Stream Flow Monitoring Report - Water Year 2021 – Salmon Creek

Annex Creek/Salmon Creek Hydroelectric Project

(FERC Project No. 2307)

Alaska Electric Light and Power Company

Juneau, Alaska

November 12, 2021

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1. INTRODUCTION AND PURPOSE

In October 2015, Alaska Electric Light & Power Company (AELP) requested an amendment to its license that would allow the operation of the stream gage to be performed by the licensee. By Order issued December 30, 2015, the Federal Energy Regulatory Commission (FERC) approved the amendment and stipulated that a new stream flow plan be developed after consultation with Alaska Department of Fish and Game (ADFG), National Marine Fisheries Service (NMFS), and the United State Fish and Wildlife Service (USFWS). AELP prepared a plan in consultation with ADFG, NMFS, and USFWS, as well as with the Alaska Department of Natural Resources (ADNR) Water Division and National Weather Service (NWS).

By Order issued August 9, 2016 the FERC approved the stream flow monitoring plan with a requirement to file an instream flow monitoring report biannually to the FERC, NMFS, USFWS and ADFG with the requirement changing to an annual report after four successful biannual reports. The report is to review operation of the gage, identify when supplemental water was released and include information on the operation of the supplemental water valve. The report is to be submitted for agency review, with a 30-day review and comment period, prior to filing with the FERC. Documentation of agency consultation should be included in the report.

The first report was submitted to FERC on April 19, 2017, the second report on August 16, 2017, the third on February 20, 2018 and the fourth on August 28, 2018. With the submission to FERC of the fourth report, AELP requested that the due date for the annual report be changed to December 1, 2019 to allow the entire water year to be analyzed in the report. This request was approved by FERC Order on October 9, 2018.

This is the third annual report, it covers the period since the last annual report submitted on November 30, 2020 and includes all of water year 2021.

1.1. Gage Operation

The stream gage started operation on April 27, 2016, taking level measurements on a 15 minute basis. This data is automatically distributed to www.aelp.com/About-Us/Salmon-Creek-Streamflow where it is available for public display. The page has multiple graph options for quick review of the data. Real-time flow data is supplied directly to the AELP Supervisory Control and Data Acquisition (SCADA) System where it is logged and monitored. Alarms are automatically generated for low flow conditions or for loss of communication with the sensor.

The communication path between the gage and the AELP SCADA system is through a cellular phone modem, which performed well during the period. This communication link is continuously monitored by the AELP SCADA system at the AELP dispatch center which is manned 24 hours per day. The operators

are trained to respond to all alarms, either by taking direct action or calling a technical specialist who can resolve the specific problem.

After multiple communication failures in October and November of 2019, AELP worked with AT&T to install a new cellular modem intended to provide a more stable communications path for the site. Installation of the new cellular modem was completed on December 2, 2019. Except for one communications failure in late July 2020, the new cellular modem proved very reliable in water year 2020. In water year 2021, one failure occurred early on the morning of June 3, 2021 due to changes made by the cellular provider, and was resolved before noon that same day. No other failures occurred in water year 2021.

Communication failures do not result in any data loss since the data is still stored locally on the datalogger but it does result in a loss of real-time data to the AELP SCADA system. Although the typical stream flow is well above the 9CFS action level and the stream flow doesn't change rapidly, the AELP Operator opens the valve for any loss of communication event and leaves the valve opened until communication is restored. This ensures that AELP remains in compliance with the license requirements.

Figures 1 through 4 below show the plots of daily mean discharge and field measured discharge for the period from October 1, 2020 to September 30, 2021. A total of nine discharge measurements were conducted to validate discharges from October 2020 through September 2021. Calibration measurements ranged from 9.7 to 150 CFS.

Ed Neal with Alaska Hydroscience provided a new rating table for the stream on January 22, 2019, and the rating was continued in use, with slight shift adjustments, until a large peak discharge on Dec. 1, 2020. This large peak resulted in channel fill through the gage reach. Following that event, another rating was constructed based on seven discharge measurements and the highest recorded measurements conducted by the U.S. Geological Survey at this same site and gage datum. A copy of the new rating curve dated October 7, 2021, is included in Appendix C.

A table of the Daily Mean Discharge for the months of October 2016 through September 2021 is included in Appendix B.

Figure 1 – Fourth Quarter 2020 Corrected Discharge

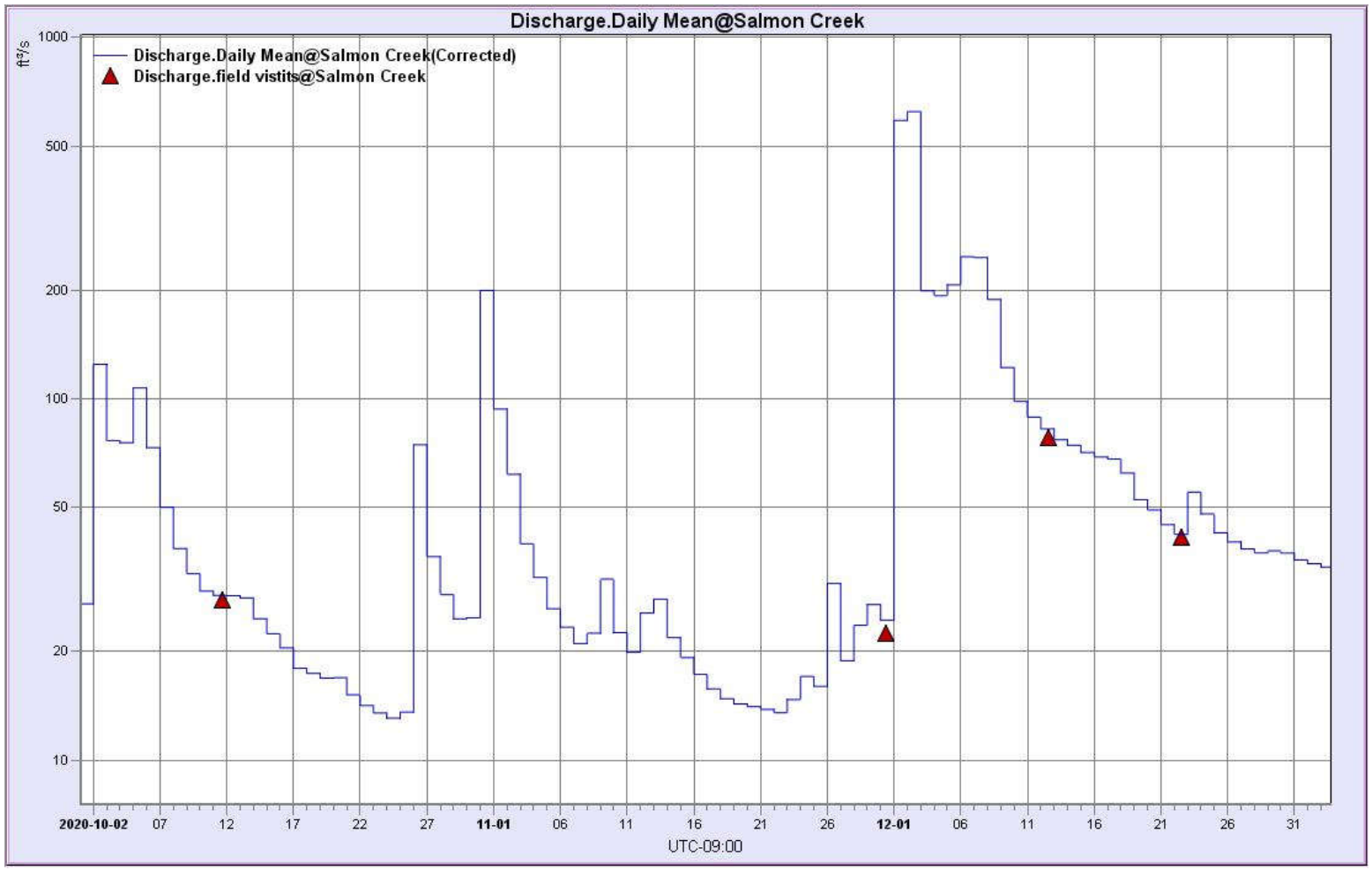


Figure 2 – First Quarter 2021 Corrected Discharge

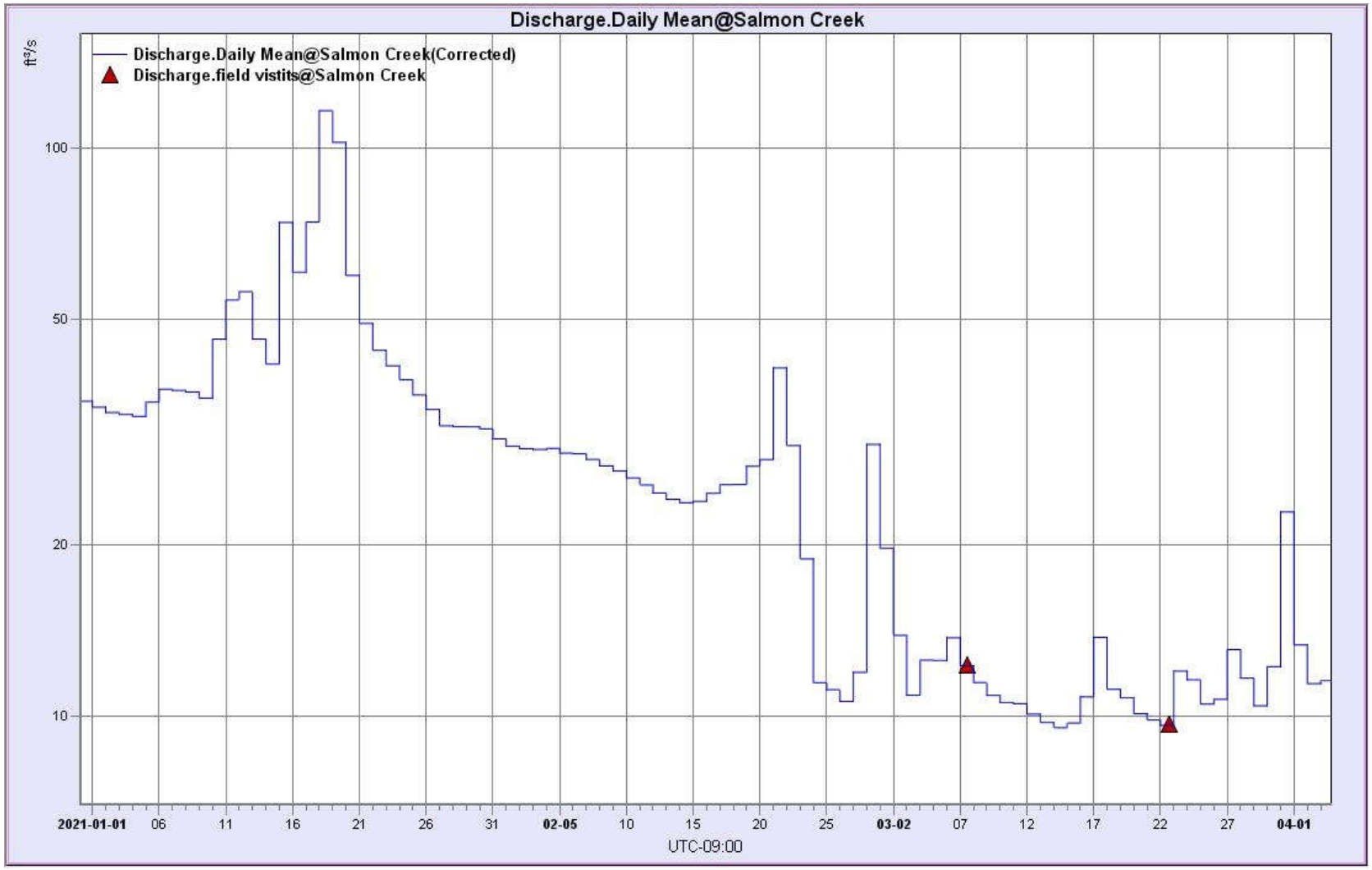


Figure 3 – Second Quarter 2021 Corrected Discharge

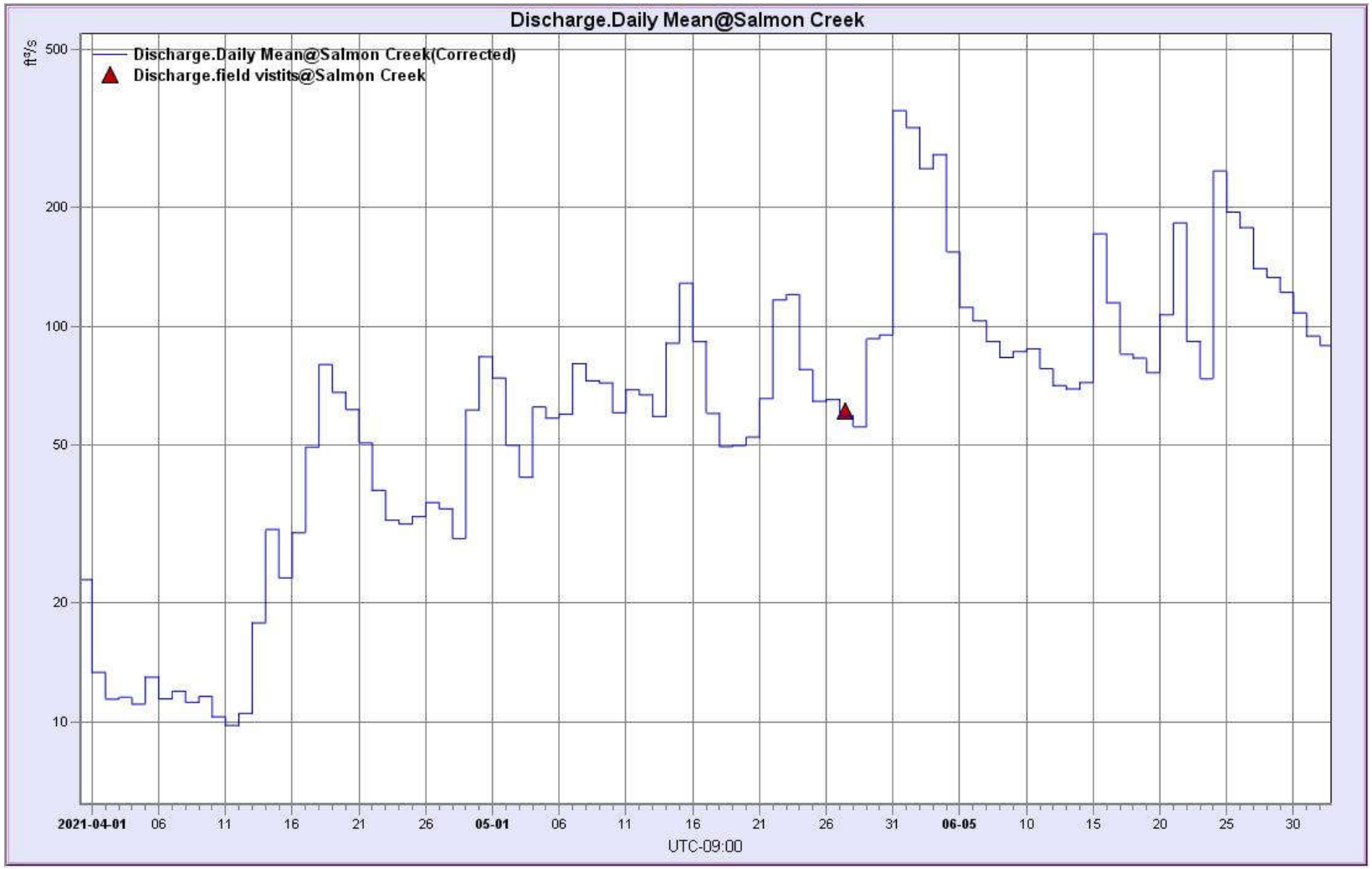
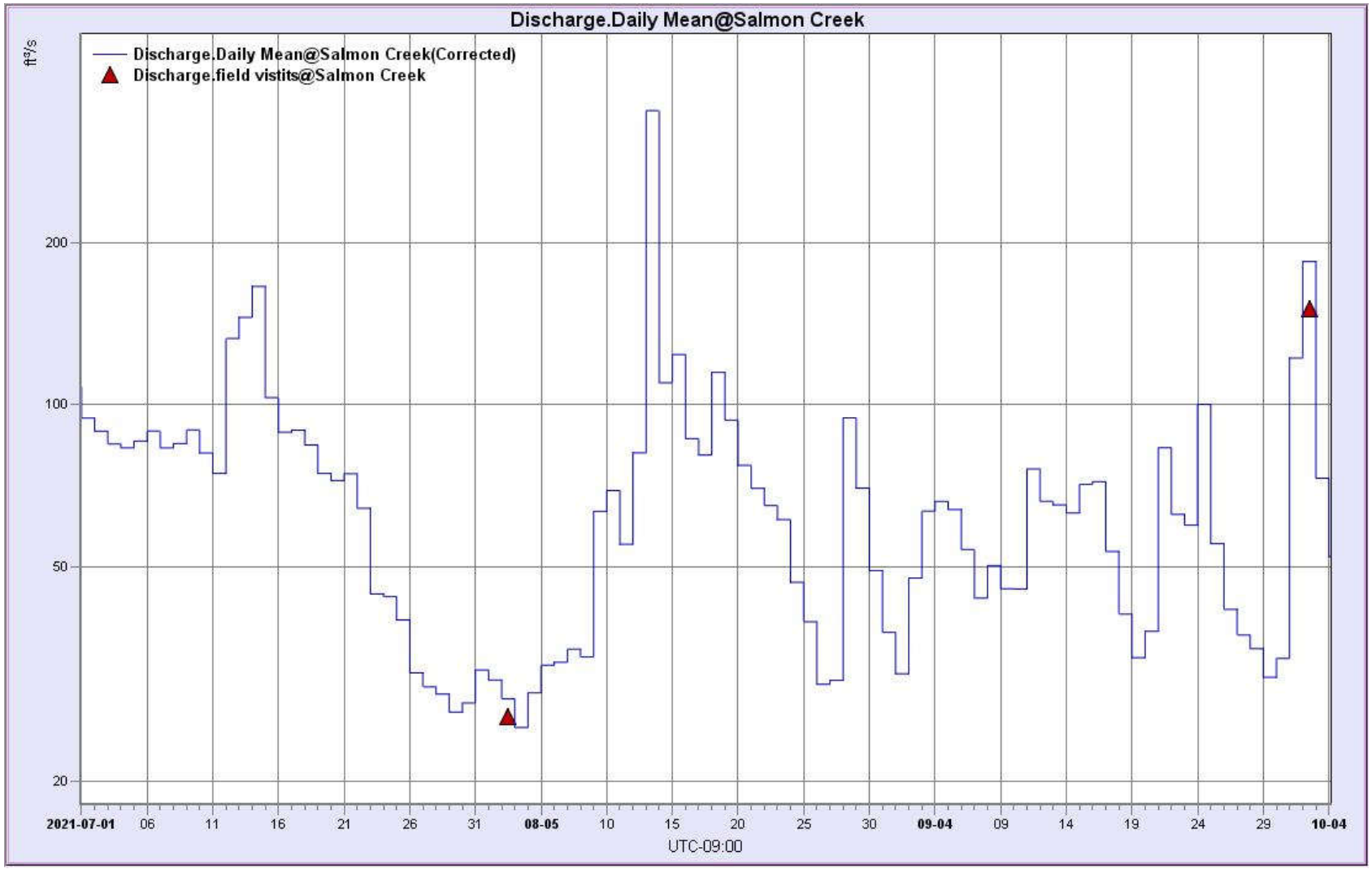


Figure 4 – Third Quarter 2021 Corrected Discharge



1.2. Supplemental Valve Operation

The supplemental water valve is a 6" valve tapped off the penstock at the base of the dam. The valve discharges water directly into the natural drainage. Operation of the valve is performed remotely by the AELP System Operator who also has real-time indication of the streamflow. When the flow drops to 9CFS, an alarm is generated, and the Operator opens the valve and logs the operation.

The valve is either open or closed, there are no intermediate positions. The Operator has feedback on the valve position, provided by limit switches which show the valve position as well as an analog signal which reflects valve position. In addition to valve position, there is a flowmeter on the outlet of the valve. The amount of flow through the valve when open varies with the reservoir elevation. At a higher elevation there is more flow and at a lower elevation the flow is less. The valve has been sized to ensure a minimum of 3CFS of flow at minimum reservoir elevation, so typically more than 3 CFS is discharged to the stream.

1.3. Supplemental Valve Release

Water year 2021 continued with the high levels of precipitation that began in the previous water year. Juneau had record rains in December of 2020, and near record levels through the first half of the 2021 calendar year. Due to high precipitation, the supplemental valve was not used to compensate for low streamflow levels after April 2021 but was used twice in accordance with the Outlet Release Plan to help reduce the elevation of the Salmon Creek Reservoir. The table below shows operations of the supplemental valve for the period since the last annual report.

Station service at the valvehouse located at the base of the dam is provided by a small hydroelectric DC generator. This power is used for monitoring, valve operation, and battery charging. The output of the turbine is discharged into the stream at the base of the dam, which increases the flow into the natural drainage. During the low flow periods, the stream flow in Salmon Creek was stable due to the consistent releases through the supplemental valve and the hydroelectric turbine output.

Date	Time	Action	Release Flow (CFS)
12/2/2020	13:15	OPEN	4
2/18/2021	10:01	CLOSED	4
2/23/2021	19:37	OPEN	4.1
2/27/2021	17:20	CLOSED	4
3/3/2021	19:27	OPEN	4.1
3/17/2021	15:42	CLOSED	4
3/18/2021	07:23	OPEN	4
3/31/2021	6:55	CLOSED	3.9
4/2/2021	04:40	OPEN	3.9

4/5/2021	14:45	CLOSED	3.9
4/6/2021	11:59	OPEN	3.8
4/13/2021	02:31	CLOSED	3.7
6/3/2021	00:47	OPEN(1)	4
6/3/2021	11:38	CLOSED	3.9
6/25/2021	17.10	OPEN(2)	4.3
7/22/2021	13:00	CLOSED	4.3
8/13/2021	21:11	OPEN(2)	4.4
8/24/2021	08:49	CLOSED	4.3

(1) Valve opened due to communication failure to stream gage, not a low flow condition.
(2) Valve opened due to reaching action level 1135' in Outlet Release Plan.

1.3.1. Low Level Outlet Valve Operation – Special Circumstances

The Salmon Creek reservoir level is controlled by a Low Level Outlet Valve combination at the base of the dam, operation of these valves are described in the Outlet Release Plan. They are typically operated only if the reservoir level is nearing control elevation; however, in December 2020 a landslide event damaged the Salmon Creek penstock. During that period, AELP discharged water from the Low Level Outlet valves to enable Douglas Island Pink and Chum (DIPAC) to remove water from the stream at the lower elevation for hatchery operations. The valve was opened on December 2, 2020 and left open until repairs were complete in mid-February 2021. Some of this flow was captured by DIPAC prior to the stream gage location, but not all and that is reflected by the higher flow measurements during this period.

1.4. Agency Consultation

A copy of the report with a request for consultation was sent out on October 13, 2021, by Steve Vorderbruggen with AELP to ADFG, USFWS and NMFS by e-mail.

A copy of the request for consultation and comments received are included in Appendix A.

APPENDIX A: AGENCY COMMENTS

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Draft copies of this report were sent to the following agencies on Oct 14, 2021:

Kevin D. Keith
FERC Hydropower Coordinator
Instream Flow Program
Alaska Department of Fish & Game

Doug Cooper
Anchorage Fish and Wildlife Field Office
Endangered Species Branch
US Fish and Wildlife Service

Sean Eagan
Hydropower Coordinator, Habitat Division, Alaska Region
NOAA Fisheries
U.S. Department of Commerce

Comments:

- ADF&G had no comments.
- USFWS had no comments.
- NOAA replied that the report complied with the FERC license and reporting requirements but requested AELP back calculate the flow that occurred on Dec 1-2, 2020.
  AELP Response: The purpose of the streamflow monitoring plan is to provide minimum flows for fisheries in the lower reach of the stream. The NMFS comments recommended back-calculation of the high flow period on December 1-2, 2020 but noted that this is not a requirement. Since Salmon Creek is a regulated basin with both 100 year and probable maximum flood analyses completed for the project, AELP does not have any operational reason to complete these calculations at this time.

A copy of the email sent to the agencies along with copies of their response emails follows.

AELP Email Sent to Agencies:

Steve Vorderbruggen

From: Steve Vorderbruggen
Sent: Wednesday, October 13, 2021 11:35 AM
To: 'sean.eagan@noaa.gov'; 'kevin.keith@alaska.gov'; 'douglass_cooper@fws.gov'; 'benjamin.johnson@noaa.gov'
Cc: Christy Yearous; Bryan Farrell; Edward Neal
Subject: AELP Salmon Creek Streamflow Report - WY2021
Attachments: 2021WY_P2307_StreamFlow_Report.pdf

Hello,

Attached is the Salmon Creek Streamflow Report for water year 2021 for your review. Please send a response to me by Nov 19th, containing your comments or "no comments" if applicable, for inclusion in AEL&P's final report submittal to FERC.

Feel free to contact me if you have any questions.

Regards,

Steve Vorderbruggen, PE
Generation System Engineer
Alaska Electric Light and Power Company (AEL&P)
5601 Tonsgard Court
Juneau, AK 99801-7201
Office Phone: (907) 463-6396

ADF&G Email Response:

Steve Vorderbruggen

From: Keith, Kevin D (DFG) <kevin.keith@alaska.gov>
Sent: Tuesday, November 9, 2021 11:24 AM
To: Steve Vorderbruggen
Subject: ** EXTERNAL ** RE: AELP Salmon Creek Streamflow Report - WY2021

Hi Steve-

Thank you for the opportunity to review the Stream Flow Monitoring Report for Salmon Creek for water year 2021.

It appears that AEL&P is doing a very good job of operating the streamgage on Salmon Creek. I appreciate the adherence to USGS standards for the operation and maintenance of the streamgage, as well as the thoroughness and level of detail in the report.

Regards,
Kevin

Kevin D. Keith
FERC Hydropower Coordinator
Instream Flow Program
Alaska Department of Fish & Game

907-267-2836

USFWS Email:

Steve Vorderbruggen

From: Markegard, Sarah I <sarah_markegard@fws.gov>
Sent: Wednesday, November 3, 2021 8:41 AM
To: Steve Vorderbruggen
Cc: Cooper, Douglass; Foley, Kevin
Subject: ** EXTERNAL ** USFWS Comments on AELP Salmon Creek Streamflow Report (WY2021)

Hello Steve,

Thank you for the opportunity to comment on the Salmon Creek Streamflow Report for water year 2021. The U.S. Fish and Wildlife Service has reviewed the report and has no comments.

Please let me know if you need anything else from us,
Sarah

Sarah Markegard (she/her)
Fish and Wildlife Biologist
Anchorage Fish and Wildlife Conservation Office
Alaska Region | U.S. Fish and Wildlife Service

4700 BLM Road
Anchorage, AK 99507
Office: 907-271-2440

I acknowledge that I live on the traditional lands of the Dena'ina people, and I work throughout the ancestral territory of the Indigenous Peoples of Alaska. I am grateful for their continued care and stewardship of this land.

NOAA Email:

Steve Vorderbruggen

From: Sean Eagan - NOAA Federal <sean.eagan@noaa.gov>
Sent: Thursday, October 21, 2021 10:45 AM
To: Steve Vorderbruggen
Cc: kevin.keith@alaska.gov; douglass_cooper@fws.gov; benjamin.johnson@noaa.gov; Christy Yearous; Bryan Farrell; Edward Neal
Subject: ** EXTERNAL ** Re: AELP Salmon Creek Streamflow Report - WY2021

Follow Up Flag: Follow up
Flag Status: Flagged

Steve,

Thank you for the report. With this report AEL&P complied with the FERC license minimum flows requirement and the reporting requirements as stated in the Stream Monitoring Plan during WY2021.

The FERC license does not require AEL&P to measure or back calculate the highest flow on record that occurred on Dec 1-2 of 2020, but it would be wise to do so. The main mention of this was on page 33. It would be interesting to know if it just barely exceeded the highest flow on record of 2110 cfs from 2005, or if it exceeded it by 500 cfs or more. Without a value for the Dec 1- 2, 2020 flow it is difficult to develop accurate flood frequency curves. The closer AEL&P can come to defining that flow the better handle AEL&P can have at defining the 10-year, 20-year, 50 year and 100-year recurrence event.

Thank you,

Sean

APPENDIX B: DAILY DISCHARGE TABLE OCTOBER 2016-SEPTEMBER 2021

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Salmon Creek

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: Oct. 2016 to Sept. 2017 **Aggr:** 39 **Min:** 8.2 **Max:** 560

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	25	11	19	12	13	12	34	34	64	63	21	150
2	22	12	67	12	12	12	21	37	62	92	19	96
3	20	24	98	12	11	12	16	39	57	110	18	59
4	19	33	38	11	11	11	13	32	46	70	17	120
5	17	59	25	11	12	11	17	27	45	52	16	76
6	16	31	20	11	13	11	17	25	59	47	15	56
7	15	27	19	9.9	12	11	14	25	68	40	14	75
8	14	51	17	9.5	11	10	13	34	78	36	13	80
9	13	64	15	9	10	10	19	69	67	54	12	140
10	13	76	14	8.6	11	10	16	42	48	46	12	120
11	12	120	13	8.3	19	9.8	16	46	39	49	12	72
12	12	95	14	8.8	31	9.6	18	55	37	46	14	57
13	12	65	16	16	53	9.4	22	50	36	69	16	46
14	11	63	15	43	74	9.2	20	49	33	82	33	39
15	11	43	14	45	77	9	18	43	35	54	30	34
16	12	33	13	130	43	8.7	18	44	51	57	69	31
17	17	27	15	55	27	8.6	17	48	77	46	130	32
18	37	23	17	29	21	8.4	16	49	49	37	110	27
19	32	20	19	34	17	8.3	13	81	45	33	73	23
20	31	18	20	22	15	8.3	12	81	53	29	73	21
21	23	16	24	17	14	8.2	13	300	43	27	110	20
22	26	16	15	15	13	8.2	18	150	42	37	150	27
23	25	16	12	14	12	8.3	22	94	37	39	75	31
24	19	15	11	15	11	8.2	25	73	42	30	51	68
25	16	14	10	23	11	8.2	32	59	40	27	68	50
26	15	14	12	22	12	8.2	30	58	37	35	95	74
27	14	14	13	27	13	8.6	41	52	41	76	70	150
28	13	13	15	33	13	12	62	47	36	48	55	130
29	12	27	11	25		16	38	61	34	35	43	60
30	12	30	13	18		13	29	64	50	29	42	41
31	11		12	15		42		62		24	100	
Aggr	18	36	21	23	21	11	22	62	48	49	51	67
Min	11	11	10	8.3	10	8.2	12	25	33	24	12	20
Max	37	120	98	130	77	42	62	300	78	110	150	150

Salmon Creek - Daily Mean Discharge

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: Oct. 2017-Sept. 2018 **Aggr:** 28 **Min:** 7.8 **Max:** 210

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	33	42	12	10	14	8.6	8.7	37	31	31	12	43
2	28	35	10	25	14	8.2	8.6	50	31	24	11	33
3	39	32	11	48	13	8.2	8.5	28	29	23	9.7	27
4	35	29	27	41	13	8	8.3	56	33	21	12	23
5	41	26	20	45	12	7.8	8.3	100	35	20	11	20
6	75	24	24	35	11	8	8.4	71	31	18	11	18
7	47	22	25	28	11	7.8	8.7	54	31	17	14	16
8	60	20	52	18	10	7.9	9.9	53	29	15	23	15
9	60	19	120	16	9.4	7.9	18	63	26	14	100	14
10	40	17	72	15	9.1	8.1	22	64	33	16	53	13
11	31	16	200	13	9.7	12	21	79	38	20	30	12
12	26	15	95	18	10	16	16	110	32	20	25	11
13	23	14	130	20	10	25	15	75	29	16	39	11
14	24	13	210	57	10	22	15	56	31	15	100	10
15	42	12	83	63	9.9	16	14	37	27	32	38	9.9
16	49	11	70	50	9.8	15	13	31	28	100	28	9.5
17	40	11	52	35	9.6	14	12	30	44	40	26	9.5
18	32	11	38	26	9.5	12	16	36	40	28	21	12
19	27	11	31	22	9.3	14	28	39	35	24	18	12
20	35	10	28	20	9.2	16	20	41	33	20	16	11
21	33	10	24	17	9	13	14	77	31	18	16	11
22	27	10	21	16	8.9	11	15	85	25	17	21	11
23	37	10	19	15	8.9	11	49	49	21	15	23	16
24	37	9.9	18	16	8.7	9.8	41	43	20	14	26	12
25	28	9.5	17	17	8.7	9.9	27	42	18	13	57	18
26	57	9.2	16	16	8.4	10	36	66	19	12	35	32
27	560	9.2	15	16	8.4	10	36	69	20	11	36	18
28	110	9.1	14	15	8.3	9.9	24	51	18	11	96	14
29	61	12	14	15		9.5	19	42	30	10	50	12
30	52	18	12	15		9.1	17	37	39	9.5	34	11
31	54		11	15		8.8		34		9.9	43	
Aggr	59	17	48	25	10	11	19	55	30	21	33	16
Min	23	9.1	10	10	8.3	7.8	8.3	28	18	9.5	9.7	9.5
Max	560	42	210	63	14	25	49	110	44	100	100	43

Salmon Creek - Daily Mean Discharge

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: Oct. 2018-Sept. 2019 **Aggr:** 32 **Min:** 7.4 **Max:** 600

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	9.9	23	20	120	19	9.5	15	14	39	14	13	10
2	9.3	22	18	50	18	9.2	15	17	36	13	12	14
3	11	20	17	29	16	8.9	15	26	31	13	11	20
4	12	19	17	21	16	8.8	16	31	37	12	10	14
5	16	17	16	20	16	8.7	14	44	31	12	9.9	12
6	17	16	15	18	16	8.5	13	78	26	11	9.5	10
7	14	15	14	18	15	8.4	14	130	27	13	9.2	12
8	28	22	16	18	15	8.3	19	120	28	14	8.7	11
9	19	34	30	17	15	8.4	18	110	35	14	8.3	10
10	16	27	42	14	14	9.1	20	71	32	13	8.1	10
11	26	64	56	15	14	9.4	17	52	81	13	7.8	9.8
12	19	40	32	15	13	9.5	17	37	54	12	7.7	10
13	28	46	25	35	13	10	15	33	36	12	7.5	29
14	160	58	20	61	12	11	13	31	29	12	7.4	23
15	190	38	18	33	12	11	12	37	30	11	7.7	13
16	81	30	18	26	11	15	12	40	45	13	7.4	12
17	100	79	25	21	11	29	13	46	52	12	13	12
18	56	110	24	18	11	76	45	41	69	14	10	18
19	71	83	31	16	11	45	39	38	45	13	8.6	33
20	56	70	23	15	11	38	24	39	34	14	7.9	330
21	42	50	19	16	11	40	19	48	32	12	7.6	340
22	47	37	17	15	10	41	26	41	30	11	9.5	99
23	46	31	16	13	10	42	25	35	28	11	21	67
24	37	27	15	16	9.8	35	20	31	25	11	27	170
25	49	26	14	47	9.6	27	17	31	22	11	35	130
26	44	37	13	160	9.6	22	16	40	21	14	32	94
27	39	32	16	55	9.6	20	14	43	24	15	52	57
28	31	26	16	35	9.6	19	13	41	22	40	26	41
29	27	24	14	33		18	13	33	17	19	17	33
30	31	22	13	35		17	13	30	16	13	13	34
31	27		23	30		16		35		12	11	
Aggr	44	38	21	33	13	21	18	47	34	14	14	56
Min	9.3	15	13	13	9.6	8.3	12	14	16	11	7.4	9.8
Max	190	110	56	160	19	76	45	130	81	40	52	340

Daily Mean Discharge 2020 WY-Salmon Creek

Identifier: Discharge.Daily Mean@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: 2020 Water Year **Aggr:** 48 **Min:** 7 **Max:** 300

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	270	51	25	56	11	18	7.4	56	84	48	46	85
2	160	47	47	35	12	17	7.2	46	83	55	44	89
3	70	49	29	26	13	15	7.4	61	110	51	73	100
4	49	61	23	21	13	12	7.2	64	83	55	120	62
5	62	51	24	18	15	11	7.1	53	60	45	59	45
6	590	44	23	17	12	12	7.2	46	53	36	41	35
7	86	79	19	16	11	12	7	48	82	33	83	32
8	52	45	21	15	14	12	8.3	52	93	45	120	34
9	40	31	21	13	13	14	7.8	83	66	61	170	32
10	38	26	23	12	68	11	7.4	130	64	56	260	28
11	66	25	26	12	32	11	7.3	110	64	42	140	24
12	53	24	23	12	23	11	7.4	78	61	41	110	22
13	41	44	20	12	18	9.7	8.5	71	66	36	100	19
14	32	67	18	12	14	9.1	17	72	93	83	98	18
15	34	66	16	12	13	10	19	70	61	61	110	16
16	38	100	15	12	11	9.8	26	70	70	41	100	15
17	33	270	14	12	12	9.5	32	70	69	36	110	15
18	39	89	16	12	13	9.4	35	63	88	79	93	15
19	37	60	16	12	13	9.2	39	89	96	110	87	14
20	31	180	15	12	16	9.2	44	100	120	190	81	14
21	26	190	13	11	21	9.1	68	67	87	85	80	14
22	23	210	13	11	14	9.4	130	59	68	55	76	15
23	62	120	18	15	11	9	100	62	60	48	78	15
24	60	74	16	15	12	8.7	65	100	56	41	86	15
25	46	52	17	15	13	8.6	52	87	60	93	91	15
26	34	39	41	27	17	8.8	55	72	110	300	73	18
27	31	31	27	17	30	8.8	63	53	72	130	47	74
28	25	27	43	12	29	8.3	92	48	60	66	44	100
29	33	24	29	30	19	7.8	78	58	68	53	39	41
30	41	22	120	17		7.5	70	61	52	49	61	31
31	32		72	13		7.5		61		43	97	
Aggr	72	74	27	17	18	10	36	70	75	70	91	35
Min	23	22	13	11	11	7.5	7	46	52	33	39	14
Max	590	270	120	56	68	18	130	130	120	300	260	100

Daily Mean Discharge 2021 WY Salmon Creek

Identifier: Discharge.1@Salmon Creek
Location: Salmon Creek Juneau
Units: ft^3/s
Filter: None

Year: 2021 Water Year **Aggr:** 62 **Min:** 9.4 **Max:** 1300

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	27	94	590	35	30	20	13	74	320	94	31	32
2	120	62	620	34	30	14	11	50	250	89	28	48
3	77	40	200	34	29	11	12	42	270	85	25	63
4	76	32	190	34	30	13	11	63	150	83	29	66
5	110	26	210	36	29	13	13	59	110	86	33	64
6	73	23	250	38	29	14	11	60	100	89	33	54
7	50	21	250	37	28	12	12	80	91	83	35	44
8	39	22	190	37	28	11	11	73	83	85	34	50
9	33	32	120	36	27	11	12	72	86	90	63	46
10	29	23	98	46	26	11	10	60	88	81	69	46
11	29	20	89	54	26	11	9.8	69	78	75	55	76
12	29	26	83	56	25	10	11	67	71	130	81	66
13	28	28	77	46	24	9.8	18	59	69	150	350	65
14	25	22	74	42	24	9.6	31	91	72	170	110	63
15	22	19	71	74	24	9.7	23	130	170	100	120	71
16	20	17	69	60	25	11	30	91	110	89	87	72
17	18	16	68	74	26	14	49	60	85	90	81	53
18	17	15	62	120	26	11	80	50	83	84	110	41
19	17	14	53	100	28	11	68	50	76	75	94	34
20	17	14	49	60	28	10	62	52	110	72	77	38
21	15	14	45	49	41	9.9	51	66	180	74	70	83
22	14	14	42	44	30	9.6	39	120	92	64	65	63
23	14	15	55	41	19	12	32	120	74	45	61	60
24	13	17	48	39	11	12	32	78	250	44	47	100
25	14	16	43	37	11	11	33	65	190	40	40	55
26	75	31	40	35	11	11	36	65	180	32	30	42
27	37	19	38	32	12	13	35	59	140	30	31	37
28	29	24	37	32	30	12	29	56	130	29	95	35
29	25	27	38	32		10	61	93	120	27	70	31
30	25	24	37	32		12	84	95	110	28	49	34
31	200		36	31		23		350		32	38	
Aggr	42	26	120	47	25	12	31	81	130	76	69	54
Min	13	13	34	30	9.5	9.4	9.5	39	63	24	23	30
Max	410	140	1300	230	52	30	100	890	780	220	1000	160

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APPENDIX C: STREAM RATING CURVE

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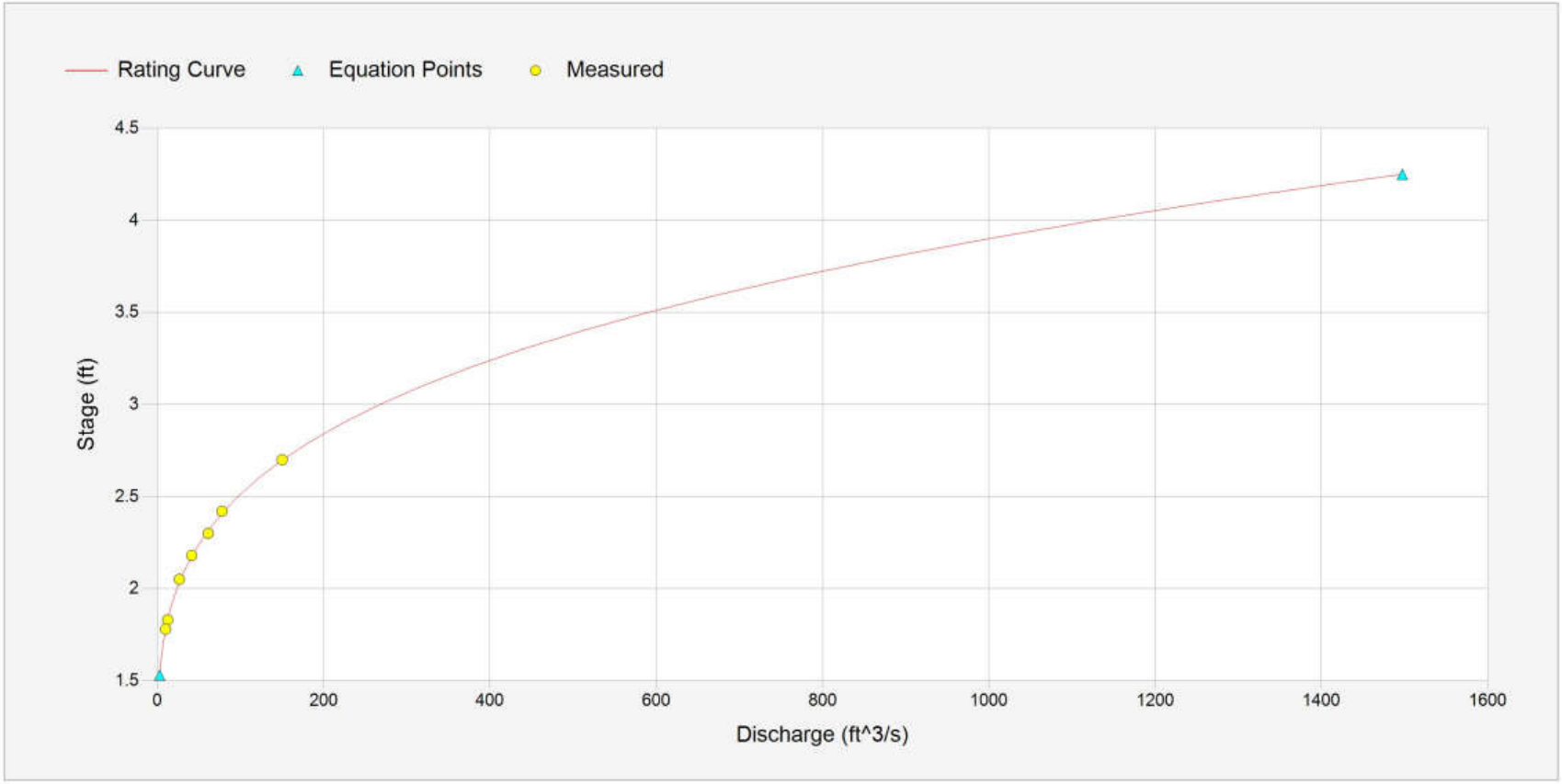
Rating Curve

Rating 3

Label: Salmon Creek
Description: Site ID-Salmon Creek

Curve on: October 7, 2021 Curve Start Date: December 1, 2020 Location: Salmon Creek Juneau



STATION NUMBER Salmon Creek Salmon Creek Juneau SOURCE AGENCY:
LATITUDE 49.28 LONGITUDE -123.11
Date Processed: 2021-10-11 08:18:25 UTC-09:00 By admin
Rating for Discharge (ft^3/s)
Created by admin on 2021-10-07 18:23:19 [UTC], Updated by admin on 2021-10-09 19:46:22 [UTC]
Remarks:

Offset1: 0.98

EXPANDED CAQRating TABLE

Stage (m)	Discharge (ft^3/s)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
1.50				2.560*	2.730	2.909	3.095	3.290	3.494	3.706	1.954
1.60	3.928	4.159	4.400	4.651	4.912	5.183	5.465	5.758	6.061	6.377	2.776
1.70	6.704	7.042	7.393	7.757	8.133	8.522	8.924	9.340	9.769	10.21	3.966
1.80	10.67	11.14	11.63	12.13	12.65	13.18	13.73	14.30	14.88	15.48	5.430
1.90	16.10	16.73	17.39	18.06	18.74	19.45	20.18	20.92	21.69	22.47	7.180
2.00	23.28	24.10	24.95	25.82	26.71	27.62	28.56	29.51	30.49	31.49	9.240
2.10	32.52	33.57	34.64	35.74	36.86	38.01	39.19	40.39	41.61	42.87	11.630
2.20	44.15	45.45	46.79	48.15	49.54	50.96	52.41	53.89	55.40	56.93	14.350
2.30	58.50	60.10	61.73	63.40	65.09	66.82	68.58	70.37	72.19	74.06	17.450
2.40	75.95	77.88	79.84	81.84	83.88	85.95	88.06	90.20	92.38	94.60	20.910
2.50	96.86	99.16	101.5	103.9	106.3	108.7	111.2	113.8	116.4	119.0	24.740
2.60	121.6	124.3	127.1	129.9	132.7	135.6	138.5	141.5	144.5	147.6	29.100
2.70	150.7	153.8	157.0	160.3	163.6	166.9	170.3	173.8	177.3	180.8	33.700
2.80	184.4	188.0	191.7	195.5	199.3	203.2	207.1	211.0	215.0	219.1	38.800
2.90	223.2	227.4	231.7	236.0	240.3	244.7	249.2	253.7	258.3	263.0	44.500
3.00	267.7	272.4	277.3	282.1	287.1	292.1	297.2	302.3	307.5	312.8	50.400
3.10	318.1	323.5	329.0	334.5	340.1	345.8	351.5	357.3	363.2	369.1	57.000
3.20	375.1	381.2	387.3	393.5	399.8	406.2	412.6	419.1	425.7	432.3	64.000
3.30	439.1	445.9	452.7	459.7	466.7	473.8	481.0	488.3	495.6	503.0	71.400
3.40	510.5	518.1	525.8	533.5	541.4	549.3	557.3	565.3	573.5	581.7	79.600
3.50	590.1	598.5	607.0	615.5	624.2	633.0	641.8	650.8	659.8	668.9	88.000
3.60	678.1	687.4	696.8	706.3	715.8	725.5	735.3	745.1	755.1	765.1	97.100
3.70	775.2	785.5	795.8	806.2	816.8	827.4	838.1	848.9	859.9	870.9	106.800
3.80	882.0	893.3	904.6	916.0	927.6	939.2	951.0	962.8	974.8	986.8	117.000
3.90	999.0	1011	1024	1036	1049	1062	1074	1087	1100	1114	128.000
4.00	1127	1140	1154	1167	1181	1195	1209	1223	1237	1251	139.000
4.10	1266	1280	1295	1310	1325	1340	1355	1370	1386	1401	151.000
4.20	1417	1433	1449	1465	1481						

"*" indicates a rating descriptor point

ID	Starting Date	Ending Date	Aging	Comments
ah01	2020-12-01 16:00:00 [UTC-09:00]		0	

APPENDIX D: PLOTS OF 15 MINUTE DATA

FOURTH QUARTER 2020 – THIRD QUARTER 2021

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Figure D1 – Fourth Quarter 2020

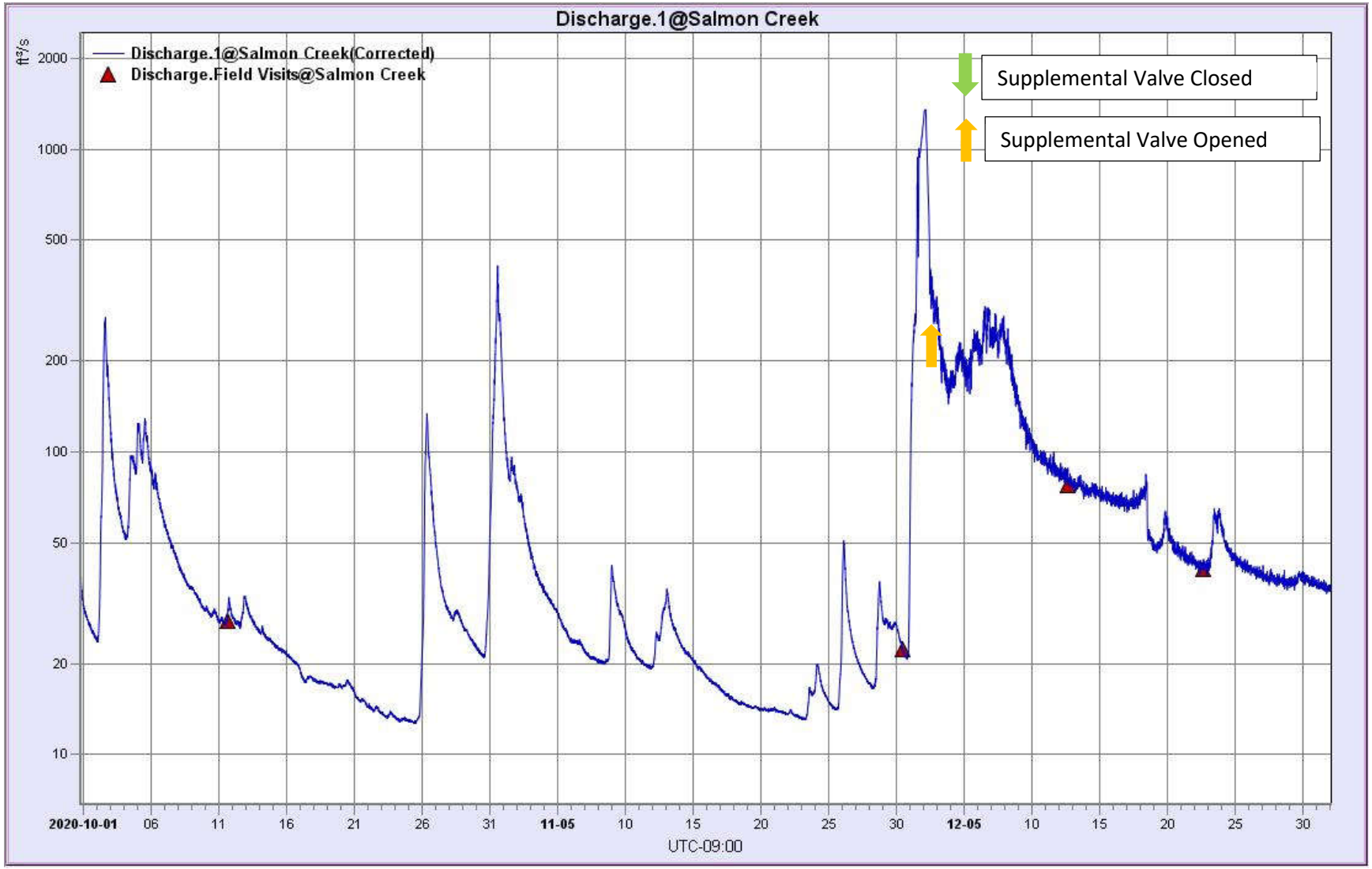


Figure D2 – First Quarter 2021

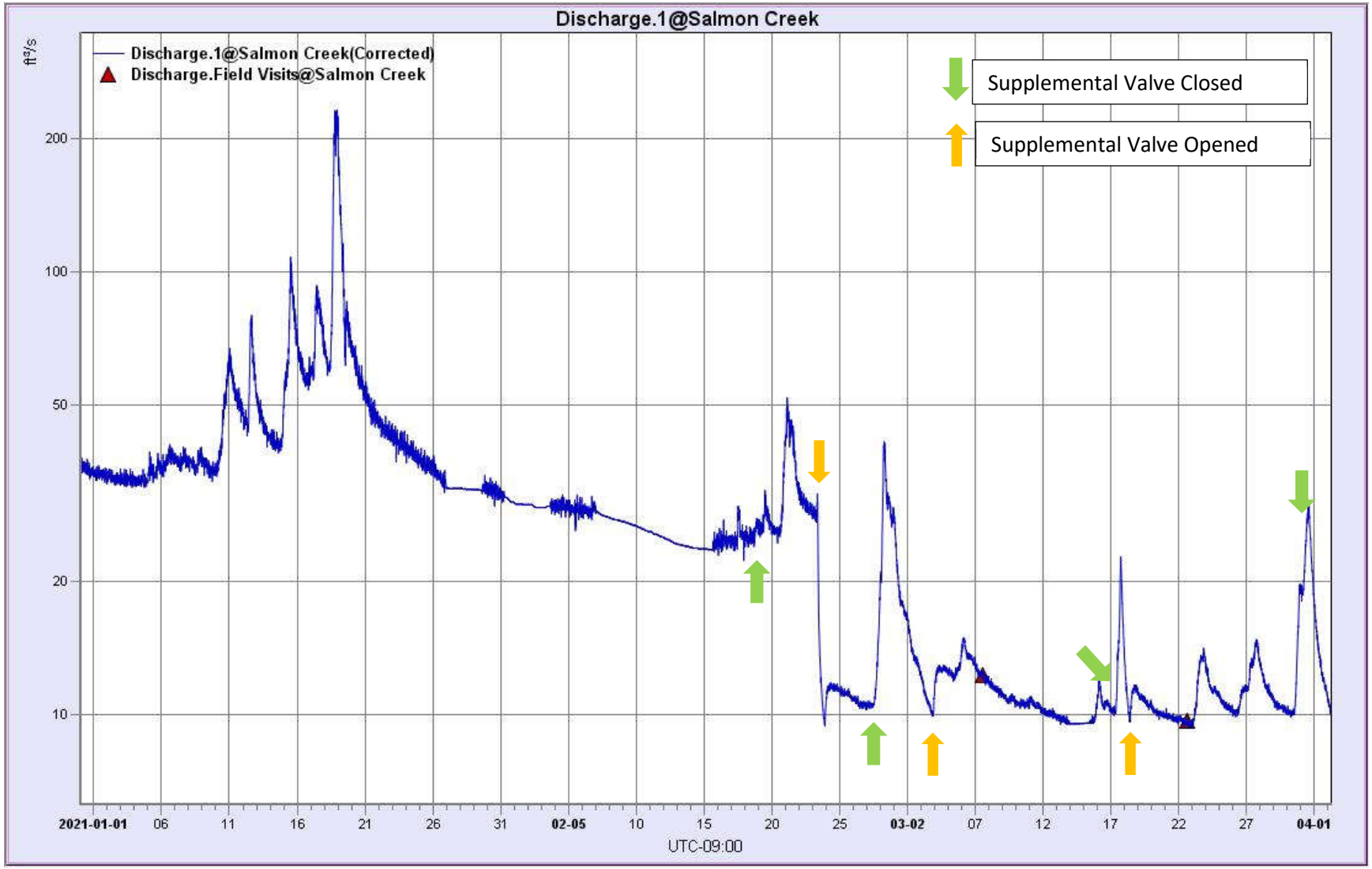


Figure D3 – Second Quarter 2021

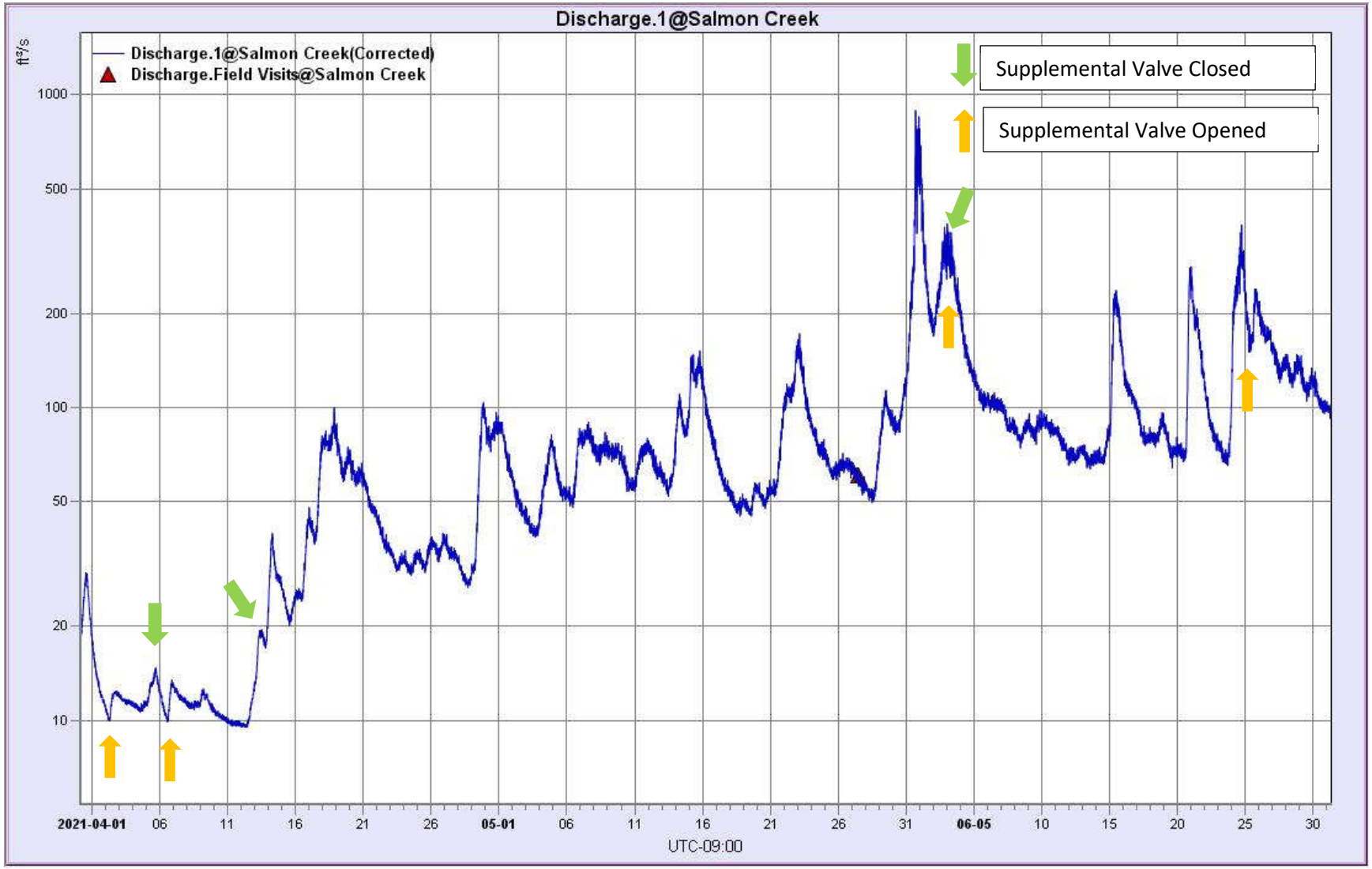
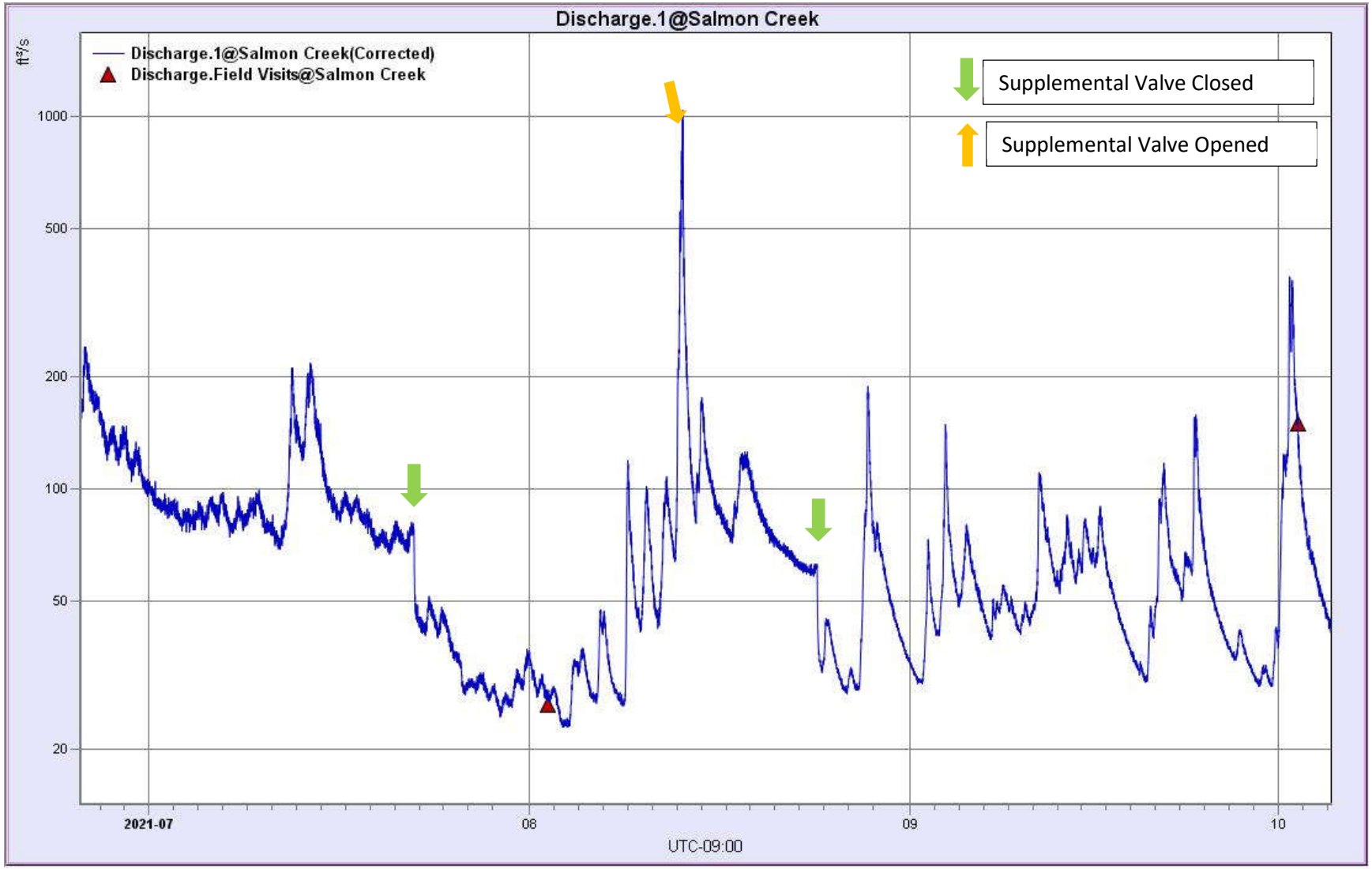


Figure D4 – Third Quarter 2021



APPENDIX E: SALMON CREEK STATION DESCRIPTION AND ANALYSIS WATER YEAR 2021 (ALASKA HYDROSCIENCE)

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Salmon Creek Gaging Station near Juneau, Alaska

Station Description for the 2021 Water Year

LOCATION.—Lat 58°19'57", long 134°27'57" referenced to North American Datum of 1927, and Lat 58°19'56", long 134°28'04" referenced to World Geodetic System 1984. Gage is located on the left bank (when facing downstream), about 0.3 mi upstream from the mouth and 2.5 mi northwest of Juneau.

DRAINAGE AREA.—Drainage area 9.69 mi^2 as reported by the USGS, discharges are regulated.

ESTABLISHMENT AND HISTORY.—Gage established on April 27, 2016 at the same location and datum of U.S. Geological gaging station number 15051010.

GAGE.—A Campbell Scientific CS450 vented and temperature compensated transducer is coupled to a Campbell Scientific CR6 data logger and records stage data in 15 minute intervals. The transducer is housed in 1 inch galvanized pipe and is set and referenced to vertical datum established by the U.S. Geological Survey (see reference marks). Additional equipment is housed in a gage house on left bank.

CONTROL.—Low flow control is a boulder/cobble riffle immediately below the orifice and staff gage. The channel is the control at medium and high stages. Shifting from the rating is possible at all stages as the gage reach can be alternately scoured and filled.

DISCHARGE MEASUREMENTS.—Measurements are made by wading in the vicinity of the gage. High flow measurements can be measured from a bridge approximately 0.25 mi downstream.

FLOODS.—U.S. Geological Survey recorded a maximum discharge of 2110 ft^3/s, Nov. 22, 2005 and gage height 4.20 ft. Minimum discharge recorded by the U.S. Geological Survey was 3.5 ft^3/s, March 17-20, 2006. The maximum gage height of 4.20 ft was also attained on Dec. 1-2, 2020 just prior to the transducer being damaged by the high-flow event.

WINTER FLOW.—The stage-discharge relationship will be periodically affected by ice during cold periods during most winters.

REGULATION AND DIVERSIONS.—Flow is regulated by Salmon Creek Reservoir located 2 miles upstream. Diversion upstream for off-stream hydropower plant; outflow from the plant goes into Gastineau Channel and is not included in the discharge records. There is a supplemental water valve tapped off of the penstock at the base of the dam to supply additional water to Salmon Creek during periods of low flow. The valve discharges water directly into the natural channel. Operation of the valve is performed remotely by the AEL&P System Operator who also has real-time indication of the streamflow. When the flow drops to 9 ft^3/s, an alarm is generated and the Operator opens the valve and logs the operation.

ACCURACY.— Accuracy of the discharge records should be fair to good with the exception of ice affected record which will be fair to poor.

REFERENCE MARKS.—The gage is referenced to several vertical reference marks (RMs) established by the U.S. Geological Survey to accurately track vertical datum for the gage. The existing gage continues to reference these RMs to maintain accurate vertical datum. In a survey conducted on July 3, 2020 additional reference marks were added to the station to facilitate accurate tracking of station datum.

RM 1 – Brass cap anchored in concrete 2 feet shoreward of the orifice on left bank, elevation 2.64 feet. This RM is the base RM from which to begin level surveys.

RM2-- Established July 3, 2020. Head of rock bolt protruding from top of boulder 3 feet upstream from RM1, elevation 4.87 feet.

RM3—Established July 3, 2020. 3/8 in anchor bolt in on top of 5-foot boulder located approximately 15 feet upstream near the left edge of water, elevation 3.77 feet.

RP 1 – ¼ inch anchor bolt drilled in concrete block 1 foot upstream of orifice, elevation 2.44 feet.

RM 5 – ¼ inch lag bolt on upstream side of two-foot diameter cottonwood 25 feet from left edge of water and 12 feet downstream of the orifice, elevation 8.59 feet.

RM5.1-- Established July 3, 2020. Lag bolt on upstream side of 26-inch cottonwood tree on left bank 25 feet shoreward and 12 feet downstream of orifice, elevation 8.70 feet. Replacing RM5, which was nearly grown over by bark.

RM 6 – ¼ inch lag bolt on upstream side of 1-foot diameter spruce tree, 15 feet from the left edge of water and 15 feet upstream of the orifice, elevation 7.77 feet.

RM6.1- Established July 3, 2020. Lag bolt on same tree as RM6, elevation 8.02 feet. Used to replace RM6, which is nearly overgrown.

2021 WATER YEAR STATION ANALYSIS

GAGE HEIGHT RECORD.—The gage height record is missing or considered unreliable for a brief period from Dec.1-10, 2020 when a large peak flow damaged the transducer housing. The transducer housing was repaired on Dec. 10, 2020. Discharge records were estimated from Dec. 1-10. Gage height record is complete for the remainder of the 2021 water year with no periods of missing record. The gage height record was periodically subject to backwater due to ice during which times discharges were estimated. Gage height record was subject to backwater from ice during the following dates:

Jan. 27-29, 2020; Jan. 31- Feb. 3; Feb. 7-15; Mar. 14-15.

GAGE HEIGHT CORRECTIONS.— Pressure transducers used to record stage are often subject to slight drift in recorded values. Gage height corrections to the recorder are used to adjust for differences between the recorded values and readings of the outside reference gage during site visits. Gage height corrections are typically prorated over time between site visits. Gage height corrections for the 2021 water year ranged from +0.04 ft in October to +0.07 ft on Dec. 1. Following repair to the damaged orifice in Dec. corrections to the gage height were 0.01 ft or less. A plot of corrected gage height and measured field values of gage height is shown below in figures 1 and 2.

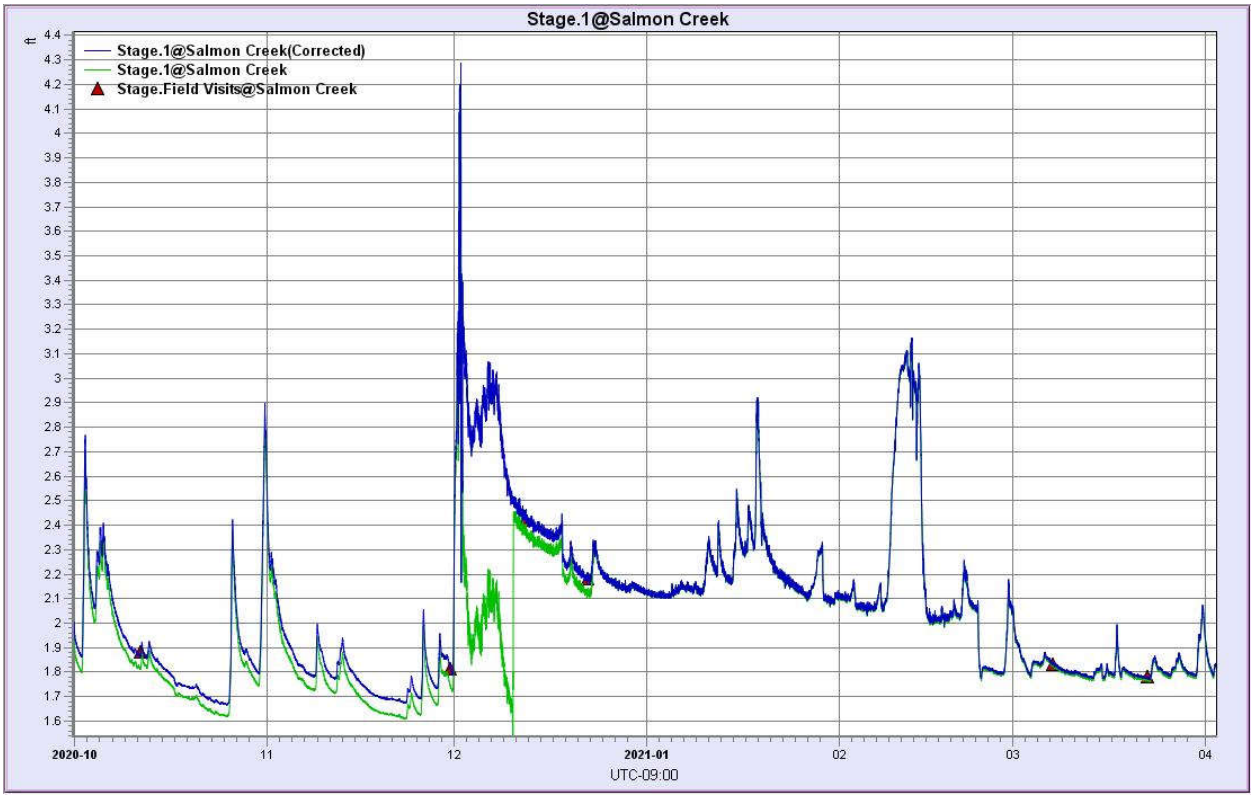


Figure 1. Stage data from Salmon Creek gaging station showing raw and corrected recorded values and field readings from the outside reference gage (Oct. 2020 to April 2021).

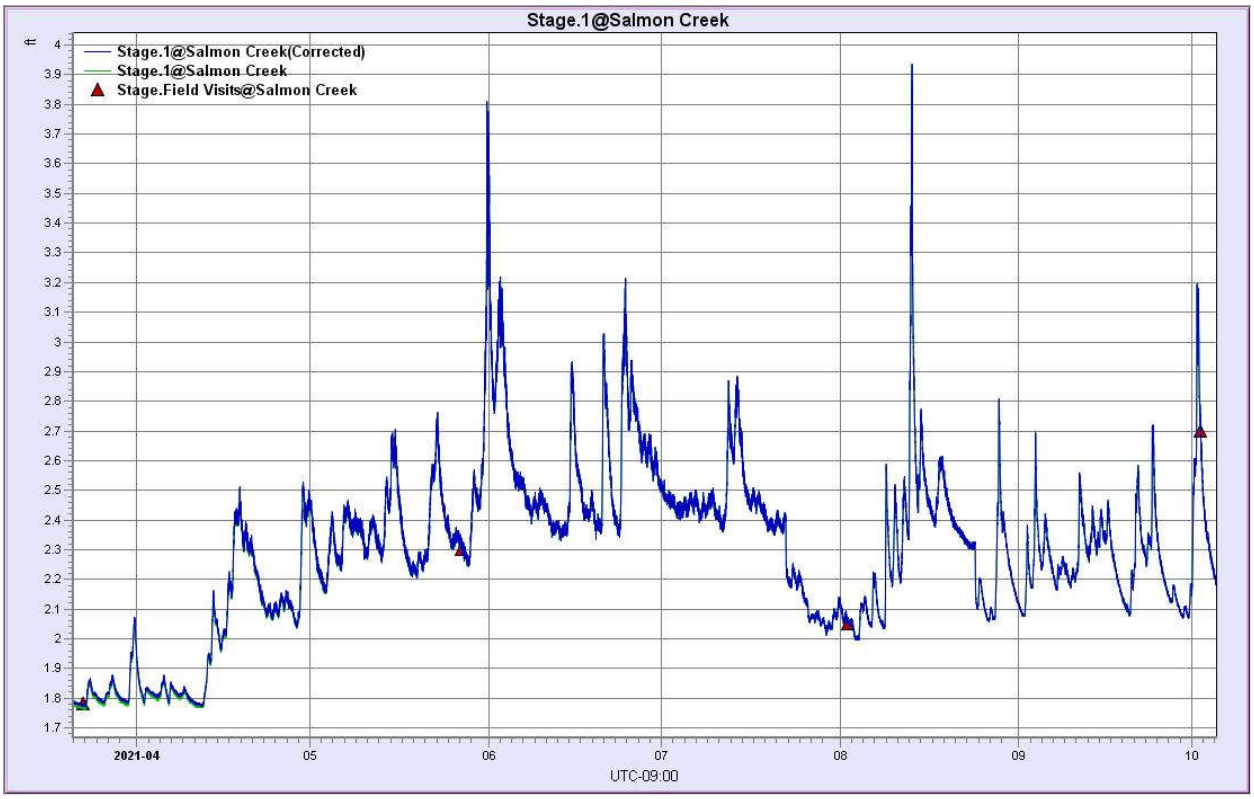


Figure 2. Stage data from Salmon Creek gaging station showing raw and corrected recorded values and field readings from the outside reference gage (April 2021 to October 2021).

DATUM CORRECTIONS.— A complete level survey was conducted on July 3, 2020. No datum corrections were needed. Additional reference marks were added and documented in the station description.

RATING.— The gage reach is under section control at low to midrange discharges and channel control at greater discharges. The gage reach is subject to scour and fill during peak flows and during salmon spawning season when salmon spawn throughout the gage reach.

Rating 2 was put into use on Feb. 5, 2018 and was in use to December 1, 2020. Rating 2 was developed to account for consistent scour conditions relative to rating 1 in lower to mid-range stages as defined by measurements in 2017 and 2018. Rating 2 provided better definition of low to mid-range discharges without the need for application of stage variable shifts. A large peak on Oct. 6, 2019 resulted in additional fill conditions at the gage reach and a single stage variable shift adjustment of -0.07 feet was applied until Oct.2, 2020. On Oct. 2, 2020 a small peak resulted in slight scour to existing fill conditions and a stage variable shift adjustment of -0.04 feet was applied until an exceptionally large peak occurred on Dec. 1-2, 2020. The peak resulted in damage to the transducer and fill conditions throughout the gage reach. Rating 3 was developed following this peak based on discharge measurements 34-40 and the highest discharge measurements taken by the U.S. Geological Survey. Rating 3 utilized historic peak

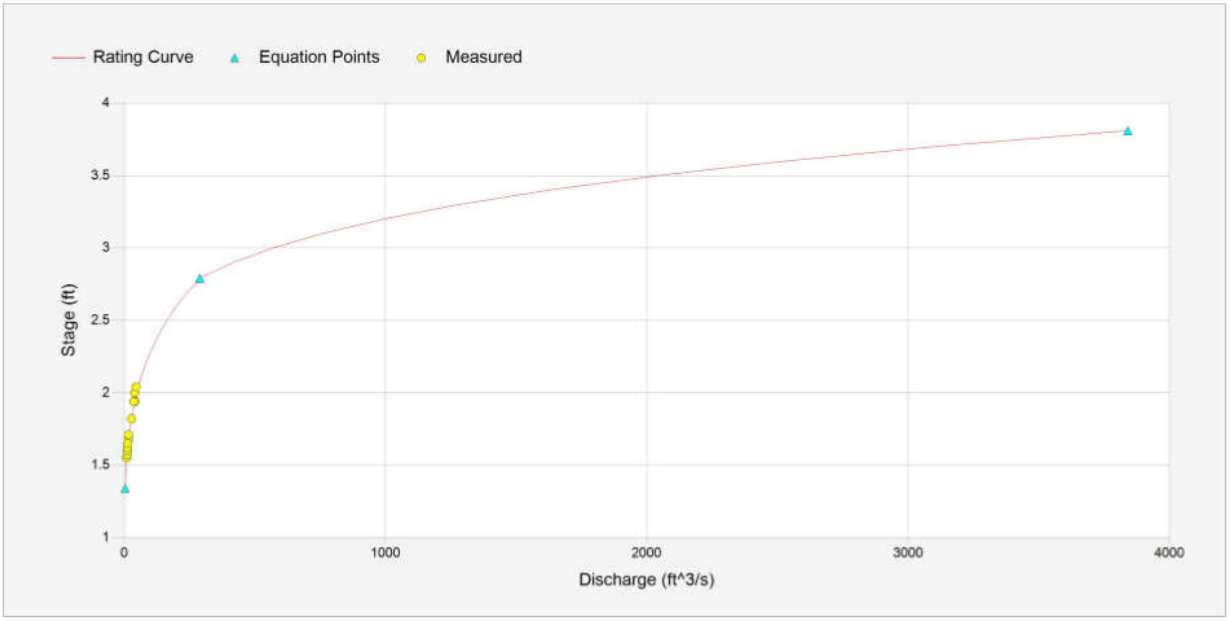
discharge measurements taken by the U.S. Geological Survey to define the high end of the rating. Rating 3 suggests lesser discharges throughout the range of stage, particularly obvious are the differences at the higher stages.

Seven discharge measurements (numbers 32-40), ranging from 9.7-150 ft^3/s, were conducted since the beginning of the 2021 water year. All measurements were used in rating analysis. Measurements 2 and 33 plotted within 5% of shifted rating number 2, and measurements 34-40 plotted within 5% of rating 3 used directly with no shifts. Rating curve and rating equation points for both ratings are shown below:

Rating Curve

Salmon Creek Rating #2 - Used to compute discharge for 2019 WY

Label: Salmon Creek
Description: Site ID-Salmon Creek
Curve on: October 1, 2019 Curve Start Date: February 5, 2018 Location: Salmon Creek Juneau



Rating Curve

Salmon Creek Rating #2-Used to compute discharge for 2020 WY

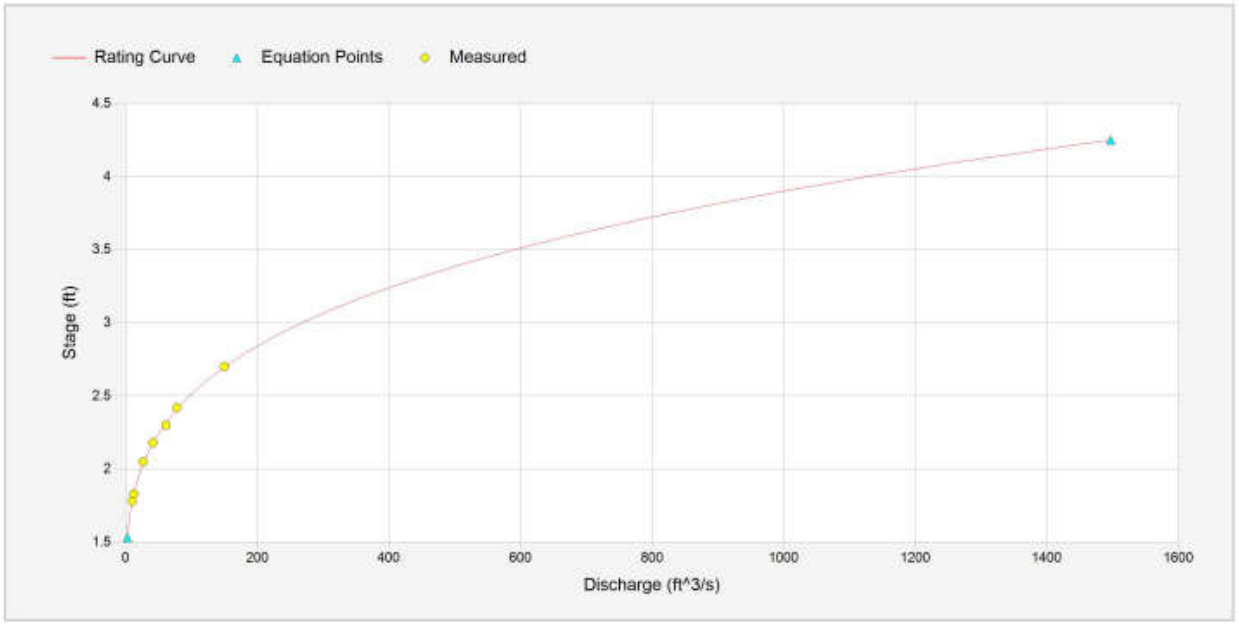
Label: Salmon Creek
Description: Site ID-Salmon Creek
Curve on: October 15, 2020 Curve Start Date: February 5, 2018 Location: Salmon Creek Juneau

Stage (ft)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	0	0	0	0	4.27	7.19	11.36	17.09	24.69	34.52
2	46.96	62.4	81.27	104.03	131.14	163.11	200.45	243.7	298.43	417.14
3	568.77	759.1	994.41	1281.51	1627.72	2040.9	2529.43	3102.24	3768.81	3841

Rating Curve

Rating 3

Label: Salmon Creek
Description: Site ID-Salmon Creek
Curve on: October 7, 2021 Curve Start Date: December 1, 2020 Location: Salmon Creek Juneau



Label: Salmon Creek
Description: Site ID-Salmon Creek
Curve on: October 7, 2021 Curve Start Date: December 1, 2020 Location: Salmon Creek Juneau

Stage (ft)	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1.00	0.00	0.00	0.00	0.00	0.00	0.00	3.93	6.70	10.67	16.10
2.00	23.28	32.52	44.15	58.50	75.95	96.86	121.64	150.67	184.40	223.25
3.00	267.67	318.12	375.10	439.07	510.55	590.05	678.10	775.24	882.03	999.01
4.00	1,126.78	1,265.92	1,417.02	1,497.25						

Figure 3. Salmon Creek Ratings 2 and 3. Used for computing discharge for the 2021 water year, shown in graphic and tabular formats.

DISCHARGE RECORD.—Rating number 2 was used with two stage variable shifts to compute discharge from October 1 to Dec. 1, 2020. Stage variable shift number one was used from Oct. 1-2, and stage variable shift number 2 was used until the transition to rating 3 on December 1, 2020. The shifts were defined by measurements 24-31 (shift 1) and measurements 32-33 (shift 2), and both adjust the rating for slight fill at the gage control reach. Rating number three was used direct from December 1, 2020 through the remainder of the 2021 water year.

Discharge record was affected by ice and discharges were estimated from Jan. 27-29; Feb. 2-3; Feb. 7-15; and Mar. 14-15. Discharges were also estimated from December 1-10, 2020 due to damage to the

transducer housing. Discharges were estimated from discharge measurements, examination of the stage record, and comparison with Juneau weather records.

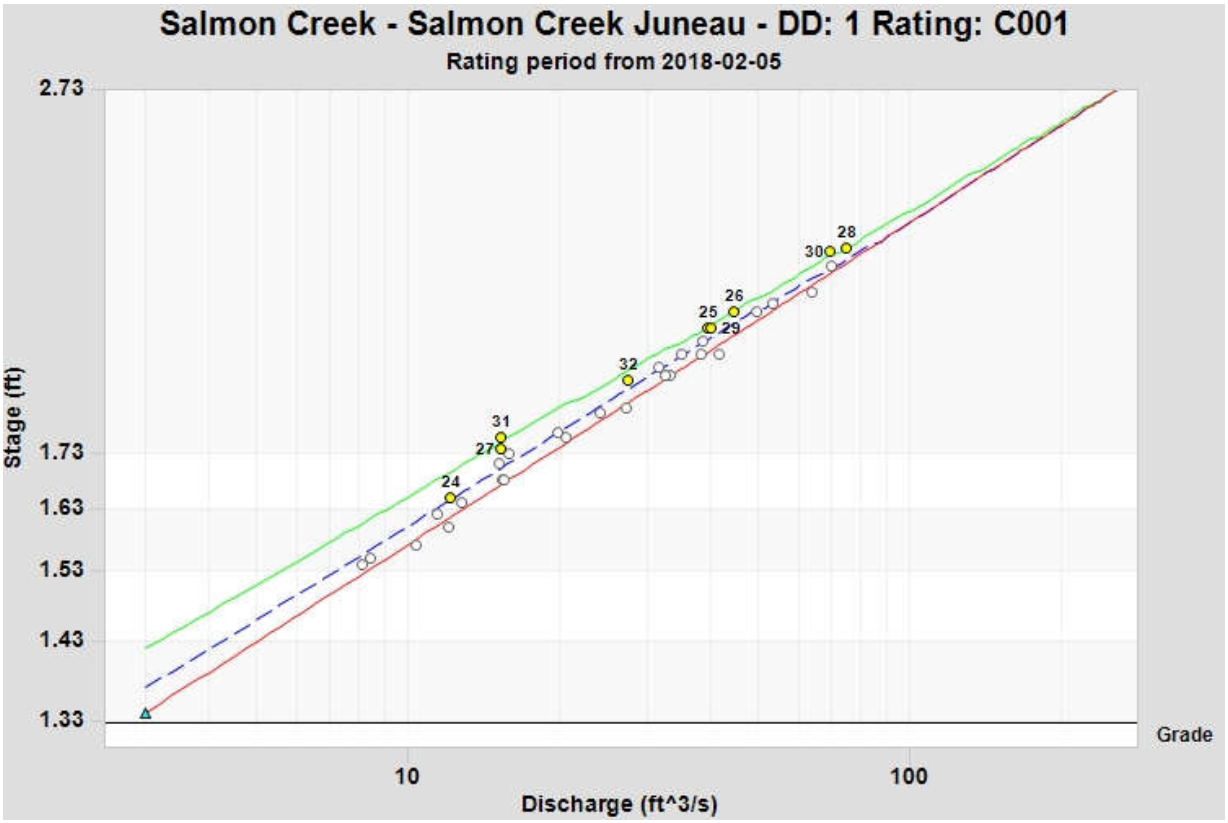


Figure 4. Salmon Creek rating number 2 (log scale) shown with stage variable shift 1 (blue line) and stage variable shift 2 (green line) used to compute discharge for the early 2021 water year.

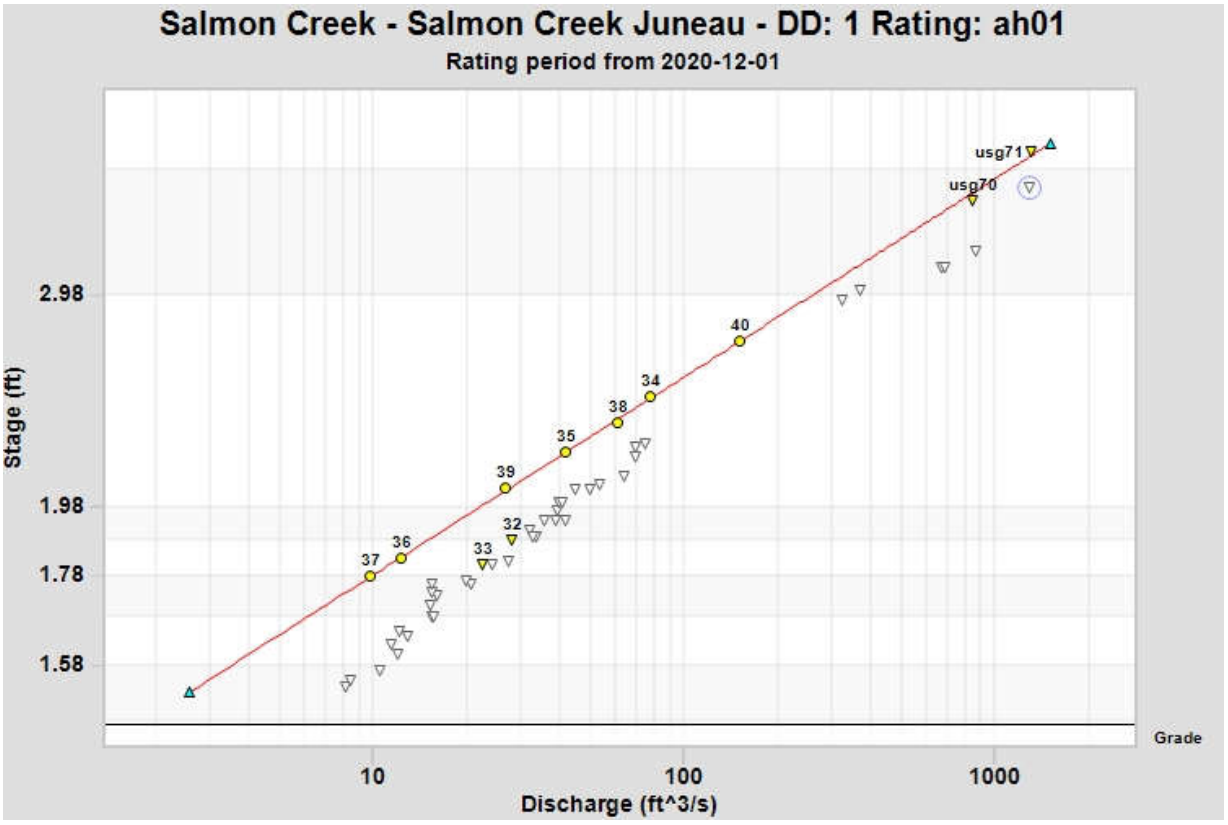


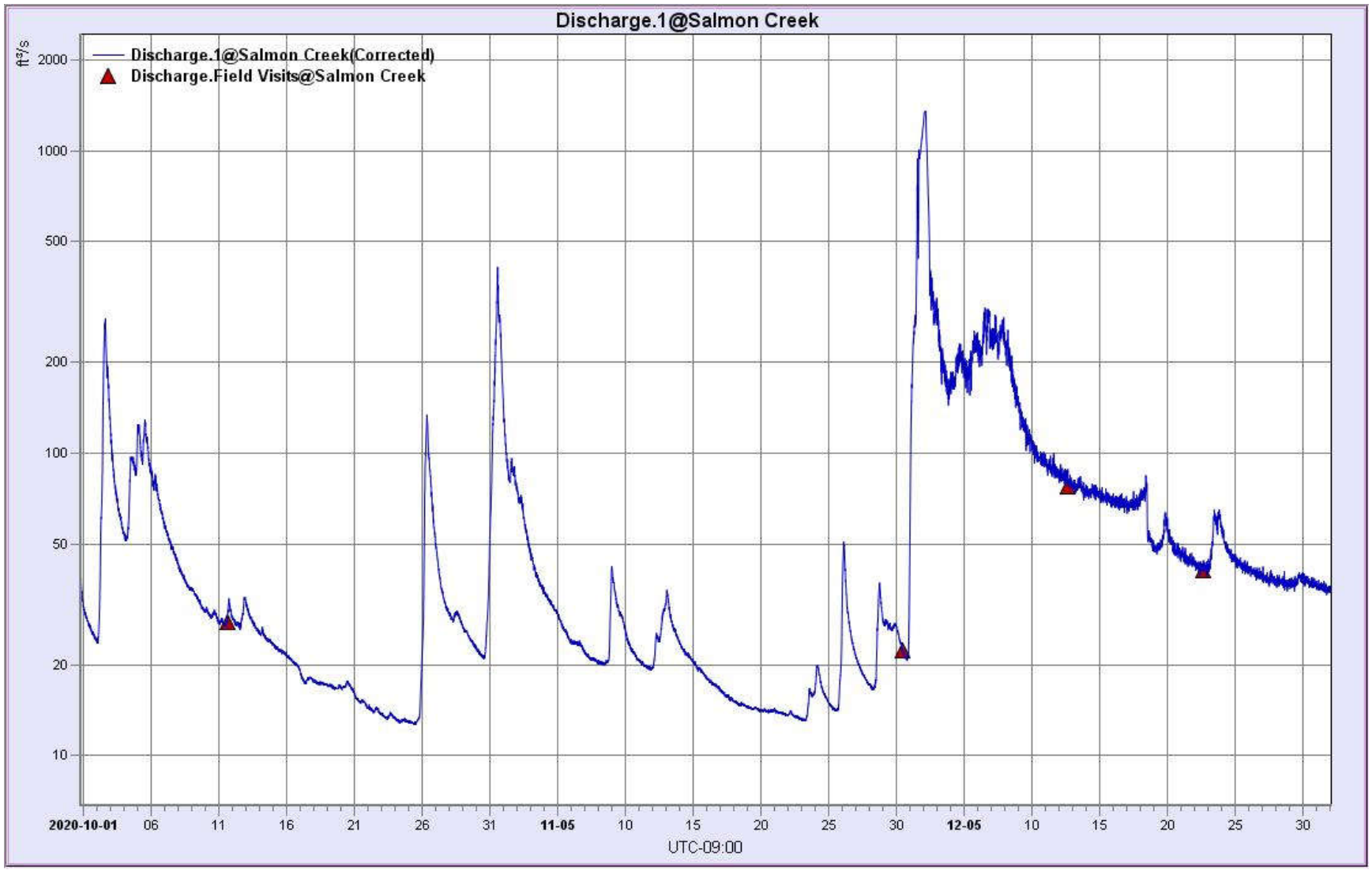
Figure 5. Salmon Creek rating number 3 (log scale) used to compute discharge from December 1, 2020 through the remainder of the 2021 water year.

REMARKS.— Records of discharge are complete. Discharge records are fair to good for discharges below 300 ft^3/s and poor for higher discharges due to the relatively poor gage reach and lack of cross sections available to consistently make good discharge measurements. Discharges estimated due to backwater from ice are poor.

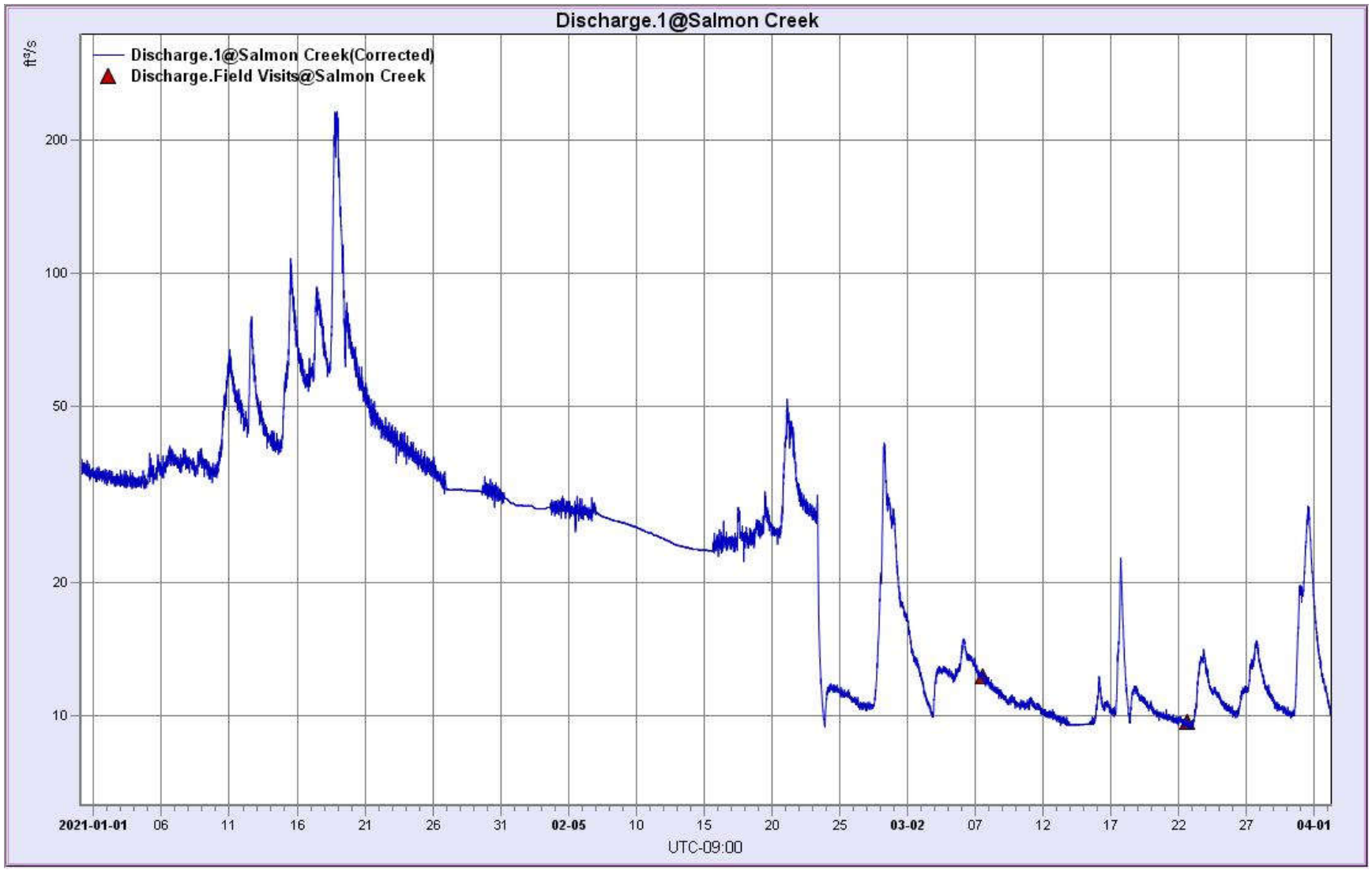
The following files were included as an attachment to this document:

Salmon Creek 15 min. 2021 Final.

Salmon Creek Daily Mean 2021 WY Final.

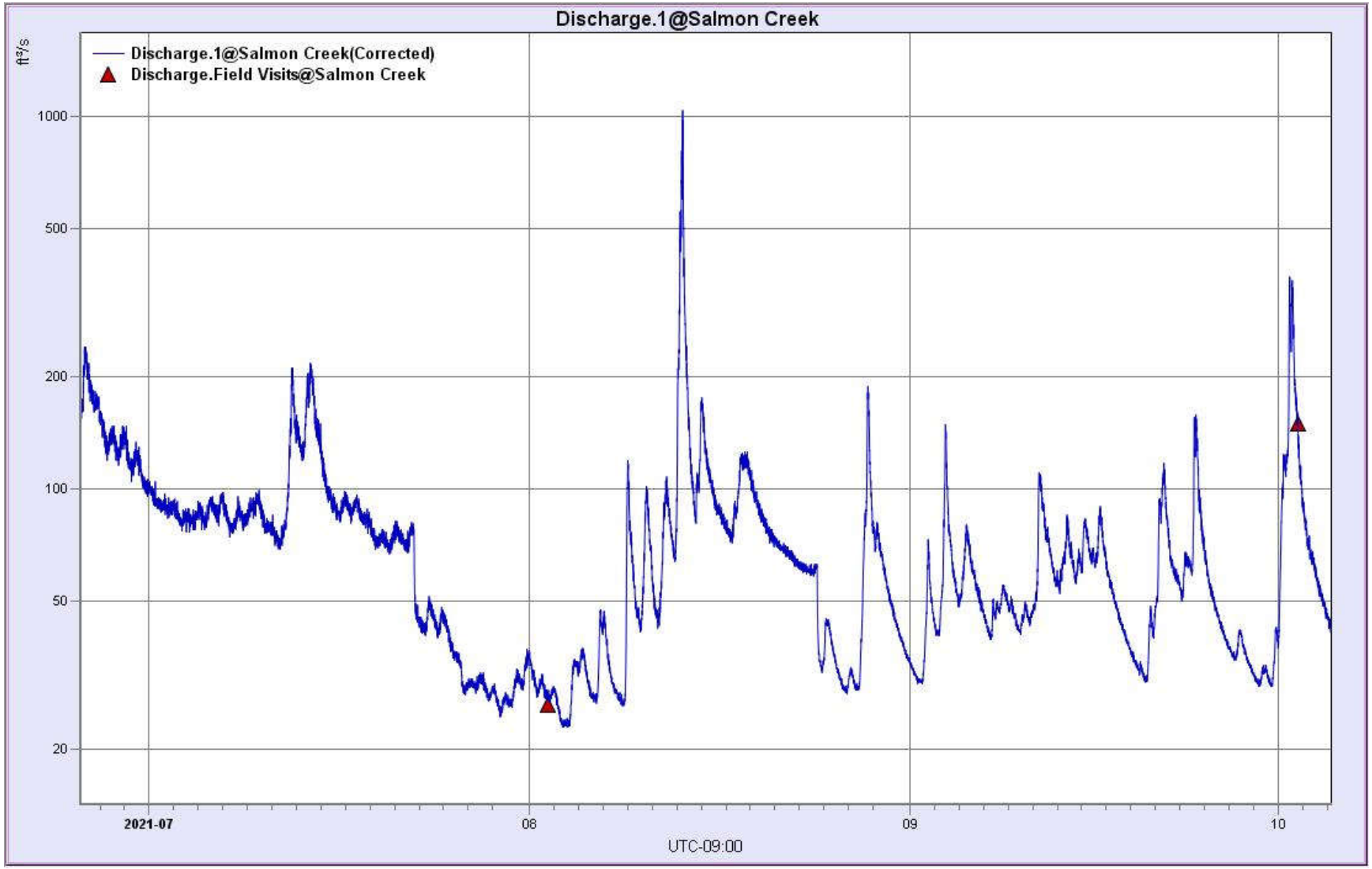


Computed discharge and field measurements for Salmon Creek near Juneau, Alaska from October 2020 to January 2021.



Computed discharge and field measurements for Salmon Creek near Juneau, Alaska from January to April, 2021.

Computed discharge and field measurements for Salmon Creek near Juneau, Alaska from April to July 2021.



Computed discharge and field measurements for Salmon Creek near Juneau, Alaska from July to October 2021.