Appendix 6.4-B

Baseline Hydrology Report – 2014 Streamflow Monitoring

KGHM Ajax Mining Inc.

AJAX PROJECT
BASELINE HYDROLOGY REPORT – 2014 STREAMFLOW MONITORING

FINAL

PROJECT NO.: 1125007 April 9, 2015

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

KGHM AJAX MINING INC.

AJAX PROJECT

BASELINE HYDROLOGY REPORT – 2014 STREAMFLOW MONITORING

FINAL

PROJECT NO.:	1125-007-03	DISTRIBUTION:	
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April 9, 2015
Project No.: 1125-007-03

Nettie Ore
KGHM Ajax Mining Inc.
200-124 Seymour Street
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Dear Ms. Ore,

Re: Ajax Project, Baseline Hydrology Report – 2014 Streamflow Monitoring

Please find attached a copy of the above-referenced report dated April 9, 2015. We appreciate the opportunity to work on this project and look forward to our continued involvement. Should you have any questions or comments, please do not hesitate to contact the undersigned.

Yours sincerely,

BGC ENGINEERING INC.
per:

Hamish Weatherly, M.Sc., P.Geo.
Principal Hydrologist

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LIST OF ACRONYMS

BC	British Columbia
BC MoE	British Columbia Ministry of Environment
BGC	BGC Engineering Inc.
EA	Environmental Assessment
EIS	Environmental Impact Statement
FLNRO	British Columbia Ministry of Forests, Lands and Natural Resource Operations
KAM	KGHM Ajax Mining Inc.
SWE	Snow Water Equivalence

1.0 INTRODUCTION

BGC Engineering Inc. (BGC) was retained by KGHM Ajax Mining Inc. (KAM) to complete a baseline surface water hydrology assessment for the Ajax Project (the Project) near Kamloops, British Columbia. Surface water monitoring has been ongoing at the proposed Project site since 2008 by various parties and a report describing the local and regional hydrological and meteorological conditions at the site was produced by Knight Piésold Ltd. (Knight Piésold) in 2013 (Knight Piésold, 2013).

This report summarizes the 2014 surface water monitoring results with the objective of defining the baseline hydrologic conditions in the local study area for the Project. This report will support the provincial Application for an Environmental Assessment (EA) Certificate and the federal Environmental Impact Statement (EIS) for the Project, to be submitted in 2015.

1.1. Scope of Work

Previous surface water hydrology baseline data collection and analysis for the Project was conducted by Knight Piésold, including hydrometeorology and climatology reports that summarize local and regional hydrology and climate information (Knight Piésold, 2013, 2015). This work included installation of hydrometric stations in 2008 within the local study area, stage-discharge measurements between 2008 and 2012, and the development of rating curves for each station. Where relevant, these historical data have been incorporated into the 2014 analysis. The study area is shown in Figure 1-1.

The focus of this report is on the 2014 streamflow monitoring and it does not include an assessment of regional hydrological conditions or climate, which are provided in Knight Piésold (2013). As described by Knight Piésold (2013), the climate of the study area is semi-arid, characterized by low precipitation, high evaporation rates and correspondingly low streamflow. Consistent with regional hydrologic patterns, the peak streamflows at the study site generally occur in the spring (between April and June) in response to snowmelt and low flows occur during the remainder of the year. It is observed that flows remain low in the summer and fall following large rain storm events. The low flows are attributed to the area's relatively permeable and dry soils that readily absorb rainfall, resulting in limited runoff to the creeks. Accordingly, several of the monitoring sites were observed to be dry during the 2014 summer site visits.

In addition to flow monitoring during the open-water season, snow surveys were conducted in February and March of 2014 in the study area. The objective of these surveys was to measure the snow water equivalence (SWE) at selected locations throughout the Keynes Creek and Peterson Creek watersheds.

The objective of this report is to summarize the results of the 2014 hydrometric monitoring program. This work includes extending the stage-discharge measurement record and updating the stage-discharge relationship for each station. The report includes the following information:

- Station descriptions
- Instrumentation
- Sampling periods
- Manual streamflow measurements
- Station rating curves
- 2014 daily discharge hydrographs for each station
- Annual discharge summaries.

The monitored streamflows and snow survey data help inform the concurrent water balance modelling being conducted by BGC for the Project.

1.2. Instrumentation

The Project is a proposed open pit copper-gold mine located in the South-Central Interior of British Columbia (BC), Canada, near the City of Kamloops. Five (5) hydrometric gauging stations are currently active in the study area, as shown in Figure 1-1. Of these, four (4) were installed in 2008 by Knight Piésold and one (1) was installed in 2014 by BGC. All hydrometric stations are instrumented with a pressure transducer and datalogger to automatically measure and record water levels. These stations provide automatic streamflow measurements at 5- to 10-minute intervals. An additional site was installed by Knight Piésold in 2008 (TSFINF) and monitored until 2012, but it was not active in 2014 as project layout changes made it obsolete.

A summary of relevant station information is provided in Table 1-1. In addition to the hydrometric stations on site, there are two barometric data loggers and two climate stations, as shown in Figure 1-1 and detailed in Table 1-1. All pressure transducers on site are non-vented, meaning that they measure absolute pressure, which includes both air pressure and water pressure. In order to obtain only the water pressure, which corresponds to the water level above the logger, the air pressure collected at a nearby barometric pressure data logger is subtracted, as described in Section 2.4. Additionally, there are two meteorological stations near the study site that record air temperature and precipitation, which provide useful information alongside streamflow records. Meteorological data are not presented in detail here; however, these data are provided under separate cover by others for use by KAM as environmental baseline data.

Table 1-1. Summary of site hydrometric, barometric and meteorological stations.

Station ID	Description	Latitude	Longitude	Watershed Area (km^2)	Station Elevation (masl)	Installation Date (Installer)	Period of Record
Active Hydrometric Stations							
JACINF	Peterson Creek inflow to Jacko Lake	50.602	-120.441	31	912	April 2008 (Knight Piésold)	April 2008 – October 2014
JACLAKE	Jacko Lake upstream of spillway	50.606	-120.412	41	891	April 2008 (Knight Piésold)	April 2008 – October 2014
JACSEEP	Jacko Lake seepage and gate control	50.605	-120.410	41	883	April 2008 (Knight Piésold)	April 2008 – October 2014
PETER	Peterson Creek, downstream of Jacko Lake	50.606	-120.376	60	880	April 2008 (Knight Piésold)	April 2008 – October 2014
KEYNES	Keynes Creek, tributary to Peterson Creek, downstream of Jacko Lake	50.604	-120.414	11	915	March 2014 (BGC)	March 2014 – October 2014
Inactive Hydrometric Stations							
TSFINF	Old Afton Tailings Storage Facility Inflow	50.643	-120.535	53	721	April 2008 (Knight Piésold)	April 2008 – October 2012
Barometric Stations							
BARO1	Barologger installed in monitoring well MW11-03S	50.625	-120.471	n/a	820	March 2014 (BGC)	March 2014 – October 2014
BARO2	Barologger installed at Keynes Creek	50.604	-120.414	n/a	915	March 2014 (BGC)	March 2014 – October 2014
Climate Stations							
AJAXMET	Meteorological Station near Ajax Exploration Camp	50.642	-120.462	n/a	950	August 2010 (Knight Piésold)	June 2010 – present
Lac Le Jeune Meteorological Station	Meteorological Station near Lac Le Jeune Road	50.580	-120.435	n/a	1051	August 2014 (Advanced Monitoring Methods)	August 2014 – present

2.0 METHODOLOGY

2.1. Hydrometric Stations

A network of hydrometric stations has been installed at the proposed Project site that currently includes five active hydrometric stations and one inactive station, as summarized in Table 1-1. The station locations were selected to capture representative flows in the study area. A description of the five (5) stations active in 2014 follow and their watersheds are shown in Figure 2-1. A summary of channel physical characteristics for each station is provided in Table 2-1.

- JACINF – Monitors the primary inflow to Jacko Lake (Peterson Creek) and provides a record of natural unregulated flows in the study area.
- JACLAKE – Monitors the water level in Jacko Lake and any flow over the spillway when occurring.
- JACSEEP – Monitors the seepage and low level outlet release from Jacko Lake through the earth-fill embankment (flows from JACLAKE and JACSEEP combine to give the total flows leaving Jacko Lake).
- PETER – Monitors the flows in Peterson Creek downstream of Jacko Lake, and includes flows from all upstream watersheds.
- KEYNES – Established near the mouth of Keynes Creek in 2014 by BGC to evaluate the proposed tailings storage facility (TSF) watershed. Keynes Creek is at a significantly lower average elevation than JACINF; therefore, it provides representative flow data for the small, lower elevation tributaries around the proposed mine site.

Table 2-1. Summary of local channel characteristics at streamflow gauging stations.

Station	Width (m)	Depth (m)	Gradient (%)
JACINF	3.50	0.71	1.3
JACLAKE	3.10	0.51	3.1
JACSEEP	1.84	0.69	0.3
PETER	2.50	0.35	1.4
KEYNES	0.07	0.17	3.3

2.2. Streamflow Measurements

Manual streamflow measurements were completed at the gauging stations by Knight Piésold from 2008 to 2012 with the exception of the KEYNES station, which was installed in 2014. Streamflow measurements were not undertaken in 2013. In 2014, BGC and KAM staff continued the streamflow measurements for all active gauging stations. A summary of site visits and manual streamflow measurements is provided in Table 2-2. Detailed stage-discharge measurement results from 2008 to 2014 are provided for each station in Appendix A, while site photographs are provided in Appendix B.

Table 2-2. Summary of site visits and manual streamflow measurements.

Record Period:	2008 - 2011		2014	
Station	**Number of Site Visits**	**Number of Manual Flow Measurements**	**Number of Site Visits**	**Number of Manual Flow Measurements**
JACINF	23	10	13	12
JACLAKE	21	4	14	12
JACSEEP	28	11	14	2
PETER	23	11	13	12
KEYNES	n/a	n/a	14	10

Discharge at each site was measured using the velocity-area method, when possible. This involves subdividing a cross-section of the channel into subsections and measuring the average velocity of the water in each subsection, as described in Rantz et al., 1982a. The cross-sectional area of each subsection is then multiplied by the measured velocity in that subsection to give the discharge. The total discharge in the cross-section is then the sum of the discharges in the subsections. The majority of the streamflow measurements were taken with an OTT MF Pro current meter, which has an electro-magnetic sensor head that is ideal for use in low-flow environments. A Swoffer 2100 current meter with a propeller head was used for the remainder of measurements velocity measurements. All units were calibrated per manufacturer requirements prior to velocity measurements. A suitable number of velocity measurements were taken across the channel at each station with the objective of having each measurements account for less than 10% of the total discharge.

At each sounding point across the channel, the current water velocities were measured at 60% of the flow depth of water (all water depths flows were less than 0.75 m). The measurement was assumed to be the mean velocity for the vertical water section. In all cases, the adopted methods followed standard RISC (2009) procedures.

The velocity-area method is not applicable during extreme low flows, when the flow is not deep or fast enough to measure with a current meter. In these cases the volumetric method was used. Volumetric measurements are conducted by measuring the period of time required to capture a known volume of water in a container, such as a 1.25 gallon bucket. This method was used for all non-zero discharge measurements at the JACSEEP station (including one measurement in 2014) because the control section is a v-notch weir, which precludes use of the velocity-area method. This method was also required once at the KEYNES station in 2014 when sandbags were used to constrict the flow for improved capture.

2.3. Stage-Discharge Rating Curves

A stage-discharge rating curve is a fixed relationship between water level (stage) and streamflow (discharge) at a given site, which is used to estimate flows from recorded water levels. The commonly accepted practice for developing a stage-discharge rating curve is to

manually measure streamflow and stage simultaneously at a site and develop the relation empirically as the best-fit curve through the observed measurements (Rantz et al., 1982b). Discharge is measured using the procedures outlined in Section 2.2 and stage is measured from a staff gauge that is installed in a fixed location near each station. Ideally, stage-discharge measurements are conducted on numerous occasions to capture a range of flow conditions. Many (at least 10) measurements are needed to develop the rating curve initially in order to capture the entire range of stage at the site, but if the cross-section remains stable then fewer measurements are required to confirm the rating or to follow shifts thereafter (Rantz et al., 1982b).

The rating curve function takes the form:

[1] $$Q = a * (h - h_0)^b$$

Where Q is the discharge (m^3/s), h is the stage height (m), h_0 is the stage height at zero flow (m), a is a constant that is numerically equal to the discharge when the head (h-h_0) equals 1.0 m, and b is the slope of the rating curve (Rantz et al., 1982b). The constants a and b in Equation 1 are adjusted to obtain a best-fit curve through the stage-discharge measurements. The resulting equation, or rating curve, is then applied to the continuous water levels recorded by the pressure transducer to estimate streamflows. Barometric pressure measurements are used to correct raw water level measurements from non-vented pressure transducers, as described in Section 2.4.

Stage-discharge rating curves had previously been developed by Knight Piésold for all of the stations excluding KEYNES. Thus, stage-discharge measurements from 2008 to 2012 were combined with the 2014 measurements where available in order to generate an updated rating curve. The updated rating curve and the corresponding streamflow hydrograph for each station are described in Section 3.0. Daily average streamflows for each station are provided in Appendix C.

2.4. Pressure Transducer Data Compensation

A pressure transducer is installed at each active hydrometric station in order to automatically measure and record water levels at set time intervals. There is also a staff gauge at each station for manual stage measurements. Water level is measured continuously and recorded at 5- to 10-minute intervals using pressure transducer data loggers. The record interval, summarized in Table 2-3, was originally set at 5 minutes for all stations excluding KEYNES, but this was changed to 10 minutes during the May 6th site visit to extend the time period between downloads. Solinst® Leveloggers are installed at four out of the five active hydrometric stations, excluding Keynes Creek, as summarized in Table 2-3. Hydrometric station equipment summary. The pressure transducer at Keynes Creek is a HOBO® Water Level Logger. All pressure transducers on site are non-vented, meaning that they measure absolute pressure, which includes both air pressure and water pressure. In order to obtain only the water pressure, which corresponds to the water level (height) above the logger, the air pressure collected at a nearby barometric pressure data logger is subtracted.

Data compensation is conducted according to the following equation:

[2] $$P_g = P_a - P_{atm}$$

Where P_g is the gauge pressure (or water pressure), P_a is the absolute pressure measured by the pressure transducer and P_{atm} is atmospheric pressure measured by the barometric pressure transducers.

A Solinst® Barologger (BARO1) installed inside a groundwater monitoring well on site, well MW11-03S, was used to compensate the raw water level data for all stations except KEYNES. The pressure transducer at Keynes Creek is a HOBO® Water Level Logger, so a corresponding HOBO® barometric pressure data logger (BARO2) installed within the standpipe at the station is used to compensate the KEYNES water level data for barometric pressure. Table 2-3 provides a summary of the equipment and flow measurement information for the active hydrometric stations.

Table 2-3. Hydrometric station equipment summary

Station	Streamflow measurement method	Pressure Transducer Data logger brand (make/model)	Barometric datalogger used to compensate data	Water Level sampling interval
JACINF	Velocity-area	Solinst® Levelogger	BARO1	5 minutes (until May 6), 10 minutes from May 6 onwards
JACLAKE	Velocity-area	Solinst® Levelogger	BARO1	5 minutes (until May 6), 10 minutes from May 6 onwards
JACSEEP	Volumetric (v-notch weir)	Solinst® Levelogger	BARO1	5 minutes (until May 6), 10 minutes from May 6 onwards
PETER	Velocity-Area	Solinst® Levelogger	BARO1	5 minutes (until May 6), 10 minutes from May 6 onwards
KEYNES	Velocity-Area or volumetric at low flows	HOBO® Water Level Logger	BARO2	10 minutes

2.5. Snowpack Surveys

BGC conducted snow surveys in the Keynes Creek watershed and the upper watershed of Peterson Creek. The objective of the snow survey was to measure SWE at distributed locations in the two watersheds (Figure 4-1). Surveys were conducted on two separate dates: February 26-27, 2014 and March 18-19, 2014. The snow survey of February 26-27, 2014 was restricted to the Keynes Creek watershed, as access could not be obtained to the Upper Peterson Creek watershed (the access road was impassable by snowmobile due to fallen trees). The subsequent survey included upper Peterson Creek, but much of the snow in

Keynes Creek had melted by this point. SWE was calculated at a total of 29 sites where snow was present throughout the study area. Results of the snow surveys are provided in Section 4.0.

The snow survey was conducted using a Federal snow sampling tube and standard methods as outlined in the BC Ministry of Environment (BC MoE) snow sampling survey guide were followed (BC MoE, 1981). The BC Ministry of Forests, Lands, and Natural Resource Operations (FLNRO) typically conducts manual snow surveys on the first day of each month for the January through May period. The Peterson Creek survey was conducted prior to April 1 due to concerns of snowmelt prior to that date.

3.0 HYDROLOGY RESULTS

3.1. Jacko Lake Inflow (JACINF)

3.1.1. Site Description

The JACINF hydrometric station was installed in April 2008 by Knight Piésold to monitor the primary inflows in to Jacko Lake from Peterson Creek and to provide a record of natural, unregulated flows in the study area. The station is located just upstream of a culvert under Lac Le Jeune Rd., about 1 km upstream of its mouth at Jacko Lake. The station is located in a reach that has well-vegetated banks overgrown with shrubs and a bed comprised primarily of sand or silt and organics. There is large woody debris scattered throughout the channel. Photo 1 in Appendix B shows the hydrometric station and the nearby culvert. A staff gauge is installed on the right bank of the stream, attached to the station riser pipe.

3.1.2. 2014 Monitoring

Manual streamflow measurements were conducted at this site using a current meter and the velocity area method, as described in Section 2.2. Twelve (12) measurements were conducted by KAM and BGC personnel in 2014 and an additional 10 stage-discharge measurements are available from 2008 and 2012. All 22 of the stage-discharge measurements were used to develop the rating curve. The stream banks are heavily vegetated and woody debris was noted in the channel during some of the discharge measurements, which may have led to slightly increased measurement error. The stage-discharge measurements and rating curve for JACINF are shown in Figure 3-1.

Continuous water level data were collected at this station between March 24, 2014 and October 2, 2014. There is a gap in the data between June 19 and July 24, 2014 due to a download error. The rating curve was used to estimate streamflows from the compensated water levels and a hydrograph of average daily discharge is provided in Figure 3-2.

3.2. Jacko Lake (JACLAKE)

3.2.1. Site Description

The JACLAKE hydrometric station was installed in April 2008 to monitor the water level in the lake and any flow over the spillway when occurring. The station is located in the southeast arm of the lake about 30 m from the entrance to the overflow spillway channel. The bank of the lake is grassy and there is woody debris around the station. It is not uncommon for the spillway channel to be dry, as it was during field inspections from July through October 2014. The spillway is shown in Photos 2 and 3 in Appendix B.

There are two staff gauges for this site: one is attached to the station riser pipe; the other one is attached to the large red platform near the lake outflow that provides access to control releases from the low level outlet. The staff gauge on the riser pipe dates from the station installation in 2008 and was used for stage measurements from 2008 to 2012. The riser pipe

staff gauge is too high and is often entirely above the lake's surface, which prevents accurate staff gauge readings at low lake levels. The staff gauge on the red platform was installed in 2014 and was used for the 2014 stage measurements. An offset of 0.37 m (based on measurements of water levels at both staff gauges taken on May 5, 2014) was applied to convert readings between staff gauges for the measurements prior to 2014. The staff gauges are shown in Photos 4 and 5 in Appendix B.

3.2.2. 2014 Monitoring

Manual streamflow measurements are conducted in the spillway downstream of the station using a velocity meter and the velocity area method, as described in Section 2.2, when possible. The spillway was observed to be dry between July and October 2014. Four (4) stage-discharge measurements are available between 2008 and 2011, but two of these were not included in the updated rating curve as they underestimated discharge compared to 2014 measurements. It is possible that some degradation of the bed or vegetative growth had occurred within the spillway that had affected the stage-discharge relationship at these lower flows. An additional 14 field visits were conducted by KAM and BGC personnel in 2014, which resulted in 7 complete stage and discharge measurements to be used in the development of the rating curve. The stage-discharge rating curve and measurements for JACLAKE are shown in Figure 3-3.

Water level data were collected at this station between March 24, 2014 and October 2, 2014. The rating curve was used to estimate average daily discharge shown in Figure 3-4. As shown in Figure 3-5, the lake spillway was in operation between May 3 and July 11, 2014. Lake water levels for the period of record are shown in Figure 3-5: an elevation of zero represents the invert of the spillway at the lake outlet. From Lidar data, the elevation of the spillway invert is approximately 892.2 m.

3.3. Jacko Lake Seepage (JACSEEP)

3.3.1. Site Description

The JACSEEP hydrometric station was installed in April 2008 to monitor the seepage and low level outlet (pipe) release from Jacko Lake. Flow measurements are taken from a v-notch weir between man-made concrete abutments about 35 m downstream of the embankment. Backflow conditions appear to exist at this site and the water was often observed to be stagnant, which precludes accurate flow measurement. The backflow conditions were originally thought to be due to two culverts downstream under the access road, but these were replaced by a bridge in early 2014 and these conditions persist. They are likely due to the extremely low gradient of the seepage channel. The station is installed against one of the concrete abutments on the right bank of the channel. The hydrometric station and seepage channel are shown in Photos 6 through 8 in Appendix B.

3.3.2. 2014 Monitoring

Few measurements were taken at JACSEEP in 2014, as the lake was overflowing through the spillway during much of the summer and as such, the low level outlet was not operating. At these times, the v-notch weir was flooded, which limited flow measurements using conventional methods. Two (2) complete stage-discharge measurements were collected; one of these used the volumetric method described in Section 2.2, and the other was under zero-flow conditions. A rating curve was previously developed for this site by Knight Piésold and the stage-discharge relationship has not been updated due to the lack of measurements in 2014 that expand the stage range of the curve. Due to the short operating period of the Jacko Lake low-flow outlet, the stage-discharge measurements obtained between 2008 and 2014 do not sufficiently capture flows across the entire stage range, particularly in the upper stage levels, as is recommended in Rantz et al., 1982b. Thus, as a reliable rating curve has not been generated for this station, results shown in Figure 3-6 should be used with caution. The rating curve for JACSEEP is shown in Figure 3-6 with all available stage-discharge measurements from 2008 to 2014.

Water level data were collected at this station between March 23, 2014 and October 2, 2014. The rating curve was used to estimate streamflows from the compensated water levels and a hydrograph of average daily discharge is provided in Figure 3-7. Figure 3-7 indicates that the low-level outlet was operated from July 6 to July 25 and August 6 to August 30.

3.4. Peterson Creek (PETER)

3.4.1. Site Description

The PETER hydrometric station was installed in April 2008 to monitor the flows in Peterson Creek downstream of Jacko Lake, which includes flows from upstream watersheds. The station is located in Peterson Creek about 3 km downstream of Jacko Lake, just upstream of the Goose Lake Road crossing. Streamflows are measured about 15 m downstream of the station on the east side of the road where there is a more defined channel and no backflow conditions. The channel banks are overgrown with small shrubs and there is cattle activity around the crossing. The stream bed is comprised of sand with small gravels and cobbles in the centre of the channel. The left bank is slightly undercut, which introduces some error into the flow measurements as they may be slightly underestimated at high flow conditions. The hydrometric station and streamflow measurement section are shown in Photos 9 and 10 in Appendix B.

3.4.2. 2014 Monitoring

Manual streamflow measurements were conducted at this site using a velocity meter and the velocity area method, as described in Section 2.2. A rating curve was previously developed for this site by Knight Piésold based on 11 stage-discharge measurements taken between 2008 and 2012. An additional 11 measurements were conducted by KAM and BGC personnel in 2014. All of these stage-discharge measurements were used to develop the updated rating

curve. The stage-discharge measurements and rating curve for PETER are shown in Figure 3-8. In general, the 2014 stage-discharge measurements are consistent with the Knight Piésold rating curve. However, additional zero-flow stage measurements in 2014 indicate that the zero-flow stage height is lower than previously modeled. The rating curve coefficient (h_0) was adjusted accordingly in the updated curve.

Water level data were collected at this station between March 23, 2014 and October 2, 2014. There is a gap in the data between June 20 and July 24, 2014 as with the JACINF station, which is attributed to data download error. Figure 3-9 provides average daily discharge at PETER. Additionally, the hydrographs for JACLAKE, JACSEEP and PETER are plotted together in Figure 3-10 for comparison. Because the Jacko Lake outflow enters Peterson Creek with few tributaries entering upstream of the PETER station (Keynes Creek contributes minimal flow, as discussed in Section 3.5), flows from JACLAKE and JACSEEP (when operated) should approximate flows at PETER, which is observed in Figure 3-10.

3.5. Keynes Creek (KEYNES)

3.5.1. Site Description

The KEYNES hydrometric station was installed in March 2014 by BGC near the mouth of Keynes Creek (a tributary of Peterson Creek) to evaluate runoff for small, lower-elevation watersheds within the study area. At the station, Keynes Creek is a small (70 cm wide) channel in a wooded area with shrubs on the banks and organic matter on the bed. The station and staff gauge are shown in Photo 11 in Appendix B. The channel was observed to be dry through most of the summer from mid-June through October.

3.5.2. 2014 Monitoring

Manual streamflow measurements were conducted at this site using a velocity meter and the velocity area method, where possible, or the volumetric method during low-flow conditions as described in Section 2.2. As this station was installed in 2014, no earlier stage-discharge measurements are available and the rating curve was developed from the 2014 measurements. The 2014 monitoring consisted of 14 site visits during which 10 complete stage-discharge measurements were obtained. One of these stage-discharge measurements was not included in the rating curve analysis as it appeared to be an overestimate of discharge. This measurement was conducted using the volumetric method with sandbags to constrict the flow for improved flow capture, which likely increased measurement error and led to the overestimate. Of the eight measurements used to develop the relationship, four were zero-flow measurements when the creek was dry. The stage-discharge measurements and rating curve for KEYNES are shown in Figure 3-11. The lack of stage-discharge measurements in 2014 limits the accuracy of the rating curve for KEYNES. Limited runoff is expected for this watershed due to a poorly defined channel (see Photo 11 in Appendix B) and active water licenses in the upstream watershed.

Water level data were collected at this station between March 19, 2014 and October 2, 2014. A hydrograph of average daily discharge is provided in Figure 3-12.

3.6. Summary

A summary of the rating curves for each of the hydrometric stations is provided below in Table 3-1, including the total number of stage-discharge measurements used to derive the equation.

Table 3-1. Summary of rating curve measurements and equations

Station	# of measurements used in Rating Curve	Rating Curve Equation
JACINF	22	$Q = 1.512 (h-0.014)^{2.239}$
JACLAKE	9	$Q = 5.424 (h-0.125)^{2.309}$
JACSEEP	12	$Q = 10 (h-0.175)^{2.500}$
PETER	22	$Q = 1.600 (h-0.09)^{2.194}$
KEYNES	8	$Q = 1.525 (h-0)^{4.082}$

The streamflow monitoring program was conducted between March and October, 2014 for all of the active stations previously described. Thus, six (6) full months of streamflow data from April through September are available for most of the stations, except JACINF and PETER, which only have partial streamflow data in June and July 2014. A summary of monthly 2014 streamflow statistics based on average daily discharge estimates is provided in Table 3-2, including average unit runoff. Monthly peak instantaneous discharge is also provided. Monthly statistics are not provided for KEYNES given the limited streamflow at this station. Discharge hydrographs and additional baseline hydrological indicators from previous monitoring periods are provided in Knight Piésold (2013).

Table 3-2. Monthly discharge statistics summary.

Station	Month	Average Daily Discharge (m^3/s)	Maximum Daily Discharge (m^3/s)	Minimum Daily Discharge (m^3/s)	Maximum Instantaneous Discharge (m^3/s)	Average Unit Runoff ($L/s/km^2$)
JACINF	April	0.065	0.151	0.012	0.232	2.13
	May	0.211	0.414	0.090	0.475	6.93
	June	Partial*	Partial*	Partial*	Partial*	Partial*
	July	Partial*	Partial*	Partial*	Partial*	Partial*
	August	0.005	0.011	0.002	0.022	0.17
	September	0.005	0.011	0.002	0.027	0.16
JACLAKE	April	0.000	0.001	0.000	0.009	0.00
	May	0.168	0.257	0.000	0.418	4.11
	June	0.080	0.141	0.038	0.342	1.95
	July	0.008	0.039	0.000	0.062	0.20
	August	0.000	0.000	0.000	0.000	0.00
	September	0.000	0.000	0.000	0.000	0.00
JACSEEP	April	0.000	0.000	0.000	0.0000	0.00
	May	0.000	0.000	0.000	0.0000	0.00
	June	0.000	0.000	0.000	0.0000	0.00
	July	0.034	0.079	0.000	0.1630	0.83
	August	0.048	0.146	0.000	0.2307	1.17
	September	0.001	0.003	0.000	0.0264	0.02
PETER	April	0.000	0.000	0.000	0.000	0.00
	May	0.218	0.399	0.000	0.476	3.63
	June	Partial*	Partial*	Partial*	Partial*	Partial*
	July	Partial*	Partial*	Partial*	Partial*	Partial*
	August	0.051	0.227	0.000	0.286	0.84
	September	0.000	0.000	0.000	0.000	0.00

*Monthly discharge statistics were not computed as only partial monthly data was available.

4.0 SNOWPACK SURVEY RESULTS

Snow surveys were conducted on two separate occasions in 2014: in the Keynes Creek watershed in February and in the Upper Peterson Creek watershed in March 2014. In the February survey, snow was observed to be often missing on south facing slopes and on the tops of hills, and it was deepest in valley bottoms on north aspects. A wind slab had formed on most aspects and the snowpack was faceted below.

The average SWE observed in the Keynes Creek watershed in February was 66 mm. In March, most of the snow had melted from the Keynes Creek watershed, which is at a lower average elevation than the upper Peterson Creek watershed. The average SWE observed at measurement sites in the Peterson Creek watershed in March was 129 mm. The locations of the survey sampling sites and the measured SWE results for each sampling location, except the snow-free locations, are shown in Figure 4-1 for both surveys. Detailed results are also provided in Table 4-1 including slope aspect, snow depth and calculated SWE as well as field observations of location and snow conditions.

The nearest active manual snow survey station operated by the Ministry of Forest, Lands and Natural Resource Operations (FLNRO) is the Highland Valley station (ID No. 1C09A), located 40 km southwest of the study area at an elevation of 1475 m (FLNRO, 2015). The normal maximum SWE at this station occurs during the April 1st sampling period and the long-term average SWE for this period is 98 mm. Results from the 2014 manual survey gave a SWE of 103 mm, which is only slightly above the long-term average. The nearest regional climate station with a long-term precipitation record for comparison is the Kamloops A station, located about 9 km north of the study site and at a lower elevation of 345 masl. This station is operated by Environment Canada: snowfall recorded at this station for the 2013-2014 winter season (October through April) was 50.9 cm, which is below the long-term normal of 63.5 cm (Government of Canada, 2015). Thus, snowpack conditions at the Project site can best be characterized as normal for the 2013/2014 season.

Table 4-1. Snowpack survey results.

Latitude	Longitude	Sample Date	Aspect	Snow Depth (mm)	SWE (mm)	Comments
50.60533	-120.42045	26-Feb-14	310	130	10	Wind packed and sugary snow.
50.59722	-120.42404	26-Feb-14	240	100	20	Wind packed and sugary snow. Top of slope has no snow, opposite side of the road has more snow.
50.59673	-120.42508	26-Feb-14	11	210	100	Sugary, windpacked.
50.59211	-120.41669	26-Feb-14	140	65	10	Small, local depression - average of the area.
50.59627	-120.41669	26-Feb-14	84	80	10	Grassland location, snow is sublimating. Snow is compact and sugary.
50.59641	-120.41495	26-Feb-14	84	180	80	Grassland, bottom of small gully.
50.60233	-120.41605	26-Feb-14	240	210	90	Glades on hill, benched area
50.58123	-120.42413	26-Feb-14	33	310	110	Small conifers on grass slope. Loose snow (drift) with ice crystal texture. Wind packed snow nearby.
50.58082	-120.42422	26-Feb-14	320	100	40	Grassland on top of hill. Sublimating.
50.58035	-120.42493	26-Feb-14	234	290	100	Bottom of hill next to the road. Within a stand of deciduous trees
50.57995	-120.38959	26-Feb-14	234	210	80	Location is approximately midslope. Slope is dry below.
50.5798	-120.38971	26-Feb-14	234	250	110	Grassed slope with intermittent conifers. Wind crust and sugary below.
50.58034	-120.39181	26-Feb-14	n/a	320	100	Goose Lake. Wind slab - loose and hollow below.
50.57378	-120.39687	26-Feb-14	0	80	20	Under forest canopy, on the side of the road adjacent to the barbed wire fence
50.56393	-120.41761	26-Feb-14	290	300	100	Side of plateau, semi-treed area. Thicker snow on the plateau and thinner snow under trees
50.5578	-120.4296	26-Feb-14	0	260	90	Heavily treed.

Latitude	Longitude	Sample Date	Aspect	Snow Depth (mm)	SWE (mm)	Comments
50.56381	-120.43418	27-Feb-14	10	70	30	Treed area near the road at the top of a hill, fairly flat
50.57319	-120.44212	27-Feb-14	0	240	80	Edge of the open area, next to the trees
50.57976	-120.47173	27-Feb-14	60	260	80	Directly on the road
50.57967	-120.47177	27-Feb-14	40	160	70	In trees adjacent to the road
50.55499	-120.45677	18-Mar-14	30	350	110	Under trees, slope forms the side of a swale.
50.55119	-120.48728	18-Mar-14	240	600	140	Sugary snow adjacent to trail edge.
50.55309	-120.50228	18-Mar-14	45	630	180	Adjacent to road, sugary, compact snow.
50.56948	-120.46788	18-Mar-14	50	380	120	Sugary snow adjacent to trail edge.
50.56756	-120.47616	18-Mar-14	20	580	90	Sugary snow, under trees adjacent to the trail edge.
50.56078	-120.49399	18-Mar-14	25	430	140	
50.54835	-120.53641	19-Mar-14	45	910	160	Deep snow in cutblock adjacent to trees. Crust with unconsolidated snow bellow
50.55550	-120.53602	19-Mar-14	80	760	90	Windblown snow crust, unconsolidated and hollow beneath.

5.0 CLOSURE

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Yours sincerely,

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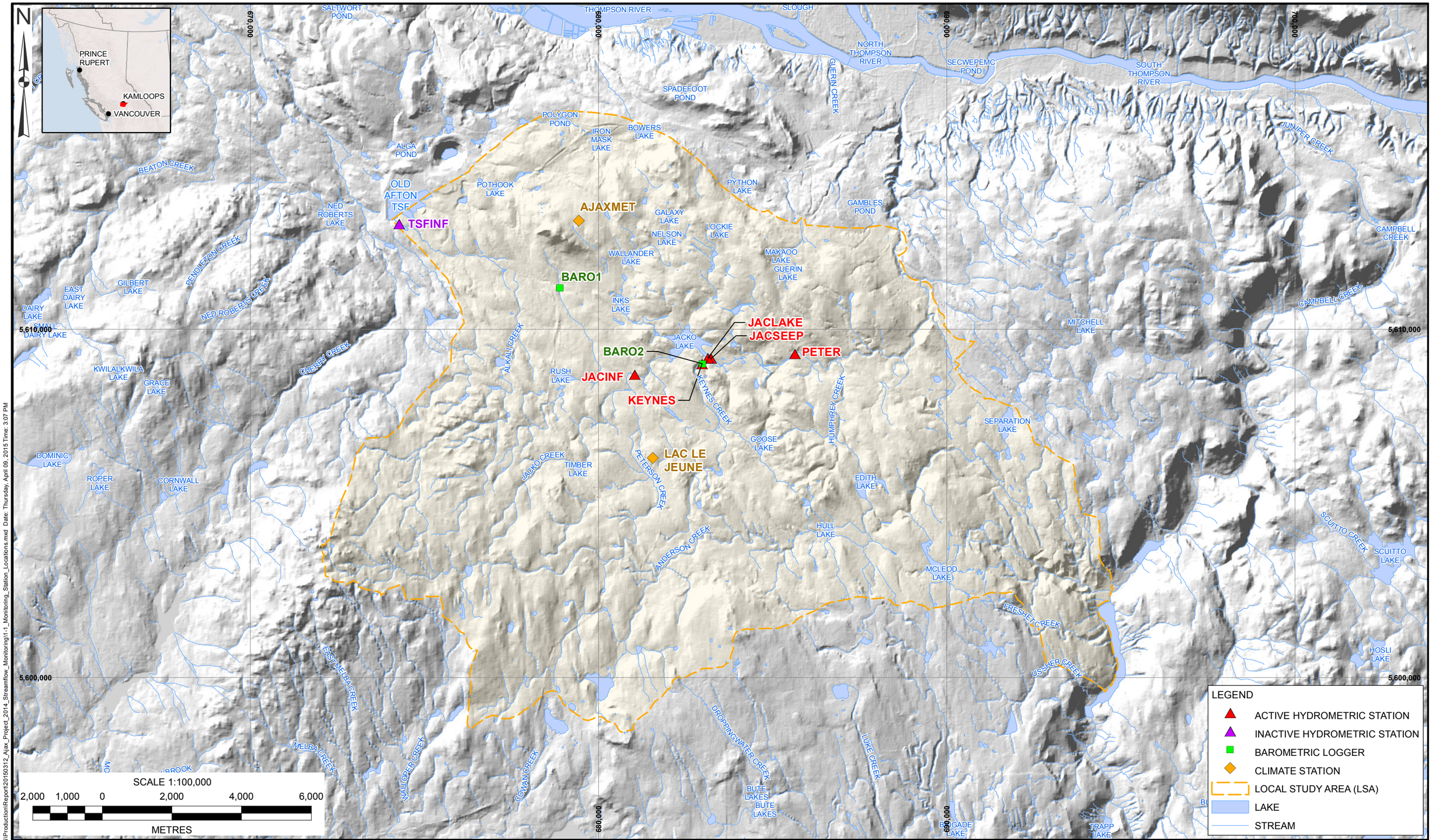
FIGURES



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TITLE
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PROJECT No.	DWG No:
1125-007-03	1-1

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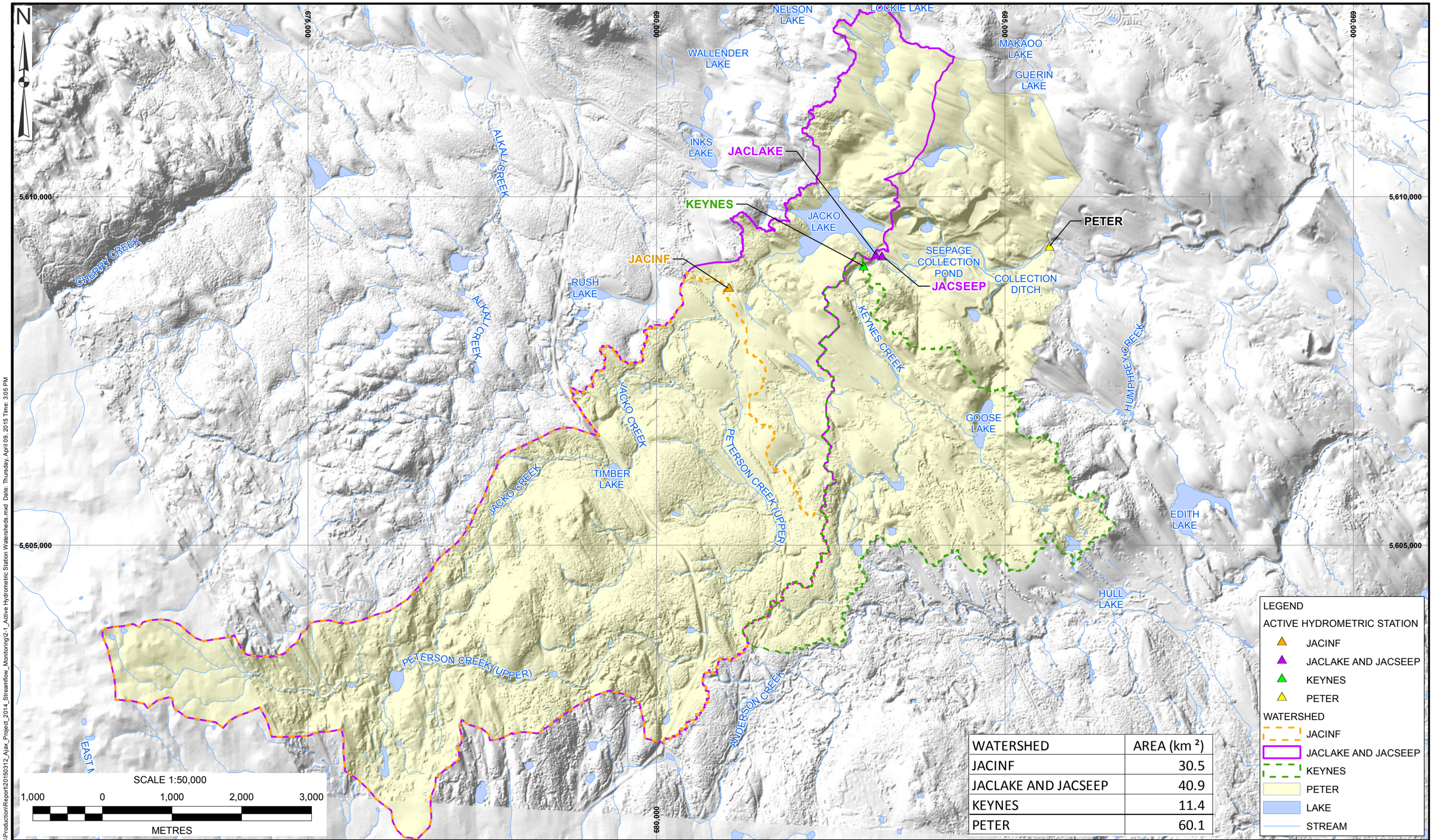

LEGEND

ACTIVE HYDROMETRIC STATION

- JACINF
- JACLAKE AND JACSEEP
- KEYNES
- PETER

WATERSHED

- JACINF
- JACLAKE AND JACSEEP
- KEYNES
- PETER
- LAKE
- STREAM

WATERSHED	AREA (km ²)
JACINF	30.5
JACLAKE AND JACSEEP	40.9
KEYNES	11.4
PETER	60.1

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TITLE: ACTIVE HYDROMETRIC STATION WATERSHEDS

PROJECT No.	DWG No:
1125-007-03	2-1

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Figure 3-1. JACINF Rating Curve

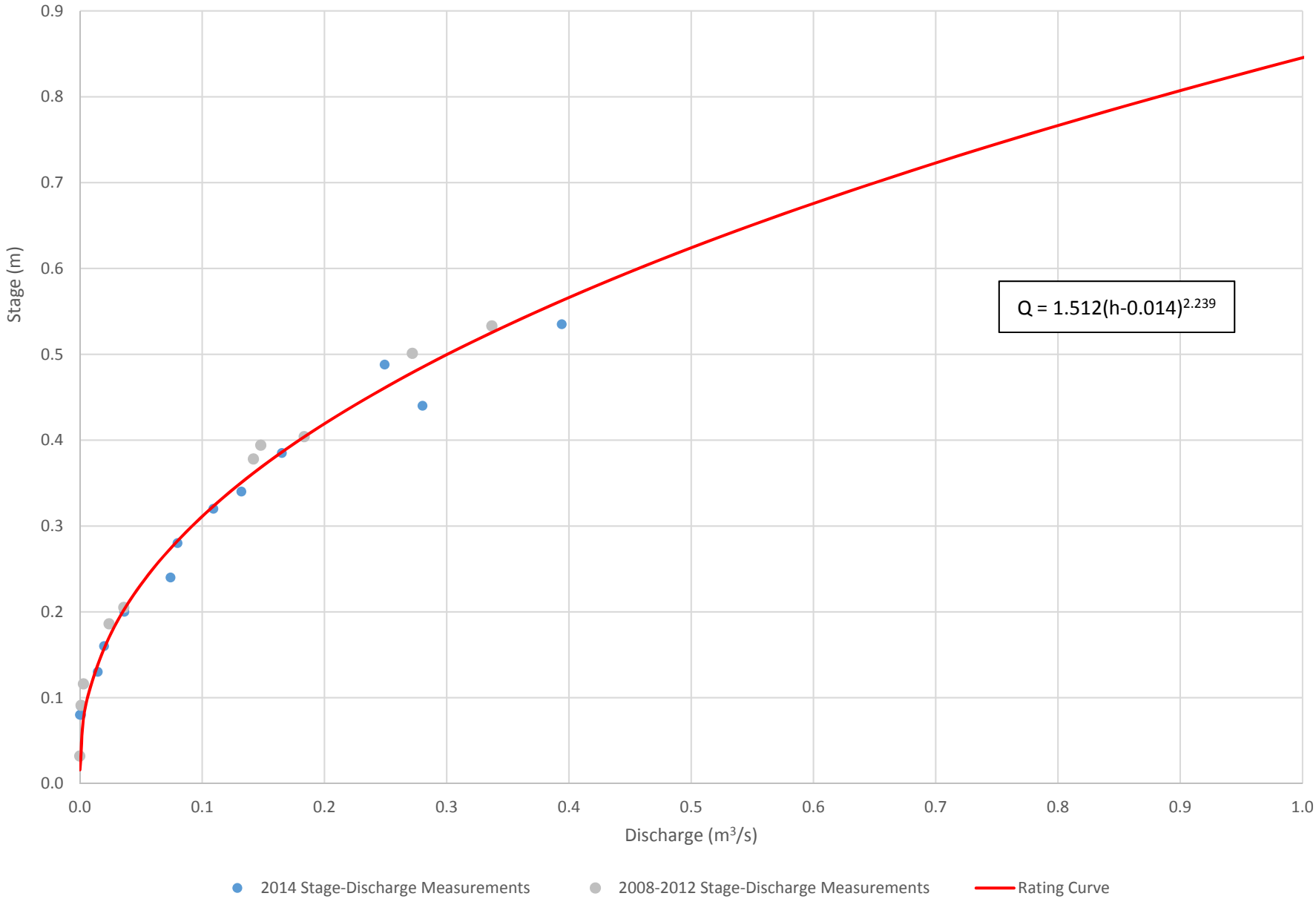


Figure 3-2. JACINF 2014 Daily Streamflow Hydrograph

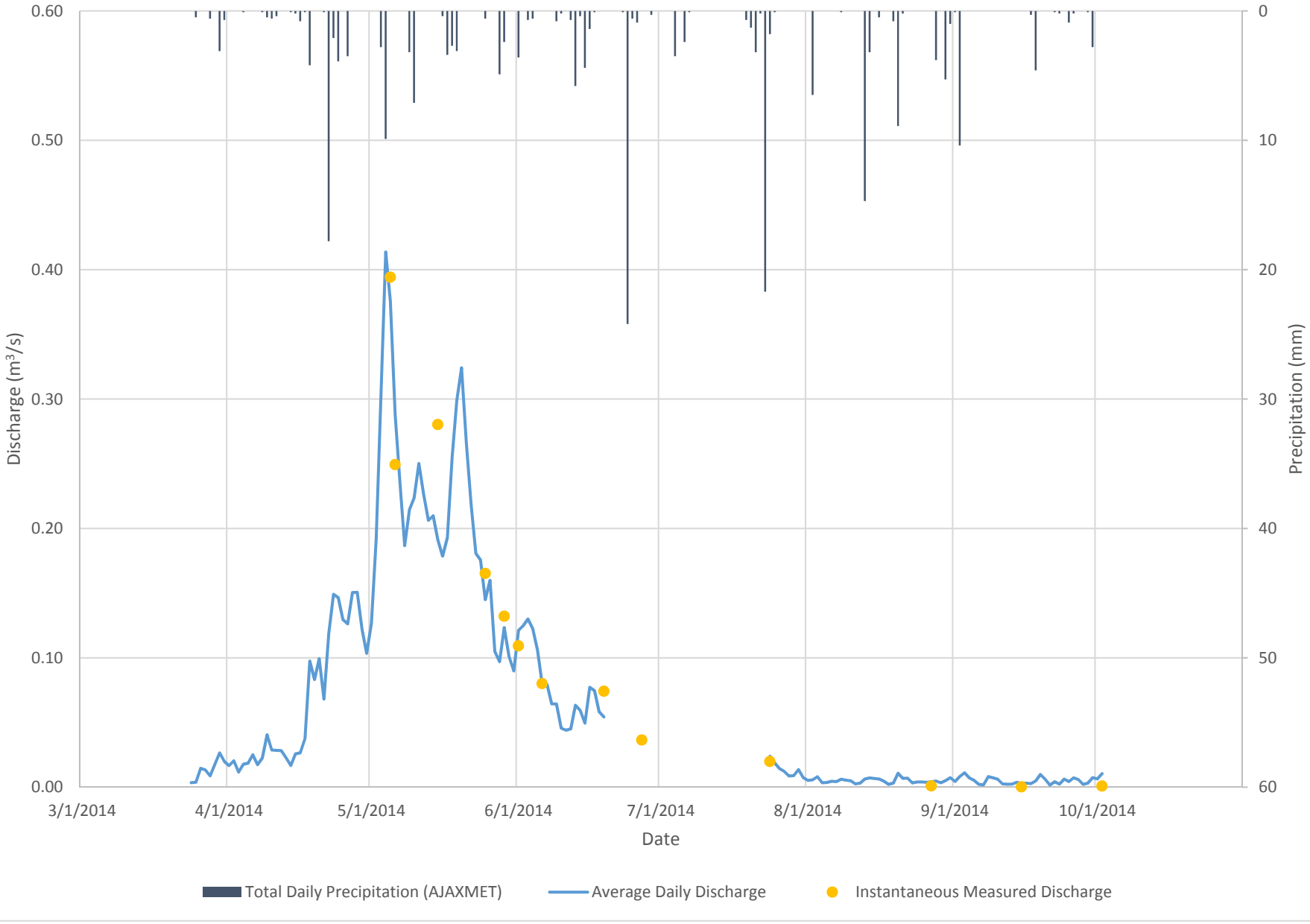
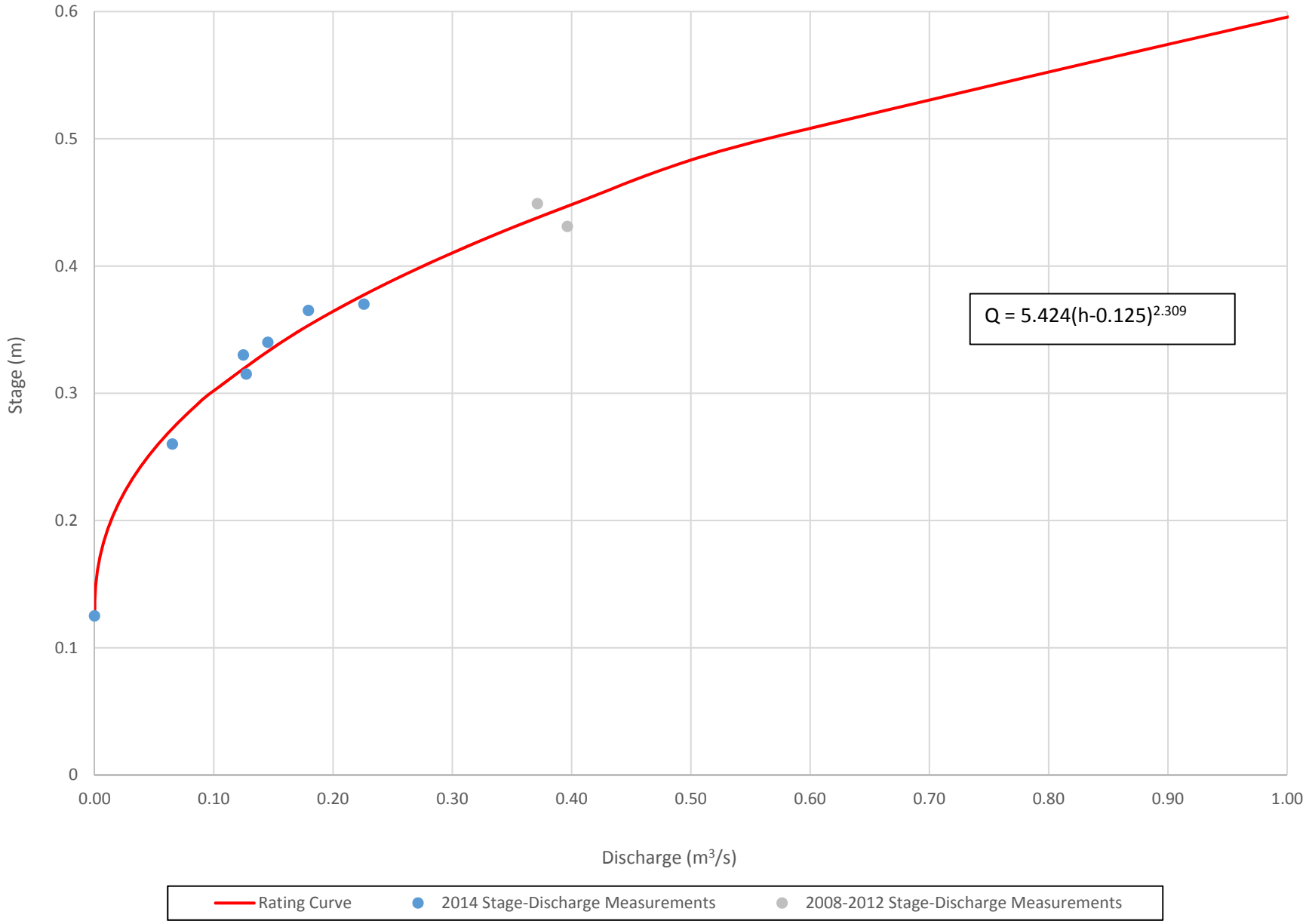


Figure 3-3. JACLAKE Rating Curve



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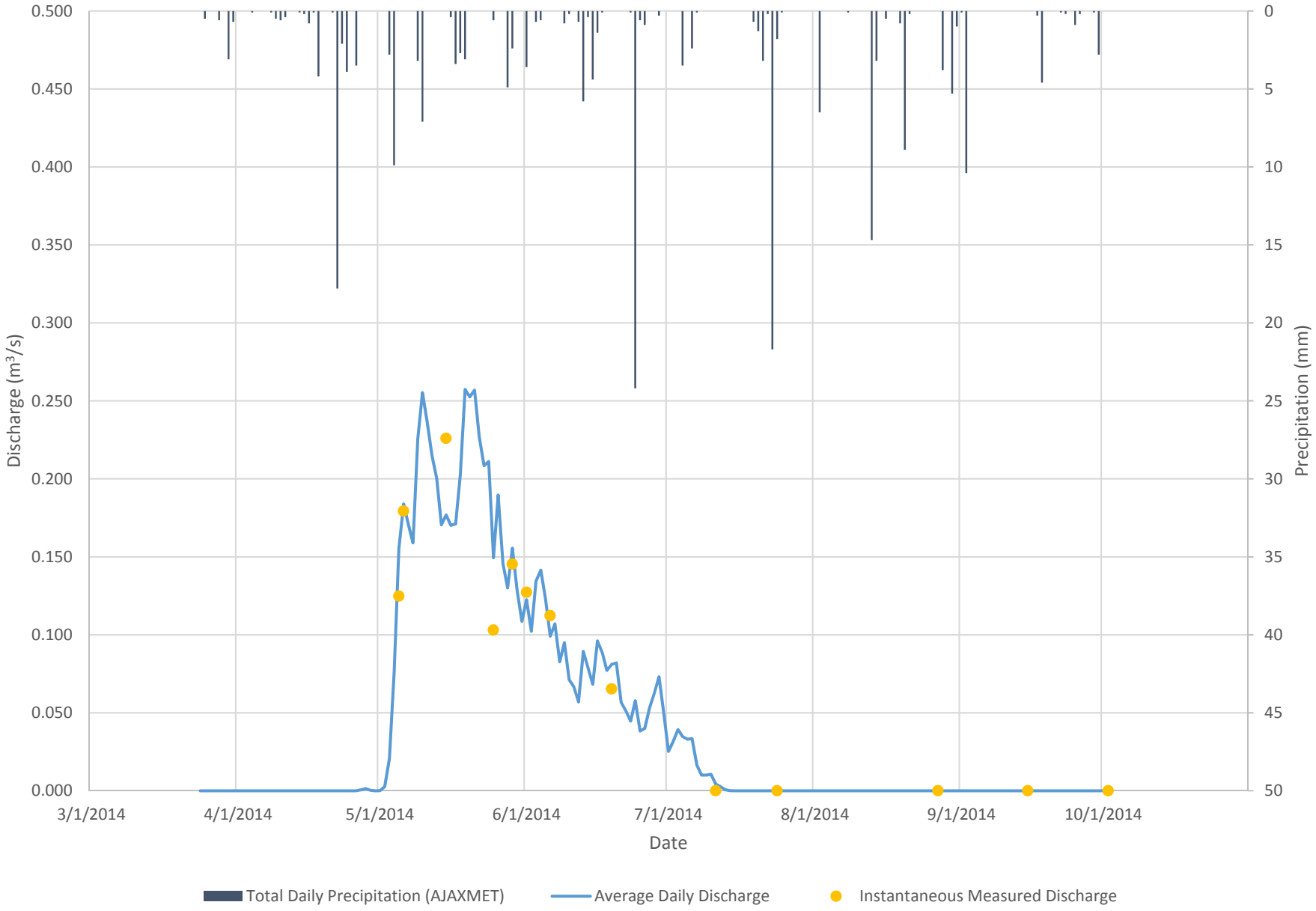


Figure 3-5. Jacko Lake 2014 Water Levels

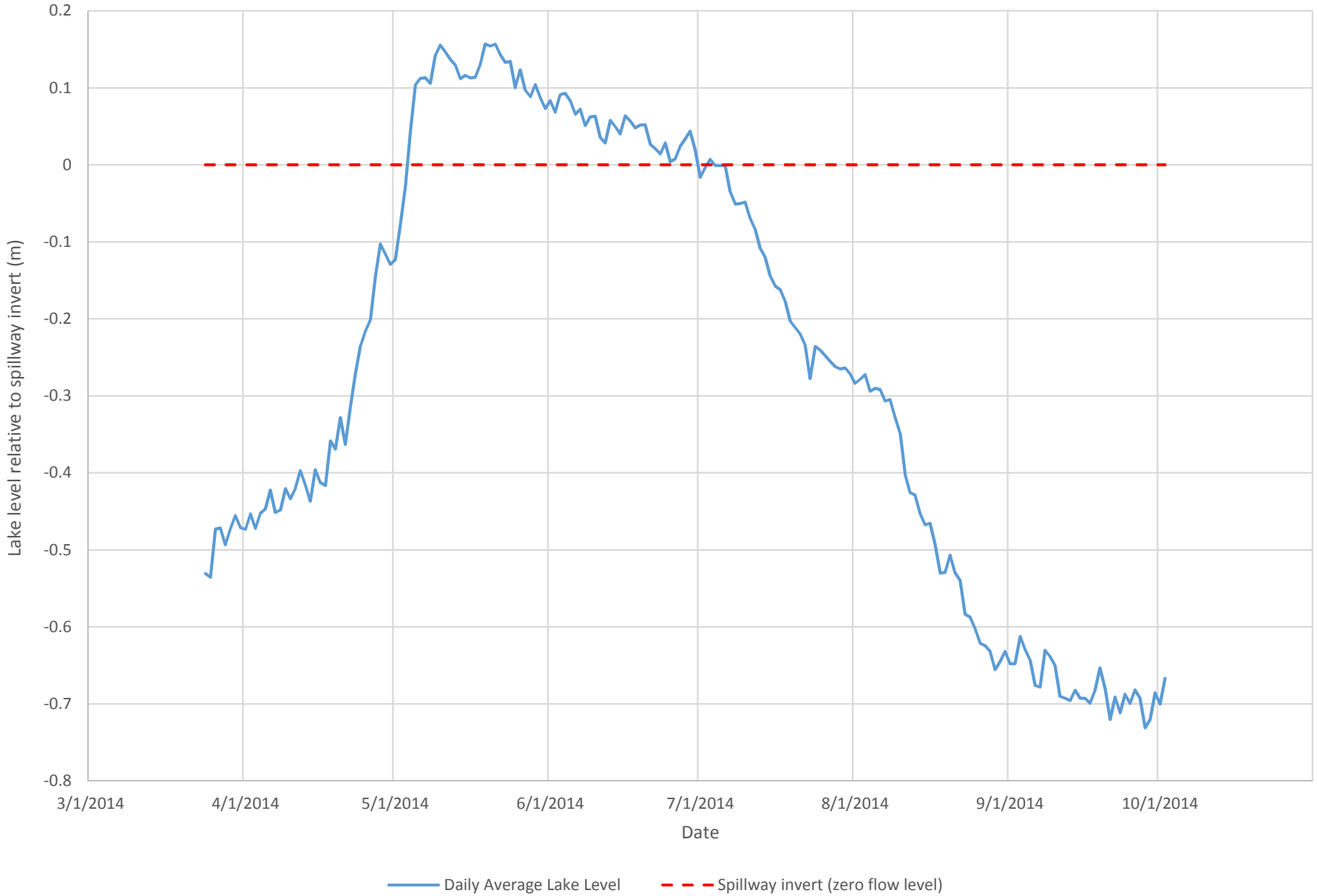


Figure 3-6. JACSEEP Rating Curve

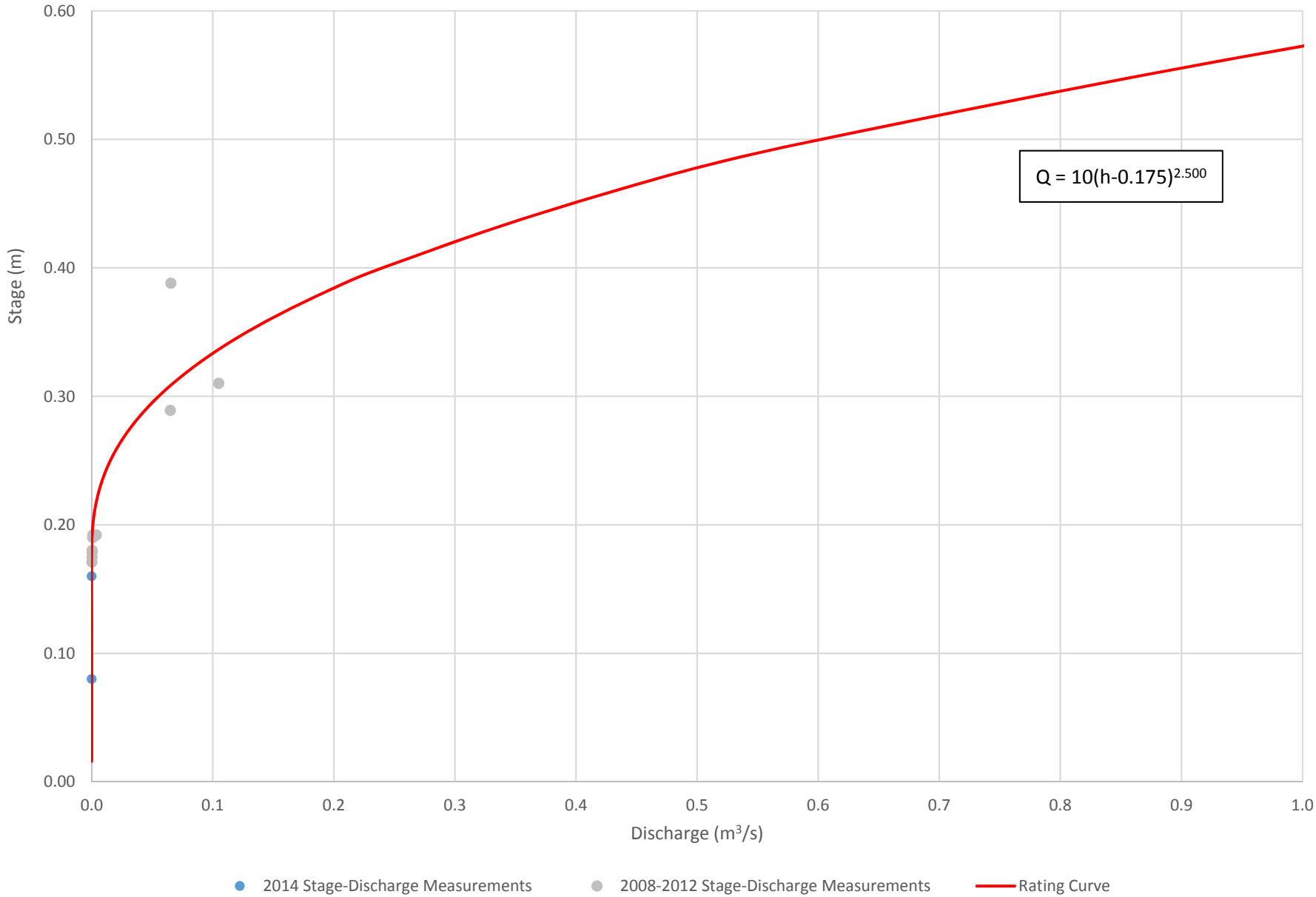


Figure 3-7. JACSEEP 2014 Daily Streamflow Hydrograph

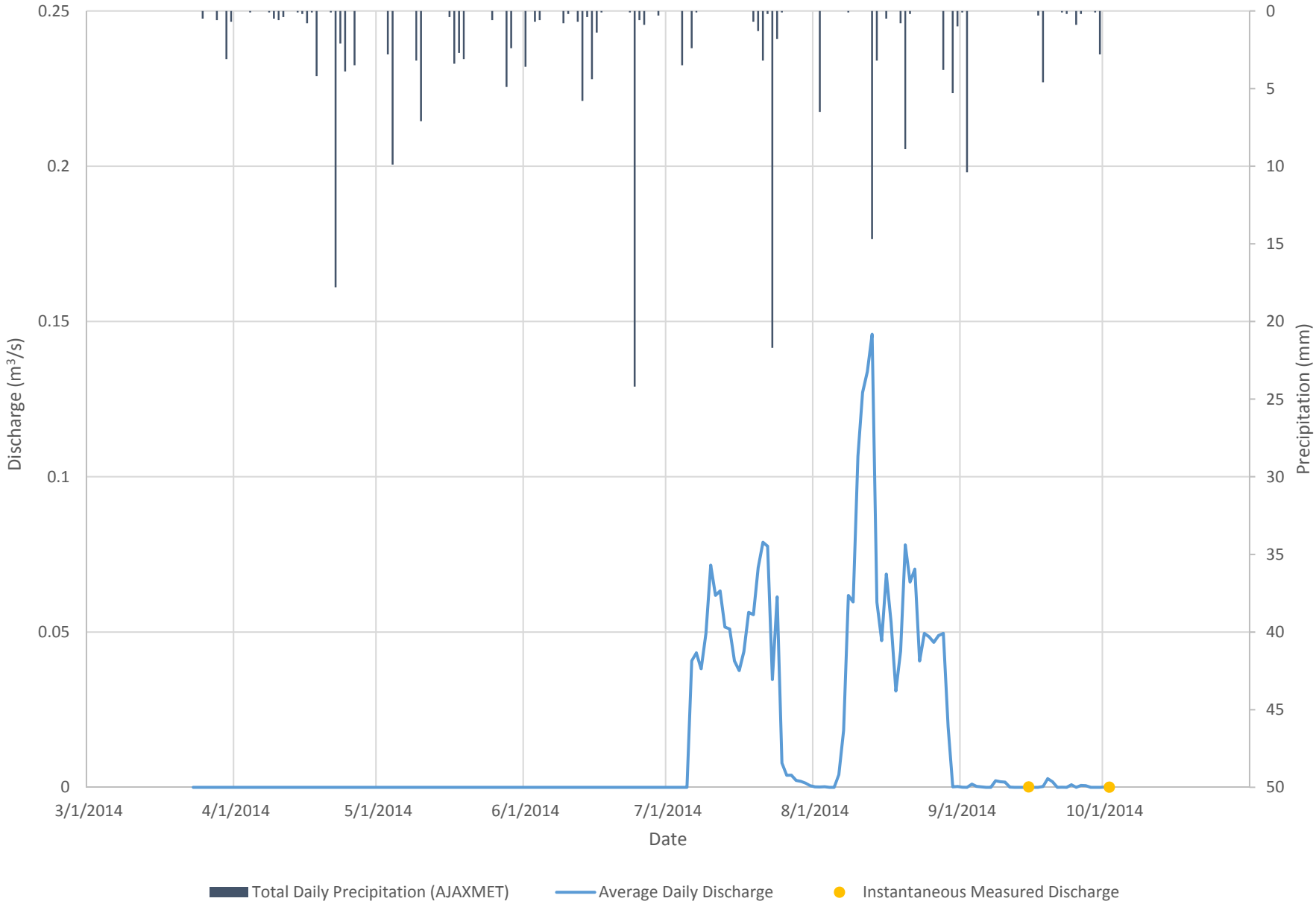


Figure 3-8. PETER Rating Curve

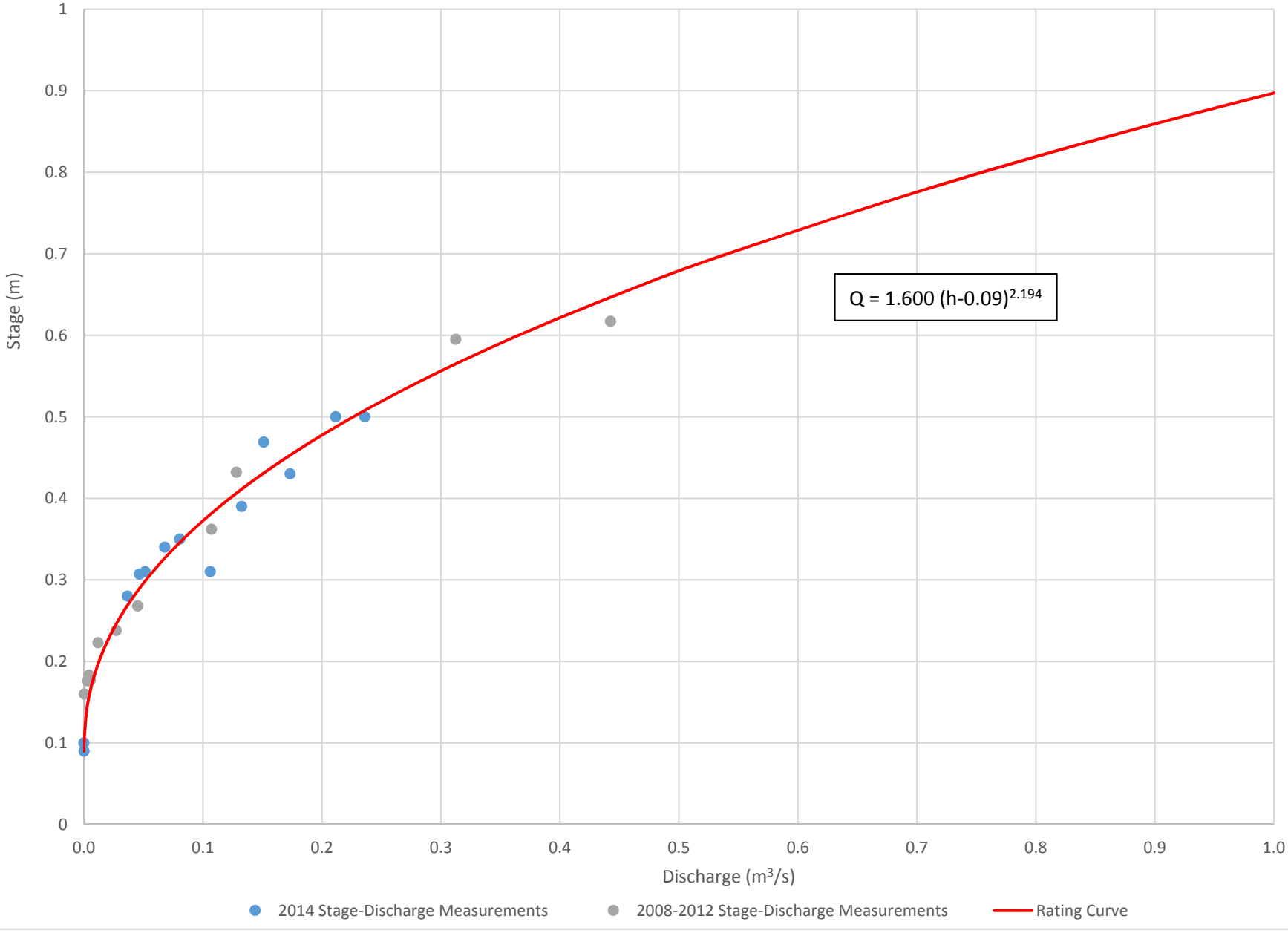


Figure 3-9. PETER 2014 Daily Streamflow Hydrograph

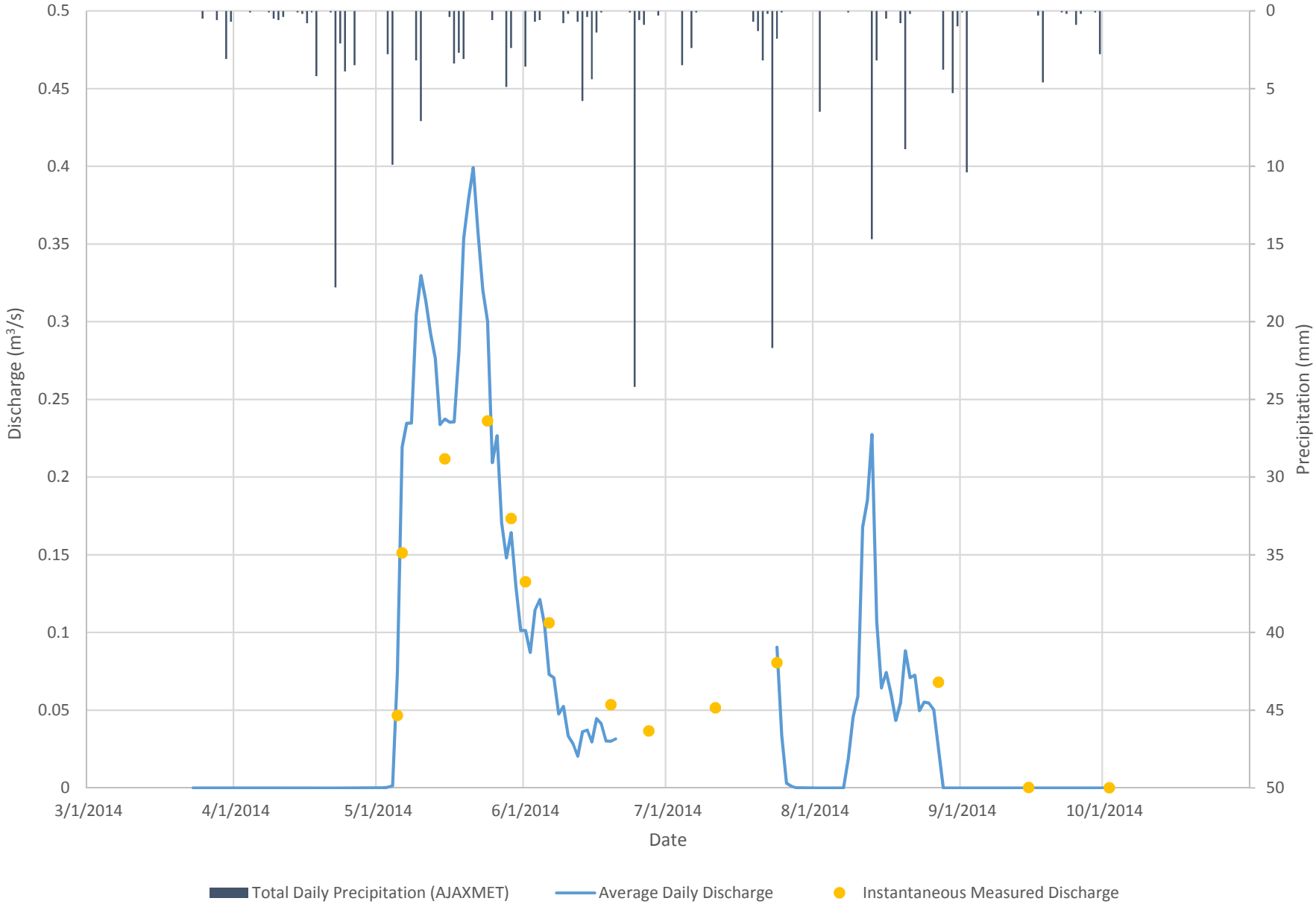


Figure 3-10. Comparison of JACLAKE, JACSEEP and PETER Hydrographs

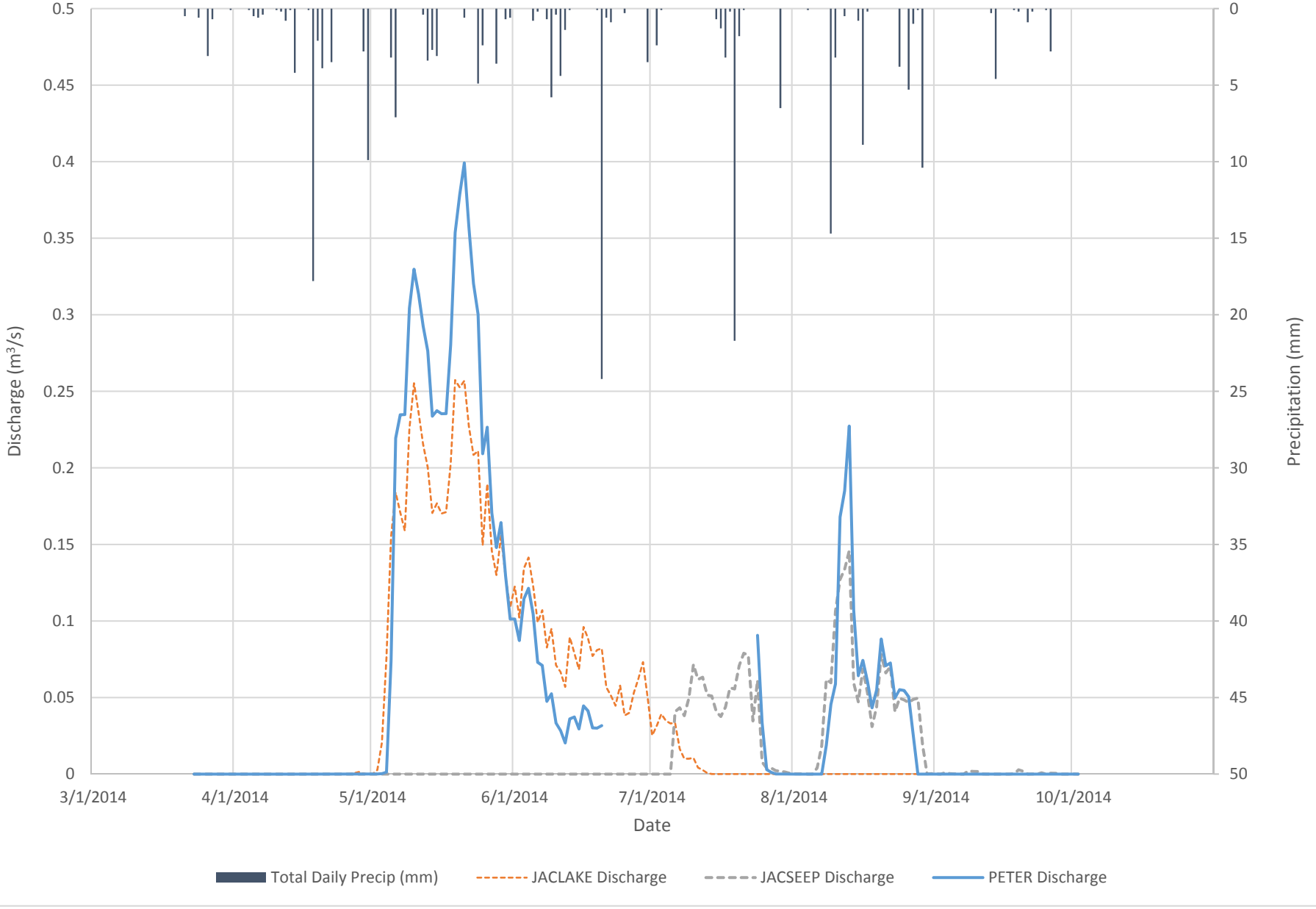


Figure 3-11. KEYNES Rating Curve

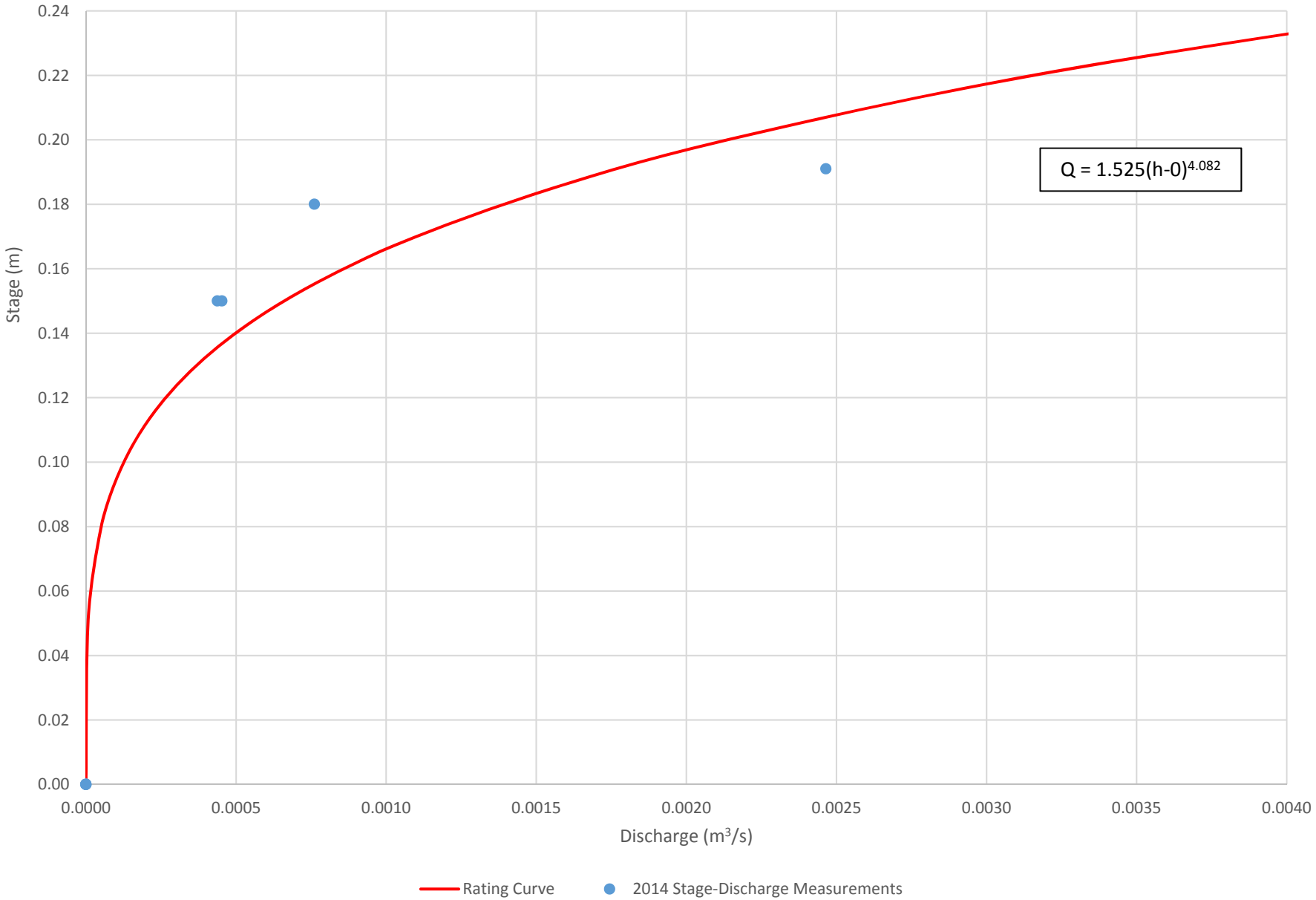
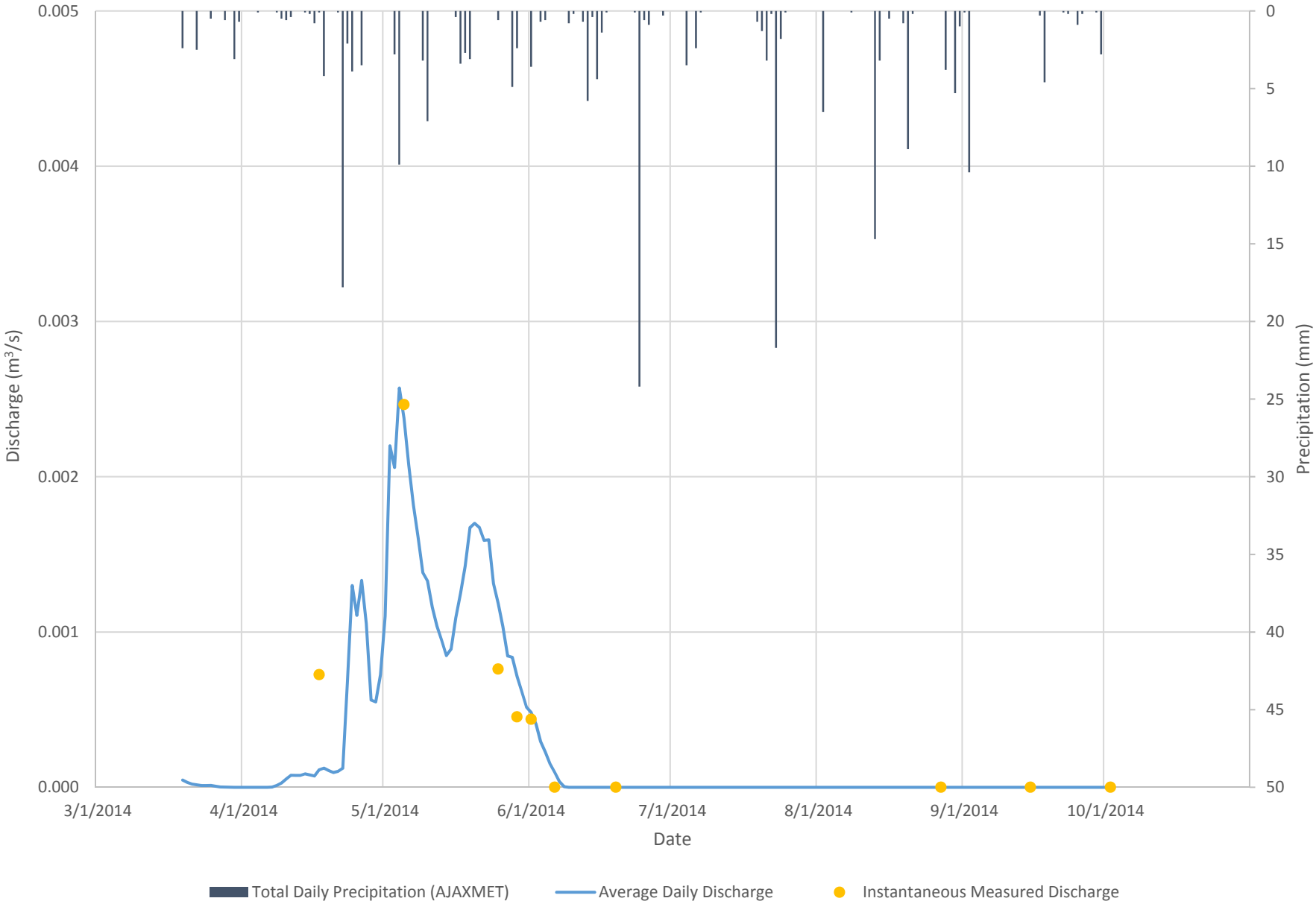
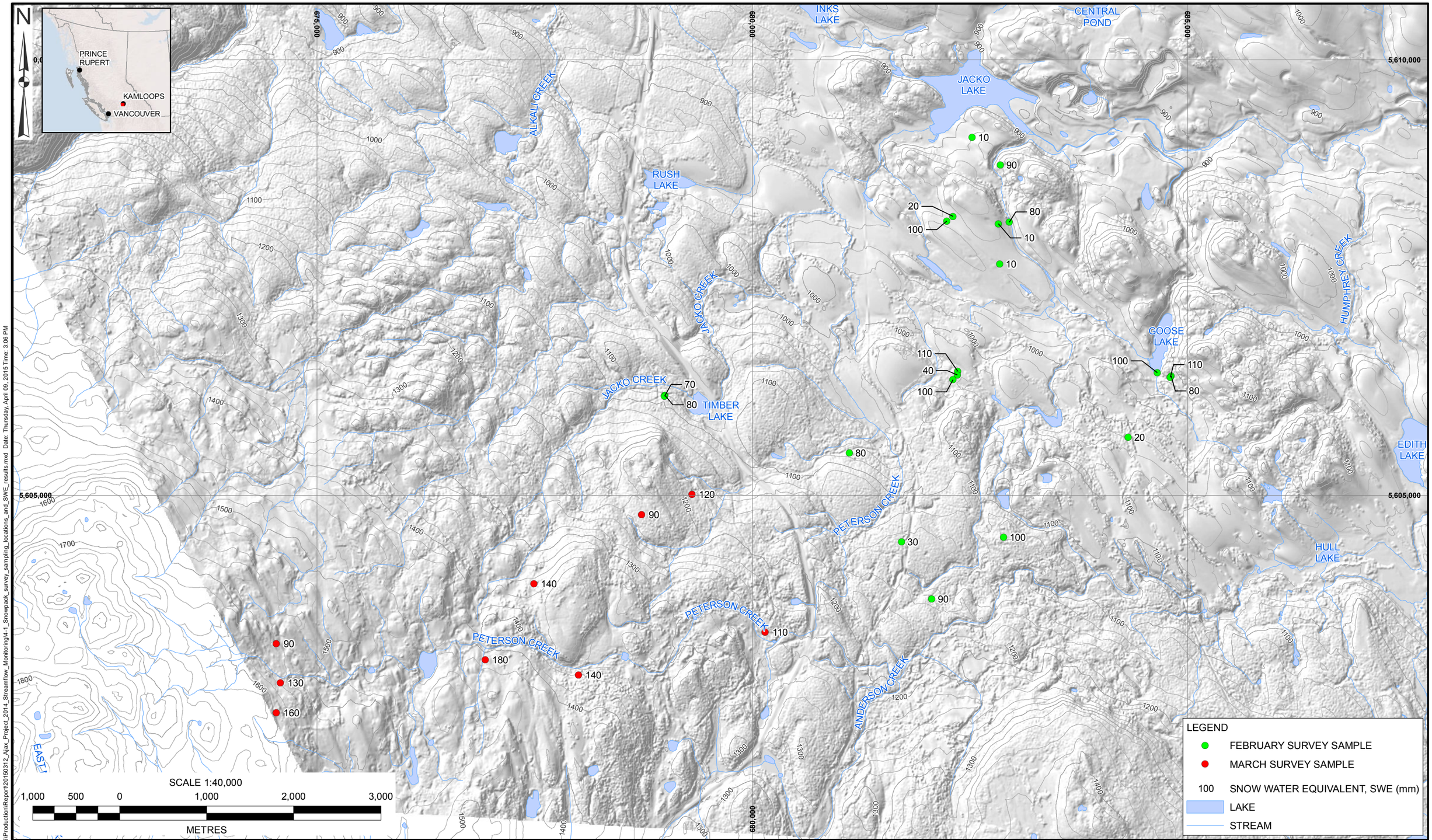


Figure 3-12. KEYNES 2014 Daily Streamflow Hydrograph





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TITLE
SNOWPACK SURVEY SAMPLING LOCATIONS AND SWE RESULTS

PROJECT No.	DWG No:
1125-007-03	4-1

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APPENDIX A
MANUAL STREAMFLOW MEASUREMENTS

Table A-1. Summary of Stage-Discharge Measurements for JACINF

Year	Date	Time	Discharge (m^3/s)	Staff Gauge (m)
2008	27-Apr-08	-	0.024	0.186
	28-Apr-08	-	0.036	0.205
	3-Jun-08	-	0.148	0.394
	9-Jun-08	-	0.142	0.378
	12-Jul-08	-	0.003	0.116
	6-Sep-08	-	0.000	0.032
2011	20-May-11	-	0.272	0.501
	2-Jun-11	-	0.337	0.533
	1-Sep-11	-	0.001	0.091
2012	11-May-12	-	0.184	0.404
2014	24-Mar-14	15:18	-	0.121
	5-May-14	14:00	0.394	0.535
	6-May-14	14:16	0.249	0.488
	15-May-14	8:40	0.280	0.440
	25-May-14	12:30	0.165	0.385
	29-May-14	14:07	0.132	0.340
	1-Jun-14	13:47	0.109	0.320
	6-Jun-14	12:11	0.080	0.280
	19-Jun-14	7:51	0.074	0.240
	27-Jun-14	8:44	0.036	0.200
	11-Jul-14	13:40	0.015	0.130
	24-Jul-14	14:56	0.020	0.160
	27-Aug-14	7:55	0.001	0.080
	15-Sep-14	11:10	0.000	0.080
	2-Oct-14	14:50	0.001	0.090

Table A-2. Summary of Stage-Discharge Measurements for JACLAKE

Year	Date	Time	Discharge (m^3/s)	Staff Gauge (m)
2008	2-Jun-08	-	0.077	0.351
	9-Jun-08	-	0.059	0.360
2011	20-May-11	-	0.397	0.431
	2-Jun-11	-	0.371	0.449
2014	24-Mar-14	16:00	-	-
	5-May-14	9:59	0.125	0.330
	6-May-14	9:30	0.179	0.365
	15-May-14	11:15	0.226	0.370
	25-May-14	13:59	0.103	-
	29-May-14	12:58	0.145	0.340
	1-Jun-14	12:36	0.127	0.315
	6-Jun-14	11:08	0.112	-
	19-Jun-14	9:46	0.065	0.260
	27-Jun-14	10:38	-	-
	11-Jul-14	15:07	0.000	0.125
	27-Aug-14	-	0.000	-
	15-Sep-14	9:53	0.000	-0.450
	2-Oct-14	11:40	0.000	-0.460

Table A-3. Summary of Stage-Discharge Measurements for JACSEEP

Year	Date	Time	Discharge (m^3/s)	Staff Gauge (m)
2008	25-Apr-08	9:05	0.000	0.180
	26-Apr-08	15:50	0.001	0.192
	27-Apr-08	11:45	0.000	0.175
	9-Jun-08	14:00	0.001	0.190
	12-Jul-08	12:15	0.105	0.310
	6-Sep-08	15:15	0.000	0.179
2010	31-May-10	13:15	0.065	0.289
2011	30-Mar-11	9:45	0.000	0.171
	29-Aug-11	14:38	0.065	0.388
2012	11-May-12	-	0.004	0.192
2014	23-Mar-14	18:00	-	0.186
	5-May-14	9:40	-	0.212
	6-May-14	9:04	-	0.210
	15-May-14	11:09	-	0.200
	24-May-14	13:42	-	0.210
	29-May-14	12:51	-	0.195
	1-Jun-14	12:38	-	0.200
	6-Jun-14	10:59	-	-
	19-Jun-14	10:06	-	-
	27-Jun-14	11:15	-	0.200
	11-Jul-14	15:08	-	0.290
	27-Aug-14	9:50	-	0.280
	15-Sep-14	9:55	0.000	0.160
	2-Oct-14	12:05	0.000	0.080

Table A-4. Summary of Stage-Discharge Measurements for PETER

Year	Date	Time	Discharge (m^3/s)	Staff Gauge (m)
2008	25-Apr-08	15:26	0.003	-
	28-Apr-08	13:15	0.004	-
	2-Jun-08	14:25	0.107	-
	9-Jun-08	10:00	0.045	-
	12-Jul-08	16:30	0.027	-
	18-Nov-08	9:00	0.000	-
2011	30-Mar-11	12:12	0.012	-
	19-May-11	14:00	0.313	-
	2-Jun-11	13:50	0.443	-
	30-Aug-11	14:17	0.128	-
2012	11-May-12	6:41	0.005	-
2014	23-Mar-14	18:00	-	0.186
	5-May-14	11:00	0.047	0.307
	6-May-14	11:04	0.151	0.469
	15-May-14	9:50	0.212	0.500
	24-May-14	16:00	0.236	0.500
	29-May-14	11:50	0.173	0.410
	1-Jun-14	10:16	0.133	0.390
	6-Jun-14	13:50	0.106	3.100
	19-Jun-14	11:33	0.053	-
	27-Jun-14	10:15	0.037	0.280
	11-Jul-14	14:32	0.052	0.310
	24-Jul-14	10:15	0.081	0.350
	27-Aug-14	8:57	0.068	0.340
	15-Sep-14	11:10	0.000	0.090
	2-Oct-14	11:40	0.000	0.100

Table A-5. Summary of Stage-Discharge Measurements for KEYNES

Year	Date	Time	Discharge (m^3/s)	Staff Gauge (m)
2014	19-Mar-14	16:13	-	-
	17-Apr-14	10:46	0.001	0.095
	5-May-14	12:17	0.002	0.191
	6-May-14	10:04	-	-
	15-May-14	8:40	-	0.160
	25-May-14	14:26	0.001	0.180
	29-May-14	13:17	0.000	0.150
	1-Jun-14	13:10	0.000	0.150
	6-Jun-14	11:39	-	-
	19-Jun-14	10:29	0.000	-
	27-Jun-14	9:41	0.000	0.000
	27-Aug-14	10:30	0.000	0.000
	15-Sep-14	9:40	0.000	0.000
	2-Oct-14	0:00	0.000	0.000

APPENDIX B
SITE PHOTOGRAPHS

Photo 1. JACINF hydrometric station on May 5, 2014. Note flow into the culvert.

Photo 2. Jacko Lake overflow spillway entrance on May 6, 2014.

Photo 3. Streamflow measurement at Jacko Lake overflow spillway on May 25, 2014. Note the new access road bridge in the background, downstream of the confluence of the overflow spillway and the low-flow seepage channel.

Photo 4. Jacko Lake red platform (spillway overflow control) staff gauge on May 29, 2014. The BGC monitoring station and staff gauge is located in the photo background at the edge of the lake.

Photo 5. JACLAKE monitoring station and BGC staff gauge at the edge of Jacko Lake on July 11, 2014.

Photo 6. JACSEEP hydrometric station and staff gauge on May 29, 2014.

Photo 7. Looking downstream from JACSEEP hydrometric station towards confluence with Jacko Lake overflow spillway and bridge on May 25, 2014.

Photo 8. Looking upstream from JACSEEP hydrometric station towards the Jacko Lake low-flow outlet on June 1, 2014. Backflow conditions in the overflow channel have flooded the v-notch weir at the station, which prevents manual discharge measurement. Note that the red platform from which the outflow is controlled is visible in the background at the edge of the lake.

Photo 9. PETER hydrometric station and staff gauge on May 15, 2014.

Photo 10. Steamflow gauging at Peterson Creek on May 15, 2014. This section is located downstream of the PETER monitoring station, on the other side of Goose Lake Rd.

Photo 11. KEYNES hydrometric station and staff gauge on May 25, 2014. Note the poorly defined channel and abundance of large woody debris and organic matter.

APPENDIX C
DAILY STREAMFLOWS

Table C-1. Estimated 2014 daily streamflows for all active hydrometric stations

Date	Discharge (m^3/s)				
	JACINF	JACLAKE	JACSEEP	PETER	KEYNES
3/19/2014	-	-	-	-	0.00005
3/20/2014	-	-	-	-	0.00003
3/21/2014	-	-	-	-	0.00002
3/22/2014	-	-	-	-	0.00002
3/23/2014	-	-	0.0000	0.000	0.00001
3/24/2014	0.003	0.000	0.0000	0.000	0.00001
3/25/2014	0.004	0.000	0.0000	0.000	0.00001
3/26/2014	0.015	0.000	0.0000	0.000	0.00001
3/27/2014	0.013	0.000	0.0000	0.000	0.00000
3/28/2014	0.009	0.000	0.0000	0.000	0.00000
3/29/2014	0.018	0.000	0.0000	0.000	0.00000
3/30/2014	0.026	0.000	0.0000	0.000	0.00000
3/31/2014	0.020	0.000	0.0000	0.000	0.00000
4/1/2014	0.017	0.000	0.0000	0.000	0.00000
4/2/2014	0.020	0.000	0.0000	0.000	0.00000
4/3/2014	0.012	0.000	0.0000	0.000	0.00000
4/4/2014	0.018	0.000	0.0000	0.000	0.00000
4/5/2014	0.019	0.000	0.0000	0.000	0.00000
4/6/2014	0.025	0.000	0.0000	0.000	0.00000
4/7/2014	0.017	0.000	0.0000	0.000	0.00000
4/8/2014	0.023	0.000	0.0000	0.000	0.00001
4/9/2014	0.041	0.000	0.0000	0.000	0.00003
4/10/2014	0.029	0.000	0.0000	0.000	0.00005
4/11/2014	0.028	0.000	0.0000	0.000	0.00008
4/12/2014	0.028	0.000	0.0000	0.000	0.00008
4/13/2014	0.023	0.000	0.0000	0.000	0.00008
4/14/2014	0.017	0.000	0.0000	0.000	0.00009
4/15/2014	0.026	0.000	0.0000	0.000	0.00008
4/16/2014	0.027	0.000	0.0000	0.000	0.00007
4/17/2014	0.038	0.000	0.0000	0.000	0.00011
4/18/2014	0.097	0.000	0.0000	0.000	0.00012
4/19/2014	0.083	0.000	0.0000	0.000	0.00011
4/20/2014	0.099	0.000	0.0000	0.000	0.00009

Date	Discharge (m^3/s)				
	JACINF	JACLAKE	JACSEEP	PETER	KEYNES
4/21/2014	0.068	0.000	0.0000	0.000	0.00010
4/22/2014	0.119	0.000	0.0000	0.000	0.00012
4/23/2014	0.149	0.000	0.0000	0.000	0.00068
4/24/2014	0.146	0.000	0.0000	0.000	0.00130
4/25/2014	0.130	0.000	0.0000	0.000	0.00111
4/26/2014	0.126	0.000	0.0000	0.000	0.00133
4/27/2014	0.150	0.001	0.0000	0.000	0.00105
4/28/2014	0.151	0.001	0.0000	0.000	0.00056
4/29/2014	0.122	0.000	0.0000	0.000	0.00055
4/30/2014	0.103	0.000	0.0000	0.000	0.00073
5/1/2014	0.127	0.000	0.0000	0.000	0.00110
5/2/2014	0.192	0.003	0.0000	0.000	0.00220
5/3/2014	0.303	0.021	0.0000	0.000	0.00206
5/4/2014	0.414	0.077	0.0000	0.001	0.00257
5/5/2014	0.376	0.155	0.0000	0.074	0.00238
5/6/2014	0.288	0.184	0.0000	0.219	0.00207
5/7/2014	0.236	0.171	0.0000	0.235	0.00182
5/8/2014	0.187	0.159	0.0000	0.235	0.00161
5/9/2014	0.215	0.226	0.0000	0.304	0.00138
5/10/2014	0.224	0.255	0.0000	0.330	0.00133
5/11/2014	0.250	0.236	0.0000	0.313	0.00116
5/12/2014	0.226	0.215	0.0000	0.293	0.00104
5/13/2014	0.206	0.200	0.0000	0.276	0.00095
5/14/2014	0.210	0.171	0.0000	0.234	0.00085
5/15/2014	0.191	0.177	0.0000	0.237	0.00089
5/16/2014	0.179	0.170	0.0000	0.235	0.00109
5/17/2014	0.193	0.171	0.0000	0.235	0.00125
5/18/2014	0.255	0.203	0.0000	0.280	0.00143
5/19/2014	0.299	0.257	0.0000	0.354	0.00167
5/20/2014	0.324	0.253	0.0000	0.379	0.00170
5/21/2014	0.266	0.257	0.0000	0.399	0.00167
5/22/2014	0.219	0.227	0.0000	0.357	0.00159
5/23/2014	0.181	0.208	0.0000	0.320	0.00159
5/24/2014	0.176	0.211	0.0000	0.300	0.00131

Date	Discharge (m^3/s)				
	JACINF	JACLAKE	JACSEEP	PETER	KEYNES
5/25/2014	0.145	0.149	0.0000	0.209	0.00118
5/26/2014	0.160	0.190	0.0000	0.227	0.00103
5/27/2014	0.105	0.146	0.0000	0.171	0.00085
5/28/2014	0.097	0.130	0.0000	0.148	0.00084
5/29/2014	0.123	0.156	0.0000	0.164	0.00071
5/30/2014	0.101	0.129	0.0000	0.129	0.00062
5/31/2014	0.090	0.109	0.0000	0.101	0.00052
6/1/2014	0.121	0.122	0.0000	0.101	0.00048
6/2/2014	0.125	0.102	0.0000	0.087	0.00041
6/3/2014	0.130	0.134	0.0000	0.114	0.00029
6/4/2014	0.123	0.141	0.0000	0.121	0.00023
6/5/2014	0.106	0.123	0.0000	0.105	0.00015
6/6/2014	0.079	0.099	0.0000	0.073	0.00009
6/7/2014	0.080	0.107	0.0000	0.071	0.00004
6/8/2014	0.064	0.083	0.0000	0.048	0.00000
6/9/2014	0.064	0.095	0.0000	0.052	0.00000
6/10/2014	0.046	0.071	0.0000	0.033	0.00000
6/11/2014	0.044	0.067	0.0000	0.028	0.00000
6/12/2014	0.045	0.057	0.0000	0.020	0.00000
6/13/2014	0.063	0.089	0.0000	0.036	0.00000
6/14/2014	0.059	0.079	0.0000	0.037	0.00000
6/15/2014	0.049	0.068	0.0000	0.029	0.00000
6/16/2014	0.077	0.096	0.0000	0.045	0.00000
6/17/2014	0.075	0.089	0.0000	0.041	0.00000
6/18/2014	0.058	0.077	0.0000	0.030	0.00000
6/19/2014	0.054	0.081	0.0000	0.030	0.00000
6/20/2014	-	0.082	0.0000	0.032	0.00000
6/21/2014	-	0.057	0.0000	-	0.00000
6/22/2014	-	0.051	0.0000	-	0.00000
6/23/2014	-	0.045	0.0000	-	0.00000
6/24/2014	-	0.058	0.0000	-	0.00000
6/25/2014	-	0.038	0.0000	-	0.00000
6/26/2014	-	0.040	0.0000	-	0.00000
6/27/2014	-	0.053	0.0000	-	0.00000

Date	Discharge (m^3/s)				
	JACINF	JACLAKE	JACSEEP	PETER	KEYNES
6/28/2014	-	0.062	0.0000	-	0.00000
6/29/2014	-	0.073	0.0000	-	0.00000
6/30/2014	-	0.050	0.0000	-	0.00000
7/1/2014	-	0.025	0.0000	-	0.00000
7/2/2014	-	0.032	0.0000	-	0.00000
7/3/2014	-	0.039	0.0000	-	0.00000
7/4/2014	-	0.035	0.0000	-	0.00000
7/5/2014	-	0.033	0.0000	-	0.00000
7/6/2014	-	0.033	0.0407	-	0.00000
7/7/2014	-	0.017	0.0433	-	0.00000
7/8/2014	-	0.010	0.0382	-	0.00000
7/9/2014	-	0.010	0.0496	-	0.00000
7/10/2014	-	0.011	0.0715	-	0.00000
7/11/2014	-	0.004	0.0618	-	0.00000
7/12/2014	-	0.003	0.0632	-	0.00000
7/13/2014	-	0.001	0.0516	-	0.00000
7/14/2014	-	0.000	0.0510	-	0.00000
7/15/2014	-	0.000	0.0407	-	0.00000
7/16/2014	-	0.000	0.0376	-	0.00000
7/17/2014	-	0.000	0.0437	-	0.00000
7/18/2014	-	0.000	0.0563	-	0.00000
7/19/2014	-	0.000	0.0556	-	0.00000
7/20/2014	-	0.000	0.0708	-	0.00000
7/21/2014	-	0.000	0.0789	-	0.00000
7/22/2014	-	0.000	0.0776	-	0.00000
7/23/2014	-	0.000	0.0347	-	0.00000
7/24/2014	0.024	0.000	0.0613	0.091	0.00000
7/25/2014	0.019	0.000	0.0078	0.034	0.00000
7/26/2014	0.014	0.000	0.0039	0.003	0.00000
7/27/2014	0.012	0.000	0.0039	0.001	0.00000
7/28/2014	0.009	0.000	0.0023	0.000	0.00000
7/29/2014	0.009	0.000	0.0020	0.000	0.00000
7/30/2014	0.014	0.000	0.0015	0.000	0.00000
7/31/2014	0.007	0.000	0.0007	0.000	0.00000

Date	Discharge (m^3/s)				
	JACINF	JACLAKE	JACSEEP	PETER	KEYNES
8/1/2014	0.005	0.000	0.0004	0.000	0.00000
8/2/2014	0.006	0.000	0.0004	0.000	0.00000
8/3/2014	0.008	0.000	0.0004	0.000	0.00000
8/4/2014	0.003	0.000	0.0002	0.000	0.00000
8/5/2014	0.004	0.000	0.0002	0.000	0.00000
8/6/2014	0.005	0.000	0.0043	0.000	0.00000
8/7/2014	0.004	0.000	0.0183	0.000	0.00000
8/8/2014	0.006	0.000	0.0618	0.019	0.00000
8/9/2014	0.005	0.000	0.0597	0.045	0.00000
8/10/2014	0.005	0.000	0.1066	0.059	0.00000
8/11/2014	0.003	0.000	0.1271	0.168	0.00000
8/12/2014	0.003	0.000	0.1338	0.185	0.00000
8/13/2014	0.006	0.000	0.1459	0.227	0.00000
8/14/2014	0.007	0.000	0.0596	0.107	0.00000
8/15/2014	0.007	0.000	0.0472	0.064	0.00000
8/16/2014	0.006	0.000	0.0687	0.074	0.00000
8/17/2014	0.005	0.000	0.0531	0.061	0.00000
8/18/2014	0.002	0.000	0.0310	0.043	0.00000
8/19/2014	0.003	0.000	0.0439	0.055	0.00000
8/20/2014	0.011	0.000	0.0781	0.088	0.00000
8/21/2014	0.007	0.000	0.0661	0.071	0.00000
8/22/2014	0.007	0.000	0.0703	0.073	0.00000
8/23/2014	0.003	0.000	0.0407	0.050	0.00000
8/24/2014	0.004	0.000	0.0496	0.055	0.00000
8/25/2014	0.004	0.000	0.0485	0.055	0.00000
8/26/2014	0.004	0.000	0.0467	0.050	0.00000
8/27/2014	0.004	0.000	0.0489	0.025	0.00000
8/28/2014	0.005	0.000	0.0496	0.000	0.00000
8/29/2014	0.003	0.000	0.0196	0.000	0.00000
8/30/2014	0.005	0.000	0.0004	0.000	0.00000
8/31/2014	0.007	0.000	0.0005	0.000	0.00000
9/1/2014	0.004	0.000	0.0003	0.000	0.00000
9/2/2014	0.008	0.000	0.0003	0.000	0.00000
9/3/2014	0.011	0.000	0.0012	0.000	0.00000

Date	Discharge (m^3/s)				
	JACINF	JACLAKE	JACSEEP	PETER	KEYNES
9/4/2014	0.007	0.000	0.0005	0.000	0.00000
9/5/2014	0.005	0.000	0.0004	0.000	0.00000
9/6/2014	0.002	0.000	0.0002	0.000	0.00000
9/7/2014	0.002	0.000	0.0002	0.000	0.00000
9/8/2014	0.008	0.000	0.0023	0.000	0.00000
9/9/2014	0.007	0.000	0.0019	0.000	0.00000
9/10/2014	0.006	0.000	0.0018	0.000	0.00000
9/11/2014	0.003	0.000	0.0002	0.000	0.00000
9/12/2014	0.002	0.000	0.0002	0.000	0.00000
9/13/2014	0.002	0.000	0.0002	0.000	0.00000
9/14/2014	0.004	0.000	0.0003	0.000	0.00000
9/15/2014	0.003	0.000	0.0003	0.000	0.00000
9/16/2014	0.003	0.000	0.0003	0.000	0.00000
9/17/2014	0.003	0.000	0.0003	0.000	0.00000
9/18/2014	0.005	0.000	0.0005	0.000	0.00000
9/19/2014	0.010	0.000	0.0029	0.000	0.00000
9/20/2014	0.006	0.000	0.0019	0.000	0.00000
9/21/2014	0.002	0.000	0.0002	0.000	0.00000
9/22/2014	0.004	0.000	0.0004	0.000	0.00000
9/23/2014	0.002	0.000	0.0003	0.000	0.00000
9/24/2014	0.006	0.000	0.0010	0.000	0.00000
9/25/2014	0.004	0.000	0.0003	0.000	0.00000
9/26/2014	0.007	0.000	0.0008	0.000	0.00000
9/27/2014	0.006	0.000	0.0007	0.000	0.00000
9/28/2014	0.002	0.000	0.0002	0.000	0.00000
9/29/2014	0.003	0.000	0.0001	0.000	0.00000
9/30/2014	0.007	0.000	0.0002	0.000	0.00000
10/1/2014	0.006	0.000	0.0002	0.000	0.00000
10/2/2014	0.010	0.000	0.0002	0.000	0.00000