Eklutna Hydroelectric Project

Stream Gaging

Year 2 Study Report

FINAL

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Terms, Acronyms, and Abbreviations

1991 Agreement	1991 Fish and Wildlife Agreement
AWWU	Alaska Water and Wastewater Utility
C	degree Celsius
cfs	cubic feet per second
ft	foot
FSP	Final Study Plans
NCEI	National Centers for Environmental Information
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NVE	Native Village of Eklutna
PME	protection, mitigation, and enhancement
PVC	Polyvinyl chloride
RM	river mile
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1 INTRODUCTION

The 1991 Fish and Wildlife Agreement (1991 Agreement) was executed amongst the Municipality of Anchorage, Chugach Electric Association, Inc., Matanuska Electric Association, Inc. (collectively "Project Owners"), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the State of Alaska as part of the sale of the Eklutna Hydroelectric Project (Project) from the Federal government to the now Project Owners. The 1991 Agreement requires that the Project Owners conduct studies that examine and quantify, if possible, the impacts to fish and wildlife from the Project. The studies must also examine and develop protection, mitigation, and enhancement (PME) measures for fish and wildlife affected by such hydroelectric development. This examination shall consider the impact of fish and wildlife measures on other resources, including stream flow in Eklutna River, as well as available means to mitigate these impacts. The Project Owners initiated consultation in 2019 and have implemented studies to inform the development of the future Fish and Wildlife Program for the Project. As part of these studies, the Project Owners contracted McMillen, Inc. to describe and evaluate water quality in the Project area.

The Stream Gaging Study was initiated in 2021 in accordance with Section 3.6 of the May 2021 Final Study Plans (FSP). As noted in the FSP, and based on early outreach efforts, the main goal of the agencies and interested parties is to find a new balance amongst the uses of water in the Eklutna River basin, including power production, potable water supply, and fish habitat. Potential flow related PME measures include the potential for providing a flow regime into the Eklutna River that would accomplish habitat restoration and increase the anadromous fish production of the river. Stream flows in the Eklutna River downstream from Eklutna Lake have been altered by several management actions over the past century, primarily from controlled water withdrawals and storage in constructed reservoirs. Quantitative documentation of stream flow volumes and conveyance at select Eklutna River locations is an important component to assist with evaluating the effectiveness of potential future flow releases and other aquatic habitat improvement measures.

As summarized in the Initial Information Package, historical stream gaging data of relatively short duration (< 10 years) has been collected within the watershed prior to development (pre-1929) and after 1955, when outflows from Eklutna Lake were diverted and controlled similar to present day. Table 1-1 summarizes available United States Geological Survey (USGS) gaging station data in the Eklutna River basin since 1955. Because none to limited mean daily flow records are available at USGS stations 15280100 and 15280200, located on Eklutna River below Eklutna Lake, the stream gaging program was initiated at these two Eklutna River monitoring points. These gaging data will supplement flow records and provide a brief, qualitative comparison of current runoff characteristics.

Table 1-1. Stream Gages in the Eklutna River Watershed

Gage Station Number	Date Range	Location
15277600	1960 – 1962 1985 – 1988	East Fork of Eklutna Creek
15277800	1960 – 1962 1985 – 1988	West Fork of Eklutna Creek
15280000	1955 – 1962*	Eklutna River 200 feet downstream of Eklutna Lake
15280100	1954 – 1956 2002 – 2007	Eklutna River above Thunderbird Creek
15280200	1981 2002 – 2007	Eklutna River at Old Glenn Highway
**flow records from 1946-1954 are available, but under a substantially different flow diversion capacity and operational regime of Eklutna Lake from 1955 to present.*		

This Study Report provides continuous or monthly instantaneous discharge records from mid-May of 2021 through early October of 2022 at four monitoring stations within the lower Eklutna River watershed. Accretion data (i.e., stream flow gains or losses) are also presented along the longitudinal profile of the lower Eklutna River from River Mile (RM) 1.3 to RM 10.3 under existing conditions and a 25 cubic feet per second (cfs) flow release from the Eklutna Lake Dam. The monitoring of stream gages will continue over the winter and through the fall of 2023.

2 STUDY OBJECTIVES

The goals of this study were to gain a better understanding of the current flow regime in the Eklutna River and to support other aquatic studies being conducted in parallel with this assessment. To achieve these goals, the primary objective of this study was to generate a flow record in the Eklutna River, Thunderbird Creek, Lach Q'atnu Creek, and the unnamed tributary to the pond upstream of the existing dam throughout the 2021 and 2022 study program. A secondary objective was to collect instantaneous flow measurements under stable low-flow conditions, as well as during one of the study flow releases (25 cfs), in order to assess accretion along the longitudinal profile of the Eklutna River. While the stream gaging effort will be ongoing through at least the fall of 2023, this report should be viewed as the final discharge record required to meet study plan objectives.

3 STUDY AREA

Two stream gaging stations were installed in the lower Eklutna River. One of the stream gages was installed upstream of the Thunderbird Creek confluence, while the second stream gage was installed below the Thunderbird Creek confluence near the Old Glenn Highway bridge and location of United States Geological Survey (USGS) gage station 15280200 that operated from 2002-2007. A third stream gage was installed near the mouth of Lach Q'atnu Creek (Tributary 1) while the unnamed tributary to the pond (Tributary 2) lacked suitable conditions for installation of a stream gage. Therefore, only instantaneous measurements were taken at Tributary 2 during the 2021-2022 study period. Stream gaging and instantaneous flow monitoring locations are shown in Figure 3-1.

To assess accretion in the Eklutna River, instantaneous flow measurements were collected at five locations in the river downstream of the Eklutna Lake dam. The accretion monitoring stations are shown in Figure 3-1 and described below.

- The Eklutna River downstream of Thunderbird Creek near the railroad bridge - RM 1.3,
- The Eklutna River downstream of Thunderbird Creek at the Old Glenn Highway bridge (stream gage station) - RM 2.3,
- The Eklutna River upstream of Thunderbird Creek (stream gage station and co-located with Water Quality Station 1) - RM 3.0,
- The Eklutna River near the downstream terminus of the AWWU access road (co-located with Water Quality Station 2) - RM 5.5, and
- The Eklutna River near RM 10.3.

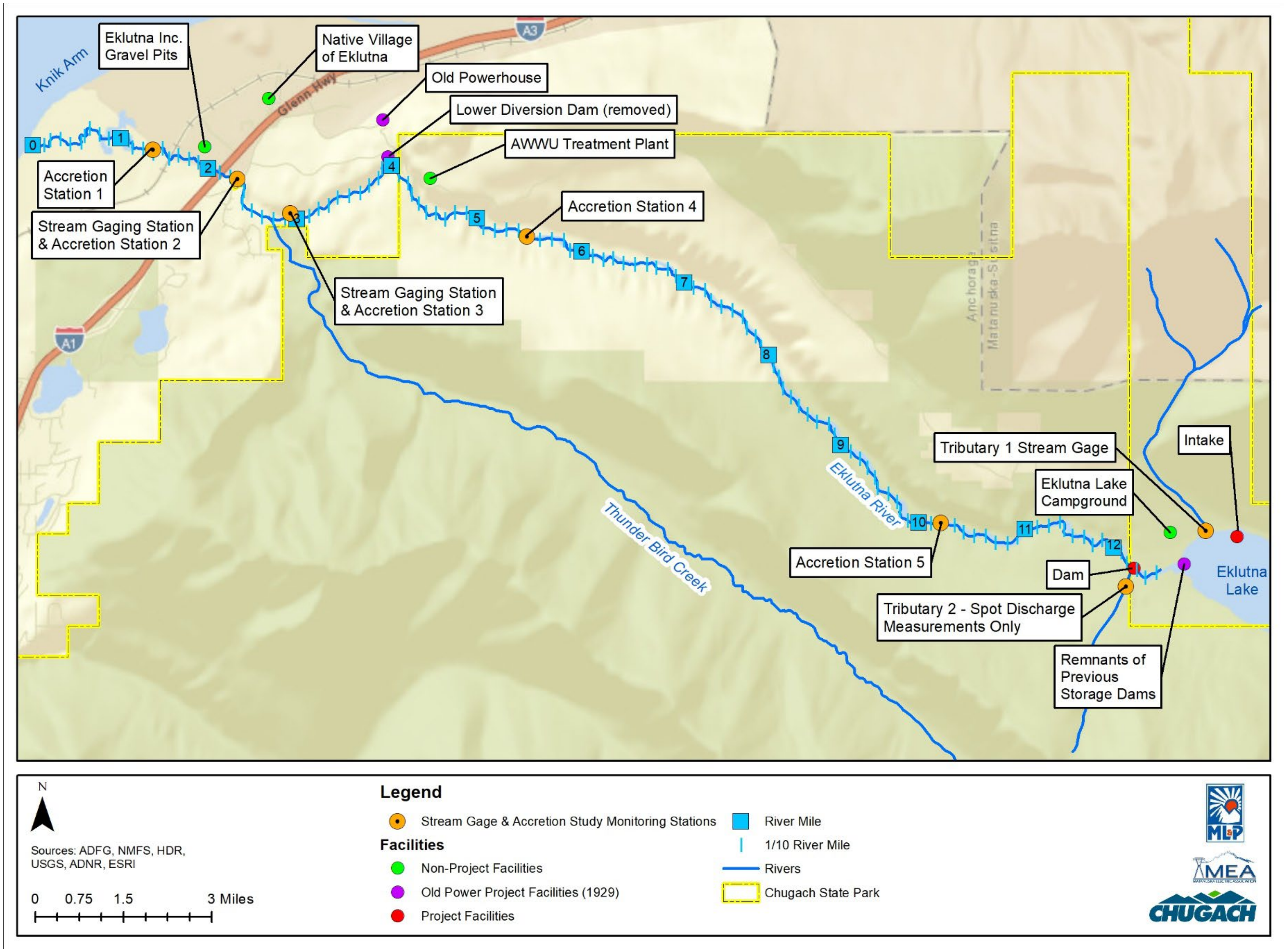

Figure 3-1. Stream gages, spot discharge measurement, and accretion study locations within the lower Eklutna River watershed.

4 METHODS

4.1. Stream Gages

Following USGS guidelines, the Eklutna River and tributary stream gages consisted of a staff gage and a continuous stage data logger, each anchored individually to the stream bank and near the shoreline to avoid debris and damage during high flow conditions. The data loggers were a pressure transducer system with an accuracy of +/-0.02 feet or +/-0.15% full scale (0.0 to 13.0 feet). The data logger accurately records pressure, which is related to the water surface elevation at the staff gage. Data loggers recorded the following parameters at 15-minute intervals:

- Date and time
- Temperature (°C)
- Pressure/Water level (feet)

Staff gages were 3.3 feet long and mounted vertically in the stream channel to measure water levels to the nearest hundredth of a foot for the full range of flow conditions. The data loggers were housed in a shoreline enclosure consisting of 2-inch PVC pipe located within the wetted channel. Figure 4-1 provides a schematic and example of a typical data logger and staff gage installation.

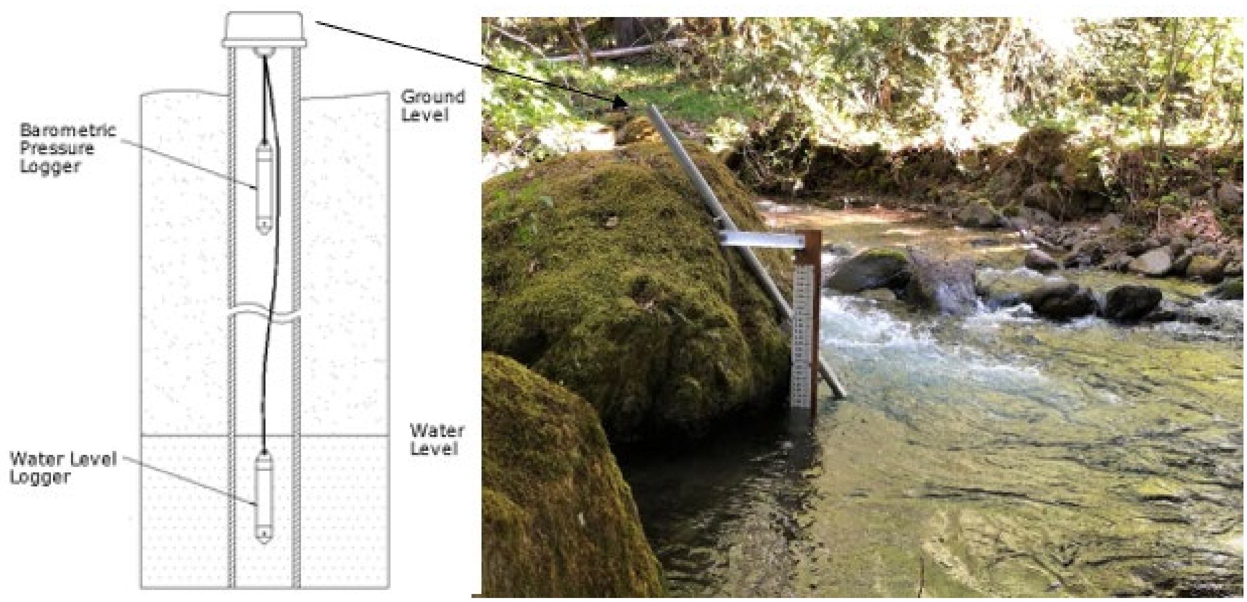

Figure 4-1. Schematic and example of a typical data logger and staff gage installation.

Following gage installation from May18-20, 2021, trained staff maintained and calibrated the stream gaging stations approximately monthly during the study period. During each calibration and maintenance effort, discharge data were collected to develop and maintain a stage-discharge rating relationship at the Eklutna River and tributary stream gages. Discharge measurements followed field procedures laid out in Rantz et al (1982) and continued for the duration of the 2021-2022 study program through mid-October to ensure an accurate rating equation was maintained at the monitoring locations. At each maintenance and calibration event, the following occurred:

- Comparison of electronic stage levels to reference staff gage
- Discharge measurement (safe wading conditions only)
- Downloading of electronic stage record

Supplemental maintenance and monitoring activities that occurred during the 2021-2022 study program included establishment of the vertical datum for the reference staff gage, as well as a cross-section profile at the three stream gaging locations. During the typical low-flow winter period, surface water at some or all of the gaging stations was intermittently frozen and did not always provide an accurate continuous stage record. During this November-April timeframe, stage recorders remained in place with visual site inspections conducted on a bi-monthly basis to document site conditions and confirm the expected low-flow discharge condition.

4.2. Accretion Assessment

For the accretion portion of the study, discharge measurements were collected at five locations in the Eklutna River (Figure 3-1) under a stable base flow or zero-flow release condition on June 22, 2021. Discharge measurements in support of the accretion assessment were also conducted at the same five monitoring stations during the 25 cfs study flow release on September 30, 2021.

Field crews read the staff plates at both Eklutna River stream gaging stations then immediately moved upstream to conduct a discharge measurement at Accretion Station 5 located at RM 10.3. After completing the discharge measurement at Accretion Station 5, field staff continued downstream to conduct a discharge measurement at Accretion Station 4 (RM 5.5). Once efforts in the upper reach were completed, field staff moved downstream to measure discharge at Accretion Station 1 near the railroad bridge at RM 1.3. Following the measurement at Accretion Station 1, field staff continued upstream and completed discharge measurements at Accretion Stations 2 and 3. The final step was to re-read staff plates at the Eklutna River stream gages to verify a stable runoff condition during the 8-hour measurement period.

5 RESULTS

5.1. Eklutna River below Thunderbird Creek

5.1.1. Discharge Measurements and Rating Equation

As summarized in Table 5-1, a total of twelve discharge measurements were taken to assess and validate the stage-discharge relationship at the Eklutna River below Thunderbird Creek and provide 199 and 274 days of mean daily flow data in 2021 and 2022, respectively.

Table 5-1. Eklutna River below Thunderbird Creek discharge measurements.

Meas. No.	Date	Stream Gage Level (ft)	Measured Discharge (cfs)	Rated Discharge (cfs)	Percent Difference	Shift Adj.
1	5/18/2021	0.62 [1]	33.1	32.6	1.5%	
2	6/22/2021	0.88 [1]	93.6	89.7	4.4%	
1	6/25/2021	1.26 [2]	93.6	91.5	2.3%	
2	7/12/2021	1.13	66.8	69.2	-3.5%	
3	8/23/2021	0.93	42.5	42.0	1.3%	
4	9/30/2021	1.13	66.2	69.2	-4.3%	
5	10/7/2021	0.95	44.9	44.3	1.3%	
6	5/19/2022	1.00	45.2	45.5	-0.7%	-0.04
7	6/29/2022	1.58	142.5	153.2	-7.0%	-0.04
8	8/2/2022	1.16	72.4	67.6	7.0%	-0.04
9	9/14/2022	1.27	80.8	86.0	-6.1%	-0.04
10	10/16/2022	1.32	90.0	95.3	-5.5%	-0.04

Notes:
1 Stage and discharge data from initial stream gage location
2 Stable stage and flow conditions verified through 6/25/2021. Measured discharge of 93.6 cfs applied to initial stage reading at second gaging location.

Due to hydraulic conditions creating noisy stage data at the original gaging location, a second gaging station was installed approximately 350 feet upstream on June 25, 2021. This second location provided more accurate and stable stage data as well as a reliable stage-discharge relationship. Therefore, 2 unique gaging stations were utilized to generate the 2021 discharge record. Standard log-log analysis methods of these discharge measurements yielded the following rating curves at both gaging locations. From May 19 to June 25, the following rating curve was utilized from the initial gaging location:

Flow (cfs) = 129.74 * (stage)^2.888

After June 25, the following rating curve was applied from the second gaging station located 350 feet upstream of the initial gaging location:

Flow (cfs) = 50.56 * (stage)^2.567

In May of 2022, the initial discharge measurement following winter ice out was off by greater than 10.6%. Therefore, an initial shift adjustment of -0.04 was applied to the rating equation. Discharge measurements 7-10 confirm this shift adjustment and it was applied to all discharge calculations starting on May 4, 2022. Graphical displays summarizing the predictive accuracy or R^2 value of each rating equation and check measurements are provided in Appendix B.

5.1.2. Discharge Record

Figure 5-1 shows the daily mean discharge recorded for the Eklutna River below Thunderbird Creek. These data are also tabulated in Appendix A. The 2021 peak mean daily flow volume of

215 cfs occurred on September 17, 2021, and was directly influenced by the study flow releases conducted in support of the instream flow and geomorphology studies. In 2022, the peak mean daily discharge of 270 cfs occurred on June 10th. Although the drainage gate to the pond was opened from June 20-25, 2022 for operations and maintenance purposes, the maximum mean daily flows for the 2022 season are entirely attributed to a substantial rain event and runoff from the Thunderbird Creek watershed.

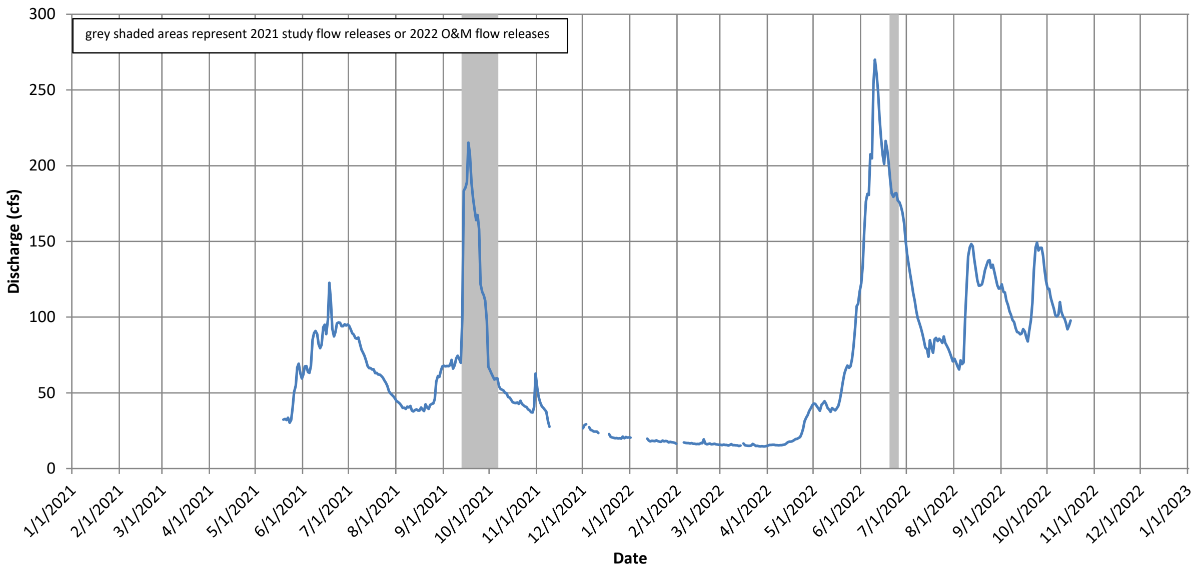

Figure 5-1. Eklutna River below Thunderbird Creek daily mean discharge, calendar years 2021-2022.

5.2. Eklutna River above Thunderbird Creek

5.2.1. Discharge Measurements and Rating Equations

As summarized in Table 5-2, a total of thirteen discharge measurements were taken to assess and validate the stage-discharge relationship at the Eklutna River above Thunderbird Creek and provide 211 and 285 days of mean daily flow data in 2021 and 2022 respectively.

Table 5-2. Eklutna River above Thunderbird Creek discharge measurements.

Meas. No.	Date	Stream Gage Level (ft)	Measured Discharge (cfs)	Rated Discharge (cfs)	Percent Difference	Shift Adj.
1	5/19/2021	0.68	6.9	6.1 [1]	12.6%	
2	6/22/2021	0.69	6.1	6.3 [1]	-3.1%	
3	7/12/2021	0.68	5.7	6.1 [1]	-6.9%	
4	8/23/2021	0.66	5.7	5.8 [1]	-1.5%	
5	9/29/2021	1.14	65.5	64.0 [2]	2.4%	
6	9/30/2021	0.80	23.8	25.3 [2]	-6.0%	
7	10/7/2021	0.51	8.0	7.8 [2]	2.6%	

Meas. No.	Date	Stream Gage Level (ft)	Measured Discharge (cfs)	Rated Discharge (cfs)	Percent Difference	Shift Adj.
8	5/19/2022	0.64	12.1	13.0 [2]	-6.8%	-0.02
9	6/29/2022	0.57	8.4	9.5 [2]	-11.5%	-0.02
10	8/2/2022	0.56	9.5	9.0 [2]	5.1%	-0.02
11	8/3/2022	0.55	9.0	8.6 [2]	4.5%	-0.02
12	9/14/2022	0.60	10.5	10.9 [2]	-3.7%	-0.02
13	10/16/2022	0.70	16.5	16.5 [2]	-0.2%	-0.02

1 Discharge calculation from Rating Equation 1
2 Discharge calculation from Rating Equation 2

Due to scouring of the streambed during the study flow releases, two unique rating curves are applied during the study period. Up until September 13, 2021, the following rating curve was used to generate the flow record at the gaging station:

Flow (cfs) = 12.70 * (stage)^1.890

After September 13, 2021, the following rating curve was utilized:

Flow (cfs) = 45.41 * (stage)^2.619

In May 2022, the initial discharge measurement following winter ice out was off by greater than 14%. Therefore, an initial shift adjustment of -0.02 was applied to the rating equation. Despite an error greater than 11% on June 29, 2022, discharge measurements 9-13 confirm this shift adjustment and it was applied to all discharge calculations starting on February 3, 2022. Graphical displays summarizing the predictive accuracy or R^2 value of each rating equation and check measurement are provided in Appendix B.

5.2.2. Discharge Record

Figure 5-2 shows the daily mean discharge recorded for the Eklutna River above Thunderbird Creek. These data are also tabulated in the Appendix A. The 2021 peak mean daily flow volume of 120 cfs occurred on September 24, 2021 and was directly influenced by the study flow releases conducted in support of the instream flow and geomorphology studies. In 2022, the maximum mean daily discharge of 26 cfs occurred on April 26, 2022, with an imperceptible flow increase between June 20-25, 2022 when the drainage gate to the pond was opened for operations and maintenance purposes.

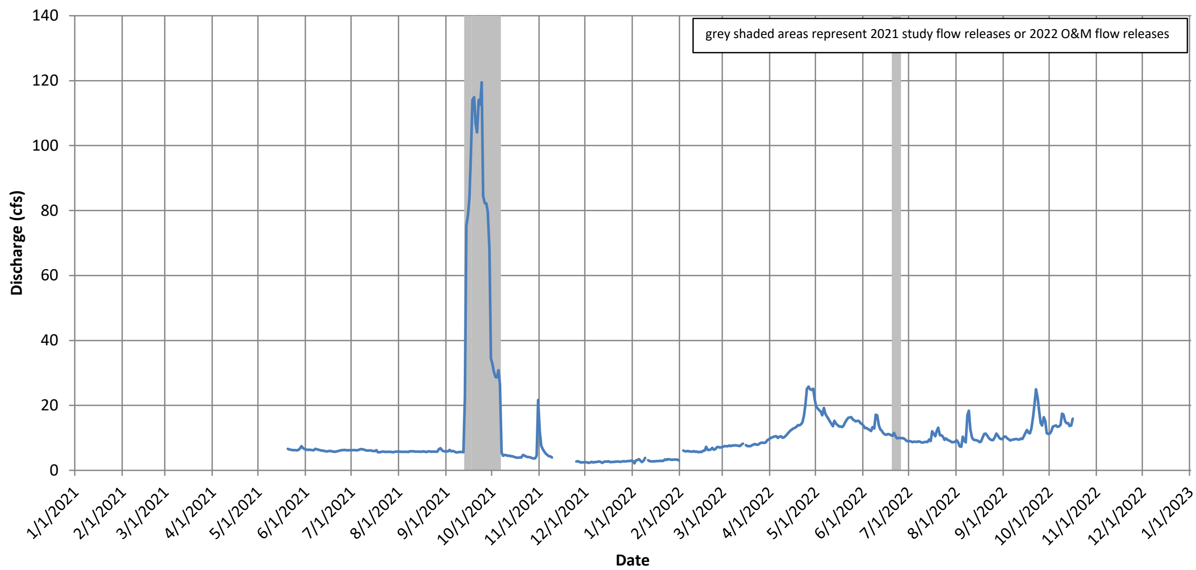

Figure 5-2. Eklutna River above Thunderbird Creek daily mean discharge, calendar years 2021-2022.

5.3. Thunderbird Creek

5.3.1. Discharge Measurements and Rating Equations

Discharge measurements and development of rating equations were not conducted for Thunderbird Creek. The flow record was estimated by subtracting daily mean discharge data for the Eklutna River above the Thunderbird Creek confluence from the Eklutna River below the Thunderbird Creek confluence. These flow estimate calculations provide 226 and 289 days of mean daily flow data in 2021 and 2022, respectively.

5.3.2. Discharge Record

Figure 5-3 shows the daily mean discharge estimates for Thunderbird Creek in comparison to the two Eklutna River gaging stations. These data are also tabulated in the Appendix A. The 2021 peak mean daily flow volume of 117 cfs occurred on June 18, 2021, and September 17, 2021. In 2022, the peak mean daily discharge of 253 cfs occurred on June 10, 2022.

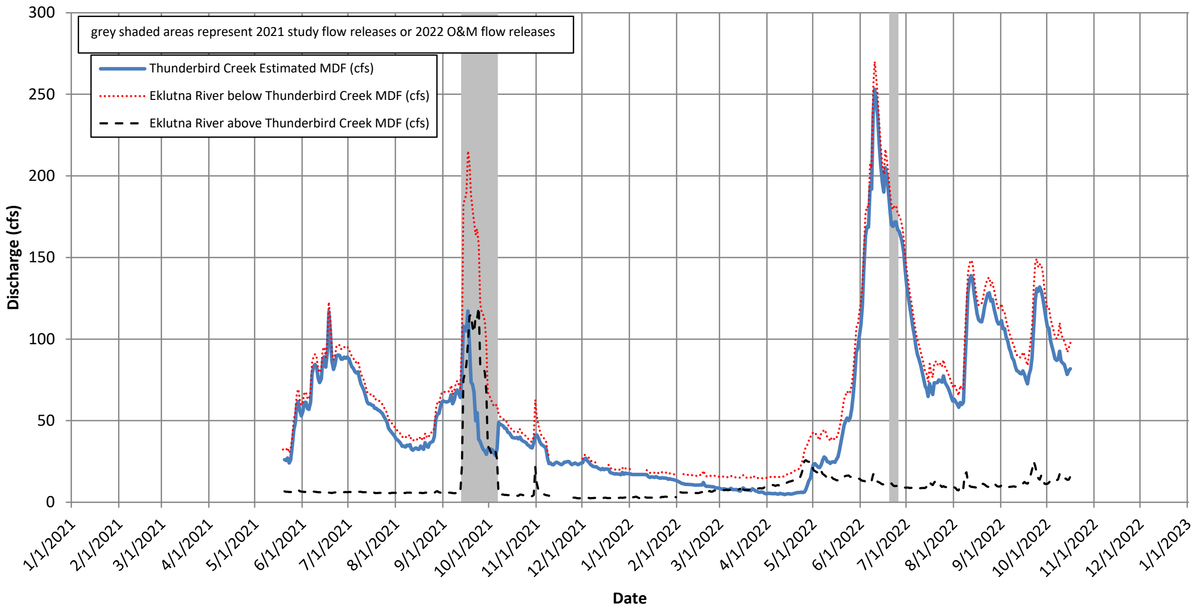

Figure 5-3. Thunderbird Creek estimated daily mean discharge vs Eklutna River stream gaging records, calendar years 2021-2022.

5.4. Lach Q'atnu Creek

5.4.1. Discharge Measurements and Rating Equation

As summarized in Table 5-3, a total of twelve discharge measurements were taken to assess and validate the stage-discharge relationship at Lach Q'atnu Creek and provide 222 and 281 days of mean daily flow data in 2021 and 2022 respectively.

Table 5-3. Lach Q'atnu Creek discharge measurements.

Meas. No.	Date	Stream Gage Level (ft)	Measured Discharge (cfs)	Rated Discharge (cfs)	Percent Difference	Shift Adj.
1	5/18/2021	13.50	6.1	6.1 [1]	0.5%	
2	6/23/2021	13.45	4.7	4.7 [1]	-0.5%	
3	7/13/2021	13.32	2.0	2.0 [1]	-0.7%	
4	8/26/2021	13.29	1.6	1.6 [1]	0.7%	
5	9/28/2021	13.35	2.5	2.5 [1]	-0.9%	
6	5/18/2022	13.65	7.6	7.7 [1]	-0.9%	-0.10
7	6/11/2022	13.85	14.2	15.7 [2]	-9.6%	
8	6/28/2022	13.64	6.3	6.0 [2]	4.8%	
9	8/2/2022	13.55	2.6	2.4 [2]	10.4%	-0.02
10	8/3/2022	13.55	2.3	2.4 [2]	-2.3%	-0.02

Meas. No.	Date	Stream Gage Level (ft)	Measured Discharge (cfs)	Rated Discharge (cfs)	Percent Difference	Shift Adj.
11	9/13/2022	13.60	3.6	3.9 [2]	-7.0%	-0.02
12	10/16/2022	13.63	4.7	4.9 [2]	-4.1%	-0.02

1 Discharge calculation from Rating Equation 1
2 Discharge calculation from Rating Equation 2

Standard log-log analysis methods for these discharge measurements yielded the following rating curve for the station:

Flow (cfs) = 33.38 * (stage – 13.0)^2.460

In May of 2022, the initial discharge measurement following winter ice out was off by greater than 34%. Therefore, an initial shift adjustment of -0.10 was required to recalibrate the rating equation. By June the shift adjustment increased to -0.14 feet and by August it was up to -0.20 feet. After plotting all of the 2022 discharges, a new rating equation was developed for the gaging station and applied to the 2022 record from May 19, 2022, until the end of the monitoring season on October 16, 2022:

Flow (cfs) = 53.195 * (stage – 13.4)^1.528

As verified by field observation, these shift adjustments and need for an updated rating equation are indicative of a channel with erodible stream banks and a shifting bedload. Graphical displays summarizing the predictive accuracy or R^2 value of the rating equations and check measurements are provided in Appendix B.

5.4.2. Discharge Record

Figure 5-4 shows the daily mean discharge recorded for Lach Q'atnu Creek. These data are also tabulated in Appendix 1. The 2021 peak mean daily flow volume of 12.2 cfs occurred on May 28, 2021, while in in 2022 the maximum mean daily discharge of 35 cfs occurred on May 23, 2022. Discharge from this tributary represents the natural runoff condition and is not influenced by operation of the hydroelectric or drinking water projects.

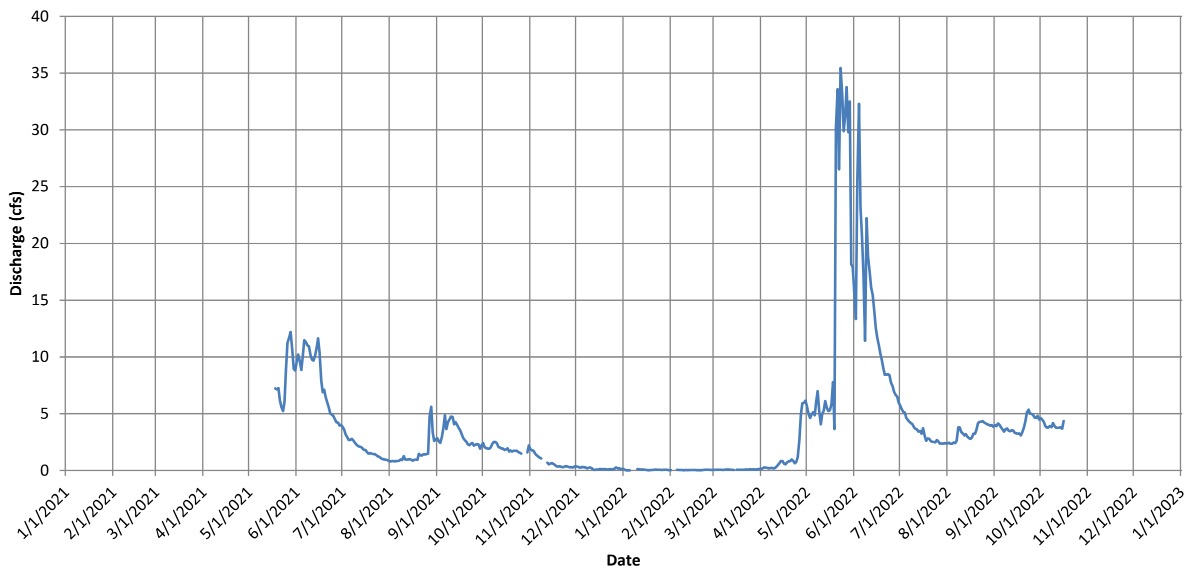

Figure 5.4. Lach Q'atnu Creek daily mean discharge, calendar years 2021-2022.

5.5. Unnamed Tributary to Pond

5.5.1. Discharge Measurements

Table 5-4 summarizes the ten instantaneous discharge measurements collected during the 2021 and 2022 study seasons. A peak instantaneous flow volume of 2.7 cfs was measured on June 28, 2022. In general, 2022 had detectably higher discharges than in 2021, indicative of a year with more rainfall. Also, precipitation after the early August 2022 measurement recharged the tributary and more than doubled the channel flows by mid-September 2022.

Table 5-4. Unnamed pond tributary (Tributary 2) discharge measurements.

Meas. No.	Date	Measured Discharge (cfs)
1	5/19/2021	0.9
2	6/23/2021	0.5
3	7/14/2021	0.5
4	8/25/2021	0.5
5	9/28/2021	0.3
6	5/15/2022	1.1
7	6/28/2022	2.7
8	8/3/2022	0.6
9	9/13/2022	1.4
10	10/16/2022	0.8

5.6. Accretion Study

5.6.1. Discharge Measurements

Tables 5-5 and 5-6 summarize the instantaneous discharge measurements collected in support of the accretion study. Maximum instantaneous flow volumes occurred at RM 3.0 above Thunderbird Creek and at RM 2.3 downstream of the Thunderbird Creek confluence. Accretion patterns along the Eklutna River reveal a consistent pattern under the existing conditions and 25 cfs study flow release from Eklutna Lake Dam that occurred between September 29 and October 6, 2021.

Table 5-5. Eklutna River accretion discharge measurements on 6/22/2021.

Location	Measured Discharge (cfs)
Railroad bridge (RM 1.3)	88.2
Old Glenn Highway bridge (RM 2.3)	93.6
Gage above Thunderbird Creek (RM 3.0)	6.1
Mid-reach (RM 5.5)	3.2
Upper (RM 10.3)	0.2

Table 5-6. Eklutna River accretion discharge measurements on 9/30/2021.

Location	Measured Discharge (cfs)
Railroad bridge (RM 1.3)	63.0
Old Glenn Highway bridge (RM 2.3)	66.2
Gage above Thunderbird Creek (RM 3.0)	23.8
Mid-reach (RM 5.5)	22.1
Upper (RM 10.3)	19.4

6 STUDY CONCLUSIONS AND CONTINUED STUDY EFFORTS

The results and conclusions from this study will be utilized during the alternatives analysis to evaluate any potential impacts to Eklutna River stream flows that may result from future water management changes. Computed stage-discharge relationships predicted streamflow measurements within 10% at all established gaging locations except for one instance above Thunderbird Creek.

In 2021, Eklutna River flows below Thunderbird Creek were relatively high in spring, tapered off mid to late summer, then peaked during the study flow releases in September. As expected, winter (December 2021 to mid-April 2022) represents the lowest flow period at this location with mean daily flows ranging from 15 to 29 cfs and averaging 18 cfs. In 2022, the start of spring runoff and increasing flows began in late April and peaked at 270 cfs on June 10, 2022. In comparison to 2021, peak mean daily discharge without study flow release influence occurred in the same timeframe (June 18, 2021) but was substantially lower at 123 cfs. These interannual variances in peak flow volumes can be directly attributed to differences in rainfall. Based on more than 95 years of precipitation data from the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI, 2022), May 2022 – October 2022 was ranked as "much above average", whereas the May 2021 – October 2021 period was ranked as "below average". Finally, these 2 years of gaging data reflect the 2002-2007 record from the USGS. Daily flow statistics from USGS gage 15280200 show that peak mean daily flows occur in mid-June and that winter flows range from 12-25 cfs. Also, the peak mean daily flow of 270 cfs on June 10, 2022, is similar to the peak daily flow volume of 255 cfs calculated by the USGS on 8/25/2006.

In 2021, mean daily flows above Thunderbird Creek were extremely stable through the spring-summer monitoring period, ranging from 6-7 cfs until the onset of the study flow releases on September 13, 2021. During 24 days of study flow releases from September 13 to October 6, 2021, mean daily flows ranged from 22 cfs to 122 cfs. Immediately following the end of study flow releases, mean daily discharges returned to a stable flow condition of 4-5 cfs starting on October 7, 2021. Over the winter of 2021-2022, mean daily discharges stabilized after one short duration runoff event, and remained in the 2-3 cfs range. In 2022, the trend of slowly increasing flow volumes began in mid-February and peaked at 26 cfs on April 26, 2022. As pointed out above, the "much above average" precipitation ranking by NCEI (2022) reveals a much more dynamic hydrograph in response to the increased rainfall, with mean daily flow volumes fluctuating substantially in comparison to the stable runoff condition detected in 2021. Finally, the range of discharges have not change much over time. Flows not augmented by study flow releases ranged from 2-26 cfs for the 2021-2022 study period, while the 35 instantaneous discharge measurements from 1954-2006 at USGS gaging station 15280100 ranged from 4-24 cfs. Overall, these 2021-2022 continuous flow data indicate that "below average" precipitation periods result in stable discharges, likely dominated by groundwater inputs. In contrast, "much above average" periods of precipitation lead to greater surface water runoff volumes and a dynamic hydrograph that appears to be directly responding to rainfall events.

In 2021, estimated mean daily flows for Thunderbird Creek are similar to those summarized by the Native Village of Eklutna (NVE 2003), which had peak mean daily flows of ~100 cfs occurring in the third week of June in 2002 and 2003. Although the magnitude of peak Thunderbird Creek flows in 2022 are substantially greater than data from 2021 and NVE (2003), the time series hydrograph pattern is similar. In 2022, winter flow data (January 1-April 15) from Thunderbird Creek slowly and consistently decreases, ranging from 18 cfs to 5 cfs and again, closely matches flow volumes and patterns from NVE (2003). Finally, as demonstrated in Figure 5-3, the Thunderbird Creek watershed serves as the primary contributor of surface water discharge to the lower Eklutna River.

In 2021, flows in Lach Q'atnu Creek peaked in the spring at 12 cfs on May 28, 2021, decreased substantially during summer, and slightly increased again in response to fall rains. Over the 2021-2022 winter, discharges from mid-November to late April were stable, but extremely low, ranging from nearly 0 cfs to 0.8 cfs, with an average mean daily flow of 0.2 cfs. In spring of 2022, detectable flow increases began in late April with a peak discharge of 35 cfs on May 23, 2021. Although peak discharges were nearly 3 times greater in 2022, the Lach Q'atnu Creek watershed appears to be a snowpack driven system. Despite wetter than normal precipitation in

2022, Lach Q'atnu Creek flows tailed off rapidly through July and were only slightly greater than 2022 flows from August 1- October 16. In 2021 and 2022, the August to mid-October mean daily flow averaged 2.3 cfs and 3.7 cfs, respectively. Overall, if flows from Lach Q'atnu Creek would be considered for diversion to the Eklutna River below the dam, it appears that discharges greater than 5 cfs would be available from May through June, with little to no flow contributions in the winter.

Monthly spot discharge measurements taken at the unnamed tributary to the pond indicate relatively low flow volumes in 2021(≤0.9 cfs) that decreased through the fall in 2021. In 2022, the average of the five instantaneous measurements was higher than in 2021 (1.3 cfs vs. 0.54 cfs, respectively), but also showed variable flow volumes over the 2022 season. Similar to responses at the Eklutna River gaging stations, it appears that the higher precipitation totals in 2022 directly impacted flow volumes at this unnamed tributary. However, similar to Lach Q'atnu Creek, diversions from this tributary into the Eklutna River would minimally augment flows, rarely providing more than 1 cfs of surface water. Overall, the gaging efforts at Lach Q'atnu Creek and the unnamed tributary will assist with knowledge of the expected seasonal inflows from these two drainages.

The accretion study shows that measurable stream flows do not occur under existing conditions for approximately 2.0 miles downstream of the Eklutna Lake Dam. Also, both sets of accretion measurements indicate minimal flow accumulations ranging from 4-6 cfs from RM 10.3 downstream to just above the confluence with Thunderbird Creek at RM 3.0. Downstream of the Thunderbird Creek confluence there is a slight, but consistently measured flow loss averaging about 4 cfs from the Old Glenn Highway bridge downstream to the railroad bridge. The minor flow loss in this one-mile stream reach of the Eklutna River represents a decrease of less than 5.8 percent of the total flow volume.

As mentioned in Section 1 (Introduction) of this Study Report, efforts will continue over the winter and through the fall of 2023 to build upon the 2021-2022 discharge record. In addition, continued stream gaging efforts will provide another year of discharge records and background information in support of the development of a Fish and Wildlife Program for the project. Given the consistent findings and stable flow conditions in which the accretion study was conducted, data from the Year 1 accretion study effort represents the completion to this component of the stream gaging study.

7 VARIANCES FROM FINAL STUDY PLAN AND IMPLEMENTED MODIFICATIONS

There were two notable variations from the FSP. As described in Section 2, a stream gage was not installed at the unnamed tributary to the pond. This was due to a braided, steep channel in which a single gaging location would not accurately represent flow volumes. Monthly, instantaneous discharge measurements were conducted to assess the seasonal flow conditions from May-October.

The second variance from the FSP was the relocation of Accretion Site 5 from RM 8 upstream to RM 10.3. The formation of a substantial beaver pond downstream of RM 10 limited reliable access to RM 8 of the Eklutna River. Therefore, a site was chosen that had measurable surface water flows under a zero-spill condition and was not going to experience a backwater effect from the beaver pond.

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Appendix A: Daily Mean Discharge Tables

Table A1-1. Eklutna River below Thunderbird Creek 2021-2022.

Day	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	m	m	m	m	m	62	94	45	68	65	53	27*
2	m	m	m	m	m	67	92	44	67	63	47	29
3	m	m	m	m	m	68	89	43	68	61	44	29*
4	m	m	m	m	m	64	88	42	68	59	41	m
5	m	m	m	m	m	63	86	40	68	60	40	27*
6	m	m	m	m	m	68	86	40	72	60	39	26
7	m	m	m	m	m	85	87	39	66	54	38	25
8	m	m	m	m	m	89	83	41	68	52	31	24
9	m	m	m	m	m	91	79	40	73	52	28*	24
10	m	m	m	m	m	89	77	41	75	51	m	24
11	m	m	m	m	m	82	75	38	72	50	m	23
12	m	m	m	m	m	79	71	38	70	50	m	m
13	m	m	m	m	m	82	68	39	99	47	m	m
14	m	m	m	m	m	93	66	39	183	47	m	m
15	m	m	m	m	m	95	66	38	186	45	m	m
16	m	m	m	m	m	89	65	38	189	44	m	m
17	m	m	m	m	m	98	65	40	215	43	m	m
18	m	m	m	m	m	123	63	39	208	43	m	23*
19	m	m	m	m	32*	111	63	38	188	44	m	21
20	m	m	m	m	33	92	62	42	179	43	m	21
21	m	m	m	m	32	87	62	40	171	45	m	20
22	m	m	m	m	34	90	61	39	164	43	m	20
23	m	m	m	m	30	96	60	42	167	42	m	20
24	m	m	m	m	32	97	58	43	158	41	m	20
25	m	m	m	m	40	96	57	43	122	41	m	20
26	m	m	m	m	50	94	55	46	117	39	m	20
27	m	m	m	m	55	94	51	57	115	39	m	21
28	m	m	m	m	67	95	50	61	111	37	m	20
29	m	---	m	m	69	94	49	60	97	37	m	21
30	m	---	m	m	63	95	47	64	67	41	m	20
31	m	---	m	---	59	---	46	67	---	63	---	21
Mean	m	m	m	m	46	88	68	44	119	48	40	23
Min	m	m	m	m	30	62	46	38	66	37	28	20
Max	m	m	m	m	69	123	94	67	215	65	53	29

Notes:
1. **m – missing data**
2. *** - mean daily flow computed from partial record**

Table A1-1 (continued). Eklutna River below Thunderbird Creek 2021-2022.

Day	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	20*	m	16	15	43	122	142	72	122	119	m	m
2	m	m	15	16	43	134	135	70	117	119	m	m
3	m	m	16	16	41	156	128	68	116	113	m	m
4	m	m	16	16	40	176	123	65	111	109	m	m
5	m	17*	16	16	38	181	116	71	108	106	m	m
6	m	17	15	15	42	181	110	69	104	101	m	m
7	m	17	16*	15	43	208	104	70	101	100	m	m
8	m	17	16	15	44	205	99	101	98	102	m	m
9	m	17	15	15	43	254	96	121	97	110	m	m
10	m	17*	15	15	40	270	93	140	93	104	m	m
11	m	16	15	16	39	261	89	146	90	100	m	m
12	20*	16	15	16	37	249	85	148	90	99	m	m
13	19	16	15	17	40	232	80	147	89	96	m	m
14	18	16	15*	17	39	219	79	138	89	92	m	m
15	18	16	m	18	38	207	74	131	92	95	m	m
16	18	17	17*	18	40	201	85	124	90	98*	m	m
17	18*	17	15	18	41	216	79	121	87	m	m	m
18	19*	19	15	19	45	210	77	121	84	m	m	m
19	18	17	15	19	51	201	85	122	91	m	m	m
20	18	16	15	20	57	190	86	126	98	m	m	m
21	18	16	15	20	63	182	84	131	109	m	m	m
22	18	17	16	21	66	179	86	134	131	m	m	m
23	18	16	16	23	68	182	85	137	146	m	m	m
24	18	16	15	26	66	182	83	138	149	m	m	m
25	18	16	15	31	68	177	87	133	144	m	m	m
26	17	16	15	34	72	176	83	135	146	m	m	m
27	18	16	15	35	80	173	81	130	146	m	m	m
28	17	16	15	38	93	169	79	126	140	m	m	m
29	17	---	15	40	107	162	76	121	131	m	m	m
30	17	---	15	42	109	151	74	119	124	m	m	m
31	16*	---	15	---	117	---	71	119	---	m	---	m
Mean	18	17	15	21	57	193	92	116	111	104	m	m
Min	16	16	15	15	37	122	71	65	84	92	m	m
Max	20	19	17	42	117	270	142	148	149	119	m	m

Notes:

1. m – missing data

2. * - mean daily flow computed from partial record

Table A1-2. Eklutna River above Thunderbird Creek 2021-2022.

Day	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	m	m	m	m	m	6.4	6.2	5.8	5.8	33	12	2.5
2	m	m	m	m	m	6.3	6.2	5.7	5.8	30	7.5	2.5
3	m	m	m	m	m	6.3	6.2	5.7	6.3	29	6.6	2.3
4	m	m	m	m	m	6.3	6.2	5.7	5.9	29	5.7	2.4
5	m	m	m	m	m	6.2	6.2	5.7	5.9	31	5.1	2.6
6	m	m	m	m	m	6.2	6.4	5.7	5.8	27	4.7	2.4
7	m	m	m	m	m	6.6	6.5	5.6	5.6	5.4	4.4	2.5
8	m	m	m	m	m	6.5	6.5	5.9	5.5	4.5	4.3	2.5
9	m	m	m	m	m	6.4	6.4	5.8	5.6	4.7	3.9*	2.7
10	m	m	m	m	m	6.2	6.1	5.9	5.7	4.7	m	2.7
11	m	m	m	m	m	6.1	6.1	5.7	5.7	4.5	m	2.5
12	m	m	m	m	m	6.1	6.1	5.8	5.6	4.5	m	2.3
13	m	m	m	m	m	6.0	6.1	5.8	22	4.3	m	2.6
14	m	m	m	m	m	5.8	6.0	5.8	75	4.3	m	2.7
15	m	m	m	m	m	5.9	6.0	5.7	79	4.2	m	2.7
16	m	m	m	m	m	6.0	5.9	5.7	84	4.0	m	2.8
17	m	m	m	m	m	6.0	6.2	5.8	98	3.9	m	2.5
18	m	m	m	m	m	5.9	5.6	5.7	114	3.9	m	2.5
19	m	m	m	m	m	5.8	5.6	5.7	115	3.9	m	2.6
20	m	m	m	m	6.6*	5.7	5.6	5.9	107	3.9	m	2.6
21	m	m	m	m	6.4	5.8	5.8	5.8	104	4.7	m	2.7
22	m	m	m	m	6.4	6.0	5.8	5.7	114	4.5	m	2.7
23	m	m	m	m	6.3	6.1	5.7	5.8	113	4.3	m	2.7
24	m	m	m	m	6.2	6.2	5.7	5.8	120	4.1	m	2.6
25	m	m	m	m	6.2	6.3	5.7	5.7	85	4.1	2.7*	2.7
26	m	m	m	m	6.2	6.3	5.7	5.8	82	4.0	2.8	2.8
27	m	m	m	m	6.3	6.2	5.6	6.6	82	3.8	2.6	2.7
28	m	m	m	m	6.7	6.2	5.6	6.8	80	3.6	2.4	2.8
29	m	---	m	m	7.4	6.3	5.7	6.2	68	3.7	2.5	2.9
30	m	---	m	m	6.8	6.2	5.8	5.9	35	4.5	2.5	2.9
31	m	---	m	---	6.5	---	5.8	5.8	---	22	---	3.0
Mean	m	m	m	m	6.5	6.1	6.0	5.8	55	9.7	4.6	2.6
Min	m	m	m	m	6.2	5.7	5.6	5.6	5.5	3.6	2.4	2.3
Max	m	m	m	m	7.4	6.6	6.5	6.8	120	33	12	3.0

Notes:
1. **m – missing data**
2. *** - mean daily flow computed from partial record**

Table A1-2 (continued). Eklutna River above Thunderbird Creek 2021-2022.

Day	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	2.9	m	7.3	9.9	20	14	9.0	9.2	10	11	m	m
2	2.2	m	7.5	10	19	13	8.9	8.6	10	12	m	m
3	3.1	6.1*	7.5	10	19	13	8.7	7.4	9.9	13	m	m
4	3.2	5.9	7.4	10	18	13	8.8	7.2	9.6	14	m	m
5	3.5*	5.9	7.7	10	17	12	8.8	10	9.2	14	m	m
6	2.9	5.9	7.5	10	19	12	8.7	9.1	9.4	13	m	m
7	2.5	5.9	7.6*	10	17	13	8.9	8.6	9.4	14	m	m
8	3.0	5.8	7.6	10	17	13	8.8	17	9.6	14	m	m
9	3.9*	5.8	7.7	10	16	17	8.6	18	9.7	17	m	m
10	m	5.9*	7.7	10	15	17	8.5	13	9.5	17	m	m
11	3.1*	5.7	7.6	11	14	14	8.7	10	9.5	15	m	m
12	2.8	5.8	7.5	11	14	13	8.7	9.5	9.8	14	m	m
13	2.8	5.6	7.8	12	15	12	8.7	9.3	9.7	15	m	m
14	2.8	5.7	8.2*	12	14	11	9.5	9.3	10	14	m	m
15	2.8	5.7	m	13	14	11	9.0	9.0	11	14	m	m
16	2.8	6.1	7.8*	13	14	11	12	8.7	12	16*	m	m
17	2.9	6.1	7.5	13	13	11	11	8.9	12	m	m	m
18	2.9	7.3	7.4	13	13	11	10	10	11	m	m	m
19	2.9	6.3	7.5	14	14	11	12	11	13	m	m	m
20	2.9	6.3	7.7	14	15	11	13	11	16	m	m	m
21	2.9	6.4	8.0	14	16	12	11	11	20	m	m	m
22	3.4	6.9	8.1	15	16	10	11	10.0	25	m	m	m
23	3.2	6.4	7.9	17	16	9.9	10	9.5	22	m	m	m
24	3.4	6.5	7.9	20	16	10.0	9.4	9.3	18	m	m	m
25	3.4	7.1	8.3	25	16	9.9	9.9	9.4	15	m	m	m
26	3.3	7.2	8.5	26	15	9.9	9.4	10	14	m	m	m
27	3.2	7.0	8.5	25	15	9.9	9.2	11	16	m	m	m
28	3.3	7.1	8.4	25	15	9.7	8.9	11	15	m	m	m
29	3.3	---	8.6	25	15	9.1	8.6	9.9	11	m	m	m
30	3.3	---	9.2	22	15	8.9	8.7	9.6	11	m	m	m
31	3.1*	---	9.6	---	14	---	8.7	9.6	---	m	---	m
Mean	3.1	6.2	7.9	15	16	12	9.6	10	13	14	m	m
Min	2.2	5.6	7.3	9.9	13	8.9	8.5	7.2	9.2	11	m	m
Max	3.9	7.3	9.6	26	20	17	13	18	25	17	m	m

Notes:
1. **m – missing data**
2. *** - mean daily flow computed from partial record**

Table A1-3. Thunderbird Creek 2021-2022.

Day	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	m	m	m	m	m	56	88	39	62	33	41	24
2	m	m	m	m	m	61	86	38	62	33	40	26
3	m	m	m	m	m	61	83	37	61	32	37	27
4	m	m	m	m	m	57	82	36	62	30	35	26*
5	m	m	m	m	m	57	80	34	62	29	35	25
6	m	m	m	m	m	61	79	34	66	33	34	23
7	m	m	m	m	m	78	80	34	60	49	33	23
8	m	m	m	m	m	83	76	35	63	48	27	22
9	m	m	m	m	m	84	72	35	67	47	24	22
10	m	m	m	m	m	83	70	35	69	47	24*	22
11	m	m	m	m	m	76	68	32	66	45	23*	21
12	m	m	m	m	m	73	65	32	64	45	23*	21*
13	m	m	m	m	m	76	62	33	77	43	24*	20*
14	m	m	m	m	m	88	60	33	108	43	25*	21*
15	m	m	m	m	m	89	60	33	107	41	24*	20*
16	m	m	m	m	m	83	59	32	105	40	24*	21*
17	m	m	m	m	m	92	59	34	117	39	23*	20*
18	m	m	m	m	m	117	57	33	94	39	24*	20
19	m	m	m	m	m	105	58	32	74*	40	25*	18
20	m	m	m	m	26	87	56	37	72*	39	25*	18
21	m	m	m	m	26	81	56	34	67*	40	25*	18
22	m	m	m	m	27	84	55	34	50	38	25*	17
23	m	m	m	m	24	90	54	36	55	37	24*	17
24	m	m	m	m	26	90	53	37	38	37	23*	17
25	m	m	m	m	34	90	51	37	37	36	24*	17
26	m	m	m	m	44	88	49	40	34	35	24*	17
27	m	m	m	m	48	88	45	51	32	35	24*	18
28	m	m	m	m	60	89	44	54	31	34	23*	17
29	m	---	m	m	62	88	43	54	29	33	24*	18
30	m	---	m	m	56	89	42	59	33	36	24*	18
31	m	---	m	---	53	---	40	62	---	41	---	18
Mean	m	m	m	m	40	81	62	38	64	39	27	20
Min	m	m	m	m	24	56	40	32	29	29	23	17
Max	m	m	m	m	62	117	88	62	117	49	41	27

Notes:
1. **m – missing data**
2. *** - mean daily flow computed from partial record**

Table A1-3 (continued). Thunderbird Creek 2021-2022.

Day	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	18	13*	8.4	5.3	23	109	133	63	111	107	m	m
2	17*	13*	7.9	5.5	24	121	126	62	106	107	m	m
3	17*	12*	8.3	5.2	22	143	120	60	106	100	m	m
4	17*	12*	8.2	5.3	22	164	114	58	101	95	m	m
5	17*	11	7.9	5.2	21	169	107	61	99	92	m	m
6	17*	11	7.7	5.4	23	168	102	60	94	88	m	m
7	17*	11	7.9	5.0	26	194	95	61	92	87	m	m
8	17*	11	8.5	4.9	28	192	90	84	89	88	m	m
9	17*	11	7.8	5.5	27	237	88	103	87	93	m	m
10	17*	11	7.8	5.2	25	253	84	128	83	86	m	m
11	17*	11	7.7	5.1	25	247	80	136	81	85	m	m
12	17	11	7.7	4.7	24	236	76	139	80	84	m	m
13	16	10	7.1	4.9	25	220	71	137	79	81	m	m
14	15	11	6.9	5.1	25	207	69	129	79	78	m	m
15	16	10	7.8*	5.2	24	196	65	122	81	81	m	m
16	15	11	8.8	5.0	26	190	73	115	78	82	m	m
17	15	11	7.8	5.0	28	205	68	112	75	m	m	m
18	16	12	7.7	5.4	32	199	66	111	73	m	m	m
19	15	10	7.5	5.5	37	190	73	111	78	m	m	m
20	15	9.7	7.4	5.8	42	180	73	115	82	m	m	m
21	15	9.9	7.1	6.0	47	170	73	120	89	m	m	m
22	15	9.6	8.2	6.0	50	169	75	124	106	m	m	m
23	15	9.6	7.8	6.1	52	172	74	128	124	m	m	m
24	15	9.5	7.0	5.9	50	172	74	128	131	m	m	m
25	15	9.2	6.8	6.2	52	167	77	123	129	m	m	m
26	14	8.7	6.2	7.9	57	166	74	124	132	m	m	m
27	14	8.8	6.0	10	65	163	72	119	129	m	m	m
28	14	8.6	6.3	13	78	160	70	115	125	m	m	m
29	14	---	6.0	15	92	153	68	111	119	m	m	m
30	14	---	5.4	20	94	142	65	109	113	m	m	m
31	13	---	5.2	---	102	---	62	109	---	m	---	m
Mean	16	11	7.4	6.7	41	182	83	106	98	90	m	m
Min	13	8.6	5.2	4.7	21	109	62	58	73	78	m	m
Max	18	13	8.8	20	102	253	133	139	132	107	m	m

Notes:
1. **m – missing data**
2. *** - mean daily flow computed from partial record**

Table A1-4. Lach Q'atnu Creek 2021-2022.

Day	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	m	m	m	m	m	9.6	3.9	0.79	2.8	2.4	1.9	0.35
2	m	m	m	m	m	10	3.6	0.82	2.6	2.1	1.8	0.33
3	m	m	m	m	m	9.6	3.2	0.85	2.4	2.0	1.7	0.28
4	m	m	m	m	m	8.9	3.0	0.81	3.0	1.9	1.5	0.25
5	m	m	m	m	m	10	2.7	0.82	3.8	1.9	1.3	0.32
6	m	m	m	m	m	11	2.7	0.84	4.9	2.0	1.2	0.29
7	m	m	m	m	m	11	2.8	0.85	3.7	2.4	1.1	0.27
8	m	m	m	m	m	11	2.7	0.97	4.3	2.5	1.1*	0.20
9	m	m	m	m	m	11	2.5	0.92	4.5	2.5	m	0.23
10	m	m	m	m	m	10	2.3	1.3	4.8	2.4	m	0.27
11	m	m	m	m	m	9.8	2.2	0.96	4.7	2.1	m	0.21
12	m	m	m	m	m	9.7	2.1	0.95	4.1	2.0	0.69*	0.09
13	m	m	m	m	m	10	2.1	0.97	4.2	2.0	0.54	0.04
14	m	m	m	m	m	11	2.0	0.99	4.0	1.9	0.61	0.08
15	m	m	m	m	m	12	1.8	0.96	3.7	1.8	0.65	0.06
16	m	m	m	m	m	10	1.8	0.86	3.5	1.9	0.58	0.11
17	m	m	m	m	m	7.9	1.6	0.94	3.2	1.9	0.49	0.11
18	m	m	m	m	7.2*	6.9	1.5	0.96	2.9	1.7	0.38	0.13
19	m	m	m	m	7.1	7.1	1.5	0.94	2.7	1.8	0.33*	0.11
20	m	m	m	m	7.3	6.5	1.5	1.5	2.5	1.7	0.36*	0.12
21	m	m	m	m	6.2	6.0	1.5	1.3	2.3	1.7	0.34	0.09
22	m	m	m	m	5.6	5.5	1.4	1.3	2.2	1.7	0.29	0.08
23	m	m	m	m	5.2	5.0	1.3	1.4	2.4	1.7	0.33	0.12
24	m	m	m	m	6.1	4.9	1.2	1.4	2.4	1.6	0.38	0.08
25	m	m	m	m	8.9	4.8	1.2	1.5	2.2	1.6	0.35	0.11
26	m	m	m	m	11	4.5	1.1	1.5*	2.3	1.5*	0.31	0.16
27	m	m	m	m	12	4.3	1.0	4.7	2.3	m	0.28	0.27
28	m	m	m	m	12	4.2	0.99	5.6	2.3	m	0.28	0.19
29	m	---	m	m	11	4.0	0.95	3.3	1.9	m	0.27	0.19
30	m	---	m	m	8.9	4.0	0.93	2.6	2.2	1.6	0.36	0.12
31	m	---	m	---	8.8	---	0.86	2.7	---	2.2	---	0.16
Mean	m	m	m	m	8.4	8.0	1.9	1.5	3.2	1.9	0.72	0.17
Min	m	m	m	m	5.2	4.0	0.86	0.79	1.9	1.5	0.27	0.04
Max	m	m	m	m	12	12	3.9	5.6	4.9	2.5	1.9	0.35

Notes:

1. **m – missing data**
2. *** - mean daily flow computed from partial record**

Table A1-3 (continued). Lach Q'atnu Creek 2021-2022.

Day	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
1	0.11	0.03*	0.05	0.14	5.6	17	5.6	2.1	4.6	5.5	m	m
2	0.05	m	0.06*	0.20	5.0	15	5.2	2.2	4.5	5.3	m	m
3	0.00	m	0.06	0.27	4.6	26	4.8	2.1	4.8	5.1	m	m
4	0.01	m	0.06	0.25	4.9	33	4.8	2.1	4.7	4.5	m	m
5	0.01*	0.06	0.07	0.23	5.1	25	4.1	2.3	4.3	4.3	m	m
6	m	0.05	0.06	0.20	4.9	22	3.9	2.2	4.0	4.3	m	m
7	m	0.04	0.04*	0.21	6.1	19	3.7	2.5	3.8	4.5	m	m
8	m	0.05	0.06	0.23	7.0	12	3.5	4.3	4.1	4.3	m	m
9	m	0.03	0.08	0.19	5.3	24	3.4	4.3	4.2	4.9	m	m
10	0.13*	0.02	0.08	0.22	4.1	20	3.0	3.7	3.9	4.5	m	m
11	0.11	0.04	0.08	0.34	5.0	19	2.9	3.5	3.8	4.3	m	m
12	0.08	0.04	0.07	0.48	5.3	17	2.8	3.2	3.9	4.2	m	m
13	0.08	0.04	0.07	0.65	6.1	17	2.5	3.4	3.9	4.3	m	m
14	0.08	0.04	0.05*	0.84	5.5	15	2.6	3.1	3.6	4.3	m	m
15	0.06	0.04	m	0.81	5.2	14	2.3	2.9	3.5	4.1	m	m
16	0.05	0.05*	0.07	0.60	5.3	13	3.3	2.7	3.5	5.2*	m	m
17	0.03	0.04	0.06	0.55	5.9	12	2.6	2.9	3.5	m	m	m
18	0.03	0.03	0.07	0.73	8.4	11	2.5	3.5	3.2	m	m	m
19	0.04	0.03	0.07	0.81	4.1	10	2.8	3.5	3.7	m	m	m
20	0.04	0.03	0.07	0.83	31	9.6	2.8	4.0	4.3	m	m	m
21	0.07	0.03	0.07	0.97	34	8.9	2.5	4.9	5.2	m	m	m
22	0.08	0.04	0.08	0.83	27	9.0	2.4	5.0	6.3	m	m	m
23	0.06	0.05	0.08	0.64	35	9.0	2.3	5.0	6.6	m	m	m
24	0.07	0.07	0.08	0.75	33	8.9	2.3	5.1	6.1	m	m	m
25	0.06	0.07	0.09	1.2	31	8.1	2.6	5.0	6.1	m	m	m
26	0.04	0.06	0.09	2.7	32	7.7	2.4	4.8	5.9	m	m	m
27	0.07	0.05	0.10	4.9	34	7.1	2.1	4.7	5.6	m	m	m
28	0.07	0.06	0.08	5.9	30	6.8	2.1	4.7	5.5	m	m	m
29	0.07	---	0.08	6.0	33	6.6	2.1	4.5	5.8	m	m	m
30	0.05	---	0.11	6.2	20	5.9	2.2	4.6	5.3	m	m	m
31	0.03	---	0.14	---	19	---	2.1	4.4	---	m	---	m
Mean	0.06	0.04	0.07	1.3	15	14	3.0	3.7	4.6	4.6	m	m
Min	0.00	0.02	0.04	0.14	4.1	5.9	2.1	2.1	3.2	4.1	m	m
Max	0.13	0.07	0.14	6.2	35	33	5.6	5.1	6.6	5.5	m	m

Notes:
1. **m – missing data**
2. *** - mean daily flow computed from partial record**

Appendix B: Station Rating Curves

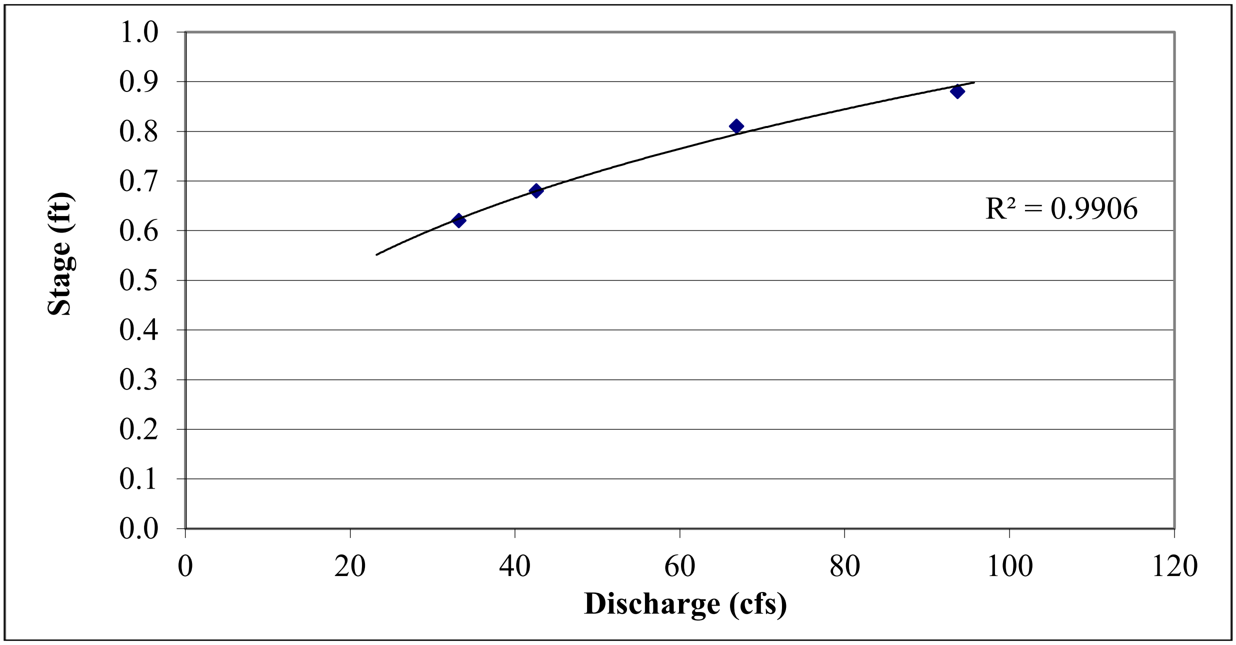

Figure A2-1. Eklutna River below Thunderbird Creek (Site 1).

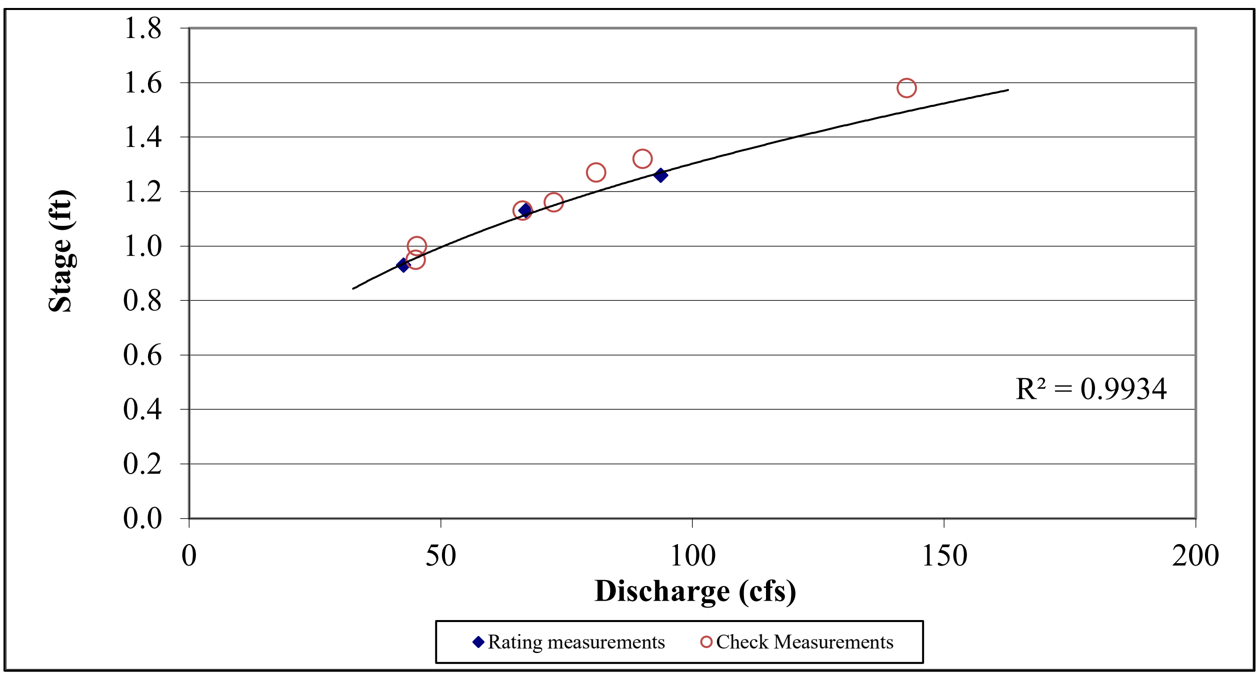

Figure A2-2. Eklutna River below Thunderbird Creek (Site 2).

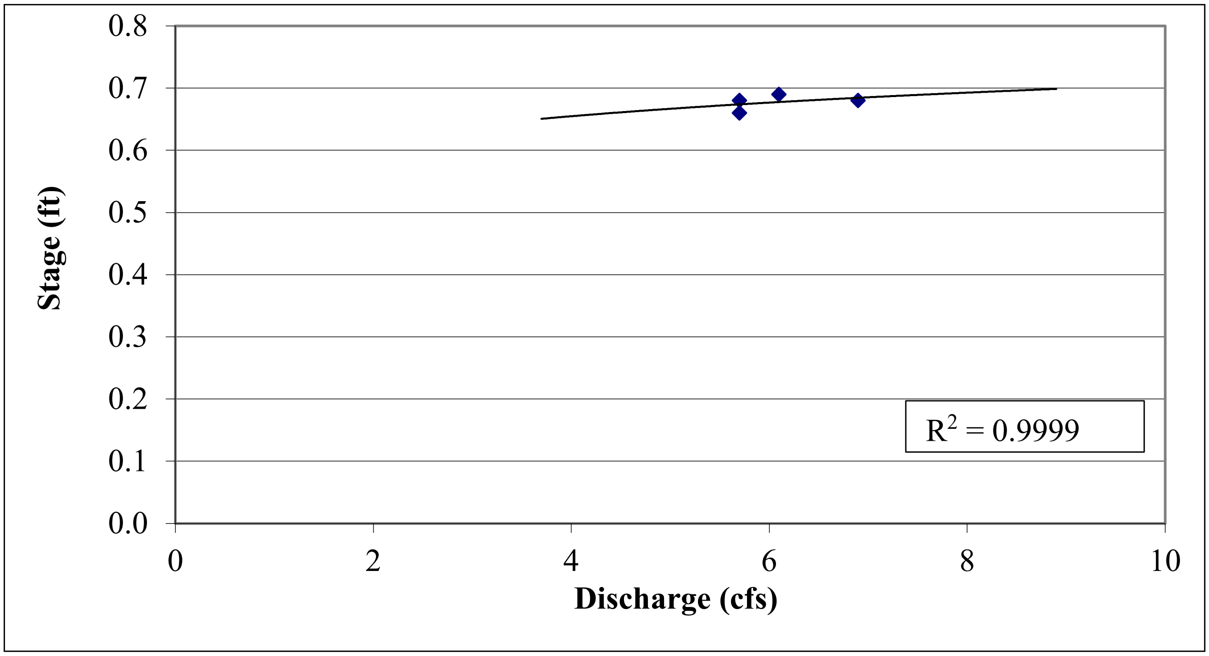

Figure A2-3. Eklutna River above Thunderbird Creek, pre-release.

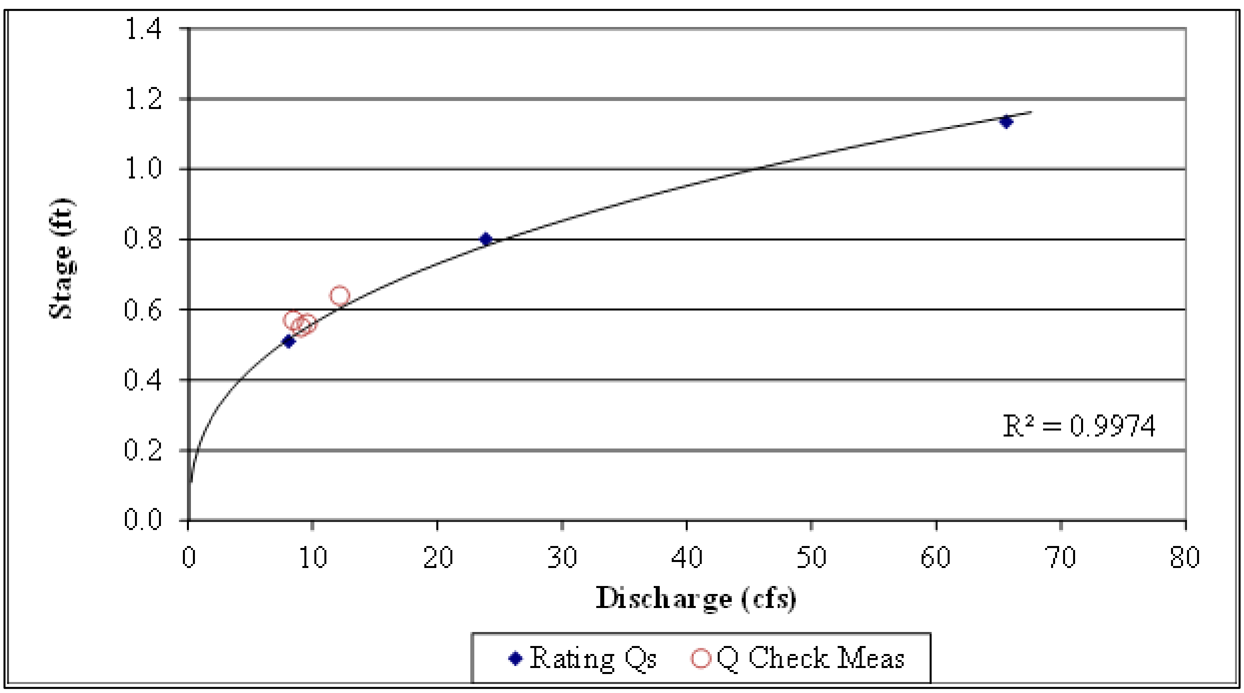

Figure A2-4. Eklutna River above Thunderbird Creek, post-release.

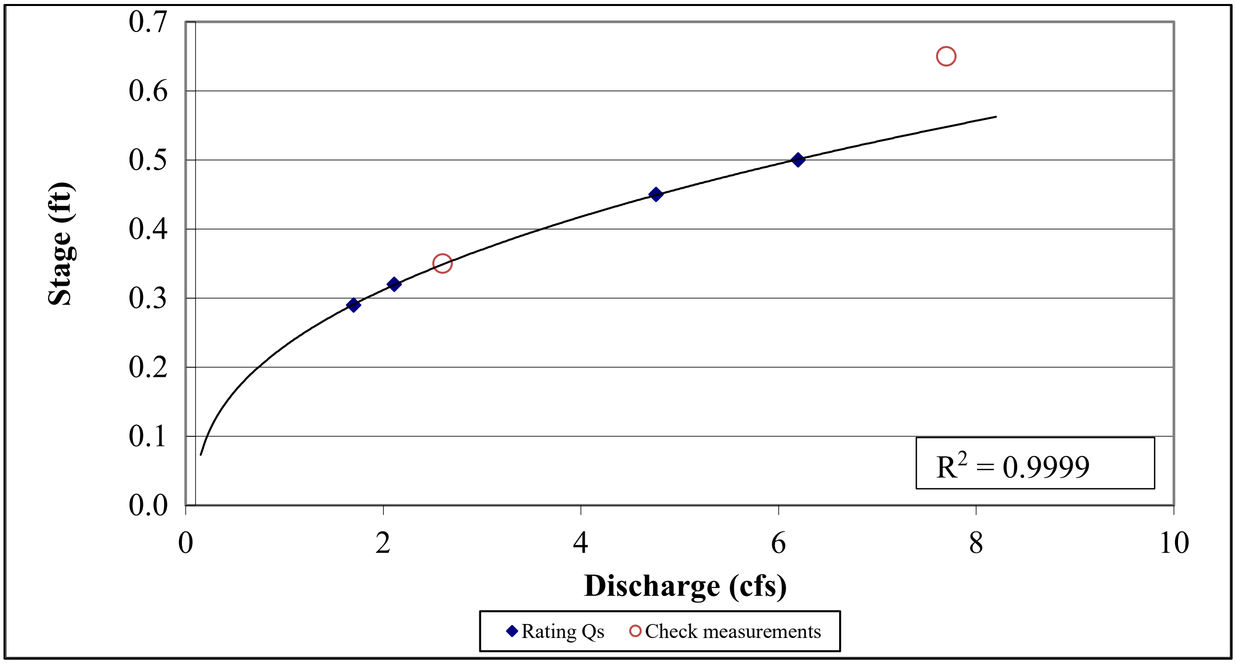

Table A2-5. Lach Q’atnu Creek Rating 1.

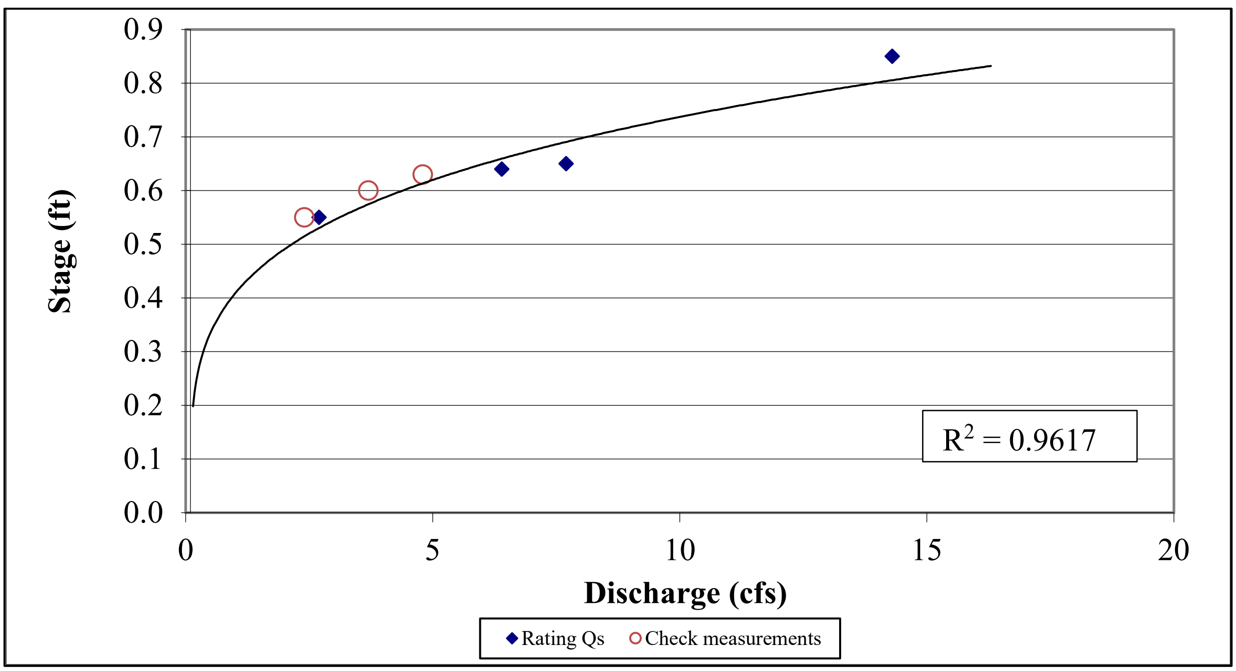

Table A2-6. Lach Q’atnu Creek Rating 2