Cheakamus Project Water Use Plan

Cheakamus River Channel Morphology Monitoring

Implementation Year 6

Reference: CMSMON-8

Annual Progress Report

Study Period: 2013-2014

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Executive Summary

The Fisheries Technical Committee developed a comprehensive monitoring plan for the Cheakamus River to address critical points of scientific uncertainty and disagreement within the Consultative Committee, and to better inform the next Water Use Plan. CMSMON8 deals with questions related to channel morphology and tributary flows.

BC Hydro's Terms of Reference for CMSMON8 identify the following three management questions, which the Cheakamus River monitoring program is intended to answer:

1. Following implementation of the WUP, has there been a change in the overall availability of suitable fish spawning substrates from the present state? If so, can this change be clearly attributed to Daisy Lake Dam operations vs. other environmental or anthropogenic factor?
2. Following implementation of the WUP, has there been a change in the overall length, access and utility for fish of naturally occurring side channels from the present state? If so, can this change be clearly attributed to Daisy Lake Dam operations vs. other environmental or anthropogenic factors?
3. To what extent does the hydrology of Rubble Creek, Culliton Creek, and Swift Creek contribute to the general hydrology of lower Cheakamus River and how does it attenuate the effects of Daisy lake dam operations.

This report summarizes work conducted in Year 6 of CMSMON8: Years 1 through 5 were conducted by a previous monitor.

The following work has been accomplished on CMSMON8 during Year 6:

- A total of 17 separate discharge measurements were conducted at three different hydrometric stations located in the reach between Daisy Lake dam and Brackendale (two stations on Cheakamus River and one on Culliton Creek).
- A new water level sensor and associated benchmarks have been installed at a location upstream of the existing Cheakamus River Pedestrian Bridge water level sensor (New "Pedestrian Bridge") to attempt to address on-going channel instability issues at the existing station.
- Three new rating curves have been developed based on the Year 6 stage-discharge data.
- Discharges have been estimated for all stations based on the adopted rating curves.

Future work on CMSMON8 will address the Management Questions, including:

- Review and analysis of the Year 1 to Year 5 hydrometric data with the goal of addressing Management Question 3. This will include evaluating the degree to which the additional hydrometric data (from the Chance Creek FSR, Pedestrian Bridge and Culliton Creek sites) assist in answering the Management Question.
- Revising the originally-proposed scope of work to better address Management Questions 1 and 2, which will involve consultation with other Cheakamus River monitors as well as with BC Hydro.

1. Introduction and Background

1.1 Introduction

Kerr Wood Leidal Associates Ltd. (KWL) has been retained by BC Hydro (BCH) to conduct monitoring work for CMSMON8: Cheakamus River Channel Morphology Monitoring. 2013-2014 is the first year that KWL has been involved in CMSMON8, which was awarded in August 2013. 2013-2014 is Year 6 of CMSMON8.

This report documents the work performed in Year 6 of CMSMON8.

1.2 Background

1.2.1 Cheakamus River WUP

The Cheakamus River Water Use Plan (WUP) was accepted by the Comptroller of Water Rights, and implemented in February 2006. The Cheakamus Consultative Committee (CC) has agreed on six fundamental objectives for the Cheakamus Water Use Plan (in no particular order):

1. **Power:** Maximise economic returns from power generated at Cheakamus Generating System;
2. **First Nations:** Protect integrity of Squamish First Nation's heritage sites and cultural values;
3. **Recreation:** Maximise physical conditions for recreation;
4. **Flooding:** Minimise adverse effects of flood events through operation of the Cheakamus Generating system;
5. **Fish:** Maximise wild fish populations; and
6. **Aquatic Ecosystem:** Maximise area and integrity of the aquatic and riparian ecosystem.

1.2.2 Cheakamus River Monitoring Program

The Fisheries Technical Committee developed a comprehensive monitoring plan for the Cheakamus River to address critical points of scientific uncertainty and disagreement within the CC, and to better inform the next WUP. The CC recognised that it is essential to address critical scientific uncertainties that can affect future decision making, and to comprehensively assess the response of the system to operation of the Cheakamus Generating System.

The monitoring plan contains nine elements in total: the current proposal addresses one element of the monitoring plan dealing with channel morphology and tributary flows (CMSMON8).

1.2.3 Management Questions for CMSMON8

BC Hydro's Terms of Reference for CMSMON8 identify the following three management questions, which the Cheakamus River monitoring program is designed to answer:

1. **Following implementation of the WUP, has there been a change in the overall availability of suitable fish spawning substrates from the present state? If so, can this change be clearly attributed to Daisy Lake Dam operations vs. other environmental or anthropogenic factor?**

2. **Following implementation of the WUP, has there been a change in the overall length, access and utility for fish of naturally occurring side channels from the present state? If so, can this change be clearly attributed to Daisy Lake Dam operations vs. other environmental or anthropogenic factors?**
3. **To what extent does the hydrology of Rubble Creek, Culliton Creek, and Swift Creek contribute to the general hydrology of lower Cheakamus River and how does it attenuate the effects of Daisy Lake Dam operations.**

Impact Hypotheses

As identified in the Terms of Reference, the Management Questions lend themselves to impact hypotheses, which will be tested based on the results of the monitoring program. Specific impact hypotheses outlined in the Terms are summarized in the following table.

Table 1-1: CMSMON8 Impact Hypotheses

Number	Hypothesis
H_o1	Total area of accessible substrate suitable for salmonid spawning has not changed since implementation of the WUP.
H_o2	Total length of connected side channel habitat wetted at typical flows has not changed since implementation of the WUP.
H_o3	The diversity of side channel habitat, as measured by the number and ratio of pool, run, and riffle habitats, has not changed since implementation of the WUP.

1.2.4 Results of First Monitor (2007-2012)

The Cheakamus River monitoring program has completed one 5-year cycle already, as follows:

- **Year 1 (2007-2008)**: "Post-WUP", Morphological Monitoring and Hydrometric Monitoring;
- **Year 2 (2008-2009)**: "Post-WUP", Hydrometric Monitoring;
- **Year 3 (2009-2010)**: "Post-WUP", Hydrometric Monitoring;
- **Year 4 (2010-2011)**: "Post-WUP", Hydrometric Monitoring; and
- **Year 5 (2011-2012)**: "Post-WUP", Hydrometric Monitoring and Hydrometric Monitoring.

Based on BC Hydro's Terms of Reference, 2006 is identified as the only "pre-WUP" year but it is our understanding that the earliest morphological mapping is 2008, with follow-up mapping conducted in 2012.

Draft reports for the first CMSMON8 (2007-2012) for Years 1, 2, and 5 were provided by BC Hydro and reviewed for this proposal.

Based on the Year 5 morphology report, the following summary points may be made:

- wetted channel is the most common habitat type, by area, and the fraction of wetted channel did not change between 2008 and 2012 mapping;
- bare gravel bars became increasingly vegetated, and the increase in areas of young vegetation was statistically significant;
- wetted habitat areas (e.g., pools, riffles, rapids) showed changes between 2008 and 2012, but not above the level of statistical significance;

- to date, there has been no specific monitoring of changes to substrate size in the wetted channel or on individual bars;
- there was no change in the number, average area or areal variance of dry side channels. A decrease in the area of wetted side channels was noted, but was not statistically significant; and
- side channel habitat classification changes depending on the flow at which it is evaluated.

Based on the Year 5 hydrometric report, the following summary points may be made:

- Three stations have been monitored to provide estimates of discharge:
  1. Cheakamus River at the Chance Creek Forest Service Road (Cheakamus FSR);
  2. Cheakamus River at the Pedestrian Bridge; and
  3. Culliton Creek at the Jack Webster Bridge Crossing.
- Rubble Creek flow is estimated by subtracting Daisy Creek flow releases from Cheakamus FSR flows. Culliton Creek flow is measured directly.
- Rating curve shifts are problematic at the Cheakamus River Pedestrian Bridge station, and somewhat less so at the other two stations.
- Flow measurements conditions are challenging, requiring a variety of approaches to obtain accurate measurements.

The Year 5 hydrometric report did not address the tributary flow management question.

1.3 Current Monitor: Year 6

As proposed by KWL, the Year 6 work program for CMSMON8 included the following main tasks:

- Project Initiation,
- Hydrometric Program, and
- Annual Reporting.

Subsequent years of the monitor will address the monitoring to address Management Questions #1 and #2.

Management Question #3 is being addressed by a separate analysis of the 2008 to 2012 hydrometric data: this time period is preferred for the analysis, compared to more recent monitoring data, since the Water Survey of Canada hydrometric data have been reviewed for quality-assurance and are no longer provisional and subject to change.

2. Year 6 Hydrometric Work

Year 6 hydrometric work continued at the three stations established in Years 1-5 of CMSMON8 (Figure 2-1):

1. Cheakamus River at Chance Creek Forest Service Road (FSR);
2. Cheakamus River at the Pedestrian Bridge; and
3. Culliton Creek.

The installation and operation of these hydrometric stations has been documented in previous annual reports prepared for CMSMON8.

Based on the findings of the previous monitor, the Pedestrian Bridge site is subject to frequent bed adjustment, which leads to instability in the rating curve. For the current monitor, KWL has added an additional water level sensor at a location upstream of the Pedestrian Bridge (see Figure 2-1) in an effort to locate a more stable section of the channel for the rating curve. This site has been named the New "Pedestrian Bridge" site.

Details of the Year 6 (2013-2014) hydrometric work at each of these hydrometric stations are provided below.

2.1 Cheakamus River at Chance Creek FSR

2.1.1 Field Measurements

Five discharge measurements were collected in Year 6 at the Cheakamus River at Chance Creek FSR station. This station is located at the FSR crossing of Cheakamus River, a short distance downstream of the Daisy Lake dam (Figure 2-1).

Due to the generally high water depth and flow velocity, wading is impractical at this location. KWL used a SonTek M9 Acoustic Doppler Current Meter (ADCP) mounted on a small, floating 'raft' to collect flow measurements. The ADCP is towed across the channel, collecting profiles of velocity and depth at a regular interval, as well as GPS position data. These data are then converted into estimated discharge using proprietary post-processing software.

KWL determined that the most reliable and safe cross section for ADCP discharge measurements is at a constriction approximately 300 m downstream of the bridge (see Photo 1, below).

Stage was measured by direct measurement from the existing benchmark (located on the right-bank FSR bridge abutment) to the water surface.

Photo 1: Discharge Measurement Cross-section at Cheakamus River Chance Creek FSR (Photo taken 2014-02-26)

Table 2-1 summarizes all flow measurements taken at the site in the Year 6 monitoring period (2013-2014).

Table 2-1: Cheakamus River at Chance Creek FSR Stage and Discharge Measurements

Date	Stage (m)	Discharge (m^3/s)	Discharge Measurement Method
Nov 11, 2013	0.99	8.79	ADCP
Feb 26, 2014	1.10	13.62	ADCP
May 21, 2014	1.73	36.07	ADCP
May 22, 2014	1.64	31.98	ADCP
Jul 30, 2014	1.64	34.55	ADCP

2.1.2 Rating Curve

The stage-discharge data points collected in Year 6 were reviewed against stage-discharge data collected in Years 1 through 5 of CMSMON8. According to the previous monitor, the rating curve for this hydrometric station has been stable.

Based on the comparison of the Year 6 data points with previous points, it appears that there has been a modest channel adjustment and that a new rating curve would be justified to better reflect the Year 6 data. The overall form of the stage-discharge points remains the same, however.

A power-law curve was fit to the Year 6 data using the method of maximum likelihood. The curve is fit considering the estimated uncertainty of both stage and discharge measurements.

The new stage-discharge equation for Year 6 is:

$$\textbf{Discharge=13.66*(Stage-0.14)}^{2.19}$$

Figure A-1 in Appendix A shows the Chance Creek stage-discharge relationship and recommended upper limit of applicability.

2.1.3 Preliminary Discharge Data

Figure B-1 in Appendix B presents the discharge time series based on the available water level data downloaded during the Year 6 period.

It should be noted that the CMSMON8 project was awarded in August 2013 but the previous monitor had ceased downloading water level data in December 2012. The dataloggers installed at each hydrometric station have a finite memory and data must be downloaded periodically or it will automatically be overwritten. As a result of the time gap between monitors, the Year 6 data begins in June 2013, which is the earliest data that was available at the time of the first download following project award.

As presented in Appendix B, the Cheakamus River Chance Creek FSR water level data available at the time of writing this report cover the period June 3, 2013 to July 30, 2014. No significant losses of data occurred in the Year 6 monitoring year.

As indicated in Figure B-1, flow at the Chance Creek station exceeded the recommended upper limit of applicability of the stage-discharge relationship 5 times during the Year 6 monitoring program. The majority of these exceedances were brief; however, on June 27, 2013 the limit was exceeded for 7.5 days.

2.2 Cheakamus River at Pedestrian Bridge

2.2.1 Field Measurements

Pedestrian Bridge

Seven flow measurements were collected at the Cheakamus River at Pedestrian Bridge station during CMSMON8 Year 6. The station is located about midway between Daisy Lake dam and the Water Survey of Canada station near Brackendale (Figure 2-1).

All flow measurements were collected using a SonTek M9 ADCP. Measurements from January 18, 2014 to May 21, 2014 were collected just upstream of the Pedestrian Bridge. However, during a higher flow event KWL noted that standing waves began affecting the quality of the discharge measurement at this location. On May 22, a new cross-section was established for discharge measurements, located about 400 m downstream of the bridge. The downstream location provides much better GPS signal and had no significant standing waves in the range of flows measured. This location was used for all subsequent discharge measurements.

Stage was measured either by direct measurement of the benchmark to water surface distance or by level survey (lower flows require a level survey).

Photo 2: Original Cheakamus River Pedestrian Bridge Discharge Measurement Cross-section (Photo taken May 21, 2014).

Photo 3: Re-located Cheakamus River Pedestrian Bridge Discharge Measurement Cross-section (About 400 m Downstream of Photo 2) (Photo taken May 22, 2014).

New "Pedestrian Bridge"

As mentioned earlier, the previous monitor noted that the Pedestrian Bridge station was subject to frequent channel adjustment leading to a need to update the rating curve regularly. Channel adjustment affects the stage that is associated with a given discharge: ideally, stage (water level) would remain constant over time as a result of a stable bed and channel geometry.

As part of the Year 6 work, KWL installed a new water level sensor (and associated benchmarks) upstream of the existing Pedestrian Bridge water level sensor. The new "Pedestrian Bridge" water level sensor is located about 1.5 km upstream of the bridge. Based on a review of historical imagery, there have not been significant gravel bars at this location of the channel and therefore KWL is optimistic that the bed may be more stable, leading to less frequent rating curve revisions. There are no significant inflows between the Pedestrian Bridge station and the New "Pedestrian Bridge" station.

Stage data was collected at both the existing and new Pedestrian Bridge water level sensors for correlation with discharge measurements. Stage at the new Pedestrian Bridge station was measured either by direct measurement of the benchmark to water surface distance or by level survey (lower flows require a level survey).

Stage measurements at the New "Pedestrian Bridge" station were collected approximately 1 hour after discharge measurements at the existing Pedestrian Bridge station (i.e., due to the travel time between the two stations). Typically stage measurements would be collected at the same time as discharge measurements (or immediately prior to and following the discharge measurement), so that the measured stage accurately reflects the water level at the time the discharge was collected.

The continuous water level data at the New "Pedestrian Bridge" station was examined for the time elapsed between discharge and stage measurements: the maximum fluctuation in water level was 1 cm. Therefore, the lag in stage readings at the New "Pedestrian Bridge" site compared to the time at which discharge was collected is not likely to have had a significant effect on the resulting stage-discharge relationship.

Table 2-2: Cheakamus River at Pedestrian Bridge Stage and Discharge Measurements

Date	Stage (m) [Pedestrian Bridge]	Stage (m) [New Pedestrian Bridge]	Discharge (m^3/s)	Discharge Measurement Method
Jan 18, 2014	0.41	0.97	14.01	ADCP
Feb 26, 2014	0.40	0.97	13.20	ADCP
May 21, 2014	0.85	1.35	N/A [1]	ADCP
May 22, 2014	0.86	1.37	38.84	ADCP
Jun 23, 2014	0.64	1.22	26.85	ADCP
Jul 30, 2014	0.77	1.34	33.39	ADCP
Aug 27, 2014	0.54	1.095	19.95	ADCP

Notes:
1. Discharge not presented because data appear to be subject to an unacceptable level of uncertainty.

2.2.2 Rating Curve

Pedestrian Bridge

The stage-discharge data points collected in Year 6 were reviewed against stage-discharge data collected in Years 1 through 5 of CMSMON8. According to the previous monitor, a total of four rating curve shifts have occurred over the course of the previous monitor.

Based on the comparison of the Year 6 data points with stage-discharge points collected during the previous monitor, it appears that there has been another channel adjustment and that a new rating curve would be justified to better reflect the Year 6 data. The overall form of the stage-discharge points remains the same, however.

A power-law curve was fit to the Year 6 data using the method of maximum likelihood. The curve is fit considering the estimated uncertainty of both stage and discharge measurements.

The new stage-discharge equation for Year 6 at the existing Pedestrian Bridge station is:

$$\textbf{Discharge}=54.03*(\textbf{Stage}-0.13)^{1.08}$$

and the rating curve is presented in Appendix A (Figure A-2).

New "Pedestrian Bridge"

Year 6 data were used to develop a rating curve for the new "Pedestrian Bridge" station. The stage discharge equation for the New Pedestrian Bridge station for Year 6 is:

$$\textbf{Discharge}=14.61*(\textbf{Stage}+0.01)^{2.94}$$

and the rating curve is presented in Appendix A (Figure A-3).

Additional years of data collection will be required to confirm whether the new station is more stable than the existing station (i.e. by observing rating curve shift at the existing station that does not occur at the new station).

2.2.3 Preliminary Discharge Data

Pedestrian Bridge

Figure B-2 in Appendix B shows the discharge time series based on the available Pedestrian Bridge water level data downloaded during the Year 6 period. As discussed in Section 2.1, Year 6 data are available starting in June 2013.

As presented in Appendix B, the Cheakamus River Pedestrian Bridge water level data available at the time of writing this report cover the period June 3, 2013 to July 30, 2014. No significant losses of data occurred in the Year 6 monitoring year.

The station exceeded the recommended upper limit of applicability of the stage-discharge relationship 8 times during the Year 6 monitoring program. The majority of these exceedances were brief; however on June 23, 2013 the limit was exceeded for 11 days and on May 15, 2014 for 3.5 days.

New "Pedestrian Bridge"

Figure B-3 in Appendix B presents the discharge time series for the New Pedestrian Bridge station. The water level data available at the time of writing this report cover the period from December 30, 2013 to July 30, 2014.

No significant losses of data happened during the Year 6 monitoring year.

The New Pedestrian Bridge station exceeded the recommended upper limit of applicability for the stage-discharge relationship 4 times during the 2013 monitoring program. Two of these instances were brief; however on May 15, 2014 the limit was exceeded for 4.5 days and on June 16, 2014 for 3.5 days.

Differences In Discharge Between the Pedestrian Bridge Stations

The stage-discharge relationships for these two sites use common discharge values, measured near the "Pedestrian Bridge" station, and unique stages measured at both stations. Due to the unique stages, different stage-discharge relationships are created for each site, which provide slightly different estimated discharges for the same stage.

Comparing the Year 6 preliminary discharge data for the Pedestrian Bridge sites, during high flow events (over the recommended maximum limit of applicability), the difference in hourly average estimate discharge between the two stations may reach as high as 50%; however, for most of the period of available data the difference was under 10%, which is in the range of expected uncertainty for estimated discharge.

2.3 Culliton Creek

2.3.1 Field Measurements

Culliton Creek is a small boulder-bed creek with turbulent flow, which enters Cheakamus River a short distance downstream of the Pedestrian Bridge (Figure 2-1). The nature of the channel morphology (cascading flow over and around boulders) means that even in low flows, the only means of accurately measuring discharge is dilution gauging.

Flow measurements at this station were performed using salt dilution gauging, using a Sommer TQ-Tracer system. Salt was injected to the creek just below the Railway Bridge, and the resulting concentration signal was measured between 400 m and 600 m downstream relative to the injection location (see Photos 4 and 5, below).

Photo 4: Culliton Creek Salt Injection Location (Photo taken May 21, 2014)

Photo 5: Culliton Creek Salt Concentration Measurement Location (Photo taken May 22, 2014)

Five flow measurements were collected at Culliton Creek (Table 2-3). In most cases, two field measurements of discharge were conducted during each site visit, for confirmation (these 'check' measurements have not been presented).

Stage was measured at the existing staff gauge.

Table 2-3: Culliton Creek Stage and Discharge Measurements

Date	Stage (m)	Discharge (m^3/s)	Discharge Measurement Method
Jan 18, 2014	0.28	2.08	Salt Dilution
May 21, 2014	0.57	6.11	Salt Dilution
May 22, 2014	0.59	7.94	Salt Dilution
Jul 30, 2014	0.49	5.98	Salt Dilution
Aug 27, 2014	0.48	5.38	Salt Dilution

2.3.2 Rating Curve

The stage-discharge data points collected in Year 6 were reviewed against stage-discharge data collected in Years 1 through 5 of CMSMON8. According to the previous monitor, the rating curve for this hydrometric station changed once during the previous monitor.

There is a large degree of overlap between the Year 6 stage-discharge points and the data collected during Years 1 through 5 of the monitor. Based on the comparison of the Year 6 data points with the more recent points that form the basis for the most recent rating curve, it does not appear that there have been significant channel changes. Therefore, the stage-discharge relationship from the previous monitor, presented in the "Cheakamus River Hydrometric Monitoring Year 5 Reporting" Report, has been adopted for Year 6.

The stage-discharge equation for Year 6 is:

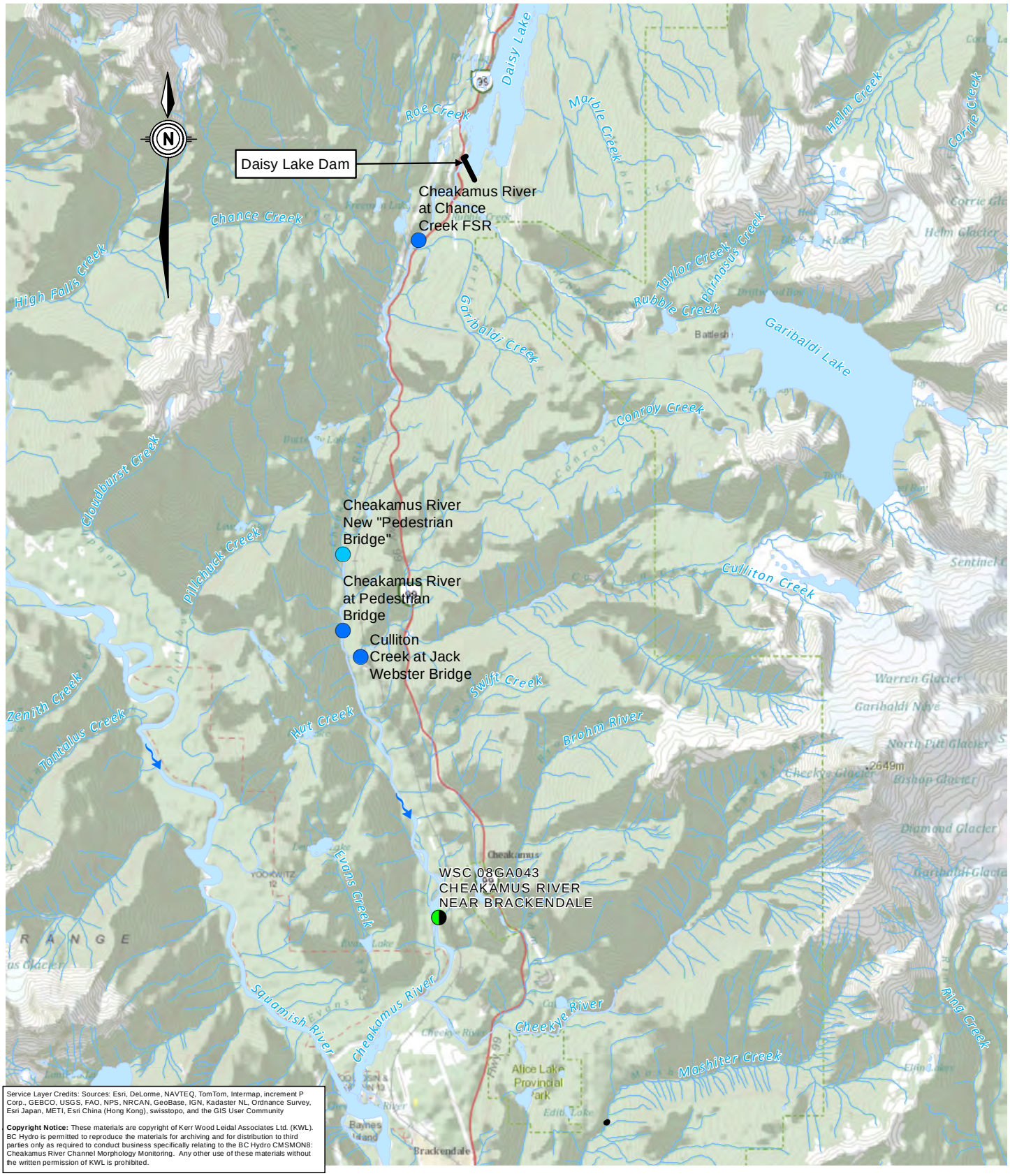
$$\text{Discharge} = 20.61 * (\text{Stage} - 0.05)^{1.689}$$

Figure A-4 in Appendix A shows the Culliton Creek stage-discharge relationship and the recommended upper limit of applicability.

2.3.3 Preliminary Discharge Data

Figure B-4 in Appendix B presents the discharge time series for the Culliton Creek station for the period of available record at the time of writing this report (June 3, 2013 to July 30, 2014). No significant losses of data happened in the Year 6 monitoring period.

As indicated in Figure A-4, the recommended limit of rating curve applicability was briefly exceeded three times.



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CMSMON8: Cheakamus River Channel Morphology Monitoring

Project No.	Date
478-164	October 2014

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CMSMON8 Hydrometric Stations

Figure 2-1

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Author: EEllis

3. Summary and Future Work

3.1 Summary

The following work has been accomplished on CMSMON8 during Year 6:

- Five (5) stage-discharge measurements have been collected at the Cheakamus River at Chance Creek FSR station and a new rating curve has been developed.
- Seven (7) stage-discharge measurements have been collected at the Cheakamus River at Pedestrian Bridge station and a new rating curve has been developed.
- A new water level sensor and associated benchmarks have been installed at a location upstream of the existing Pedestrian Bridge water level sensor (New “Pedestrian Bridge”).
- Seven (7) stage measurements have been collected at the New “Pedestrian Bridge” station and a rating curve has been developed for the new station.
- Five (5) stage-discharge measurements have been collected at the Culliton Creek station. Based on comparison with the previous stage-discharge data, the existing rating curve has been maintained.
- Discharges have been estimated for all stations based on the adopted rating curves.

3.2 Future Work

Future work on CMSMON8 will directly address the Management Questions. In particular, the following activities are currently anticipated:

- Review and analysis of the Year 1 to Year 5 hydrometric data with the goal of addressing Management Question 3. This will include evaluating the degree to which the additional hydrometric data (from the Chance Creek FSR, Pedestrian Bridge and Culliton Creek sites) assist in answering the Management Question.
- Revising the originally-proposed scope of work to better address Management Questions 1 and 2, which will involve consultation with other Cheakamus River monitors as well as with BC Hydro.

3.3 Report Submission

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Statement of Limitations

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This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

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Revision History

Revision #	Date	Status	Revision	Author
1	December 9, 2014	Final	Final	YB / EE
B	November 5, 2014	Draft	Draft for client review	YB / EE
A	October 28, 2014	Draft	Draft for internal review	YB / EE

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Appendix A

Stage Discharge Relationships

FIGURE A-1

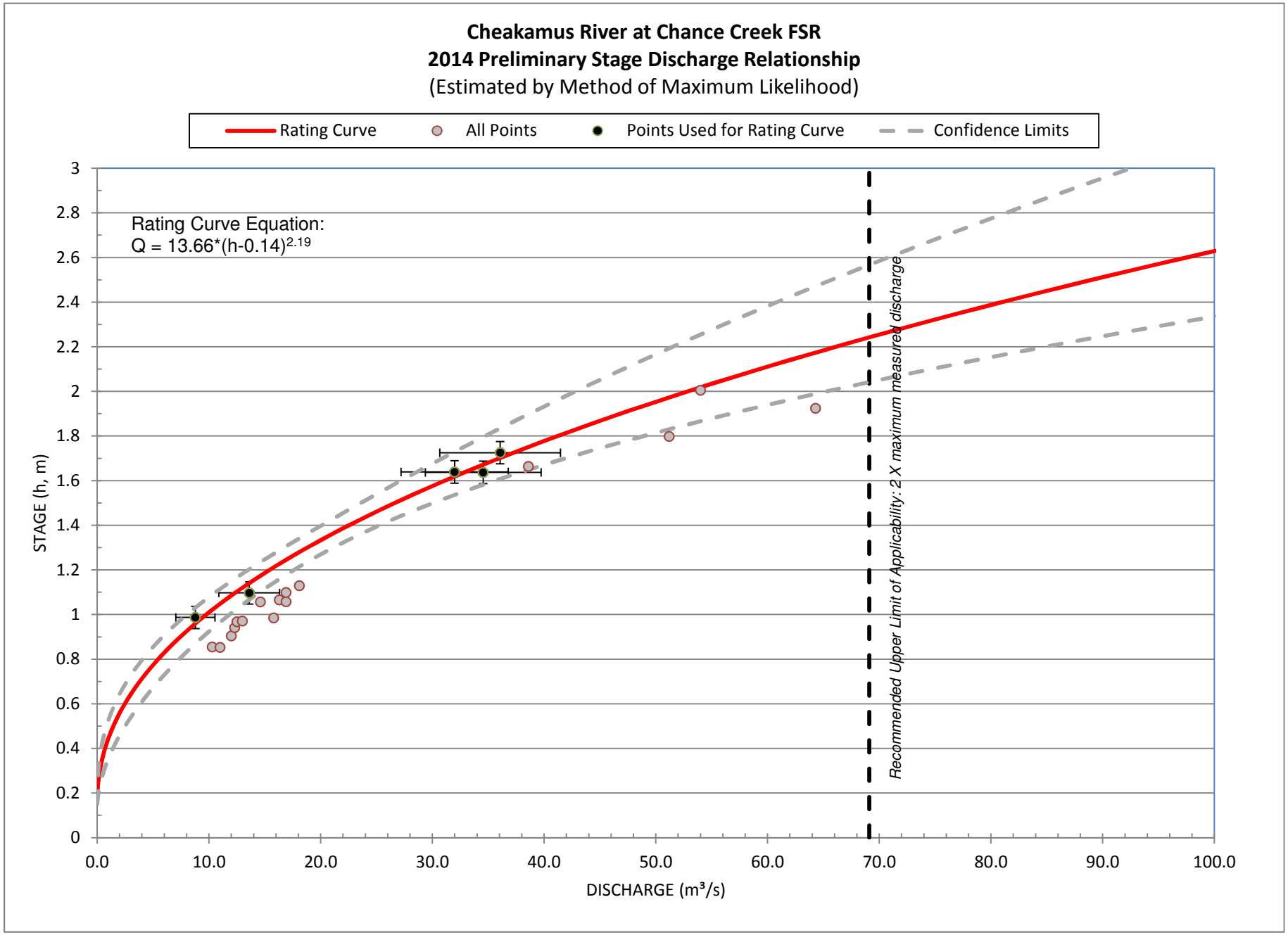

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FIGURE A-2

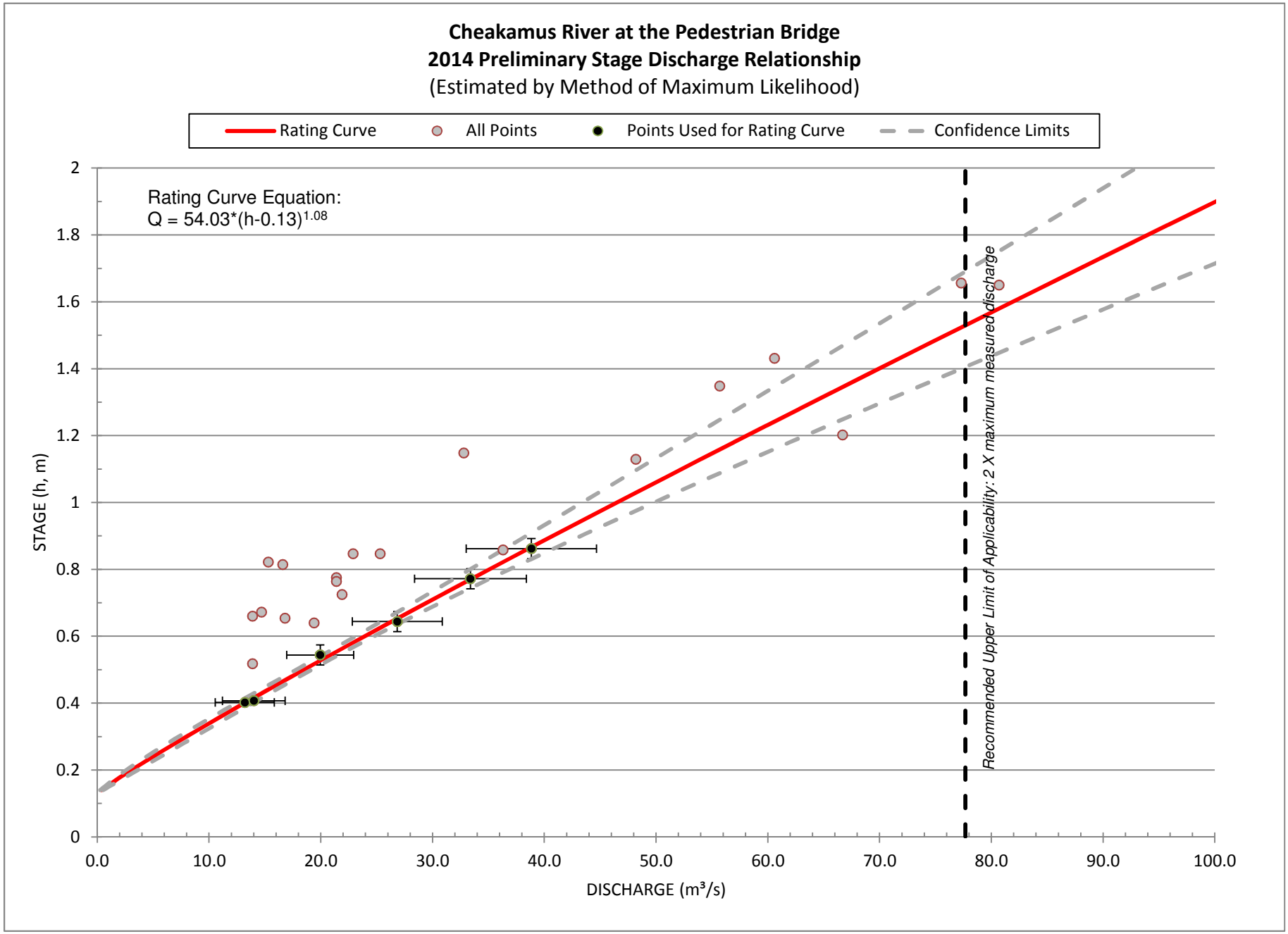

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FIGURE A-3

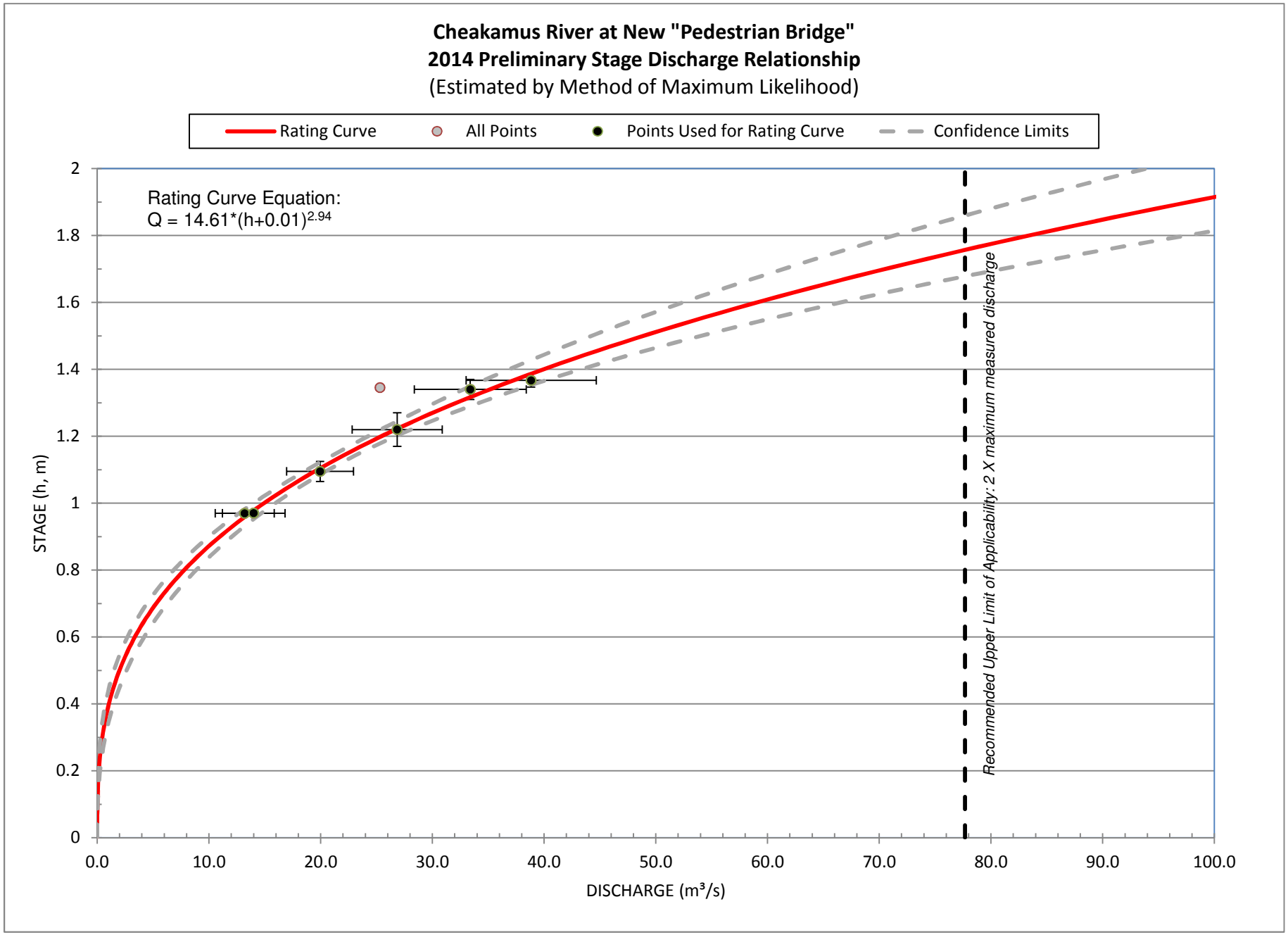

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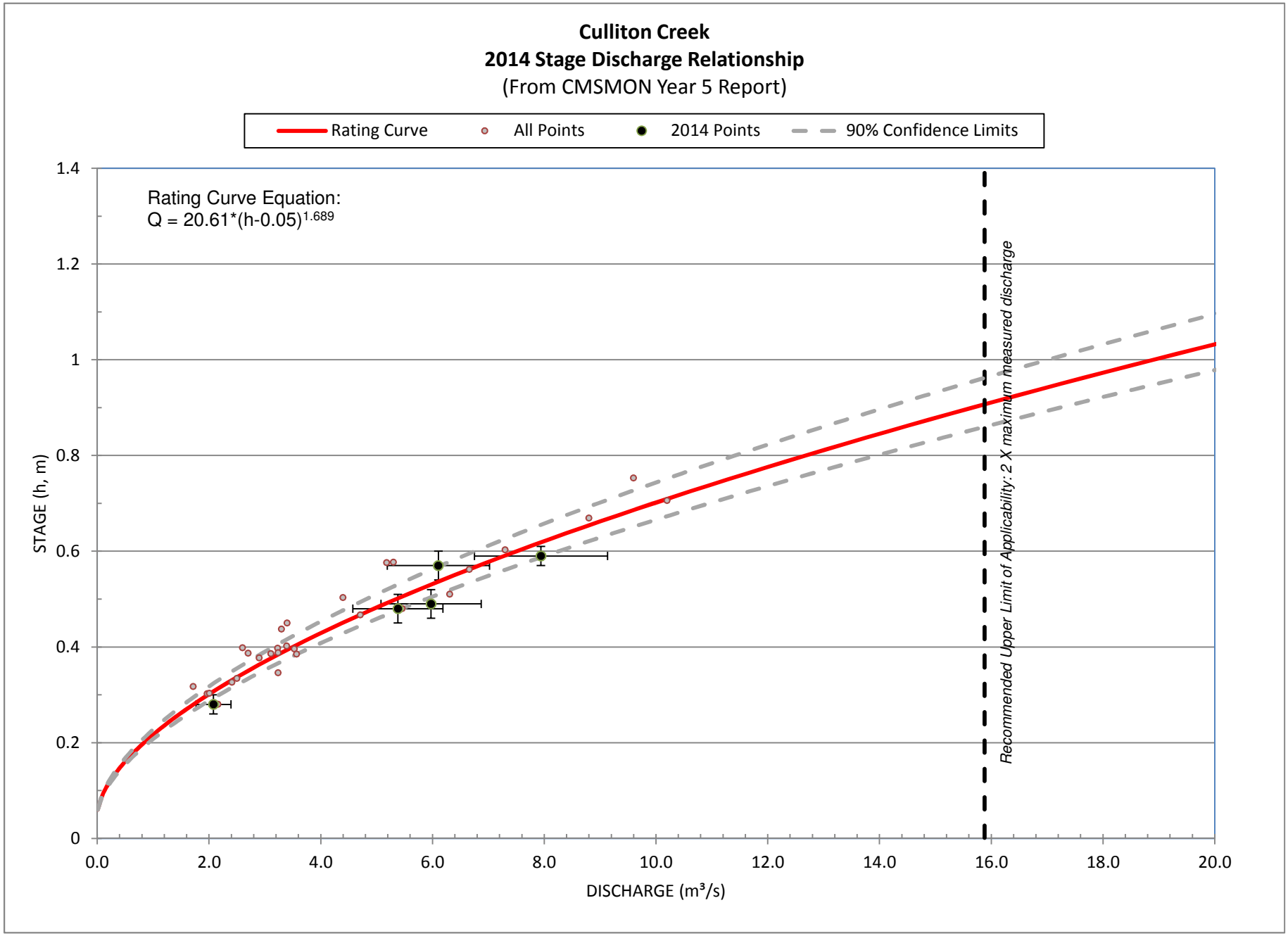
FIGURE A-4



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Appendix B

Year 6 Discharge Summaries

FIGURE B-1

Cheakamus at Chance Creek Discharge
CMSMON-8 Year 6

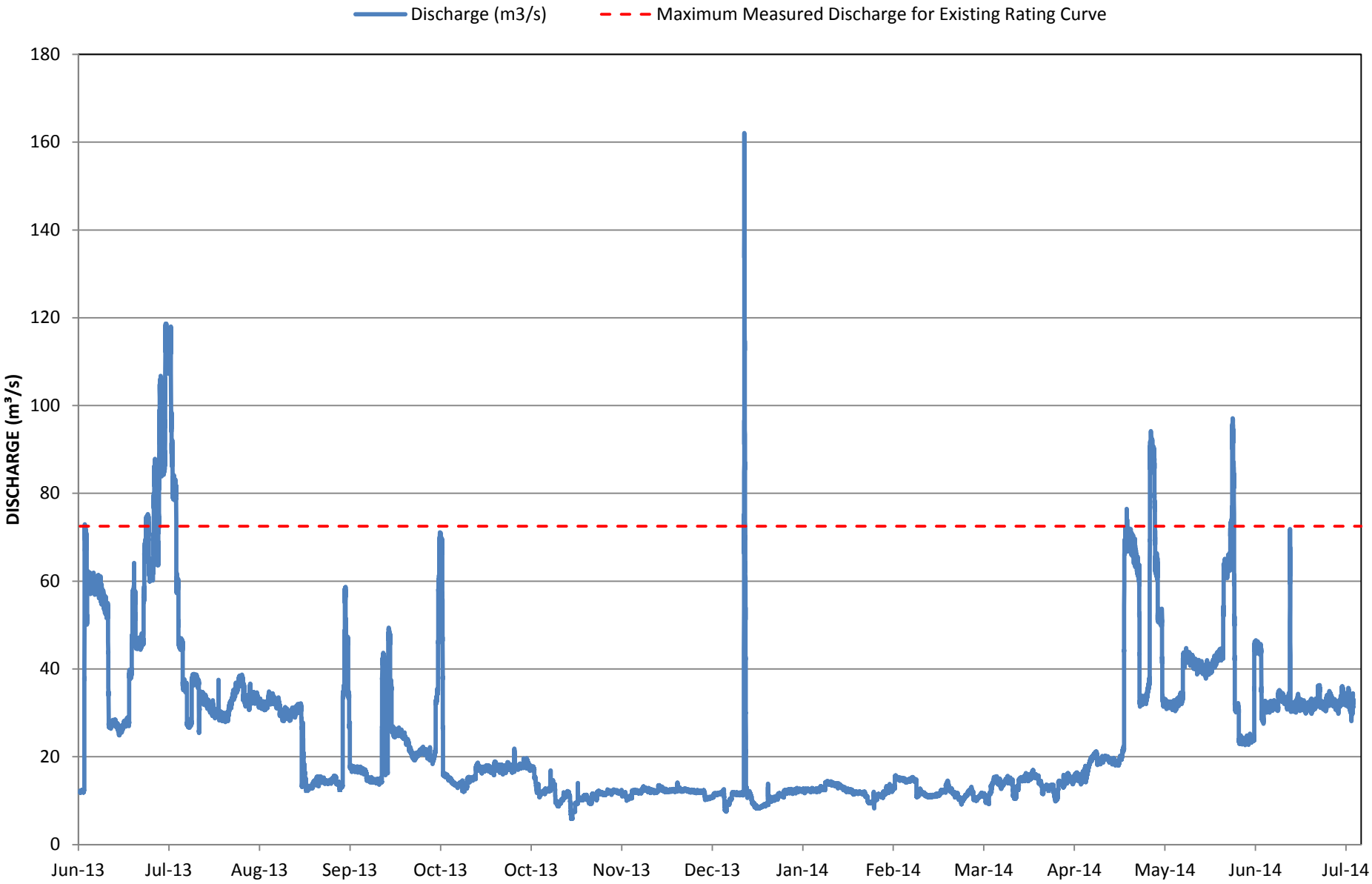

FIGURE B-2

Cheakamus at Pedestrian Bridge Discharge
CMSMON-8 Year 6

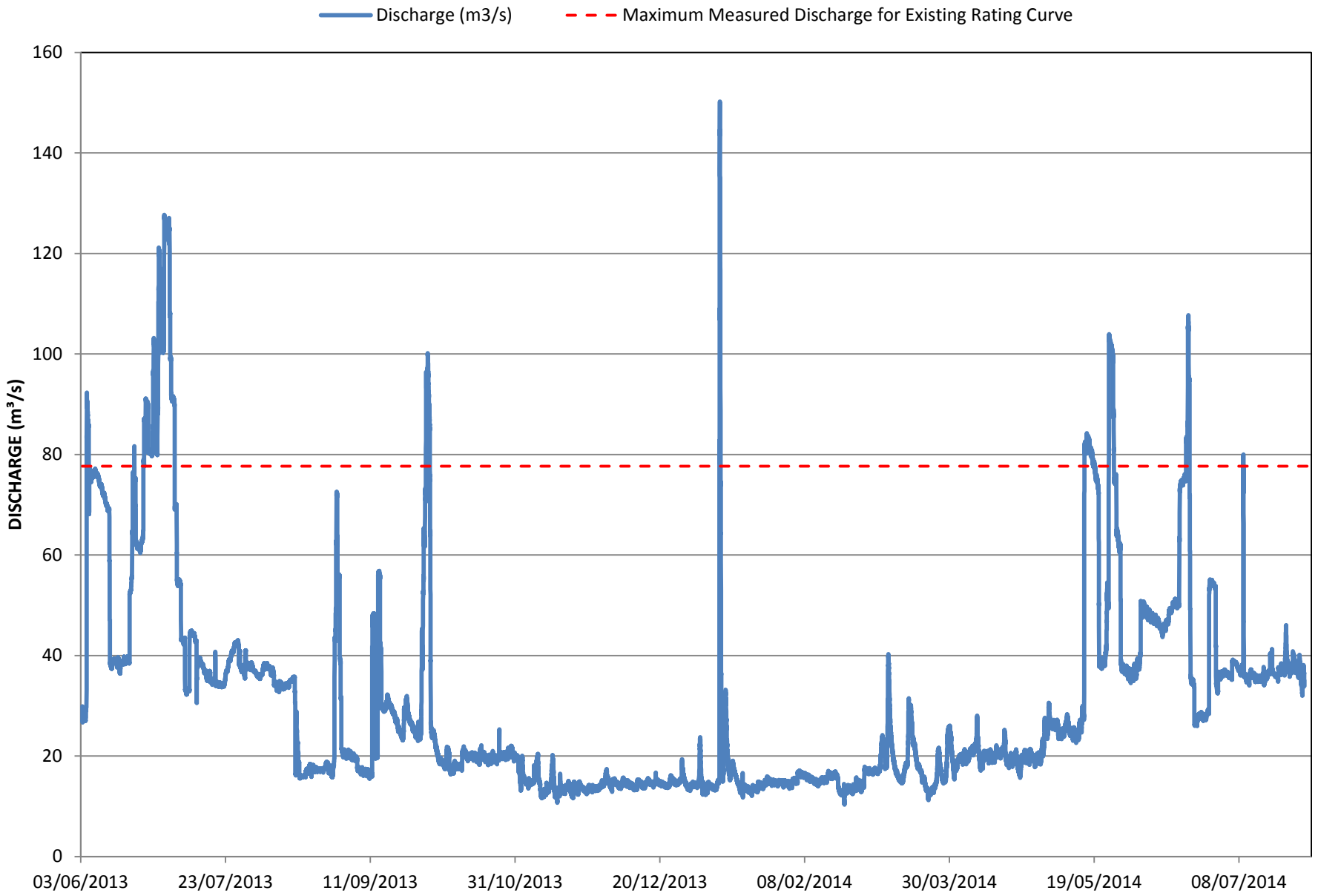

FIGURE B-3

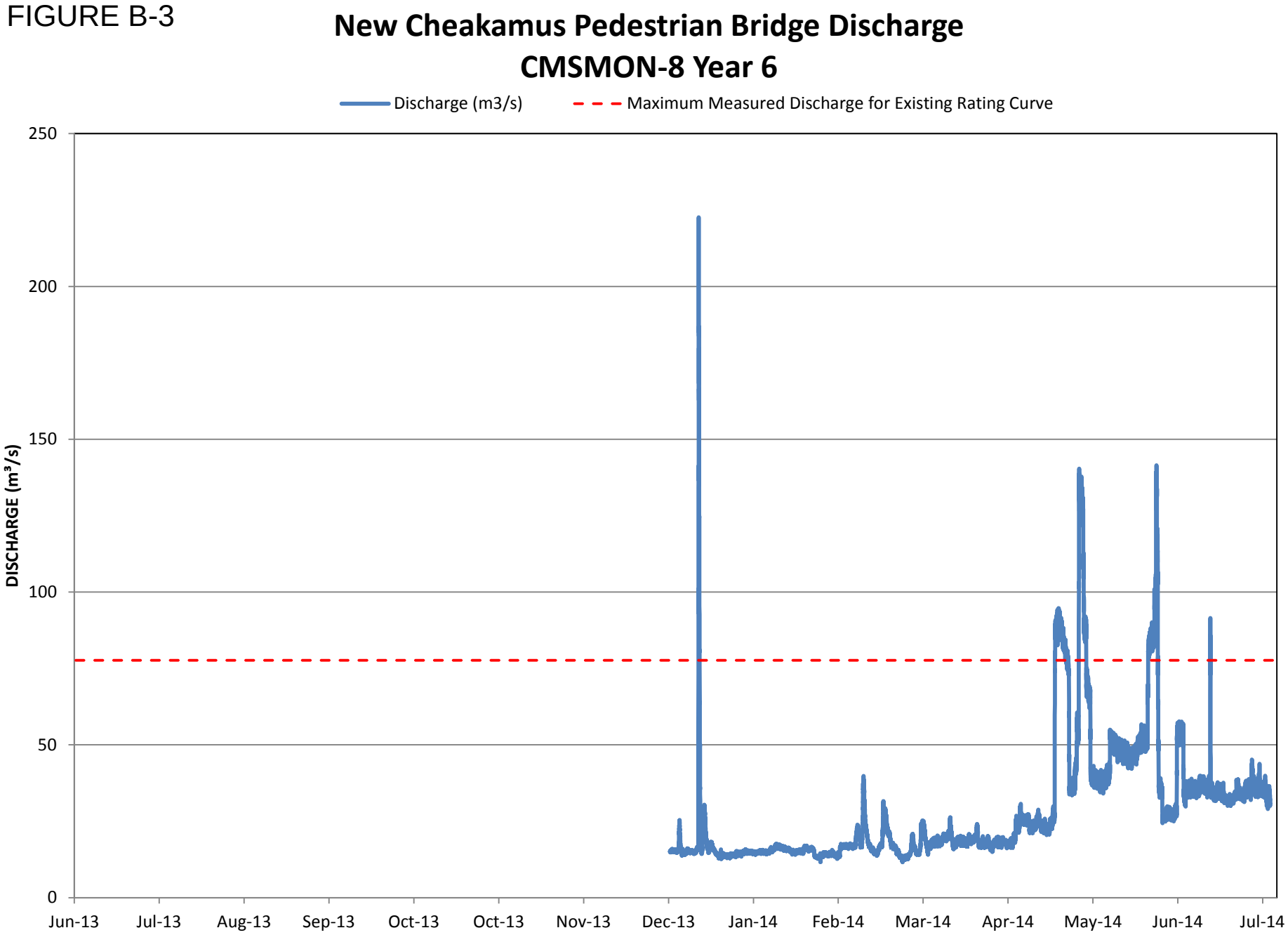
New Cheakamus Pedestrian Bridge Discharge
CMSMON-8 Year 6
Discharge (m3/s)
Maximum Measured Discharge for Existing Rating Curve
DISCHARGE (m³/s)
250
200
150
100
50
0
Jun-13
Jul-13
Aug-13
Sep-13
Oct-13
Oct-13
Nov-13
Dec-13
Jan-14
Feb-14
Mar-14
Apr-14
May-14
Jun-14
Jul-14

FIGURE B-4

Culliton Creek Discharge
CMSMON-8 Year 6