed discharge measurements, 2) lake water levels, 3) ocean tide levels at Roberts Bay, 4) determined stage-discharge relationships, 5) discharge hydrographs, and 6) calculated hydrological indices.

3.1 DISCHARGE MEASUREMENTS

Discharge measurements were taken during the June freshet period at hydrometric stations TL-2, TL-3, and Roberts Hydro. Additional measurements were conducted during the months of July, August, September, and October. A total of 17 water discharge measurements in 2011. The measurements were collected through the open water season in order to obtain a range of discharges at different flow conditions (Table 3.1-1 and Appendix A).

Table 3.1-1. Summary of Completed Discharge Measurements in 2011

Hydrometric Station and Drainage Area	Date Measured	Pressure Transducer Stage (m)*	Measured Discharge (m^3/s)	Method (Equipment Used)
TL-2 (Doris Creek upstream location; 94.6 km^2)	June 15	99.039	1.42	Velocity-Area (Flo-Mate current meter)
	June 21	99.367	4.92	Velocity-Area (Flo-Mate current meter)
	July 24	98.963	1.26	Velocity-Area (Flo-Mate current meter)
	August 18	98.737	0.417	Velocity-Area (Flo-Mate current meter)
	September 24	98.810	0.670	Velocity-Area (Flo-Mate current meter)
	September 27	98.825	0.673	
TL-3 (Doris Creek downstream location; 95.3 km^2)	June 19	97.927	4.46 (E)	Velocity-Area (ADCP)†
	June 22	97.999	6.46 (E)	Velocity-Area (ADCP)
	July 21	997.517	1.31	Velocity-Area (Flo-Mate current meter)
	July 22	97.531	1.37	Velocity-Area (Flo-Mate current meter)
	July24	97.486	1.13	Velocity-Area (Flo-Mate current meter)
	August 17	97.189	0.473	Velocity-Area (Flo-Mate current meter)
	September 25	97.276	0.663	Velocity-Area (Flo-Mate current meter)
Roberts Hydro (97.9 km^2)	June 17	99.517	4.60	Velocity-Area (Flo-Mate current meter)
	June 21	99.764	6.82	Velocity-Area (Flo-Mate current meter)
	July 22	99.165	1.06	Velocity-Area (Flo-Mate current meter)
	September 25	99.089	0.80	Velocity-Area (Flo-Mate current meter)

(E) - measurement graded as estimates because of anomalies/limitations of the measurement instrument used.
** - Stage is referenced to a site specific (non-geodetic) datum.*
† - Discharge measured by means of an ADCP.

In August 2011, field personnel were not able to access the hydrometric station Roberts Hydro because of the persistent presence of grizzly bears in the area. Thus, a flow discharge measurement was not completed during that site visit.

3.2 LAKE LEVELS

Lake water level variation for Doris Lake over the open-water season was 0.737 m, ranging from a minimum of 97.725 m on September 6th to a maximum of 98.462 m on July 5th (Table 3.2-1). Two distinct high water levels occurred at this lake. The first high water level of 99.443 m was generated by the melting of snow and ice during the freshet period and occurred June 22nd. The second and highest recorded water level of 99.462 m occurred on July 5th as a result of 32 mm of rain that fell between June 30th and July 1st. After July 5th, lake water levels declined at a steady rate of approximately 0.01 m/day until September 6th. Water levels were augmented by rainfall bursts that occurred between September 5th and 7th respectively. Mean daily lake levels are presented in Figure 3.2-1 and in tabular form in Appendix B.

Table 3.2-1. Lake Level Variations, 2011

Lake	Min Water Level (m)	Max Water Level (m)	Water Level Change (m)	Lake Area (km^2)
Doris	97.725	98.462	0.737	3.4
Tail	94.545	95.171	0.626	0.8
Windy	95.386	95.621	0.235	5.3

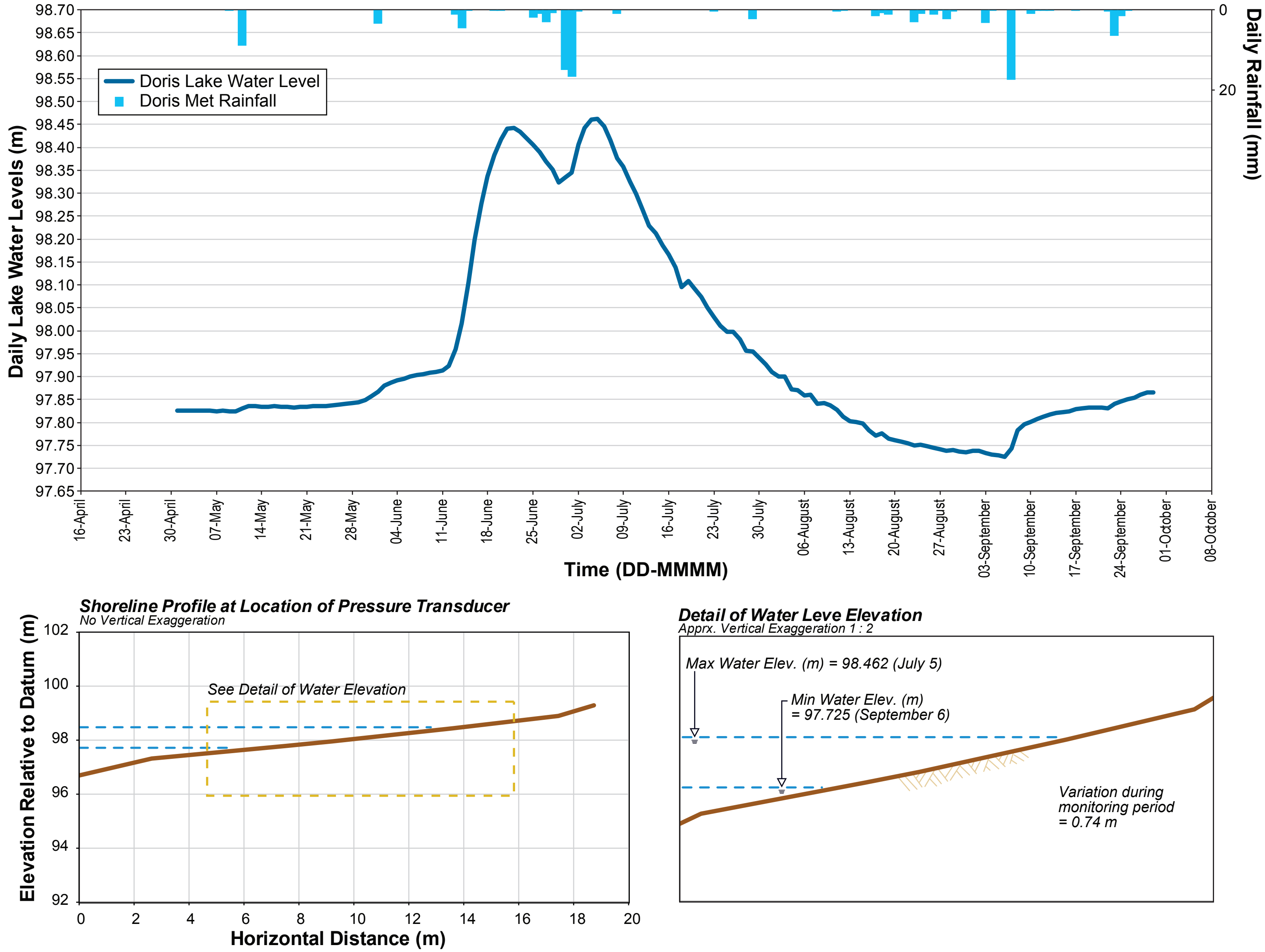
The partial construction of the North Dam blocked the natural outflow from Tail Lake. As a result, the water level fluctuations in Tail Lake were different from the fluctuations at Doris Lake. At Tail Lake only a single peak water level of 95.171 m was recorded on July 9th. After that, the water levels remained elevated but declined steadily at an approximate rate of 0.0003 m/day until September 6th. The lake levels were recharged by rainfall that occurred between September 5th and 7th. Mean daily lake levels are presented in Figure 3.2-2 and in tabular form in Appendix B.

At Windy Lake the water level variation over the open-water season was 0.235 m, ranging from a minimum of 95.386 m on September 6th to a maximum of 95.621 m on July 5th. In contrast to Doris Lake, only a single peak water level was observed at Windy Lake. This peak resulted from the melting of ice and snow associated with freshet conditions. The water level was augmented by 32 mm of rain that fell within the drainage area between June 30th and July 1st. After July 5th, lake levels decreased steadily at approximately 0.004 m/day until September 6th. The lake levels began to rise when they were recharged by rainfall events that occurred between September 5th and 7th. Mean daily lake levels are presented in Figure 3.2-3 and in tabular form in Appendix B.

3.3 TIDE VARIATIONS

The data recorded by the tide gauge primarily reflect changes in tide height, but also reflect waves and wind-driven seiches within Roberts Bay. Tides with one cycle (one high and one low) per lunar day (24 hours, 50 minutes) are diurnal and tides with two cycles per lunar day are semi-diurnal. The results from Roberts Bay (Figure 3.3-1) show that the tides in Roberts Bay are predominantly semi-diurnal. A diurnal tide frequency also occurs every two weeks preceding the spring tides of the new and full moons. Hence, the tides in Roberts Bay are classified as mixed tides.

The tides in Roberts Bay were microtidal (less than 2 m tide range). Daily tide ranges were generally between 0.25 m and 0.35 m (average: 0.30±0.07 m), with a maximum tidal range (the difference between high and low water in one tidal cycle) of 0.33 m on September 20, 2011 during the spring tide.



Note: Water levels are referenced to a site specific non-geodetic datum

Figure 3.2-1

NEWMONT NORTH AMERICA

2011 Lake Water Levels at Doris Lake

Figure 3.2-1

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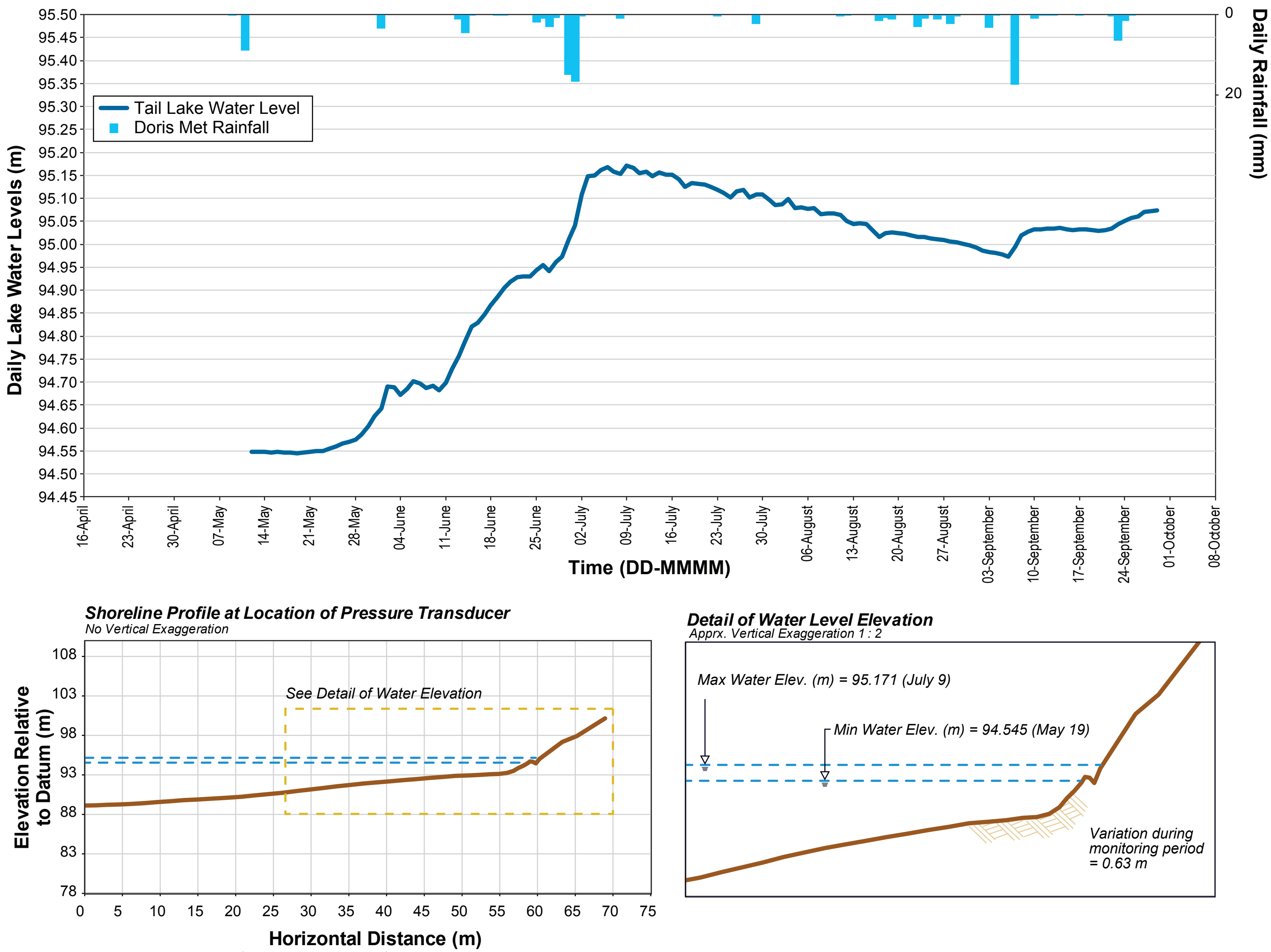

Note: Water levels are referenced to a site specific non-geodetic datum

Figure 3.2-2

NEWMONT NORTH AMERICA

2011 Lake Water Levels at Tail Lake

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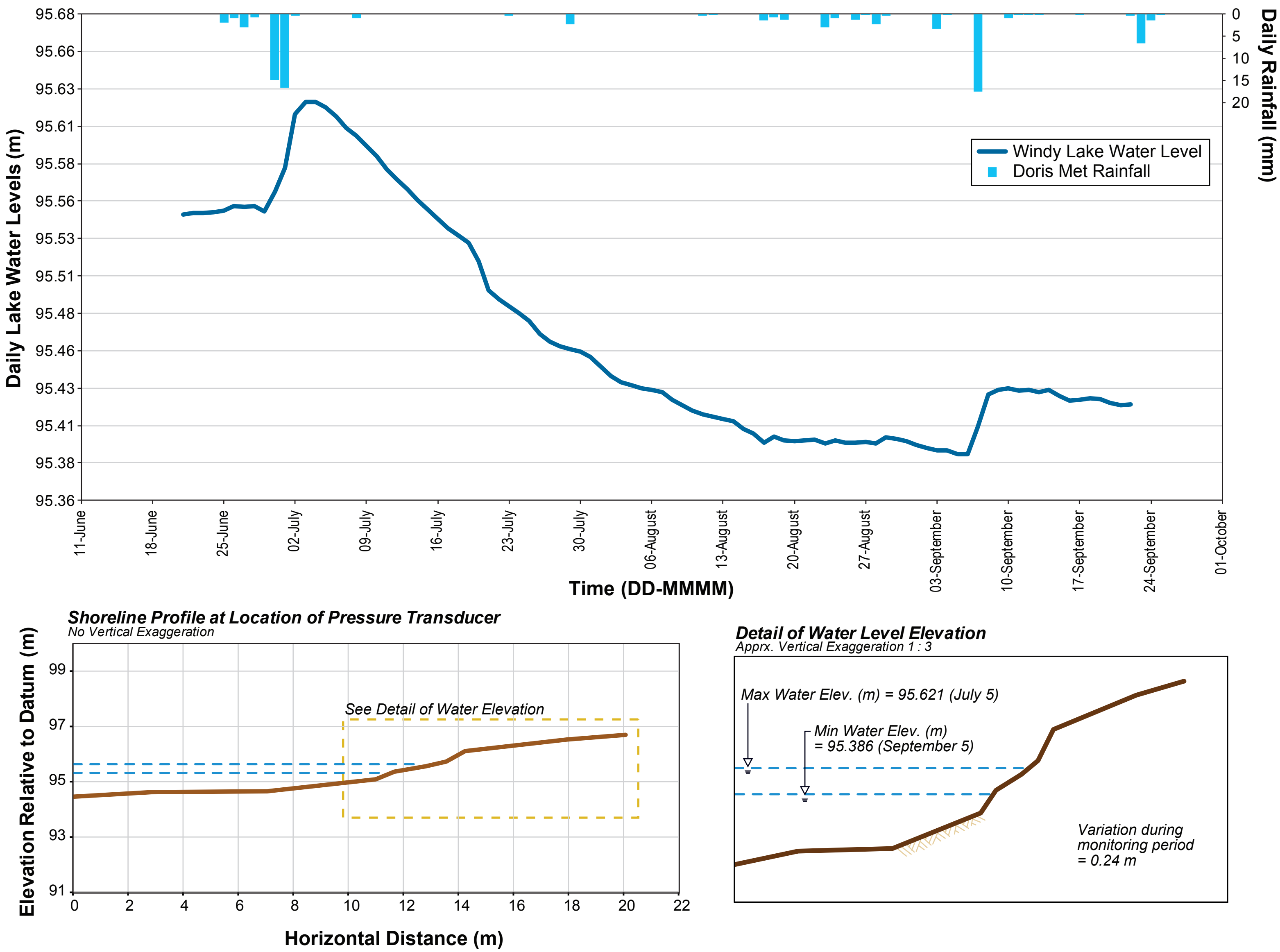

Note: Water levels are referenced to a site specific non-geodetic datum

Figure 3.2-3

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2011 Lake Water Levels at Windy Lake

Figure 3.2-3

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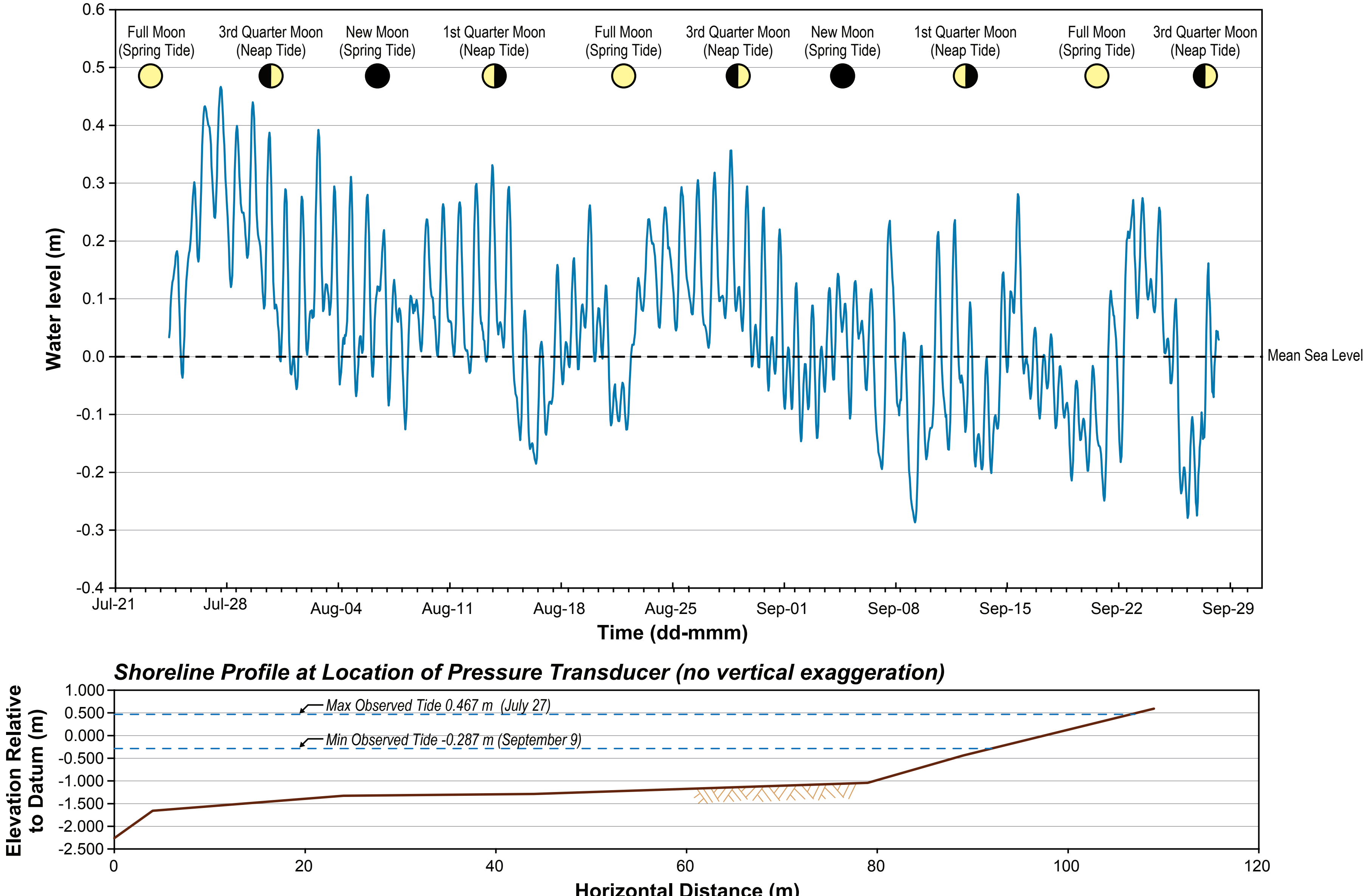

Note: Sea levels are referenced to a geodetic datum (elevation 2.945 masl).

Figure 3.3-1

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Tidal Fluctuation at Roberts Bay, July to September 2011

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Figure 3.3-1

3.4 STAGE-DISCHARGE RELATIONSHIPS

At stations TL-2 and Roberts Hydro, discharge measurements obtained during 2011 were used to update existing individual stage-discharge relationships. Seven measurements were used to generate a preliminary rating curve for station TL-3. Additional measurements will be required in order to increase the range and robustness of the stage-discharge relationship for this site.

At stations TL-2 and TL-3, the developed stage-discharge relationships changed between high and low stage conditions. As a result, the relationships had to be expressed as both high and low stage rating curves. A two-stage rating curve (i.e., high and low stage) is typically developed when the hydraulic conditions at a site change from section control to channel control. Section control occurs when water flows are well-confined within the channel, whereas channel control occurs when the channel overflows its banks during high flow conditions.

It is important to note that the Root Mean Square (RMS) is used by Aquarius® software as an overall measure of error of the stage-discharge relation. The RMS is a statistical parameter that describes how well the values predicted by the stage-discharge relation fit or represent the observed data. The departure from true values computed by this statistic combines both bias and lack of precision. The lower the RMS, the better the estimated values provided by the rating relationship. Rating equations for all sites are summarized in Table 3.4-1 and rating curves for the hydrometric stations are provided in Appendix C.

Table 3.4-1. Summary of 2011 Rating Equations

Hydrometric Station	Rating Equation $Q = C\,(h\text{-}a)^B$	Root Mean Square
TL-2 (Doris upstream)		
low stage	$Q = 1.43\,(h-96.60)^{2.10}$	9.1
high stage	$Q = 7.44\,(h-97.10)^{2.03}$	9.1
TL-3 (Doris downstream)		
low stage	$Q = 1.68\,(h-98.20)^{2.04}$	6.0
high stage	$Q = 8.73\,(h-98.57)^{2.08}$	6.0
Roberts-Hydro	$Q = 15.11(h-98.78)^{2.04}$	13

Q = discharge [m^3/s]; C = y intercept; h = recorded stage [m]; a = stage at zero flow (datum correction) [m]; ^{B} = slope.

3.5 HYDROGRAPHS

Discharge hydrographs for 2011 were generated for the hydrometric stations TL-2 (Doris Creek upstream), TL-3 (Doris Creek Downstream), and Roberts Hydro. The hydrographs are presented as mean daily discharge (m^3/s) in graphic form in Figures 3.5-1 to 3.5-3 and in tabular form in Appendix E.

The onset of the spring freshet occurred in early June 2011. By June 22nd, water levels reached maximum elevations as a result of the melting of ice and snow associated with freshet conditions. After that, water discharges increased until July 5th when flows reached their annual peaks. This occurred as a result of 32 mm of rain that was produced by storms that occurred between June 30th and July 1st.

After July 5th, flow steadily decreased until early September when it was augmented by rainfall bursts between September 5th and September 7, 2011.

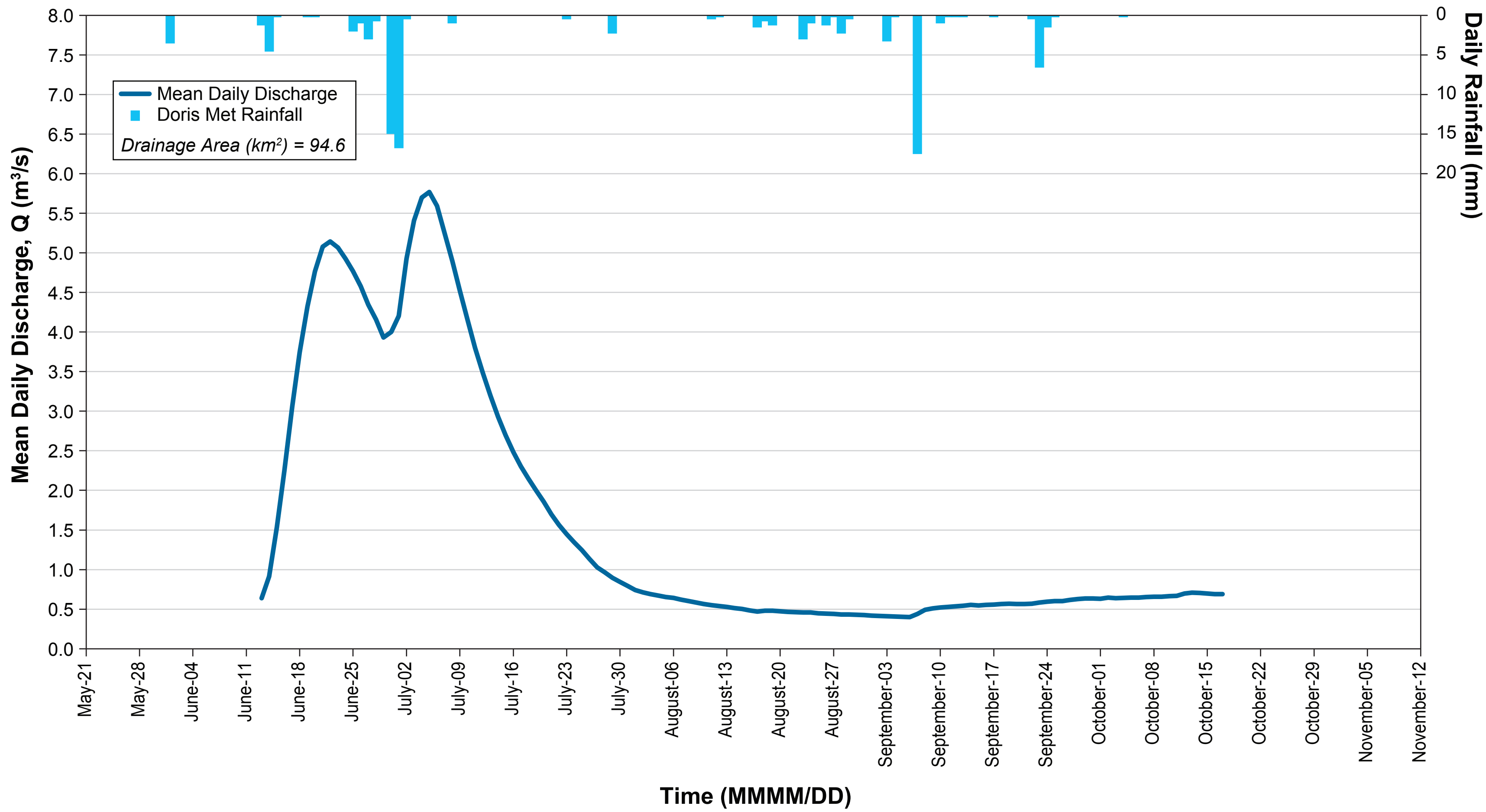

Figure 3.5-1

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2011 Annual Discharge Hydrograph at Station TL-2 (Doris Creek Upstream)

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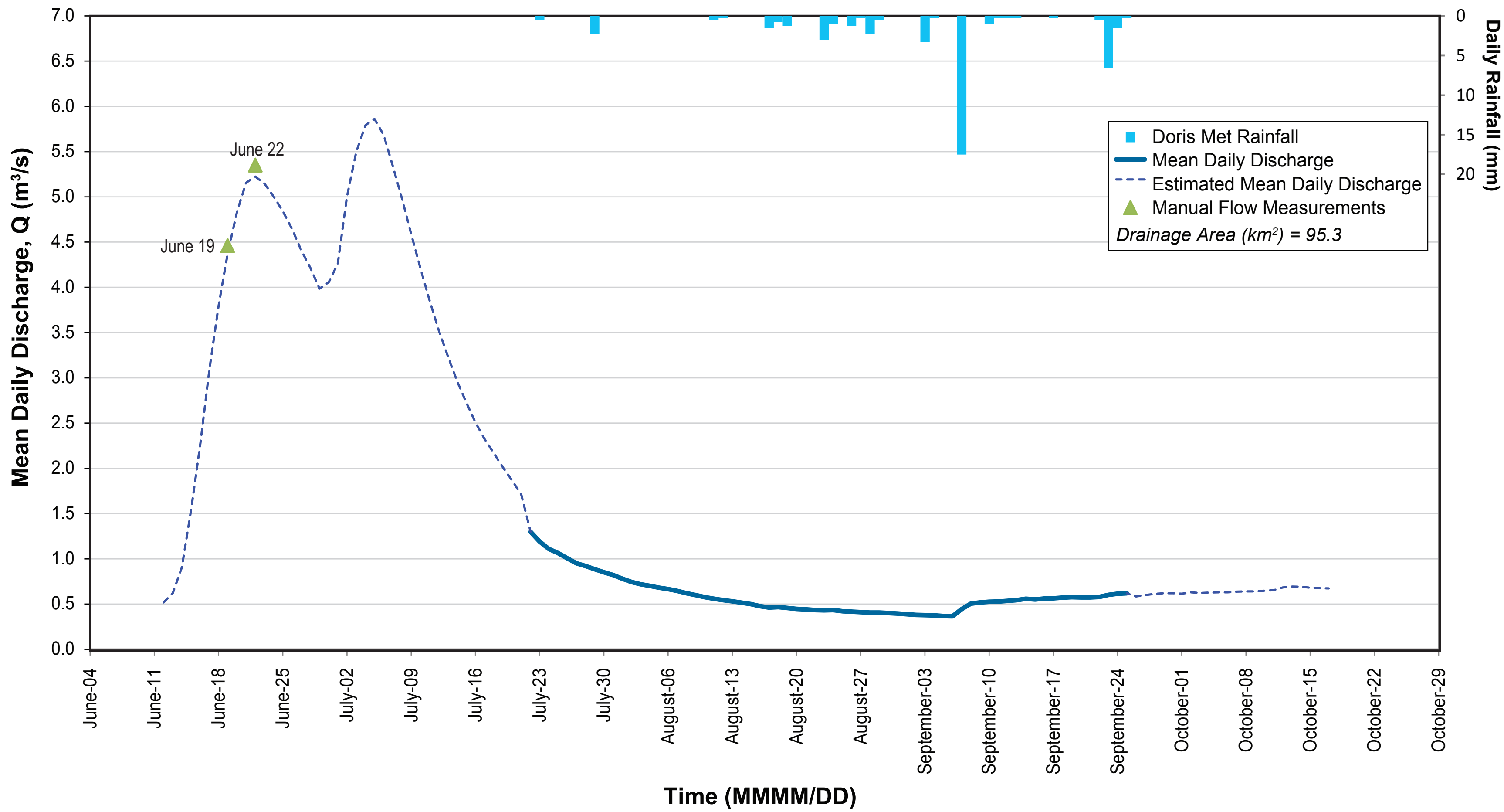

Figure 3.5-2

NEWMONT NORTH AMERICA

2011 Annual Discharge Hydrograph at Station TL-3 (Doris Creek Downstream)

Rescan Engineers & Scientists

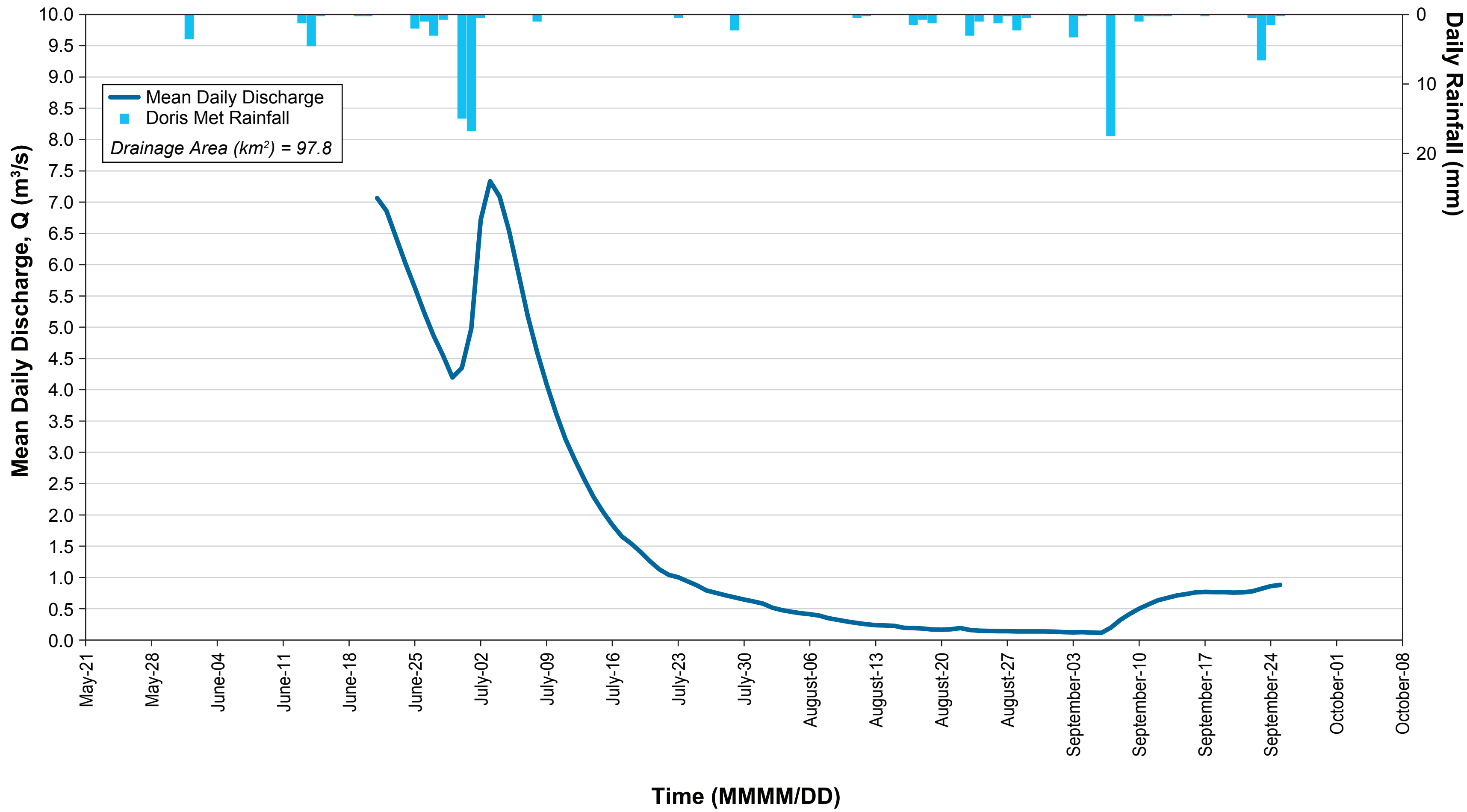

Figure 3.5-3

2011 Annual Discharge Hydrograph at Station Roberts Hydro

Figure 3.5-3

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3.6 HYDROLOGICAL INDICES

3.6.1 Calculated Runoff and Mean Flow

The calculated runoff and mean flow for station TL-2 (Doris Creek upstream location) for the period of record in 2011 were 184 mm and 1.58 m^3/s, respectively (Table 3.6-1). Comparatively, 2011 was a wetter year than 2010 in terms of annual runoff and mean flow. In 2010, the calculated annual runoff amounted to 121 mm, and the mean flow for the period of record was 1.15 m^3/s (Rescan 2011).

Table 3.6-1. 2011 Annual Runoff and Mean Flow for the Period of Record

Station	Watershed Area (km^2)	Calculated Runoff Over 2011 Period of Record (mm)	Calculated Runoff Over 2010 Period of Record (mm)	Mean Flow for 2011 Period of Record (m^3/s)	Mean Flow for 2010 Period of Record (m^3/s)
TL-2 (Doris Creek upstream location)	94.6	184 (June 12 to October 17)	121 (June 10 to October 4)	1.58	1.15
TL-3 (Doris Creek downstream location)	95.3	183 (June 12 to October 17)	n/a	1.58	n/a
Roberts Hydro	97.8	144 (June 21 to September 25)	137 (June 14 to October 2)	1.68	1.0

N/a - not applicable; station was not in operation during 2010.

The calculated runoff and mean flow for station TL-3 (Doris downstream location) for the period of record in 2011 were 183 mm and 1.58 m^3/s, respectively (Table 3.6-1). This station was a new addition to the monitoring network in 2011. Thus, comparisons to results for previous years are not possible.

The calculated runoff and mean flow for the Roberts Hydro station for the period of record in 2011 were 144 mm and 1.68 m^3/s, respectively (Table 3.6-1). Comparatively, 2011 was a wetter year than 2010 in terms of annual runoff and mean flow. In 2010, the calculated annual runoff amounted to 137 mm and the mean flow for the period of record was 1.0 m^3/s (Rescan 2011).

Frequency analysis results were reported by Rescan (2011) for the Doris Watershed, showing that the mean annual runoff for this watershed is 99 mm. In terms of annual runoff, the 2011 results are consistent with wetter hydrologic conditions associated with a 1-in-100 year return period interval.

3.6.2 Peak and Low Flows

The calculated daily peak flow for station TL-2 (Doris upstream location) was 5.77 m^3/s on July 5th, 2011. Similarly, instantaneous peak unit yield was 60.9 $L/s/km^2$ (Table 3.6-2). In 2011, the observed peak was higher than the 4.44 m^3/s peak observed in 2010.

The calculated daily peak flow for station TL-3 (Doris downstream location) was 5.86 m^3/s on July 5th. Similarly, instantaneous peak unit yield was 61.5 $L/s/km^2$.

At the Roberts Hydro station the peak occurred two days earlier than at stations TL-2 and TL-3. Water discharge at Roberts Hydro reached a peak of 7.34 m^3/s on July 3rd. Similarly, instantaneous peak unit yield was 75 $L/s/km^2$. In 2011 the observed peak was higher than the 5.78 m^3/s peak observed in 2010.

Frequency analysis results reported by Rescan (2011) for the Doris Watershed showed that the mean annual peak flow for this watershed is 1.68 m^3/s. In 2011, calculated peak flows exceeded the wetter hydrologic conditions associated with a 1-in-100 year return period interval.

Table 3.6-2. 2011 Annual Peak Flow and Unit

Station	2011 Peak Flow (m^3/s)		2010 Peak Flow (m^3/s)	2011 Peak Unit Yield ($L/s/km^2$)
	Daily	Date	Daily	Daily
TL-2 (Doris Creek upstream location)	5.77	July 5	4.44	60.9
TL-3 (Doris Creek downstream location)	5.86	July 5	n/a	61.5
Roberts Hydro	7.34	July 3	5.78	75

N/a- not applicable; station was not in operation during 2010.

Low flows in the Arctic occur at two different times of year, as a function of the size of the channel and its associated drainage area. Smaller streams reach their lowest flows during the open-water season in the late summer or early fall season. They typically produce no surface water flows throughout the winter period. However larger river channels may produce water flows all year round and reach their lowest flows during late winter season (i.e., during the months of March or April).

On September 6, 2011, the lowest water discharge at station TL-2 (Doris Creek upstream location) was 0.400 m^3/s. In comparison, the low flow in 2011 was slightly less than the 0.450 m^3/s low flow discharge that was observed in 2010 (Table 3.6-3).

Table 3.6-3. Daily Minimum Flows (July to September 2011)

Station	Daily Minimum Flow Over		Watershed Area (km^2)	% Lake Coverage in Watershed
	2011 Monitoring Period (m^3/s)	2010 Monitoring Period (m^3/s)		
TL-2 (Doris Creek upstream location)	0.400 (September 6)	0.450 (September 29)	94.6	20
TL-3 (Doris Creek downstream location)	0.365 (September 6)	n/a	95.3	20
Roberts Hydro	0.116 (September 3)	0.327 (September 3)	97.9	17

N/a - not applicable; station was not in operation during 2010.

On September 6, 2011, the lowest water discharge that occurred at station TL-3 (Doris Creek downstream location) was 0.365 m^3/s. In contrast, the minimum water discharge at the Roberts Hydro station was 0.116 m^3/s and occurred on September 3, 2011. The 2011 flow discharge was slightly lower than the 0.327 m^3/s low flow discharge that was observed in 2010.

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Appendix A
Manual Discharge Measurements

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Appendix A-1. Manual Discharge Measurements at Doris-Hydro TL-2 in 2011

Date Monitored:	15-Jun-11	**Discharge:**	1.42 m^3/s
Strart Time (24 hr):			
End Time (24 hr):	10:15		
Personnel:	Craig Hatt; Max Taylor		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	99.039		

Notes	**Station (m)**	**Depth (m)**	**Width (m)**	**Area (m^2)**	**Velocity 60% (m/s)**	**Velocity 20% (m/s)**	**Velocity 80% (m/s)**	**Average Vel. (m/s)**	**Q (m^3/s)**	**% of Total Q**
Right Bank	0.80	0.00	0.20	0.012	0.00			0.00	0.000	0.0
	1.20	0.12	0.30	0.04	0.00			0.00	0.000	0.0
	1.40	0.29	0.25	0.07	0.13			0.13	0.009	0.7
	1.70	0.38	0.30	0.11	0.41			0.41	0.047	3.3
	2.00	0.40	0.30	0.12	0.81			0.81	0.097	6.9
	2.30	0.40	0.30	0.12	0.95			0.95	0.114	8.1
	2.60	0.41	0.30	0.12	0.94			0.94	0.116	8.2
	2.90	0.36	0.30	0.11	0.99			0.99	0.107	7.6
	3.20	0.38	0.25	0.10	1.11			1.11	0.105	7.5
	3.40	0.41	0.20	0.08	1.11			1.11	0.091	6.4
	3.60	0.32	0.20	0.06	1.01			1.01	0.065	4.6
	3.80	0.40	0.25	0.10	0.90			0.90	0.090	6.4
	4.10	0.36	0.30	0.11	0.80			0.80	0.086	6.1
	4.40	0.34	0.30	0.10	0.93			0.93	0.095	6.7
	4.70	0.36	0.30	0.11	0.78			0.78	0.084	6.0
	5.00	0.36	0.30	0.11	0.80			0.80	0.086	6.1
	5.30	0.34	0.25	0.09	0.97			0.97	0.082	5.8
	5.50	0.32	0.20	0.06	0.84			0.84	0.054	3.8
start of grassy area	5.70	0.28	0.20	0.06	0.26			0.26	0.015	1.0
	5.90	0.24	0.25	0.06	0.21			0.21	0.013	0.9
	6.20	0.22	0.30	0.07	0.35			0.35	0.023	1.6
	6.50	0.22	0.25	0.06	0.25			0.25	0.014	1.0
	6.70	0.22	0.25	0.06	0.19			0.19	0.010	0.7
	7.00	0.18	0.50	0.09	0.13			0.13	0.012	0.8
Left Bank	7.70	0.00	0.35	0.03	0.00			0.00	0.000	0.0
Total Q									1.42	

Appendix A-1. Manual Discharge Measurements at Doris-Hydro TL-2 in 2011

Date Monitored: 21-Jun-11 **Discharge:** 4.92 m^3/s
Strart Time (24 hr):
End Time (24 hr): 17:15
Personnel: Craig Hatt; Max Taylor
Method: Velocity-Area
Instrument: Flow Mate 2000 with top setting rod
Stage: 99.367

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Right Bank	1.00	0.00	0.50	0.055	0.00			0.00	0.000	0.0
	2.00	0.22	1.00	0.22	0.02			0.02	0.004	0.1
	3.00	0.24	1.00	0.24	0.04			0.04	0.010	0.2
	4.00	0.34	0.75	0.26	0.19			0.19	0.048	1.0
	4.50	0.34	0.50	0.17	0.22			0.22	0.037	0.8
	5.00	0.38	0.75	0.29	0.14			0.14	0.040	0.8
	6.00	0.36	1.50	0.54	0.03			0.03	0.016	0.3
	8.00	0.42	1.75	0.74	0.08			0.08	0.059	1.2
	9.50	0.42	1.25	0.53	0.12			0.12	0.063	1.3
	10.50	0.38	0.75	0.29	0.15			0.15	0.043	0.9
	11.00	0.50	0.50	0.25	0.46			0.46	0.115	2.3
	11.50	0.54	0.45	0.24	0.61			0.61	0.148	3.0
	11.90	0.84	0.40	0.34		0.83	0.60	0.72	0.240	4.9
	12.30	0.78	0.40	0.31		1.20	1.00	1.10	0.343	7.0
	12.70	0.76	0.40	0.30	1.29			1.29	0.392	8.0
	13.10	0.74	0.40	0.30	1.33			1.33	0.394	8.0
	13.50	0.80	0.40	0.32		1.40	1.08	1.24	0.397	8.1
	13.90	0.78	0.40	0.31		1.42	1.07	1.25	0.388	7.9
	14.30	0.76	0.40	0.30	1.23			1.23	0.374	7.6
	14.70	0.74	0.40	0.30	1.18			1.18	0.349	7.1
	15.10	0.72	0.40	0.29	1.26			1.26	0.363	7.4
	15.50	0.66	0.40	0.26	1.19			1.19	0.314	6.4
	15.90	0.60	0.40	0.24	1.20			1.20	0.288	5.9
	16.30	0.55	0.40	0.22	1.01			1.01	0.222	4.5
	16.70	0.53	0.80	0.42	0.45			0.45	0.191	3.9
	17.90	0.42	1.15	0.48	0.03			0.03	0.014	0.3
	19.00	0.23	0.85	0.20	0.13			0.13	0.025	0.5
	19.60	0.25	0.75	0.19	0.16			0.16	0.030	0.6
	20.50	0.14	0.95	0.13	0.01			0.01	0.001	0.0
	21.50	0.11	1.00	0.11	0.05			0.05	0.006	0.1
Left Bank	22.50	0.00	0.50	0.03	0.00			0.00	0.000	0.0
Total Q									4.92	

Appendix A-1. Manual Discharge Measurements at Doris-Hydro TL-2 in 2011

Date Monitored:	24-Jul-11	**Discharge:**	1.26 m^3/s
Strart Time (24 hr):			
End Time (24 hr):	16:20		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	98.963		

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Right Bank	1.10	0.00	0.15	0.014	0.00			0.00	0.000	0.0
	1.40	0.18	0.35	0.06	0.07			0.07	0.004	0.4
	1.80	0.20	0.30	0.06	0.03			0.03	0.002	0.1
	2.00	0.37	0.20	0.07	0.37			0.37	0.027	2.2
	2.20	0.39	0.20	0.08	0.87			0.87	0.068	5.4
	2.40	0.42	0.20	0.08	1.09			1.09	0.092	7.3
	2.60	0.40	0.20	0.08	1.12			1.12	0.090	7.1
	2.80	0.40	0.20	0.08	0.96			0.96	0.077	6.1
	3.00	0.40	0.20	0.08	1.01			1.01	0.081	6.4
	3.20	0.36	0.20	0.07	1.10			1.10	0.079	6.3
	3.40	0.40	0.20	0.08	1.03			1.03	0.082	6.5
	3.60	0.38	0.20	0.08	1.01			1.01	0.077	6.1
	3.80	0.34	0.20	0.07	0.97			0.97	0.066	5.2
	4.00	0.34	0.20	0.07	0.90			0.90	0.061	4.9
	4.20	0.31	0.20	0.06	0.89			0.89	0.055	4.4
	4.40	0.32	0.20	0.06	0.95			0.95	0.061	4.8
	4.60	0.34	0.20	0.07	0.86			0.86	0.058	4.6
	4.80	0.33	0.20	0.07	0.87			0.87	0.057	4.6
	5.00	0.34	0.20	0.07	0.91			0.91	0.062	4.9
	5.20	0.28	0.20	0.06	0.95			0.95	0.053	4.2
	5.40	0.28	0.20	0.06	0.95			0.95	0.053	4.2
	5.60	0.29	0.15	0.04	0.80			0.80	0.035	2.8
	5.70	0.28	0.15	0.04	0.40			0.40	0.017	1.3
	5.90	0.17	0.30	0.05	0.04			0.04	0.002	0.2
	6.30	0.12	0.40	0.05	0.00			0.00	0.000	0.0
	6.70	0.12	0.35	0.04	0.00			0.00	0.000	0.0
Left Bank	7.00	0.00	0.15	0.01	0.00			0.00	0.000	0.0
Total Q									1.26	

Appendix A-1. Manual Discharge Measurements at Doris-Hydro TL-2 in 2011

Date Monitored:	18-Aug-11				**Discharge:**		0.42 m^3/s		
Start Time (24 hr):									
End Time (24 hr):	9:55								
Personnel:	Craig Hatt and Assistant								
Method:	Velocity-Area								
Instrument:	Flow Mate 2000 with top setting rod								
Stage:	98.737								

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Right Bank	1.00	0.00	0.08	0.005	0.00			0.00	0.000	0.0
	1.15	0.14	0.15	0.02	0.00			0.00	0.000	0.0
	1.30	0.62	0.15	0.09	0.03			0.03	0.003	0.7
	1.45	0.62	0.15	0.09	0.12			0.12	0.011	2.7
	1.60	0.62	0.15	0.09	0.25			0.25	0.023	5.6
	1.75	0.60	0.15	0.09	0.28			0.28	0.025	6.0
	1.90	0.60	0.15	0.09	0.29			0.29	0.026	6.3
	2.05	0.60	0.15	0.09	0.29			0.29	0.026	6.3
	2.20	0.61	0.15	0.09	0.31			0.31	0.028	6.8
	2.35	0.55	0.15	0.08	0.31			0.31	0.026	6.1
	2.50	0.60	0.15	0.09	0.28			0.28	0.025	6.0
	2.65	0.59	0.15	0.09	0.27			0.27	0.024	5.7
	2.80	0.58	0.15	0.09	0.27			0.27	0.023	5.6
	2.95	0.54	0.15	0.08	0.31			0.31	0.025	6.0
	3.10	0.60	0.15	0.09	0.32			0.32	0.029	6.9
	3.25	0.60	0.15	0.09	0.32			0.32	0.029	6.9
	3.40	0.60	0.15	0.09	0.30			0.30	0.027	6.5
	3.55	0.64	0.15	0.10	0.29			0.29	0.028	6.7
	3.70	0.62	0.13	0.08	0.26			0.26	0.020	4.8
	3.80	0.62	0.13	0.08	0.14			0.14	0.011	2.6
	3.95	0.38	0.15	0.06	0.12			0.12	0.007	1.6
	4.10	0.26	0.23	0.06	0.01			0.01	0.001	0.1
Left Bank	4.40	0.00	0.15	0.02	0.00			0.00	0.000	0.0
Total Q									0.42	

Appendix A-1. Manual Discharge Measurements at Doris-Hydro TL-2 in 2011

Date Monitored: 24-Sep-11 **Discharge:** 0.67 m^3/s
Start Time (24 hr): 19:25
End Time (24 hr): 15:00 approximated
Personnel: Craig Hatt and Assistant
Method: Velocity-Area
Instrument: Flow Mate 2000 with top setting rod
Stage: 98.810

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Right Bank	1.30	0.00	0.05	0.009	0.00			0.00	0.000	0.0
	1.40	0.36	0.13	0.05	0.01			0.01	0.000	0.1
	1.55	0.42	0.15	0.06	0.29			0.29	0.018	2.7
	1.70	0.44	0.15	0.07	0.61			0.61	0.040	6.0
	1.85	0.43	0.15	0.06	0.75			0.75	0.048	7.2
	2.00	0.32	0.15	0.05	0.85			0.85	0.041	6.1
	2.15	0.29	0.15	0.04	0.92			0.92	0.040	6.0
	2.30	0.26	0.15	0.04	0.90			0.90	0.035	5.2
	2.45	0.26	0.15	0.04	0.91			0.91	0.035	5.3
	2.60	0.28	0.15	0.04	0.81			0.81	0.034	5.1
	2.75	0.34	0.15	0.05	0.84			0.84	0.043	6.4
	2.90	0.30	0.15	0.05	0.87			0.87	0.039	5.9
	3.05	0.30	0.15	0.05	0.90			0.90	0.041	6.1
	3.20	0.32	0.15	0.05	0.85			0.85	0.041	6.1
	3.35	0.30	0.15	0.05	0.28			0.28	0.013	1.9
	3.50	0.30	0.15	0.05	0.43			0.43	0.019	2.9
	3.65	0.32	0.15	0.05	0.71			0.71	0.034	5.1
	3.80	0.25	0.15	0.04	0.75			0.75	0.028	4.2
	3.95	0.26	0.15	0.04	0.62			0.62	0.024	3.6
	4.10	0.26	0.15	0.04	0.38			0.38	0.015	2.2
	4.25	0.26	0.15	0.04	0.58			0.58	0.023	3.4
	4.40	0.18	0.15	0.03	0.65			0.65	0.018	2.6
	4.55	0.20	0.15	0.03	0.62			0.62	0.019	2.8
	4.70	0.20	0.13	0.03	0.56			0.56	0.014	2.1
	4.80	0.18	0.10	0.02	0.40			0.40	0.007	1.1
Left Bank	4.90	0.00	0.05	0.00	0.00			0.00	0.000	0.0
Total Q									0.67	

Appendix A-1. Manual Discharge Measurements at Doris-Hydro TL-2 in 2011

Date Monitored:	27-Sep-11	**Discharge:**	0.67 m^3/s
Strart Time (24 hr):			
End Time (24 hr):	11:50		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	98.825		

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Right Bank	2.00	0.00	0.10	0.018	0.00			0.00	0.000	0.0
	2.20	0.36	0.20	0.07	0.05			0.05	0.004	0.5
	2.40	0.37	0.20	0.07	0.40			0.40	0.030	4.4
	2.60	0.36	0.20	0.07	0.51			0.51	0.037	5.5
	2.80	0.38	0.20	0.08	0.70			0.70	0.053	7.9
	3.00	0.48	0.20	0.10	0.66			0.66	0.063	9.4
	3.20	0.46	0.20	0.09	0.27			0.27	0.025	3.7
	3.40	0.44	0.20	0.09	0.33			0.33	0.029	4.3
	3.60	0.40	0.20	0.08	0.55			0.55	0.044	6.5
	3.80	0.39	0.15	0.06	0.83			0.83	0.049	7.2
	3.90	0.30	0.10	0.03	0.82			0.82	0.025	3.7
	4.00	0.39	0.10	0.04	0.81			0.81	0.032	4.7
	4.10	0.37	0.10	0.04	0.75			0.75	0.028	4.1
	4.20	0.38	0.15	0.06	0.66			0.66	0.038	5.6
	4.40	0.36	0.20	0.07	0.42			0.42	0.030	4.5
	4.60	0.34	0.20	0.07	0.70			0.70	0.048	7.1
	4.80	0.34	0.20	0.07	0.43			0.43	0.029	4.3
	5.00	0.30	0.20	0.06	0.45			0.45	0.027	4.0
	5.20	0.16	0.20	0.03	0.70			0.70	0.022	3.3
	5.40	0.21	0.20	0.04	0.69			0.69	0.029	4.3
	5.60	0.22	0.18	0.04	0.67			0.67	0.026	3.8
	5.75	0.20	0.13	0.03	0.29			0.29	0.007	1.1
Left Bank	5.85	0.00	0.05	0.00	0.00			0.00	0.000	0.0
Total Q									0.67	

Appendix A-2. Manual Discharge Measurements at Doris-Hydro TL-3 in 2011

Date Monitored:	22-Jun-11	**Mean Discharge Q (m^3/s):**	6.46
Start Time (24 hr):	16:28	**% Measured:**	31.23
End Time (24 hr):	16:41		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Acoustic Doppler Current Profiler		

Transect	Discharge Q (m^3/s)						% Bad	
	Top	Mid	Bottom	Left	Right	Total Q	Ens	Bins
1	1.35	1.84	2.22	0.183	0.896	6.48	37	18
2	1.23	2.21	1.94	0.159	0.813	6.35	18	12
3	1.38	1.97	2.26	0.106	0.929	6.64	17	8
4	1.41	2.05	2.33	0.142	0.525	6.46	56	11
5	1.32	2.02	1.96	0.165	0.906	6.37	27	12
Mean	1.34	2.02	2.14	0.151	0.814	6.46	31	12

Date Monitored:	19-Jun-11	**Mean Discharge Q (m^3/s):**	4.46
Start Time (24 hr):	10:37	**% Measured:**	37.12
End Time (24 hr):	11:07		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Acoustic Doppler Current Profiler		

Transect	Discharge Q (m^3/s)						% Bad	
	Top	Mid	Bottom	Left	Right	Total Q	Ens	Bins
1	0.882	1.95	1.35	0.296	0.097	4.58	30	7
2	0.858	1.48	1.67	0.231	0.227	4.46	45	29
3	0.786	1.80	1.13	0.445	0.186	4.35	49	2
4	0.924	1.70	1.42	0.124	0.456	4.62	39	16
5	0.880	1.36	1.43	0.107	0.535	4.31	38	14
Mean	0.866	1.66	1.40	0.241	0.300	4.46	40	13

Appendix A-2. Manual Discharge Measurements at Doris-Hydro TL-3 in 2011

Date Monitored: 21-Jul-11 **Discharge:** 1.31 m³/s

Start Time (24 hr):

End Time (24 hr): 17:05

Personnel: Craig Hatt; Cathy Anablak

Method: Velocity-Area

Instrument: Flow Mate 2000 with top setting rod

Stage: 97.517

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	60% Velocity (m/s)	20% Velocity (m/s)	80% Velocity (m/s)	Velocity (m/s)	Q (m^3/s)	% of Total Q
Left Bank	1.00	0.00	0.10	0.01	0.00			0.00	0.00	0.0
	1.20	0.14	0.25	0.04	0.04			0.04	0.00	0.1
	1.50	0.07	0.40	0.03	0.02			0.02	0.00	0.0
	2.00	0.14	0.50	0.07	0.03			0.03	0.00	0.2
	2.50	0.16	0.50	0.08	0.03			0.03	0.00	0.2
	3.00	0.26	0.50	0.13	0.06			0.06	0.01	0.6
	3.50	0.33	0.35	0.12	0.06			0.06	0.01	0.5
	3.70	0.86	0.18	0.15		0.35	0.27	0.31	0.05	3.6
	3.85	0.86	0.15	0.13		0.44	0.41	0.43	0.05	4.2
	4.00	0.88	0.15	0.13		0.5	0.4	0.45	0.06	4.5
	4.15	0.88	0.15	0.13		0.53	0.52	0.53	0.07	5.3
	4.30	0.90	0.15	0.14		0.53	0.51	0.52	0.07	5.4
	4.45	0.88	0.15	0.13		0.57	0.53	0.55	0.07	5.6
	4.60	0.85	0.15	0.13		0.59	0.55	0.57	0.07	5.6
	4.75	0.88	0.15	0.13		0.58	0.57	0.58	0.08	5.8
	4.90	0.86	0.15	0.13		0.62	0.59	0.61	0.08	6.0
	5.05	0.88	0.15	0.13		0.65	0.61	0.63	0.08	6.4
	5.20	0.88	0.15	0.13		0.65	0.6	0.63	0.08	6.3
	5.35	0.88	0.15	0.13		0.63	0.63	0.63	0.08	6.4
	5.50	0.90	0.15	0.14		0.65	0.63	0.64	0.09	6.6
	5.65	0.90	0.15	0.14		0.61	0.59	0.60	0.08	6.2
	5.80	0.89	0.15	0.13		0.6	0.54	0.57	0.08	5.8
	5.95	0.86	0.15	0.13		0.57	0.35	0.46	0.06	4.5
	6.10	0.84	0.17	0.15		0.58	0.22	0.40	0.06	4.5
	6.30	0.80	0.20	0.16		0.35	0.23	0.29	0.05	3.6
	6.50	0.50	0.35	0.18	0.03			0.03	0.01	0.4
	7.00	0.42	0.50	0.21	0.03			0.03	0.01	0.5
	7.50	0.32	0.50	0.16	0.04			0.04	0.01	0.5
	8.00	0.26	0.50	0.13	0.03			0.03	0.00	0.3
	8.50	0.26	0.50	0.13	0.04			0.04	0.01	0.4
	9.00	0.18	0.55	0.10	0.02			0.02	0.00	0.2
Right Bank	9.60	0.00	0.30	0.03	0.00			0.00	0.00	0.0
Total Q									1.31	

Appendix A-2. Manual Discharge Measurements at Doris-Hydro TL-3 in 2011

Date Monitored: 22-Jul-11 **Discharge:** 1.37 m^3/s

Start Time (24 hr):

End Time (24 hr): 11:05

Personnel: Craig Hatt;Fraser Ross

Method: Velocity-Area

Instrument: Flow Mate 2000 with top setting rod

Stage: 97.506

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	60% Velocity (m/s)	20% Velocity (m/s)	80% Velocity (m/s)	Velocity (m/s)	Q (m^3/s)	% of Total Q
Left Bank	11.10	0.00	0.10	0.01	0.00			0.00	0.00	0.0
	10.90	0.15	0.30	0.05	0.02			0.02	0.00	0.1
	10.50	0.08	0.45	0.04	0.01			0.01	0.00	0.0
	10.00	0.12	0.50	0.06	0.02			0.02	0.00	0.1
	9.50	0.20	0.50	0.10	0.02			0.02	0.00	0.1
	9.00	0.16	0.50	0.08	0.03			0.03	0.00	0.2
	8.50	0.38	0.30	0.11	0.10			0.10	0.01	0.8
	8.40	0.86	0.13	0.11		0.33	0.18	0.26	0.03	2.0
	8.25	0.84	0.15	0.13		0.39	0.41	0.40	0.05	3.7
	8.10	0.88	0.15	0.13		0.5	0.42	0.46	0.06	4.4
	7.95	0.88	0.15	0.13		0.52	0.49	0.51	0.07	4.9
	7.80	0.88	0.15	0.13		0.57	0.54	0.56	0.07	5.3
	7.65	0.86	0.15	0.13		0.58	0.52	0.55	0.07	5.2
	7.50	0.86	0.15	0.13		0.61	0.51	0.56	0.07	5.3
	7.35	0.85	0.15	0.13		0.61	0.56	0.59	0.07	5.4
	7.20	0.86	0.15	0.13		0.66	0.6	0.63	0.08	5.9
	7.05	0.86	0.15	0.13		0.67	0.61	0.64	0.08	6.0
	6.90	0.86	0.15	0.13		0.69	0.59	0.64	0.08	6.0
	6.75	0.86	0.15	0.13		0.69	0.67	0.68	0.09	6.4
	6.60	0.88	0.15	0.13		0.74	0.66	0.70	0.09	6.7
	6.45	0.88	0.15	0.13		0.69	0.66	0.68	0.09	6.5
	6.30	0.89	0.15	0.13		0.69	0.63	0.66	0.09	6.4
	6.15	0.86	0.15	0.13		0.66	0.47	0.57	0.07	5.3
	6.00	0.83	0.15	0.12		0.61	0.25	0.43	0.05	3.9
	5.85	0.82	0.15	0.12		0.57	0.29	0.43	0.05	3.9
	5.70	0.78	0.13	0.10		0.23	0.29	0.26	0.03	1.8
	5.60	0.48	0.35	0.17	0.08			0.08	0.01	1.0
	5.00	0.42	0.55	0.23	0.04			0.04	0.01	0.7
	4.50	0.32	0.50	0.16	0.05			0.05	0.01	0.6
	4.00	0.24	0.50	0.12	0.05			0.05	0.01	0.4
	3.50	0.28	0.50	0.14	0.05			0.05	0.01	0.5
	3.00	0.17	0.60	0.10	0.05			0.05	0.01	0.4
Right Bank	2.30	0.00	0.35	0.03	0.00			0.00	0.00	0.0
Total Q									1.37	

Appendix A-2. Manual Discharge Measurements at Doris-Hydro TL-3 in 2011

Date Monitored: 24-Jul-11 **Discharge:** 1.13 m^3/s
Start Time (24 hr):
End Time (24 hr): 13:20 (approximation)
Personnel: Craig Hatt; Mark Tupper
Method: Velocity-Area
Propeller Size: Flow Mate 2000 with top setting rod
Indicator Constant: 97.449

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	60% Velocity (m/s)	20% Velocity (m/s)	80% Velocity (m/s)	Velocity (m/s)	Q (m^3/s)	% of Total Q
Right Bank	0.70	0.00	0.45	0.05	0.00			0.00	0.00	0.0
	1.60	0.24	0.70	0.17	0.04			0.04	0.01	0.6
	2.10	0.22	0.50	0.11	0.00			0.00	0.00	0.0
	2.60	0.28	0.50	0.14	0.01			0.01	0.00	0.1
	3.10	0.40	0.58	0.23	0.05			0.05	0.01	1.0
	3.75	0.46	0.35	0.16	0.14			0.14	0.02	2.0
	3.80	0.78	0.10	0.08		0.27	0.12	0.20	0.02	1.3
	3.95	0.78	0.15	0.12		0.42	0.26	0.34	0.04	3.5
	4.10	0.80	0.15	0.12		0.55	0.23	0.39	0.05	4.1
	4.25	0.83	0.15	0.12		0.52	0.34	0.43	0.05	4.7
	4.40	0.84	0.15	0.13		0.54	0.55	0.55	0.07	6.1
	4.55	0.84	0.15	0.13		0.59	0.53	0.56	0.07	6.2
	4.70	0.84	0.15	0.13		0.62	0.63	0.63	0.08	6.9
	4.85	0.84	0.15	0.13		0.6	0.56	0.58	0.07	6.4
	5.00	0.82	0.15	0.12		0.66	0.57	0.62	0.08	6.7
	5.15	0.82	0.15	0.12		0.63	0.56	0.60	0.07	6.5
	5.30	0.82	0.15	0.12		0.6	0.53	0.57	0.07	6.1
	5.45	0.80	0.15	0.12		0.59	0.49	0.54	0.06	5.7
	5.60	0.78	0.15	0.12		0.55	0.47	0.51	0.06	5.3
	5.75	0.80	0.15	0.12		0.53	0.49	0.51	0.06	5.4
	5.90	0.82	0.15	0.12		0.51	0.49	0.50	0.06	5.4
	6.05	0.82	0.15	0.12		0.48	0.4	0.44	0.05	4.8
	6.20	0.80	0.15	0.12		0.44	0.39	0.42	0.05	4.4
	6.35	0.80	0.15	0.12		0.39	0.36	0.38	0.05	4.0
	6.50	0.80	0.15	0.12		0.31	0.19	0.25	0.03	2.6
	6.65	0.30	0.25	0.07	0.01			0.01	0.00	0.1
	7.00	0.21	0.42	0.09	0.00			0.00	0.00	0.0
	7.50	0.16	0.70	0.11	0.00			0.00	0.00	0.0
Left Bank	8.40	0.00	0.45	0.04	0.00			0.00	0.00	0.0
Total Q									1.13	

Appendix A-2. Manual Discharge Measurements at Doris-Hydro TL-3 in 2011

Date Monitored:	17-Aug-11	**Discharge:**	0.47 m^3/s
Time (24 hr):	13:45		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	97.188		

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	60% Velocity (m/s)	20% Velocity (m/s)	80% Velocity (m/s)	Velocity (m/s)	Q (m^3/s)	% of Total Q
Right Bank	1.00	0.00	0.20	0.01	0.00			0.00	0.00	0.0
	1.40	0.14	0.40	0.06	0.01			0.01	0.00	0.1
	1.80	0.16	0.30	0.05	0.01			0.01	0.00	0.1
	2.00	0.19	0.15	0.03	0.01			0.01	0.00	0.1
	2.10	0.48	0.13	0.06	0.01			0.01	0.00	0.1
	2.25	0.51	0.15	0.08	0.18			0.18	0.01	2.9
	2.40	0.54	0.15	0.08	0.07			0.07	0.01	1.2
	2.55	0.56	0.15	0.08	0.08			0.08	0.01	1.4
	2.70	0.58	0.15	0.09	0.27			0.27	0.02	5.0
	2.85	0.58	0.15	0.09	0.40			0.40	0.03	7.4
	3.00	0.56	0.11	0.06	0.44			0.44	0.03	5.9
	3.075	0.56	0.08	0.04	0.45			0.45	0.02	4.0
	3.15	0.55	0.11	0.06	0.47			0.47	0.03	6.2
	3.30	0.56	0.11	0.06	0.47			0.47	0.03	6.3
	3.375	0.56	0.08	0.04	0.44			0.44	0.02	3.9
	3.45	0.54	0.08	0.04	0.44			0.44	0.02	3.8
	3.525	0.55	0.08	0.04	0.42			0.42	0.02	3.7
	3.60	0.55	0.09	0.05	0.41			0.41	0.02	4.2
	3.70	0.56	0.13	0.07	0.41			0.41	0.03	6.1
	3.85	0.56	0.15	0.08	0.39			0.39	0.03	7.0
	4.00	0.56	0.15	0.08	0.37			0.37	0.03	6.6
	4.15	0.56	0.15	0.08	0.35			0.35	0.03	6.3
	4.30	0.57	0.15	0.09	0.28			0.28	0.02	5.1
	4.45	0.58	0.13	0.07	0.22			0.22	0.02	3.4
	4.55	0.58	0.13	0.07	0.21			0.21	0.02	3.2
	4.70	0.58	0.13	0.07	0.23			0.23	0.02	3.6
	4.80	0.58	0.13	0.07	0.15			0.15	0.01	2.3
Left Bank	4.95	0.00	0.08	0.02	0.00			0.00	0.00	0.0
Total Q									0.47	

Appendix A-2. Manual Discharge Measurements at Doris-Hydro TL-3 in 2011

Date Monitored:	25-Sep-11	**Discharge:**	0.66 m^3/s
Time (24 hr):	9:50 approximation		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	97.277		

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	60% Velocity (m/s)	20% Velocity (m/s)	80% Velocity (m/s)	Velocity (m/s)	Q (m^3/s)	% of Total Q
Right Bank	0.90	0.00	0.30	0.02	0.00			0.00	0.00	0.0
	1.50	0.14	0.55	0.08	0.00			0.00	0.00	0.0
	2.00	0.18	0.50	0.09	0.00			0.00	0.00	0.0
	2.50	0.24	0.50	0.12	0.00			0.00	0.00	0.0
	3.00	0.30	0.33	0.10	0.00			0.00	0.00	0.0
	3.15	0.58	0.15	0.09	0.01			0.01	0.00	0.1
	3.30	0.60	0.15	0.09	0.25			0.25	0.02	3.4
	3.45	0.64	0.15	0.10	0.17			0.17	0.02	2.5
	3.60	0.68	0.15	0.10	0.20			0.20	0.02	3.1
	3.75	0.68	0.15	0.10	0.35			0.35	0.04	5.4
	3.90	0.68	0.15	0.10	0.43			0.43	0.04	6.7
	4.05	0.68	0.15	0.10	0.53			0.5	0.05	8.2
	4.20	0.67	0.13	0.08	0.50			0.50	0.04	6.4
	4.30	0.66	0.10	0.07	0.52			0.52	0.03	5.2
	4.40	0.66	0.10	0.07	0.52			0.52	0.03	5.2
	4.50	0.66	0.10	0.07	0.49			0.49	0.03	4.9
	4.60	0.64	0.10	0.06	0.50			0.50	0.03	4.9
	4.70	0.62	0.10	0.06	0.50			0.50	0.03	4.7
	4.80	0.63	0.13	0.08	0.46			0.46	0.04	5.5
	4.95	0.64	0.15	0.10	0.43			0.43	0.04	6.3
	5.10	0.65	0.15	0.10	0.43			0.43	0.04	6.4
	5.25	0.66	0.15	0.10	0.34			0.34	0.03	5.1
	5.40	0.66	0.15	0.10	0.32			0.32	0.03	4.8
	5.55	0.66	0.15	0.10	0.31			0.31	0.03	4.7
	5.70	0.66	0.13	0.08	0.28			0.28	0.02	3.5
	5.80	0.66	0.15	0.10	0.19			0.19	0.02	2.9
Left Bank	6.00	0.00	0.10	0.03	0.00			0.00	0.00	0.0
Total Q									0.66	

Appendix A-3. Manual Discharge Measurements at Roberts Hydro in 2011

Date Monitored:	17-Jun-11	**Discharge:**	4.60 m^3/s
Start Time (24 hr):			
End Time (24 hr):	12:15		
Personnel:	Craig Hatt; Max Taylor		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	99.517		

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Right Bank	2.30	0.00	0.35	0.02	0.00			0.00	0.000	0.0
	3.00	0.11	0.85	0.09	0.14			0.14	0.013	0.3
	4.00	0.12	1.00	0.12	0.06			0.06	0.007	0.2
	5.00	0.32	1.00	0.32	0.19			0.19	0.061	1.3
	6.00	0.36	1.00	0.36	0.55			0.55	0.198	4.3
	7.00	0.40	0.75	0.30	0.77			0.77	0.231	5.0
	7.50	0.34	0.50	0.17	0.46			0.46	0.078	1.7
	8.00	0.60	0.50	0.30	0.69			0.69	0.207	4.5
	8.50	0.62	0.50	0.31	0.96			0.96	0.298	6.5
	9.00	0.30	0.50	0.15	1.09			1.09	0.164	3.6
	9.50	0.32	0.50	0.16	1.04			1.04	0.166	3.6
	10.00	0.52	0.50	0.26	0.95			0.95	0.247	5.4
	10.50	0.60	0.50	0.30	0.80			0.80	0.240	5.2
	11.00	0.40	0.50	0.20	0.89			0.89	0.178	3.9
	11.50	0.46	0.50	0.23	0.86			0.86	0.198	4.3
	12.00	0.60	0.50	0.30	0.82			0.82	0.246	5.3
	12.50	0.62	0.50	0.31	0.81			0.81	0.251	5.5
	13.00	0.69	0.50	0.35	0.64			0.64	0.221	4.8
	13.50	0.69	0.50	0.35	0.55			0.55	0.190	4.1
	14.00	0.70	0.50	0.35	0.64			0.64	0.224	4.9
	14.50	0.70	0.50	0.35	0.48			0.48	0.168	3.7
	15.00	0.52	0.50	0.26	0.78			0.78	0.203	4.4
	15.50	0.66	0.50	0.33	0.48			0.48	0.158	3.4
	16.00	0.64	0.50	0.32	0.68			0.68	0.218	4.7
	16.50	0.67	0.50	0.34	0.31			0.31	0.104	2.3
	17.00	0.34	0.75	0.26	0.31			0.31	0.079	1.7
	18.00	0.32	1.00	0.32	0.29			0.29	0.093	2.0
	19.00	0.29	1.00	0.29	0.28			0.28	0.081	1.8
	20.00	0.29	1.00	0.29	0.06			0.06	0.017	0.4
	21.00	0.26	1.00	0.26	0.19			0.19	0.049	1.1
	22.00	0.26	0.90	0.23	0.05			0.05	0.012	0.3
Left Bank	22.80	0.00	0.40	0.05	0.00			0.00	0.000	0.0
Total Q									4.60	

Appendix A-3. Manual Discharge Measurements at Roberts Hydro in 2011

Date Monitored:	21-Jun-11	**Discharge:**	6.82 m^3/s
Start Time (24 hr):			
End Time (24 hr):	15:00		
Personnel:	Craig Hatt; Max Taylor		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	99.764		

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Right Bank	2.80	0.00	0.50	0.05	0.00			0.00	0.000	0.0
	3.80	0.20	1.00	0.20	0.19			0.19	0.038	0.6
	4.80	0.20	1.00	0.20	0.19			0.19	0.038	0.6
	5.80	0.28	1.00	0.28	0.28			0.28	0.078	1.1
	6.80	0.40	1.00	0.40	0.42			0.42	0.168	2.5
	7.80	0.44	0.75	0.33	0.79			0.79	0.261	3.8
	8.30	0.54	0.50	0.27	0.77			0.77	0.208	3.0
	8.80	0.52	0.50	0.26	0.42			0.42	0.109	1.6
	9.30	0.72	0.50	0.36	0.60			0.60	0.216	3.2
	9.80	0.67	0.50	0.34	0.93			0.93	0.312	4.6
	10.30	0.44	0.50	0.22	1.12			1.12	0.246	3.6
	10.80	0.34	0.50	0.17	1.18			1.18	0.201	2.9
	11.30	0.58	0.50	0.29	1.09			1.09	0.316	4.6
	11.80	0.74	0.50	0.37	1.03			1.03	0.381	5.6
	12.30	0.64	0.50	0.32	0.91			0.91	0.291	4.3
	12.80	0.74	0.50	0.37	0.71			0.71	0.263	3.9
	13.30	0.70	0.50	0.35	0.95			0.95	0.333	4.9
	13.80	0.68	0.50	0.34	1.01			1.01	0.343	5.0
	14.30	0.74	0.50	0.37	0.87			0.87	0.322	4.7
	14.80	0.72	0.50	0.36	0.84			0.84	0.302	4.4
	15.30	0.60	0.50	0.30	0.93			0.93	0.279	4.1
	15.80	0.64	0.50	0.32	0.75			0.75	0.240	3.5
	16.30	0.72	0.50	0.36	0.86			0.86	0.310	4.5
	16.80	0.75	0.50	0.38	0.72			0.72	0.270	4.0
	17.30	0.80	0.50	0.40		0.91	0.47	0.69	0.276	4.0
	17.80	0.82	0.50	0.41		0.97	0.23	0.60	0.246	3.6
	18.30	0.34	0.75	0.26	0.66			0.66	0.168	2.5
	19.30	0.40	1.00	0.40	0.41			0.41	0.164	2.4
	20.30	0.45	1.00	0.45	0.45			0.45	0.203	3.0
	21.30	0.38	1.00	0.38	0.13			0.13	0.049	0.7
	22.30	0.32	1.00	0.32	0.25			0.25	0.080	1.2
	23.30	0.33	0.85	0.28	0.32			0.32	0.090	1.3
	24.00	0.24	0.70	0.17	0.13			0.13	0.022	0.3
Left Bank	24.70	0.00	0.35	0.04	0.00			0.00	0.000	0.0
Total Q									6.82	

Appendix A-3. Manual Discharge Measurements at Roberts Hydro in 2011

Date Monitored:	22-Jul-11	**Discharge:**	1.06 m^3/s
Start Time (24 hr):			
End Time (24 hr):	15:00 approximated		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	99.165		

Notes	Station (m)	Depth (m)	Width (m)	Area (m^2)	Velocity 60% (m/s)	Velocity 20% (m/s)	Velocity 80% (m/s)	Average Vel. (m/s)	Q (m^3/s)	% of Total Q
Left Bank	5.00	0.00	0.08	0.02	0.00			0.00	0.000	0.0
	4.85	0.44	0.15	0.07	0.10			0.10	0.007	0.6
	4.70	0.42	0.15	0.06	0.25			0.25	0.016	1.5
	4.55	0.44	0.15	0.07	0.46			0.46	0.030	2.9
	4.40	0.44	0.15	0.07	0.62			0.62	0.041	3.9
	4.25	0.45	0.15	0.07	0.82			0.82	0.055	5.2
	4.10	0.42	0.15	0.06	0.89			0.89	0.056	5.3
	3.95	0.44	0.15	0.07	0.95			0.95	0.063	5.9
	3.80	0.46	0.15	0.07	0.89			0.89	0.061	5.8
	3.65	0.46	0.15	0.07	0.87			0.87	0.060	5.7
	3.50	0.46	0.15	0.07	0.94			0.94	0.065	6.1
	3.35	0.47	0.15	0.07	0.97			0.97	0.068	6.5
	3.20	0.47	0.15	0.07	0.88			0.88	0.062	5.9
	3.05	0.48	0.15	0.07	0.82			0.82	0.059	5.6
	2.90	0.48	0.15	0.07	0.84			0.84	0.060	5.7
	2.75	0.46	0.15	0.07	0.80			0.80	0.055	5.2
	2.60	0.42	0.15	0.06	0.73			0.73	0.046	4.3
	2.45	0.43	0.15	0.06	0.71			0.71	0.046	4.3
	2.30	0.43	0.15	0.06	0.78			0.78	0.050	4.8
	2.15	0.46	0.15	0.07	0.72			0.72	0.050	4.7
	2.00	0.42	0.15	0.06	0.60			0.60	0.038	3.6
	1.85	0.42	0.15	0.06	0.59			0.59	0.037	3.5
	1.70	0.42	0.12	0.05	0.38			0.38	0.020	1.9
	1.60	0.40	0.15	0.06	0.16			0.16	0.010	0.9
	1.40	0.18	0.20	0.04	0.06			0.06	0.002	0.2
Right Bank	1.20	0.00	0.10	0.01	0.00			0.00	0.000	0.0
Total Q									1.06	

Appendix A-3. Manual Discharge Measurements at Roberts Hydro in 2011

Date Monitored:	25-Sep-11	**Discharge:**	0.80 m^3/s
Start Time (24 hr):			
End Time (24 hr):	13:00 **(approximation)**		
Personnel:	Craig Hatt and Assistant		
Method:	Velocity-Area		
Instrument:	Flow Mate 2000 with top setting rod		
Stage:	99.089		

Notes	**Station (m)**	**Depth (m)**	**Width (m)**	**Area (m^2)**	**Velocity 60% (m/s)**	**Velocity 20% (m/s)**	**Velocity 80% (m/s)**	**Average Vel. (m/s)**	**Q (m^3/s)**	**% of Total Q**
Right Bank	0.90	0.00	0.05	0.01	0.00			0.00	0.000	0.0
	1.00	0.24	0.13	0.03	0.00			0.00	0.000	0.0
	1.15	0.26	0.15	0.04	0.48			0.48	0.019	2.3
	1.30	0.26	0.15	0.04	0.68			0.68	0.027	3.3
	1.45	0.26	0.15	0.04	0.84			0.84	0.033	4.1
	1.60	0.26	0.15	0.04	0.85			0.85	0.033	4.2
	1.75	0.28	0.15	0.04	0.74			0.74	0.031	3.9
	1.90	0.30	0.15	0.05	0.91			0.91	0.041	5.1
	2.05	0.28	0.15	0.04	1.04			1.04	0.044	5.5
	2.20	0.28	0.15	0.04	1.12			1.12	0.047	5.9
	2.35	0.29	0.15	0.04	1.09			1.09	0.047	5.9
	2.50	0.30	0.15	0.05	1.01			1.01	0.045	5.7
	2.65	0.30	0.15	0.05	1.11			1.11	0.050	6.3
	2.80	0.30	0.15	0.05	1.11			1.11	0.050	6.3
	2.95	0.30	0.15	0.05	1.07			1.07	0.048	6.0
	3.10	0.26	0.15	0.04	1.08			1.08	0.042	5.3
	3.25	0.25	0.15	0.04	1.10			1.10	0.041	5.2
	3.40	0.25	0.15	0.04	1.05			1.05	0.039	4.9
	3.55	0.25	0.15	0.04	1.02			1.02	0.038	4.8
	3.70	0.25	0.15	0.04	1.01			1.01	0.038	4.7
	3.85	0.24	0.15	0.04	0.84			0.84	0.030	3.8
	4.00	0.24	0.15	0.04	0.74			0.74	0.027	3.3
	4.15	0.24	0.15	0.04	0.57			0.57	0.021	2.6
	4.30	0.24	0.13	0.03	0.24			0.24	0.007	0.9
Left Bank	4.40	0.00	0.05	0.01	0.00			0.00	0.000	0.0
Total Q									0.80	

Appendix B
Summary of Daily Mean Water Levels

Appendix B-1. Summary of Daily Mean Water Level (m) at Doris Lake Station in 2011

Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)
1-Jan	*97.813*	1-Mar	*97.819*	1-May	*97.826*	1-Jul	98.344	1-Sep	97.738	1-Nov	
2-Jan	*97.813*	2-Mar	*97.819*	2-May	*97.826*	2-Jul	98.405	2-Sep	97.738	2-Nov	
3-Jan	*97.814*	3-Mar	*97.822*	3-May	*97.825*	3-Jul	98.443	3-Sep	97.734	3-Nov	
4-Jan	*97.813*	4-Mar	*97.822*	4-May	*97.826*	4-Jul	98.461	4-Sep	97.730	4-Nov	
5-Jan	*97.813*	5-Mar	*97.821*	5-May	*97.825*	5-Jul	98.462	5-Sep	97.728	5-Nov	
6-Jan	*97.813*	6-Mar	*97.821*	6-May	*97.825*	6-Jul	98.446	6-Sep	97.725	6-Nov	
7-Jan	*97.813*	7-Mar	*97.822*	7-May	*97.825*	7-Jul	98.416	7-Sep	97.744	7-Nov	
8-Jan	*97.813*	8-Mar	*97.823*	8-May	*97.825*	8-Jul	98.377	8-Sep	97.783	8-Nov	
9-Jan	*97.813*	9-Mar	*97.824*	9-May	*97.825*	9-Jul	98.357	9-Sep	97.797	9-Nov	
10-Jan	*97.813*	10-Mar	*97.823*	10-May	*97.825*	10-Jul	98.325	10-Sep	97.801	10-Nov	
11-Jan	*97.814*	11-Mar	*97.824*	11-May	*97.831*	11-Jul	98.298	11-Sep	97.807	11-Nov	
12-Jan	*97.815*	12-Mar	*97.823*	12-May	*97.835*	12-Jul	98.262	12-Sep	97.813	12-Nov	
13-Jan	*97.815*	13-Mar	*97.823*	13-May	*97.835*	13-Jul	98.229	13-Sep	97.817	13-Nov	
14-Jan	*97.815*	14-Mar	*97.823*	14-May	*97.835*	14-Jul	98.212	14-Sep	97.820	14-Nov	
15-Jan	*97.811*	15-Mar	*97.824*	15-May	*97.835*	15-Jul	98.186	15-Sep	97.822	15-Nov	
16-Jan	*97.811*	16-Mar	*97.824*	16-May	*97.835*	16-Jul	98.167	16-Sep	97.824	16-Nov	
17-Jan	*97.812*	17-Mar	*97.824*	17-May	*97.835*	17-Jul	98.138	17-Sep	97.828	17-Nov	
18-Jan	*97.811*	18-Mar	*97.824*	18-May	*97.834*	18-Jul	98.095	18-Sep	97.831	18-Nov	
19-Jan	*97.812*	19-Mar	*97.823*	19-May	*97.833*	19-Jul	98.109	19-Sep	97.832	19-Nov	
20-Jan	*97.812*	20-Mar	*97.823*	20-May	*97.833*	20-Jul	98.092	20-Sep	97.833	20-Nov	
21-Jan	*97.813*	21-Mar	*97.823*	21-May	*97.835*	21-Jul	98.074	21-Sep	97.833	21-Nov	
22-Jan	*97.812*	22-Mar	*97.822*	22-May	*97.835*	22-Jul	98.051	22-Sep	97.831	22-Nov	
23-Jan	*97.813*	23-Mar	*97.822*	23-May	*97.835*	23-Jul	98.029	23-Sep	97.841	23-Nov	
24-Jan	*97.814*	24-Mar	*97.822*	24-May	*97.836*	24-Jul	98.012	24-Sep	97.845	24-Nov	
25-Jan	*97.815*	25-Mar	*97.822*	25-May	*97.838*	25-Jul	97.998	25-Sep	97.850	25-Nov	
26-Jan	*97.815*	26-Mar	*97.822*	26-May	*97.839*	26-Jul	97.998	26-Sep	97.854	26-Nov	
27-Jan	*97.816*	27-Mar	*97.822*	27-May	*97.840*	27-Jul	97.981	27-Sep	97.860	27-Nov	
28-Jan	*97.816*	28-Mar	*97.822*	28-May	*97.842*	28-Jul	97.957	28-Sep	97.865	28-Nov	
29-Jan	*97.814*	29-Mar	*97.822*	29-May	*97.844*	29-Jul	97.955	29-Sep	97.866	29-Nov	
30-Jan	*97.813*	30-Mar	*97.821*	30-May	*97.848*	30-Jul	97.941	30-Sep		30-Nov	
31-Jan	*97.814*	31-Mar	*97.821*	31-May	*97.857*	31-Jul	97.926	1-Oct		1-Dec	
1-Feb	*97.813*	1-Apr	*97.821*	1-Jun	97.867	1-Aug	97.910	2-Oct		2-Dec	
2-Feb	*97.813*	2-Apr	*97.822*	2-Jun	97.880	2-Aug	97.901	3-Oct		3-Dec	
3-Feb	*97.812*	3-Apr	*97.823*	3-Jun	97.888	3-Aug	97.901	4-Oct		4-Dec	
4-Feb	*97.813*	4-Apr	*97.823*	4-Jun	97.892	4-Aug	97.872	5-Oct		5-Dec	
5-Feb	*97.813*	5-Apr	*97.822*	5-Jun	97.896	5-Aug	97.871	6-Oct		6-Dec	
6-Feb	*97.815*	6-Apr	*97.822*	6-Jun	97.901	6-Aug	97.859	7-Oct		7-Dec	
7-Feb	*97.813*	7-Apr	*97.822*	7-Jun	97.903	7-Aug	97.861	8-Oct		8-Dec	
8-Feb	*97.814*	8-Apr	*97.824*	8-Jun	97.905	8-Aug	97.841	9-Oct		9-Dec	
9-Feb	*97.814*	9-Apr	*97.824*	9-Jun	97.908	9-Aug	97.842	10-Oct		10-Dec	
10-Feb	*97.813*	10-Apr	*97.825*	10-Jun	97.910	10-Aug	97.837	11-Oct		11-Dec	
11-Feb	*97.813*	11-Apr	*97.824*	11-Jun	97.914	11-Aug	97.828	12-Oct		12-Dec	
12-Feb	*97.813*	12-Apr	*97.821*	12-Jun	97.924	12-Aug	97.812	13-Oct		13-Dec	
13-Feb	*97.814*	13-Apr	*97.822*	13-Jun	97.960	13-Aug	97.803	14-Oct		14-Dec	
14-Feb	*97.815*	14-Apr	*97.822*	14-Jun	98.016	14-Aug	97.801	15-Oct		15-Dec	
15-Feb	*97.816*	15-Apr	*97.822*	15-Jun	98.105	15-Aug	97.798	16-Oct		16-Dec	
16-Feb	*97.817*	16-Apr	*97.821*	16-Jun	98.197	16-Aug	97.783	17-Oct		17-Dec	
17-Feb	*97.816*	17-Apr	*97.821*	17-Jun	98.276	17-Aug	97.771	18-Oct		18-Dec	
18-Feb	*97.817*	18-Apr	*97.822*	18-Jun	98.337	18-Aug	97.776	19-Oct		19-Dec	
19-Feb	*97.817*	19-Apr	*97.822*	19-Jun	98.383	19-Aug	97.765	20-Oct		20-Dec	
20-Feb	*97.817*	20-Apr	*97.823*	20-Jun	98.418	20-Aug	97.761	21-Oct		21-Dec	
21-Feb	*97.818*	21-Apr	*97.824*	21-Jun	98.440	21-Aug	97.757	22-Oct		22-Dec	
22-Feb	*97.818*	22-Apr	*97.824*	22-Jun	98.443	22-Aug	97.754	23-Oct		23-Dec	
23-Feb	*97.819*	23-Apr	*97.824*	23-Jun	98.433	23-Aug	97.750	24-Oct		24-Dec	
24-Feb	*97.819*	24-Apr	*97.824*	24-Jun	98.419	24-Aug	97.751	25-Oct		25-Dec	
25-Feb	*97.818*	25-Apr	*97.824*	25-Jun	98.407	25-Aug	97.747	26-Oct		26-Dec	
26-Feb	*97.818*	26-Apr	*97.824*	26-Jun	98.389	26-Aug	97.745	27-Oct		27-Dec	
27-Feb	*97.819*	27-Apr	*97.823*	27-Jun	98.369	27-Aug	97.742	28-Oct		28-Dec	
28-Feb	*97.820*	28-Apr	*97.825*	28-Jun	98.351	28-Aug	97.739	29-Oct		29-Dec	
		29-Apr	*97.826*	29-Jun	98.324	29-Aug	97.739	30-Oct		30-Dec	
		30-Apr	*97.826*	30-Jun	98.336	30-Aug	97.736	31-Oct		31-Dec	
						31-Aug	97.735				

Note: lake water levels affected by ice conditions are italicized

Appendix B-2. Summary of Daily Mean Water Level (m) at Tail Lake Station in 2011

Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)
1-Jan		1-Mar		1-May		1-Jul	95.040	1-Sep	94.993	1-Nov	
2-Jan		2-Mar		2-May		2-Jul	95.108	2-Sep	94.986	2-Nov	
3-Jan		3-Mar		3-May		3-Jul	95.148	3-Sep	94.982	3-Nov	
4-Jan		4-Mar		4-May		4-Jul	95.150	4-Sep	94.981	4-Nov	
5-Jan		5-Mar		5-May		5-Jul	95.161	5-Sep	94.978	5-Nov	
6-Jan		6-Mar		6-May		6-Jul	95.167	6-Sep	94.974	6-Nov	
7-Jan		7-Mar		7-May		7-Jul	95.158	7-Sep	94.994	7-Nov	
8-Jan		8-Mar		8-May		8-Jul	95.153	8-Sep	95.020	8-Nov	
9-Jan		9-Mar		9-May		9-Jul	95.171	9-Sep	95.028	9-Nov	
10-Jan		10-Mar		10-May		10-Jul	95.166	10-Sep	95.032	10-Nov	
11-Jan		11-Mar		11-May		11-Jul	95.155	11-Sep	95.033	11-Nov	
12-Jan		12-Mar		12-May	*94.549*	12-Jul	95.158	12-Sep	95.035	12-Nov	
13-Jan		13-Mar		13-May	*94.548*	13-Jul	95.149	13-Sep	95.035	13-Nov	
14-Jan		14-Mar		14-May	*94.547*	14-Jul	95.156	14-Sep	95.035	14-Nov	
15-Jan		15-Mar		15-May	*94.547*	15-Jul	95.151	15-Sep	95.033	15-Nov	
16-Jan		16-Mar		16-May	*94.548*	16-Jul	95.151	16-Sep	95.031	16-Nov	
17-Jan		17-Mar		17-May	*94.547*	17-Jul	95.142	17-Sep	95.032	17-Nov	
18-Jan		18-Mar		18-May	*94.546*	18-Jul	95.125	18-Sep	95.032	18-Nov	
19-Jan		19-Mar		19-May	*94.545*	19-Jul	95.133	19-Sep	95.030	19-Nov	
20-Jan		20-Mar		20-May	*94.546*	20-Jul	95.131	20-Sep	95.029	20-Nov	
21-Jan		21-Mar		21-May	*94.549*	21-Jul	95.129	21-Sep	95.031	21-Nov	
22-Jan		22-Mar		22-May	*94.549*	22-Jul	95.124	22-Sep	95.034	22-Nov	
23-Jan		23-Mar		23-May	*94.551*	23-Jul	95.118	23-Sep	95.044	23-Nov	
24-Jan		24-Mar		24-May	*94.555*	24-Jul	95.112	24-Sep	95.051	24-Nov	
25-Jan		25-Mar		25-May	*94.560*	25-Jul	95.102	25-Sep	95.056	25-Nov	
26-Jan		26-Mar		26-May	*94.566*	26-Jul	95.116	26-Sep	95.061	26-Nov	
27-Jan		27-Mar		27-May	*94.570*	27-Jul	95.119	27-Sep	95.070	27-Nov	
28-Jan		28-Mar		28-May	94.575	28-Jul	95.102	28-Sep	95.072	28-Nov	
29-Jan		29-Mar		29-May	94.586	29-Jul	95.108	29-Sep	95.073	29-Nov	
30-Jan		30-Mar		30-May	94.605	30-Jul	95.108	30-Sep		30-Nov	
31-Jan		31-Mar		31-May	94.626	31-Jul	95.096	1-Oct		1-Dec	
1-Feb		1-Apr		1-Jun	94.642	1-Aug	95.085	2-Oct		2-Dec	
2-Feb		2-Apr		2-Jun	94.690	2-Aug	95.087	3-Oct		3-Dec	
3-Feb		3-Apr		3-Jun	94.689	3-Aug	95.098	4-Oct		4-Dec	
4-Feb		4-Apr		4-Jun	94.672	4-Aug	95.079	5-Oct		5-Dec	
5-Feb		5-Apr		5-Jun	94.685	5-Aug	95.081	6-Oct		6-Dec	
6-Feb		6-Apr		6-Jun	94.702	6-Aug	95.077	7-Oct		7-Dec	
7-Feb		7-Apr		7-Jun	94.697	7-Aug	95.079	8-Oct		8-Dec	
8-Feb		8-Apr		8-Jun	94.688	8-Aug	95.065	9-Oct		9-Dec	
9-Feb		9-Apr		9-Jun	94.693	9-Aug	95.067	10-Oct		10-Dec	
10-Feb		10-Apr		10-Jun	94.683	10-Aug	95.067	11-Oct		11-Dec	
11-Feb		11-Apr		11-Jun	94.698	11-Aug	95.064	12-Oct		12-Dec	
12-Feb		12-Apr		12-Jun	94.728	12-Aug	95.050	13-Oct		13-Dec	
13-Feb		13-Apr		13-Jun	94.756	13-Aug	95.044	14-Oct		14-Dec	
14-Feb		14-Apr		14-Jun	94.788	14-Aug	95.045	15-Oct		15-Dec	
15-Feb		15-Apr		15-Jun	94.821	15-Aug	95.044	16-Oct		16-Dec	
16-Feb		16-Apr		16-Jun	94.829	16-Aug	95.030	17-Oct		17-Dec	
17-Feb		17-Apr		17-Jun	94.848	17-Aug	95.017	18-Oct		18-Dec	
18-Feb		18-Apr		18-Jun	94.868	18-Aug	95.024	19-Oct		19-Dec	
19-Feb		19-Apr		19-Jun	94.886	19-Aug	95.027	20-Oct		20-Dec	
20-Feb		20-Apr		20-Jun	94.905	20-Aug	95.025	21-Oct		21-Dec	
21-Feb		21-Apr		21-Jun	94.919	21-Aug	95.022	22-Oct		22-Dec	
22-Feb		22-Apr		22-Jun	94.928	22-Aug	95.019	23-Oct		23-Dec	
23-Feb		23-Apr		23-Jun	94.930	23-Aug	95.015	24-Oct		24-Dec	
24-Feb		24-Apr		24-Jun	94.931	24-Aug	95.016	25-Oct		25-Dec	
25-Feb		25-Apr		25-Jun	94.942	25-Aug	95.013	26-Oct		26-Dec	
26-Feb		26-Apr		26-Jun	94.955	26-Aug	95.011	27-Oct		27-Dec	
27-Feb		27-Apr		27-Jun	94.942	27-Aug	95.008	28-Oct		28-Dec	
28-Feb		28-Apr		28-Jun	94.961	28-Aug	95.005	29-Oct		29-Dec	
		29-Apr		29-Jun	94.973	29-Aug	95.004	30-Oct		30-Dec	
		30-Apr		30-Jun	95.010	30-Aug	95.002	31-Oct		31-Dec	
						31-Aug	94.998				

Note: lake water levels affected by ice conditions are italicized

Appendix B-3. Summary of Daily Mean Water Level (m) at Windy Lake Station in 2011

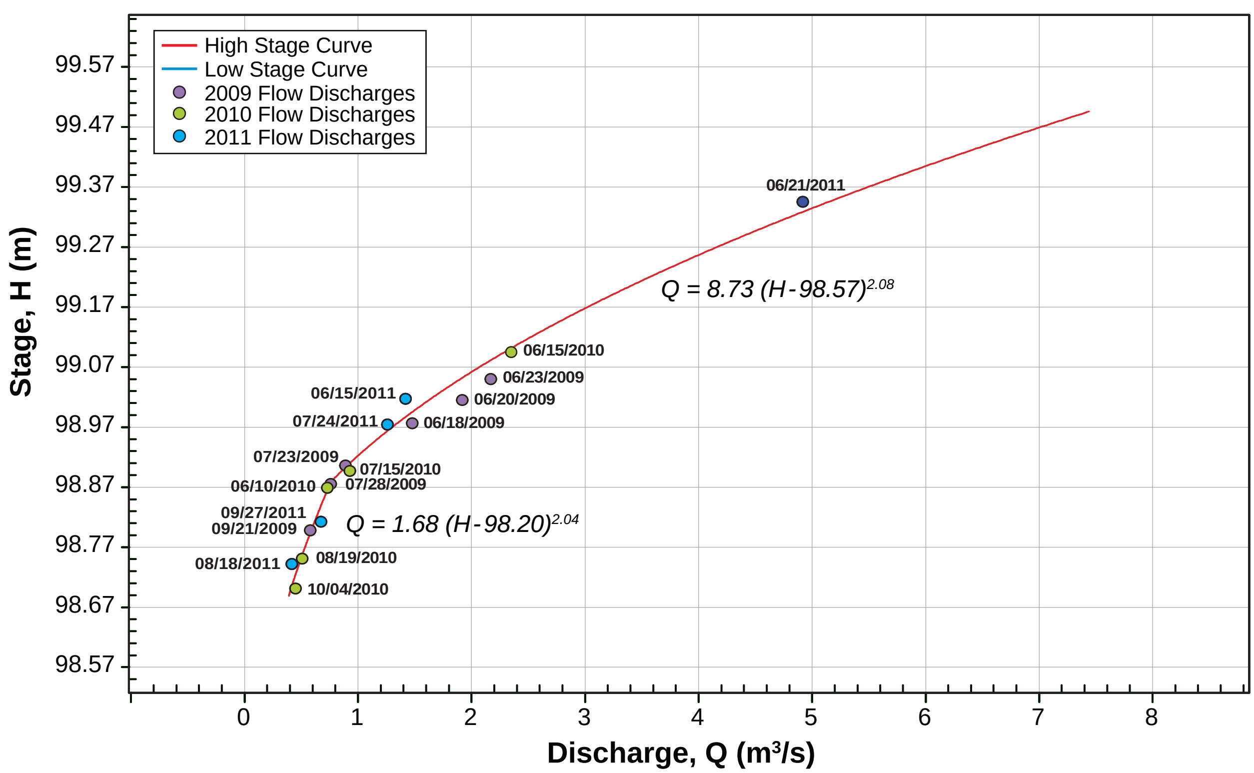
Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)	Date	Water Level (m)
1-Jan		1-Mar		1-May		1-Jul	95.577	1-Sep	95.392	1-Nov	
2-Jan		2-Mar		2-May		2-Jul	95.613	2-Sep	95.390	2-Nov	
3-Jan		3-Mar		3-May		3-Jul	95.621	3-Sep	95.389	3-Nov	
4-Jan		4-Mar		4-May		4-Jul	95.621	4-Sep	95.388	4-Nov	
5-Jan		5-Mar		5-May		5-Jul	95.617	5-Sep	95.386	5-Nov	
6-Jan		6-Mar		6-May		6-Jul	95.611	6-Sep	95.386	6-Nov	
7-Jan		7-Mar		7-May		7-Jul	95.604	7-Sep	95.404	7-Nov	
8-Jan		8-Mar		8-May		8-Jul	95.599	8-Sep	95.426	8-Nov	
9-Jan		9-Mar		9-May		9-Jul	95.592	9-Sep	95.429	9-Nov	
10-Jan		10-Mar		10-May		10-Jul	95.585	10-Sep	95.430	10-Nov	
11-Jan		11-Mar		11-May		11-Jul	95.576	11-Sep	95.429	11-Nov	
12-Jan		12-Mar		12-May		12-Jul	95.569	12-Sep	95.429	12-Nov	
13-Jan		13-Mar		13-May		13-Jul	95.563	13-Sep	95.427	13-Nov	
14-Jan		14-Mar		14-May		14-Jul	95.556	14-Sep	95.429	14-Nov	
15-Jan		15-Mar		15-May		15-Jul	95.549	15-Sep	95.425	15-Nov	
16-Jan		16-Mar		16-May		16-Jul	95.543	16-Sep	95.422	16-Nov	
17-Jan		17-Mar		17-May		17-Jul	95.537	17-Sep	95.422	17-Nov	
18-Jan		18-Mar		18-May		18-Jul	95.532	18-Sep	95.423	18-Nov	
19-Jan		19-Mar		19-May		19-Jul	95.527	19-Sep	95.423	19-Nov	
20-Jan		20-Mar		20-May		20-Jul	95.515	20-Sep	95.420	20-Nov	
21-Jan		21-Mar		21-May		21-Jul	95.495	21-Sep	95.418	21-Nov	
22-Jan		22-Mar		22-May		22-Jul	95.489	22-Sep	95.419	22-Nov	
23-Jan		23-Mar		23-May		23-Jul	95.484	23-Sep		23-Nov	
24-Jan		24-Mar		24-May		24-Jul	95.480	24-Sep		24-Nov	
25-Jan		25-Mar		25-May		25-Jul	95.475	25-Sep		25-Nov	
26-Jan		26-Mar		26-May		26-Jul	95.466	26-Sep		26-Nov	
27-Jan		27-Mar		27-May		27-Jul	95.461	27-Sep		27-Nov	
28-Jan		28-Mar		28-May		28-Jul	95.458	28-Sep		28-Nov	
29-Jan		29-Mar		29-May		29-Jul	95.456	29-Sep		29-Nov	
30-Jan		30-Mar		30-May		30-Jul	95.455	30-Sep		30-Nov	
31-Jan		31-Mar		31-May		31-Jul	95.451	1-Oct		1-Dec	
1-Feb		1-Apr		1-Jun		1-Aug	95.444	2-Oct		2-Dec	
2-Feb		2-Apr		2-Jun		2-Aug	95.438	3-Oct		3-Dec	
3-Feb		3-Apr		3-Jun		3-Aug	95.434	4-Oct		4-Dec	
4-Feb		4-Apr		4-Jun		4-Aug	95.432	5-Oct		5-Dec	
5-Feb		5-Apr		5-Jun		5-Aug	95.430	6-Oct		6-Dec	
6-Feb		6-Apr		6-Jun		6-Aug	95.429	7-Oct		7-Dec	
7-Feb		7-Apr		7-Jun		7-Aug	95.427	8-Oct		8-Dec	
8-Feb		8-Apr		8-Jun		8-Aug	95.422	9-Oct		9-Dec	
9-Feb		9-Apr		9-Jun		9-Aug	95.419	10-Oct		10-Dec	
10-Feb		10-Apr		10-Jun		10-Aug	95.415	11-Oct		11-Dec	
11-Feb		11-Apr		11-Jun		11-Aug	95.413	12-Oct		12-Dec	
12-Feb		12-Apr		12-Jun		12-Aug	95.411	13-Oct		13-Dec	
13-Feb		13-Apr		13-Jun		13-Aug	95.410	14-Oct		14-Dec	
14-Feb		14-Apr		14-Jun		14-Aug	95.408	15-Oct		15-Dec	
15-Feb		15-Apr		15-Jun		15-Aug	95.403	16-Oct		16-Dec	
16-Feb		16-Apr		16-Jun		16-Aug	95.399	17-Oct		17-Dec	
17-Feb		17-Apr		17-Jun		17-Aug	95.394	18-Oct		18-Dec	
18-Feb		18-Apr		18-Jun		18-Aug	95.398	19-Oct		19-Dec	
19-Feb		19-Apr		19-Jun		19-Aug	95.395	20-Oct		20-Dec	
20-Feb		20-Apr		20-Jun		20-Aug	95.394	21-Oct		21-Dec	
21-Feb		21-Apr		21-Jun	95.546	21-Aug	95.395	22-Oct		22-Dec	
22-Feb		22-Apr		22-Jun	95.547	22-Aug	95.396	23-Oct		23-Dec	
23-Feb		23-Apr		23-Jun	95.547	23-Aug	95.393	24-Oct		24-Dec	
24-Feb		24-Apr		24-Jun	95.548	24-Aug	95.395	25-Oct		25-Dec	
25-Feb		25-Apr		25-Jun	95.549	25-Aug	95.393	26-Oct		26-Dec	
26-Feb		26-Apr		26-Jun	95.552	26-Aug	95.393	27-Oct		27-Dec	
27-Feb		27-Apr		27-Jun	95.551	27-Aug	95.394	28-Oct		28-Dec	
28-Feb		28-Apr		28-Jun	95.552	28-Aug	95.393	29-Oct		29-Dec	
		29-Apr		29-Jun	95.548	29-Aug	95.397	30-Oct		30-Dec	
		30-Apr		30-Jun	95.561	30-Aug	95.396	31-Oct		31-Dec	
						31-Aug	95.395				

Appendix C

Rating Curves

Engineers and Scientists

Left: Doris Outflow (TL-2) looking downstream (north). The hydrometric station is on the right bank. The pressure transducer and data logger recorded water levels at 10 minute intervals. The data were then sent to a web portal via satellite link and were available on a real-time basis. *Right:* Photograph of the same location now facing upstream (south). Note on the left bank the flood terrace with overgrown grasses where the channel overflows during high flow conditions. This causes the differnce between the slopes of the rating relationship at low and high stage conditions. Photographs taken on July 24, 2011.



Note: pressure transducer stage readings are referenced to a site specific non-geodetic datum

Appendix C+/

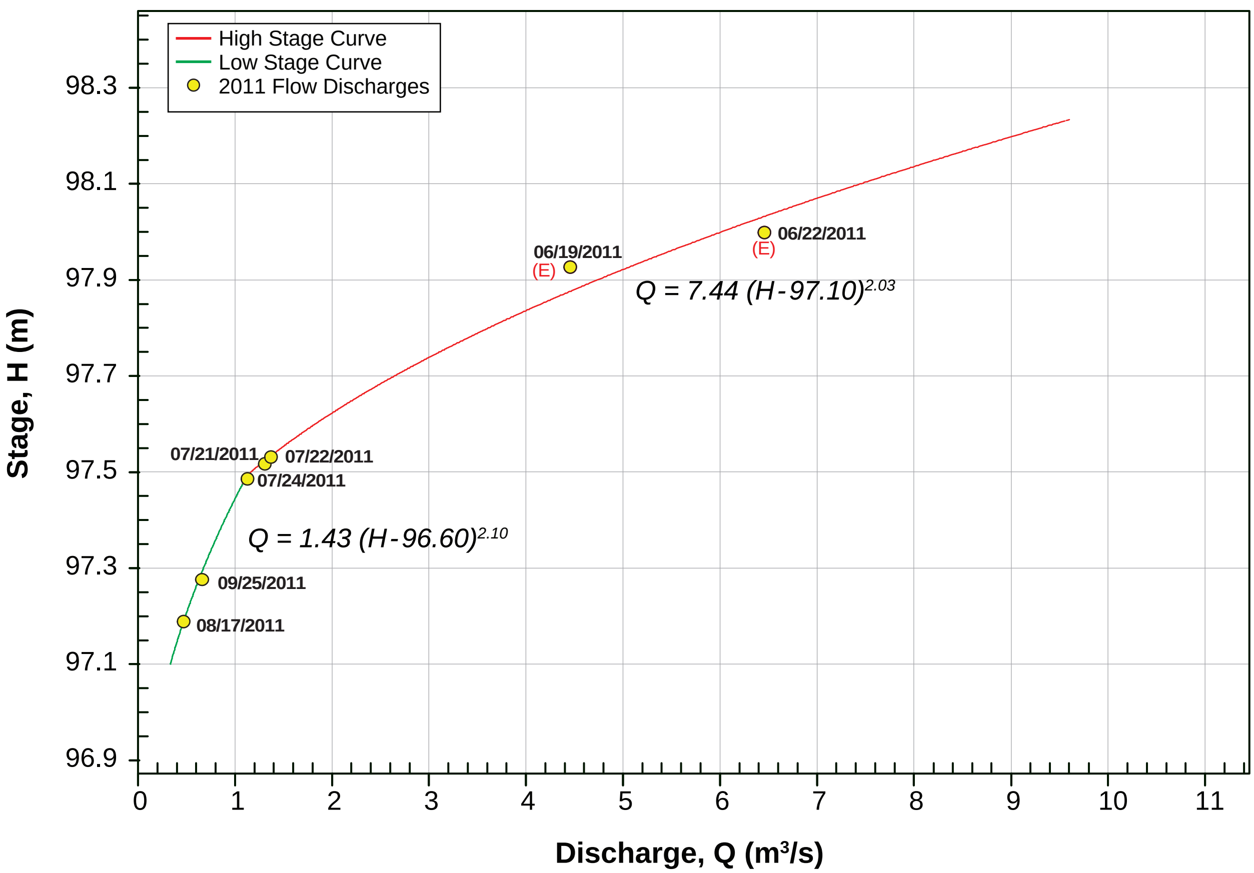
NEWMONT NORTH AMERICA

Doris Outflow (TL-2) - Stage-Discharge Rating Curve

(Rating Period from June 12 to October 18, 2011)

Rescan Engineers & Scientists

Left: low angle view of Doris Creek Downstream (TL-3) facing south. At moderate to high flows, the channel overflows its banks. Photograph taken on July 22, 2011 during high to moderate flow conditions. Here the channel overflows the banks over flood terraces located on the left bank. Right: Low angle view of the same location under lower flow conditions. Flows are well confined by the channel and water does not flow over the flood terraces. Photograph taken on September 25, 2011. In both photographs Doris Falls can be observed in the background. Note that the different rating relationships at low and high stages reflect the physical characteristics of this channel under varying flow conditions.



Note: pressure transducer stage readings are referenced to a site specific non-geodetic datum

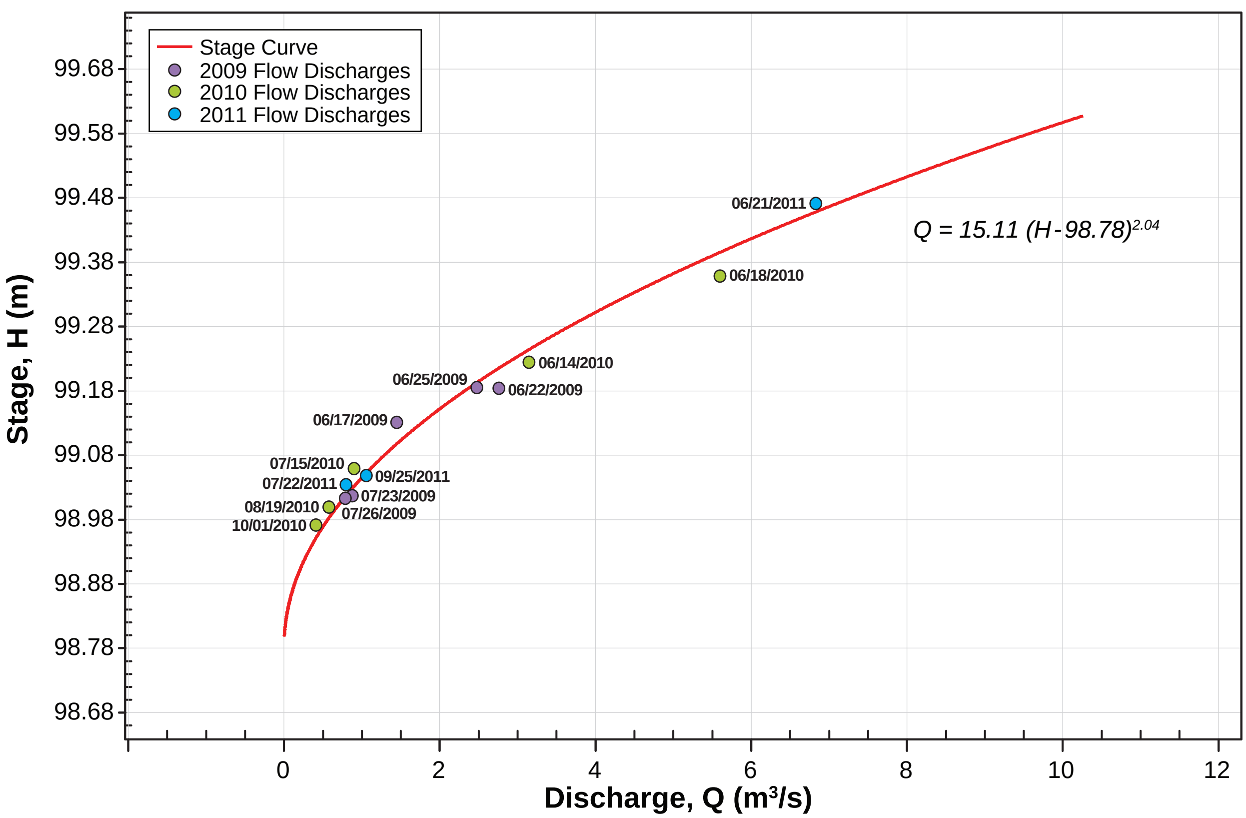
(E) -These measurements were graded as estimates because of anomalies / limitations of the measurement instrument used.

NEWMONT NORTH AMERICA

Doris Creek Downstream (TL-3) Stage-Discharge Rating Curve
(Rating Period from July 21 to September 25, 2010)

Rescan Engineers & Scientists

Left: Roberts Lake outflow looking downstream (northwest). The hydrometric station is on the foreground and was reestablished on June 21, 2011. The pressure transducer recorded water levels at 10 min intervals. The yellow circle indicates a riffle section in the channel that controls the rate of water flowing from the lake. Right: Close up view of the the control section (riffle). Farther downstream, on the background of the photograph, a fish fence can be observed. Photographs taken on July 22, 2011.



Note: pressure transducer stage readings are referenced to a site specific non-geodetic datum

NEWMONT NORTH AMERICA

Roberts Hydro- Stage-Discharge Rating Curve
(Rating Period from June 16 to September 26, 2010)

Appendix C-1

Rescan Engineers & Scientists

Appendix D

Memorandum: Estimation of Maximum Allowable Water Discharges from the Tail Lake Impoundment Area into Doris Creek (TL-2)

Rescan™
Engineers and Scientists

Memorandum

DATE: November 25, 2011

TO: Angela Hopzapfel

FROM: Xavier Pinto

CC: Deborah Muggli; Bob Askin

SUBJECT: Estimation of Maximum Allowable Water Discharges from the Tail Lake Impoundment Area into Doris Creek (TL-2)

1.0 Introduction

The purpose of this memorandum is to describe the methods used to calculate the allowable maximum daily volumes that could be discharged from the Tail Lake impoundment area into Doris Creek.

The integrity of an earth dam that impounds the waters from Tail Lake could have been compromised by the higher than normal water levels experienced during the freshet conditions in 2011. In order to avoid potential damage to the dam by rising water levels, Hope Bay Mining Ltd. (HBML) requested Rescan Environmental Services Ltd. (Rescan) to provide with the allowable maximum daily volumes that could be discharged from Tail Lake into Doris Creek.

Any discharge of water from Tail Lake into Doris Creek needed to be done in compliance with the following regulatory requirement:

Doris North Gold Mine Project Type A Water License (2AM-DOH0713, issued September 19, 2007).

The license states in Part G, Section 30 that:

"The Licensee shall ensure that the flow from the Tailings Impoundment Area into Doris Creek at monitoring station TL-4 does not exceed 10% of the background flow in Doris Creek as measured at monitoring station TL-2 at the time of discharge".

The hydrometric station TL-2 located along the banks of Doris Creek was reactivated on June 14, 2011. Water level data (stage) were monitored and recorded every 10 minutes at the station. These data were uploaded every two hours (to a web server via satellite link) and downloaded on a daily basis to the Rescan head office located in Vancouver.

2.0 Methodology

2.1 Discharge Estimation Using June 2011 Rating Curve

In June 2011 water discharges were determined from current velocity measurements that were sampled at Doris Creek (TL-2). The flow discharges were used to update the existing stage-discharge relationship for this site (Rescan, 2010).

Water stage data were downloaded each day from station TL-2. Then, QA/QC procedures were followed to assure the integrity and validity of the information. The updated stage-discharge relationship was then applied to convert the stage data collected into a continuous discharge time-series or hydrograph. The mean daily discharges were determined from the hydrograph.

According to current regulatory requirements the maximum daily discharge from Tail Lake cannot exceed 10% of the background flow at Doris Creek (TL-2). As a result, HBML personnel needed to know before any water was discharged into Doris Creek what the mean daily discharge was on any given day. Because the mean daily discharge for a particular day at the Doris Creek (TL-2) station could only be computed by the end of that day, a procedure was developed to forecast the mean daily discharge for the next several days. The procedure is described in the following example.

A section of the recession limb of the developed hydrograph for the period between July 11th and July 19th was selected. This section represented the general receding trend followed by the mean daily discharge (Figure 1). Following the selection of the dataset, regression analysis techniques were used to fit a model that best described the decreasing trend of the hydrograph recession limb. Different models were evaluated and a power model was found to have the best fit for the dataset. The high coefficient of determination (R^2) indicates that the model described the data appropriately for prediction purposes (Table 1).

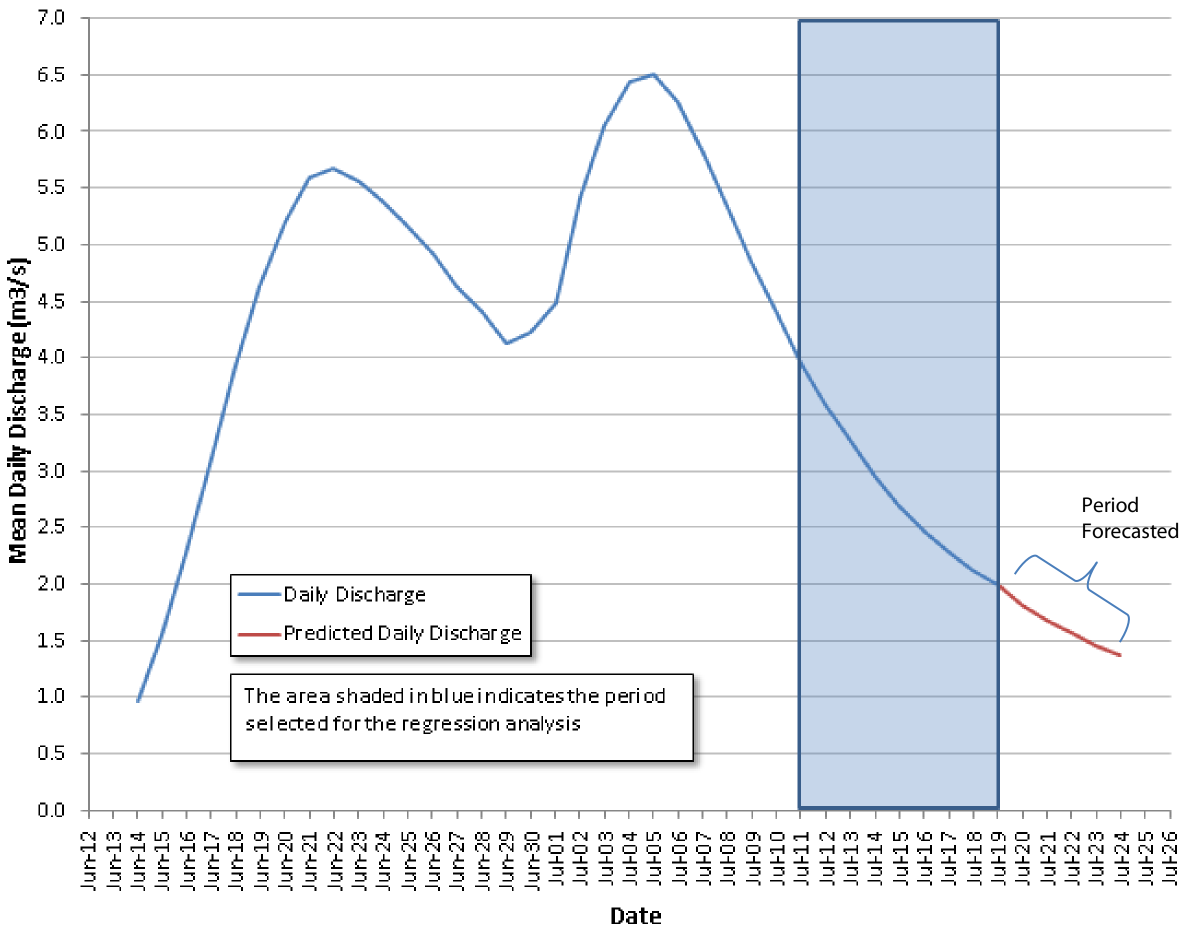


FIGURE 1. PERIOD OF DATA USED TO DEVELOP THE REGRESSION MODEL AT DORIS CREEK (TL-2)

TABLE 1. REGRESSION MODEL USED TO PREDICT MEAN DAILY DISCHARGE VALUES AT DORIS CREEK (TL-2)

Period of Data used to Build Model	Period Estimated	Model Equation	R^2
July 11th –July 19th	July 20th – July 26th	$y = 41067^{-2.777}$	0.99

The developed model was then used to estimate mean daily discharges at Doris Creek (TL-2) for the week following the day the calculations were made. For instance, the model developed on Tuesday July 19th was used to estimate mean daily discharges at Doris Creek (TL-2) for the period of Wednesday July 20th to Tuesday July 26th. Once the mean daily discharges were estimated, mean daily volumes were calculated. The maximum allowable discharge from Tail Lake was calculated as 10% of the mean daily volume at Doris Creek (TL2) (Appendix A, Table A.1).

Daily stage data retrieved remotely from station TL2 every day were used to refine the developed regression model and to improve the fit of the model to the dataset. When the regression model was revised, the estimated mean daily discharges and maximum allowable daily volumes were updated. When these values were updated the difference between the estimated and the recorded discharges at station TL-2 were also provided. These values were used to adjust the daily pumping rates from Tail Lake (Appendix A, Table A.2).

2.2 Revision of Discharge Estimates Using Updated September 2011 Rating Curve

Additional discharge data for Doris Creek (station TL-2) were collected in July, August, and September 2011. These data were used to update the developed stage-discharge relationship. This updated rating curve gives the opportunity to update and revise the daily discharge volumes determined for station TL-2 and compare those values to the values previously calculated using the June 2011 rating curve. Revised values calculated using the September 2011 rating curve are provided in Appendix B.

The maximum available volumes for Doris Creek TL-2 are shown in Figure 2. When using the June 2011 rating curve 32 days exceeded the maximum allowable 10% discharge between July 20 and September 19. This exceedance represents a total volume of 258 m^3. In contrast, when determining daily volumes using the updated September 2011 rating curve, only 11 days were over the maximum allowable 10%. However, the total discharge volume for the period July 20-September 19 was under the maximum allowable 10% by 50,950 m^3 (Table 2).

In summary, the results show that the estimated maximum allowable discharges were conservative in estimating the daily water volumes at Doris Creek. For the period between July 20 and September 19, 2011 these estimates were well below 10% of the background flow recorded at the monitoring station TL-2 in Doris Creek.

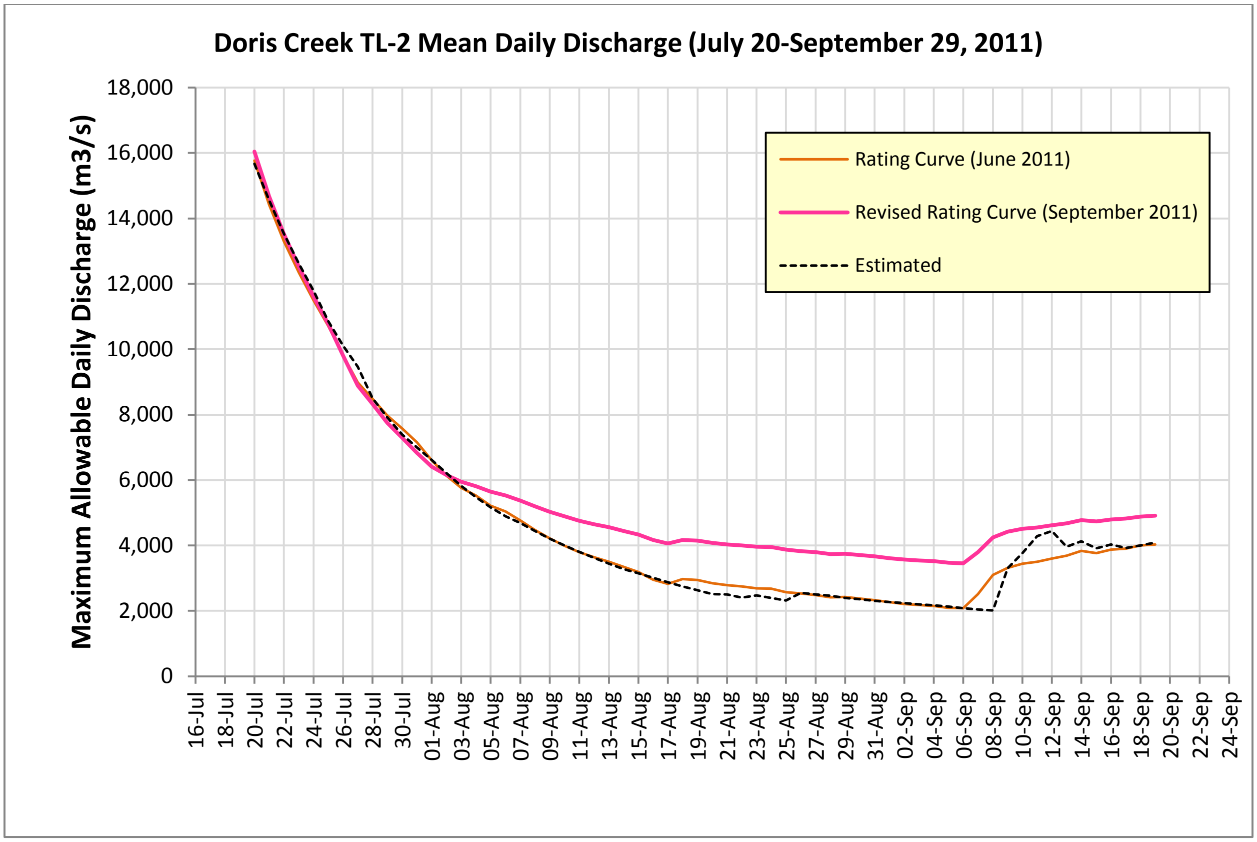


FIGURE 2. MAXIMUM ALLOWABLE DISCHARGE VOLUMES AT DORIS CREEK- TL-2 JULY20-SEPTEMBER 19, 2011

TABLE 2. SUMMARY OF MAXIMUM ALLOWABLE DISCHARGE VOLUMES AT DORIS CREEK (TL-2) JULY 20-SEPTEMBER 19, 2011.

Rating Relationship	Period of Record (days)	Days exceeding 10% allowable discharge	Total Max. Allowable Volume (m^3) from Estimated Values (July 20-September 19)	Total Max Allowable Volume (m^3) from Recorded Values (July 20-September 19)	Difference Recorded-Estimated (m^3)	Notes
June 2011	62	32	299, 629	299, 371	-258	Volume over 10% allowable discharge
September 2011	62	11	299, 629	350, 582	50, 953	Volume under 10% allowable discharge

Prepared By:

Xavier M. Pinto (M.Sc.)
Hydrology Discipline Coordinator
Rescan - Environmental Engineering

References

Rescan. 2010. *Hydrology Compliance Report, 2010.* Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

APPENDIX A- DISCHARGE VOLUME ESTIMATES USING UPDATED RATING CURVE (JUNE 2011)

TABLE A.1 ESTIMATED VALUES USING A REGRESSION MODEL BASED ON THE DATA RECORDED AT TL-2.

Date	Mean Daily Discharge at TL-2 (m3/s)	Maximum Allowable Discharge- (10% of TL-2, m3/s)	Daily Volume at TL-2 (m^3)	Maximum Allowable Discharge (10% of TL-2, m^3)
20-Jul-11	1.81	0.181	156,715	15,671
21-Jul-11	1.68	0.168	144528	14,553
22-Jul-11	1.57	0.157	135,401	13,540
23-Jul-11	1.46	0.146	126,208	12,621
24-Jul-11	1.36	0.136	117,844	11,784
25-Jul-11	1.26	0.126	108,495	10,849
26-Jul-11	1.17	0.117	101,062	10,106
27-Jul-11	1.10	0.110	94,664	9,466
28-Jul-11	0.98	0.098	85,046	8,505
29-Jul-11	0.92	0.092	79,131	7,913
30-Jul-11	0.86	0.086	73,921	7,392
31-Jul-11	0.81	0.081	69,973	6,997
01-Aug-11	0.77	0.077	66,132	6,613
02-Aug-11	0.72	0.072	62,150	6,215
03-Aug-11	0.67	0.067	58,205	5,820
04-Aug-11	0.63	0.063	54,817	5,482
05-Aug-11	0.60	0.060	51,686	5,169
06-Aug-11	0.57	0.057	48,965	4,896
07-Aug-11	0.54	0.054	46,824	4,682
08-Aug-11	0.51	0.051	44,381	4,438
09-Aug-11	0.49	0.049	42,106	4,211
10-Aug-11	0.46	0.046	39,985	3,998
11-Aug-11	0.44	0.044	38,003	3,800
12-Aug-11	0.42	0.042	36,151	3,615
13-Aug-11	0.40	0.040	34,417	3,442
14-Aug-11	0.38	0.038	32,793	3,279
15-Aug-11	0.36	0.036	31,523	3,152
16-Aug-11	0.35	0.035	30,091	3,009
17-Aug-11	0.33	0.033	28,745	2,874
18-Aug-11	0.32	0.032	27,478	2,748
19-Aug-11	0.30	0.030	26,285	2,629
20-Aug-11	0.29	0.029	25,160	2,516
21-Aug-11	0.29	0.029	25,017	2,502
22-Aug-11	0.28	0.028	24,019	2,402
23-Aug-11	0.29	0.029	24,746	2,475
24-Aug-11	0.28	0.028	23,915	2,392
25-Aug-11	0.27	0.027	23,124	2,312
26-Aug-11	0.30	0.030	25,499	2,550
27-Aug-11	0.29	0.029	25,041	2,504
28-Aug-11	0.28	0.028	24,597	2,460
29-Aug-11	0.28	0.028	23,974	2,397
30-Aug-11	0.27	0.027	23,535	2,354
31-Aug-11	0.27	0.027	23,110	2,311
01-Sep-11	0.26	0.026	22,698	2,270
02-Sep-11	0.26	0.026	22,414	2,241
03-Sep-11	0.26	0.026	22,036	2,204
04-Sep-11	0.25	0.025	21,670	2,167
05-Sep-11	0.25	0.025	21,313	2,131
06-Sep-11	0.24	0.024	20,781	2,078
07-Sep-11	0.24	0.024	20,437	2,044
08-Sep-11	0.23	0.023	20,102	2,010

09-Sep-11	0.38	0.038	33,014	3,301
10-Sep-11	0.44	0.044	37,654	3,765
11-Sep-11	0.50	0.050	42,882	4,288
12-Sep-11	0.51	0.051	44,428	4,443
13-Sep-11	0.46	0.046	39,593	3,959
14-Sep-11	0.48	0.048	41,314	4,131
15-Sep-11	0.45	0.045	39,094	3,909
16-Sep-11	0.47	0.047	40,308	4,031
17-Sep-11	0.45	0.045	39,218	3,922
18-Sep-11	0.46	0.046	40,038	4,004
19-Sep-11	0.47	0.047	40,866	4,087

TABLE A.2 DIFFERENCES BETWEEN ESTIMATED VALUES AND CALCULATED VALUES AT TL-2 USING RATING (JUNE 2011)

Date	Estimated Maximum Allowable Discharge (10% of TL-2, m3)	From Recorded Data Maximum Allowable Discharge (10% of TL-2, m3)*	Difference Recorded-Estimated (m3)	Notes
20-Jul-11	15,671	15,768	97	estimated volume was under 10%
21-Jul-11	14,553	14,413	-140	estimated volume was over 10%
22-Jul-11	13,540	13,305	-235	estimated volume was over 10%
23-Jul-11	12,621	12,342	-279	estimated volume was over 10%
24-Jul-11	11,784	11,487	-297	estimated volume was over 10%
25-Jul-11	10,849	10,704	-145	estimated volume was over 10%
26-Jul-11	10,106	9,820	-287	estimated volume was over 10%
27-Jul-11	9,466	8,985	-481	estimated volume was over 10%
28-Jul-11	8,505	8,482	-22	estimated volume was over 10%
29-Jul-11	7,913	7,979	66	estimated volume was under 10%
30-Jul-11	7,392	7,575	183	estimated volume was under 10%
31-Jul-11	6,997	7,158	161	estimated volume was under 10%
01-Aug-11	6,613	6,608	-5	estimated volume was over 10%
02-Aug-11	6,215	6,134	-81	estimated volume was over 10%
03-Aug-11	5,820	5,759	-62	estimated volume was over 10%
04-Aug-11	5,482	5,524	43	estimated volume was under 10%
05-Aug-11	5,169	5,216	47	estimated volume was under 10%
06-Aug-11	4,896	5,039	143	estimated volume was under 10%
07-Aug-11	4,682	4,761	79	estimated volume was under 10%
08-Aug-11	4,438	4,468	29	estimated volume was under 10%
09-Aug-11	4,211	4,219	8	estimated volume was under 10%
10-Aug-11	3,998	3,993	-5	estimated volume was over 10%
11-Aug-11	3,800	3,800	-1	estimated volume was over 10%
12-Aug-11	3,615	3,638	23	estimated volume was under 10%
13-Aug-11	3,442	3,504	62	estimated volume was under 10%
14-Aug-11	3,279	3,342	62	estimated volume was under 10%
15-Aug-11	3,152	3,189	36	estimated volume was under 10%
16-Aug-11	3,009	2,958	-51	estimated volume was over 10%
17-Aug-11	2,874	2,826	-48	estimated volume was over 10%
18-Aug-11	2,748	2,969	221	estimated volume was under 10%
19-Aug-11	2,629	2,939	311	estimated volume was under 10%
20-Aug-11	2,516	2,841	325	estimated volume was under 10%
21-Aug-11	2,502	2,783	282	estimated volume was under 10%
22-Aug-11	2,402	2,751	349	estimated volume was under 10%
23-Aug-11	2,475	2,688	214	estimated volume was under 10%
24-Aug-11	2,392	2,681	289	estimated volume was under 10%
25-Aug-11	2,312	2,576	264	estimated volume was under 10%
26-Aug-11	2,550	2,529	-21	estimated volume was over 10%
27-Aug-11	2,504	2,487	-17	estimated volume was over 10%
28-Aug-11	2,460	2,420	-40	estimated volume was over 10%
29-Aug-11	2,397	2,427	30	estimated volume was under 10%
30-Aug-11	2,354	2,378	24	estimated volume was under 10%
31-Aug-11	2,311	2,330	19	estimated volume was under 10%
01-Sep-11	2,270	2,268	-2	estimated volume was over 10%
02-Sep-11	2,241	2,214	-28	estimated volume was over 10%
03-Sep-11	2,204	2,184	-19	estimated volume was over 10%
04-Sep-11	2,167	2,155	-12	estimated volume was over 10%

05-Sep-11	2,131	2,094	-37	estimated volume was over 10%
06-Sep-11	2,078	2,085	7	estimated volume was under 10%
07-Sep-11	2,044	2,515	472	estimated volume was under 10%
08-Sep-11	2,010	3,099	1,089	estimated volume was under 10%
09-Sep-11	3,301	3,318	16	estimated volume was under 10%
10-Sep-11	3,765	3,438	-327	estimated volume was over 10%
11-Sep-11	4,288	3,504	-784	estimated volume was over 10%
12-Sep-11	4,443	3,596	-847	estimated volume was over 10%
13-Sep-11	3,959	3,693	-267	estimated volume was over 10%
14-Sep-11	4,131	3,835	-296	estimated volume was over 10%
15-Sep-11	3,909	3,768	-142	estimated volume was over 10%
16-Sep-11	4,031	3,869	-162	estimated volume was over 10%
17-Sep-11	3,922	3,906	-16	estimated volume was over 10%
18-Sep-11	4,004	4,003	-1	estimated volume was over 10%
19-Sep-11	4,087	4,032	-54	estimated volume was over 10%

* Values were updated as new recorded data were retrieved on a daily basis.

APPENDIX B- DISCHARGE VOLUME ESTIMATES USING UPDATED RATING CURVE (SEPTEMBER 2011)

TABLE A.2 DIFFERENCES BETWEEN ESTIMATED VALUES AND CALCULATED VALUES AT TL-2 USING UPDATED RATING RELATIONSHIP (SEPTEMBER 2011).

Date	Estimated From Recorded Data Maximum Allowable Discharge (10% of TL-2, m3)	Maximum Allowable Discharge (10% of TL-2, m3)	Difference Recorded-Estimated (m3)	Notes
20-Jul-11	15,671	16,047	375	estimated volume was under 10%
21-Jul-11	14,553	14,673	120	estimated volume was under 10%
22-Jul-11	13,540	13,527	(13)	estimated volume was over 10%
23-Jul-11	12,621	12,516	-104	estimated volume was over 10%
24-Jul-11	11,784	11,610	-175	estimated volume was over 10%
25-Jul-11	10,849	10,763	-87	estimated volume was over 10%
26-Jul-11	10,106	9,810	-297	estimated volume was over 10%
27-Jul-11	9,466	8,881	-585	estimated volume was over 10%
28-Jul-11	8,505	8,328	-176	estimated volume was over 10%
29-Jul-11	7,913	7,747	-166	estimated volume was over 10%
30-Jul-11	7,392	7,295	-97	estimated volume was over 10%
31-Jul-11	6,997	6,834	-164	estimated volume was over 10%
1-Aug-11	6,613	6,409	-204	estimated volume was over 10%
2-Aug-11	6,215	6,155	-60	estimated volume was over 10%
3-Aug-11	5,820	5,949	129	estimated volume was under 10%
4-Aug-11	5,482	5,816	334	estimated volume was under 10%
5-Aug-11	5,169	5,642	473	estimated volume was under 10%
6-Aug-11	4,896	5,533	636	estimated volume was under 10%
7-Aug-11	4,682	5,372	690	estimated volume was under 10%
8-Aug-11	4,438	5,192	754	estimated volume was under 10%
9-Aug-11	4,211	5,034	823	estimated volume was under 10%
10-Aug-11	3,998	4,887	889	estimated volume was under 10%
11-Aug-11	3,800	4,758	958	estimated volume was under 10%
12-Aug-11	3,615	4,650	1,035	estimated volume was under 10%
13-Aug-11	3,442	4,558	1,116	estimated volume was under 10%
14-Aug-11	3,279	4,444	1,165	estimated volume was under 10%
15-Aug-11	3,152	4,334	1,182	estimated volume was under 10%
16-Aug-11	3,009	4,167	1,158	estimated volume was under 10%
17-Aug-11	2,874	4,060	1,185	estimated volume was under 10%
18-Aug-11	2,748	4,166	1,418	estimated volume was under 10%
19-Aug-11	2,629	4,149	1,521	estimated volume was under 10%
20-Aug-11	2,516	4,075	1,559	estimated volume was under 10%
21-Aug-11	2,502	4,032	1,530	estimated volume was under 10%
22-Aug-11	2,402	4,001	1,599	estimated volume was under 10%
23-Aug-11	2,475	3,958	1,483	estimated volume was under 10%
24-Aug-11	2,392	3,952	1,560	estimated volume was under 10%
25-Aug-11	2,312	3,870	1,557	estimated volume was under 10%
26-Aug-11	2,550	3,828	1,279	estimated volume was under 10%
27-Aug-11	2,504	3,796	1,292	estimated volume was under 10%
28-Aug-11	2,460	3,740	1,280	estimated volume was under 10%
29-Aug-11	2,397	3,747	1,350	estimated volume was under 10%
30-Aug-11	2,354	3,706	1,353	estimated volume was under 10%
31-Aug-11	2,311	3,665	1,354	estimated volume was under 10%
1-Sep-11	2,270	3,613	1,343	estimated volume was under 10%
2-Sep-11	2,241	3,567	1,326	estimated volume was under 10%

3-Sep-11	2,204	3,542	1,338	estimated volume was under 10%
4-Sep-11	2,167	3,518	1,351	estimated volume was under 10%
5-Sep-11	2,131	3,468	1,337	estimated volume was under 10%
6-Sep-11	2,078	3,457	1,379	estimated volume was under 10%
7-Sep-11	2,044	3,791	1,748	estimated volume was under 10%
8-Sep-11	2,010	4,250	2,239	estimated volume was under 10%
9-Sep-11	3,301	4,420	1,118	estimated volume was under 10%
10-Sep-11	3,765	4,506	741	estimated volume was under 10%
11-Sep-11	4,288	4,552	264	estimated volume was under 10%
12-Sep-11	4,443	4,614	171	estimated volume was under 10%
13-Sep-11	3,959	4,679	720	estimated volume was under 10%
14-Sep-11	4,131	4,779	648	estimated volume was under 10%
15-Sep-11	3,909	4,733	824	estimated volume was under 10%
16-Sep-11	4,031	4,798	767	estimated volume was under 10%
17-Sep-11	3,922	4,823	901	estimated volume was under 10%
18-Sep-11	4,004	4,885	881	estimated volume was under 10%
19-Sep-11	4,087	4,910	823	estimated volume was under 10%

Appendix E

Summary of Mean Daily Discharges

Appendix E-1. Summary of Daily Mean Discharge [Q] at Doris-Hydro TL-2 in 2011

Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)
1-Jan		1-Mar		1-May		1-Jul	4.20	1-Sep	0.42	1-Nov	
2-Jan		2-Mar		2-May		2-Jul	4.93	2-Sep	0.41	2-Nov	
3-Jan		3-Mar		3-May		3-Jul	5.41	3-Sep	0.41	3-Nov	
4-Jan		4-Mar		4-May		4-Jul	5.70	4-Sep	0.41	4-Nov	
5-Jan		5-Mar		5-May		5-Jul	5.77	5-Sep	0.40	5-Nov	
6-Jan		6-Mar		6-May		6-Jul	5.59	6-Sep	0.40	6-Nov	
7-Jan		7-Mar		7-May		7-Jul	5.25	7-Sep	0.44	7-Nov	
8-Jan		8-Mar		8-May		8-Jul	4.90	8-Sep	0.49	8-Nov	
9-Jan		9-Mar		9-May		9-Jul	4.52	9-Sep	0.51	9-Nov	
10-Jan		10-Mar		10-May		10-Jul	4.15	10-Sep	0.52	10-Nov	
11-Jan		11-Mar		11-May		11-Jul	3.80	11-Sep	0.53	11-Nov	
12-Jan		12-Mar		12-May		12-Jul	3.48	12-Sep	0.53	12-Nov	
13-Jan		13-Mar		13-May		13-Jul	3.20	13-Sep	0.54	13-Nov	
14-Jan		14-Mar		14-May		14-Jul	2.93	14-Sep	0.55	14-Nov	
15-Jan		15-Mar		15-May		15-Jul	2.70	15-Sep	0.55	15-Nov	
16-Jan		16-Mar		16-May		16-Jul	2.48	16-Sep	0.56	16-Nov	
17-Jan		17-Mar		17-May		17-Jul	2.30	17-Sep	0.56	17-Nov	
18-Jan		18-Mar		18-May		18-Jul	2.15	18-Sep	0.57	18-Nov	
19-Jan		19-Mar		19-May		19-Jul	2.00	19-Sep	0.57	19-Nov	
20-Jan		20-Mar		20-May		20-Jul	1.86	20-Sep	0.57	20-Nov	
21-Jan		21-Mar		21-May		21-Jul	1.70	21-Sep	0.57	21-Nov	
22-Jan		22-Mar		22-May		22-Jul	1.57	22-Sep	0.57	22-Nov	
23-Jan		23-Mar		23-May		23-Jul	1.45	23-Sep	0.58	23-Nov	
24-Jan		24-Mar		24-May		24-Jul	1.34	24-Sep	0.59	24-Nov	
25-Jan		25-Mar		25-May		25-Jul	1.25	25-Sep	0.60	25-Nov	
26-Jan		26-Mar		26-May		26-Jul	1.14	26-Sep	0.60	26-Nov	
27-Jan		27-Mar		27-May		27-Jul	1.03	27-Sep	0.62	27-Nov	
28-Jan		28-Mar		28-May		28-Jul	0.96	28-Sep	0.63	28-Nov	
29-Jan		29-Mar		29-May		29-Jul	0.90	29-Sep	0.64	29-Nov	
30-Jan		30-Mar		30-May		30-Jul	0.84	30-Sep	0.64	30-Nov	
31-Jan		31-Mar		31-May		31-Jul	0.79	1-Oct	0.63	1-Dec	
1-Feb		1-Apr		1-Jun		1-Aug	0.74	2-Oct	0.65	2-Dec	
2-Feb		2-Apr		2-Jun		2-Aug	0.71	3-Oct	0.64	3-Dec	
3-Feb		3-Apr		3-Jun		3-Aug	0.69	4-Oct	0.64	4-Dec	
4-Feb		4-Apr		4-Jun		4-Aug	0.67	5-Oct	0.65	5-Dec	
5-Feb		5-Apr		5-Jun		5-Aug	0.65	6-Oct	0.65	6-Dec	
6-Feb		6-Apr		6-Jun		6-Aug	0.64	7-Oct	0.65	7-Dec	
7-Feb		7-Apr		7-Jun		7-Aug	0.62	8-Oct	0.66	8-Dec	
8-Feb		8-Apr		8-Jun		8-Aug	0.60	9-Oct	0.66	9-Dec	
9-Feb		9-Apr		9-Jun		9-Aug	0.58	10-Oct	0.66	10-Dec	
10-Feb		10-Apr		10-Jun		10-Aug	0.57	11-Oct	0.67	11-Dec	
11-Feb		11-Apr		11-Jun		11-Aug	0.55	12-Oct	0.70	12-Dec	
12-Feb		12-Apr		12-Jun	0.54	12-Aug	0.54	13-Oct	0.71	13-Dec	
13-Feb		13-Apr		13-Jun	0.64	13-Aug	0.53	14-Oct	0.71	14-Dec	
14-Feb		14-Apr		14-Jun	0.92	14-Aug	0.51	15-Oct	0.70	15-Dec	
15-Feb		15-Apr		15-Jun	1.54	15-Aug	0.50	16-Oct	0.69	16-Dec	
16-Feb		16-Apr		16-Jun	2.25	16-Aug	0.48	17-Oct	0.69	17-Dec	
17-Feb		17-Apr		17-Jun	3.05	17-Aug	0.47	18-Oct		18-Dec	
18-Feb		18-Apr		18-Jun	3.74	18-Aug	0.48	19-Oct		19-Dec	
19-Feb		19-Apr		19-Jun	4.32	19-Aug	0.48	20-Oct		20-Dec	
20-Feb		20-Apr		20-Jun	4.76	20-Aug	0.47	21-Oct		21-Dec	
21-Feb		21-Apr		21-Jun	5.08	21-Aug	0.47	22-Oct		22-Dec	
22-Feb		22-Apr		22-Jun	5.15	22-Aug	0.46	23-Oct		23-Dec	
23-Feb		23-Apr		23-Jun	5.07	23-Aug	0.46	24-Oct		24-Dec	
24-Feb		24-Apr		24-Jun	4.93	24-Aug	0.46	25-Oct		25-Dec	
25-Feb		25-Apr		25-Jun	4.77	25-Aug	0.45	26-Oct		26-Dec	
26-Feb		26-Apr		26-Jun	4.58	26-Aug	0.44	27-Oct		27-Dec	
27-Feb		27-Apr		27-Jun	4.34	27-Aug	0.44	28-Oct		28-Dec	
28-Feb		28-Apr		28-Jun	4.16	28-Aug	0.43	29-Oct		29-Dec	
29-Feb		29-Apr		29-Jun	3.93	29-Aug	0.43	30-Oct		30-Dec	
		30-Apr		30-Jun	4.00	30-Aug	0.43	31-Oct		31-Dec	
						31-Aug	0.42				

Note: Estimated values are italicized

Appendix E-2. Summary of Daily Mean Discharge [Q] at Doris-Hydro TL-3 in 2011

Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)
1-Jan		1-Mar		1-May		1-Jul	*4.26*	1-Sep	0.39	1-Nov	
2-Jan		2-Mar		2-May		2-Jul	*5.00*	2-Sep	0.38	2-Nov	
3-Jan		3-Mar		3-May		3-Jul	*5.50*	3-Sep	0.38	3-Nov	
4-Jan		4-Mar		4-May		4-Jul	*5.79*	4-Sep	0.37	4-Nov	
5-Jan		5-Mar		5-May		5-Jul	*5.86*	5-Sep	0.37	5-Nov	
6-Jan		6-Mar		6-May		6-Jul	*5.68*	6-Sep	0.37	6-Nov	
7-Jan		7-Mar		7-May		7-Jul	*5.33*	7-Sep	0.44	7-Nov	
8-Jan		8-Mar		8-May		8-Jul	*4.97*	8-Sep	0.50	8-Nov	
9-Jan		9-Mar		9-May		9-Jul	*4.59*	9-Sep	0.52	9-Nov	
10-Jan		10-Mar		10-May		10-Jul	*4.21*	10-Sep	0.53	10-Nov	
11-Jan		11-Mar		11-May		11-Jul	*3.85*	11-Sep	0.53	11-Nov	
12-Jan		12-Mar		12-May		12-Jul	*3.53*	12-Sep	0.54	12-Nov	
13-Jan		13-Mar		13-May		13-Jul	*3.24*	13-Sep	0.54	13-Nov	
14-Jan		14-Mar		14-May		14-Jul	*2.96*	14-Sep	0.56	14-Nov	
15-Jan		15-Mar		15-May		15-Jul	*2.73*	15-Sep	0.55	15-Nov	
16-Jan		16-Mar		16-May		16-Jul	*2.51*	16-Sep	0.56	16-Nov	
17-Jan		17-Mar		17-May		17-Jul	*2.32*	17-Sep	0.56	17-Nov	
18-Jan		18-Mar		18-May		18-Jul	*2.17*	18-Sep	0.57	18-Nov	
19-Jan		19-Mar		19-May		19-Jul	*2.01*	19-Sep	0.58	19-Nov	
20-Jan		20-Mar		20-May		20-Jul	*1.87*	20-Sep	0.57	20-Nov	
21-Jan		21-Mar		21-May		21-Jul	*1.70*	21-Sep	0.57	21-Nov	
22-Jan		22-Mar		22-May		22-Jul	1.30	22-Sep	0.58	22-Nov	
23-Jan		23-Mar		23-May		23-Jul	1.19	23-Sep	0.60	23-Nov	
24-Jan		24-Mar		24-May		24-Jul	1.11	24-Sep	0.62	24-Nov	
25-Jan		25-Mar		25-May		25-Jul	1.06	25-Sep	0.62	25-Nov	
26-Jan		26-Mar		26-May		26-Jul	1.01	26-Sep	*0.58*	26-Nov	
27-Jan		27-Mar		27-May		27-Jul	0.95	27-Sep	*0.60*	27-Nov	
28-Jan		28-Mar		28-May		28-Jul	0.92	28-Sep	*0.61*	28-Nov	
29-Jan		29-Mar		29-May		29-Jul	0.88	29-Sep	*0.62*	29-Nov	
30-Jan		30-Mar		30-May		30-Jul	0.85	30-Sep	*0.62*	30-Nov	
31-Jan		31-Mar		31-May		31-Jul	0.82	1-Oct	*0.61*	1-Dec	
1-Feb		1-Apr		1-Jun		1-Aug	0.78	2-Oct	*0.63*	2-Dec	
2-Feb		2-Apr		2-Jun		2-Aug	0.74	3-Oct	*0.62*	3-Dec	
3-Feb		3-Apr		3-Jun		3-Aug	0.72	4-Oct	*0.63*	4-Dec	
4-Feb		4-Apr		4-Jun		4-Aug	0.70	5-Oct	*0.63*	5-Dec	
5-Feb		5-Apr		5-Jun		5-Aug	0.68	6-Oct	*0.63*	6-Dec	
6-Feb		6-Apr		6-Jun		6-Aug	0.67	7-Oct	*0.64*	7-Dec	
7-Feb		7-Apr		7-Jun		7-Aug	0.64	8-Oct	*0.64*	8-Dec	
8-Feb		8-Apr		8-Jun		8-Aug	0.62	9-Oct	*0.64*	9-Dec	
9-Feb		9-Apr		9-Jun		9-Aug	0.60	10-Oct	*0.65*	10-Dec	
10-Feb		10-Apr		10-Jun		10-Aug	0.58	11-Oct	*0.65*	11-Dec	
11-Feb		11-Apr		11-Jun		11-Aug	0.56	12-Oct	*0.68*	12-Dec	
12-Feb		12-Apr		12-Jun	*0.52*	12-Aug	0.54	13-Oct	*0.69*	13-Dec	
13-Feb		13-Apr		13-Jun	*0.62*	13-Aug	0.53	14-Oct	*0.69*	14-Dec	
14-Feb		14-Apr		14-Jun	*0.91*	14-Aug	0.52	15-Oct	*0.68*	15-Dec	
15-Feb		15-Apr		15-Jun	*1.54*	15-Aug	0.50	16-Oct	*0.68*	16-Dec	
16-Feb		16-Apr		16-Jun	*2.27*	16-Aug	0.48	17-Oct	*0.67*	17-Dec	
17-Feb		17-Apr		17-Jun	*3.09*	17-Aug	0.46	18-Oct		18-Dec	
18-Feb		18-Apr		18-Jun	*3.79*	18-Aug	0.47	19-Oct		19-Dec	
19-Feb		19-Apr		19-Jun	*4.38*	19-Aug	0.46	20-Oct		20-Dec	
20-Feb		20-Apr		20-Jun	*4.84*	20-Aug	0.45	21-Oct		21-Dec	
21-Feb		21-Apr		21-Jun	*5.16*	21-Aug	0.44	22-Oct		22-Dec	
22-Feb		22-Apr		22-Jun	*5.23*	22-Aug	0.43	23-Oct		23-Dec	
23-Feb		23-Apr		23-Jun	*5.14*	23-Aug	0.43	24-Oct		24-Dec	
24-Feb		24-Apr		24-Jun	*5.00*	24-Aug	0.43	25-Oct		25-Dec	
25-Feb		25-Apr		25-Jun	*4.84*	25-Aug	0.42	26-Oct		26-Dec	
26-Feb		26-Apr		26-Jun	*4.64*	26-Aug	0.42	27-Oct		27-Dec	
27-Feb		27-Apr		27-Jun	*4.41*	27-Aug	0.41	28-Oct		28-Dec	
28-Feb		28-Apr		28-Jun	*4.22*	28-Aug	0.40	29-Oct		29-Dec	
29-Feb		29-Apr		29-Jun	*3.98*	29-Aug	0.41	30-Oct		30-Dec	
		30-Apr		30-Jun	*4.06*	30-Aug	0.40	31-Oct		31-Dec	
						31-Aug	0.39				

Note: Estimated values are italicized

Appendix E-3. Summary of Daily Mean Discharge [Q] at Roberts Hydro in 2011

Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)	Date	Q (m^3/s)
1-Jan		1-Mar		1-May		1-Jul	5.00	1-Sep	0.13	1-Nov	
2-Jan		2-Mar		2-May		2-Jul	6.20	2-Sep	0.12	2-Nov	
3-Jan		3-Mar		3-May		3-Jul	6.55	3-Sep	0.12	3-Nov	
4-Jan		4-Mar		4-May		4-Jul	6.28	4-Sep	0.12	4-Nov	
5-Jan		5-Mar		5-May		5-Jul	5.80	5-Sep	0.11	5-Nov	
6-Jan		6-Mar		6-May		6-Jul	5.22	6-Sep	0.11	6-Nov	
7-Jan		7-Mar		7-May		7-Jul	4.65	7-Sep	0.17	7-Nov	
8-Jan		8-Mar		8-May		8-Jul	4.15	8-Sep	0.25	8-Nov	
9-Jan		9-Mar		9-May		9-Jul	3.71	9-Sep	0.31	9-Nov	
10-Jan		10-Mar		10-May		10-Jul	3.31	10-Sep	0.36	10-Nov	
11-Jan		11-Mar		11-May		11-Jul	2.94	11-Sep	0.40	11-Nov	
12-Jan		12-Mar		12-May		12-Jul	2.64	12-Sep	0.44	12-Nov	
13-Jan		13-Mar		13-May		13-Jul	2.35	13-Sep	0.46	13-Nov	
14-Jan		14-Mar		14-May		14-Jul	2.10	14-Sep	0.49	14-Nov	
15-Jan		15-Mar		15-May		15-Jul	1.87	15-Sep	0.50	15-Nov	
16-Jan		16-Mar		16-May		16-Jul	1.67	16-Sep	0.51	16-Nov	
17-Jan		17-Mar		17-May		17-Jul	1.49	17-Sep	0.51	17-Nov	
18-Jan		18-Mar		18-May		18-Jul	1.37	18-Sep	0.51	18-Nov	
19-Jan		19-Mar		19-May		19-Jul	1.23	19-Sep	0.51	19-Nov	
20-Jan		20-Mar		20-May		20-Jul	1.08	20-Sep	0.50	20-Nov	
21-Jan		21-Mar		21-May		21-Jul	0.96	21-Sep	0.50	21-Nov	
22-Jan		22-Mar		22-May		22-Jul	0.86	22-Sep	0.51	22-Nov	
23-Jan		23-Mar		23-May		23-Jul	0.83	23-Sep	0.53	23-Nov	
24-Jan		24-Mar		24-May		24-Jul	0.78	24-Sep	0.55	24-Nov	
25-Jan		25-Mar		25-May		25-Jul	0.73	25-Sep	0.56	25-Nov	
26-Jan		26-Mar		26-May		26-Jul	0.67	26-Sep		26-Nov	
27-Jan		27-Mar		27-May		27-Jul	0.64	27-Sep		27-Nov	
28-Jan		28-Mar		28-May		28-Jul	0.61	28-Sep		28-Nov	
29-Jan		29-Mar		29-May		29-Jul	0.59	29-Sep		29-Nov	
30-Jan		30-Mar		30-May		30-Jul	0.56	30-Sep		30-Nov	
31-Jan		31-Mar		31-May		31-Jul	0.54	1-Oct		1-Dec	
1-Feb		1-Apr		1-Jun		1-Aug	0.51	2-Oct		2-Dec	
2-Feb		2-Apr		2-Jun		2-Aug	0.46	3-Oct		3-Dec	
3-Feb		3-Apr		3-Jun		3-Aug	0.43	4-Oct		4-Dec	
4-Feb		4-Apr		4-Jun		4-Aug	0.41	5-Oct		5-Dec	
5-Feb		5-Apr		5-Jun		5-Aug	0.39	6-Oct		6-Dec	
6-Feb		6-Apr		6-Jun		6-Aug	0.38	7-Oct		7-Dec	
7-Feb		7-Apr		7-Jun		7-Aug	0.36	8-Oct		8-Dec	
8-Feb		8-Apr		8-Jun		8-Aug	0.33	9-Oct		9-Dec	
9-Feb		9-Apr		9-Jun		9-Aug	0.31	10-Oct		10-Dec	
10-Feb		10-Apr		10-Jun		10-Aug	0.28	11-Oct		11-Dec	
11-Feb		11-Apr		11-Jun		11-Aug	0.27	12-Oct		12-Dec	
12-Feb		12-Apr		12-Jun		12-Aug	0.25	13-Oct		13-Dec	
13-Feb		13-Apr		13-Jun		13-Aug	0.24	14-Oct		14-Dec	
14-Feb		14-Apr		14-Jun		14-Aug	0.23	15-Oct		15-Dec	
15-Feb		15-Apr		15-Jun		15-Aug	0.22	16-Oct		16-Dec	
16-Feb		16-Apr		16-Jun		16-Aug	0.20	17-Oct		17-Dec	
17-Feb		17-Apr		17-Jun		17-Aug	0.20	18-Oct		18-Dec	
18-Feb		18-Apr		18-Jun		18-Aug	0.19	19-Oct		19-Dec	
19-Feb		19-Apr		19-Jun		19-Aug	0.17	20-Oct		20-Dec	
20-Feb		20-Apr		20-Jun		20-Aug	0.17	21-Oct		21-Dec	
21-Feb		21-Apr		21-Jun	7.53	21-Aug	0.17	22-Oct		22-Dec	
22-Feb		22-Apr		22-Jun	7.30	22-Aug	0.19	23-Oct		23-Dec	
23-Feb		23-Apr		23-Jun	6.87	23-Aug	0.16	24-Oct		24-Dec	
24-Feb		24-Apr		24-Jun	6.44	24-Aug	0.15	25-Oct		25-Dec	
25-Feb		25-Apr		25-Jun	6.04	25-Aug	0.15	26-Oct		26-Dec	
26-Feb		26-Apr		26-Jun	5.64	26-Aug	0.14	27-Oct		27-Dec	
27-Feb		27-Apr		27-Jun	5.26	27-Aug	0.14	28-Oct		28-Dec	
28-Feb		28-Apr		28-Jun	4.92	28-Aug	0.14	29-Oct		29-Dec	
29-Feb		29-Apr		29-Jun	4.56	29-Aug	0.14	30-Oct		30-Dec	
		30-Apr		30-Jun	4.60	30-Aug	0.14	31-Oct		31-Dec	
						31-Aug	0.14				