Eklutna Hydroelectric Project

Geomorphology and Sediment Transport

Year 2 Report

FINAL

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Terms, Acronyms, and Abbreviations

1991 Agreement	1991 Fish and Wildlife Agreement
ADFG	Alaska Department of Fish and Game
ASTM	American Society for Testing and Materials
AWWU	Anchorage Water and Wastewater Utility
cfs	cubic feet per second
FSP	Final Study Plans
GIS	Geographic Information System
GPS	Geographic Positioning System
HEC-RAS	U.S. Army Corps of Engineers River Analysis System (HEC-RAS) developed by the Hydrologic Engineering Center
LiDAR	Light Detecting and Ranging
mm	millimeter
NAD	North American Datum
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Service
NVE	Native Village of Eklutna
PIT	Passive Integrated Responder
PME	protection, mitigation, and enhancement
PMP	probable maximum precipitation
PVC	polyvinyl chloride
RM	River Mile
RTK	real time kinematics
TWG	Technical Work Group
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

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 geomorphology and sediment transport, 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 Watershed GeoDynamics to describe and evaluate geomorphology and sediment transport in the Project area.

This Geomorphology and Sediment Transport Study was initiated in 2021 in accordance with Section 3.2 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 providing a flow regime into the Eklutna River that would accomplish habitat restoration and increase the anadromous fish assemblage of the river.

Geomorphology and sediment transport processes in the Eklutna River downstream from Eklutna Lake have been altered by several management actions over the past century including water withdrawals, retention of sediment within constructed reservoirs, removal of the lower dam at River Mile (RM) 4, gravel removal from the river and floodplain, construction of the Anchorage Water and Wastewater Utility (AWWU) pipeline and access road, and channel confinement by roads and bridges. Sediment input, transport, and deposition are important processes that help to provide high quality aquatic habitat. An understanding of current substrate conditions and current and potential future sediment input and transport rates will help to provide information that can be used to assess potential future flow releases and aquatic habitat improvement measures.

This Year 2 Report includes geomorphology and sediment transport data collected in 2020, 2021, and 2022 as well as development of a sediment transport model and integration with the fisheries and hydraulic modeling studies. The sediment transport model is available for use as a tool to help assess potential effects of various flow regimes on the Eklutna River.

2 STUDY OBJECTIVES

The goal of the Geomorphology and Sediment Transport Study is to gain an understanding of how sediment supply, transport, and deposition within the Eklutna River downstream of Eklutna

Lake are influenced by current and potential future Project operations, particularly related to aquatic habitat conditions. Specific objectives include:

- document current substrate conditions (surficial and subsurface);
- identify and estimate input from major sediment sources; and
- estimate sediment transport rates under the current flow regime and provide tools for estimating sediment transport rates under potential alternative flow regimes to help assess the effects of potential future flow regimes on substrate, channel forming processes, and aquatic habitat conditions.

3 STUDY AREA

The study area includes the Eklutna River and associated major sediment sources between the outlet of Eklutna Lake and the mouth of the Eklutna River. Sediment monitoring transects included in the study are shown in Figure 3.0-1.

4 METHODS

The Geomorphology and Sediment Transport Study includes five components:

- review existing information and pre-field analysis;
- conduct field inventory and scour/sediment monitoring;
- estimate historic/current sediment sources and input rates;
- map channel position changes through time; and
- develop a sediment transport model.

4.1. Pre-field Work

Pre-field work included compiling and summarizing existing information including reports, recent and historical aerial photographs, and LiDAR data. Information collected includes:

- Aerial photographs (historic and recent)
- LiDAR (2015 Municipality of Anchorage LiDAR, 2020 and 2022 Eklutna Project LiDAR)
- USFWS cross section and fish flow assessment (Hanson 2019)
- Alaska Department of Fish and Game (ADFG) sediment monitoring (ADFG 2019)
- Habitat mapping – Prince of Wales Consortium 2007 and Native Village of Eklutna (NVE) 2020
- An existing HEC-RAS model of the lower Eklutna River (HDR 2016)
- Eklutna Inc. sediment monitoring at the railroad and highway bridges

Geomorphic reaches were delineated based on channel confinement (e.g., bedrock canyon vs. alluvial reaches), and major flow or sediment sources (e.g., Thunderbird Creek, lower dam deposits, large valley wall sediment sources).

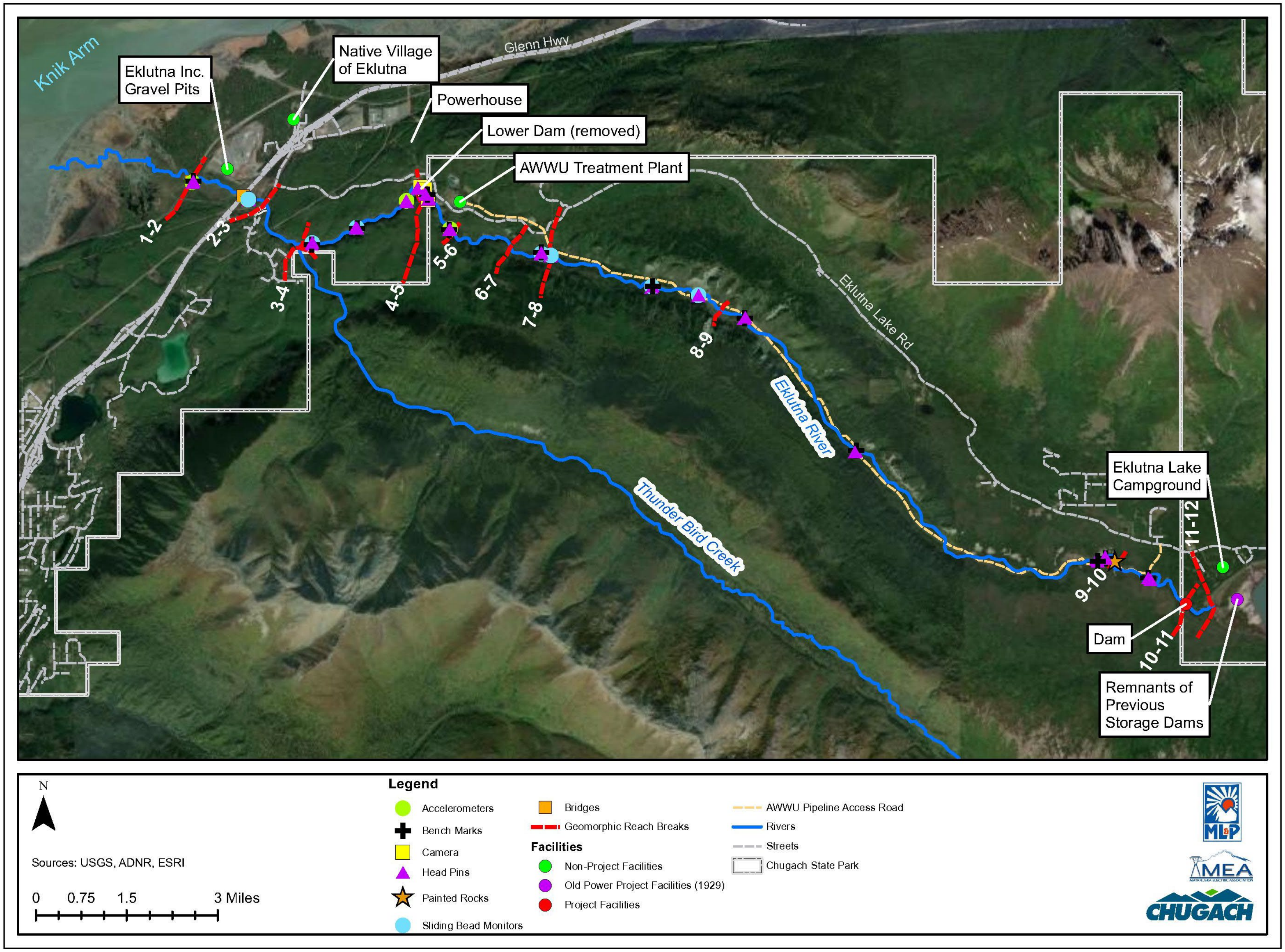


Figure 3.0-1. Study area and sediment monitoring transects.

4.2. Field Inventory and Scour/Sediment Monitoring

Field work included several site reconnaissance trips to view existing substrate, aquatic flow, and sediment source conditions as well as establish monitoring transects to measure any geomorphic changes resulting from the 2021 study flow releases. The 2021 study flow releases were intended to allow study teams to measure changes in hydraulic parameters (see Reiser et al. 2023), water quality (see Sauvageau 2023), and geomorphology (as described in this report) during different flow levels. The study flow releases started on September 13 and ended on October 6, 2021. The complete flow releases schedule is shown below.

- Monday, September 13 – Initiated flow releases at 150 cfs
- Friday, September 24 – Down-ramped to 75 cfs
- Wednesday, September 29 – Down-ramped to 25 cfs
- Wednesday, October 6 – Down-ramped to 0 cfs

Overall, the flow release schedule encompassed a 23-day period; 11 days high flow; 5 days mid-flow; 7 days low flow. Flow adjustments are described in more detail in the Instream Flow Study Year 2 Report (Reiser et al. 2023).

4.2.1. Selection of Sediment Monitoring Transect Locations

Nineteen sediment monitoring transects were established between Eklutna Lake and the railroad bridge, including eight transects that were previously established in August 2020, four transects that were established by ADFG and NMFS for the aquatic habitat monitoring effort after the lower dam removal, and two transects that are at or near transects established for the Instream Flow Study (Table 4.2-1 and Figure 4.2-1). The eight transects established in 2020 were established in case there was an unanticipated spill event in the fall of 2020. These sites were reviewed with the Aquatics Technical Work Group (TWG) during a June 9-10, 2021 site visit. The remaining transects were also selected in coordination with the Aquatics TWG during the site visit.

Sliding bead monitors were installed at 10 transects and accelerometers were installed at 5 transects. It was not possible to install scour monitoring devices in geomorphic reaches 9 or 10 due to large substrate size. Therefore, in addition to the 19 geomorphology transects, painted rocks were deployed across the channel at one additional location near RM 11.3 to provide information on gravel movement.

Table 4.2-1. Sediment monitoring transects.

Transect ID	River Mile (RM)	Geomorphic Reach[2]	ADFG Monitoring Transect?	Instream Flow Study Site Nearby?	2020?	Scour Monitoring Equipment
101	1.6	2				Sliding Bead, Accelerometer
G	2.15	2			Y	Sliding Bead, Accelerometer
ADFG 8 Down	2.9	4	Y		Y	Sliding Bead
ADFG 6 Down	3.3	4	Y		Y	Sliding Bead
ADFG 2 Down	3.8	4	Y			Sliding Bead, Accelerometer
204	4.0	5				
203	4.05	5				
202	4.1	5				
201	4.15	5				
ADFG 4 Up	4.4	5	Y			Sliding Bead, Accelerometer
102	5.3	7		Y		Sliding Bead
F	5.4	7/8			Y	Sliding Bead
103	6.3	8		Y		Sliding Bead, Accelerometer
E	6.6	8			Y	Sliding Bead
D	7.1	9				
105	10.5	9				
C	11.15	9			Y	
B	11.2	9			Y	Painted Rocks on alluvial fan
Painted Rocks[1]	11.3	9/10				Painted Rocks in stream
A	11.8	10			Y	

Notes:
1. The Painted Rocks transect is an informal transect installed to help determine movement of specific particle sizes in the stream during the flow release.
2. See Section 5.2 for discussion of geomorphic reaches.

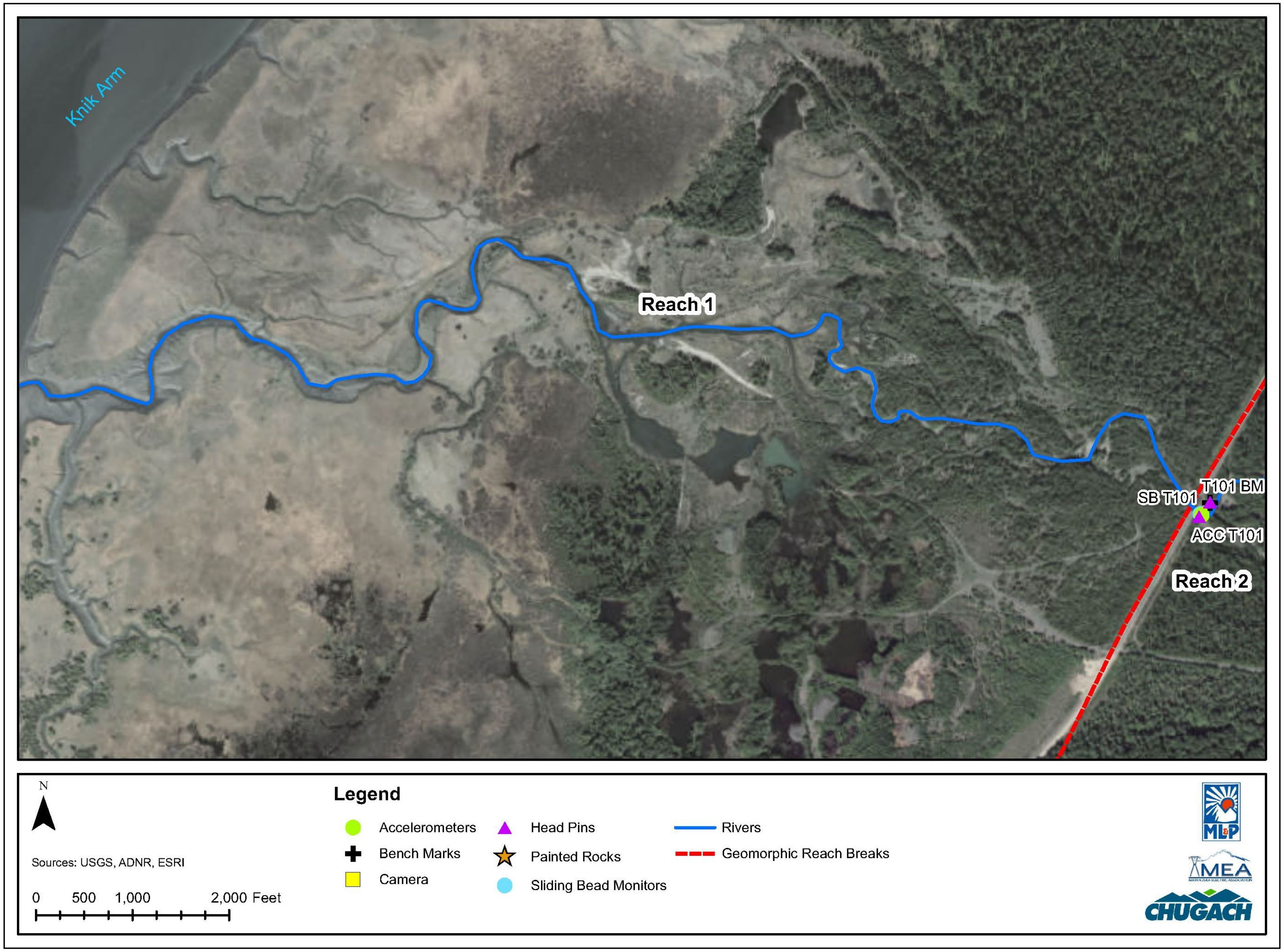


Figure 4.2-1. Sediment monitoring transect locations Map 1 of 10.

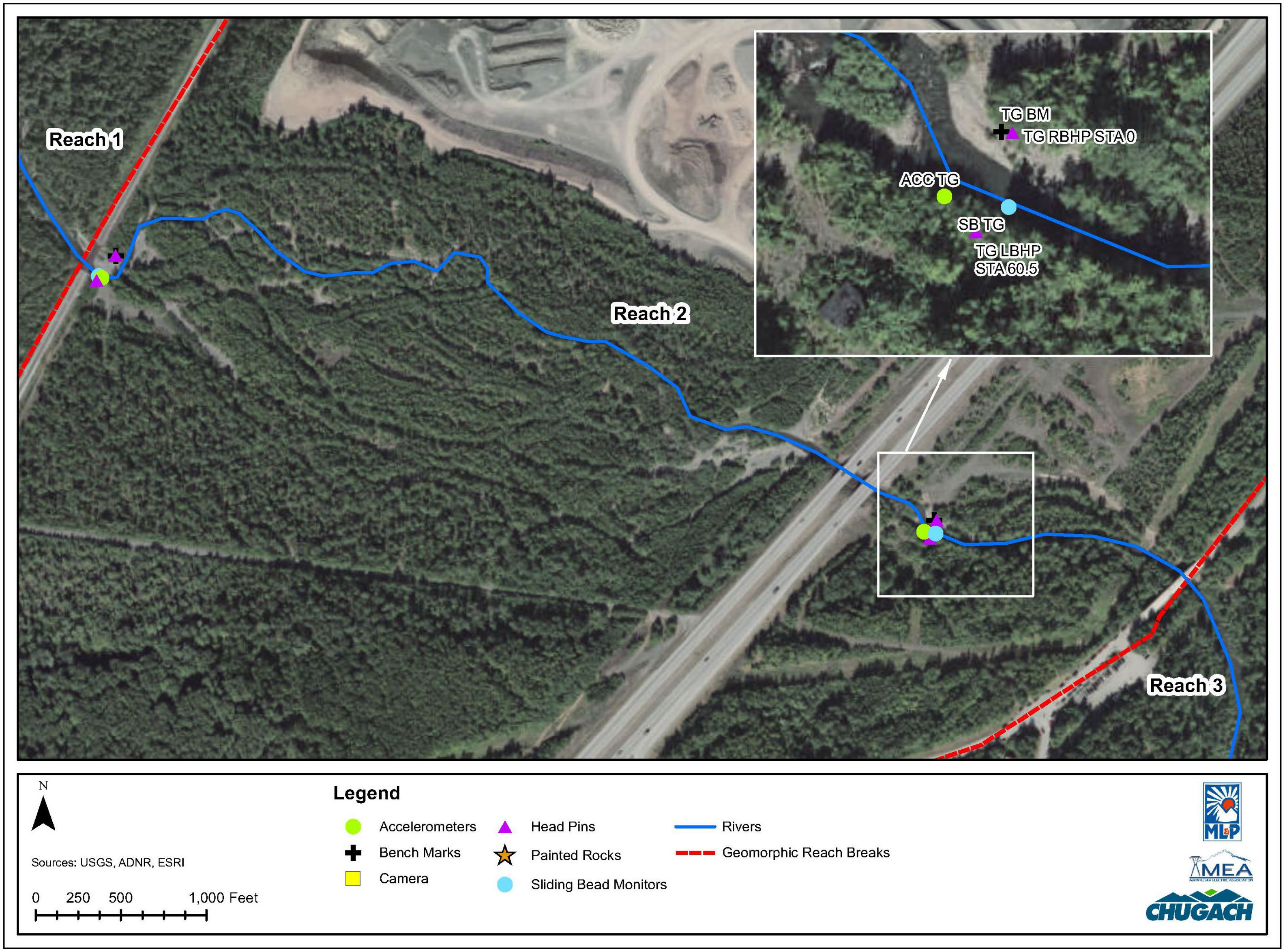


Figure 4.2-2. Sediment monitoring transect locations Map 2 of 10.

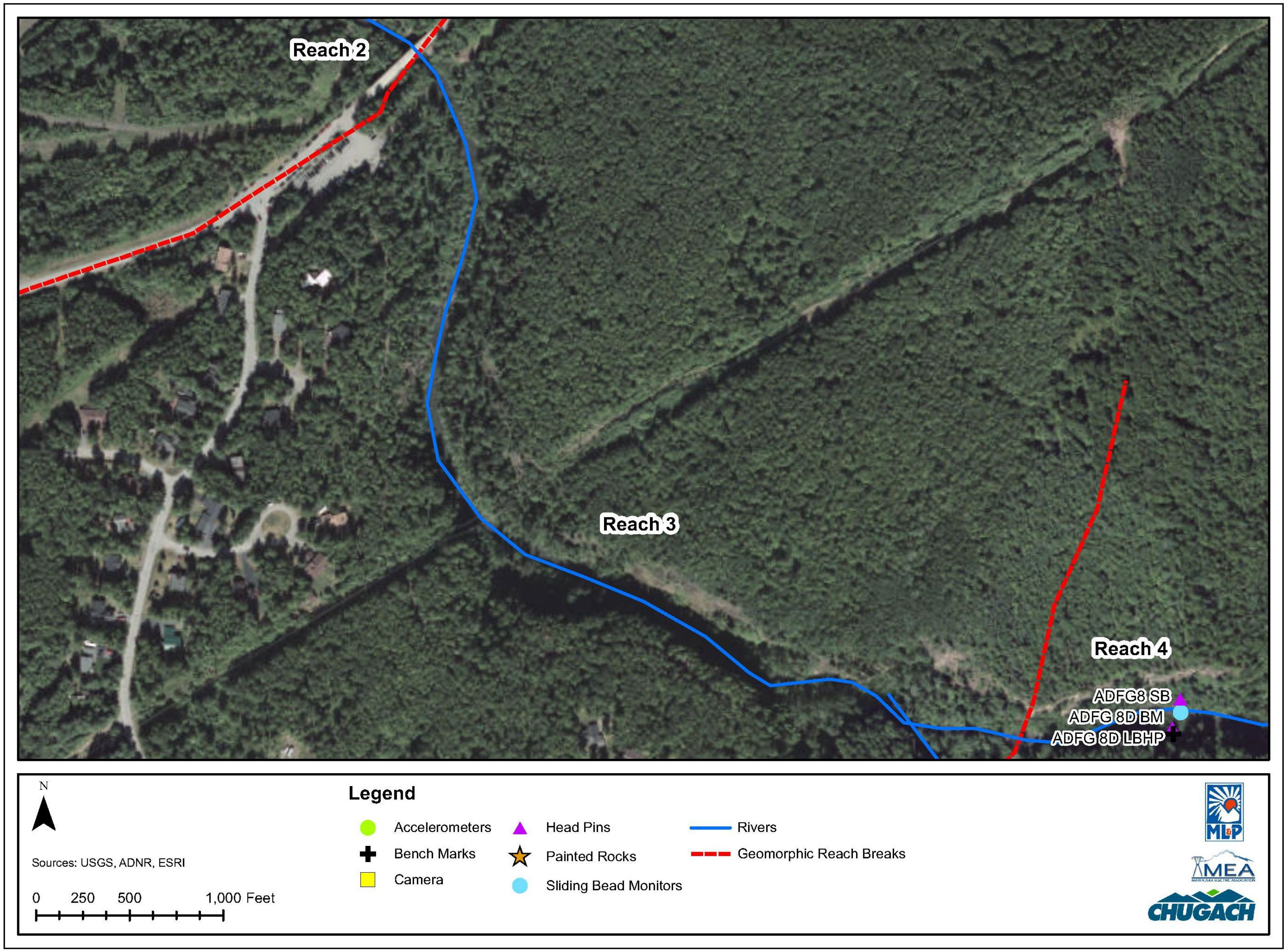


Figure 4.2-3. Sediment monitoring transect locations Map 3 of 10.

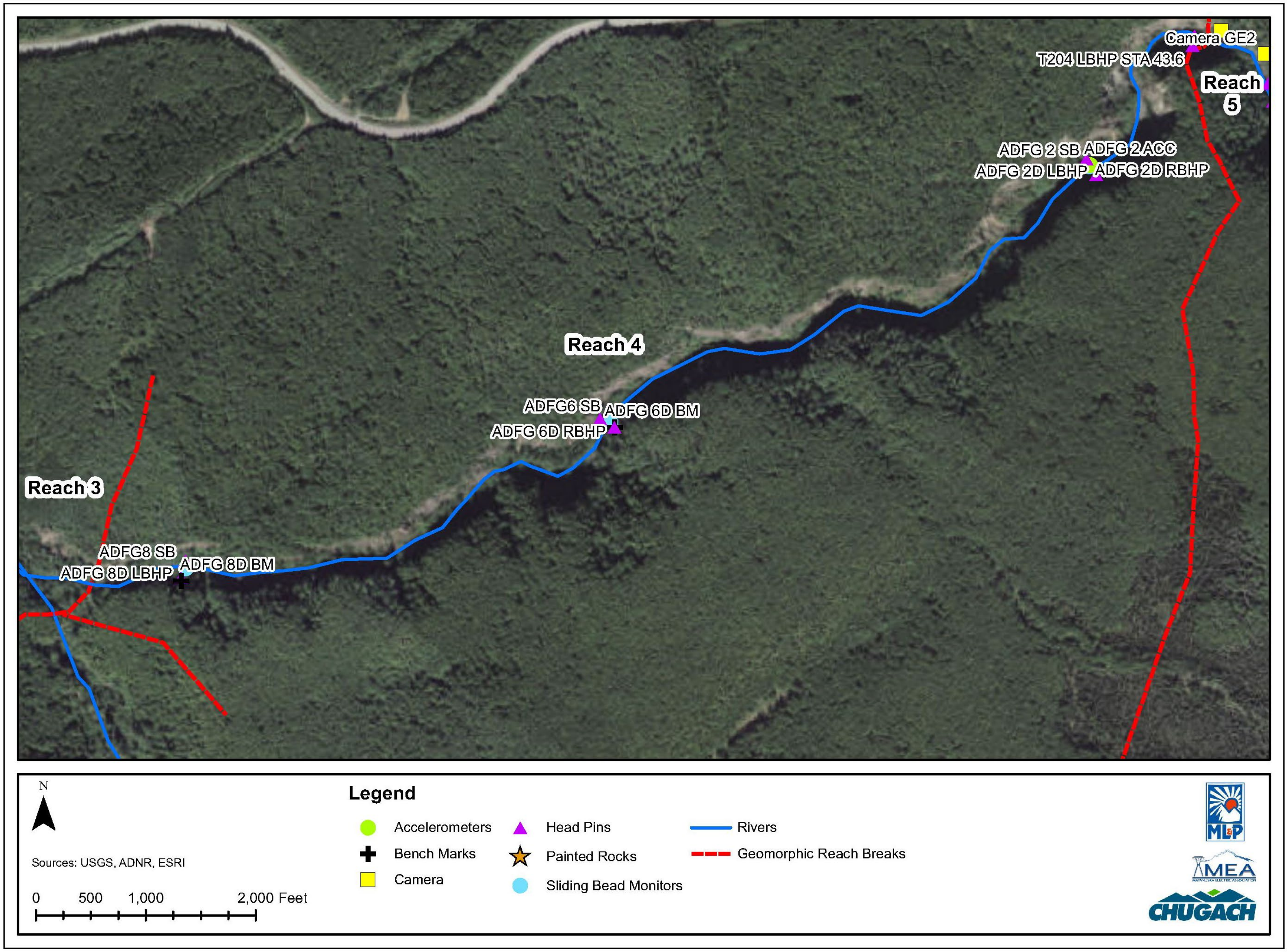


Figure 4.2-4. Sediment monitoring transect locations Map 4 of 10.

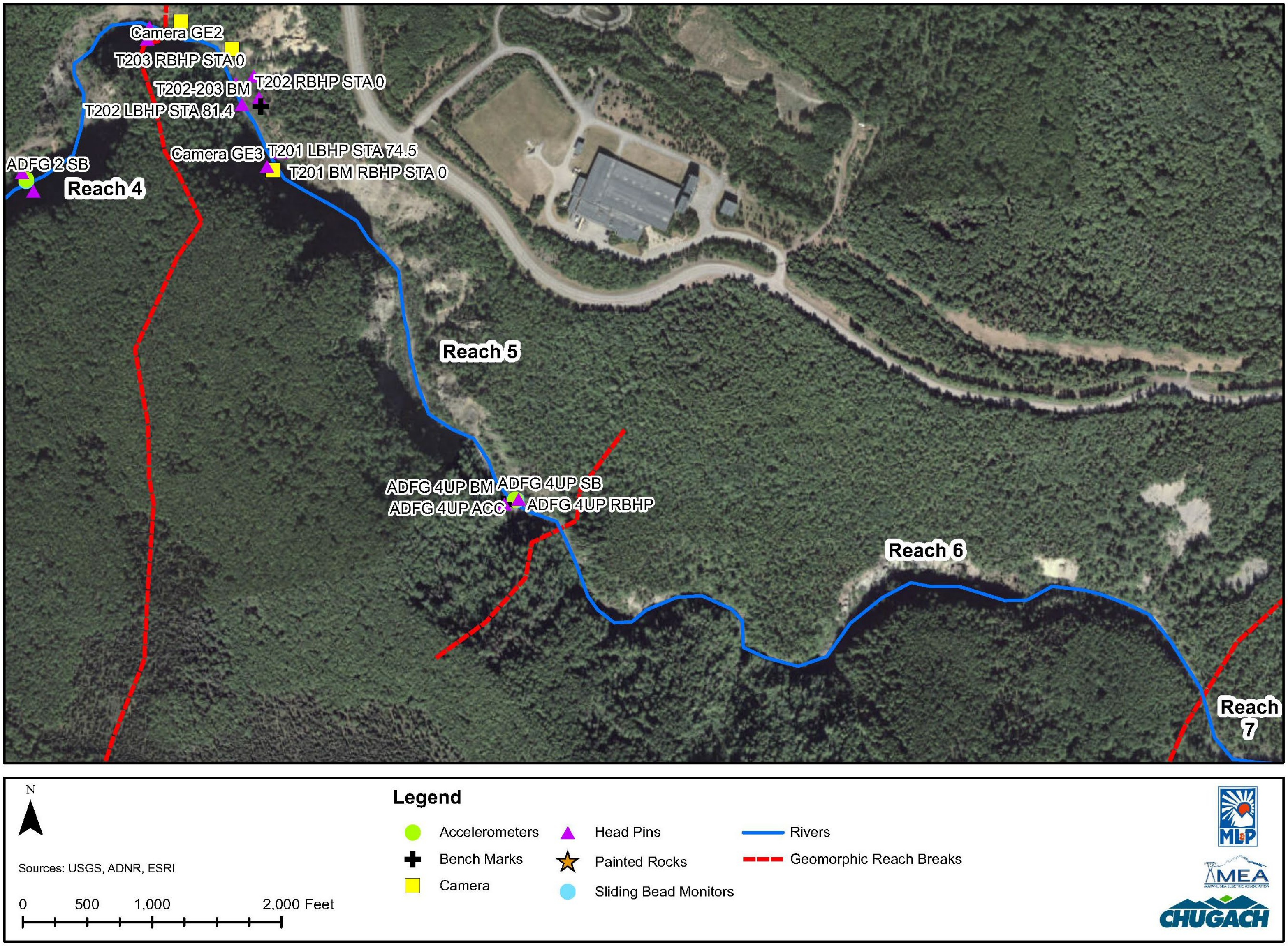


Figure 4.2-5. Sediment monitoring transect locations Map 5 of 10.

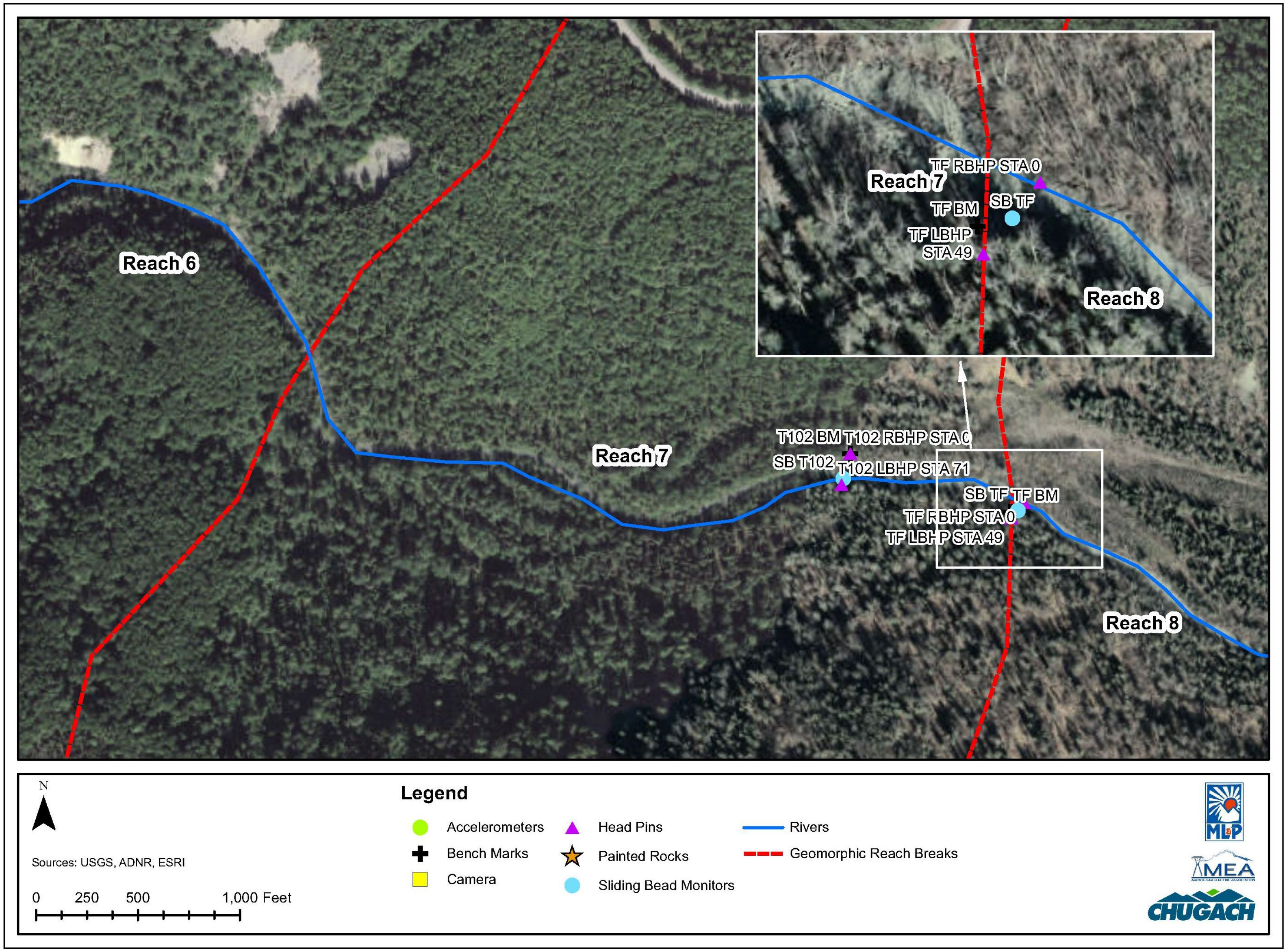


Figure 4.2-6. Sediment monitoring transect locations Map 6 of 10.

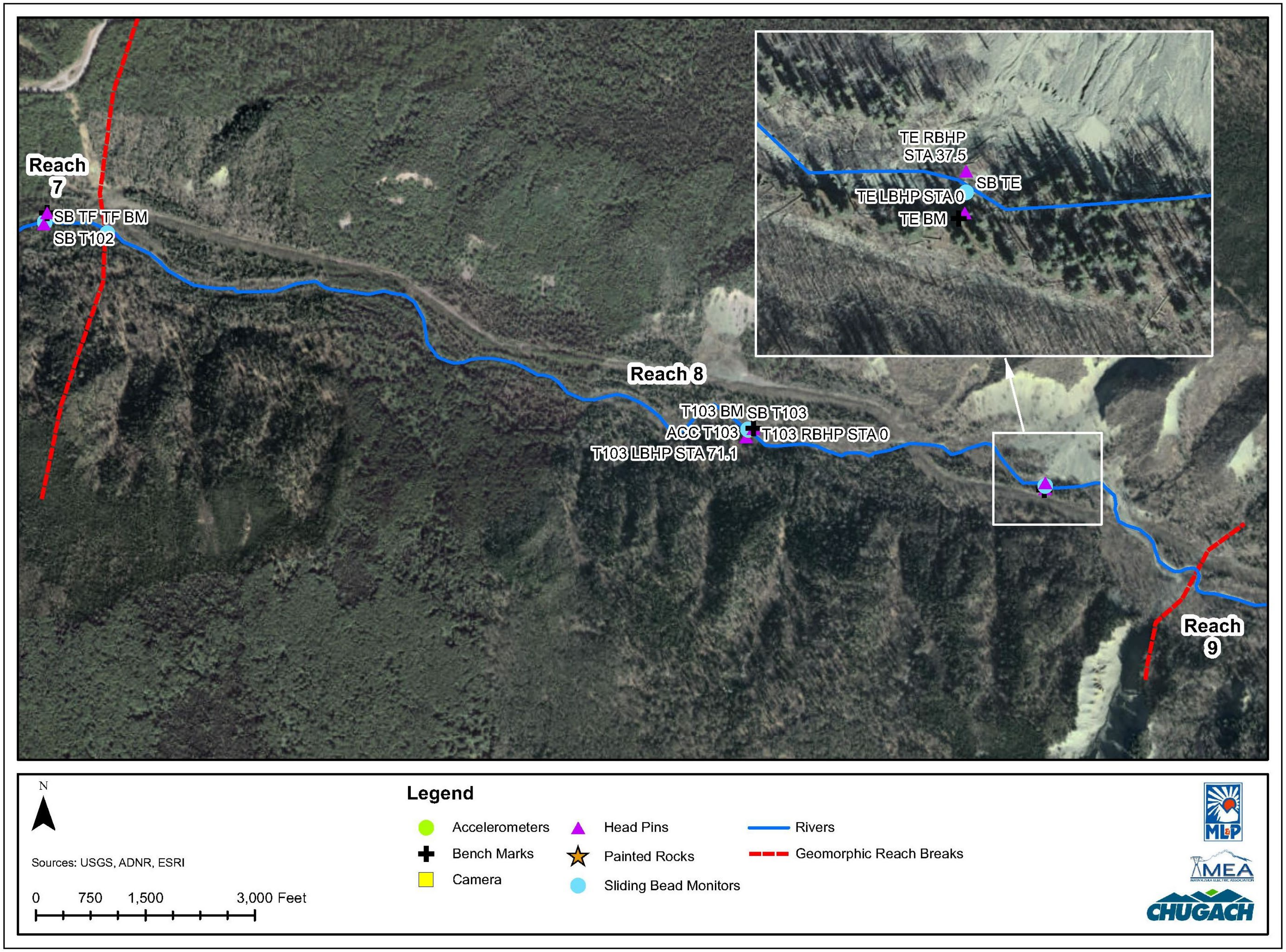


Figure 4.2-7. Sediment monitoring transect locations Map 7 of 10.

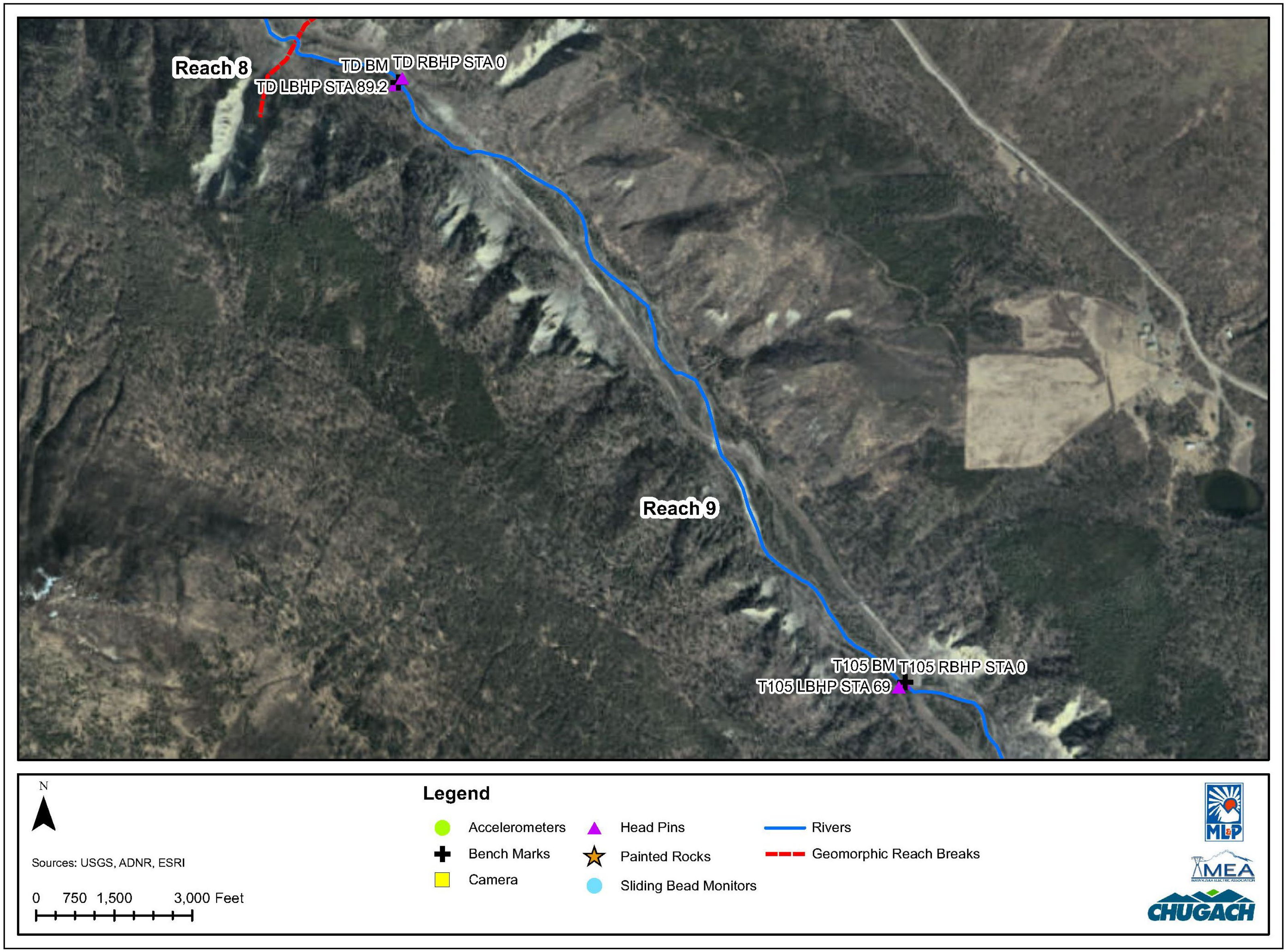


Figure 4.2-8. Sediment monitoring transect locations Map 8 of 10.

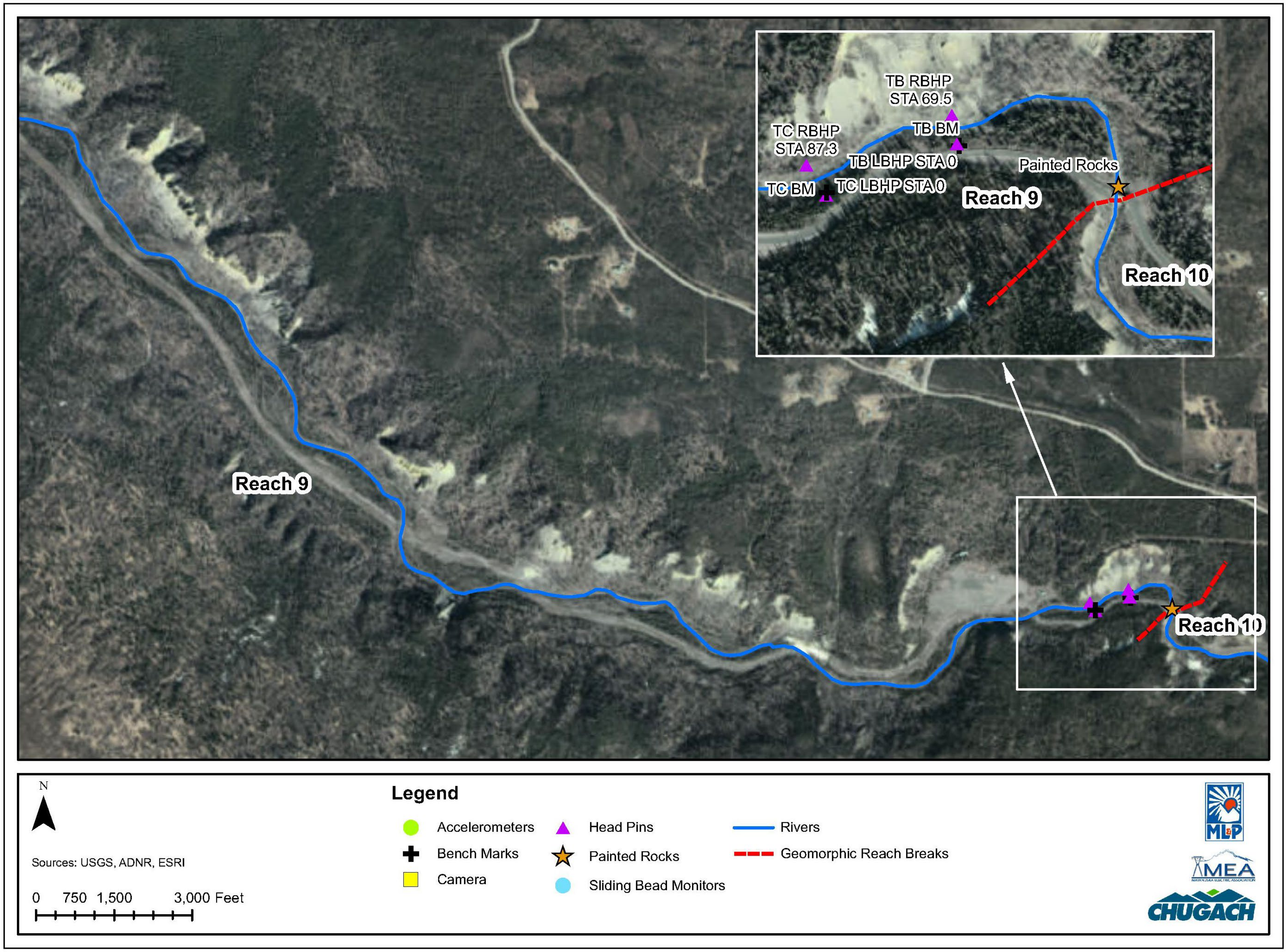


Figure 4.2-9. Sediment monitoring transect locations Map 9 of 10.

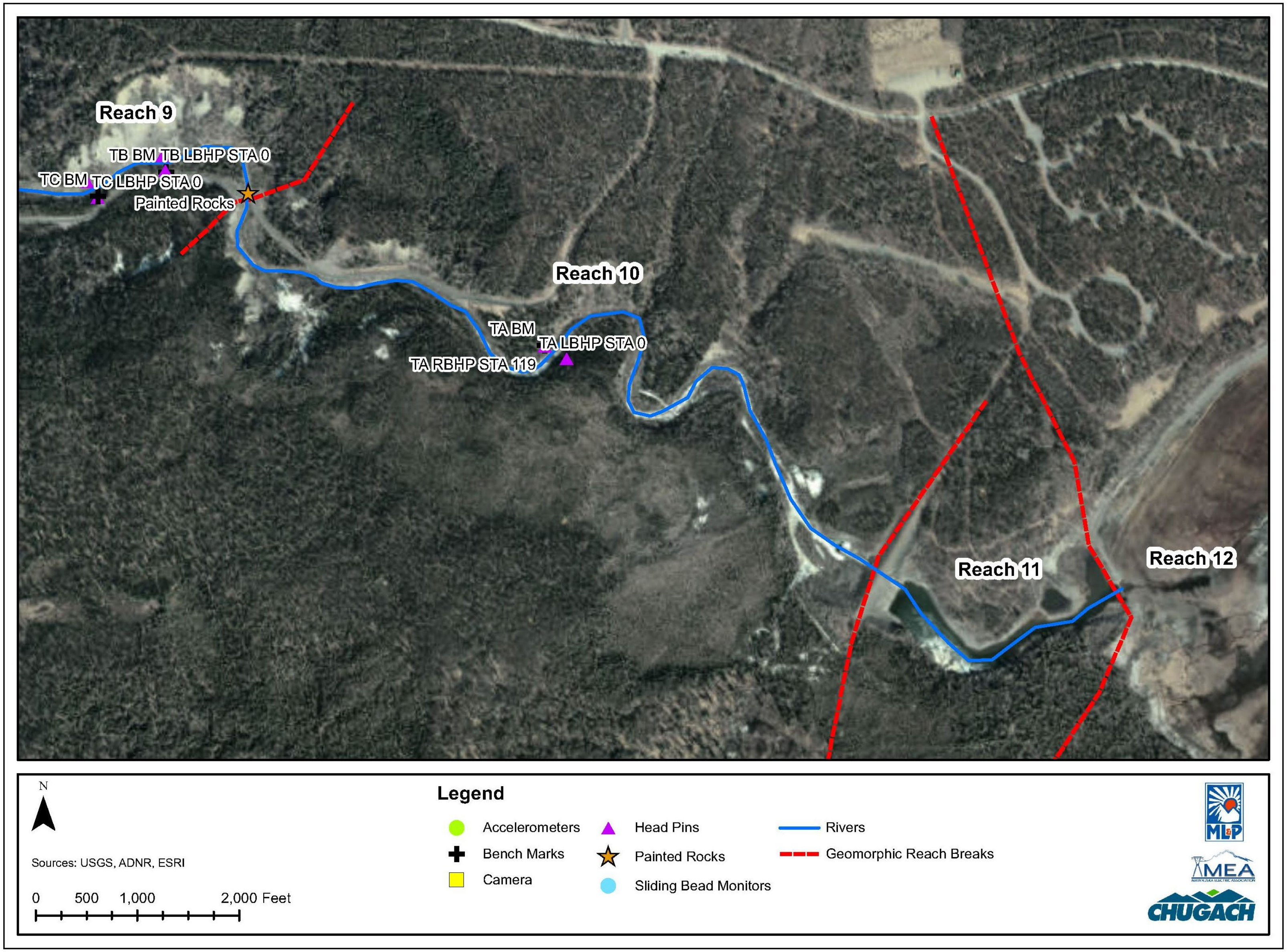


Figure 4.2-10. Sediment monitoring transect locations Map 10 of 10.

4.2.2. Cross Section and Substrate Data Collection

At each sediment monitoring transect, a benchmark and two transect headpins were installed, typically nails or plastic stakes with rock bolts used in bedrock areas. Cross sections were surveyed between headpins using a fiberglass tape, laser level, and survey rod. Stations along the tape/transect were located to define slope breaks above the bankfull channel and stations every foot within the bankfull channel. Grain size of substrate was recorded (using a gravelometer with phi scale e.g., <2mm, 2-2.8 mm, 2.8-4mm, 4-5.6 mm, 5.6-8mm, etc.) at each station within the bankfull channel for a minimum of 100 points within the bankfull channel. If the bankfull width of a cross section was less than 100 feet long (e.g., less than 100 pebble count points), additional passes across the channel were made so that at least 100 clasts are recorded at each site. Photos were taken of each transect.

Sub-surface sediment samples were taken in the vicinity of select transects by scraping away the surface armor layer and taking a bulk sample of sub-armor material. Sub-surface samples were taken at three locations in August 2021 where gravel/cobble material was available to sample. Substrate at the majority of transect locations consisted of fines covering cobble/boulder material and was not suitable for sub-surface sampling. Bulk samples were field sieved to remove particles larger than 32 mm, which were weighed in the field. A sub-sample of the remaining sediment (finer than 32 mm) was taken for laboratory sieving and weighing.

Three grab samples of fine-grained (silt/clay), compressed material from the exposed old dam deposits were taken in 2022 and sent for laboratory analysis of bulk density. They were processed using ASTM D7263 Method A, Standard Test Methods for Laboratory Determination of Density and Unit Weigh of Soil Specimens.

4.2.3. Scour Monitors and Accelerometers

Sliding bead scour monitors, slightly modified from Figure 4.2-11 (Schuett-Hames et al. 1999) were installed at 10 transects. The modification included using a 1.5-inch diameter plastic ball with a Passive Integrated Transponder (PIT) tag epoxied inside the ball instead of the PVC float since the smaller balls are less visible and easier to re-locate with a PIT tag reader. The sliding bead scour monitors record both scour and fill that takes place. The top bead on each monitor was set approximately level with the bottom of the riverbed. If the bed scours, beads are exposed and float to the top of the cable. Depth of scour is determined by number of beads exposed. If fill occurs, beads were buried, and depth of fill was determined by burial depth.

Accelerometers with a Hobo Pendant G accelerometer enclosed in a 2.5-inch black PVC holder attached to a cable and anchor as shown in Figure 4.2-12 were installed at 5 transects. The accelerometer recorded x-y-z position every 30 minutes. This allows the timing of any bed movement to be recorded, which can be correlated to flow when bed movement occurs.

The scour monitors installed in August 2020 were read in August 2021 by noting the number of beads that had floated to the top and/or any burial. All scour monitors were read in October/November 2021 following the September/October study flow releases. The accelerometers were removed in October/November 2021 or spring/summer of 2022.

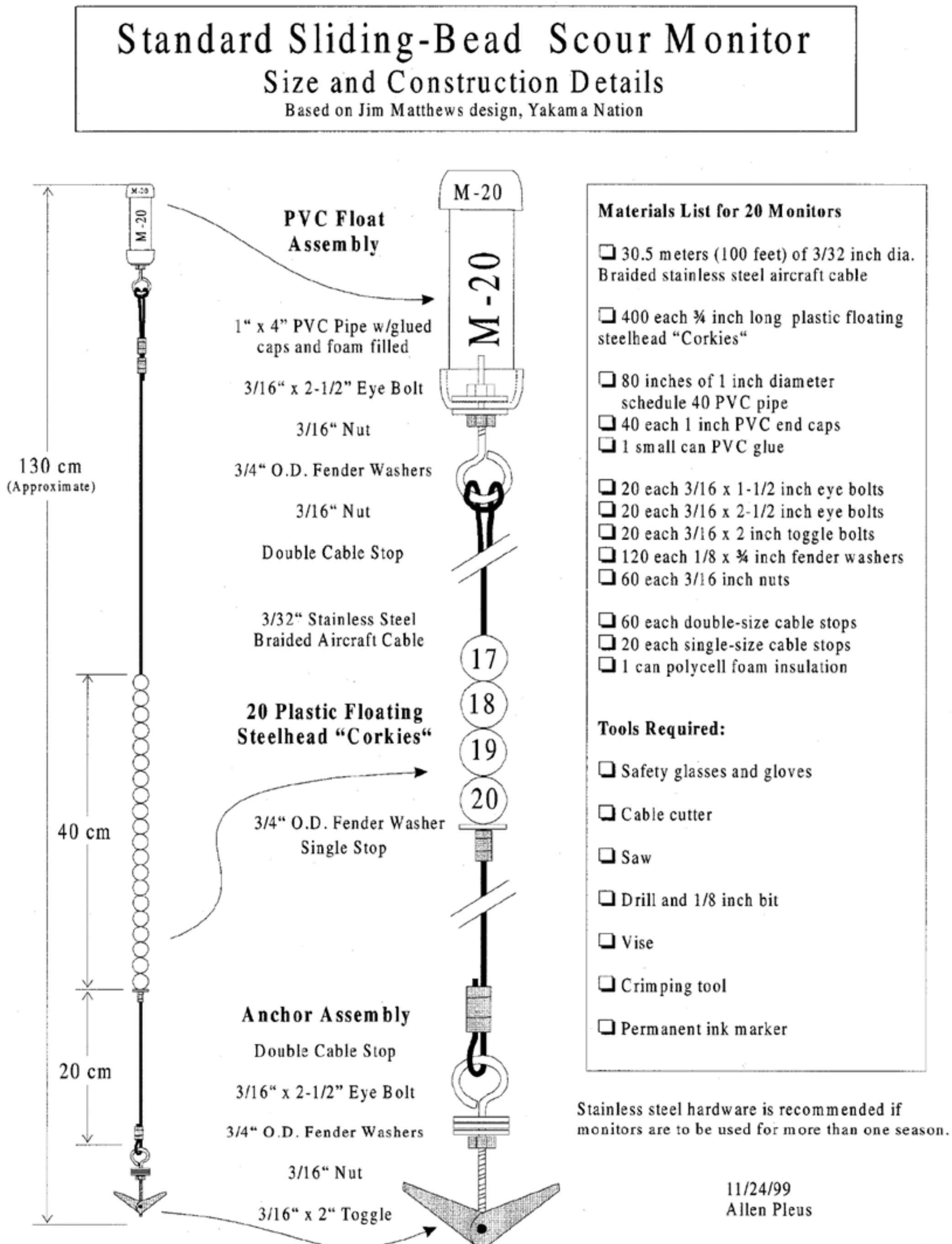


Figure 4.2-11. Sliding bead scour monitor (from Schuett-Hames et al. 1999).

Note: a 1.5-inch diameter plastic ball with a PIT tag was used in place of the PVC float since these have been found to be less visible and more stable during high flows.

Figure 4.2-12. Accelerometer before deployment.

4.2.4. Timelapse Cameras

Three timelapse cameras were installed in the old lower reservoir area (the area upstream from the lower dam site where sediment accumulated prior to removal of the dam) to record changes that took place during the study flow releases (see locations on Figure 4.2-5). Cameras were mounted on fence posts located on the top of the reservoir deposits and set to record every 10 minutes during daylight hours (Figure 4.2-13). Cameras were retrieved following the study flow releases.

Figure 4.2-13. Timelapse camera installation prior to study flow releases.

4.3. Sediment Sources and Input Rates

Sediment sources in the study area were assessed through a combination of aerial photograph/LiDAR analysis and field inventories.

Major sediment source areas were mapped using the 2021 aerial photographs and 2021/2022 LiDAR topographic data. The eroding area for each sediment source was delineated based on unvegetated areas within the study area and included gullies, streambanks, and eroding valley walls. The average volume of sediment from each source was estimated based on comparison of 2015, 2021, and 2022 LiDAR surfaces divided by time between LiDAR flights. Headscarp retreat for one of the larger sources (Source area 22) was visible and mapped from Google Maps aerial photographs from 1952-2022 to provide a longer-term estimate of sediment input rates from this source area.

Each of the major sediment sources was also observed in the field on July 6-8, 2022. At each of the source areas, grain size distribution was estimated (cobble, gravel, sand, fines) based on visual assessment of eroding banks or cliff faces. The percent of total sediment eroded from each source area that was delivered to the Eklutna River was noted based on observed grain size of sediment that reached the Eklutna River from each source. For example, if the sediment source area was directly adjacent to the river channel and all grain sizes from the source cliffs were observed to reach the river, delivery percent was noted as 100 percent. If the source cliffs were far from the Eklutna River channel and the majority of sediment from the eroding source cliffs was observed to be deposited within the valley bottom, it was noted that a small percentage of the sediment was delivered to the river. The delivery percentages are, as with the rest of the sediment observations in this report, a snapshot in time based on current river/source area locations. If the Eklutna River migrates substantially in the future, source area delivery percentages may change.

4.4. Channel Position Changes through Time

Historic aerial photographs and LiDAR hillshade were assessed to determine portions of the Eklutna River that showed evidence of current or historic channel migration. Based on this screening, the active Eklutna River channel in Geomorphic Reaches 1 and 2 between tidelands (approx. RM 0.7) and the old highway bridge (approx. RM 2.3) was selected for analysis. Geomorphic Reaches 3, 4, 5, and 6 are confined within a bedrock canyon that limit migration. In Geomorphic Reaches 7, 8, and 9 the river could migrate, but there was only one set of comprehensive aerial photographs available (1952) prior to the time when the majority of flow was diverted out of this reach of river; observations on subsequent photos showed little evidence of channel migration. Geomorphic Reach 10 is confined with limited opportunity for channel migration.

The active channel in Geomorphic Reaches 1 and 2 was mapped through time on historical aerial photographs using 1949, 1957, 1972, 1990, and 2020 photos. The active channel includes the wetted channel and unvegetated river bars. The historical aerial photographs were geo-rectified in ArcMap. Recent (2020) aerial photograph mosaics were available digitally and fully rectified. Note that particularly for the older photographs upstream of the canyon, limited positions were available for geo-rectifying because not much infrastructure existed to provide consistent reference locations. Areas downstream from the canyon had more infrastructure/development that provided better reference locations. Photographs were selected that had the river as close to the center of the image as possible to reduce errors associated with lens distortion around the edges of the photos. Note that there is error in exact channel position associated with geo-rectification errors, but for the purposes of this study, where general channel migration/lack of migration was of interest, the error was acceptable.

4.5. Sediment Transport Model Development

4.5.1. HEC-RAS 1-D Model

A HEC-RAS one-dimensional (1-D) hydraulic model developed by Kleinschmidt (Reiser et al. 2023) was augmented to use the Quasi Unsteady (Sediment) routine within HEC-RAS Version 6.2 to help assess the effects of flow augmentation in the Eklutna River. The model is one tool that is available to help assess how a new flow regime will affect sediment transport and geomorphology in the Eklutna River.

4.5.1.1. Hydraulic Model Development

A one-dimensional riverine hydraulic model (HEC-RAS 1D, Version 6.2) was developed and included a 10.8-mile long reach of the Eklutna River from Eklutna Dam (RM 12.3) to RM 1.5 (downstream from railroad bridge). Within this model reach, there is one major tributary (Thunderbird Creek) that joins the Eklutna River at RM 2.8. The HEC-RAS 1D model included the following three reaches:

1) Upper Eklutna – from Eklutna Dam to the confluence with Thunderbird Creek (9.5 miles)
2) Lower Eklutna – from the confluence with Thunderbird Creek to just downstream from the railroad bridge (1.3 miles)
3) Thunderbird Creek – from the confluence with the Eklutna River to Thunderbird Falls

Ground-based data collection was performed in 2021 for the three different study flow releases from Eklutna Dam. The morphology of the HEC-RAS 1D model relied on the following three sources of data:

1) LiDAR data acquired on May 15, 2020
    a) Projection: UTM Zone 6 North
    b) Horizontal Datum: NAD 83 (2011)
    c) Vertical Datum: NAVD88 (GEOID12B)
    d) Units: meters
2) Geomorphology study cross sections surveyed in 2021. The bottom profile of each instream flow transect was surveyed using a tape measure and an automatic level. The cross sections were surveyed prior to any study flow releases from Eklutna Dam and were then surveyed following each study flow release from Eklutna Dam (low, medium, and high).
3) Instream flow study cross sections surveyed in 2021. Horizontal and vertical control was established for each instream flow cross section using RTK GPS. The bottom profile of

each instream flow transect was surveyed using a tape measure and an automatic level. Water surface elevations were surveyed, and discharges were measured for three different study flow levels (low, medium, and high). These data were used to calibrate hydraulic roughness in the HEC-RAS 1D model.

A total of 241 cross sections were incorporated into the HEC-RAS 1D model. Data collected from the instream flow study were used to calibrate hydraulic roughness in the HEC-RAS 1D model at three different measured study flow levels (25 to 122 cfs as measured at the instream flow monitoring transects) and were used to extrapolate hydraulic conditions for 1,500 cfs (peak flow for the geomorphology study). The effective roughness option was used to calibrate the hydraulic model to the measured flows and also used to extrapolate Manning's n for 1,500 cfs.

At the 1,500 cfs flow level, Manning's n in the channel ranged from 0.027 to 0.074 with a median value of 0.040. Manning's n in the overbank areas ranged from 0.029 to 2.41 with a median value of 0.053. Manning's n values in the overbank areas were greater than Manning's n values in the channel as would be expected. Simulated hydraulic conditions at the 1,500 cfs level are expected to be reasonably accurate for the current channel configuration. HEC-RAS 1D models are routinely used to extrapolate up to large flood levels that might result from extreme storm events such as a 100-year storm or a Probable Maximum Precipitation (PMP) event, as well as a dam break flood, so extrapolation of the Eklutna River model to 1,500 cfs is within the range of normal model use.

Additions to the 1D HEC-RAS hydraulic model needed to run the sediment transport calculations include providing information on substrate, sediment inputs, and sediment transport functions as described below

4.5.1.2. Bed Gradations

Bed gradation provides information on the grain size composition of the riverbed. For initial calibration runs, the 2020 (pre-study flow release) measured substrate gradations were used. However, the pre-study flow release substrate measurements between Thunderbird Creek and the upper-most large sediment source (approximately RM 11.4) include a large proportion of fine-grained sediment that does not reflect the underlying substrate that will be present after a few years of a new flow regime. To best estimate the effects of future flow releases, the river substrate used for future flow scenarios was based on best judgment of underlying sediment from substrate sampling upstream of RM 11.4 and observations of substrate on historic (higher elevation) river bars and within the channel following the 2021 study flow releases.

4.5.1.3. Moveable Bed Limits and Maximum Scour Depth

Moveable bed limits were set to a reasonable channel width based on potential high flow channel widths that could develop under future flow scenarios. Maximum scour depth was set to 5 feet for the majority of transects with the exception of mapped bedrock or grade controls (1-2 feet) and the old reservoir deposits (up to 20 feet based on estimated sediment depths).

4.5.1.4. Boundary Conditions (Sediment Input)

Boundary conditions set the amount of incoming sediment in the model. The upper boundary condition was set to 0 sediment input since all upstream sediment is deposited in Eklutna Lake. A rating curve for Thunderbird Creek input was estimated based on substrate size in the creek. Sediment time series were set for the alluvial fan sediment sources with average annual inputs as shown in Table 2-1 above.

4.5.1.5. Sediment Transport Function

The Meyer-Peter Muller transport function was chosen based on the dominant substrate size in the river (gravel-cobble) and stream gradient. Erosion of fine-grained sediment from within the old reservoir are not expected to be modeled accurately with this transport function because erosion rates of consolidated fine-grained sediment vary widely and are site-specific based on relative grain size and consolidation of the fine sediment. In addition, time-lapse photography of the reservoir during the flow release showed that mass wasting via undercut banks, toppling, and slumping occurred within the reservoir deposits. These processes are not modeled in HEC-RAS. Because we have accurate information on the actual amount of erosion in the old reservoir deposits from the LiDAR comparison, and the majority of the fine-grained silt/clay will be transported downstream as washload, this is not considered a limitation of the overall model. Modeled erosion processes between RM 4-4.2 will not accurately reflect measured erosion within the old reservoir deposits, but the remainder of the river will not be subject to these limitations.

4.5.1.6. Calibration and Confidence

The HEC-RAS sediment transport model was run to test how well the model predicted changes that took place at the 20 geomorphic monitoring transects during the 2021 test flows. Measured Eklutna River and Thunderbird Creek flows were run and the measured and modeled net channel change (depth of erosion or deposition) were compared (Table 4-1). The modeled and measured channel changes were closely comparable at transects upstream of the old reservoir deposits. Within the old reservoir, as described above, the model predicted up to 20 feet of channel erosion through the sediments but the erosion was confined to a narrow channel since mass wasting and bank toppling are not modeled. Downstream from the old dam, model results were not as closely aligned with measured erosion/deposition depths, but the model did correctly predict erosion and deposition trends. Some of the model difficulty in these downstream areas was likely due to field evidence that suggests at least one wave of eroded reservoir deposits moved downstream as a debris torrent (likely following some of the larger mass wasting events observed on the time lapse cameras) rather than as river-borne sediment transport. HEC-RAS does not model debris torrent transport with highly viscous flow. Sediment transport scenarios under future conditions through and downstream from the old reservoir will not be subject to debris torrents and should provide more reliable results. The sediment transport calibration data provide excellent confidence in model results at flows up to the 2021 flow release levels (150 cfs). The sediment transport function chosen (Meyer-Peter Muller) has been widely-used to compute sediment transport in gravel-bed rivers for decades and used to extrapolate to high flow conditions. However, model results are less certain at very high flow levels (e.g., 1,500 cfs) where field data are not available to compare to model results.

Table 4.5-1. Comparison of Measured and Modeled Channel Change during 2021 Flow Release at Geomorphic Monitoring Transects.

Area	Transect ID	River Mile (RM)	HEC-RAS Transect	2020-2021 Measured Transect Changes	HEC-RAS Modeled Change
Downstream from Old (Lower) Dam	101	1.6	39080	Up to 1 foot deposition on edge of bar and 1 foot erosion in channel	5 feet of erosion (note that this transect is just upstream of a bridge; the sediment transport model has difficulty with bridges. The transect just downstream from bridge has 1.7 feet of erosion which is more representative of non-bridge transect changes)
	G	2.15	48205	Up to 1 foot of deposition (gravel) in channel	2.5 feet of deposition
	ADFG 8 Down	2.9	61320	Up to 0.5 foot of erosion during flow release	1.7 feet of erosion
	ADFG 6 Down	3.3	68505	Up to 2 feet of deposition during flow release	0.3 feet of deposition
	ADFG 2 Down	3.8	77134	Up to 1 foot of deposition followed by 1-2 feet of erosion during flow release	0.6 feet of deposition
Old Reservoir Deposits	204	4.0	79786	2-3 feet of deposition then 4 feet of erosion during flow release	4 feet of erosion
	203	4.05	81177	Up to 30 feet of erosion of stored sediment; thalweg erosion 3 feet	20 feet of erosion (in narrow channel)
	202	4.1	81448	Up to 14 feet of erosion of stored sediment; thalweg erosion 2 feet	20 feet of erosion (in narrow channel)
	201	4.15	82249	Up to 14 feet of erosion of stored sediment; thalweg erosion 9 feet	20 feet of erosion (in narrow channel)
Upstream from Old Reservoir	ADFG 4 Up	4.4	87709	Up to 1 foot of erosion in channel	Less than 0.1 foot of change
	102	5.3	103502	Little change	Less than 0.1 foot of change
	F	5.4	104923	Cut and then deposition of up to 1 foot during flow release	0.7 feet of deposition
	103	6.3	121186	Up to 1 foot of erosion in channel during flow release	0.9 feet of erosion
	E	6.6	128374	Up to 1 foot deposition in left bank channel; new right bank channel with 2 feet of erosion	3.2 feet of erosion (model does not simulate cutting of new channel)
	D	7.1	135979	Up to 1 foot of deposition	1.1 feet of deposition
	105	10.5	161517	Overbank deposition and up to 1.5 feet of erosion in channel	1.2 feet of erosion
	C	11.15	205961	Up to 0.5 feet of erosion	1.1 feet of erosion
	B	11.2	207178	Up to 3 feet of erosion	0.7 feet erosion
	Painted Rocks	11.3	209017	n/a	0.9 feet erosion

Area	Transect ID	River Mile (RM)	HEC-RAS Transect	2020-2021 Measured Transect Changes	HEC-RAS Modeled Change
	A	11.8	215735	Minor changes	Less than 0.1 foot change

4.5.1.7. 1-D HEC-RAS Model Limitations

The HEC-RAS model has been developed based on current hydraulic and sediment conditions. It should be noted that the existing surficial substrate in the Eklutna River upstream from Thunderbird Creek is the result of many decades of sediment input from alluvial fans and accumulations in the old reservoir area with minimal flow in the river and, as shown in Figure 2-6, includes a large proportion of fine-grained sediment. The 2021 study flow release demonstrated that substrate conditions will change substantially in the future as finer-grained sediment is winnowed out of the existing substrate. To best estimate the effects of potential future flow releases, the river substrate used for model runs was based on best judgment of underlying sediment from substrate sampling upstream of the current sediment sources and observations of substrate on historic (higher elevation) river bars. This is one area of uncertainty in model results. In addition to an adjustment in substrate conditions, vegetation (e.g., alders, willows) have encroached upon the former river channel and are altering hydraulic conditions in the channel, particularly upstream from Thunderbird Creek. As the river adjusts to a new long-term flow regime, this vegetation will die, and river hydraulics will change, another source of uncertainty in future channel conditions.

4.5.2. Two-Dimensional HEC-RAS Model

A HEC-RAS two-dimensional (2-D) hydraulic model was developed by Kleinschmidt Associates for four reaches of the Eklutna River with complex hydraulics (Figure 4.5-1; Reiser et al. 2023). Details of the 2-D hydraulic model development are included in Reiser et al. (2023). Depth and velocity output rasters from the 2-D hydraulic model were used to calculate sediment transport potential based on critical shear stress of particles that could be entrained under a given flow.

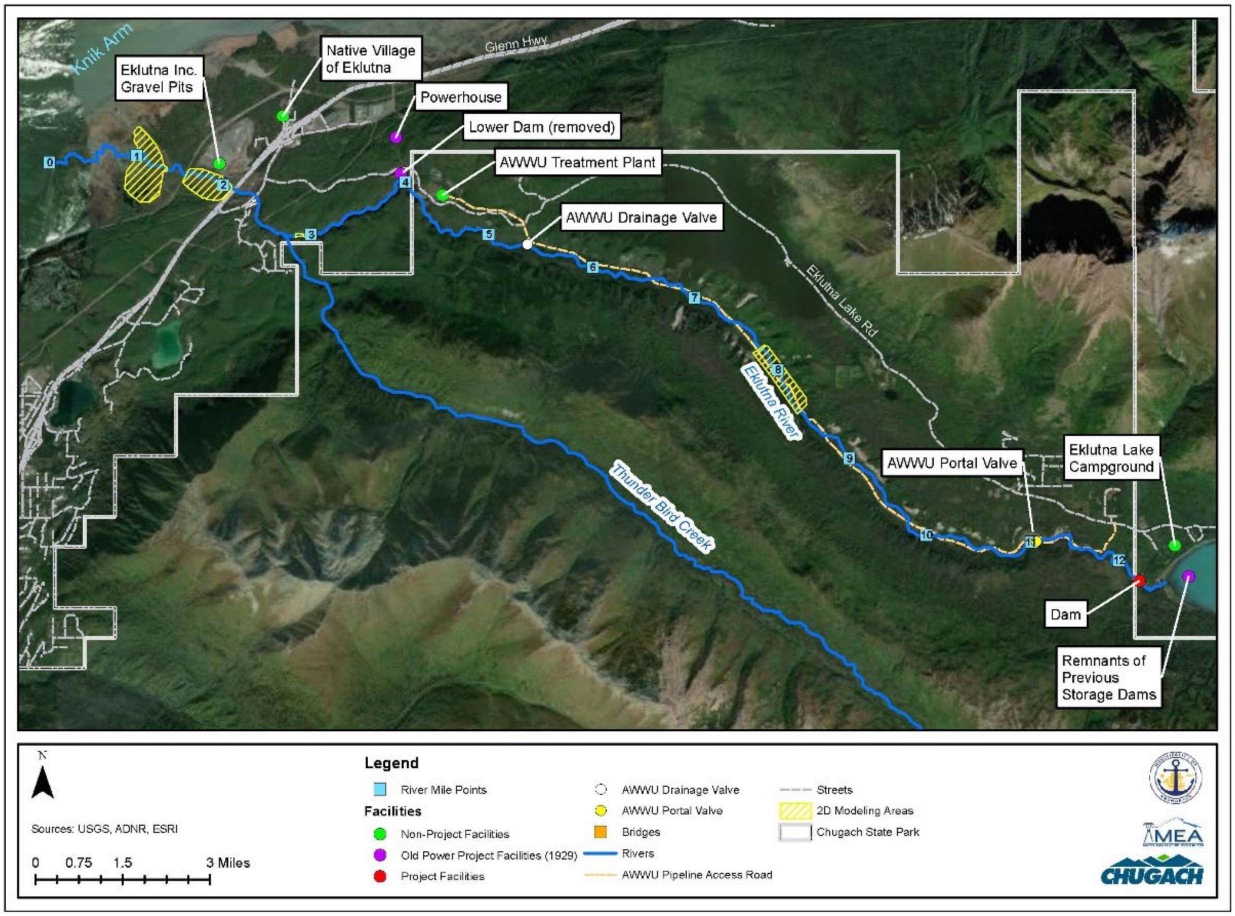


Figure 4.5-1. Location of 2-D Hydraulic Model Areas.

The critical diameter (largest diameter of the substrate that can be moved under given flow conditions) was computed for each cell in the 2-D model output using the method described in Appendix B of Engineering Manual 1110-2-1418 "Channel Stability Assessment for Flood Control Projects" (USACE 1994). This method is based upon the Manning's equation and assumes a Shields number of 0.045, and roughness height (k) equal to 3 times the median grain size (D_{50}). For this analysis, the Shields number was adjusted to 0.03 based on a study of bed-load transport in similar gravel bed streams (Mueller et al. 2005). Additionally, studies have shown the assumption that $k = 3D_{50}$ was considered too low; the ratio $k = 6.8D_{50}$ is more appropriate for use in gravel-bed streams (Clifford et al. 1992) and was, therefore, applied. Application of the adjustments noted above resulted in the following relationship for calculation of the critical diameter:

$$D_{crit} = 0.686\frac{V^3}{\sqrt{d}}$$

where:
D_{crit} = critical diameter (mm)
V = Velocity (ft/s)
d = Depth (ft)

4.6. Need for a High Calibration Flow

Per proactive discussions with the Aquatics TWG, the Geomorphology and Sediment Transport Study Plan included a provision for a high calibration flow in the fall of 2022, if needed and if liability and permitting issues could be resolved. From a sediment transport perspective, a high calibration flow would be warranted if data collected before and after the 2021 study flow releases was not sufficient to provide calibration data for the planned 1-D HEC-RAS sediment transport model.

One of the goals of the sediment transport model is to estimate flows that do geomorphic work in the river, sometimes referred to as “flushing flows” or channel maintenance flows. These flows are higher than normal base or moderate flows in a river system. We hypothesize that there are three different levels of higher flows of interest that will move accumulated sediment in the Eklutna River: 1) a flow that moves the surficial veneer of fine sediment; 2) a range of flows that moves substantial amounts of the sediment wedge from behind the old lower dam site; and 3) a flow that disrupts the armor layer and moves interstitial fine sediment. A goal of the sediment transport analysis is to help determine these different levels of flow.

Monitoring during and after the 2021 study flow release of approximately 150 cfs showed that this flow was sufficient to accomplish three levels of flushing flows in the existing channel configuration. The surface veneer of fine sediment was moved, a substantial amount of the sediment wedge at the lower dam site was moved, and the armor layer was disrupted at locations with gravel substrate. Fine sediment, sand, gravel, and cobble particles up to 128 mm in size were transported at some of the transects. Substrate in the heavily armored, pre-project channel (e.g., underlying channel) in geomorphic reach 10 was not disrupted, but data on substrate movement that did occur was sufficient to extrapolate and calibrate the sediment transport computations. The 2021 data provide sufficient information to calibrate and run the 1-D HEC-RAS sediment transport model to estimate potential channel changes from a variety of high flow conditions. The data and modeling will allow further evaluation of these three flushing flow goals as well as evaluate erosion at the toe of the alluvial fan sediment sources.

In addition to the three levels of high flows discussed above, there is another level of high flows that result in channel migration. Flows that cause channel migration are generally much higher than the other three levels of flushing flows/channel maintenance flows discussed above. Channel migration cannot be directly modeled using HEC-RAS or other widely accepted models due to the often stochastic nature of channel migration (accumulations of large woody debris can play a role in channel migration) and limitations of models to accurately calculate erosion of cohesive materials (e.g., riverbanks with tree and riparian vegetation roots). Because flow levels that result in channel migration are high and occur infrequently, they were assessed, as normal for most channel migration studies, using a combination of aerial photographic and LiDAR data and a record of peak flows. Release of a flow high enough to directly assess channel migration was not recommended due to the very large magnitude of flow required.

Based on the results of the 2021 study flow releases and monitoring data, a high calibration flow was not needed to calibrate the 1-D HEC-RAS sediment transport model.

5 RESULTS

5.1. Existing Substrate and Sediment Monitoring Data

The following is a brief summary of some of the available existing substrate and sediment monitoring data that for the Eklutna River collected by other researchers.

5.1.1. Substrate Data 2019 (Native Village of Eklutna)

NVE completed a stream habitat assessment of the Eklutna River from Cook Inlet to Eklutna Lake in 2019 (NVE 2020). Substrate composition in each habitat unit (e.g., pool, riffle, glide) was recorded as percent in each substrate class: silt/clay; sand; gravel; small cobble; large cobble; boulder; and bedrock. The data collected by NVE show that there were several distinct differences in substrate composition along the Eklutna River (Figure 5.1-1). Figure 5.1-1 shows a single bar for each habitat unit, with the percentage of substrate in that habitat unit represented by the percentage of each bar, color coded by silt/clay (light gray), sand (dark gray), gravel (yellow), small cobble (light green), large cobble (dark green), boulder (brown), and bedrock (black). For example, substrate in the first (most-downstream) habitat unit is 10 percent silt/clay (light gray), 30 percent gravel (yellow), and 60 percent small cobble (light green).

Substrate downstream of approximately RM 1.4 is primarily fine-grained silt/clay and sand deposited in the tidal flats. Substrate is coarse between RM 1.4 (just downstream from the railroad bridge) to the confluence with Thunderbird Creek and composed of cobble and gravel with boulders closer to Thunderbird Creek. Between Thunderbird Creek and the lower dam site, substrate is primarily gravel with some bedrock and silt/clay. The river through the old lower dam deposits was characterized as silt/clay with some sand and gravel. Between RM 5 to 6.6, the substrate was primarily sand with boulders; this is a zone that is heavily influenced by local sediment sources from eroding valley walls. Upstream of RM 7, substrate was composed of silt/clay and boulders, with decreasing amounts of fine-grained sediment upstream of RM 9. Close to Eklutna Lake, substrate was primarily cobble and boulder reflecting the lack of fine-grained sediment from upstream sources or valley wall erosion.

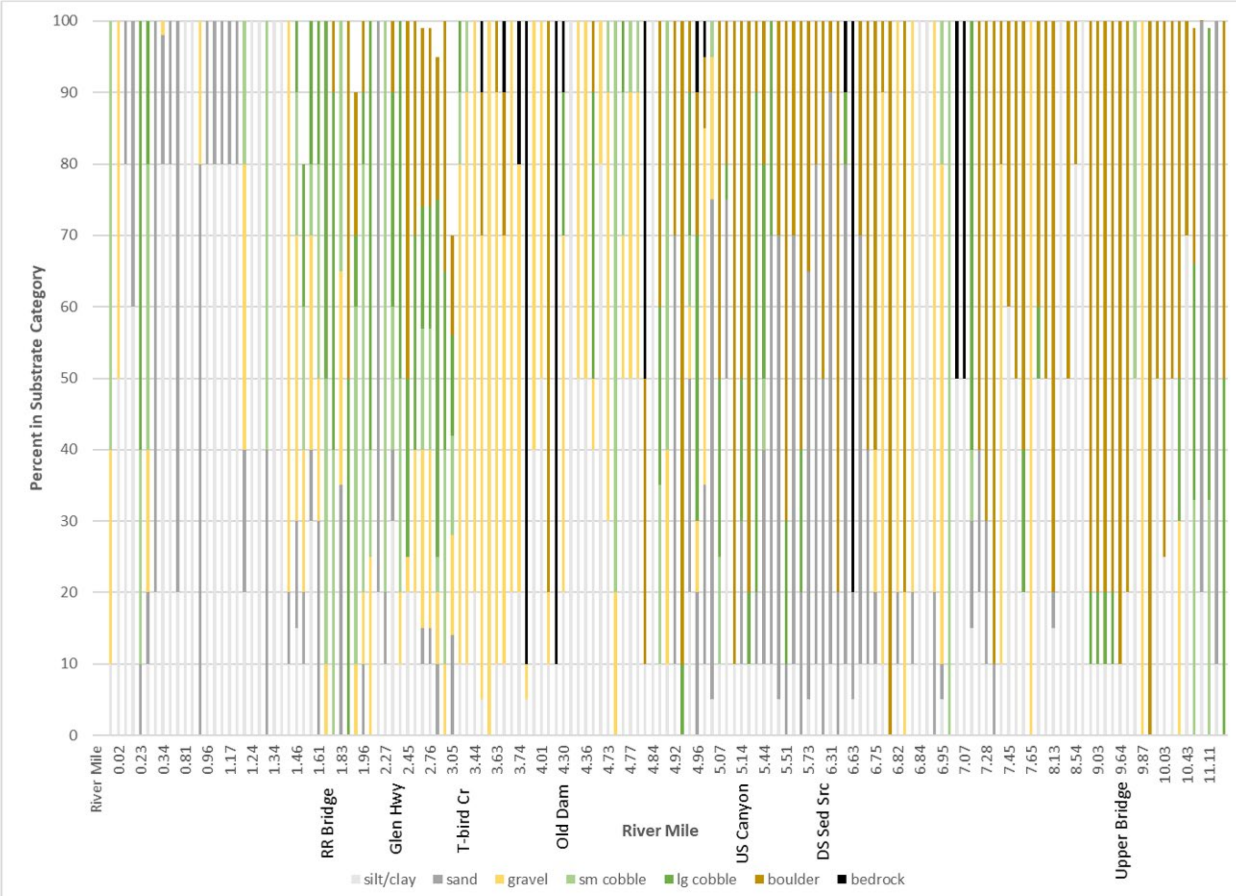


Figure 5.1-1. Eklutna River substrate 2019 (Source: NVE 2020).

5.1.2. ADFG Monitoring Transects (ongoing)

Eklutna Inc. and ADFG have established monitoring transects to evaluate sediment mobilization following removal of the lower dam. Pre-removal transects were established in 2017 to collect baseline data on channel geometry and substrate conditions at seven locations, two upstream and five downstream of the lower dam site. Post-removal monitoring was collected at three of these locations in 2019 and 2020 (Kirsch and Benkert 2020). These data are included in Section 5.3 for sites where scour monitors were deployed as part of the present study.

5.1.3. Eklutna Inc. Bridge Monitoring Transects (ongoing)

Eklutna Inc. is monitoring cross sections upstream and downstream from the three bridges below the lower dam site as part of the analysis of effects of dam removal (Figure 5.1-2). Surveys were conducted in 2017, 2018, and 2019 and showed minor changes in channel configuration. The largest change was up to 1.5 feet of aggradation in one of the channels upstream of the railroad bridge (cross section 2 left bank channel on Figure 5.1-2).

CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	2723180.03	1749724.90	90.82	REBAR
4	2722364.06	1750635.49	95.60	REBAR
5	2722396.46	1750751.68	96.66	REBAR
6	2722622.32	1749824.42	85.69	REBAR
7	2722654.48	1749872.86	88.23	REBAR
8	2722805.36	1749698.09	81.81	REBAR
9	2722726.84	1749533.14	80.81	REBAR
10	2723210.74	1749744.78	87.39	REBAR
11	2723449.64	1747800.53	56.79	REBAR
12	2723307.77	1747778.37	53.38	REBAR
13	2723223.79	1747755.60	54.89	REBAR
14	2723308.30	1747526.84	52.82	REBAR
15	2723362.02	1747482.55	53.11	REBAR

CROSS SECTION ENDPOINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
500	2723397.33	1747572.14	51.87	X-SECTION 1 – NORTH
501	2723300.20	1747521.53	57.94	X-SECTION 1 – SOUTH
502	2723480.78	1747859.94	57.74	X-SECTION 2 – NORTH
503	2723114.95	1747673.61	54.96	X-SECTION 2 – SOUTH
504	2722831.90	1749719.32	81.86	X-SECTION 3 – NORTH
505	2722683.86	1749586.52	80.27	X-SECTION 3 – SOUTH
506	2722654.25	1749982.03	84.07	X-SECTION 4 – NORTH
507	2722530.30	1749865.67	83.82	X-SECTION 4 – SOUTH
508	2722437.58	1750716.74	93.22	X-SECTION 5 – NORTH
509	2722364.79	1750642.31	95.74	X-SECTION 5 – SOUTH

SURVEY NOTES

1. FIRST FIELD SURVEY WAS PERFORMED BY F. ROBERT BELL & ASSOCIATES ON JUNE 23 AND 26, 2017.
2. FIRST FIELD SURVEY INFORMATION FOR THIS PROJECT IS LOCATED IN FIELD BOOK NO. 2017-02, PAGES 17-22.
3. SECOND FIELD SURVEY WAS CONDUCTED BY F. ROBERT BELL & ASSOCIATES ON DECEMBER 27, 2017. THE SECOND SURVEY MEASURED TOP OF ICE AS THE RIVER WAS FROZEN.
4. SECOND FIELD SURVEY INFORMATION FOR THIS PROJECT IS LOCATED IN FIELD BOOK NO. 2017-04, PAGES 17-19.
5. THIRD FIELD SURVEY WAS CONDUCTED BY F. ROBERT BELL & ASSOCIATES ON MAY 15, 2018.
6. THIRD FIELD SURVEY INFORMATION FOR THIS PROJECT IS LOCATED IN FIELD BOOK NO. 2018-01, PAGES 35-40.
7. FOURTH FIELD SURVEY WAS CONDUCTED BY F. ROBERT BELL & ASSOCIATES ON OCTOBER 12, 2018.
8. FOURTH FIELD SURVEY INFORMATION FOR THIS PROJECT IS LOCATED IN FIELD BOOK NO. 2018-03, PAGES 26-29.
9. FIFTH FIELD SURVEY WAS CONDUCTED BY F. ROBERT BELL & ASSOCIATES ON JUNE 4, 2019.
10. FIFTH FIELD SURVEY INFORMATION FOR THIS PROJECT IS LOCATED IN FIELD BOOK NO. 2019-01, PAGES 58-60.
11. SIXTH FIELD SURVEY WAS CONDUCTED BY F. ROBERT BELL & ASSOCIATES ON SEPTEMBER 30, 2019.
12. SIXTH FIELD SURVEY INFORMATION FOR THIS PROJECT IS LOCATED IN FIELD BOOK NO. 2019-03, PAGES 15-17.

LEGEND

SET REBAR
POINT NUMBER

DATE:
REVISION:

BELL & ASSOCIATES
ENGINEERING | SURVEYING | 3D SCANNING

EKLUTNA RIVER DAM REMOVAL
Lower River
Cross Section Location Map

CLIENT:
EKLUTNA SERVICES, INC.
ADDRESS:
10950 Mausel Street, Unit B-1a
Eagle River, AK 99577

JOB NUMBER: 2017-2414.04
FIELD BOOK: FRBA17-02, FRBA17-04, FRBA18-01, FRBA18-03, FRBA19-01, FRBA19-03.

DRAWN BY: WEM
CHECKED BY: VFS
SCALE: 1:150

DATE:
10/14/19

SHEET:
C1.0

Figure 5.1-2. Eklutna Inc. bridge monitoring cross sections Map 1 of 2.

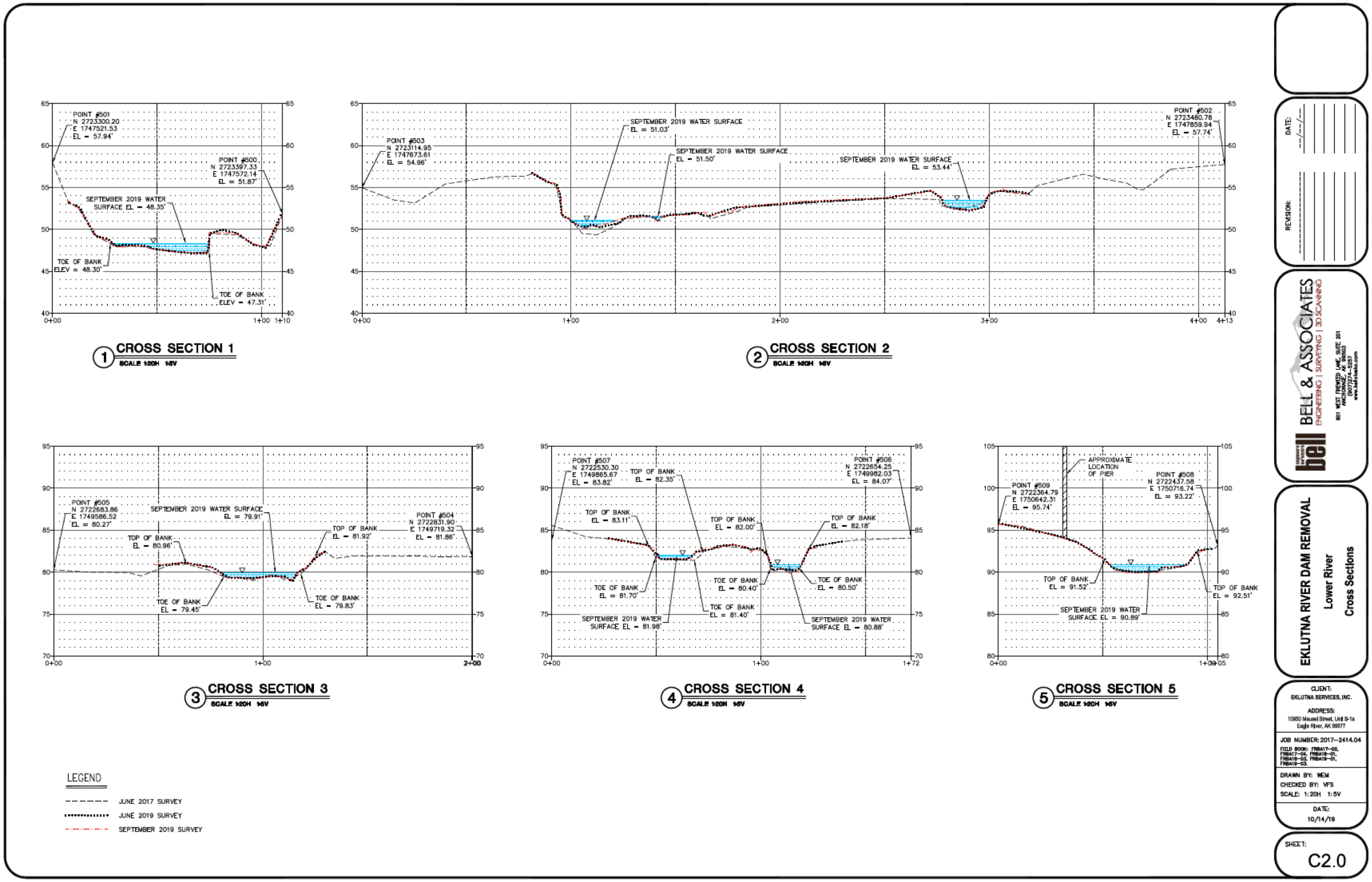


Figure 5.1-2. Eklutna Inc. bridge monitoring cross sections Map 2 of 2.

5.2. Geomorphic Reaches

Geomorphic reaches have been developed based on key geomorphic characteristics such as flow/tributary input, confinement, and sediment sources. Geomorphic reaches are shown on Figures 3.0-1, 4.2-1 (above) and summarized in Table 5.2-1.

Table 5.2-1. Geomorphic reaches.

Geomorphic Reach	River Mile Range	Confinement	Average Gradient	Comments
1	0-1.6	Unconfined	0.6%	Tidal influence at downstream end of this reach.
2	1.6-2.3	Unconfined	1.2%	Railroad bridge confines flow at downstream end of this reach. Includes flooded forest; past gravel removal in this reach.
3	2.3-2.85	Confined	1.1%	Downstream from Thunderbird Creek.
4	2.85-3.95	Confined	1.7%	Between Thunderbird Creek and old lower dam site
5	3.95-4.45	Confined	2.0%	Old lower reservoir deposits
6	4.45-5.05	Confined	1.5%	Canyon upstream from old reservoir deposits
7	5.05-5.4	Moderately confined	1.8%	Wider bedrock canyon downstream from lower AWWU access road
8	5.4-7	Unconfined	1.7%	Wide valley; contains major sediment sources
9	7-11.38	Unconfined	1.3%	Wide valley; upstream of major sediment sources (includes smaller sediment sources)
10	11.38-12.3	Moderately confined by erodible valley walls	0.8%	Upstream of sediment sources; upstream of upper AWWU bridge

5.3. Substrate and Channel Field Data

The following sections describe the data collected at the sediment monitoring transects. Field data collection occurred prior to and after the 2021 study flow releases. The flow release schedule is described in Section 4.2 above. Flow at a given point in the river during the releases depended on the amount of water being released, infiltration, tributary inflow, and travel time of released water as described in the Instream Flow Study Year 2 Report (Reiser et al. 2023).

5.3.1. Monitoring Transects, Pebble Counts, and Scour Monitor Data

5.3.1.1. Transect 101 RM 1.6

Transect 101, at RM 1.6, is located just upstream from the railroad bridge crossing (**Figure 5.3-1**). This transect was established in August 2021 and included one pre-flow release measurement and one post-flow release measurement showing up to 1 foot of deposition at the edge of the bar and up to 1 foot of channel deepening following the flow releases (**Figure 5.3-2**). Grain size measurements were taken pre- and post-flow release across the transect as well as one pre-flow release pebble count at the top of the right bank point bar (**Figure 5.3-3**). Substrate is predominantly gravel (median grain diameter 21-29 mm) and showed an increase in fine sediment following the study flow releases. A sub-surface sample was taken at this site; median grain diameter (D50) was 14 mm (**Figure 5.3-4**). An accelerometer and a sliding bead scour monitor were installed in August 2021 but were not recovered post flow release. Based on profile changes measured in the field, it is suspected that scour was deep enough to dislodge the monitors.

Figure 5.3-1. Transect 101, October 8, 2021.

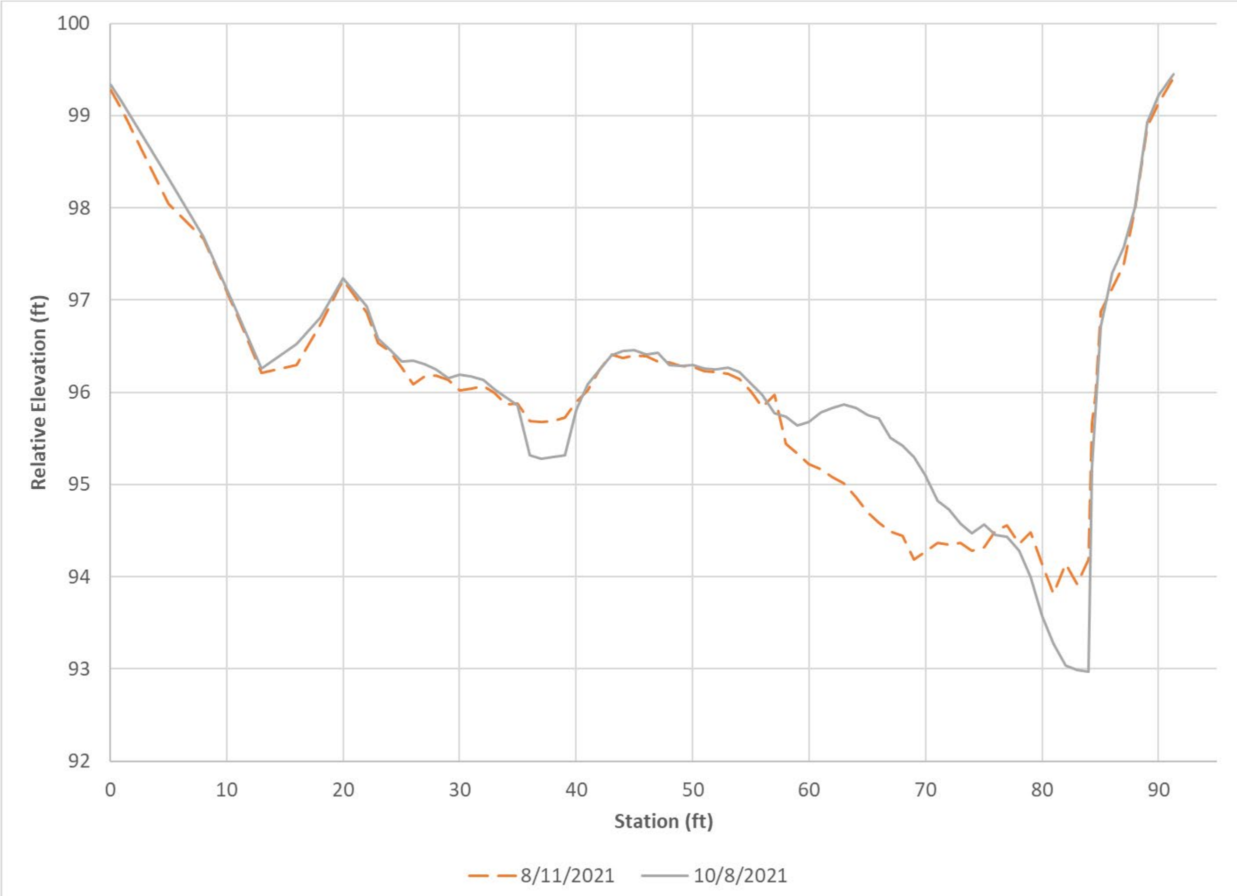


Figure 5.3-2. Transect 101 cross-sectional changes.

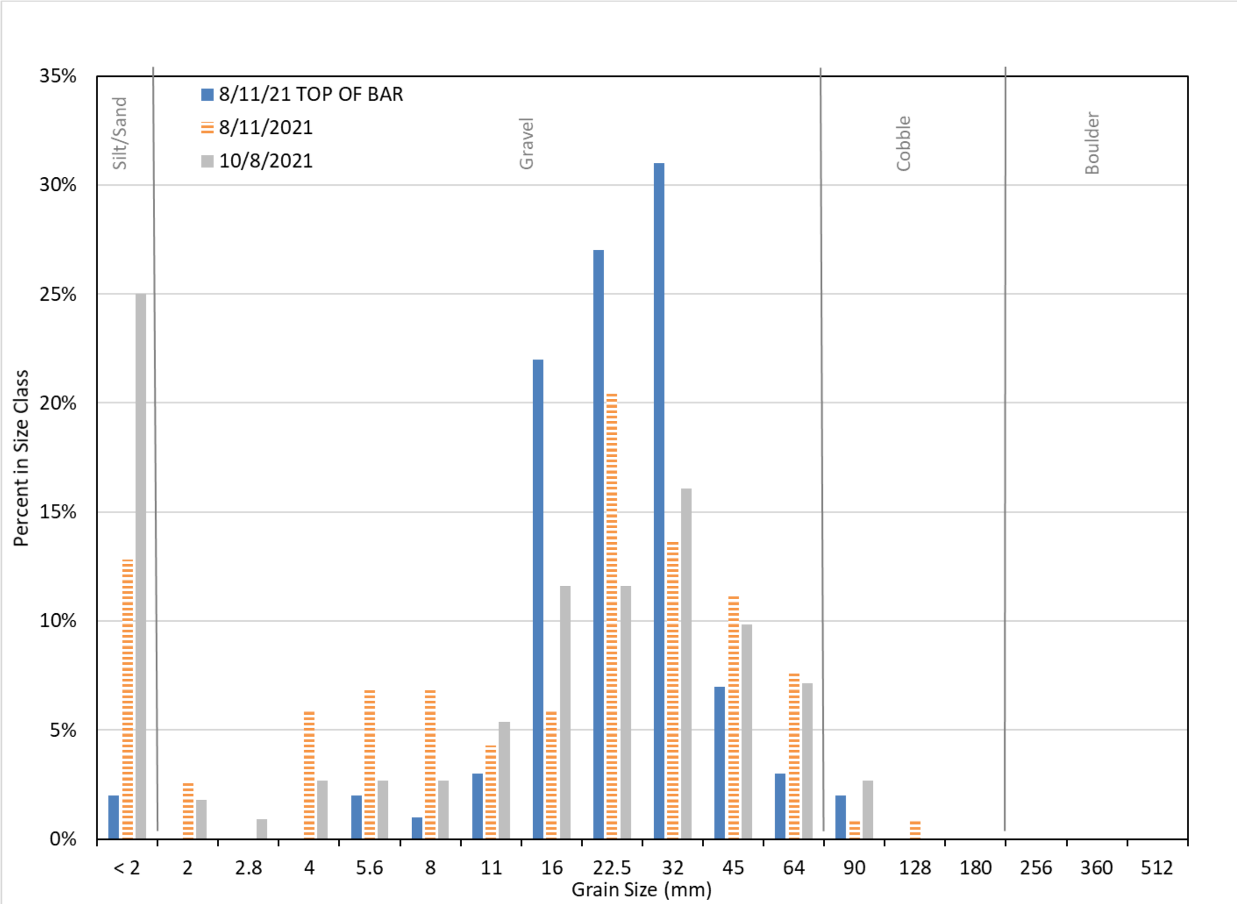


Figure 5.3-3. Transect 101 substrate grain size distribution changes.

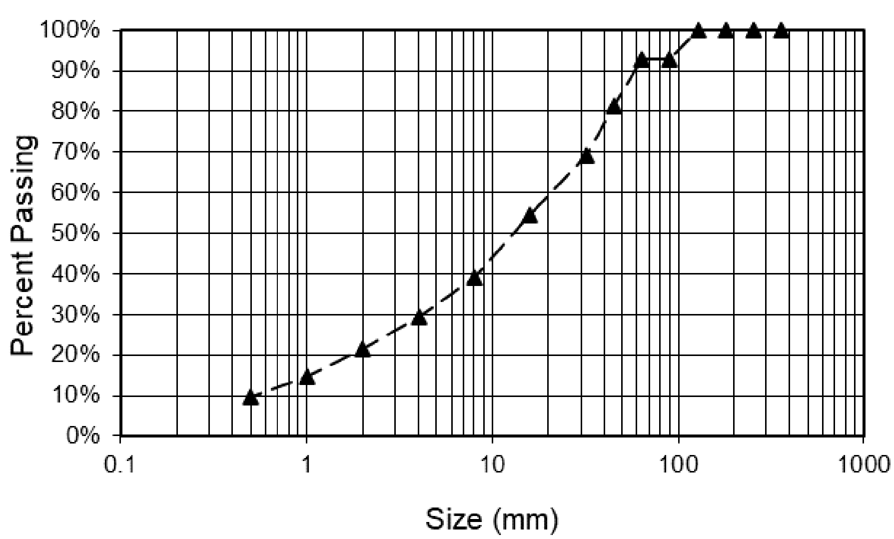


Figure 5.3-4. Transect 101 sub-surface grain size distribution.

5.3.1.2. Transect G RM 2.15

Transect G, at RM 2.15, is located just upstream of the New Glenn Highway bridges (**Figure 5.3-5**). This transect was established in September 2020 and included two pre-flow release measurements and one post-flow release measurement. The post-flow measurement showed deposition of 0.5 to 1 foot within the channel following the study flow releases (**Figure 5.3-6**). Grain size measurements were taken pre- and post-flow release across the transect (**Figure 5.3-7**). Substrate is predominantly gravel and showed an increase in median grain diameter from 13 to 23 mm following the study flow releases. An accelerometer and a sliding bead scour monitor were installed in August 2020. The sliding bead monitor was read in August and October 2021 and showed 3 inches of bed lowering between August 2020 and August 2021 followed by burial with 0.84 feet of gravel (up to 45 mm) in October 2021 following the study flow releases. The accelerometer was located, but not yet recovered post flow release due to deep, cold-water conditions in both 2021 and 2022. It is buried by 0.6 feet of gravel.

Figure 5.3-5. Transect G, October 12, 2021.

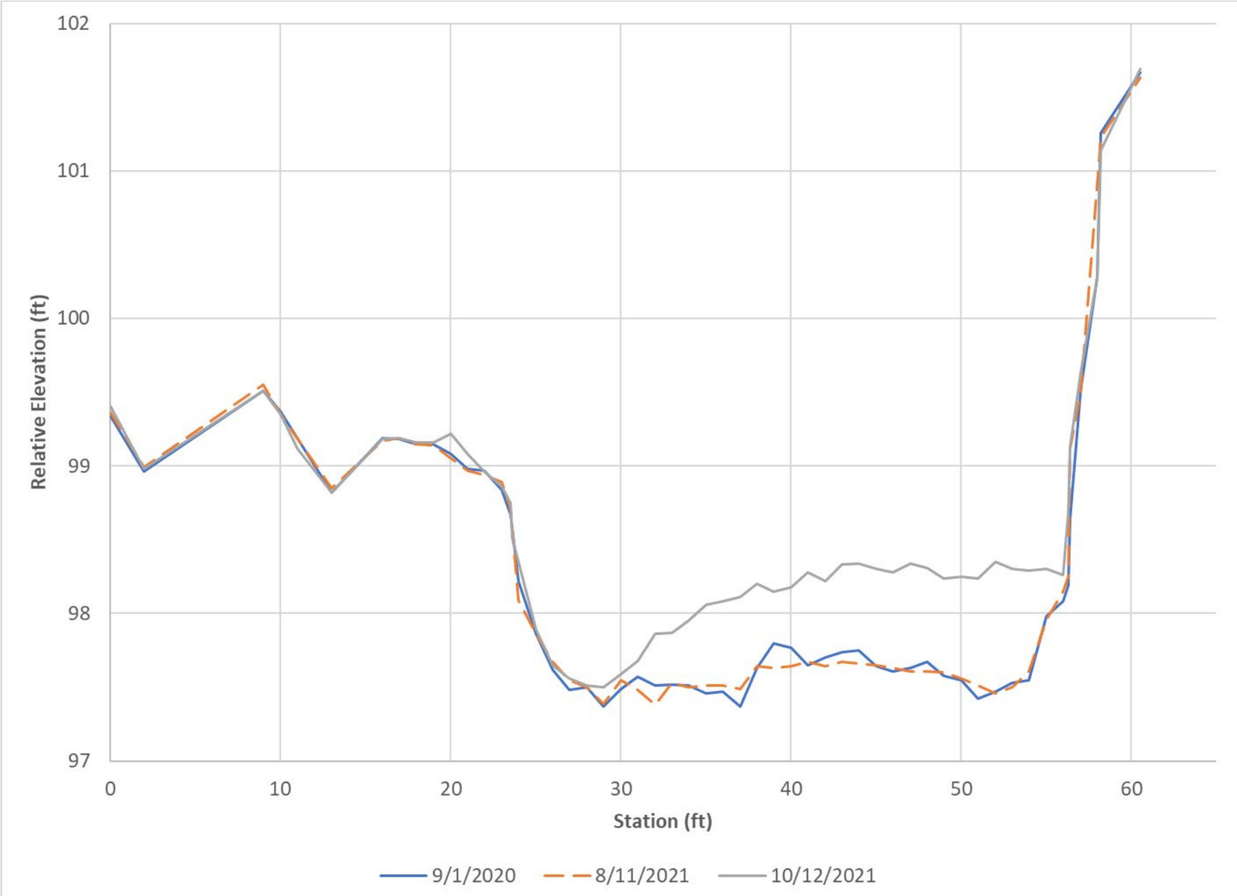


Figure 5.3-6. Transect G cross-sectional changes.

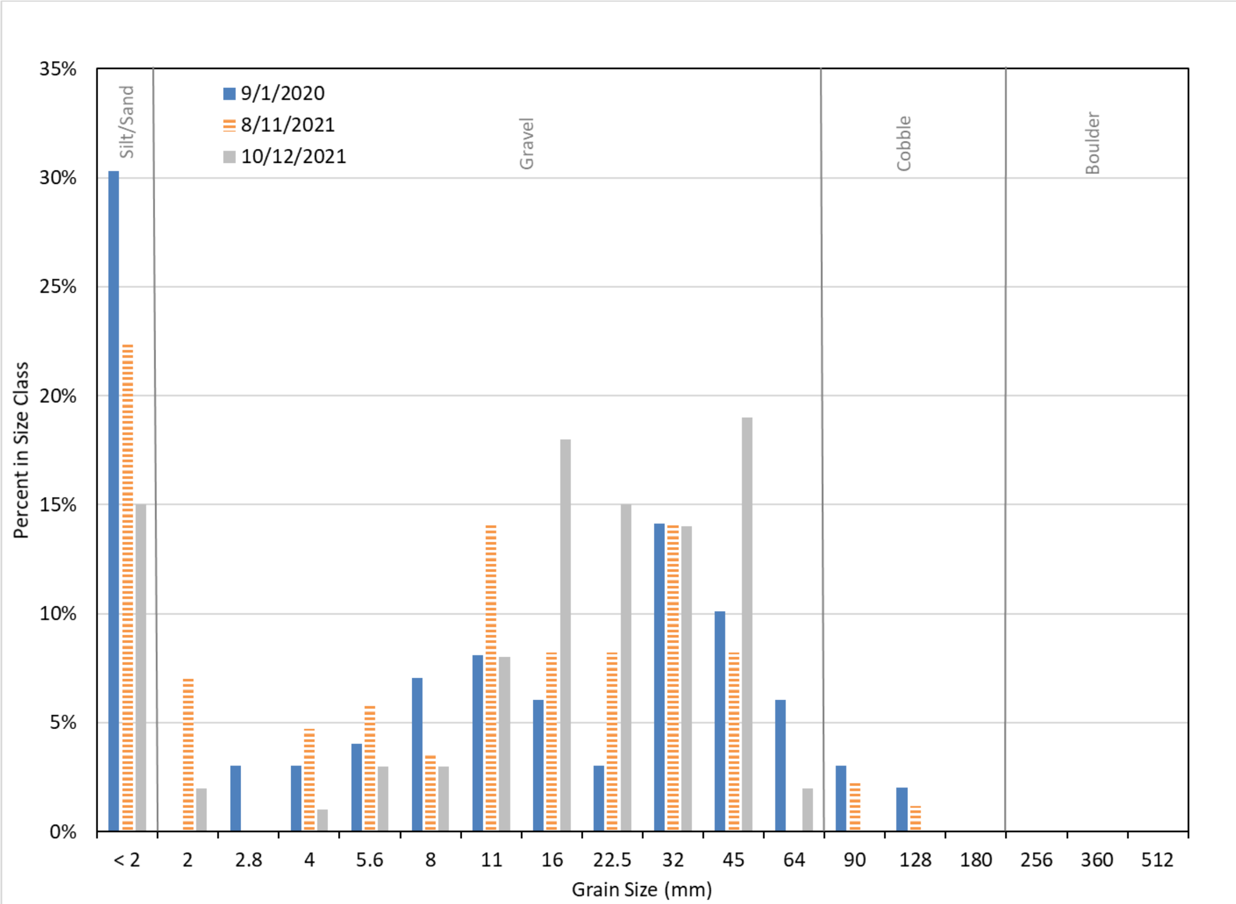


Figure 5.3-7. Transect G substrate grain size distribution changes.

5.3.1.3. Transect ADFG8 Down RM 2.9

Transect ADFG8 Down at RM 2.9 was established in 2017 as part of the aquatic habitat monitoring effort post dam removal and is located just upstream of the confluence with Thunderbird Creek (**Figure 5.3-8**). This transect included two pre-flow release measurements made by ADFG staff and one post-flow release measurement made as part of the current study. The channel at this transect has had up to 1 foot of aggradation following dam removal followed by about 0.5 foot of erosion following the study flow releases (**Figure 5.3-9**). A sliding bead scour monitor was installed at this location in August 2020. The sliding bead monitor was read in August and October 2021 and showed 0.5 foot of bed lowering between August 2020 and August 2021 followed by 4 inches of scour and then 3-4 inches of fill following the study flow releases (October 2021 reading).

Figure 5.3-8. Transect ADFG8 Down pre-flow (top) and post-flow (bottom).

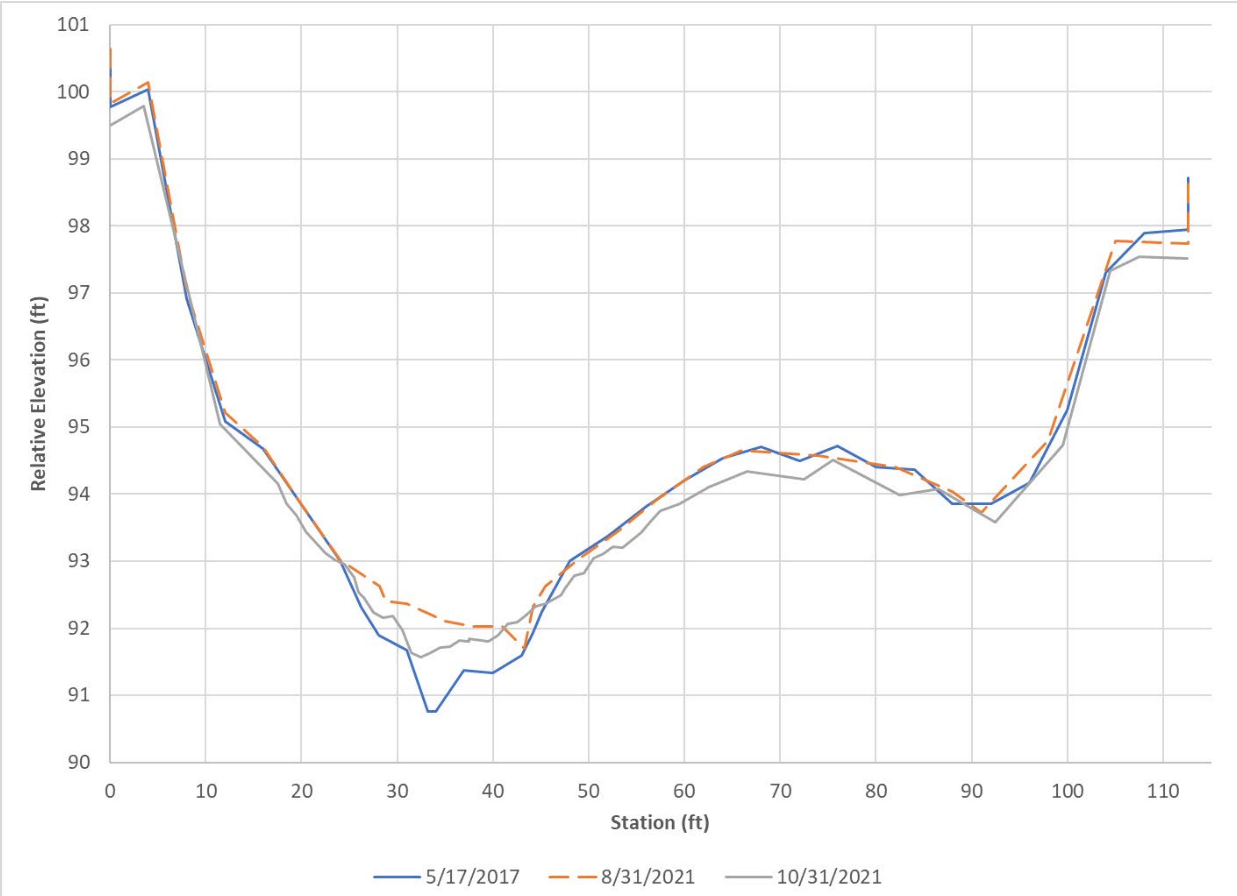


Figure 5.3-9. Transect ADFG8 Down cross-sectional changes.

5.3.1.4. Transect ADFG6 Down RM 3.3

Transect ADFG6 Down at RM 3.3 was established in 2017 as part of the aquatic habitat monitoring effort post dam removal (**Figure 5.3-10**). This transect included two pre-flow release measurements made by ADFG staff and one post-flow release measurement made as part of the current study. Up to 0.5 feet of deposition was recorded between 2017 (pre dam removal) and 2020. The post-flow measurement showed deposition of up to 2 feet within the channel following the study flow releases (**Figure 5.3-11**). A sliding bead scour monitor was installed at this location in August 2021 but was not located in October 2021 following the study flow release due to deep, cold water conditions. In July, 2022 the sliding bead monitor was recovered and showed 6 inches of scour following by 1 foot of deposition at this location with deposition including particles of 64-90 mm size class.

Figure 5.3-10. Transect ADFG6 Down pre-flow (top) and post-flow (bottom).

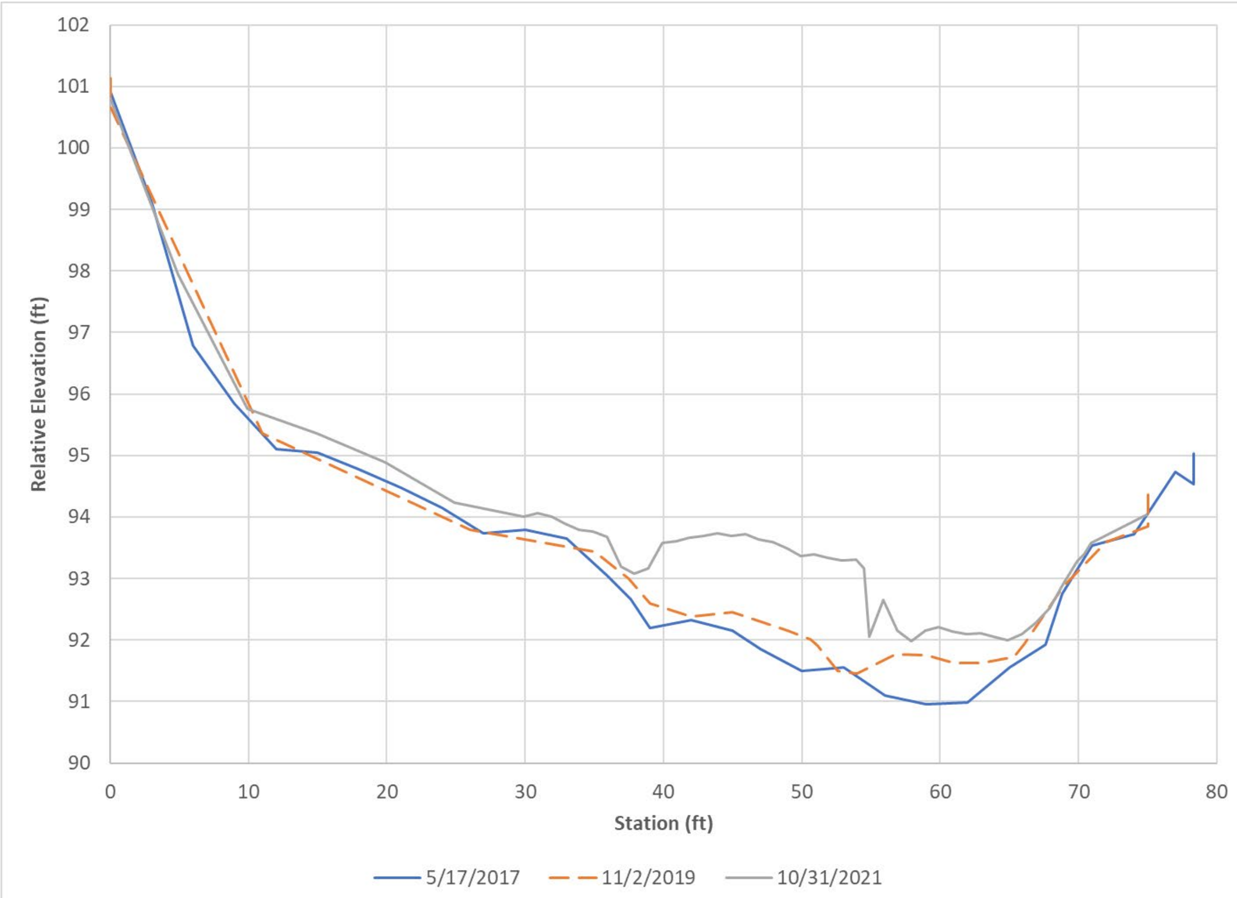


Figure 5.3-11. Transect ADFG6 Down cross-sectional changes.

5.3.1.5. Transect ADFG2 Down RM 3.8

Transect ADFG2 Down at RM 3.8 is located just below the old lower dam site and was established in 2017 as part of the aquatic habitat monitoring effort post dam removal (**Figure 5.3-12**). This transect included three pre-flow release measurements made by ADFG staff and one post-flow release measurement made as part of the current study.

This transect is very dynamic, with up to 4 feet of deposition recorded between the pre-dam removal measurement in 2017 and the first post-dam measurement in 2019 (**Figure 5.3-13**). An additional foot of deposition occurred between 2019 and 2020. During the study flow releases, up to 1 foot of additional deposition occurred, likely including a debris flow down the channel based on the debris flow levees on both sides of the channel (debris flow levees were also observed at other locations downstream from this transect). The debris flow could have been triggered by the slide that occurred in the lower dam deposits as recorded on the timelapse cameras and/or the surge of water from the breaching of the upstream beaver dam (the lowest in the series of 3 dams near RM 7) that was recorded at the downstream stream gage. By the end of the study flow releases, the channel had eroded several feet to the 2019 level.

Grain size measurements were taken pre- and post-flow release across the transect (**Figure 5.3-14**). Substrate is predominantly gravel (median grain diameter 14-26 mm) and showed an increase in fine sediment as well as an increase in coarse sediment following the study flow releases (bimodal size distribution).

An accelerometer and sliding bead scour monitor were installed at this location in August 2021. The sliding bead monitor was not recovered following the flow release; the channel survey suggests this location was scoured out. The accelerometer was recovered in October 2021, exposed at the edge of the channel. Accelerometers record their position in space (x,y,z) through time and when installed in the substrate, they record periods of movement which correlate to erosion of the bed to the point where the accelerometer is exposed. Plots of the x,y,z position show abrupt changes when the accelerometer is exposed and starts to move. The accelerometer at ADFG2 Down recorded movement on September 14, 2021 (0830) followed by a fairly stable period until September 20 at 1630 when it was in motion until September 29 (**Figure 5.3-15**). Material up to 90 mm in diameter was mobilized at this location during the flow releases.

Figure 5.3-12. Transect ADFG2 Down pre-flow (top) and post-flow (bottom).

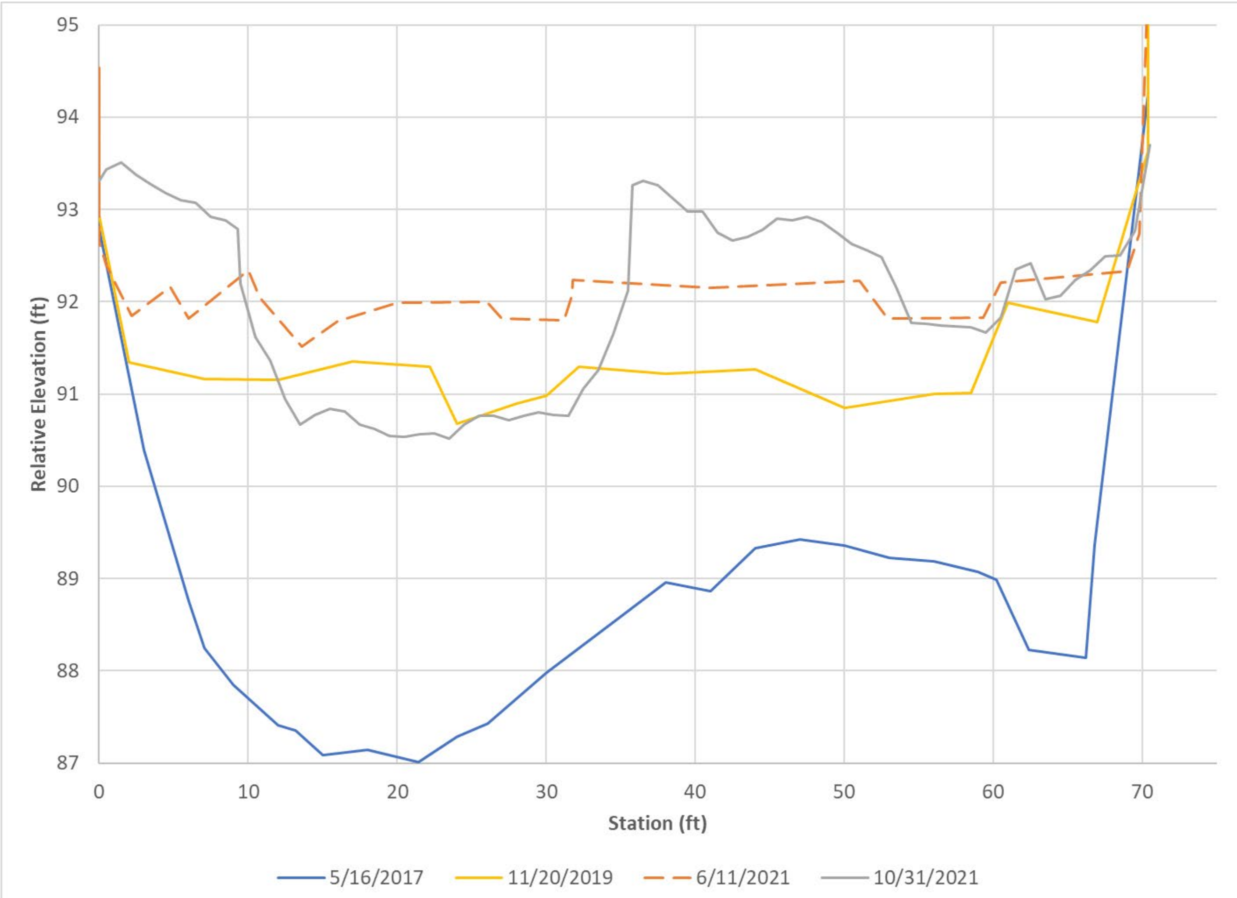


Figure 5.3-13. Transect ADFG2 Down cross-sectional changes.

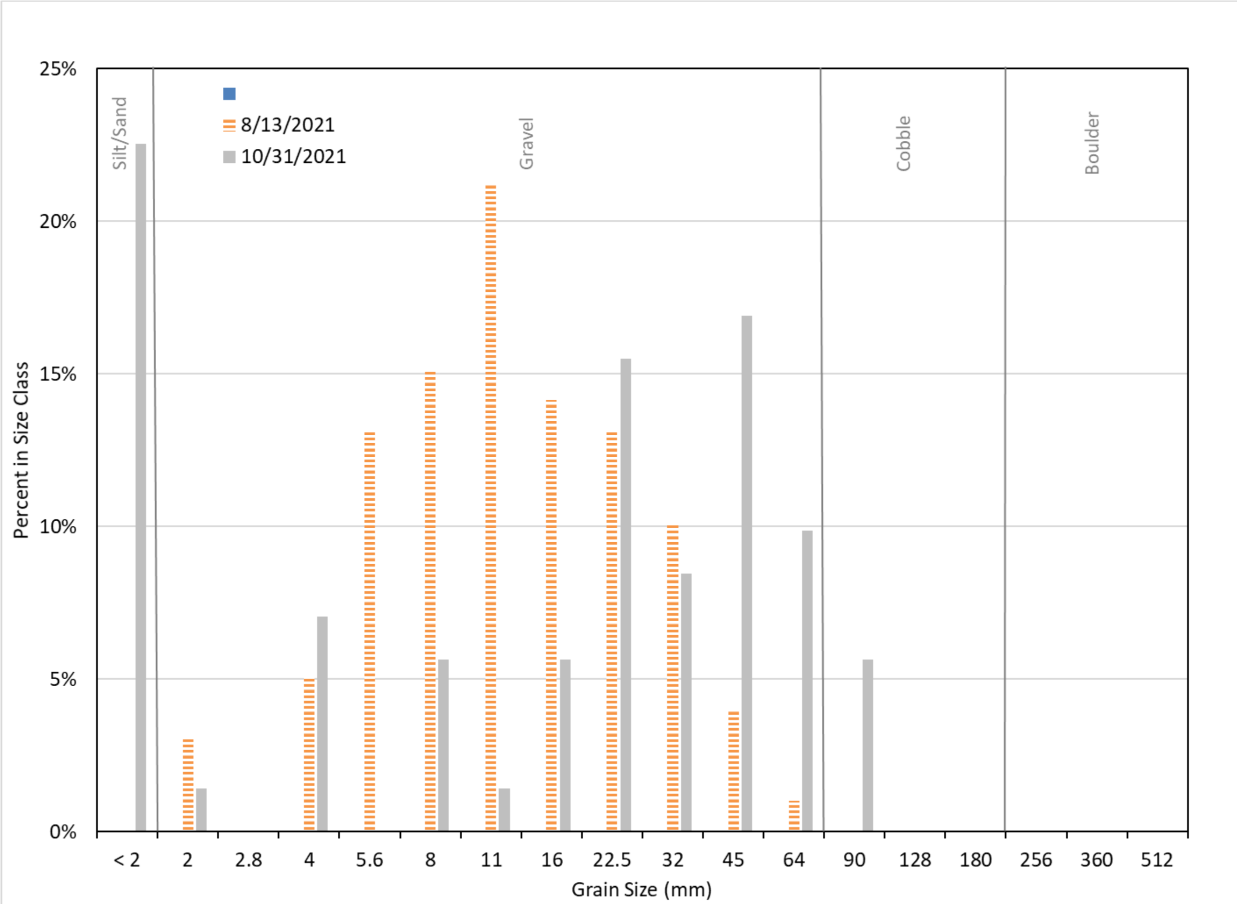
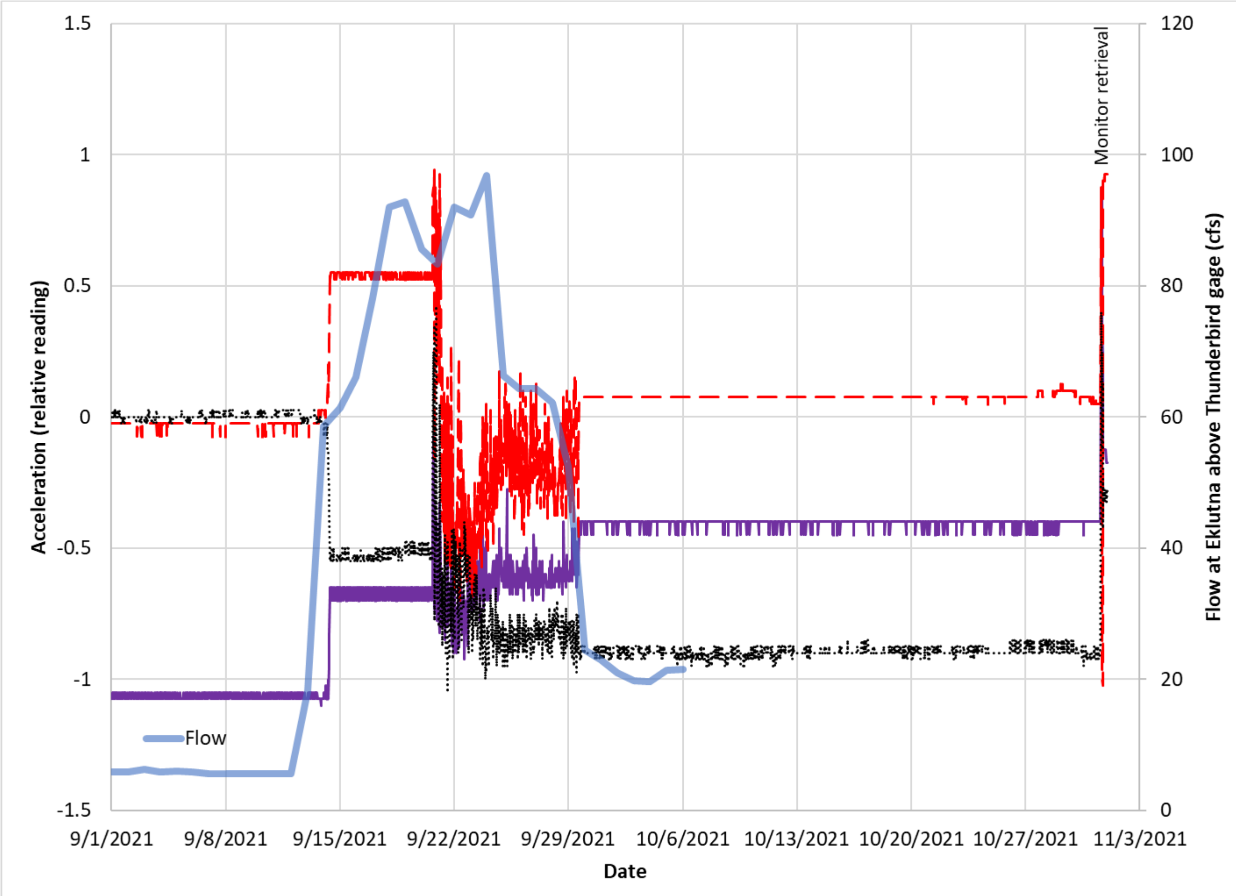


Figure 5.3-14. Transect ADFG2 Down substrate grain size distribution changes.



Flow data provisional, from Stream Gaging Year 2 Report

Figure 5.3-15. Transect ADFG2 Down accelerometer data.

5.3.1.6. Transect 204 RM 3.95

Transect 204, at RM 3.95, is located at the old lower dam abutments (**Figure 5.3-16**). This transect was established in August 2021 and included one pre-flow release measurement and one post-flow release measurement. The post-flow measurement showed deposition of up to 3 feet of sediment within the channel following the flow releases, and then subsequent erosion of the deposited sediment back to nearly pre-flow release elevations (**Figure 5.3-17**).

Figure 5.3-16. Transect 204 pre-flow (top) and post-flow (bottom).

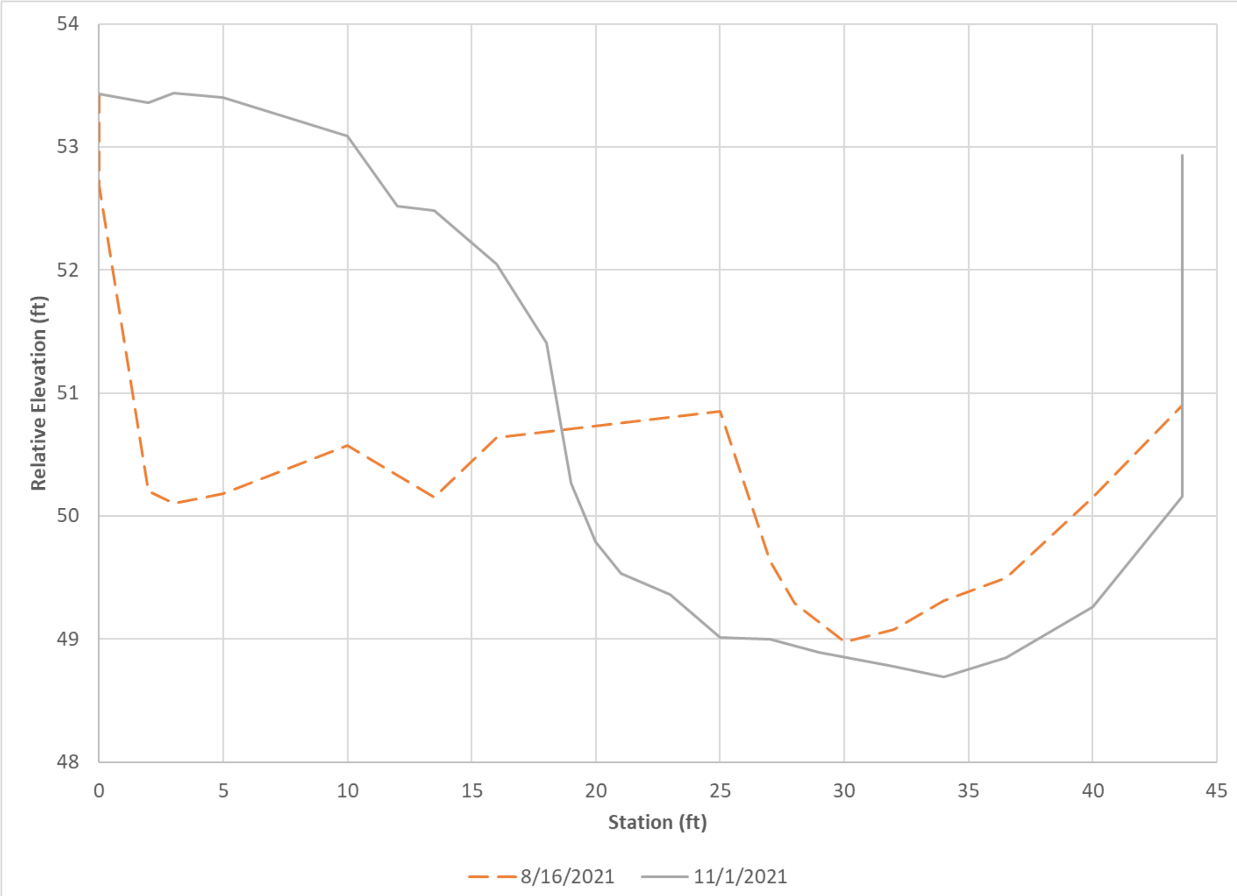


Figure 5.3-17. Transect 204 cross-sectional changes.

5.3.1.7. Transect 203 RM 4.05

Transect 20, at RM 4.05, is located in the old reservoir deposits (**Figure 5.3-18**). This transect was established in August 2021 and included one pre-flow release measurement and one post-flow release measurement. This transect showed major erosion of the old reservoir deposits, with up to 30 vertical feet of erosion of the accumulated reservoir sediments and up to 3 feet of thalweg lowering (**Figure 5.3-19**). Two mechanisms for this erosion were captured on timelapse videos (cameras G1 and G2): undercutting and toppling of the consolidated silt/clay banks; and a large slump that occurred and quickly removed a large portion of the deposits. A remnant of that slump block can be seen in the center of the post-flow photo in **Figure 5.3-18**.

Figure 5.3-18. Transect 203 pre-flow (top) and post-flow (bottom).

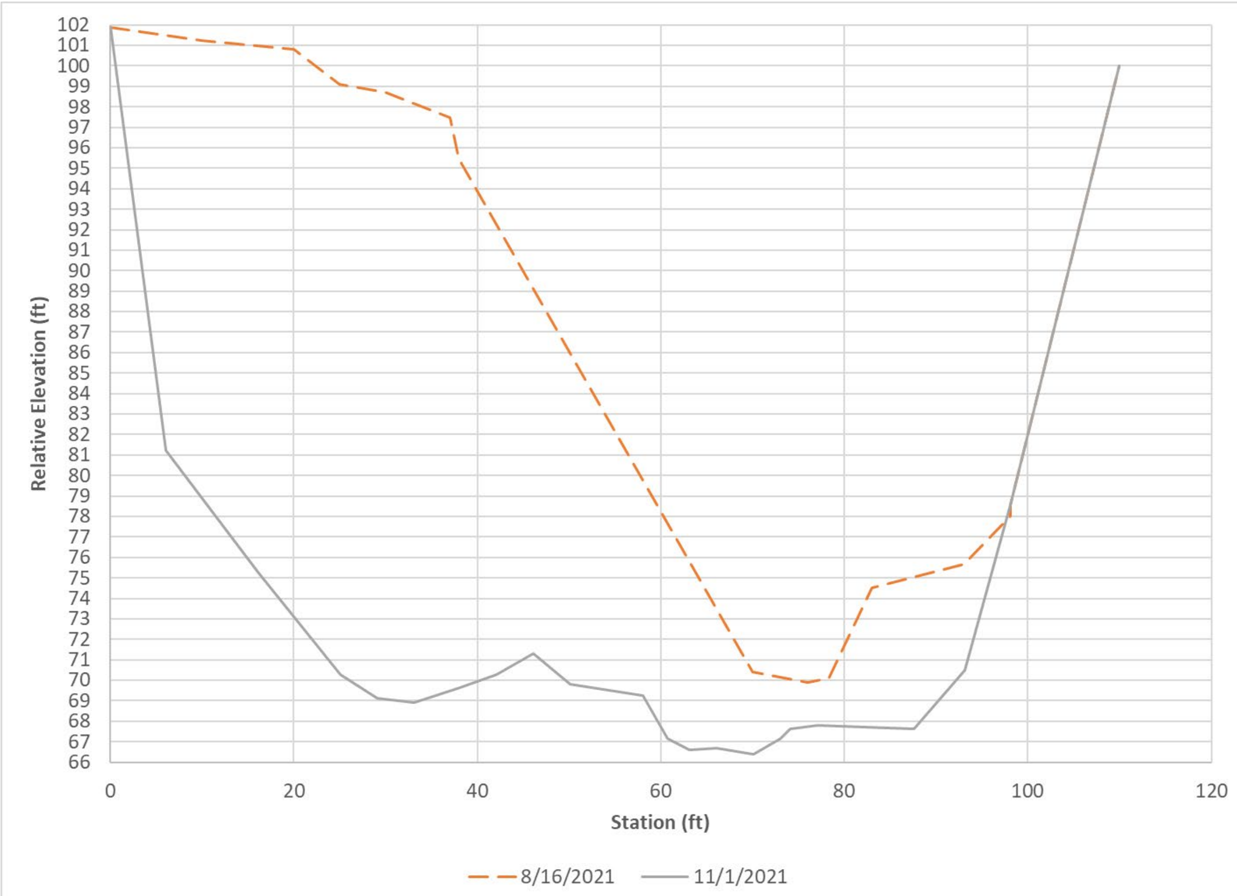


Figure 5.3-19. Transect 203 cross-sectional changes.

5.3.1.8. Transect 202 RM 4.06

Transect 204, at RM 4.06, is located in the old reservoir deposits (**Figure 5.3-20**). This transect was established in August 2021 and included one pre-flow release measurement and one post-flow release measurement. The post-flow measurement showed erosion of a large amount of reservoir sediment, particularly on the right bank where up to 14 feet of erosion occurred (station 0 is right bank; **Figure 5.3-21**). The thalweg lowered approximately 2 feet.

Figure 5.3-20. Transect 202 pre-flow (top) and post-flow (bottom).

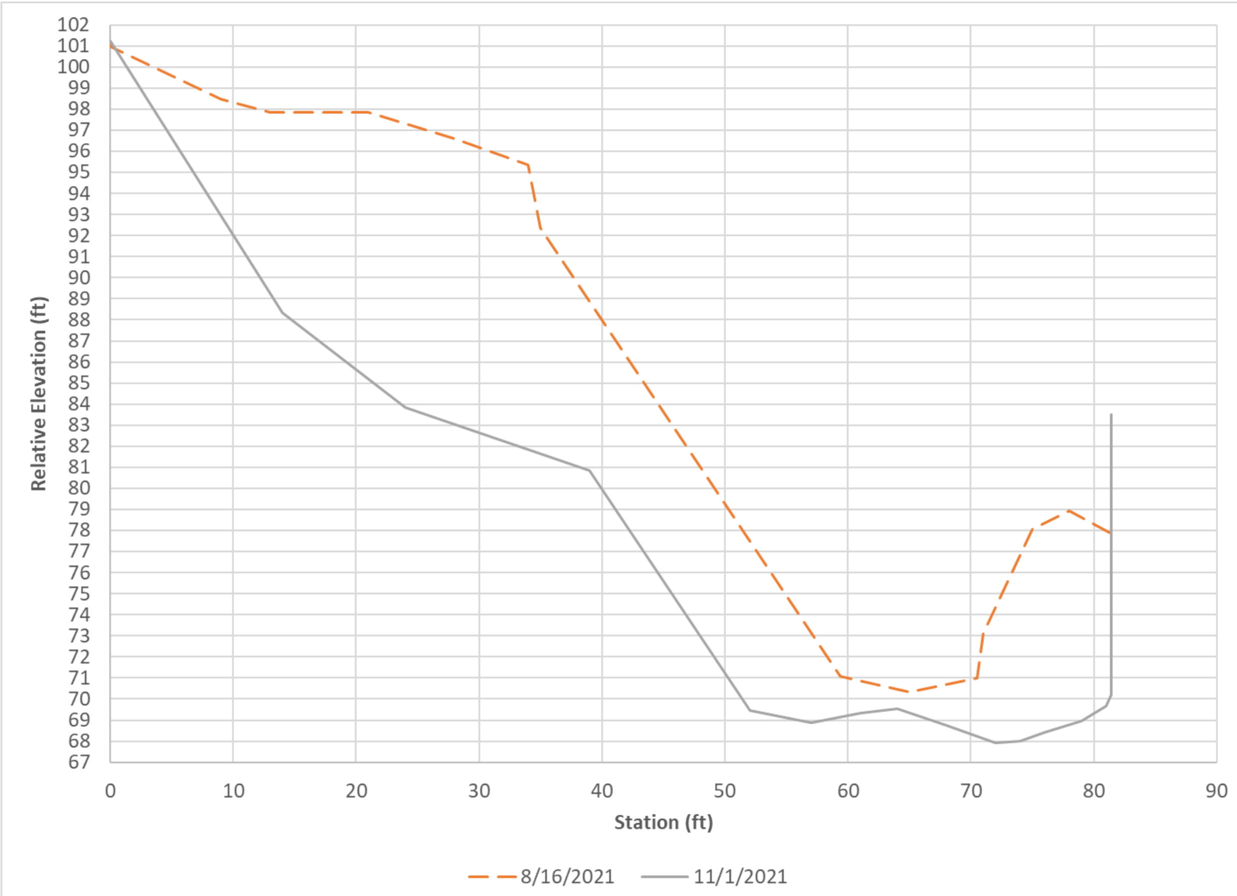


Figure 5.3-21. Transect 202 cross-sectional changes.

5.3.1.9. Transect 201 RM 4.1

Transect 201, at RM 4.1, is located at the upstream end of the old reservoir (**Figure 5.3-22**). This transect was established in August 2021 and included one pre-flow release measurement and one post-flow release measurement. The post-flow measurement showed erosion of up to 14 feet of the stored reservoir sediment and 9 feet of channel lowering following the study flow releases (**Figure 5.3-23**). A time-lapse video (camera G3) was located pointing upstream from this site and recorded erosion and headcutting during the study flow release. A sub-surface sample was taken at this site and is shown in **Figure 5.3-24**.

Figure 5.3-22. Transect 201 pre-flow (top) and post-flow (bottom).

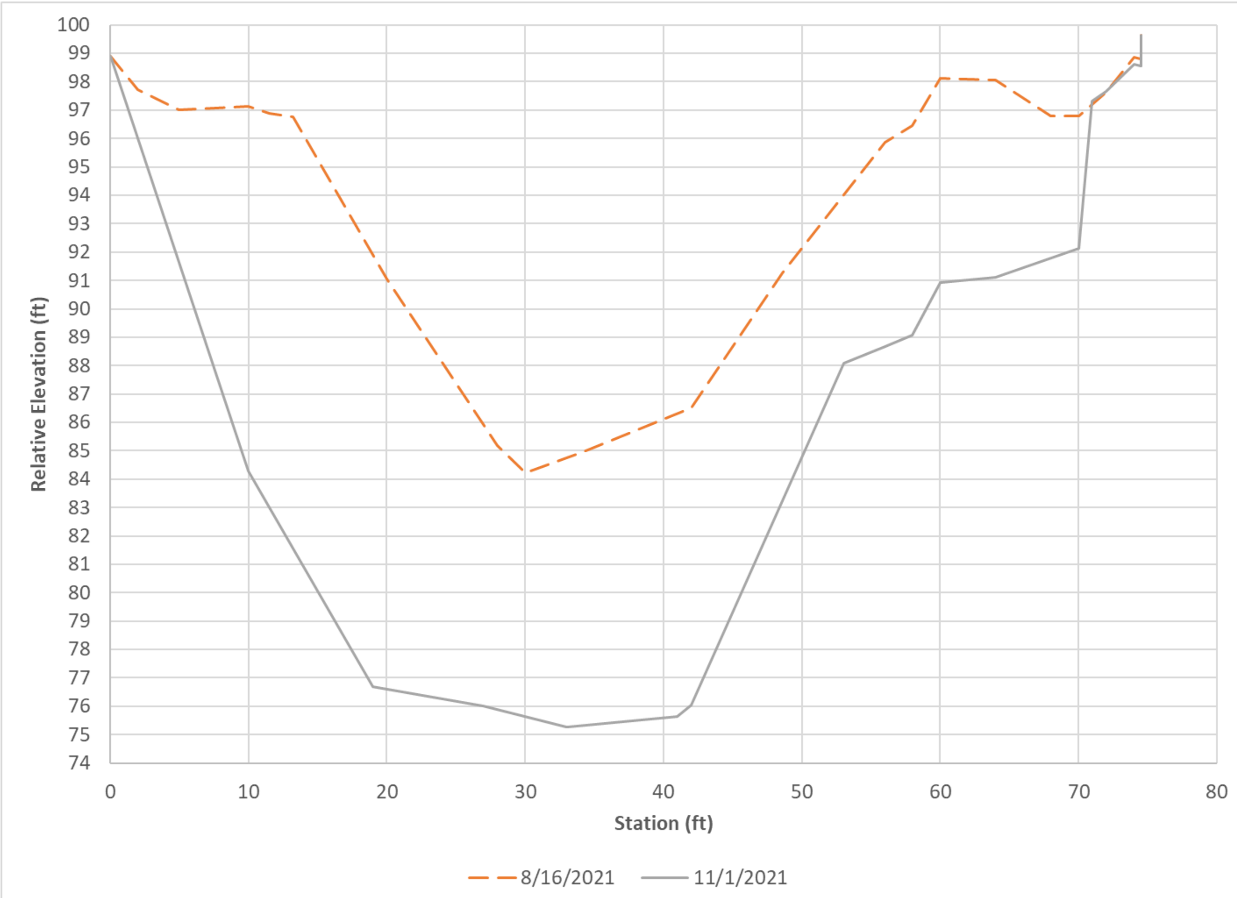


Figure 5.3-23. Transect 201 cross-sectional changes.

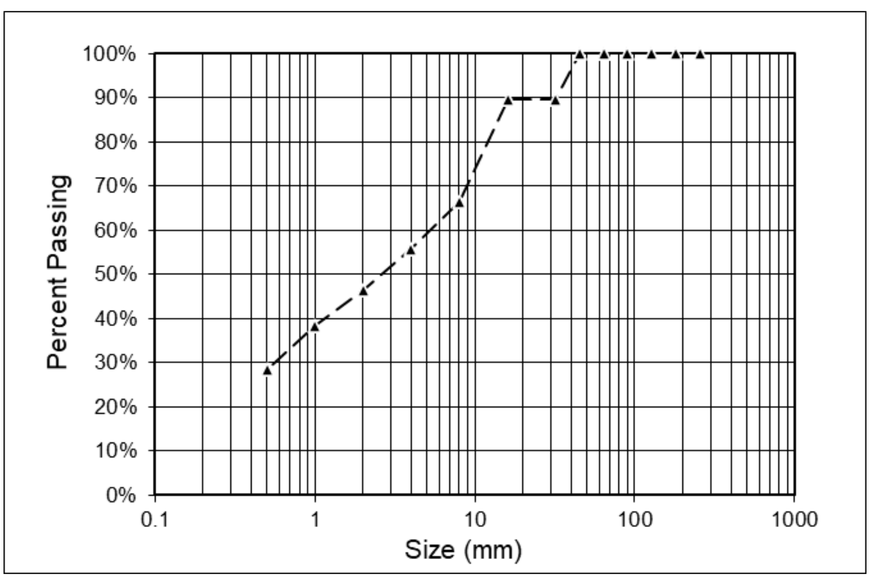


Figure 5.3-24. Transect 201 sub-surface grain size distribution.

5.3.1.10. Transect ADFG4 Up RM 4.4

Transect ADFG4 Up at RM 4.4 was established in 2017 as part of the aquatic habitat monitoring effort post dam removal and is located upstream of the old dam deposits (**Figure 5.3-25**). This transect included two pre-flow release measurements made by ADFG staff and one post-flow release measurement made as part of the current study. The post-flow measurement showed deposition of less than 0.5 feet on the left bank bar and erosion of nearly 1 foot within the channel following the study flow releases (**Figure 5.3-26**). Grain size measurements were taken pre-flow release across the transect and showed substrate was dominated by gravel with a median grain diameter of 13 mm (**Figure 5.3-27**). An accelerometer and sliding bead scour monitor were installed at this location in August 2021. The accelerometer was found in October 2021 following the flow releases. The accelerometer at ADFG4 Up recorded movement on September 14, 2021 starting at 0230 and major movement from 1730 through September 25 (**Figure 5.3-28**). The sliding bead monitor was recovered in July 2022 and showed 5.5 inches of erosion followed by 2 inches of deposition of fine-grained material.

Figure 5.3-25. Transect ADFG4 Up, November 1, 2021.

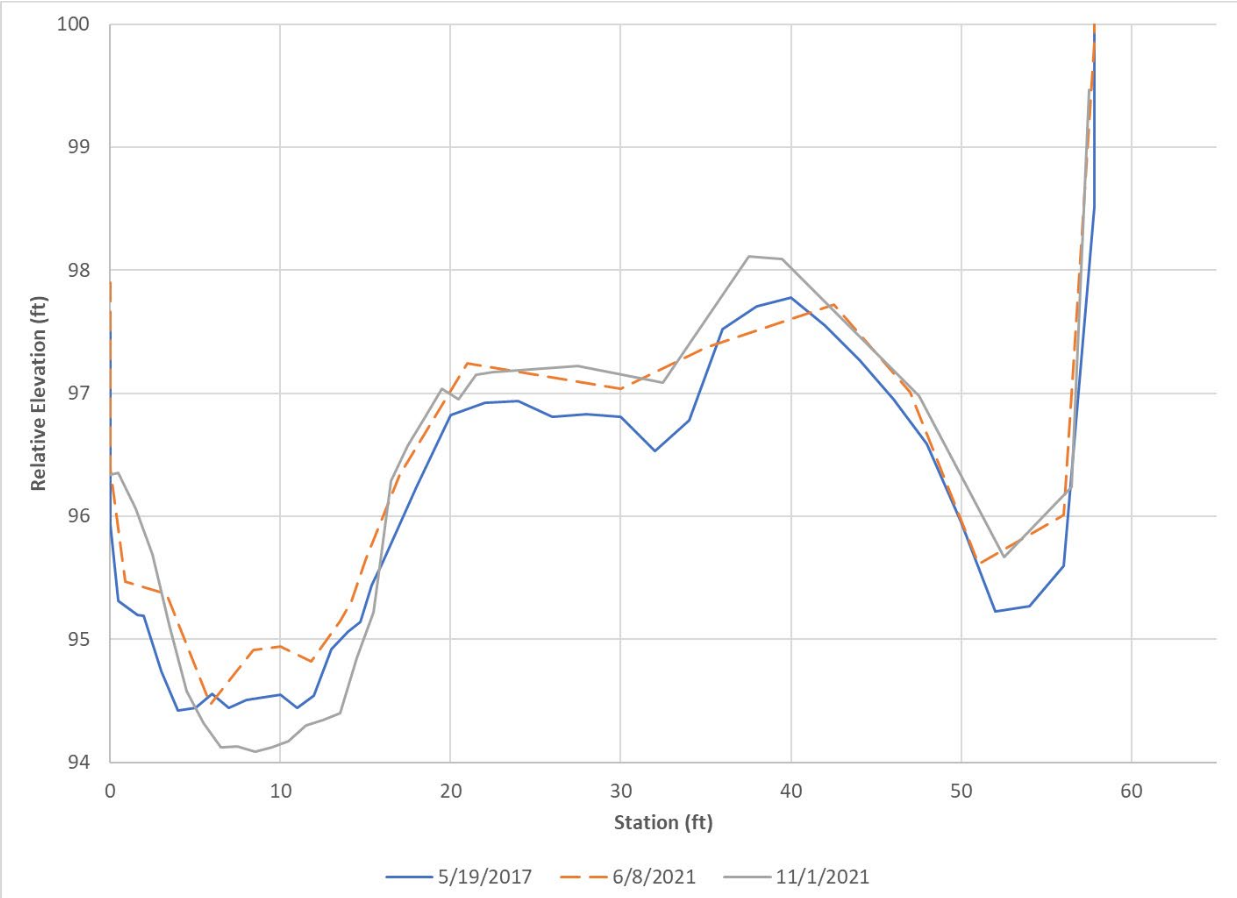


Figure 5.3-26. Transect ADFG4 Up cross-sectional changes.

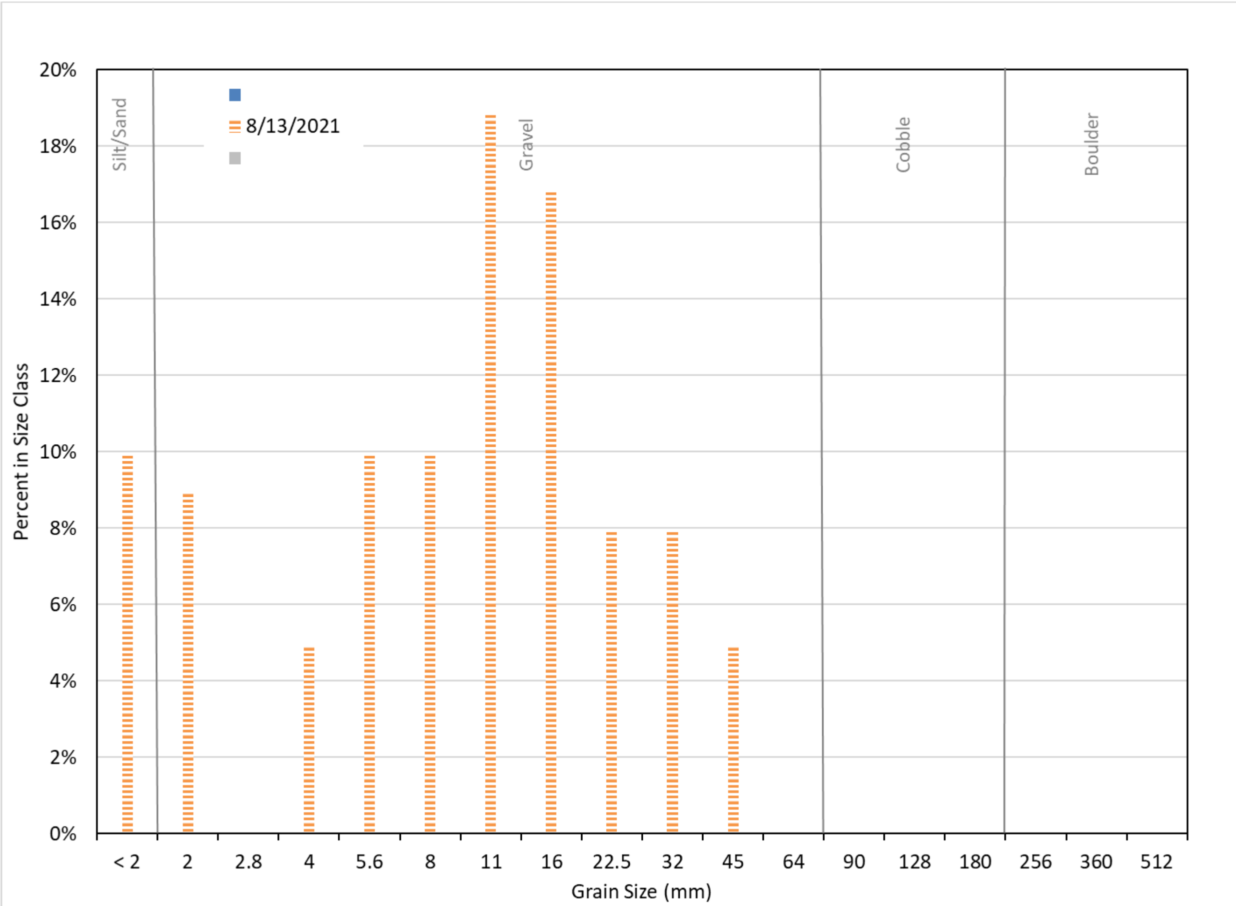
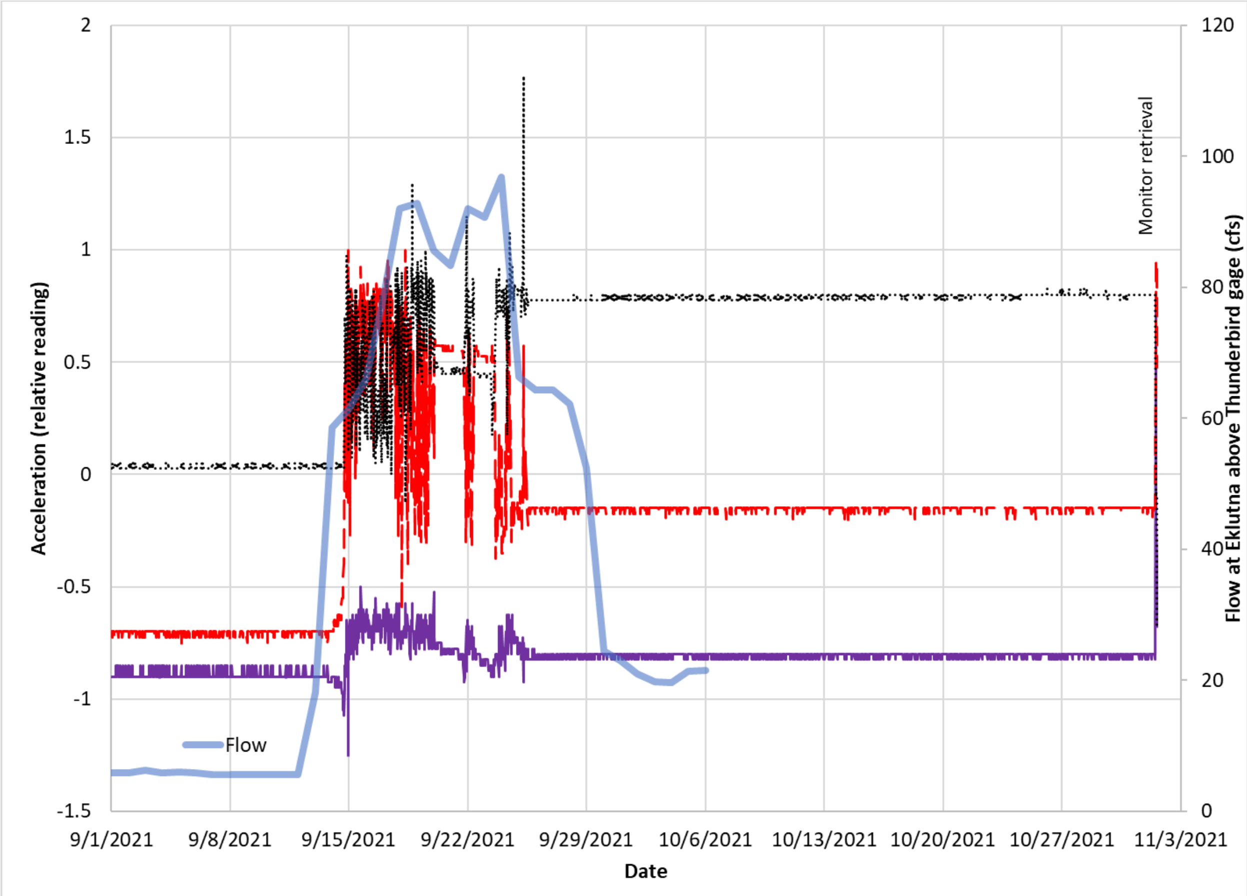


Figure 5.3-27. Transect ADFG4 Up substrate grain size distribution.



Flow data provisional, from Eklutna Stream Gaging Year 2 Report

Figure 5.3-28. Transect ADFG4 Up accelerometer data.

5.3.1.11. Transect 102 RM 5.3

Transect 102, at RM 5.3, is located at an instream flow transect (**Figure 5.3-29**). This transect was established in August 2021 and included one pre-flow release measurement and one post-flow release measurement. There was little change in the cross section from pre- to post-release (**Figure 5.3-30**). Grain size measurements were taken pre- and post-flow release across the transect and showed a mix of gravel and sand particles with little change following the study flow releases (**Figure 5.3-31**). A sliding bead scour monitor was installed in August 2020. The sliding bead monitor showed no change in October 2021 following the study flow releases.

Figure 5.3-29. Transect 102.

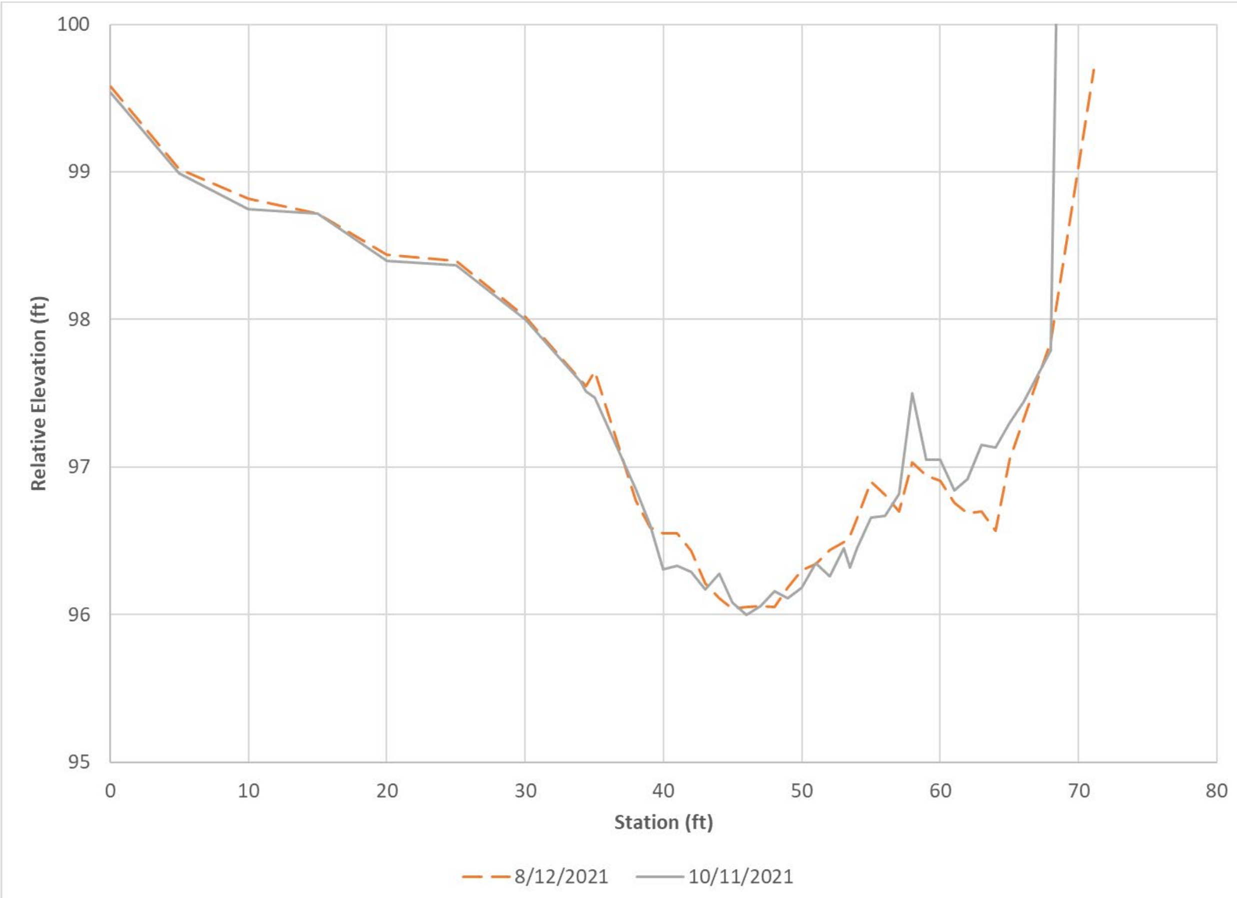


Figure 5.3-30. Transect 102 cross-sectional changes.

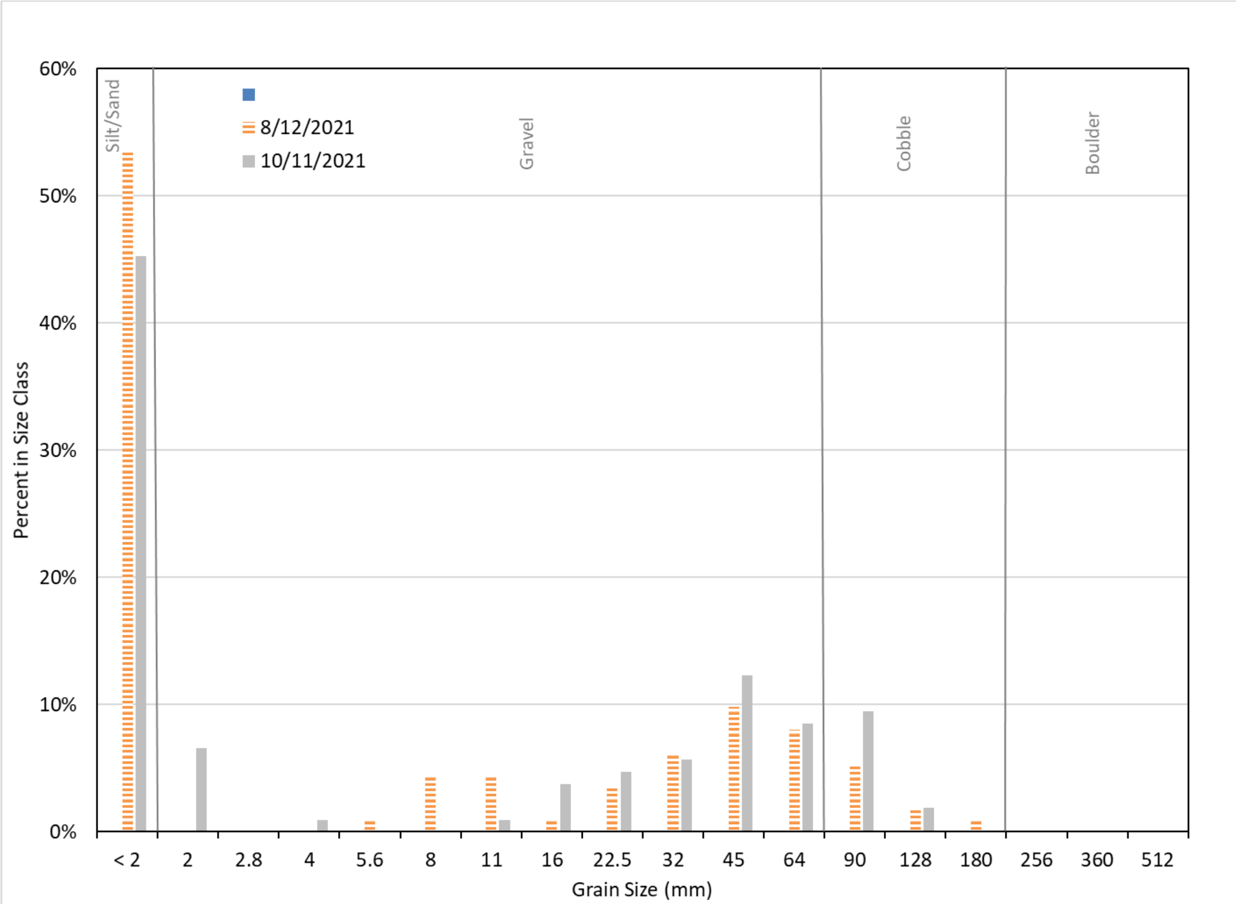


Figure 5.3-31. Transect 102 substrate grain size distribution changes.

5.3.1.12. Transect F RM 5.4

Transect F, at RM 5.4, is located in a pool at the downstream end of the AWWU access road (**Figure 5.3-32**). This transect was established in August 2020 and included two pre-flow release measurements and one post-flow release measurement. The fine sediment in this pool showed erosion of up to 0.5 feet between August 2020 and August 2021, with additional cut and fill following the study flow releases (**Figure 5.3-33**). Grain size measurements were taken pre- and post-flow release across the transect and showed little change to the fine-grained substrate during any of the measurements (**Figure 5.3-34**). A sliding bead scour monitor was installed in August 2020. The sliding bead monitor was read in August and October 2021 and showed 9 inches of bed lowering between August 2020 and August 2021 and little change in October 2021 following the study flow releases.

Figure 5.3-32. Transect F, October 10, 2021.

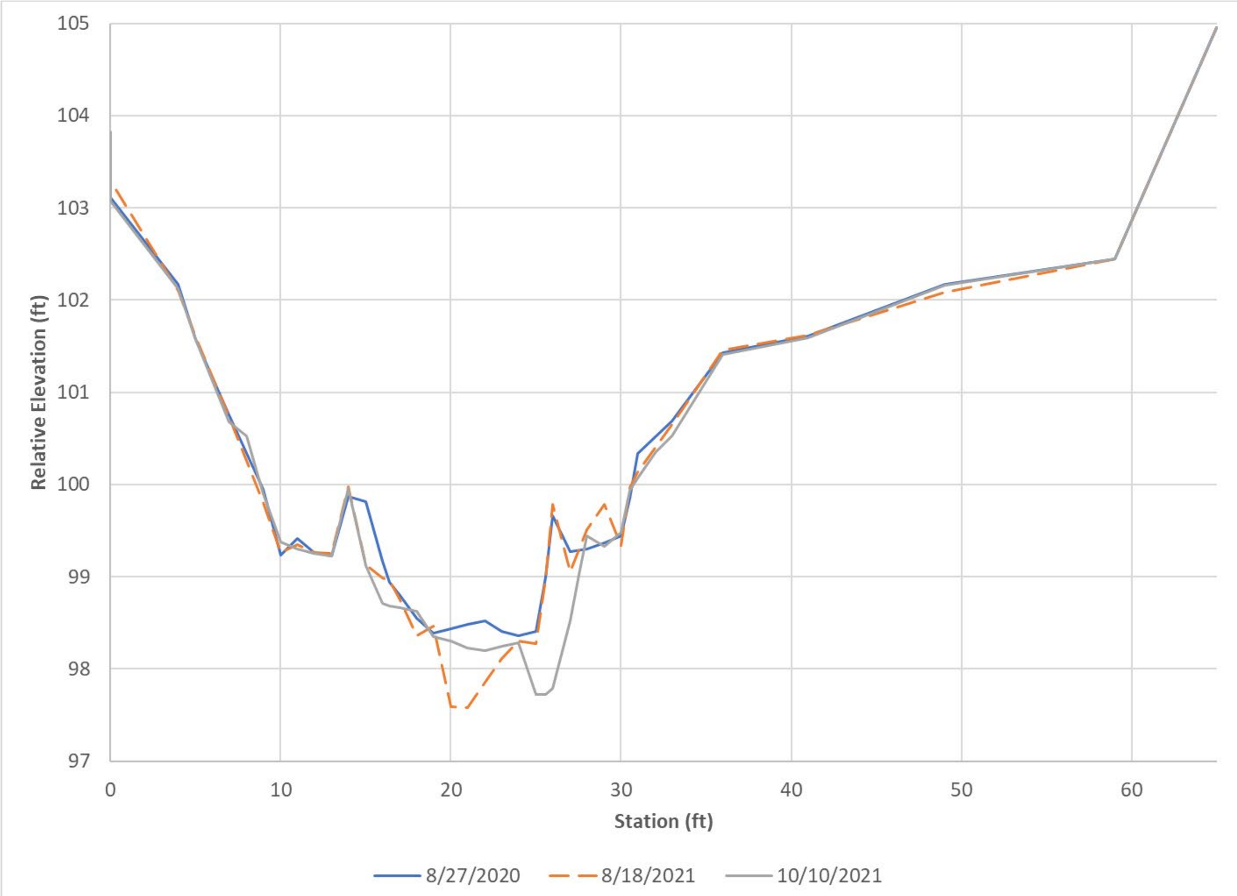


Figure 5.3-33. Transect F cross-sectional changes.

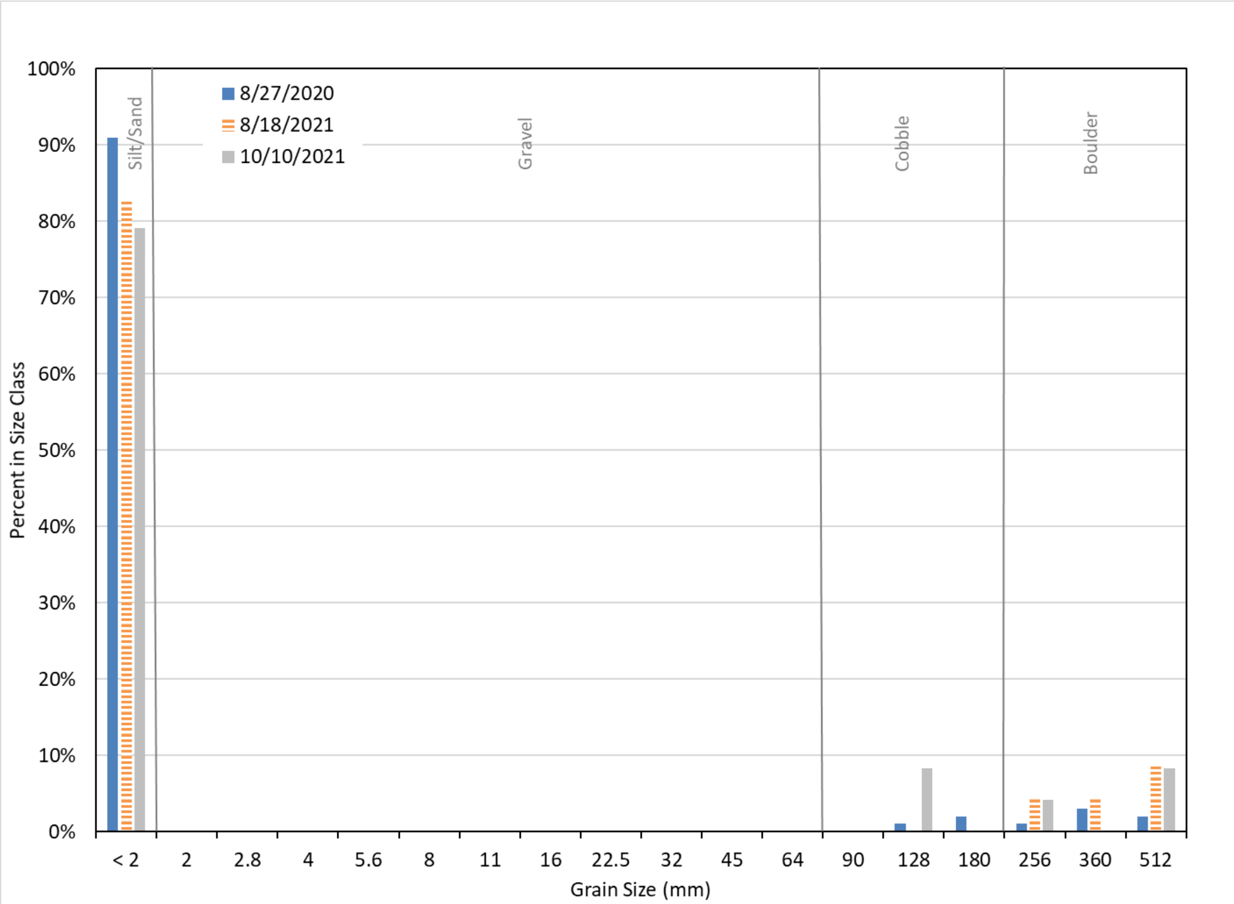


Figure 5.3-34. Transect F substrate grain size distribution changes.

5.3.1.13. Transect 103 RM 6.3

Transect 103, at RM 6.3, is located near instream flow transects (**Figure 5.3-35**). This transect was established in August 2021 and included one pre-flow release measurement and one post-flow release measurement. The post-flow measurement showed up to 1 foot of scour within the channel following the flow releases (**Figure 5.3-36**). Grain size measurements were taken pre- and post-flow release across the transect (**Figure 5.3-37**). Substrate is predominantly fine sediment and showed a slight decrease in fine sediment following the study flow releases. A sub-surface sample was taken at this site with a median (D_{50}) diameter of 1 mm (**Figure 5.3-38**). An accelerometer and a sliding bead scour monitor were installed in August 2021 about 10 feet downstream from the transect. The sliding bead monitor was not recovered, likely due to the estimated 2 feet of scour with subsequent fill at this location. The accelerometer was located and was buried under 1 foot of gravel/cobble material and recorded movement starting on September 13, 2021 at 1630 followed by battery failure which resulted in no additional data collection (**Figure 5.3-39**).

Figure 5.3-35. Transect 103, October 9, 2021.

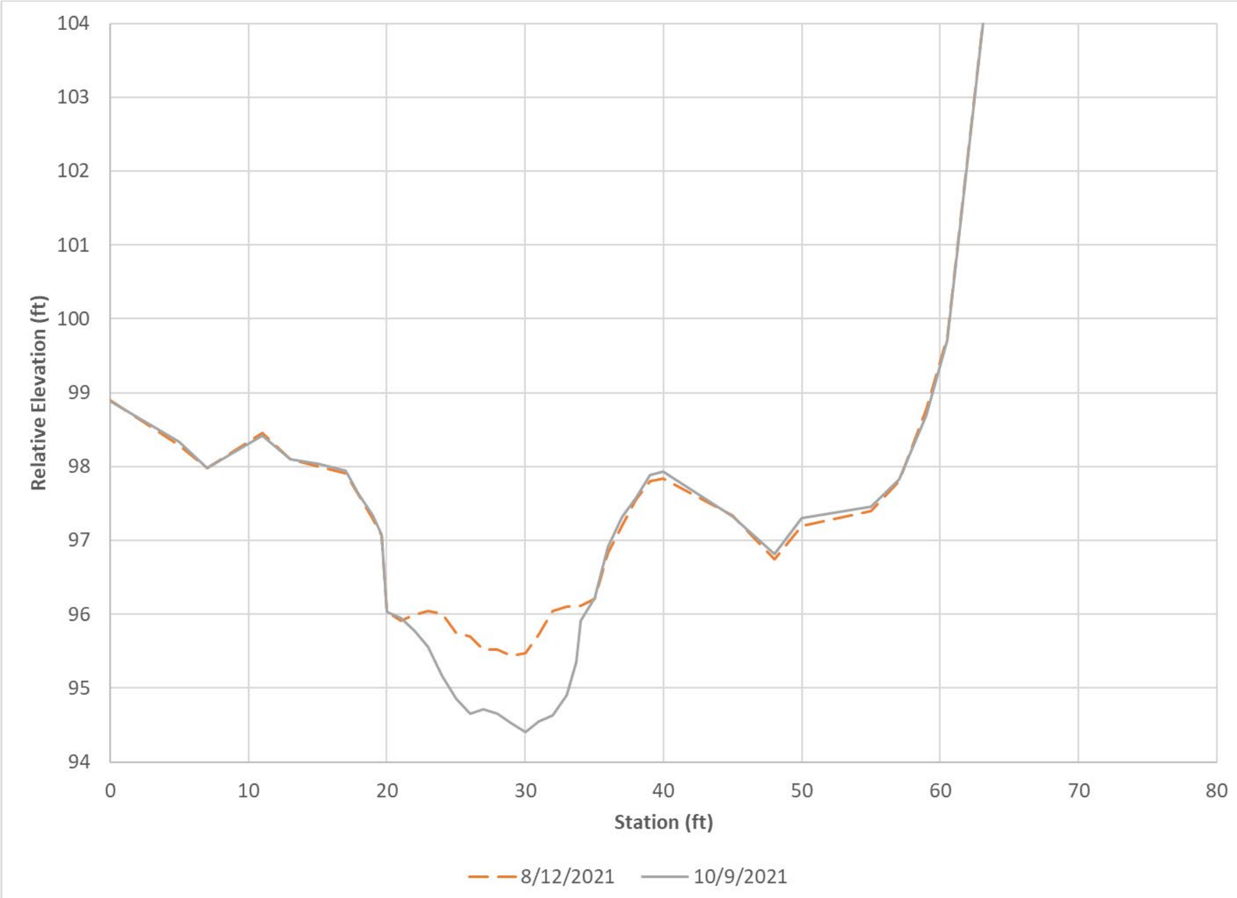


Figure 5.3-36. Transect 103 cross-sectional changes.

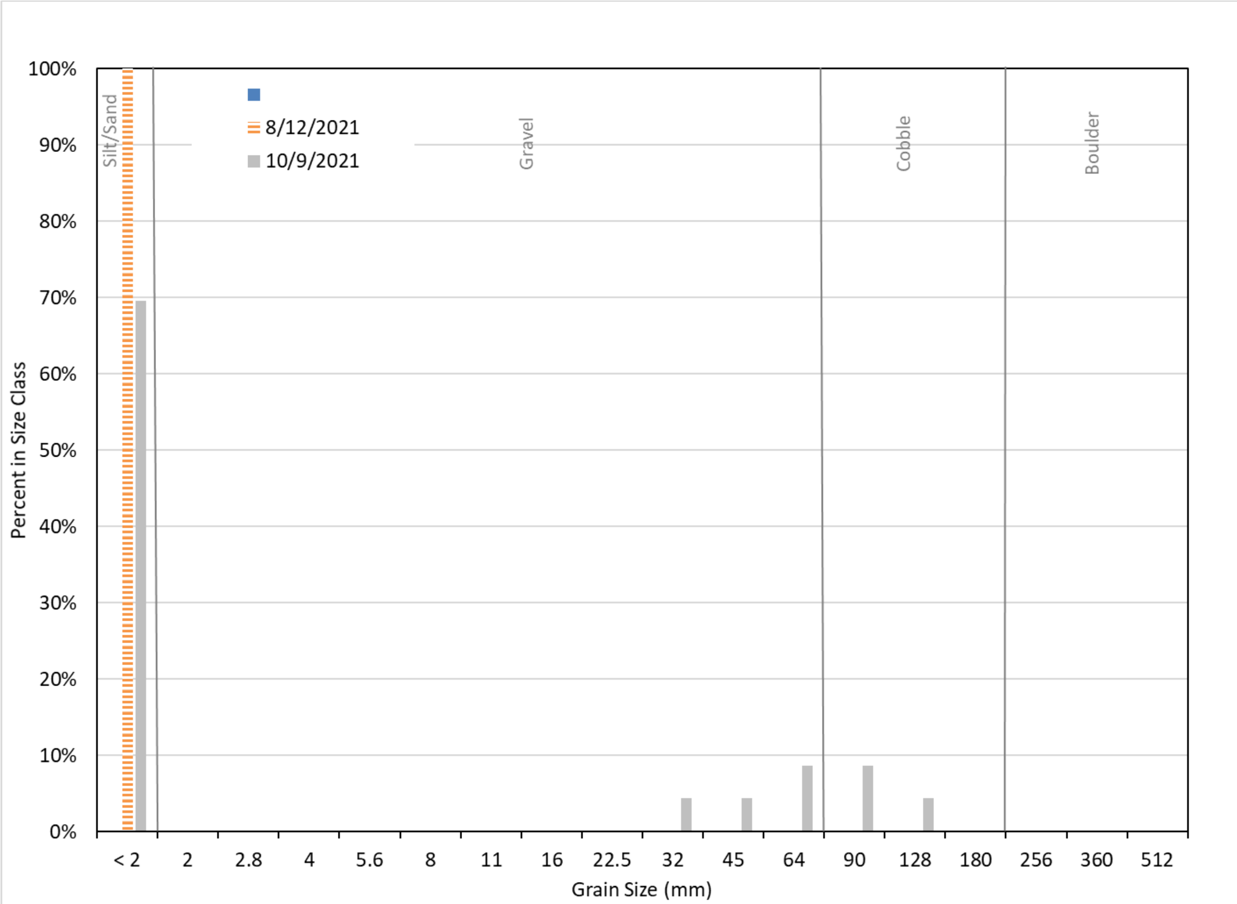


Figure 5.3-37. Transect 103 substrate grain size distribution changes.

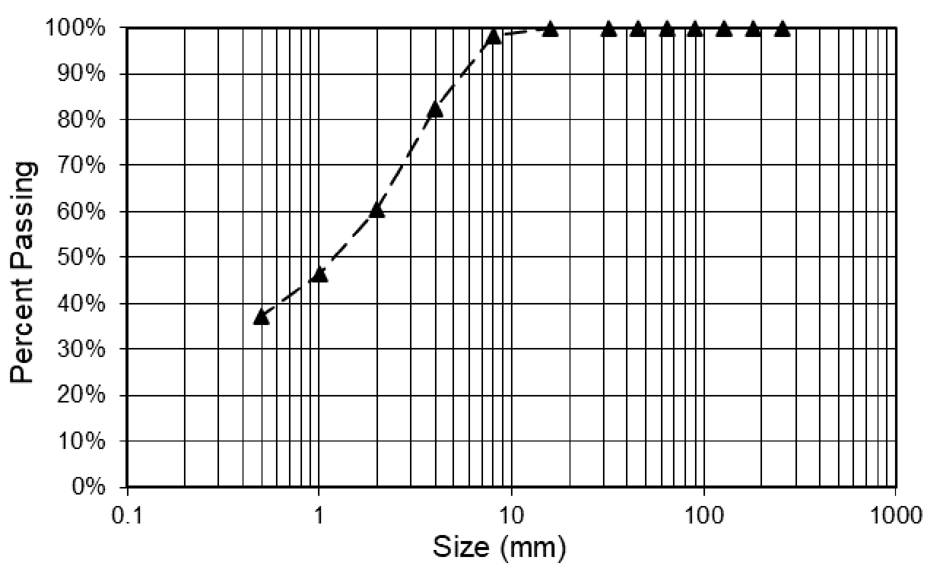
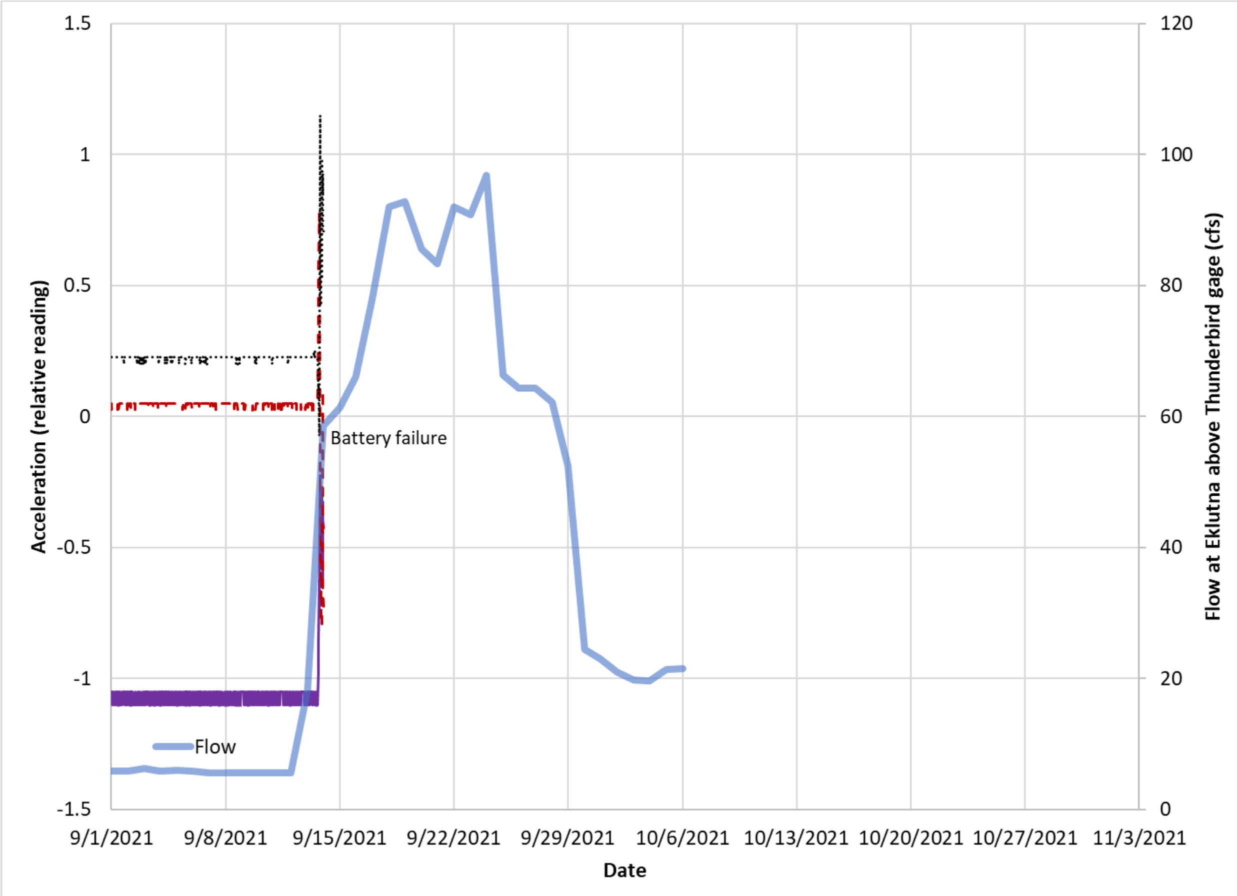


Figure 5.3-38. Transect 103 sub-surface grain size distribution.



Flow data provisional, from Eklutna Stream Gaging Year 2 Report

Figure 5.3-39. Transect 103 accelerometer data.

5.3.1.14. Transect E RM 6.75

Transect E, at RM 6.75, is located at a large alluvial fan sediment source (**Figure 5.3-40**). This transect was established in 2020 and included two pre-flow release measurements and one post-flow release measurement. This transect experienced major changes during the study flow releases as the river cut a new channel on the right bank by eroding the toe of the alluvial fan and abandoning the former channel/transect location. Based on terrace deposits, it appears that this phenomenon has occurred previously when the toe of the alluvial fan was eroded, presumably during a spill event, and the alluvial fan later filled the right bank channel resulting in the move to the left bank channel. Post-flow measurement showed deposition of up to 1 foot within the channel following the study flow releases and an estimated 2 feet of erosion in the right bank channel (**Figure 5.3-41**). Grain size measurements were taken pre- and post-flow release across the transect and showed the channel was dominated by gravel during all three measurements, with a progressive decrease in fine-grained sediment through time (**Figure 5.3-42**). A sliding bead scour monitor was installed in August 2020. The sliding bead monitor was read in August and October 2021 and showed 1.5 inches of bed lowering between August 2020 and August 2021 followed by burial with 0.5-1 foot of gravel and cobble (up to 128 mm) in October 2021 following the study flow releases.

Figure 5.3-40. Transect E left bank channel (top) and new right bank channel (bottom), October 8, 2021.

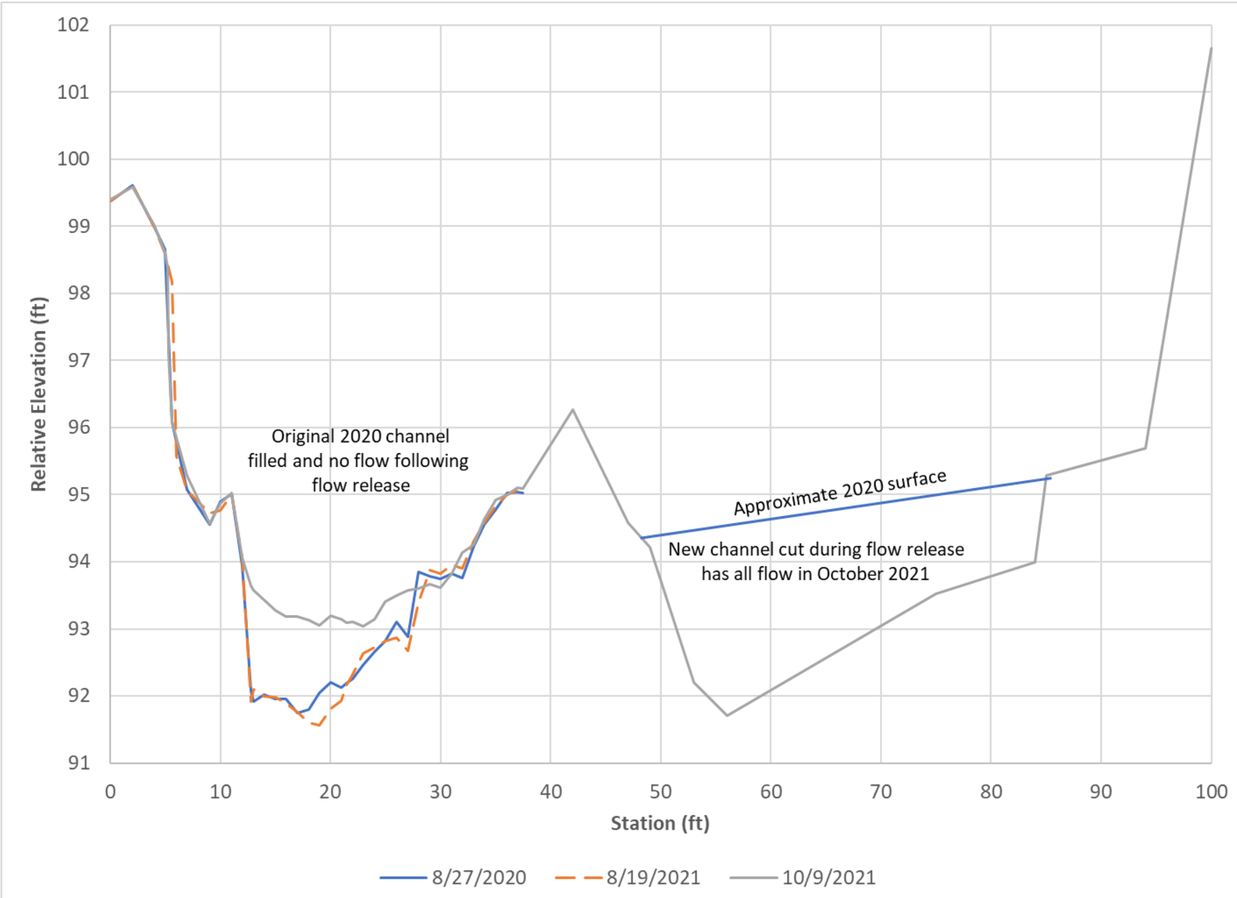


Figure 5.3-41. Transect E cross-sectional changes.

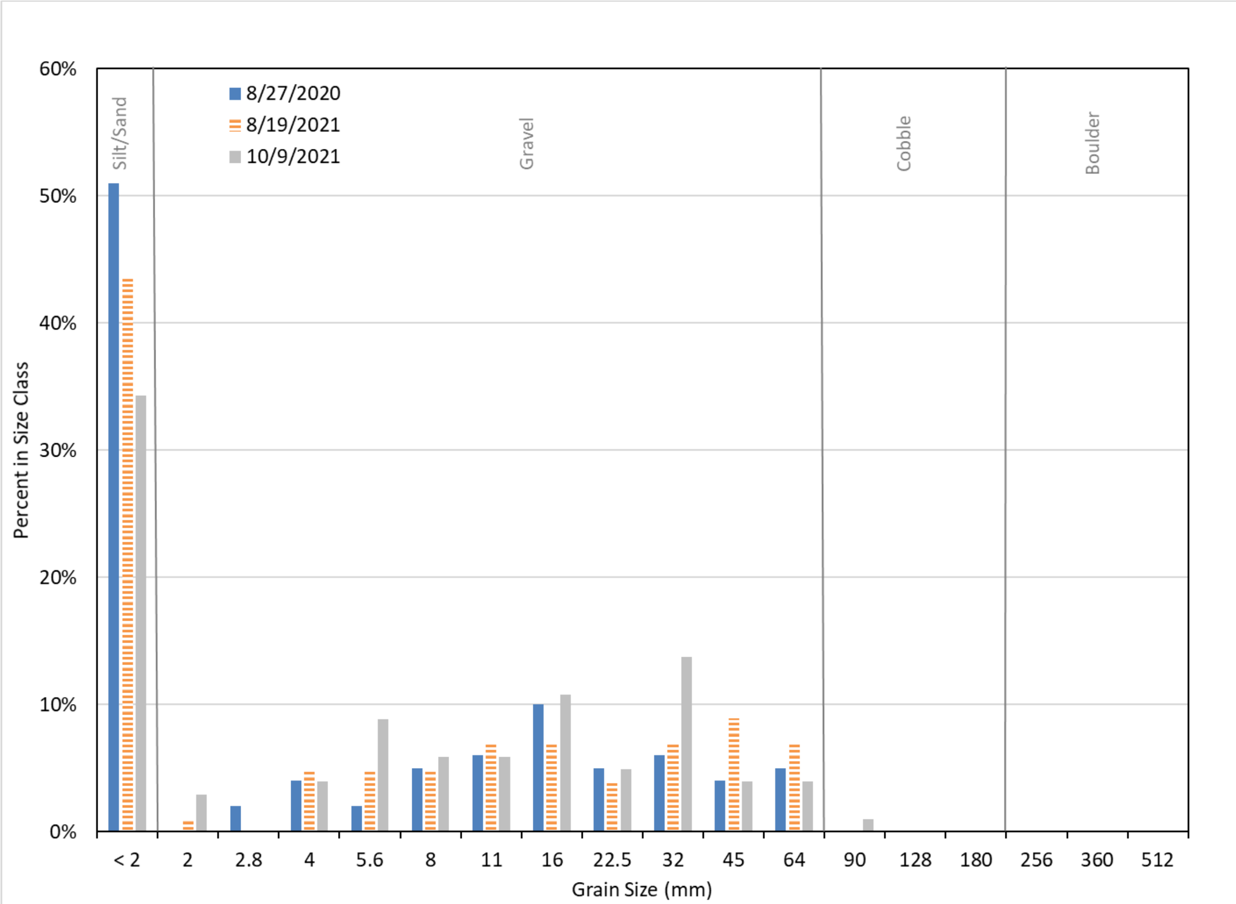


Figure 5.3-42. Transect E substrate grain size distribution changes.

5.3.1.15. Transect D RM 7.2

Transect D, at RM 7.2, is located upstream from two major sediment sources. This transect was established in August 2020 and included two pre-flow release measurements and one post-flow release measurement. Between August 2020 and August 2021, a series of beaver dams was established in the vicinity of this transect and resulted in the inundation of the transect during the 2021 measurements (**Figure 5.3-43**). Deposition of 0.5 to 1 foot within the channel following beaver dam construction was measured (**Figure 5.3-44**). Grain size measurements were taken pre- and post-flow release across the transect and showed that deposition of fine-grained sediment covered the original gravel/cobble bed (**Figure 5.3-45**).

Figure 5.3-43. Transect D before (top) and after (bottom) inundation by beaver dam.

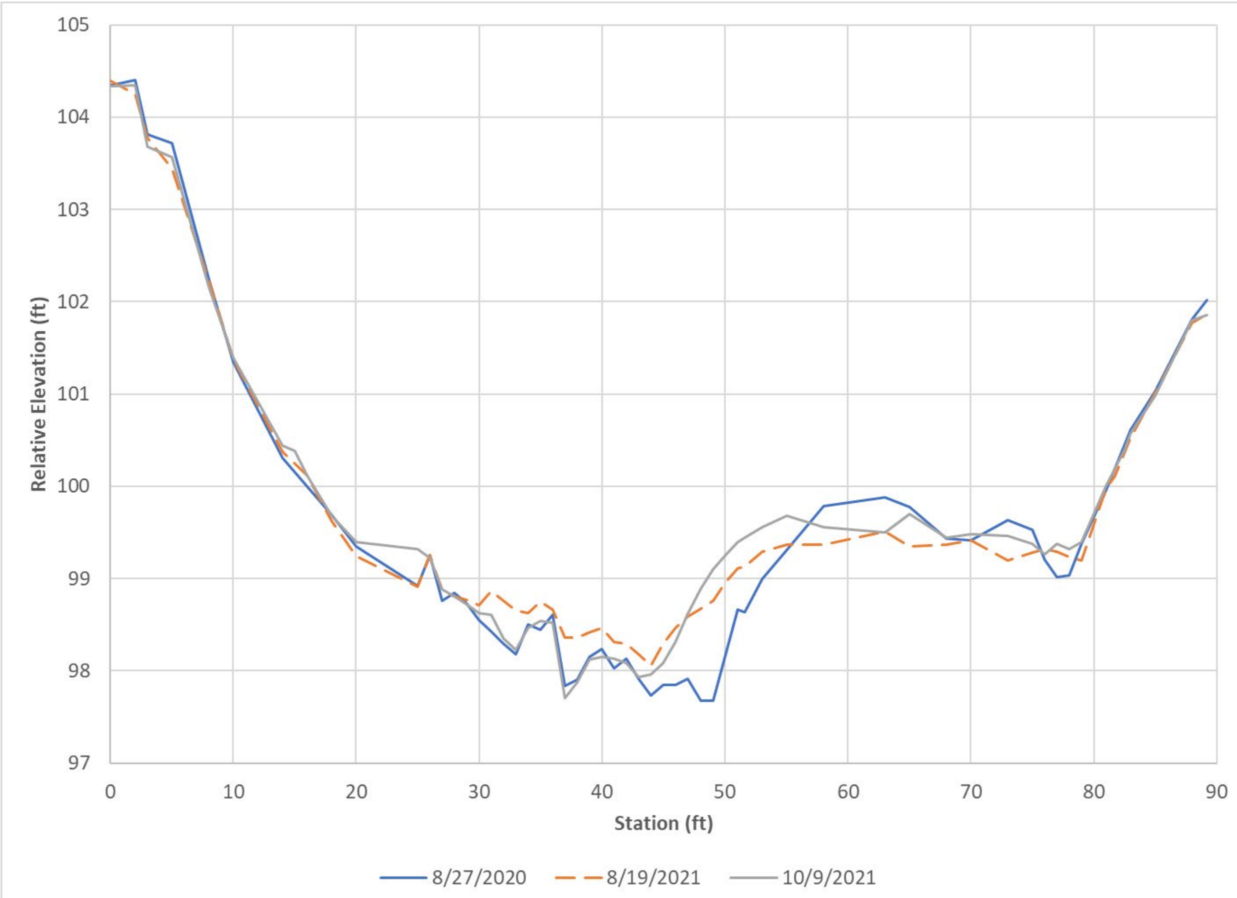


Figure 5.3-44. Transect D cross-sectional changes.

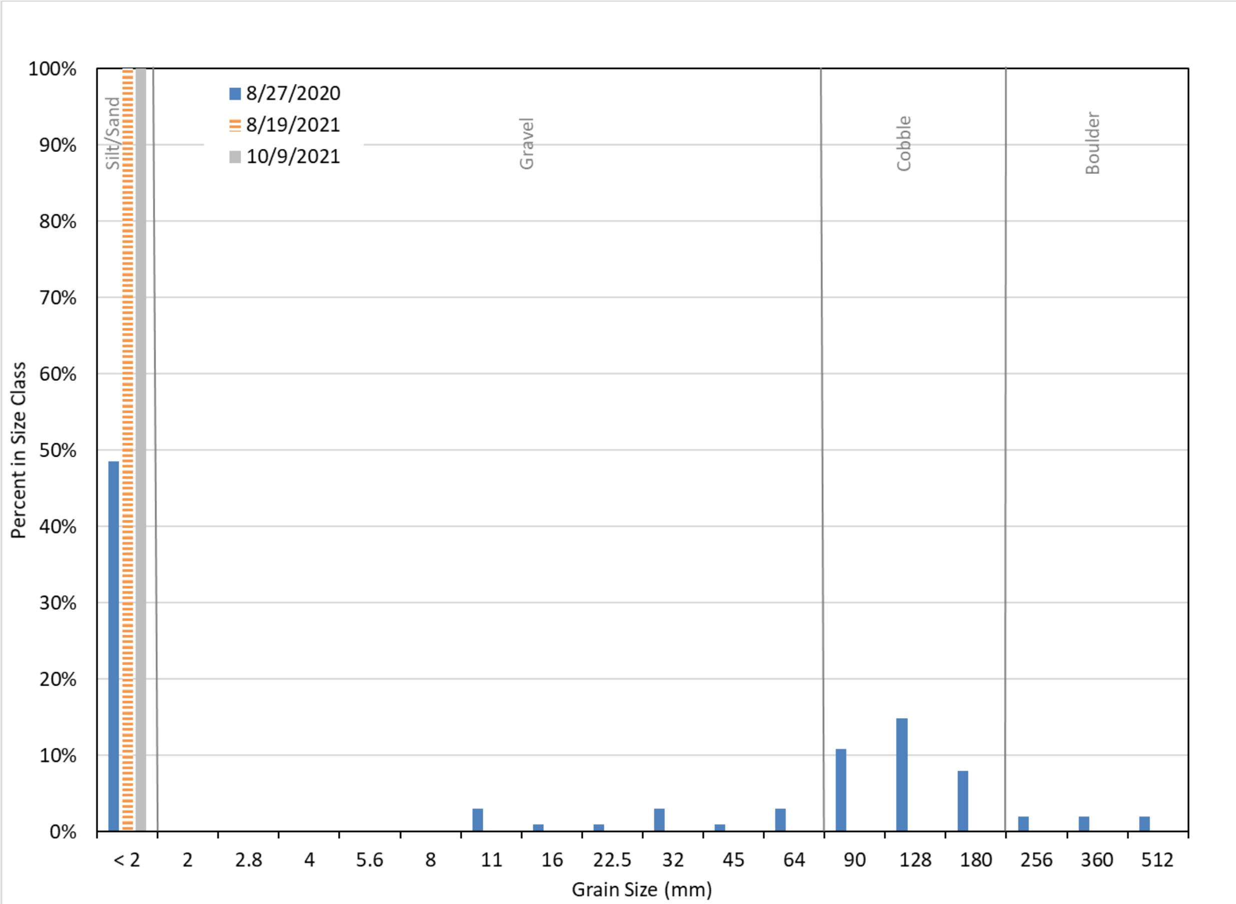


Figure 5.3-45. Transect D substrate grain size distribution changes.

5.3.1.16. Transect 105 RM 8.7

Transect 105, at RM 8.7, is located several hundred feet downstream of the sixth AWWU access road crossing below Eklutna Lake Dam (**Figure 5.3-46**). This transect was established in August 2021 and included one pre-flow release measurements and one post-flow release measurement. The post-flow measurement showed up to 1.5 feet of erosion within the channel as well as overbank deposition of fine sediment on the left bank (in the lee of a log) following the study flow releases (**Figure 5.3-47**). Grain size measurements were taken pre- and post-flow release across the transect. Substrate is predominantly fine-grained and showed a slight decrease in fine sediment following the study flow releases (**Figure 5.3-48**).

Figure 5.3-46. Transect 105, October 8, 2021.

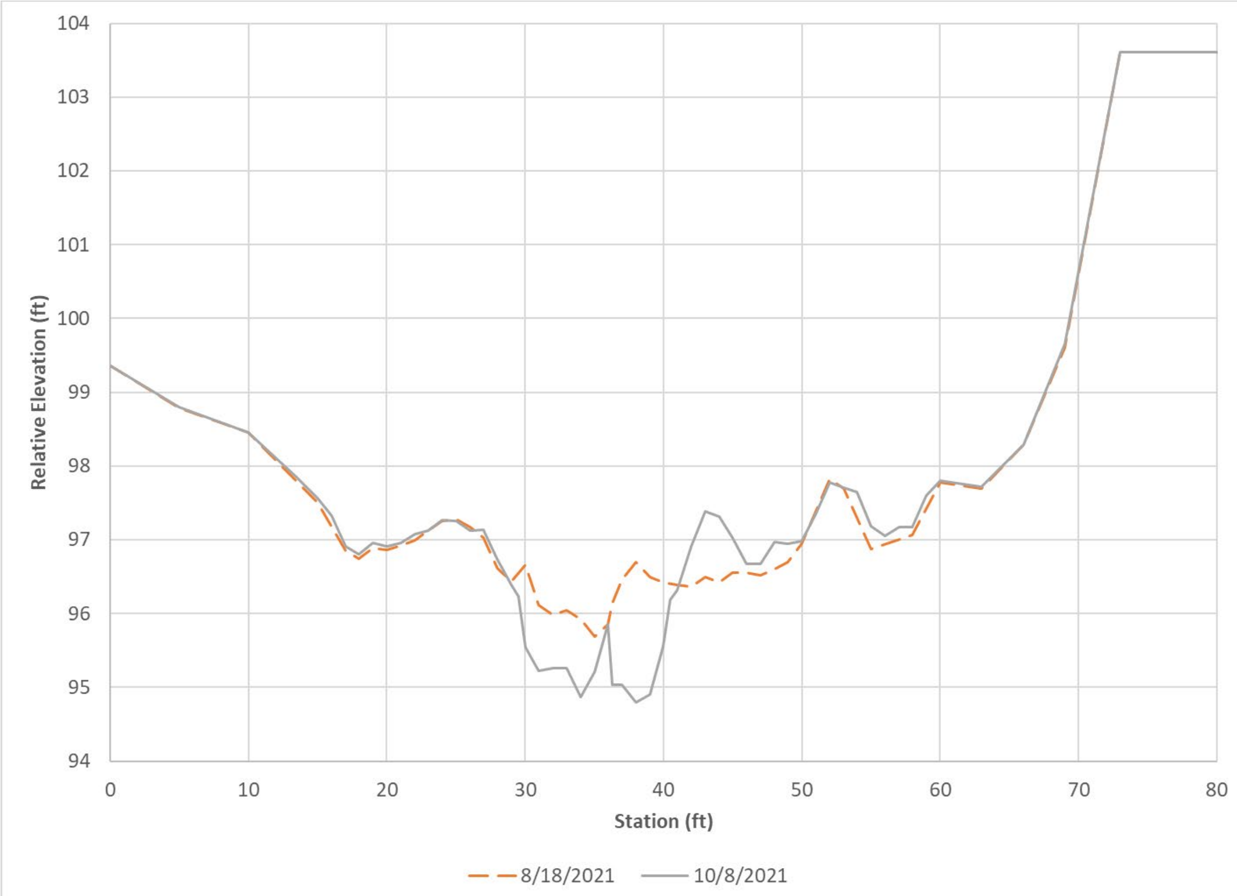


Figure 5.3-47. Transect 105 cross-sectional changes.

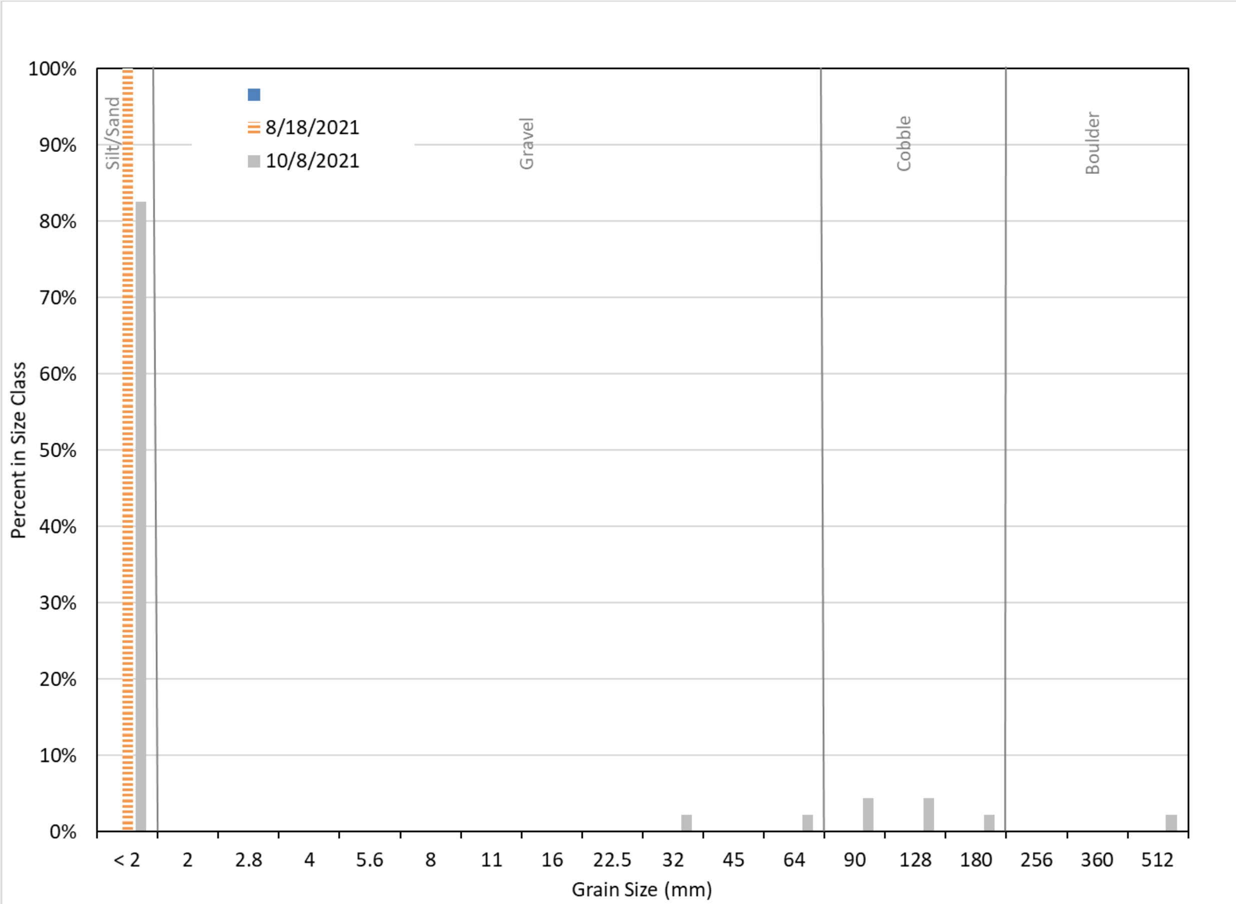


Figure 5.3-48. Transect 105 substrate grain size distribution changes.

5.3.1.17. Transect C RM 11.2

Transect C, at RM 11.2, is located just downstream from the alluvial fan source at Transect B (**Figure 5.3-49**). This transect was established in August 2020 and included two pre-flow release measurements and one post-flow release measurement. The post-flow measurement showed erosion of up to 0.5 foot within the channel following the study flow releases (**Figure 5.3-50**). Grain size measurements were taken pre- and post-flow release across the transect (**Figure 5.3-51**). Substrate following the study flow releases was predominantly gravel (median grain diameter 2-3 mm prior to the flow release and 18 mm following the flow release) and showed a marked decrease in fine sediment as the original channel bed was uncovered.

Figure 5.3-49. Transect C before (top) and after (bottom) flow release showing erosion of fine sediment and re-establishment of river channel.

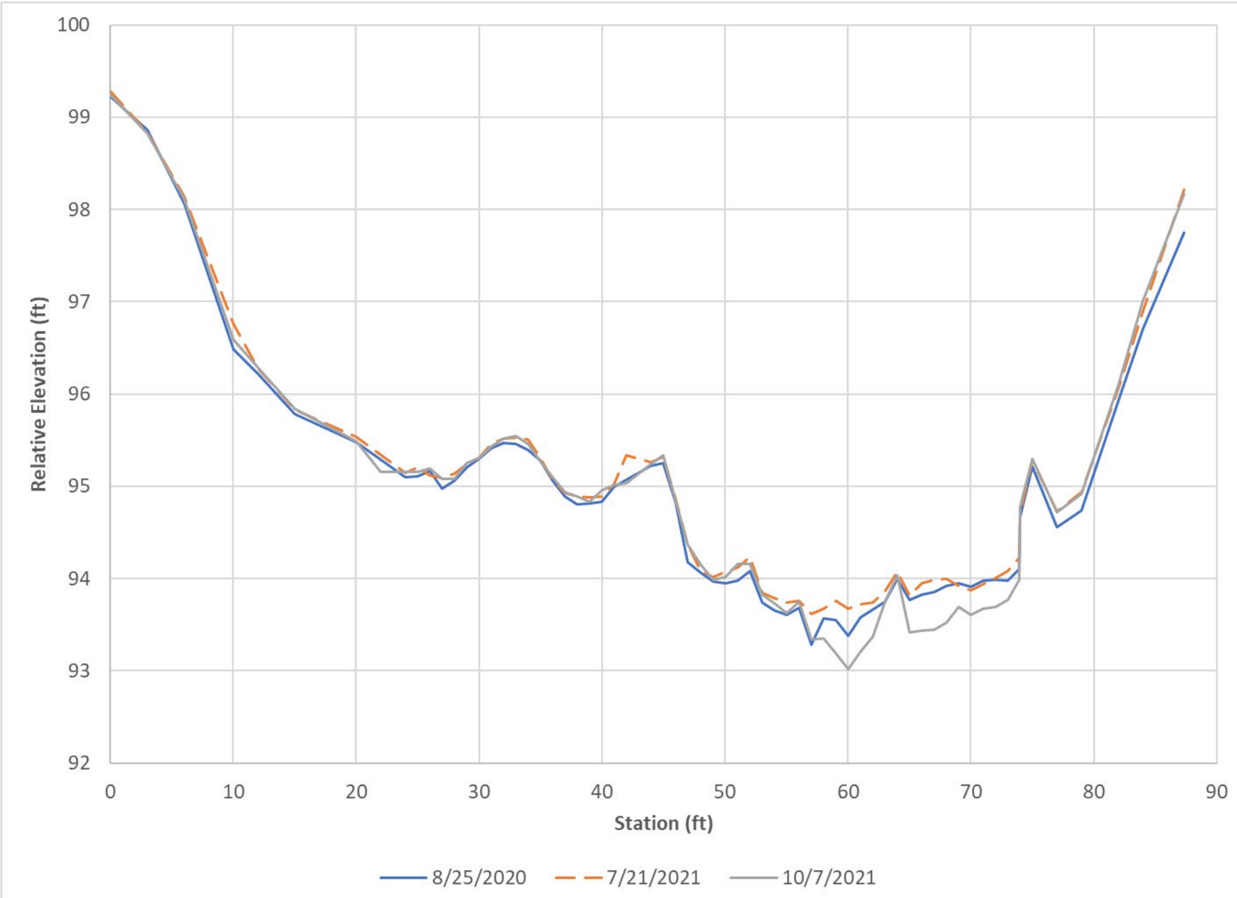


Figure 5.3-50. Transect C cross-sectional changes.

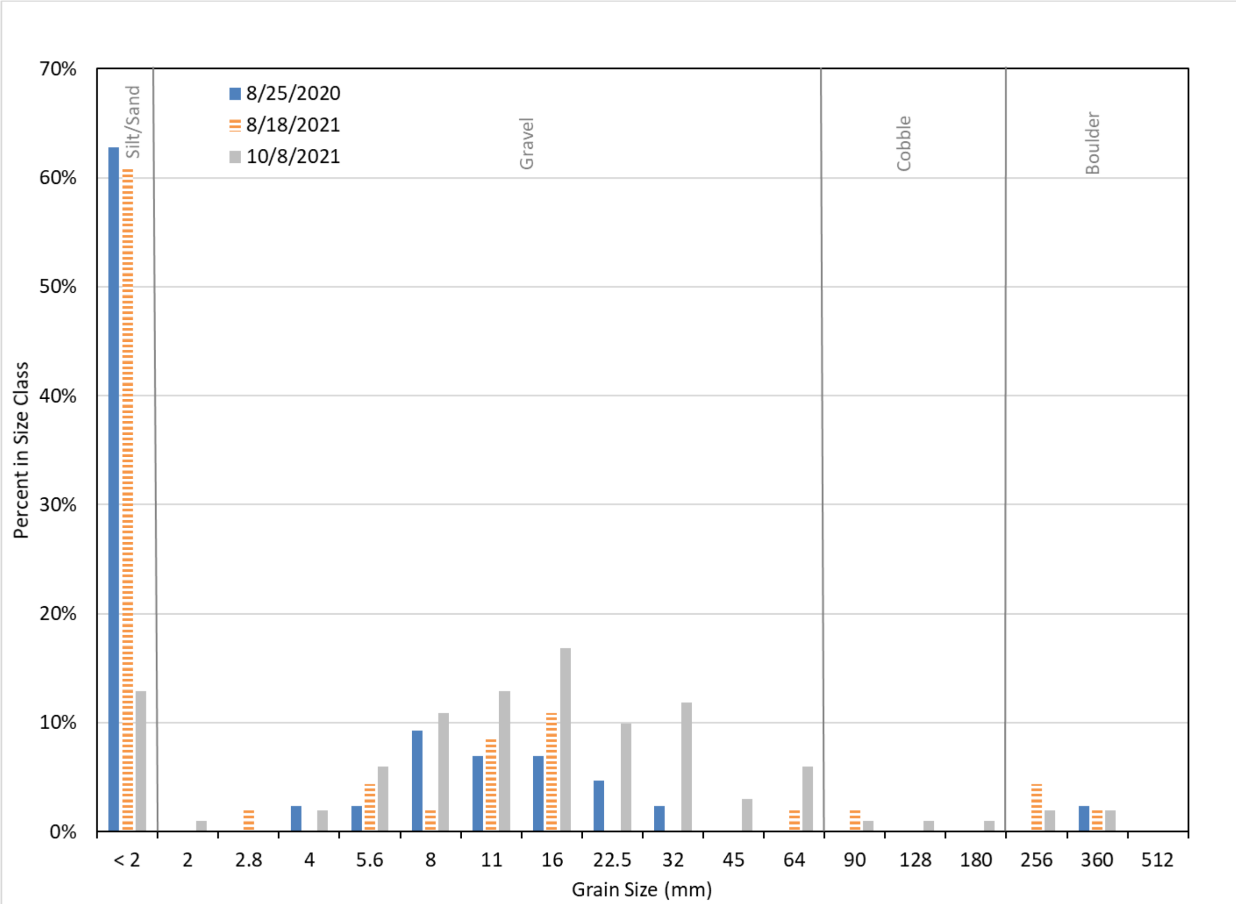


Figure 5.3-51. Transect C substrate grain size distribution changes.

5.3.1.18. Transect B RM 11.25

Transect B, at RM 11.25, is located between the two AWWU bridges at the toe of the first major sediment source downstream from Eklutna Lake Dam (**Figure 5.3-52**). This transect was established in September 2020 and included two pre-flow release measurements and one post-flow release measurement. The transect includes the toe of the alluvial fan sediment source. The post-flow measurement showed erosion of over 3 feet as the river re-established a channel by eroding the toe of the alluvial fan deposits (**Figure 5.3-53**). Grain size measurements were taken pre- and post-flow release across the transect and showed a change from nearly 100 percent fine sediment prior to the study flow releases to a median grain diameter of 51 mm (gravel) following the study flow releases as the underlying gravel, cobble, and boulder substrate was exposed (**Figure 5.3-54**).

A line of painted rocks was deployed on the alluvial fan deposits at this location to track erosion of the fan through time. The rocks were visually assessed at several times during the start of the high flow release to document how fast the fan eroded.

Figure 5.3-52. Transect B before (top) and after (bottom) flow release showing erosion of toe of alluvial fan deposits and re-establishment of river channel.

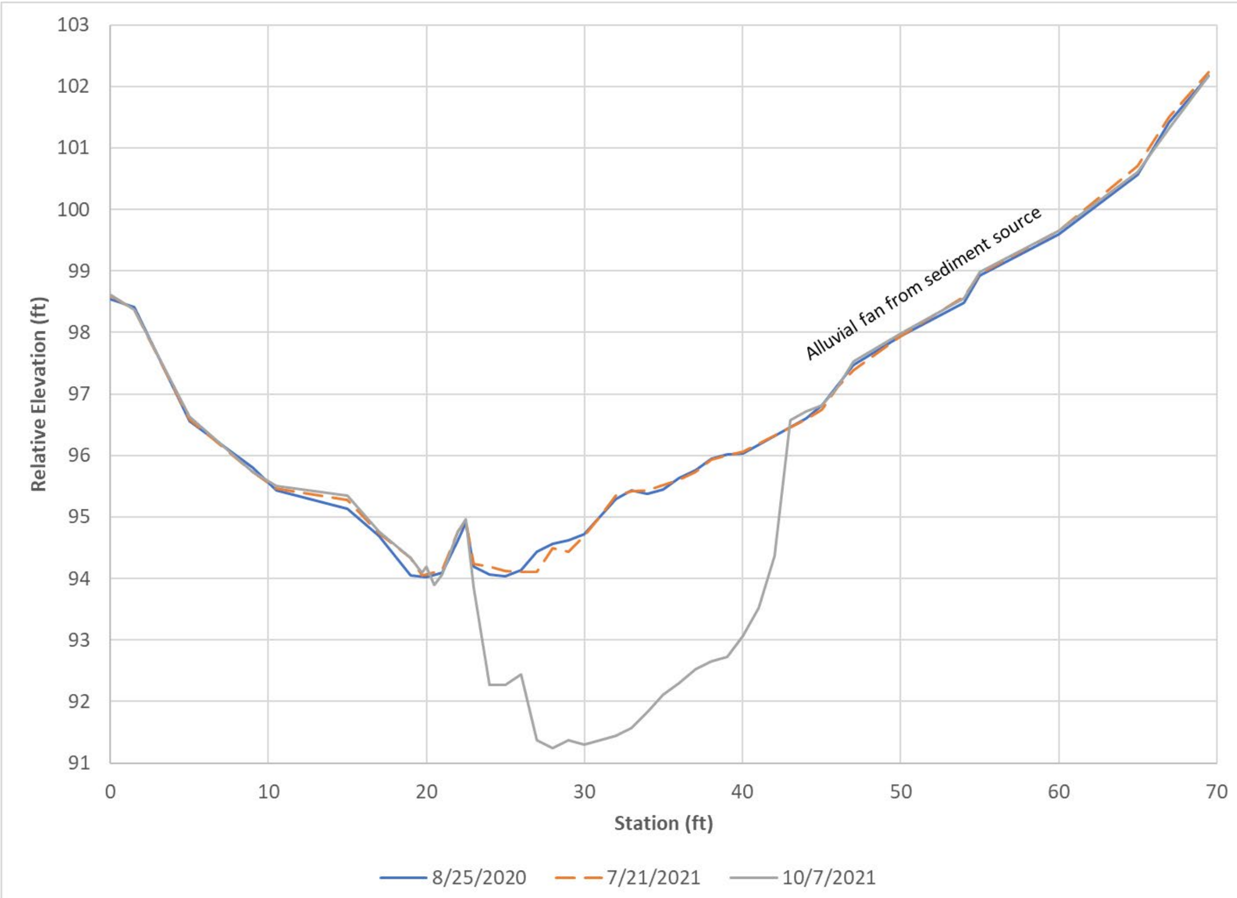


Figure 5.3-53. Transect B cross-sectional changes.

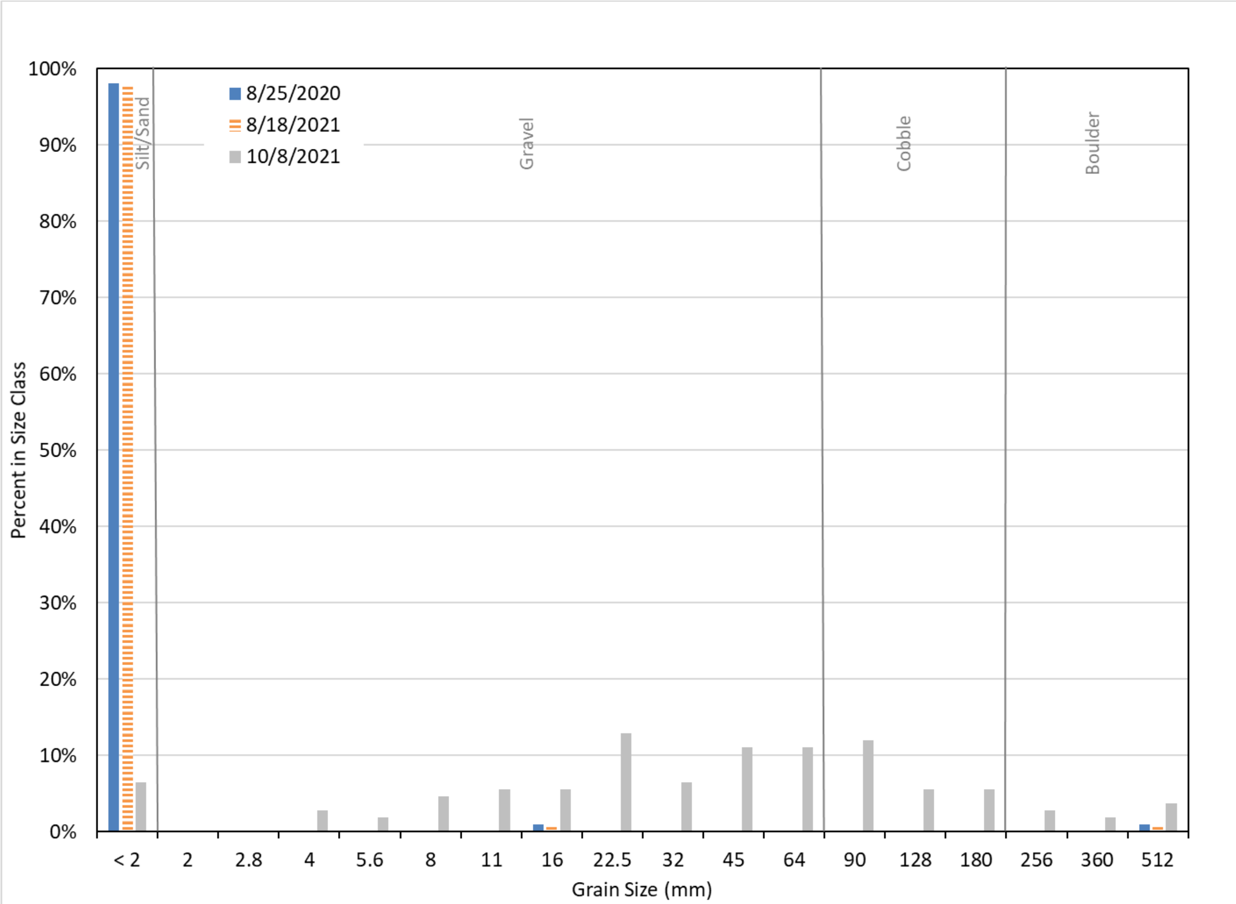


Figure 5.3-54. Transect B substrate grain size distribution changes.

5.3.1.19. Painted Rocks at Upper AWWU Bridge RM 11.3

Painted rocks were deployed just downstream from the upper AWWU bridge (RM 11.3) just prior to the study flow releases. Three rows with 13 painted rocks each were deployed across the streambed, one row of 32 mm particles, one row of 64 mm, and one row of 128 mm particles (**Figure 5.3-55**). Following the flow releases, 2 of the 32 mm particles remained on the streambed, 8 of the 64 mm particles (several of the central 64 mm particles were buried by gravel) and all of the 128 mm particles remained with one covered by gravel. A transect was surveyed following the study flow releases (**Figure 5.3-56**).

Figure 5.3-55. Painted Rocks Transect before (top) and after (bottom) flow release.

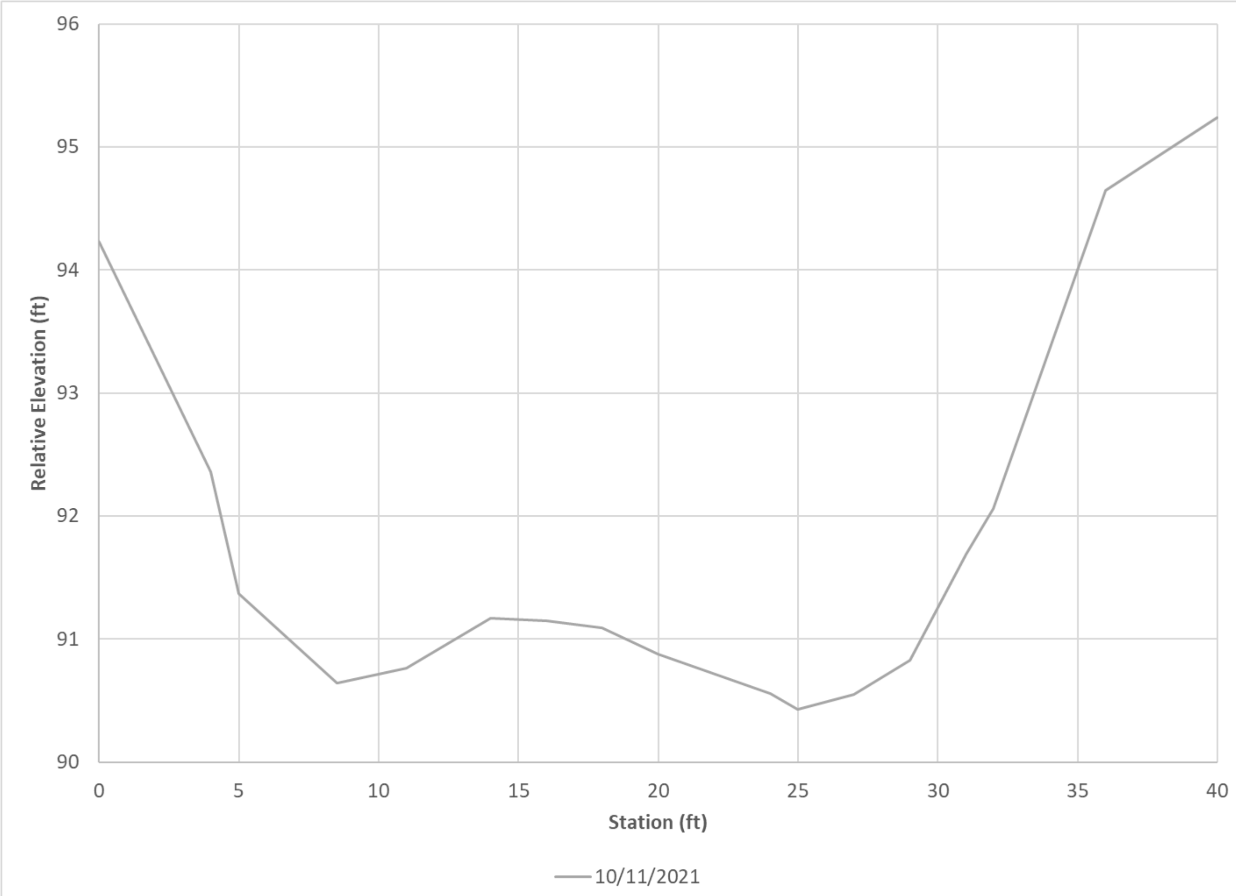


Figure 5.3-56. Painted rocks transect cross-section.

5.3.1.20. Transect A RM 11.75

Transect A, at RM 11.75, is located downstream from the Eklutna Lake Dam near the site of the USFWS 2019 study transects and near the upper instream flow study transects (**Figure 5.3-57**). This transect was established in August 2020 and included two pre-flow release measurements and one post-release measurement. The post-flow measurement showed little change in channel cross section (**Figure 5.3-58**). Grain size measurements were taken pre- and post-flow release across the transect and showed little change (**Figure 5.3-59**). Substrate is predominantly gravel and cobble (median grain diameter 67-78 mm).

Figure 5.3-57. Transect A, October 7, 2021.

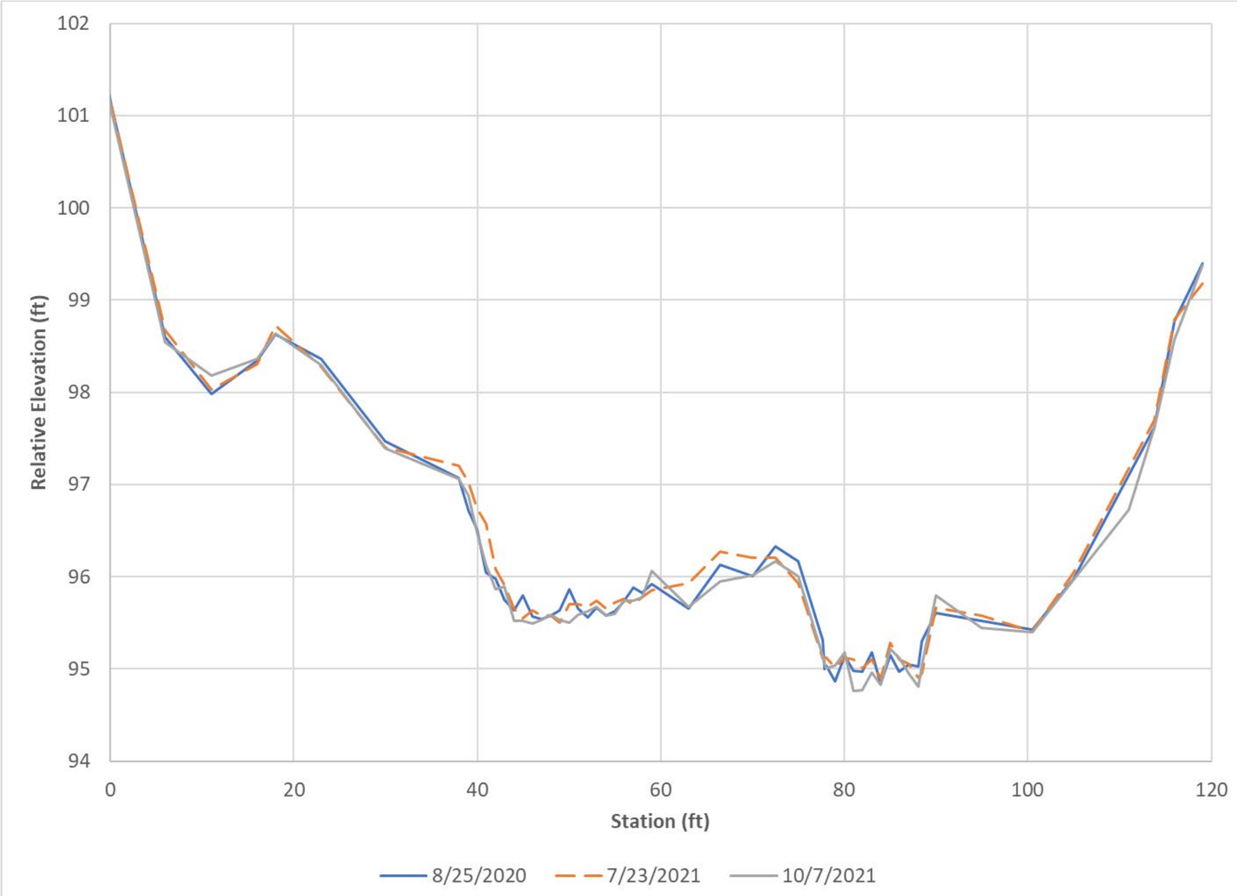


Figure 5.3-58. Transect A cross-sectional changes.

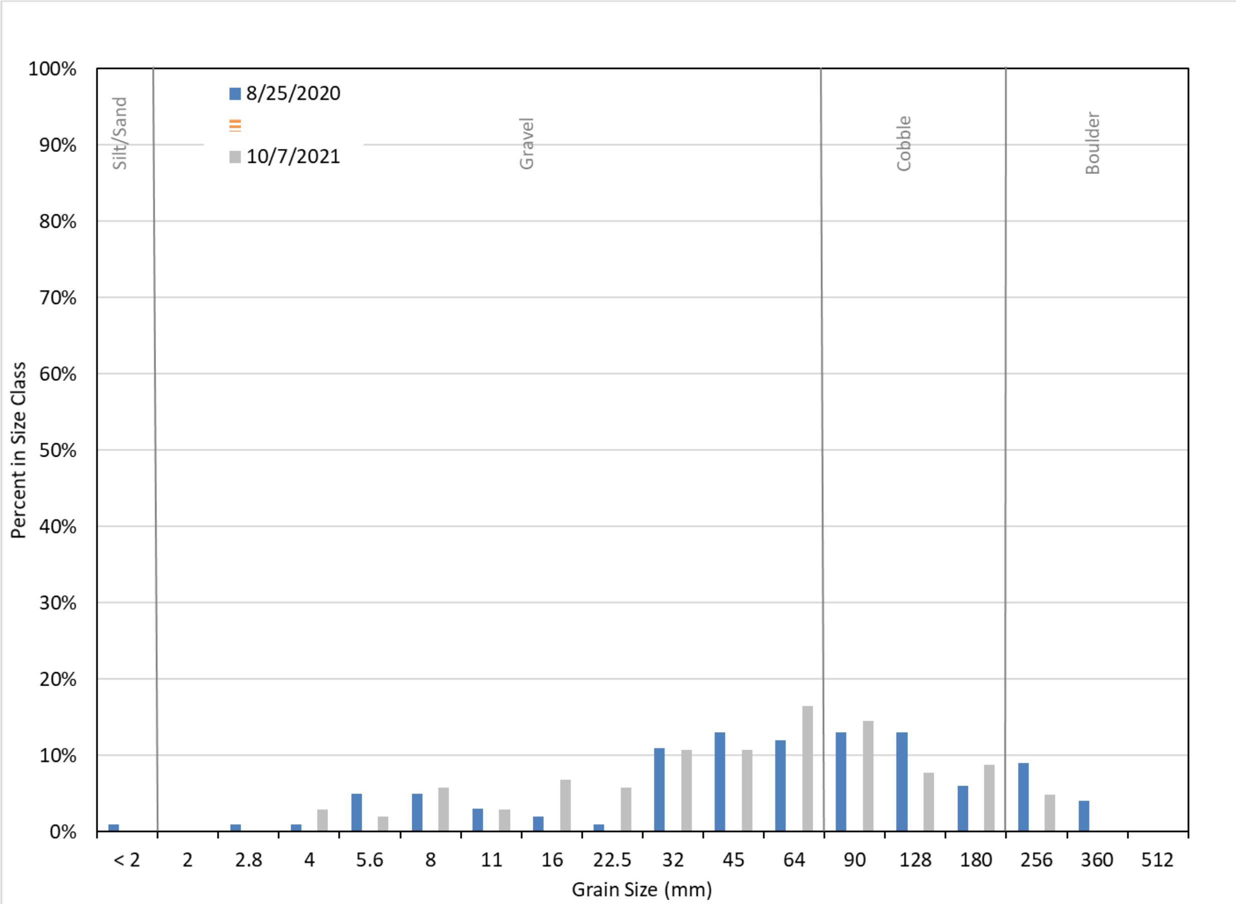


Figure 5.3-59. Transect A substrate grain size distribution changes.

5.3.1.1. Summary of Cross Section Areas at Highest Flow Release

The estimated wetted area for channel cross sections surveyed in Geomorphic Reaches 8, 9, and 10 during the highest (150 cfs) flow release was calculated based on field evidence of high-water marks (Table 5.3-1). Cross sectional areas ranged from 28 to 72 square feet, with an average of 45 square feet (Transect B was not included in average as noted in Table).

Table 5.3-1. Estimated Wetted Cross Section Area during Highest Flow Release.

Transect	Cross Section Area (sq ft)	Notes
A	68	
B	72	High water mark too high – channel was actively cutting during high flow release.
C	46	
105	46	
D	n/a	Beaver Pond, no water mark.
E	97/2 = 48 per channel	Flow eroded a new channel, only 1 active at a time.
103	38	
F	39	
102	28	

5.3.2. Bulk Density Samples

Three bulk density measurements of the fine-grained, compressed material in the old reservoir deposits resulted in dry bulk densities of 99.1, 99.4, and 106.2 lb-f/ft^3. These data were used in the HEC-RAS model to specify bulk density of the fine-grained material.

5.3.3. Timelapse Cameras

The three timelapse cameras recorded changes in the old lower dam deposits during the flow release. Erosion of the deposits via stream undercutting and one large mass wasting event were recorded, as well as headcutting at the upper end of the deposits. The majority of change occurred during the higher flow portion of the study flow releases; once flow levels dropped the rate of change/erosion also dropped. Timelapse videos are available online at the Project website: https://eklutnahydro.com/september-2021-flow-releases/ .

5.3.4. Grade Control Mapping

Grade controls were mapped in the field by visual observations of locations where large, channel-spanning boulders, bedrock, or similar permanent channel controls were located. All mapped grade controls were located within the bedrock canyon (geomorphic reaches 4 and 5) and are shown in Section 6.1 on the profile in Figure 6.1-1. The majority of features formed as a result of rockfalls from canyon walls that left large, immobile boulders blocking the canyon. Not all rockfalls are large enough to span the channel, and some do not include boulders large enough to be immobile under potential/historic peak flow conditions. These temporary grade controls were not included in this analysis. The grade control features were used in the 1-D HEC-RAS sediment transport model to control depth of future potential channel erosion at these locations. One of the features, located at RM 4.2 at the upstream end of the old reservoir deposits, persisted through the 2020-2022 study period and may or may not be a permanent feature depending upon how the boulders at this location adjust to the headcutting that is occurring in the old reservoir deposits. This location was modeled as a grade control in the current sediment transport model.

5.4. Sediment Source Areas and Sediment Input Rates

The current major sediment sources to the Eklutna River are shown in **Figure 5.4-1** and include the alluvial fans in the upper valley and one smaller eroding bluff in the canyon just downstream from RM 5. These sediment sources provide fine-grained sediment (sand, silt, clay), coarser-grained gravel and cobble that are preferred by salmonids for spawning, and boulders that are not mobile under most flow conditions but provide local hydraulic variability which is an important aspect of aquatic habitat. Other, smaller sediment sources exist along the river, such as eroding banks downstream from Thunderbird Creek, but these contribute minor amounts of sediment compared to the mapped major sediment sources. There are few eroding banks in the wide alluvial valley upstream from RM 5 and the bedrock canyon between RM 5 and Thunderbird Creek provides relatively minimal amounts of material from bank erosion (with the exception of the large eroding bank mapped as Sediment Source 23 and occasional rockfalls).

Comparison of the 2022-2020-2015 LiDAR topographic surfaces was used to estimate an average annual contribution of sediment to the Eklutna River from each of the mapped sources (see examples in **Figure 5.4-2**, **Figure 5.4-3** and **Figure 5.4-4** for examples). The net elevation change at each LiDAR grid cell was summed over each sediment source area to provide a volume of sediment exported from each source area. The 7-year interval between the 2022-2015 LiDAR flights does not provide a long-term estimate of sediment input. Historical aerial photographs from 1952 to present were reviewed to determine if changes in sediment source areas were visible. Only one source area (Source 22) had enough change to be measurable on the aerial photographs. The area of this source area was digitized on the 1952, 1957, 1963, 1972, 1990, and 2020 aerial photographs to measure the change in area between photo periods (**Figure 5.4-5**). The source area (not the fan) was multiplied by bank height (100 feet) to estimate volume of material eroded during each period for comparison with the 2020-2022 input rate (**Figure 5.4-6**). This particular sediment source area provided a very large volume of sediment in the 1957-1963 period; there appeared to be ground disturbance upslope from this source area that may have contributed to the instability and anomalously large contributions. The sediment formed a fan that crossed and blocked the Eklutna River valley and forced the river to the opposite side of the valley during this same 6-year period, a feature that persists in the landscape today. Input rates since 1963 have been consistent and align closely with the 2020-2022 LiDAR input estimate.

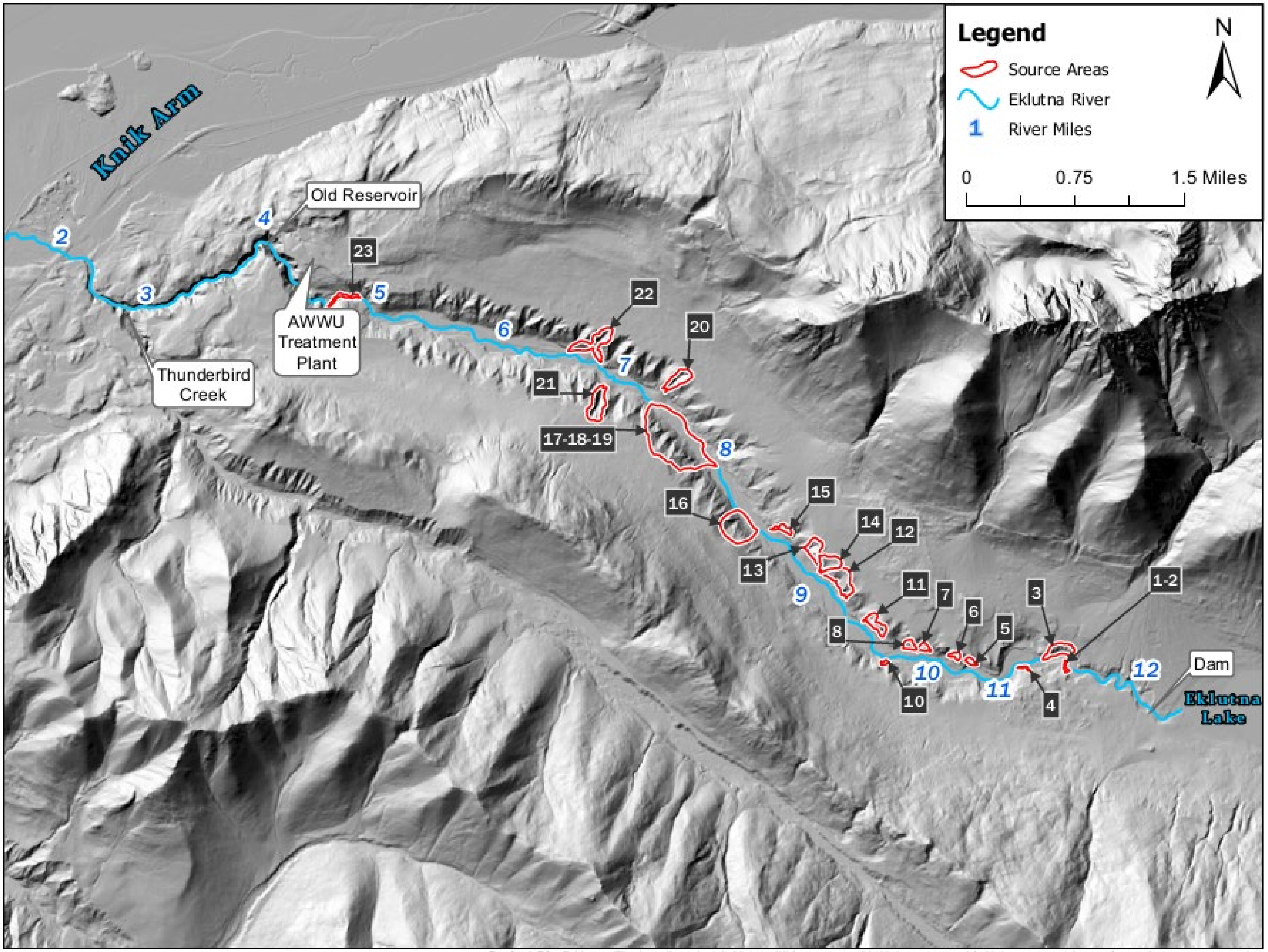


Figure 5.4-1. Eklutna River and Primary Sediment Source Areas.

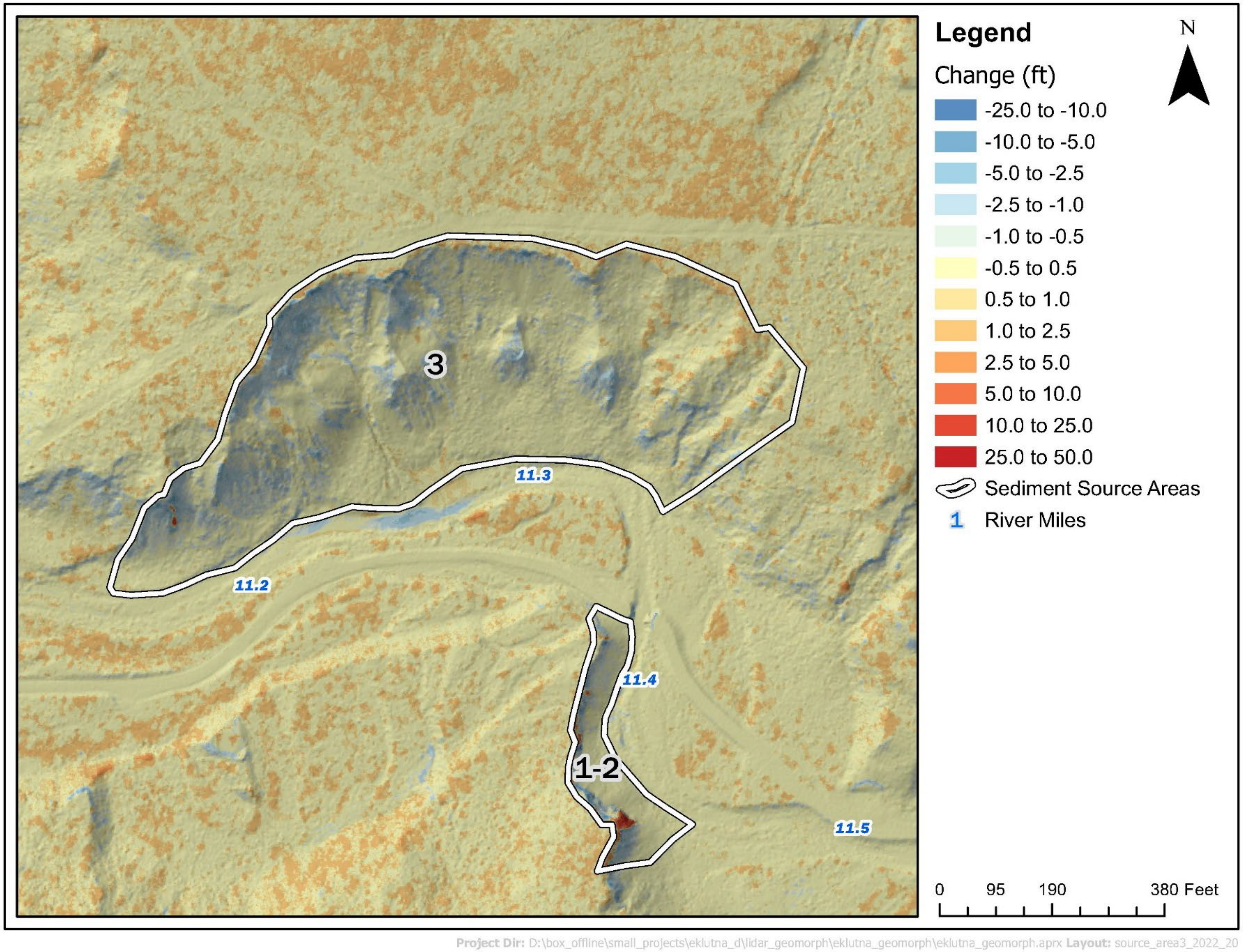


Figure 5.4-2. Comparison of 2022 minus 2020 LiDAR Elevation for Source Area 3.

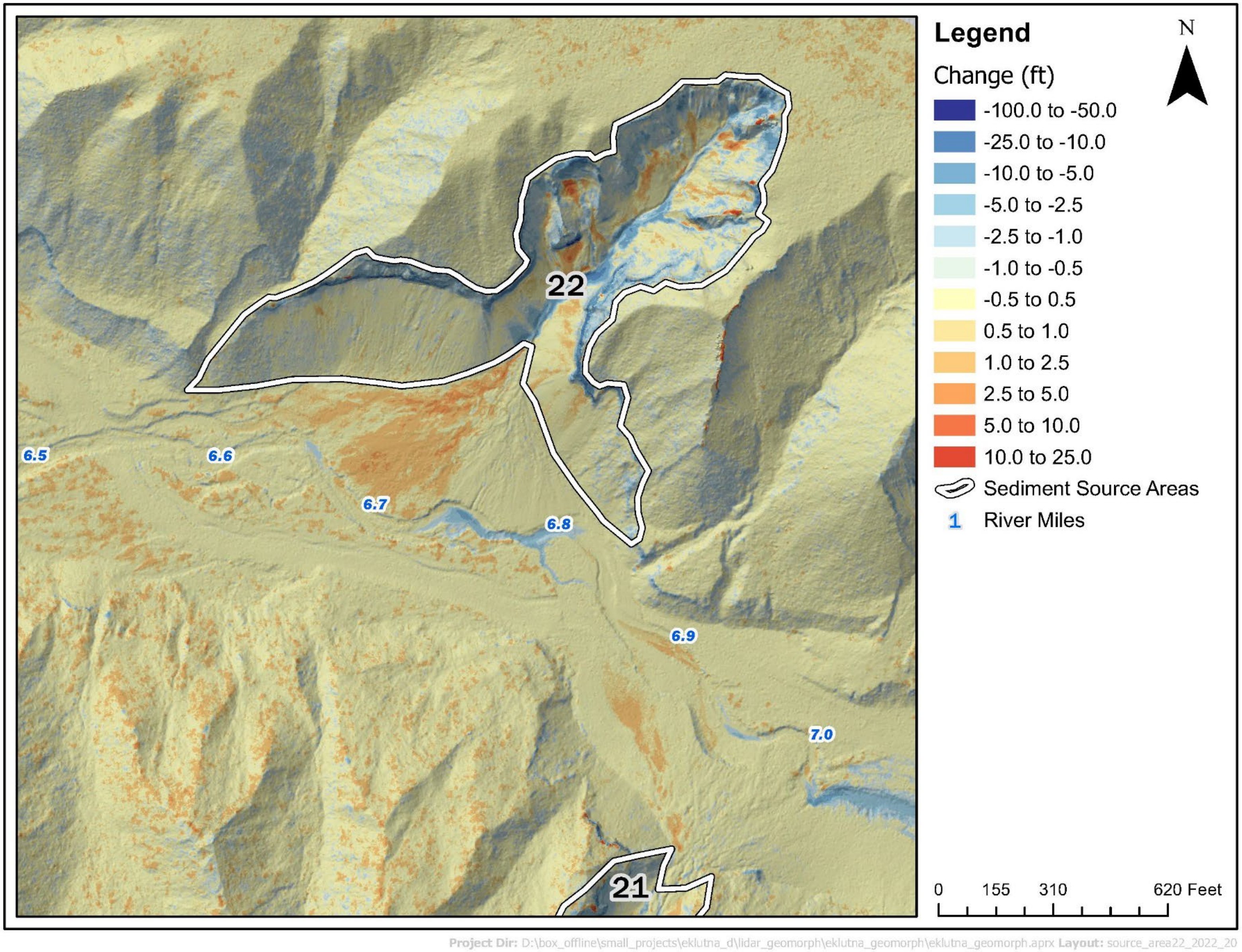


Figure 5.4-3. Comparison of 2022 minus 2020 LiDAR Elevation for Source Area 22.

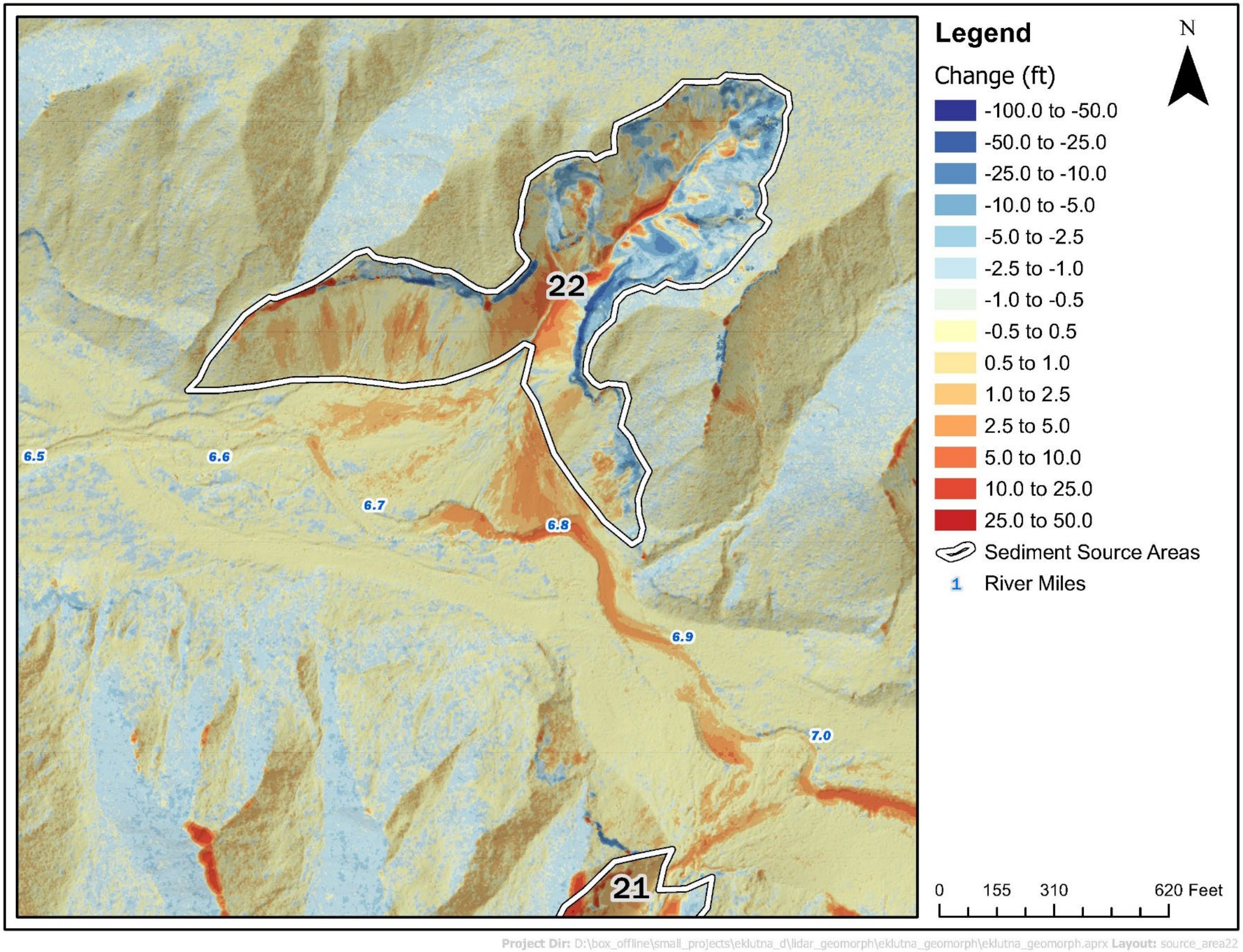


Figure 5.4-4. Comparison of 2020 minus 2015 LiDAR Elevation for Source Area 22.

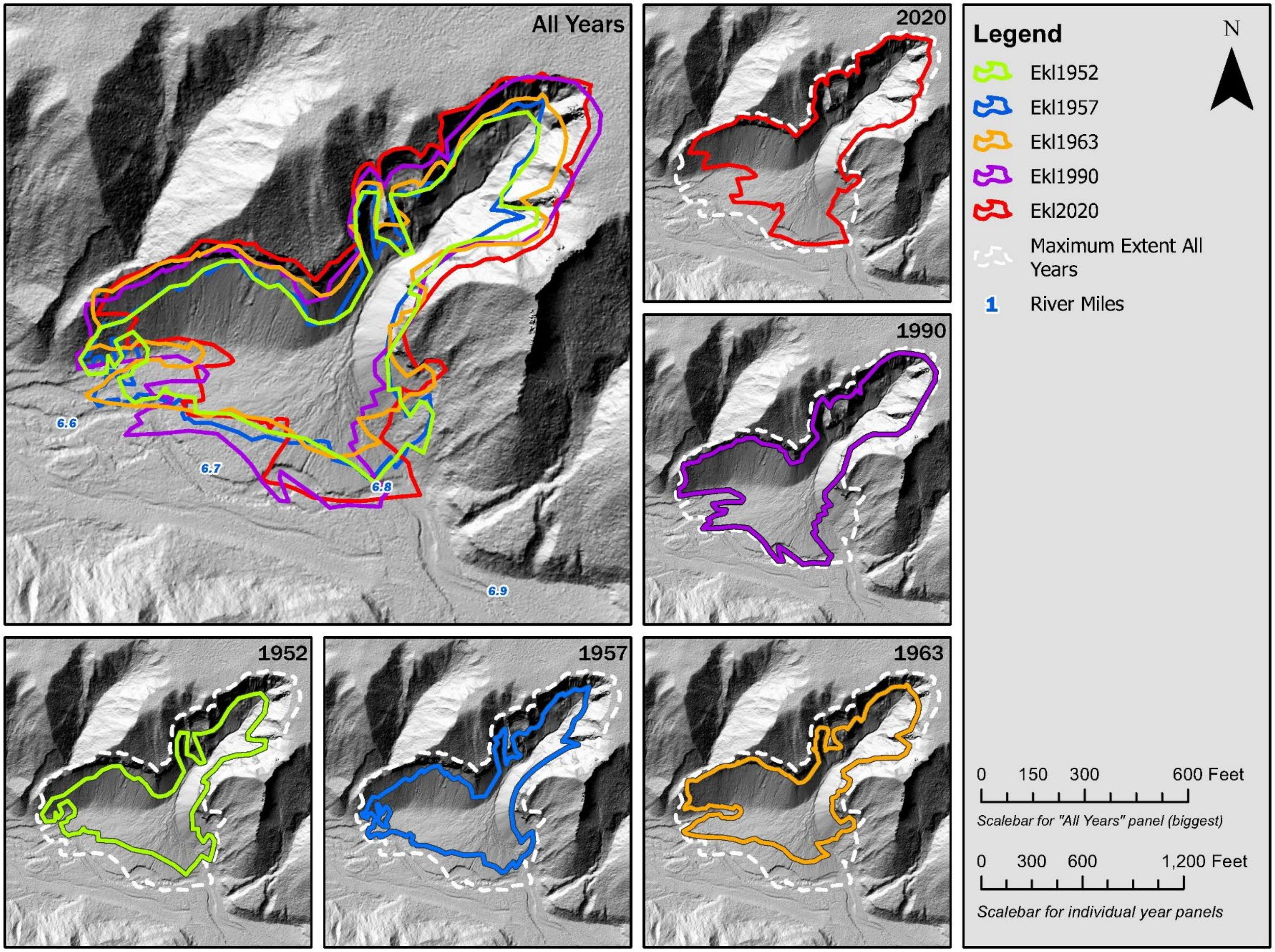


Figure 5.4-5. Growth of Source Area 22 through time.

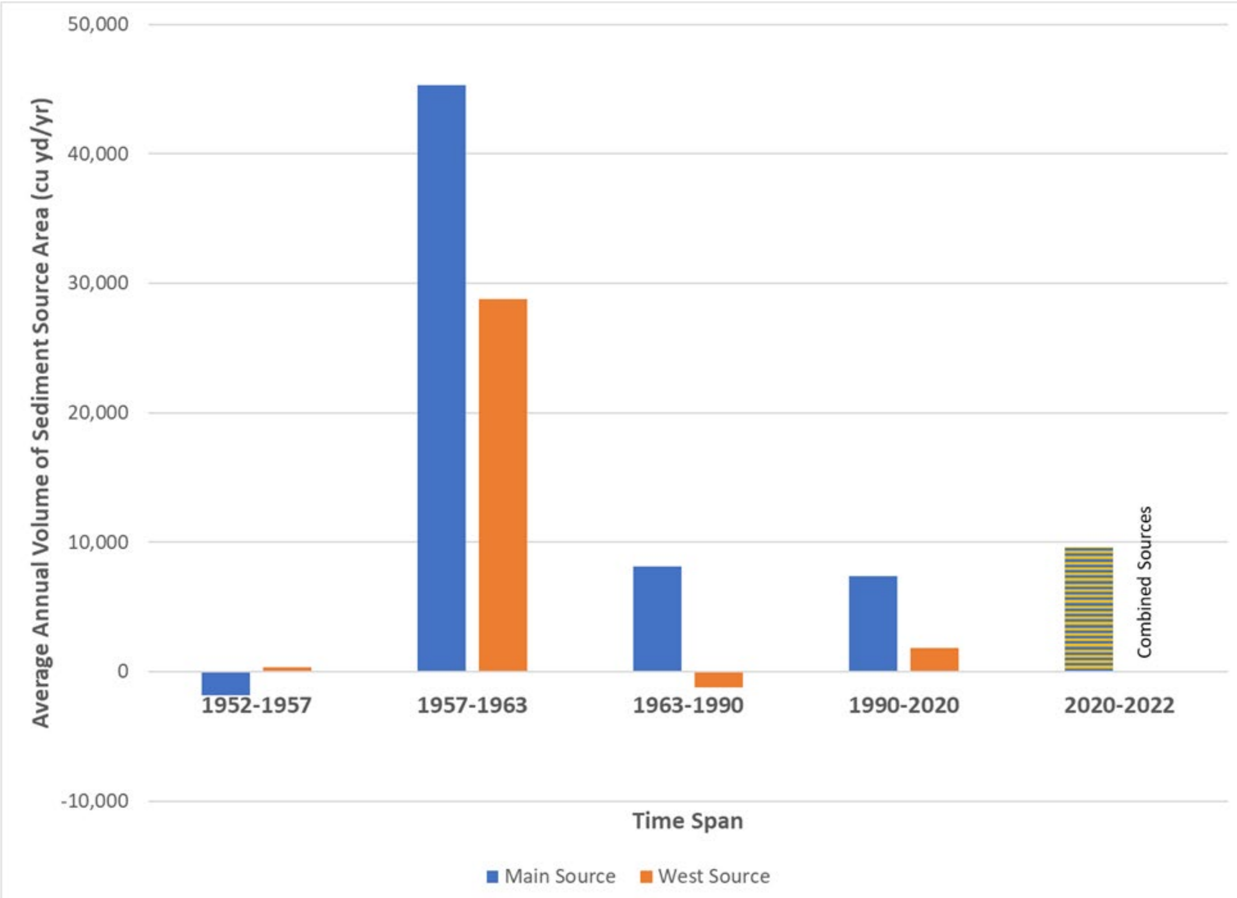


Figure 5.4-6. Average annual volume of sediment by aerial photo period for Source Area 22.

The average annual 2022-2020 volume contributed to the Eklutna River channel as well as the grain size distribution of each of the mapped sediment sources based on field observations and sediment sampling is shown in Table 5.4-1. Note that percent delivery was based on proximity of the sediment source to the Eklutna River channel. These volumes were used to estimate sediment inputs to the Eklutna River in the HEC-RAS sediment transport model.

Table 5.4-1. Estimated Average Annual Sediment Supplied to the Eklutna River Channel from Primary Sediment Source Areas[1].

Sediment Source Area	Estimated Delivery (%)	Estimated Average Annual Volume of Sediment Supplied to Eklutna River Channel (tons/yr)	Percent Cobble/Gravel	Percent Fine-grained Sediment (sand, silt, clay)[2]
1 and 2	100	25	80	20
3	100	2,600	55	45
4	100	700	80	20
5	0	0		
6	40	2,700	50	50
7	10	230	25	75
8	25	840	70	30
9	0	0		
10	100	140	80	20
11	25	1,500	70	30
12	50	3,400	55	45
13	5	450	55	45
14	50	650	55	45
15	25	630	50	50
16	25	860	50	50
17	0	0		
18	0	0		
19	0	0		
20	0	0		
21	50	4,300	50	50
22	50	6,700	50	50
23	100	4,700	50	50
Total	**--**	**30,425 tons/yr**	**16,425 tons/yr**	**14,000 tons/yr**

[1] These estimates are based on a short-term record (2022-2022) may not be completely representative of long-term sediment input.
[2] Much of the silt and clay would move as suspended or wash load through the river if baseflows are provided.

5.5. Channel Migration

Channel migration downstream from the canyon (Geomorphic Reaches 1 and 2) was evaluated using historic aerial photographs from 1949 through 2020 (**Figure 5.5-1**). In 1949 and 1952, prior to water being withdrawn from Eklutna Lake and taken out of the basin, the channel carried fine sediment and had a wide, braided character with little vegetation on mid-channel bars downstream from RM 2. These characteristics were also evident in the 1957 aerial photographs. In the 1972 photos, the river was less braided between RM 1.6 (railroad bridge) and RM 2 and was channelized downstream from RM 1.6 into a location north of the former riverbed to allow for gravel mining south of and in the former riverbed between RM 1.2-1.5. Channelization continued through the 1980's. In the 1990 photo, the river was just starting to break through into the gravel pit (former riverbed) area and flood the former pits, but it appeared the main outlet continued through the channelized area. In 1996 (poor image quality hampered detailed analysis of 1996), the main channel was flowing into the gravel pits and out to Knik Arm through the pits. Since 1996, the river has continued to flow into the old gravel pit ponds and has abandoned the former channelized flow area. The gravel bars in the former braided section in Geomorphic Reach 2 (between RM 1.6-2) has become vegetated; the channel in this area (aka the "Flooded Forest") was not visible on the aerial photograph after about 1996. Little migration was observed upstream from RM 1.5 after 1996, but some migration still occurs in the tidally-influenced reach downstream from RM 1.5 due to sediment deposition in this low-gradient area. This is apparent from field observations following the 2021 flow release that resulted in sediment deposition and channel changes in this area.

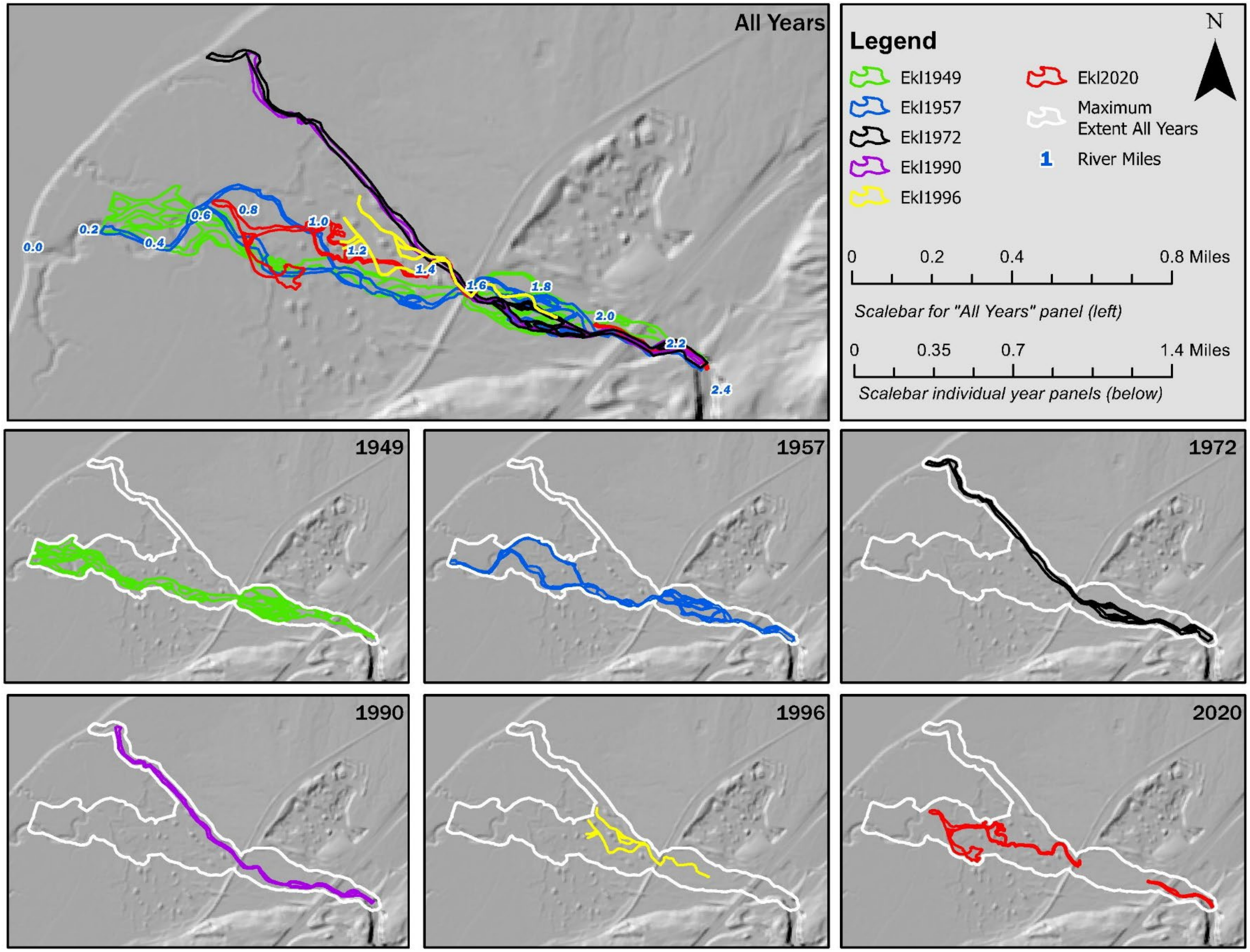


Figure 5.5-1. Eklutna River Channel Migration, Geomorphic Reaches 1 and 2.

There were limited aerial photographs of sufficient coverage and photo quality to delineate channel changes in the other unconfined sections of the Eklutna River (Geomorphic Reaches 7, 8 and 9 between RM 5 and 11.3). The channel position was mapped on the 1952 aerials and compared to the 1957 and 1963 aerials and showed evidence of braiding and recent movement between RM 5.3-6.7 (downstream from sediment source area 22) and RM 7.6 – RM 8 between 1952-1957 but little change in 1963 (except for a much smaller channel due to less water). Following 1963, vegetation growth obscured the channel position on the aerial photographs upstream from RM 5.

It is hypothesized that channel migration in the Eklutna River is triggered by high sediment loading rather than just being a response to high flows. The majority of current channel migration occurs in the tidally-influenced, low gradient areas downstream from RM 1.5 as sediment deposition causes changes in channel position. Little change has occurred upstream from RM 1.5 as vegetation has grown on gravel bars on the sides of the former larger river channel and stabilized the banks.

5.6. Lach Q’atnu Creek

Historically, Lach Q’atnu Creek flowed across an alluvial fan and into the Eklutna River near RM 12. Currently the creek is diverted into Eklutna Lake. Substrate in the streambed near the historic confluence with the Eklutna River shows the stream likely provided primarily gravel-sized material with a median diameter of 35 mm.

6 DISCUSSION

Understanding the geomorphic setting of the Eklutna River is important to understanding both the short- and long-term adjustments the river will make to a new flow regime. Results from this study will also be used during the alternatives analysis.

6.1. Geomorphic Setting

The Eklutna River downstream of Eklutna Lake includes a long, unconfined reach between the dam and the canyon (approx. RM 5-12.5), the confined bedrock canyon that includes the old dam site, the moderately confined reach downstream from the Old Glenn Highway Bridge where the river location is pinned by the New Glenn Highway Bridge and the Railroad Bridge, and an unconfined, tidally-influenced reach downstream from the Railroad Bridge[1]. The longitudinal profile of the river shows several additional features that exert large-scale grade controls and influence sediment transport in the river (Figure 6.1-1). Between the Railroad Bridge and the Old Dam Site (RM 1.5-4), the river has a concave profile, suggesting that it is in long-term equilibrium with the former sediment load downstream of the Old Dam prior to its removal. Removal of the Old Dam in 2018 has resulted in changes to the sediment load that will continue to work through the system for several decades.

[1] Note that the HEC-RAS model, as described in the Study Plan, does not include the zone of tidal influence downstream from the Railroad Bridge due to complexities of tidal influence and saltwater interactions. This tidally-influenced zone is a low gradient deposition zone.

Between the old lower dam site and Eklutna Lake, the river has a convex upward profile, with a prominent sediment wedge in the old reservoir site (RM 4-4.5). In the upper Eklutna valley (between RM 5 and 12.5), there are several large alluvial fans that are currently providing sediment to the valley. LiDAR and aerial photograph evidence shows that the process of valley wall erosion and alluvial fan development has been occurring since the last glacial maximum (approximately 16,500 years ago) as the Eklutna River cut down through thick accumulations of outwash in the upper valley and the Elmendorf Moraine near the Thunderbird Creek confluence. The currently active alluvial fans have been providing more sediment to the valley than the current river flows (with the current Eklutna Hydroelectric Project dam in place near the outlet of Eklutna Lake) can transport and have resulted in long-term aggradation upstream of RM 7. Evidence of the recent (since 1960's) aggradation upstream of the largest, valley-spanning alluvial fan (Source Area 22) can be seen at RM 6.7.

The stream profile based on the 2015, 2020, and 2022 LiDAR are shown on Figure 6.1-1 for comparison. The primary profile changes have occurred at the site of the Old Dam (RM 4) as material has been transported out of that area since dam removal in 2018, deposition in 2022 downstream from RM 1.5 as this material was deposited in the low-gradient, tidally-influenced zone, and changes associated with beaver dam construction upstream from Sediment Source Area 22 at RM 7. These changes are discussed in more detail in the next section.

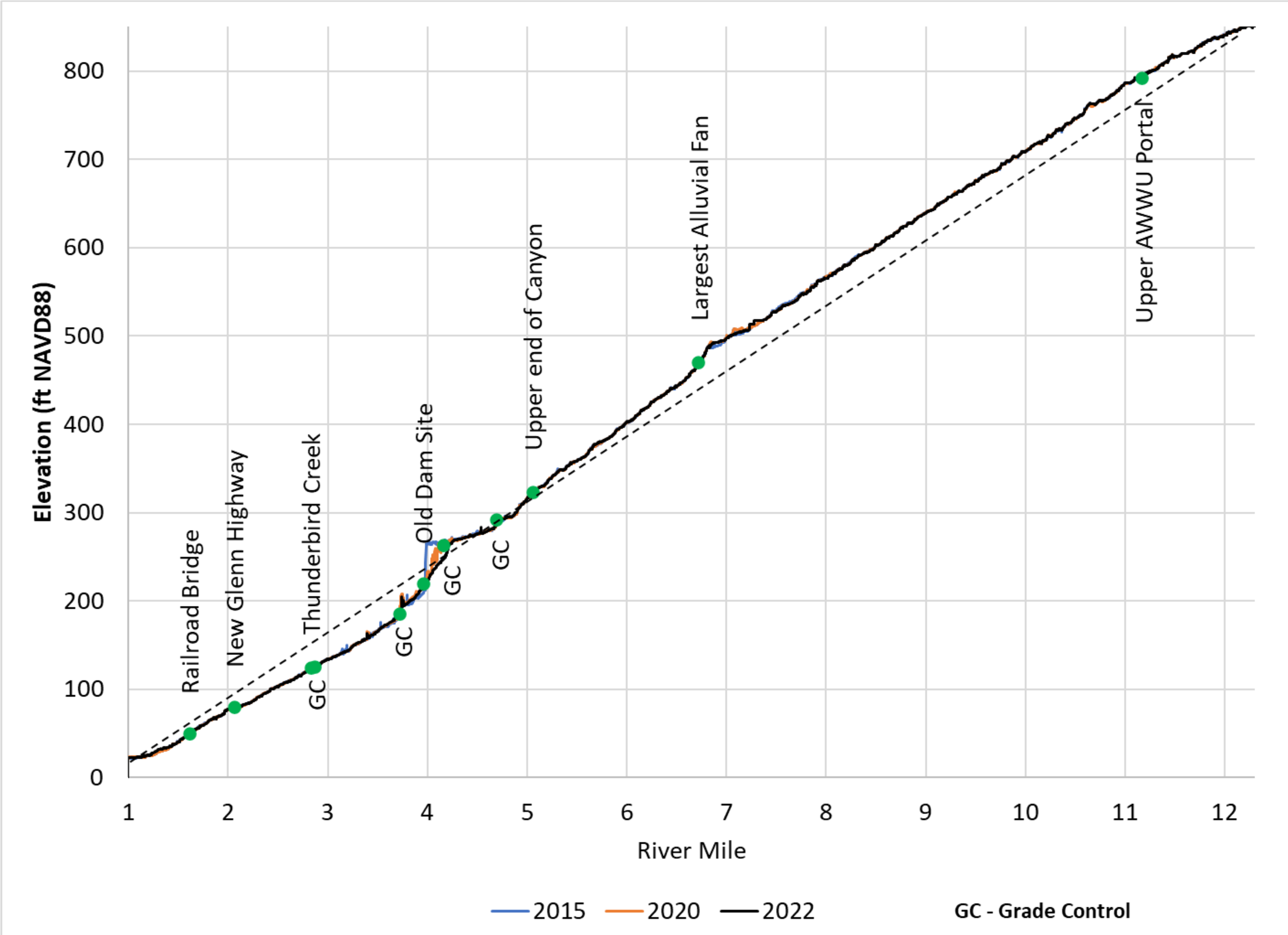


Figure 6.1-1. Longitudinal Profile of the Eklutna River (2020 LiDAR).

6.2. River Channel Changes from 2021 Flow Release

The 2021 study flow releases resulted in changes to the Eklutna River channel, including transport of fine-grained sediment out of the old reservoir at RM 4, mobilization of the fine-grained veneer upstream from Thunderbird Creek, and mobilization of the gravel substrate in many areas of the channel as described in the 2021 geomorphology and sediment transport report. Comparison of the 2015, 2020, and 2022 LiDAR showed several areas of channel change as the flows mobilized substrate.

6.2.1. Erosion of Alluvial Fan Deposits

A new stream channel was eroded through the toe of several of the alluvial fans that had been encroaching on the channel between RM 6-12. **Figure 5.4-2**, above, shows the toe of the source area 3 fan eroded between RM 11.2-11.3 and **Figure 5.4-3** shows erosion of a new channel between RM 6.7-6.8. These are the locations of two of the geomorphic monitoring transects that showed major changes (transects B and E, **Figure 5.3-53** and **Figure 5.3-41** above, respectively).

6.2.2. Old Reservoir Deposits (RM 4) and Downstream Channel

The fine-grained sediments that had accumulated in the old RM 4 reservoir were mobilized and a large volume was transported downstream prior to the 2021 study flow release (**Figure 6.2-1**) and during the 2021 study flow release (**Figure 6.2-2**). Comparison of the 2020 and 2015 LiDAR surfaces showed erosion of the reservoir deposits up to approximately RM 4.18 with deposition in the channel between the old dam site and RM 3.5 (**Figure 6.2-1**). An estimated 52,000 cubic yards of material was transported out of the old dam site between 2018 when the dam was removed and 2020.

Comparison of the 2022 and 2020 LiDAR in the old reservoir showed additional transport of material out of the old reservoir, with erosion proceeding up to RM 4.21 (**Figure 6.2-2**). An estimated 30,000 cubic yards of material was transported out of the old reservoir area between 2020-2022. Based on observations on the time lapse cameras, much of the material moved out during the first few days of the 2021 flow release as channel incision and mass wasting of the fine-grained material occurred. Surveys of cross sections prior to and following the release confirm these conclusions (**Figure 5.3-17**, **Figure 5.3-19**, **Figure 5.3-21**, and **Figure 5.3-23** above). Changes in the channel downstream from the dam showed erosion of a new channel into the previously deposited sediment between RM 3.8-3.9, little change between RM 3.7-3.8, and aggradation from RM 3-3.7. These changes are consistent with observations in the channel during field work. Sediment accumulated in the tidally-influenced mouth of the Eklutna River downstream from the Railroad Bridge between 2020 and 2022 (**Figure 6.2-3**). This is also consistent with field observations of channel changes in this area and is likely the result of deposition of the finer-grained material moved out of the old reservoir area.

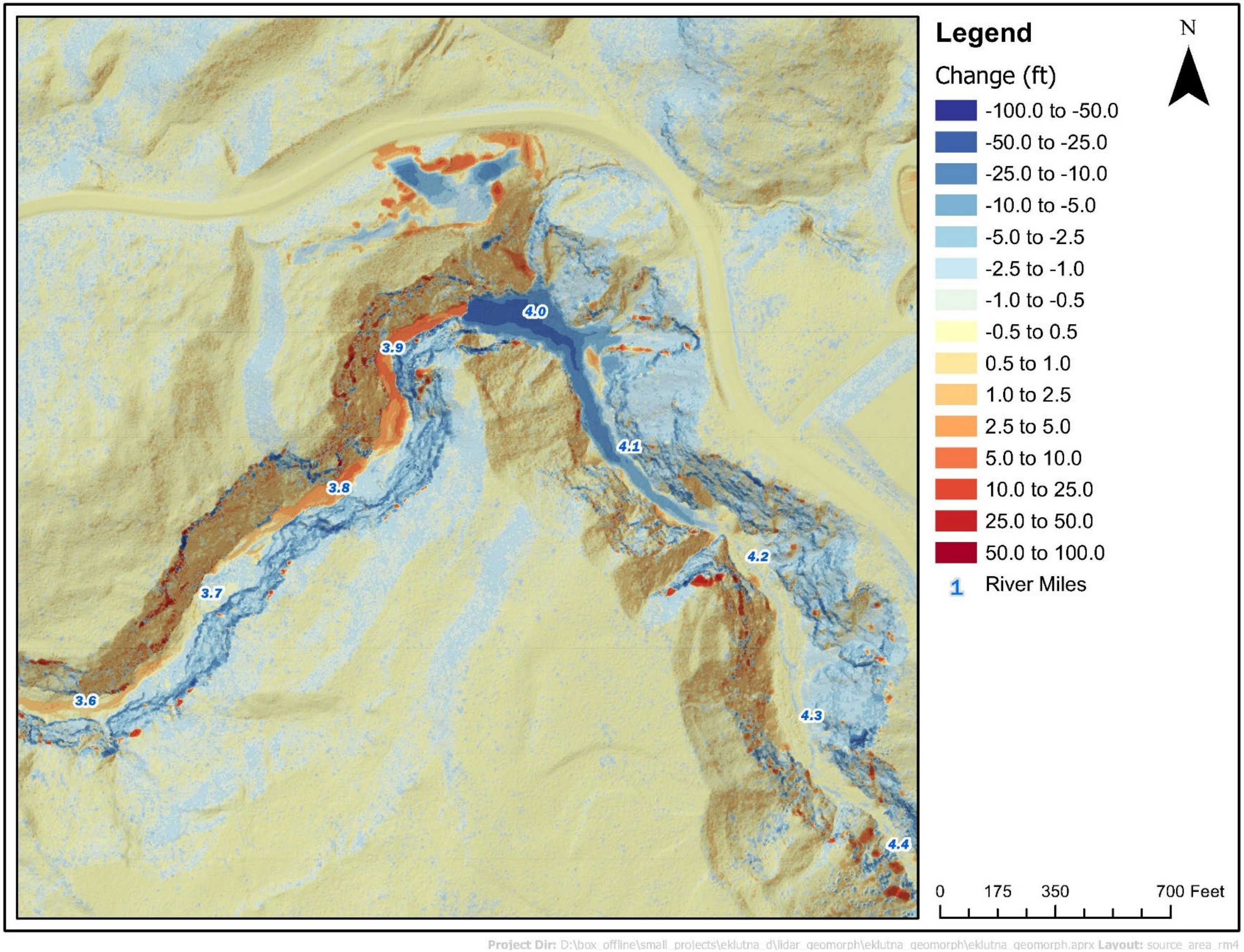


Figure 6.2-1. Comparison of 2020 minus 2015 LiDAR surfaces near Old RM 4 Dam.

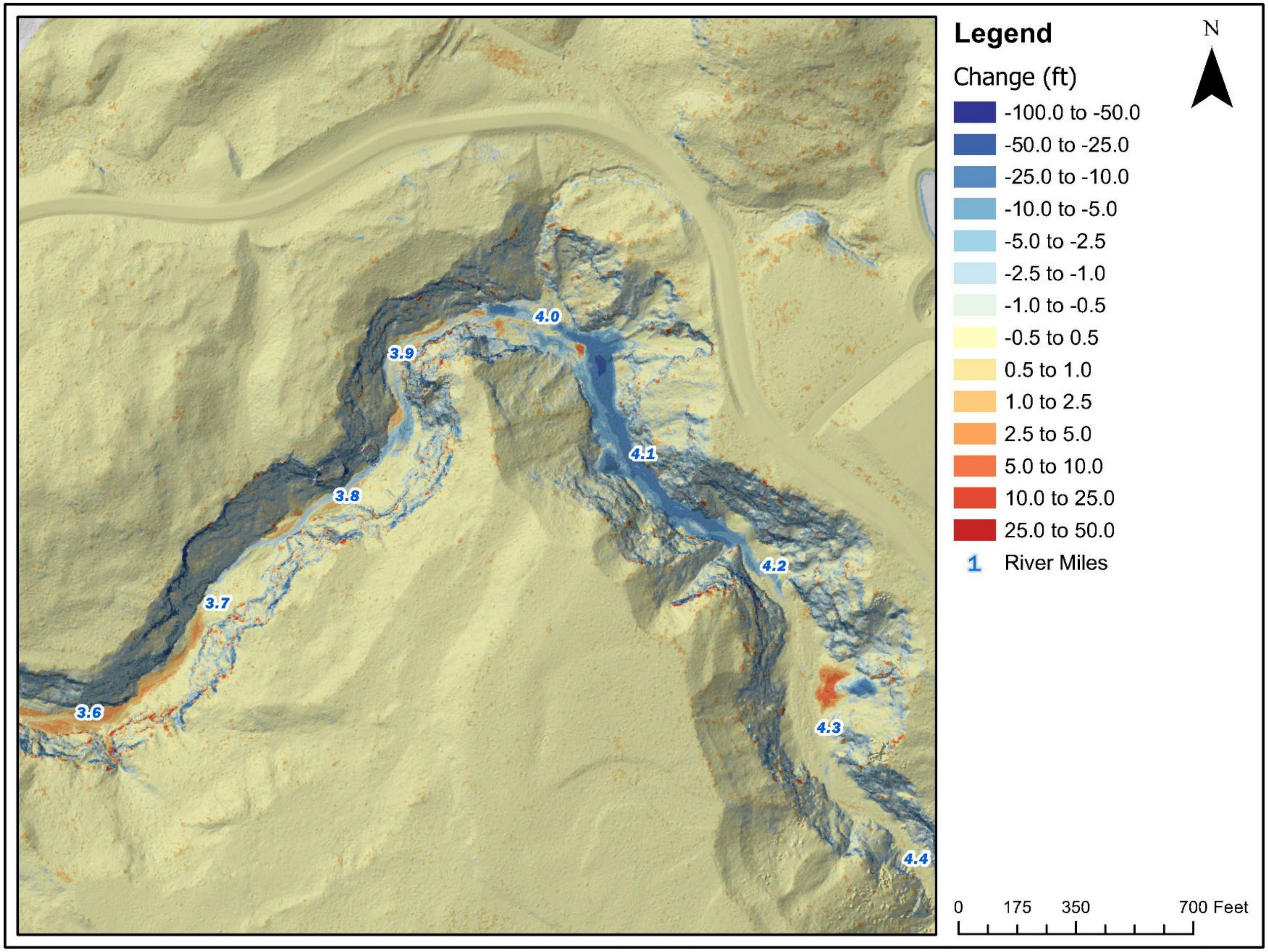


Figure 6.2-2. Comparison of 2022 minus 2020 LiDAR surfaces near Old RM 4 Dam.

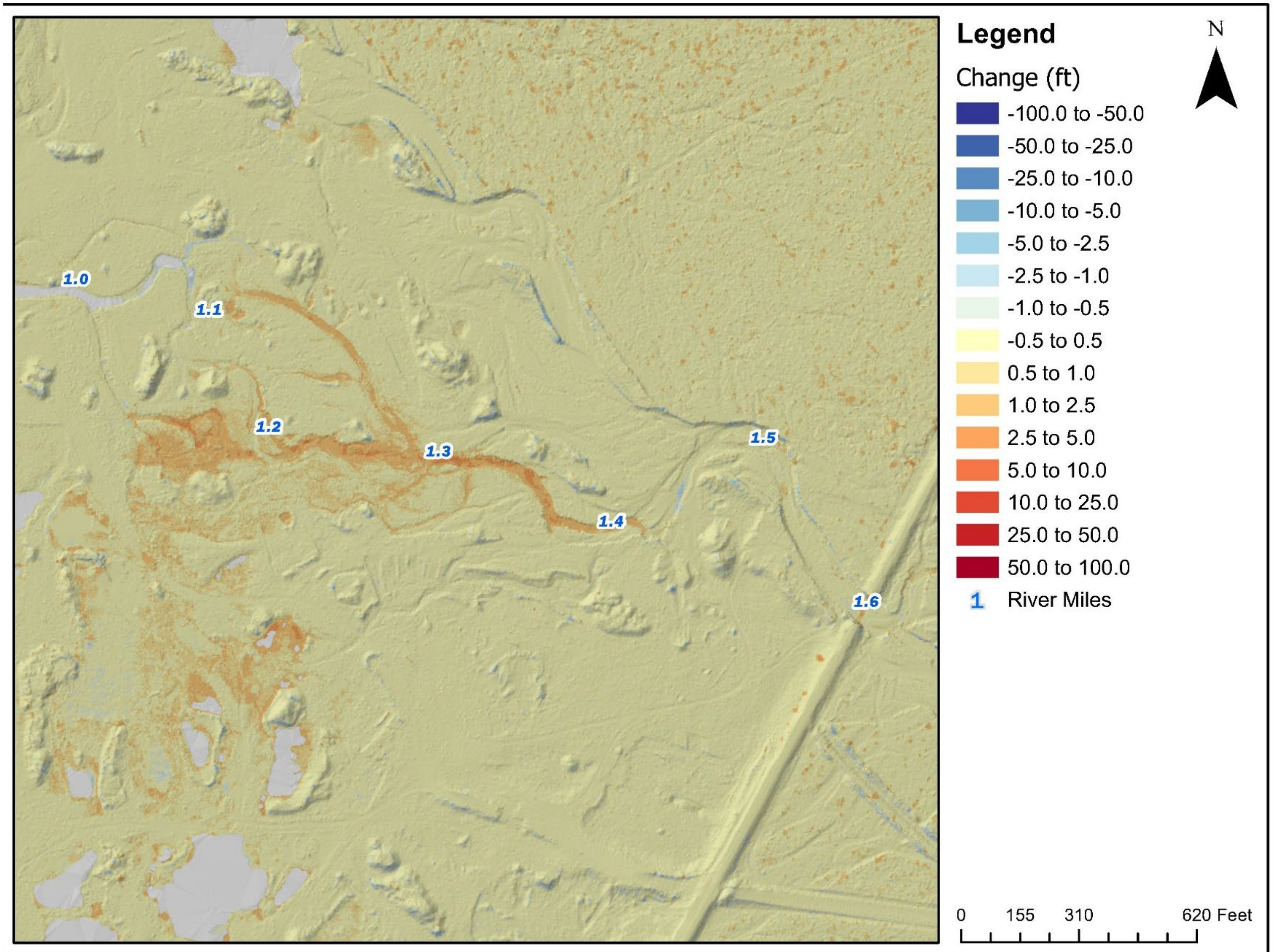


Figure 6.2-3. Comparison of 2022 minus 2020 LiDAR surfaces at mouth of Eklutna River (tidally influenced area).

6.2.3. Summary of Changes at Sediment Monitoring Transects

There were many changes in the Eklutna River as a result of the 2021 study flow releases including erosion and deposition within the channel, transport of sediment up to 128 mm in size, and erosion of alluvial fans and sediment that was stored in the old lower reservoir (Table 6.2-1).

Table 6.2-1. Summary of 2020-2021 channel changes, accelerometer, and sliding bead scour monitor data.

Transect ID	River Mile (RM)	Geomorph Reach	Transect Changes	Sliding Beads	Accelerometer	Comments
101	1.6	2	Up to 1 foot deposition on edge of bar and 1 foot deeper channel	Not recovered, scoured out	Not recovered, scoured out	Gravel substrate
G	2.15	2	Up to 1 foot of deposition (gravel) in channel	2020 – 3 inches of erosion 10 inches of deposition during flow release	Not recovered, buried 0.6 feet in gravel	Gravel substrate; coarsening during flow release
ADFG 8 Down	2.9	4	Up to 1 foot of deposition following dam removal; up to 0.5 foot of erosion during flow release	2020 – 6 inches of erosion 4 inches of scour and fill during flow release	n/a	
ADFG 6 Down	3.3	4	Up to 0.5 foot of deposition following dam removal; up to 2 feet of deposition during flow release	6 inches of scour, 1 foot of subsequent deposition	n/a	
ADFG 2 Down	3.8	4	Up to 4 feet of deposition following dam removal; up to 1 foot of deposition in 2019 and up to 1 foot of deposition followed by 1-2 feet of erosion during flow release	Not recovered, scoured out	Exposed; movement recorded 9/14-9/29 2021	Gravel substrate
204	4.0	5	2-3 feet of deposition then 4 feet of erosion during flow release	n/a	n/a	Gravel substrate

Transect ID	River Mile (RM)	Geomorph Reach	Transect Changes	Sliding Beads	Accelero meter	Comments
203	4.05	5	Up to 30 feet of erosion of stored sediment; thalweg erosion 3 feet	n/a	n/a	Fines on banks, rubble in channel
202	4.1	5	Up to 14 feet of erosion of stored sediment; thalweg erosion 2 feet	n/a	n/a	Fines on banks, rubble in channel
201	4.15	5	Up to 14 feet of erosion of stored sediment; thalweg erosion 9 feet	n/a	n/a	Sand on banks, gravel and cobble in channel
ADFG 4 Up	4.4	5	Up to 1 foot of erosion in channel	5.5 inches of erosion followed by 2 inches of deposition	Exposed; movement recorded 9/14-9/25 2021	Gravel substrate
102	5.3	7	Little change	No change	n/a	Gravel substrate
F	5.4	7/8	Up to 0.5 foot of erosion in channel during 2020; cut and fill of up to 1 foot during flow release	9 inches of erosion in 2020	n/a	Fine sediment
103	6.3	8	Up to 1 foot of erosion in channel during flow release	Not recovered; scoured out	Buried 1 foot; movement started 9/13	Accelerometer indicates total channel scour may have been 2 feet followed by 1 foot of fill.
E	6.6	8	Up to 1 foot deposition in left bank channel; new right bank channel with 2 feet of erosion	Buried 1 foot	n/a	Toe of alluvial fan sediment source cut during flows – new right bank channel
D	7.1	9	Up to 1 foot of deposition	n/a	n/a	Beaver pond inundated transect in 2020 and 2021
105	10.5	9	Overbank deposition and up to 1.5 feet of erosion in channel	n/a	n/a	Fine sediment
C	11.15	9	Up to 05 feet of erosion	n/a	n/a	Fine sediment in channel removed exposing underlying cobble/gravel
B	11.2	9	Up to 3 feet of erosion	n/a	n/a	Toe of alluvial fan sediment source eroded during flow; fines in channel removed exposing underlying cobble/gravel

Transect ID	River Mile (RM)	Geomorph Reach	Transect Changes	Sliding Beads	Accelero meter	Comments
Painted Rocks	11.3	9/10	n/a	n/a	n/a	Painted rocks – 32 mm size moved; deposition of gravel in other areas
A	11.8	10	Minor changes	n/a	n/a	Cobble/boulder in main channel – few changes. Likely representative of old channel conditions.

6.3. Sediment Transport Modeling of Example Flow Scenarios

The following flow scenarios are just example flows so decision makers can see how the model can be used and the sensitivity of the model to different flow levels and are not intended to recommend any particular flow release scenario(s).

As an example of how the models developed for the Eklutna River can be used, several initial potential flow scenarios were run through the 1D HEC-RAS sediment transport model to help bracket the effects of potential baseflow and peak flow conditions on sediment transport in the Eklutna River (Table 6.3-1). Two types of results are discussed in the following sections:

- Grain size mobility calculated based on shear stress under a specific flow release. These results show the theoretical size of substrate that the flow release could mobilize at the different transect locations along the river. These results do not integrate sediment input, transport, and bed armoring that would take place over time under a flow scenario but do provide information on the size of particles that could be mobilized and removed from the riverbed. These results were prepared for the 1-D model output for the entire river (Section 6.3.1.1) and the 2-D model output for the four detailed analysis reaches (Section 6.3.2)
- Predicted substrate median (D_{50}) grain size on the bed of the river following a long-term flow release scenario (for example, following 20 years of flow releases) that integrates sediment input from source areas, sediment transport, and re-deposition on the riverbed. These results show the predicted substrate following a long-term flow release scenario and are available using the 1-D model (Section 6.2.1.2)

The 1-D sediment transport model can be run for short or long periods of time and can integrate long-term effects of various baseflow/peak flow combinations. Peak flows of 300 cfs and 1,000 cfs were also run using 2-D hydraulic model output at the four 2-D locations. 2-D output is a snapshot in time type of analysis showing the hydraulic conditions under a specific flow rather than a long-term model integrating various flow conditions.

Table 6.3-1. 1-D Sediment Transport Model Initial Flow Scenarios Analyzed

Condition	Flow Release(cfs)
Baseflows	25
	50
	75
	100
	125
Controlled Peak flow (72 hours)	300
	500
	1,000
	1,500
Uncontrolled September peak flow (500 cfs peak, approximately 30 days of spill)	500 (varies from 1 to 500 cfs over 30-day spill)
20-year baseflow/peak flow scenario as an example of a long-term scenario	Instream flow Release Option A (water release at dam), Flow Level 2 (48 cfs November through June, 30 cfs July through October)with a 500 cfs 72-hour peak flow release every 3 years

Note that additional flow scenarios can be run using other flows and various combinations of baseflows and peak flows as well as different flow release points; these results bracket the range of flows that can be reasonably modeled with existing calibration data.

Model results in the following sections are displayed to show how potential future peak flows can affect river substrate because substrate is an important component of fish habitat that can be affected by peak flows, and one of the primary habitat factors that can change in the future. Anadromous fish, depending on the species, prefer clean gravel and cobble-sized substrate for spawning and fry use interstitial spaces between cobbles for hiding. Substrate preferences for the Eklutna River used as part of the fisheries/instream flow modeling show particles between 2-128 mm are preferred by coho and sockeye; larger Chinook prefer 16- 256 mm particles (Table 6.3-2).

Table 6.3-2. Preferred Spawning-sized Substrate for Eklutna Anadromous Fish Used for Instream Flow Modeling.

Substrate Category	Grain Size (mm)	Coho and Sockeye Spawning Habitat Suitability Curve (HSC) Preference	Chinook Salmon Habitat Suitability Curve Preference
Fines	<2	0	0
Small Gravel	2-16	0.74	0
Large Gravel	16-64	1	0.41
Small Cobble	64-128	0.7	1
Large Cobble	128-256	0	0.5
Boulder	>256	0	0
Bedrock		0	0

Note: HSC preference is on a scale of 0 to 1 with 0 = not preferred; 1 = highly preferred.

As discussed in Section 5.1.1, the NVE collected information on substrate in 2019, prior to the 2021 study flow releases (Figure 5.1-1, above). These data show that spawning-sized substrate (large gravel, cobble) dominates the stream between RM 1.4 (just downstream from the Railroad Bridge) and Thunderbird Creek. This is the same area where the majority of salmonid spawning has been observed. Between Thunderbird Creek and the Old Dam Site, gravel dominates the substrate. Between the upstream end of the canyon and the largest alluvial fan, sand and boulders dominate the substrate, with a mix of boulders and accumulated silt and clay up to the AWWU portal. There are few areas dominated by gravel and cobble, which indicates that areas with preferred spawning substrate may be limited. Based on transect measurements of grain size following the 2021 study flow releases, some of the silt and clay has been transported out of the upper valley and old reservoir area, which can improve aquatic habitat conditions. If instream flows are part of the future Fish and Wildlife Program for the Project, then changes in substrate will occur as the river adjust to a new flow regime. Evaluating a flow regime that will move fines out of the river without flushing spawning-sized gravel is one goal of the sediment transport modeling.

6.3.1. 1-D Sediment Transport Model Example Scenarios

6.3.1.1. Peak Flow Release Scenarios

Peak flow releases of 72 hours (3 days) were modeled using the 1-D sediment transport model for demonstration purposes. Initially, a sample 500 cfs uncontrolled flow release (spill event) was modeled for comparison with the controlled 72-hour flow release. The 500 cfs uncontrolled release was based on releasing flow over the spillway and was computed based on average daily inflow during September with the aim of hitting 500 cfs with natural inflow and then reducing spill as fast as possible, resulting in some spill for 30 days (**Figure 6.3-1**). A realistic high flow release could mimic a natural high flow hydrograph which would include a sharp increase from base to peak flow and a gradual decrease back to base flow conditions. Various alternative release scenarios can be run as needed as well as different flow release locations.

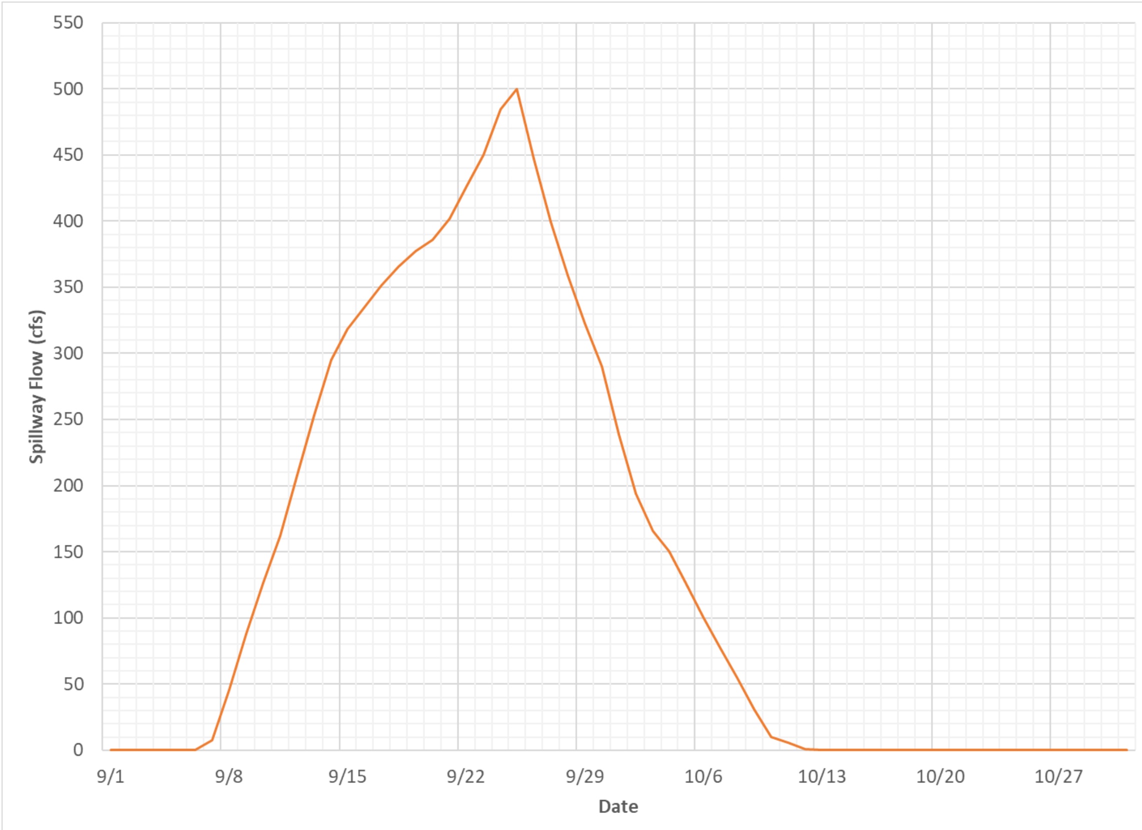


Figure 6.3-1. Calculated 500 cfs Uncontrolled (spillway) Flow Release Pattern Based on Average Daily Flow in September.

Predicted grain size mobility based on computed shear stress under different base and peak flows are shown in **Figure 6.3-2** and **Figure 6.3-3**, respectively (these data, along with mass capacity, are included in Appendix 1). The range of base flows is predicted to be capable of mobilizing the smallest-sized preferred spawning substrate upstream from approximately RM 5, with larger base flows mobilizing larger particles. The 2021 study flow release of 150 cfs mobilized material up to 128 mm in diameter at most of the sediment monitoring transects, consistent with the HEC-RAS model results. Note that between the New Glenn Highway Bridge and Thunderbird Creek little cobble/gravel mobilization is predicted. This is consistent with the location where the majority of salmonid spawning occurs under current conditions and suggests that spawning-sized gravel in this area is relatively stable, allowing embryos to develop without being scoured.

Under the modeled peak flow scenarios, particularly the highest peak flow scenarios, much of the spawning-sized substrate upstream from approximately RM 5 is predicted to be capable of being mobilized and the finer-grained spawning substrate would be mobilized downstream from RM 5 (**Figure 6.3-3**). Again, the most stable spawning-sized substrate is between the New Glenn Highway Bridge and Thunderbird Creek as well as in the canyon area.

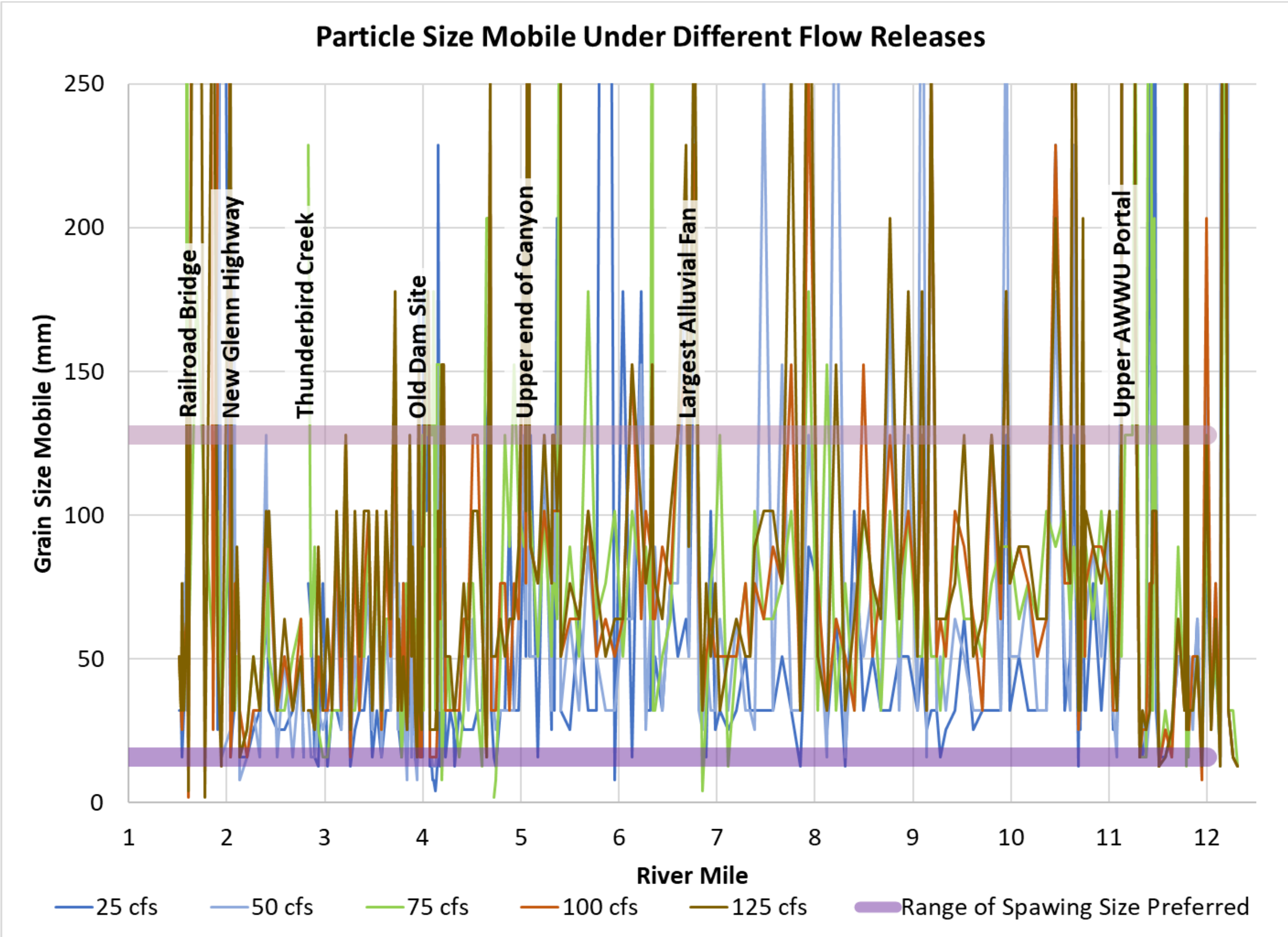


Figure 6.3-2. Eklutna River Grain Size Mobility under Base Flow Release Scenarios and Preferred Salmonid Spawning Range

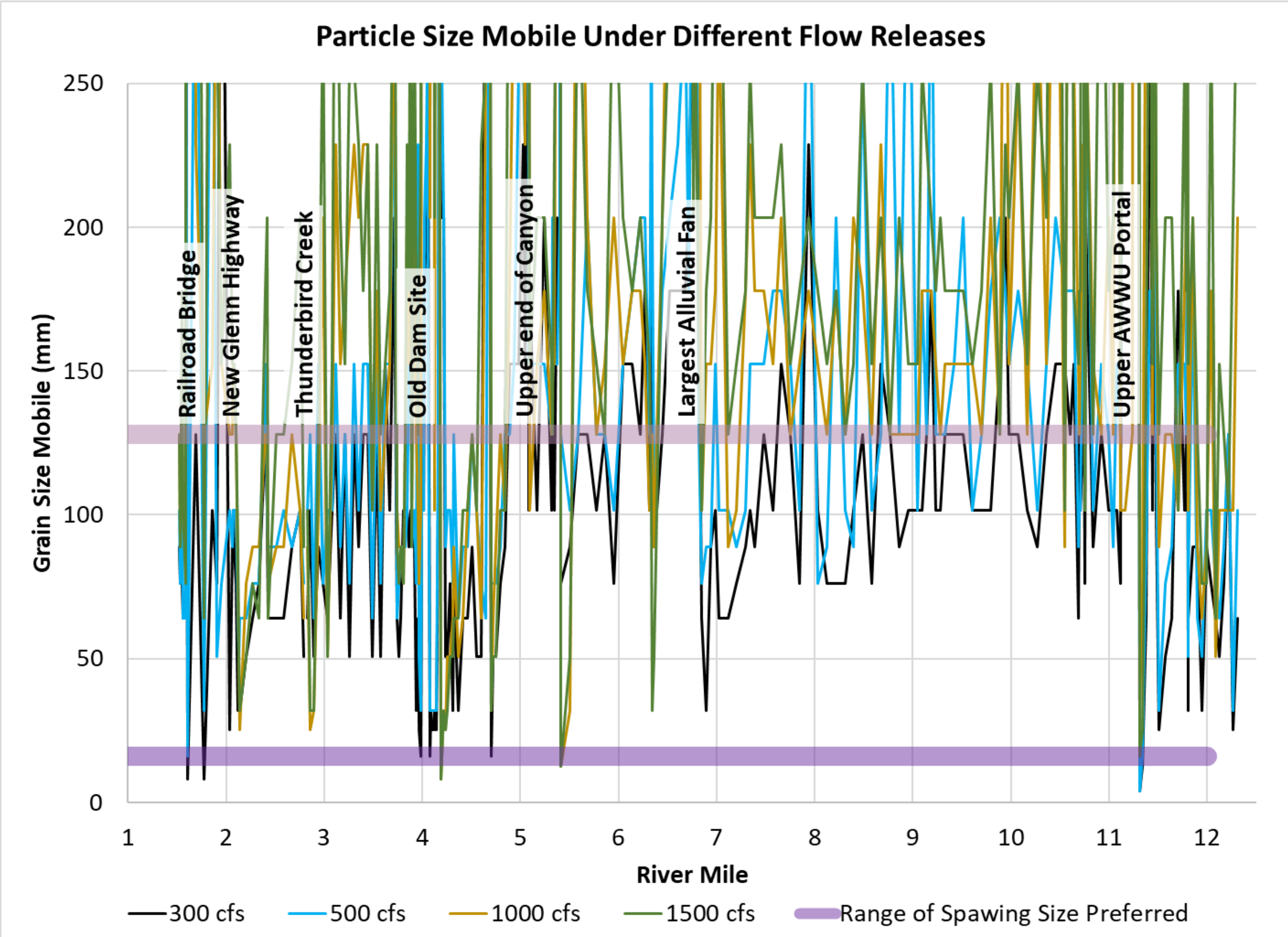


Figure 6.3-3. Eklutna River Grain Size Mobility under Peak Flow Release Scenarios and Preferred Salmonid Spawning Range

Figure 6.3-2 and **Figure 6.3-3** show the calculated grain size predicted to be capable of being mobilized under a given flow; actual transport rates depend on duration of flow as well as the mix of grain sizes on the riverbed at a particular location. To test how substrate would respond to short-duration peak flow events (72-hour release) in conjunction with the estimated sediment input from the mapped sediment sources, model runs with short-duration peak flows were run. The goal of these short-term flows would be to mobilize the substrate but not last long enough to flush it out of the river. **Figure 6.3-4** shows the predicted median (D50) grain size of the substrate following short-term peak flow releases of various magnitudes (as well as base flow scenarios for comparison). The model results suggest that peak flows of 300 to 500 cfs would achieve the objective of moving substrate but not flushing spawning-sized gravel from the system. However, larger peak flows, such as 1,000 cfs, appear to move more of the preferred spawning-sized substrate between Thunderbird Creek and the Old Dam site and upstream of approximately RM 9 suggesting that long-term flows of higher duration may flush spawning-sized sediment out of the river.

A comparison of a 500 cfs controlled 72-hour release with a 500 cfs uncontrolled flow release (see **Figure 6.3-1** for uncontrolled release flow levels) shows that more substrate is mobilized during the longer duration uncontrolled flow release, and ending grain size is large in some locations, but not all spawning-sized substrate is flushed from the river (**Figure 6.3-5**).

6.3.1.2. Long-term (20-Year) Release Scenario

One long-term (20-year) model run was made using Instream Flow Release Option A (release at the dam) with Flow Level 2 (30-48 cfs release providing 70% habitat maxima) with a 72-hour 300 cfs peak flow every 3 years as an example of how the HEC-RAS model can be used to evaluate long-term flow conditions. At the end of the 20-year run, substrate in several reaches of the river had coarsened substantially (**Figure 6.3-6**).

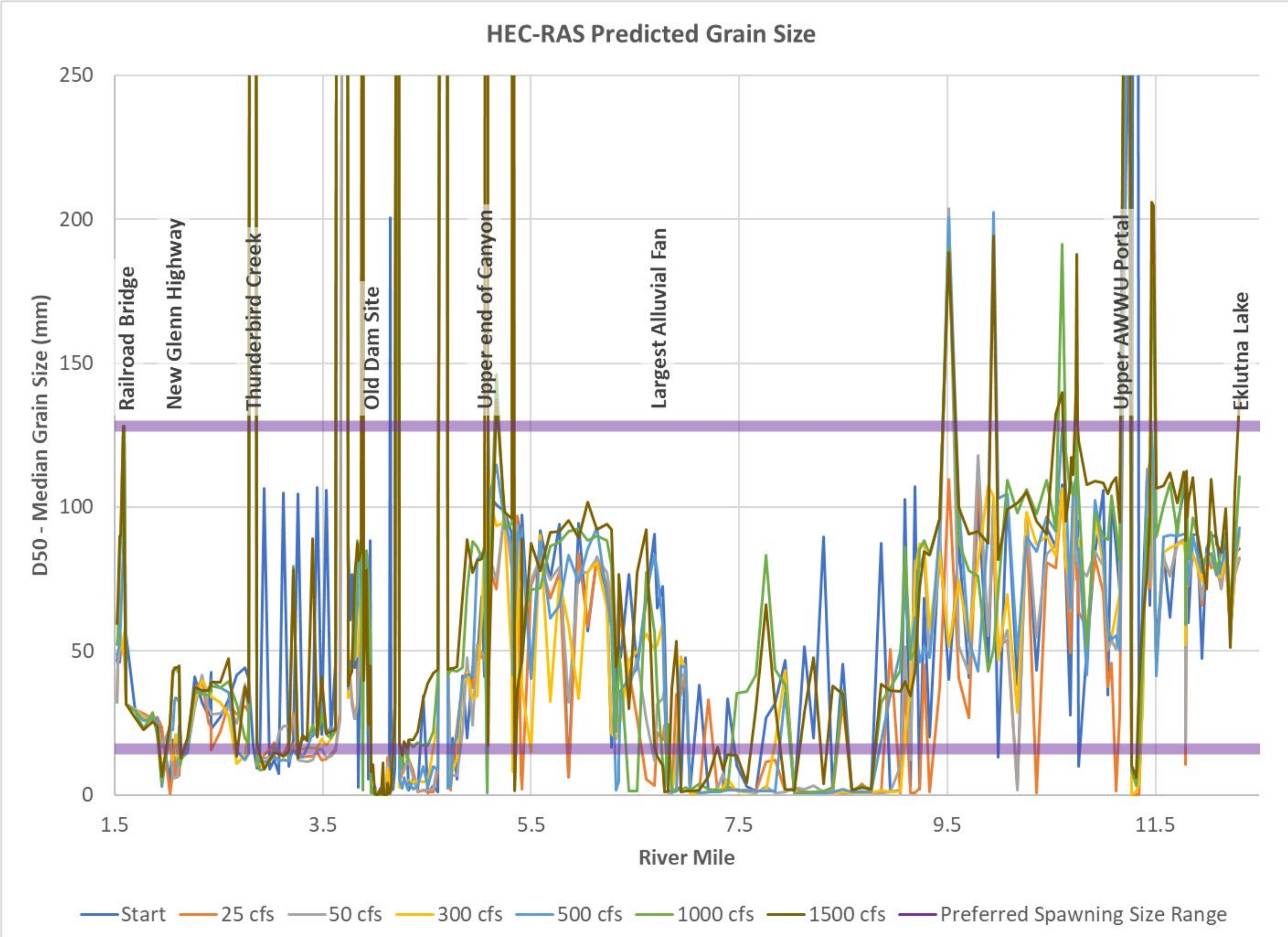


Figure 6.3-4. Eklutna River HEC-RAS Predicted Grain Size Following Different Release Scenarios (72-hour duration) and Preferred Salmonid Spawning Range

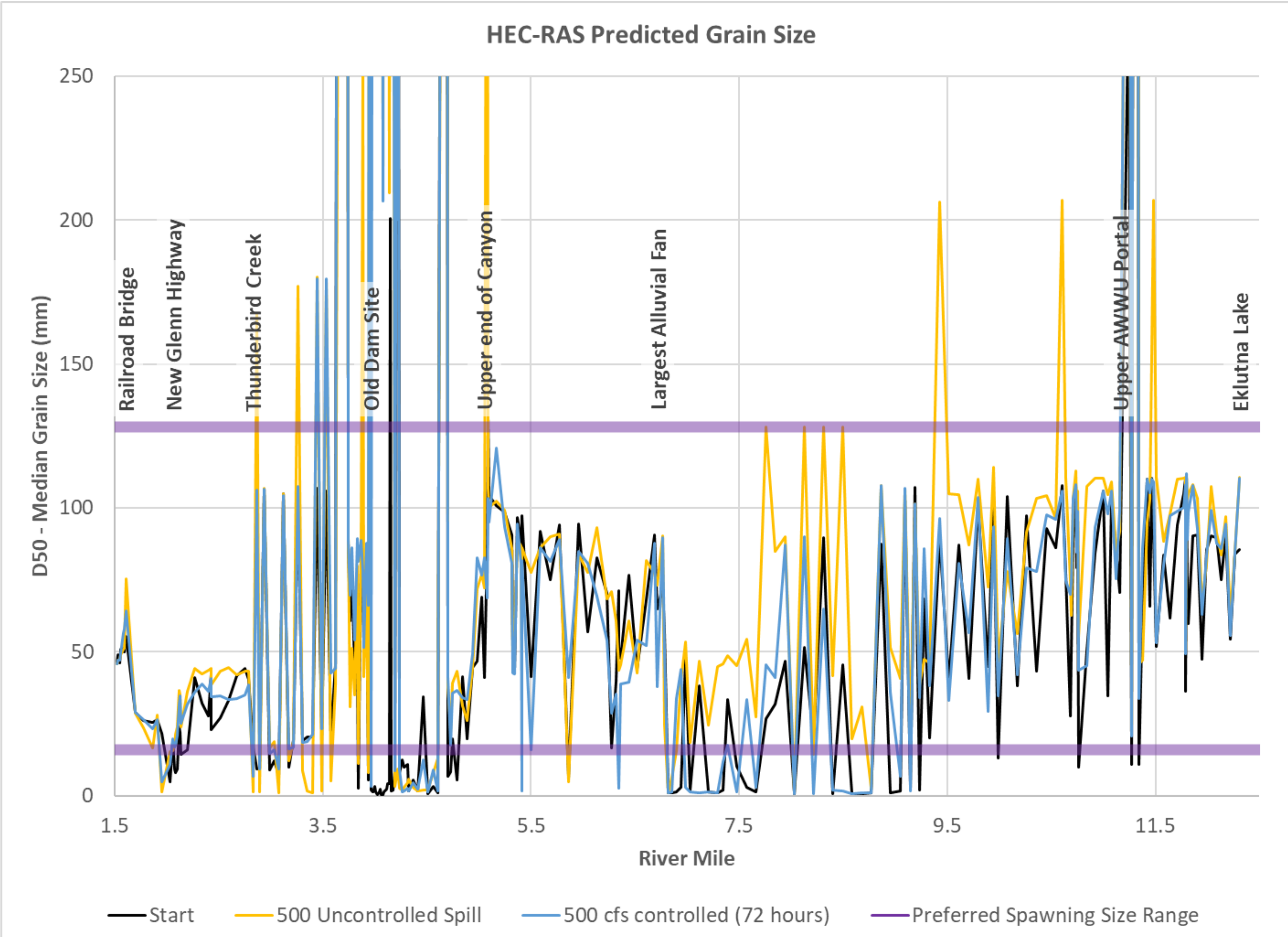


Figure 6.3-5. Eklutna River HEC-RAS Predicted Grain Size Following Controlled and Uncontrolled 500 cfs Flow and Preferred Salmonid Spawning Range

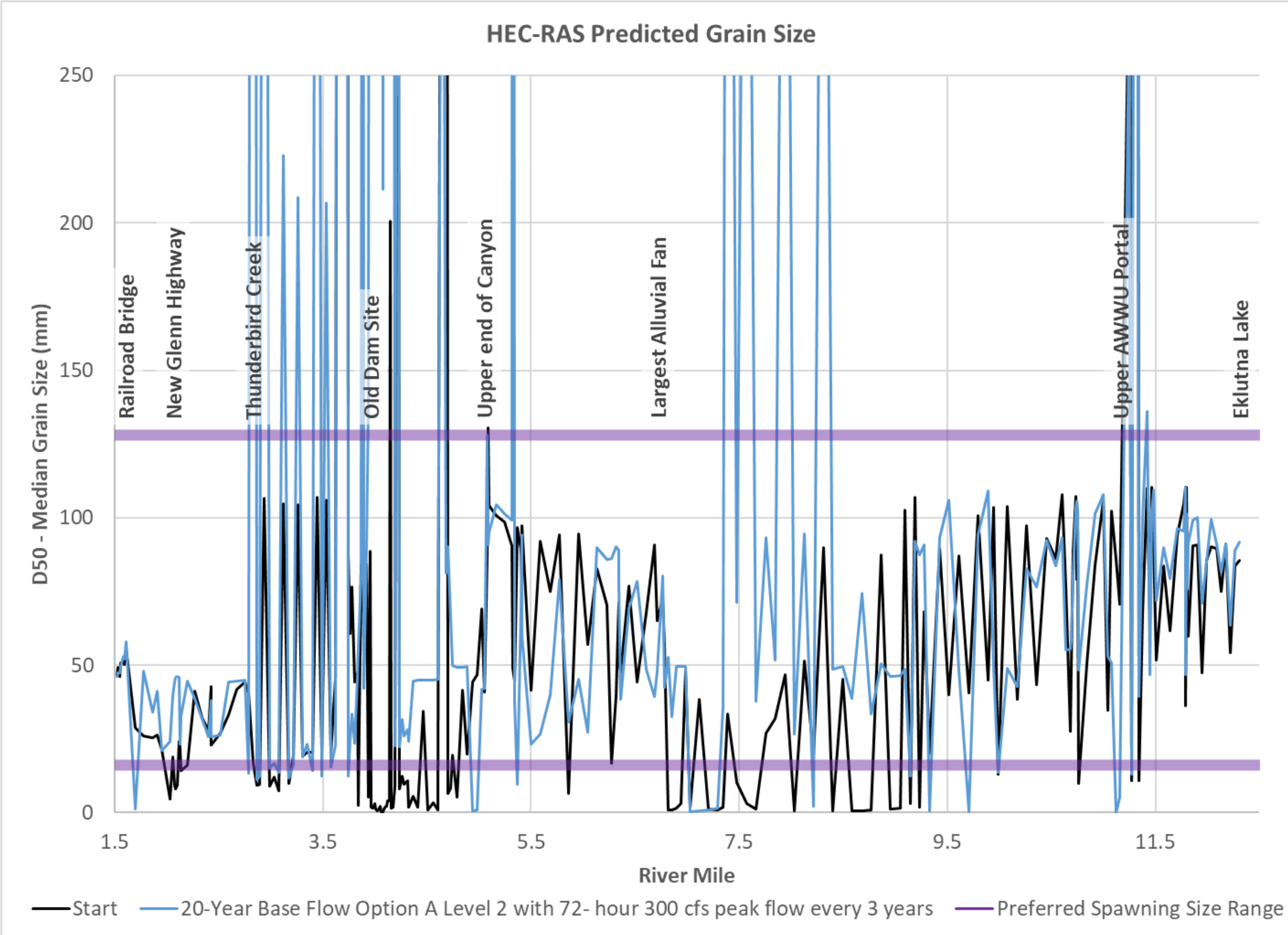


Figure 6.3-6. Eklutna River Predicted Grain Size Following 20-year Base Flow Option A, Level 2 with 72-hour 300 cfs peak every 3 Years.

6.3.2. 2-D Hydraulic Model

The 2-D hydraulic model output was used to compute grain size mobility for the four different detailed analysis areas for bounding high flow values of 300 and 1,000 cfs.

Analysis area 3 is in the tidally-influenced, low-gradient area downstream from RM 1.5. This area is primarily a deposition zone as shown in the modeling, with only the finest grain size classes predicted to be mobilized in all but the upstream-most part of the main channel even under the 1,000 cfs flow conditions (**Figure 6.3-7**).

Analysis area 4 is between the Railroad Bridge and the New Glenn Highway Bridge, often referred to as the "flooded forest." Flow in this area follows multiple flow paths, with a primary channel down the center of the area and a secondary channel to the south (**Figure 6.3-8**). In the main channel, material in the gravel-cobble size is predicted to be mobilized under a 300 cfs flow and gravel-boulder (in some spots) under a 1,000 cfs flow. Gravel is predicted to be mobilized in the secondary channel under both flow scenarios and fine material in most overbank areas.

Analysis area 6 is at RM 3, in the confined canyon just upstream from the Thunderbird Creek confluence. In this area, flow of 300 cfs is predicted to mobilize 64-512 mm material in the center of the channel and flow of 1,000 cfs is predicted to mobilize 256-512+ mm material (**Figure 6.3-9**).

Analysis area 10 is located near RM 8 in the upper, less-confined Geomorphic Reach 9. This area showed evidence of braiding/multiple channels in the 1952 aerial photographs and shows a multiple channel pattern in the 2-D model results for 300 cfs and 1,000 cfs flows (**Figure 6.3-10**). In the main part of the channel, the model predicts that grain sizes of 16-128 mm would be mobilized under 300 cfs flow release, and 64-512 mm would be mobilized under a 1,000 cfs release.

Based on hydraulic modeling, higher peak flows are predicted to mobilize cobble and larger material in the main channel areas; this is consistent with the observed underlying substrate in main channel areas, representative of substrate in the former riverbed prior to out of basin water withdrawal from Eklutna Lake. Any future flow release scenarios should consider the low-flow channel location and preferred substrate size in relation to peak flow release levels.

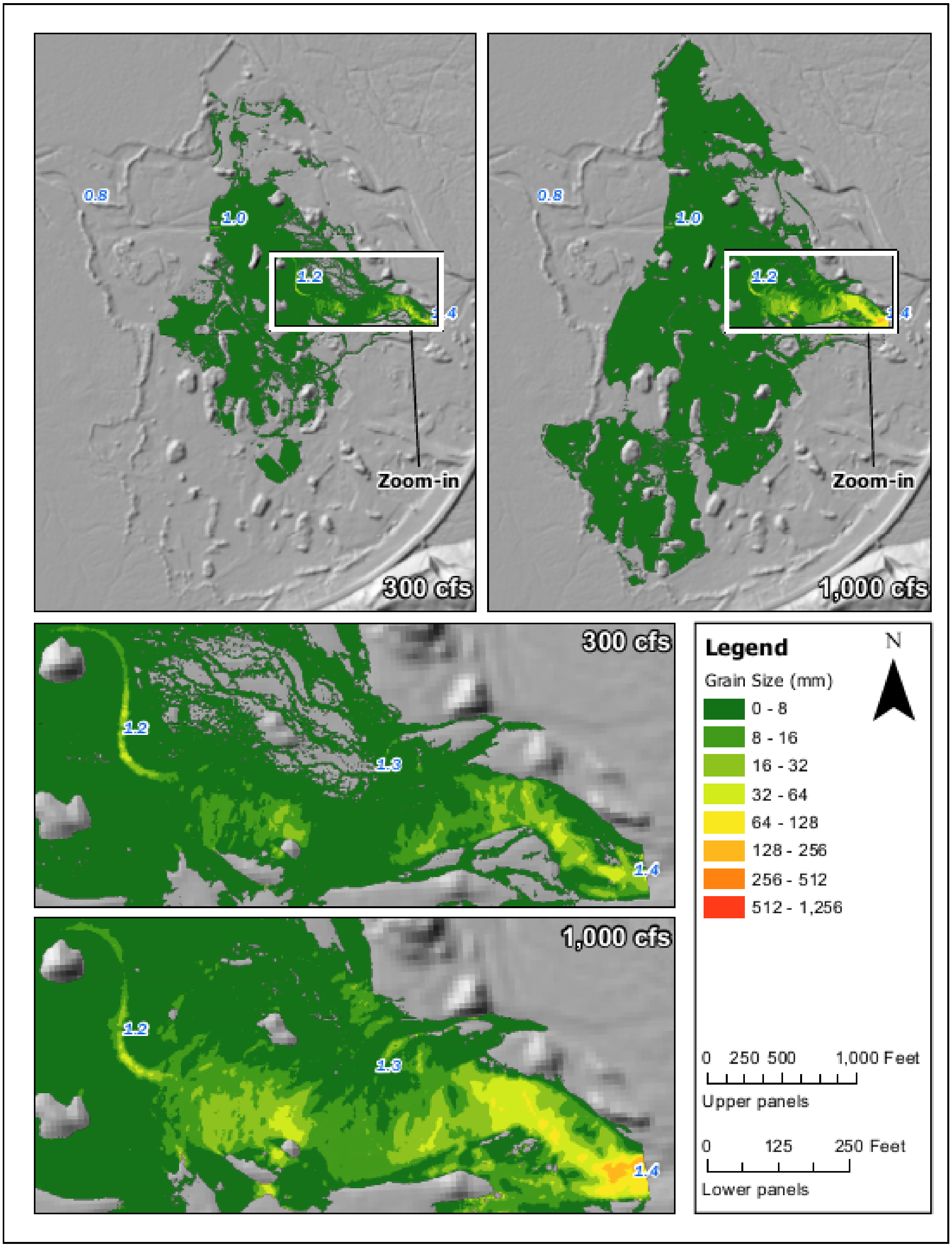


Figure 6.3-7. Eklutna River Grain Size Mobility Results from the 2-D Hydraulic Model, Analysis Areas 3 for flow of 300 cfs and 1,000 cfs.

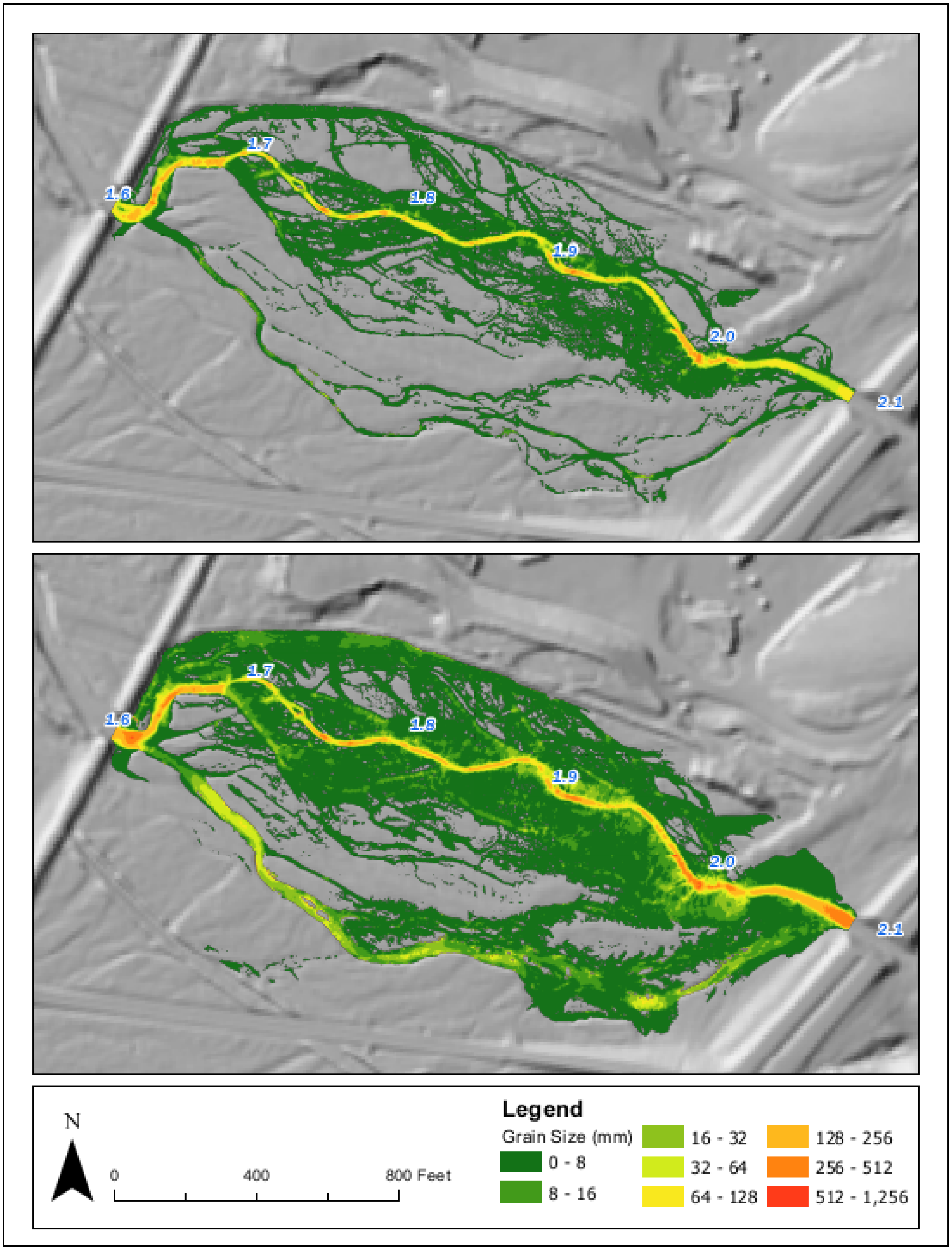


Figure 6.3-8. Eklutna River Grain Size Mobility Results from the 2-D Hydraulic Model, Analysis Areas 4 for flow of 300 cfs (top) and 1,000 cfs (bottom).

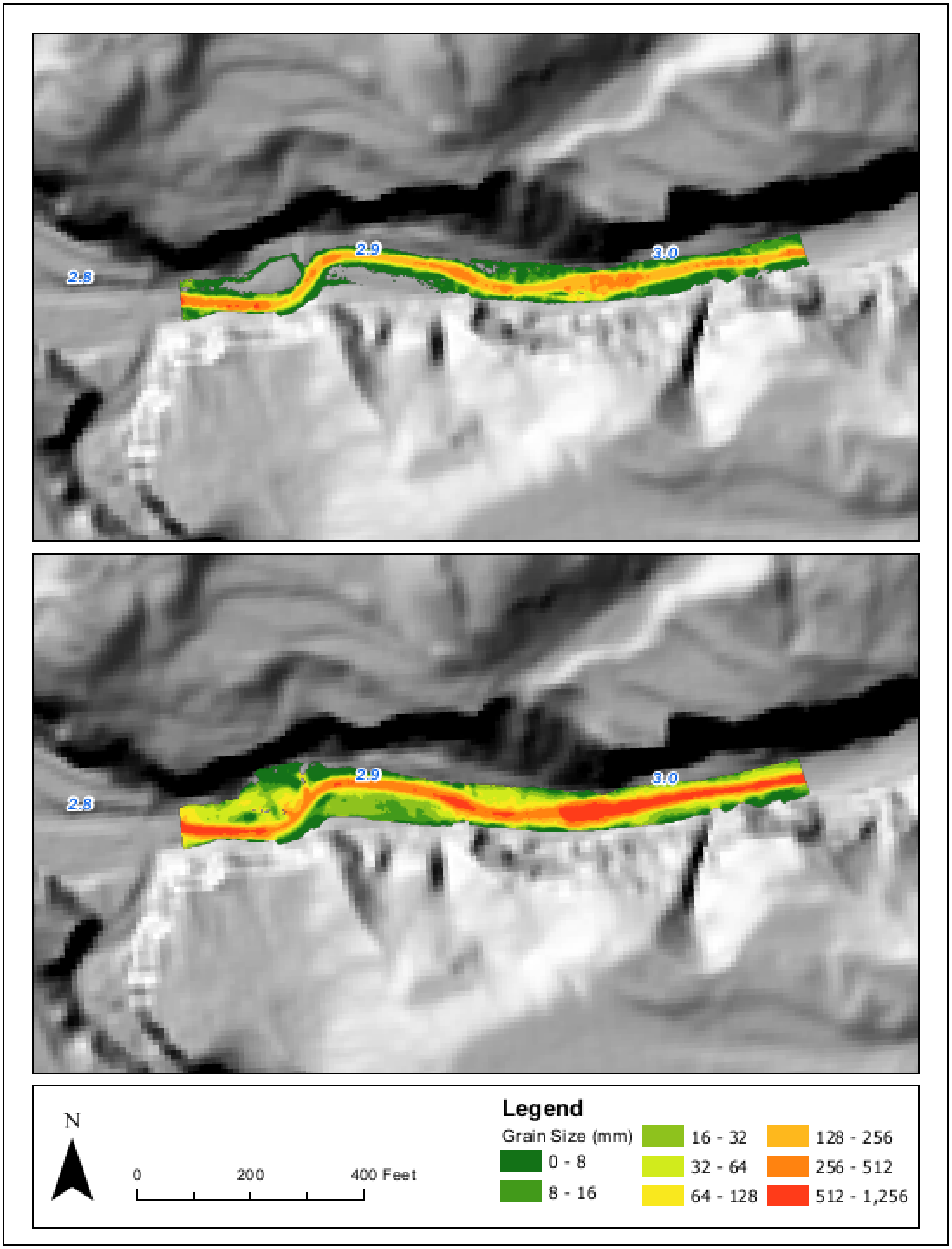


Figure 6.3-9. Eklutna River Grain Size Mobility Results from the 2-D Hydraulic Model, Analysis Area 6 for flow of 300 cfs (top) and 1,000 cfs (bottom).

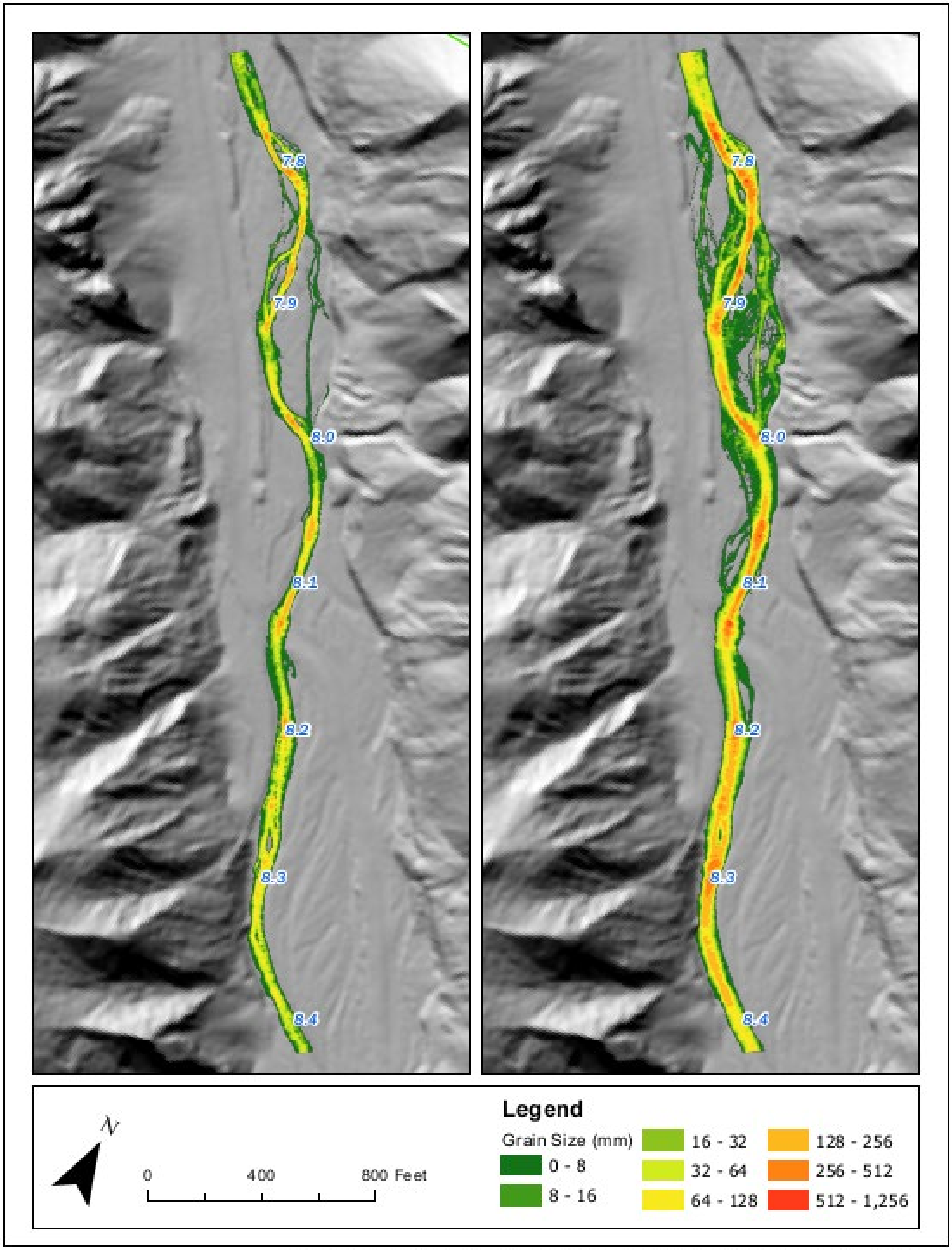


Figure 6.3-10. Eklutna River Grain Size Mobility Results from the 2-D Hydraulic Model, Analysis Area10 for flow of 300 cfs (left) and 1,000 cfs (right).

7 VARIANCES FROM FINAL STUDY PLAN

One variance from the methodology outlined in the study plan took place in the geomorphology/sediment transport study:

1) Three timelapse cameras were installed in the old lower reservoir area to gather data on changes to stored sediments during the study flow releases (Section 4.2.4).

In accordance with the provisions of the Geomorphology and Sediment Transport Study Plan, a high calibration flow was not implemented because data collected during the 2021 study flow releases was sufficient to calibrate the HEC-RAS sediment transport model and evaluate sediment transport effects of potential higher flows (Section 4.6).

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Appendix 1. HEC-RAS Sediment Transport Model Results

The tables on the following pages list output from the Eklutna River HEC-RAS sediment transport model for each transect in the model at flows of 25, 50, 75, 100, 125, 200, 300, 400, 500, 750, 1000, and 1500 cfs flow. The sediment transport capacity data listed are also shown as a graphic in Figures 6.3-2 and 6.3-3 in the main report. NOTE that the HEC-RAS model is not a static model, but each cross-section changes through time as sediment is eroded and deposited within a cross section. The data listed below represents a snapshot in time; these values change through time as the riverbed adjusts as a result of flow and sediment inputs. These data are provided in response to a request by the U.S. Fish and Wildlife Service dated April 21, 2023, and subsequent discussions with USFWS staff.

- Shear stress (lb/sq ft)
- Sediment transport competence – expressed as the grain size (in mm) mobile under a given flow based on shear stress at the transect.
- Sediment transport capacity – expressed as Mass Capacity (ton/day)

			25 cfs				50 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
218986	12.31		0.170238	12.7	0.0000		0.1841939	12.7	0.0000
218747	12.27		0.3258136	16	0.0024		2.90E-01	16	0.0247
218509	12.22		0.5470702	32	0.0000		0.4907447	32	0.0502
218270	12.18		4.954337	355.6	0.0938		24.51951	1778	0.0491
218032	12.13		0.2338329	16	0.0427		0.1897893	12.7	0.0702
217793	12.08		0.7254983	50.8	0.2023		1.049621	76.2	0.0577
217555	12.04		0.4878148	32	0.1484		0.3657734	25.4	0.1556
217316	11.99		1.295274	88.9	0.2310		2.236213	152.4	0.1447
217078	11.95		0.1995534	12.7	0.2497		0.1759204	12.7	0.3460
216839	11.90		0.8719978	64	0.3229		0.9663862	64	0.3819
216601	11.86		0.4321475	32	0.4703		0.4200039	25.4	0.3945
215844	11.81		0.8264989	50.8	0.4999		0.751107	50.8	0.4127
215735	11.81		0.3241765	16	0.5972		0.4300713	32	0.4499
215619	11.80		3.259823	228.6	0.5910		2.631521	177.8	0.4562
215566	11.80		8.365983	512	0.5959		10.42699	762	0.4436
215514	11.79		0.3670776	25.4	0.6360		0.3859886	25.4	0.4791
215403	11.79		6.653336	457.2	0.6010		6.257751	457.2	0.4794
215186	11.77		0.7029311	50.8	0.6236		0.6992963	50.8	0.4782
214042	11.71		0.7421307	50.8	0.6449		0.8024563	50.8	0.4865
212898	11.64		0.3805157	25.4	0.7204		0.3569065	25.4	0.5477
211754	11.58		0.3233079	16	0.8239		0.3109837	16	0.5842
210610	11.51		0.2385844	16	1.0707		0.1956113	12.7	0.4492
210156	11.48		0.5745154	32	1.0858		1.991202	128	0.4564
209795	11.46		8.183941	512	1.0899		1.402389	101.6	0.4513
209466	11.44		0.4944539	32	1.0964		1.55274	101.6	0.4603
209017	11.42		3.944339	279.4	1.0792		0.6391559	32	0.4534
208322	11.38		0.3352539	25.4	1.0994		0.3218905	16	1.1320
207658	11.34		0.2706042	16	5.4924		0.5485002	32	2.6767
207178	11.31		0.3389768	25.4	8.4500		0.3154756	16	6.5414
206448	11.27		2.405384	177.8	0.0281		2.369761	177.8	0.7030
205961	11.24		85.13657	2048	0.0746		93.78176	2048	0.7081
204568	11.16		242.0144	2048	9.2912		267.0821	2048	2.3836
203873	11.12		1.013867	76.2	12.4464		2.50412	177.8	2.8422
203176	11.08		0.4042524	25.4	13.7302		0.2532864	16	2.9787
202579	11.05		0.3414972	25.4	19.3561		0.4449703	32	3.3305
201784	11.00		1.031717	76.2	24.9227		1.346379	101.6	4.4708
200392	10.92		0.5783777	32	27.9371		0.7091487	50.8	4.7293
199000	10.84		1.033639	76.2	24.9598		1.197387	88.9	5.8678
197608	10.76		0.5871459	32	24.8987		0.8551633	64	6.7246
197473	10.75		0.564411	32	23.9343		0.8046114	50.8	6.6667
197355	10.74		0.7621591	50.8	24.5174		1.105797	76.2	6.9524
197140	10.73		1.659041	101.6	23.9702		1.376901	101.6	6.8761
196735	10.71		0.3595554	25.4	24.6983		0.6586725	32	7.1073
196475	10.69		0.8353832	50.8	23.8332		0.5441625	32	7.2627
196330	10.69		0.1942076	12.7	21.8467		0.3843972	25.4	9.1382

			25 cfs				50 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
195520	10.64		1.714963	128	21.9725		3.306586	228.6	10.1750
194983	10.61		0.7837908	50.8	21.3798		0.6572088	32	9.9609
193901	10.55		0.4817686	32	21.8057		0.8267059	50.8	10.9225
192282	10.45		3.116732	228.6	21.4568		2.379414	177.8	11.8820
190663	10.36		0.4428951	32	8.8490		0.6241847	32	176.3095
189043	10.27		0.4708321	32	9.1589		0.5708007	32	166.5078
187424	10.17		0.5016072	32	16.8186		1.096353	76.2	57.0649
185805	10.08		0.7625342	50.8	16.5966		0.7082549	50.8	57.4348
184186	9.98		0.5561466	32	17.7083		0.7504007	50.8	59.3836
183518	9.95		1.8756	128	19.6994		4.14736	304.8	58.4220
182567	9.89		0.5120285	32	20.0500		0.4516329	32	59.9259
180947	9.80		0.6486166	32	20.5309		1.798764	128	59.9335
179328	9.70		0.4605248	32	31.8074		0.5131831	32	52.3238
177709	9.61		0.3933724	25.4	43.8344		0.6435568	32	53.7033
176090	9.52		0.8529602	64	45.4971		0.7765843	50.8	53.2742
174470	9.42		0.4608271	32	44.7944		0.8700442	64	51.1195
172851	9.33		0.3964047	25.4	42.4470		0.5160622	32	63.0294
171937	9.28		0.2838633	16	59.8801		0.7055405	50.8	60.6897
171232	9.24		0.4724981	32	38.4557		0.5378067	32	107.5352
170379	9.19		0.543118	32	167.7573		3.494293	256	131.7205
169613	9.14		0.3515106	25.4	155.9409		0.3089311	16	163.0231
168754	9.09		0.8409624	50.8	36.1749		5.494444	406.4	348.9308
167993	9.05		0.6447843	32	142.9349		0.4619172	32	471.7192
166374	8.96		0.6954044	50.8	102.0416		1.93913	128	99.9690
164755	8.86		0.8217043	50.8	82.2808		0.5526586	32	10.7253
163136	8.77		0.5540876	32	163.7127		2.612984	177.8	312.3334
161517	8.68		0.534253	32	19.4269		0.4545355	32	356.3222
159920	8.58		0.7217699	50.8	206.9622		1.142544	76.2	87.5640
158324	8.49		0.4798551	32	69.4708		0.7101313	50.8	73.8441
156728	8.40		1.461633	101.6	27.7657		1.03238	76.2	358.1567
155132	8.31		0.2057393	12.7	94.5276		0.306254	16	278.0284
153536	8.22		0.9481711	64	44.6996		4.659641	330.2	341.9190
151940	8.12		0.3485622	25.4	179.0749		0.2463099	16	293.8282
150344	8.03		1.079906	76.2	180.1557		1.020049	76.2	388.3548
148748	7.94		1.301383	88.9	161.9844		1.766315	128	310.8095
147151	7.85		0.1728709	12.7	161.5452		0.4961166	32	124.5673
145555	7.75		0.6534616	32	154.3824		0.5820114	32	739.2240
143959	7.66		0.824546	50.8	101.7940		2.232735	152.4	144.9828
142363	7.57		0.5505092	32	146.0603		0.4484197	32	100.8660
140767	7.48		0.5568112	32	124.7768		3.487483	256	293.0369
139171	7.39		0.5961665	32	37.2893		0.4035909	25.4	261.8308
138392	7.34		0.4838613	32	22.0540		0.4662729	32	289.0605
137575	7.29		0.7010348	50.8	20.1609		0.6029832	32	224.6739
135979	7.20		0.4679887	32	42.9073		0.9511604	64	77.2888
134458	7.11		3.96E-01	25.4	18.3945		4.36E-01	32	49.6069

			25 cfs				50 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
132937	7.03		0.5768573	32	9.5764		0.8454835	64	60.5292
132269	6.99		0.4108815	25.4	16.2616		0.5582285	32	68.8165
131416	6.94		1.633337	101.6	30.8683		0.4662659	32	78.6008
130679	6.89		0.2872054	16	35.2551		0.7026644	50.8	61.4823
129895	6.85		2.52E-02	<1	3.4165		3.48E-01	25.4	20.8920
129348	6.82		0.7897156	50.8	3.5744		0.6630425	32	19.3411
128687	6.78		2.697158	203.2	5.9387		3.125581	228.6	31.6626
128374	6.76		2.288363	152.4	8.2517		3.508839	256	32.5774
127620	6.72		0.8347238	50.8	10.3337		0.7563944	50.8	33.4662
126992	6.68		0.9544787	64	25.9060		2.756596	203.2	31.7026
125611	6.60		0.7656543	50.8	40.2331		1.142014	76.2	35.0405
124229	6.52		1.064213	76.2	44.3496		1.169197	76.2	38.6068
122848	6.44		0.5354867	32	46.6489		0.551876	32	36.1473
121467	6.36		0.837696	50.8	46.5908		1.194682	88.9	37.4184
121186	6.35		0.4715866	32	46.2690		0.6502118	32	36.7866
121040	6.34		1.392703	101.6	47.3922		2.166425	152.4	36.7124
120651	6.32		0.5803394	32	47.1739		0.9048085	64	37.1737
119866	6.27		0.5000614	32	51.8458		0.3584951	25.4	37.5103
119081	6.23		2.466281	177.8	47.1043		2.015841	152.4	37.6764
117511	6.14		0.3293845	16	55.8251		0.851544	64	38.5810
115942	6.05		2.348458	177.8	49.4366		0.9025758	64	48.9092
114372	5.95		0.1575904	8	57.5742		0.5707196	32	41.4865
112803	5.86		12.2043	762	143.3883		6.51E-01	32	50.3245
111233	5.77		0.5621333	32	63.3167		0.6846159	50.8	49.6978
109663	5.68		0.5495157	32	67.8852		1.183414	88.9	51.2661
108094	5.59		0.8920505	64	52.8419		0.593151	32	50.8774
106524	5.50		0.4116564	25.4	92.8231		0.9133692	64	52.6111
104955	5.41		0.4521223	32	52.2688		0.648163	32	50.6523
104923	5.41		2.829456	203.2	56.8777		2.425117	177.8	51.0965
104809	5.40		0.696851	50.8	60.7459		1.021352	76.2	51.9642
104297	5.37		2.766778	203.2	60.5868		1.847983	128	52.8080
103785	5.34		0.5201623	32	61.5930		1.071881	76.2	51.0002
103502	5.33		1.641949	101.6	61.5976		1.765575	128	52.7988
103292	5.32		0.3535501	25.4	61.3059		0.5612626	32	51.8159
102044	5.24		1.990107	128	61.6085		1.900301	128	53.1085
100797	5.17		0.3313501	16	61.8164		0.7005609	50.8	52.2065
99550	5.10		1.949348	128	62.1298		0.7826857	50.8	53.4641
99353.5	5.09		0.8232448	50.8	61.8421		1.008791	76.2	52.8202
99157	5.08		8.431744	635	62.5288		6.55579	457.2	52.5475
98748.1	5.05		0.7258522	50.8	61.7648		0.9812607	64	53.2768
98339.2	5.03		1.512054	101.6	63.3658		1.983995	128	54.0782
97521.5	4.98		0.5712559	32	61.4395		0.8591453	64	54.1055
96703.8	4.93		0.5214686	32	59.8718		0.6593228	32	54.0212
95886.1	4.89		1.392379	101.6	58.1423		0.5398518	32	55.8212
95068.4	4.84		0.4339564	32	57.2883		0.6350615	32	54.3416

Transect ID	River Mile		25 cfs Shear Stress (lb/sq ft)	25 cfs Grain Size Mobile (mm)	25 cfs Mass Capacity (tons/day)		50 cfs Shear Stress (lb/sq ft)	50 cfs Grain Size Mobile (mm)	50 cfs Mass Capacity (tons/day)
94250.7	4.79		0.5647096	32	52.7831		0.6665363	32	50.3203
93433	4.75		1.92E-01	12.7	47.8105		3.55E-01	25.4	46.9018
93043	4.72		2.65E-01	16	46.8894		4.69E-01	32	48.1091
92615.2	4.70		4.66E-01	32	48.2375		8.75E-01	64	50.3688
92380	4.68		2.233617	152.4	48.1993		2.859902	203.2	50.1195
91797.5	4.65		1.827556	128	47.7260		0.48741	32	44.0799
90979.8	4.60		0.4341879	32	46.8610		0.6657894	32	61.2549
90162.1	4.56		0.4770733	32	40.0879		0.5696884	32	83.8994
89344.4	4.51		0.3951001	25.4	37.5227		0.8896256	64	61.9867
88526.7	4.46		0.398306	25.4	26.3336		0.4894076	32	55.7484
87709	4.42		0.3681675	25.4	19.5739		0.7820317	50.8	58.3839
86929	4.37		0.4217481	32	26.2984		0.7268292	50.8	64.3936
86149	4.33		0.1715061	12.7	27.2109		0.5340538	32	66.7112
85909	4.31		0.3760048	25.4	28.3091		0.5304176	32	67.7130
85369	4.28		0.4981062	32	26.8790		0.6237709	32	68.9089
84974	4.26		0.3444217	25.4	26.7445		0.6638278	32	65.1525
84589	4.24		0.2823916	16	27.8784		0.4975495	32	67.8322
84251	4.22		1.151797	76.2	28.3743		2.009336	152.4	70.0816
83809	4.19		1.875923	128	580.1556		1.840311	128	851.8454
83512	4.17		0.1921559	12.7	403.3112		0.4644951	32	963.1360
83272	4.16		3.334346	228.6	540.5399		2.144635	152.4	923.6597
83029	4.15		0.1997046	12.7	262.8945		0.2756707	16	631.7172
82905	4.14		0.1596189	8	696.6918		0.252217	16	1000.3214
82673	4.12		7.20E-02	4	97.4925		0.1999314	12.7	174.4100
82478	4.11		0.1304138	8	335.8021		0.2009384	12.7	759.7943
82249	4.10		0.1672141	8	464.6181		0.2095637	12.7	1074.1157
82032	4.09		1.75E-01	12.7	562.3618		2.19E-01	16	841.5805
81824	4.08		0.1777041	12.7	305.9711		0.2518821	16	521.9774
81604	4.06		1.818925	128	393.1271		1.888678	128	614.1594
81448	4.05		1.949664	128	318.5494		2.204246	152.4	526.3846
81177	4.04		1.605002	101.6	295.6084		1.830577	128	487.0500
80958	4.03		1.576748	101.6	343.1886		1.785795	128	536.0195
80688	4.01		2.366479	177.8	23.4408		1.725384	128	71.2129
80481.5	4.00		0.281839	16	24.3743		1.160818	76.2	65.8153
80234	3.98		0.4229636	32	24.9272		0.2221093	16	73.2202
79970	3.97		0.4461772	32	23.8537		0.2506396	16	72.3664
79786	3.96		0.54495	32	25.6673		2.449216	177.8	73.0257
79432	3.94		0.1899568	12.7	25.7875		0.1448272	8	72.0053
79123	3.92		0.3179857	16	25.7885		0.2713161	16	73.0915
78720	3.90		1.052206	76.2	26.0109		1.440861	101.6	73.8089
78460	3.88		0.28979	16	25.8704		0.3218032	16	73.7673
78131	3.86		0.9675139	64	26.0521		1.942899	128	73.5846
77797	3.84		0.1848764	12.7	26.0357		0.1156356	8	74.5271
77517	3.83		0.4419112	32	25.9374		0.2335814	16	74.1933
77134	3.81		1.108106	76.2	25.4918		0.635924	32	74.6476

			25 cfs				50 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
76710	3.78		0.2475037	16	25.7538		0.3133236	16	73.3507
76349.5	3.76		0.404031	25.4	25.2092		1.012011	76.2	74.1771
76088	3.74		0.4312572	32	25.4770		0.4177242	25.4	73.6875
75765	3.73		1.477668	101.6	25.3294		1.497667	101.6	73.3246
75565	3.71		1.694358	128	25.3274		1.909352	128	73.1302
74780.6	3.67		0.5417148	32	19.7845		0.5816214	32	72.2998
73996.1	3.62		0.4621407	32	21.1050		0.8695717	64	75.4910
73211.7	3.58		0.2953613	16	19.6927		0.2989117	16	75.9508
72427.2	3.53		0.6418557	32	19.5545		1.175879	88.9	76.5703
71642.8	3.49		0.3198675	16	17.8037		0.3638107	25.4	78.9724
70858.3	3.44		0.7682761	50.8	18.3433		1.07057	76.2	81.2462
70073.9	3.40		0.4827102	32	17.3465		0.7482797	50.8	79.7467
69289.4	3.35		0.4376708	32	18.0297		0.4884517	32	77.8878
68505	3.31		0.4084522	25.4	17.9593		0.7616849	50.8	79.9477
67706.6	3.26		0.2060051	12.7	18.4656		0.2431494	16	80.2732
66908.3	3.21		1.31463	88.9	149.9753		1.349242	101.6	1507.0387
66110	3.17		0.3647081	25.4	18.5539		0.3469521	25.4	82.6841
65311.6	3.12		0.5027264	32	18.6214		1.130281	76.2	91.4204
64513.3	3.08		0.4415309	32	19.2084		0.4473449	32	89.7891
63715	3.03		0.1938881	12.7	19.2698		0.4814079	32	84.9104
62916.6	2.98		1.016124	76.2	21.1609		0.3772951	25.4	89.4210
62118.3	2.94		0.1709425	12.7	23.5481		0.6475338	32	102.5764
61320	2.89		0.2151839	16	23.3293		0.2672633	16	102.0521
60788	2.86		0.8594466	64	672.2791		0.2512857	16	987.0977
60218	2.83		1.135204	76.2	23.2658		0.5033475	32	102.0172
59540	2.79		0.2978893	16	22.7225		0.2968233	16	101.5075
58905	2.75		0.726837	50.8	24.3919		0.730087	50.8	105.6667
57503.5	2.67		0.5351121	32	23.3508		0.2863714	16	104.0572
56102	2.59		0.3999685	25.4	26.1759		0.7497851	50.8	108.1745
54700.5	2.51		0.3684519	25.4	28.7787		0.3247228	16	103.4858
53299	2.43		0.6467507	32	65.0431		1.529777	101.6	107.1245
53196	2.42		0.777387	50.8	43.9310		0.755111	50.8	107.6198
52861	2.40		0.8869082	64	27.7334		1.68671	128	101.0484
51702	2.34		0.4648311	32	36.6541		0.2628922	16	105.5756
50536.3	2.27		0.3361621	25.4	33.8789		0.626619	32	100.6539
49370.6	2.20		0.2587447	16	32.9061		0.2928133	16	113.9550
48205	2.14		0.3263037	16	26.5446		0.1602813	8	81.4682
48111	2.13		0.2948665	16	22.9782		0.5269393	32	90.8655
47945	2.12		0.7010643	50.8	27.6022		0.7996381	50.8	78.4747
47622	2.10		0.9371272	64	24.5906		1.030412	76.2	66.3632
47388.6	2.09		0.7869535	50.8	24.8936		1.001431	64	65.6679
47155.3	2.07		0.6122715	32	28.0120		2.702804	203.2	62.2047
46922	2.06		0.4155987	25.4	18.9953		1.610779	101.6	59.5284
46467.5	2.03		0.2280048	16	4.3603		0.3354054	25.4	20.3282
44990	1.95		8.356225	512	2.1083		0.2136105	16	6.5450

			25 cfs				50 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
44251.2	1.91		0.412133	25.4	1.1306		5.033509	381	2.2608
43512.5	1.86		20.46088	1524	3.4145		6.62E-03	<1	21.8027
42035	1.78		2.02E-03	<1	0.0374		1.92E+01	1270	0.0000
40557.5	1.69		20.73633	1524	0.0008		17.12966	1270	0.0013
39080	1.61		1.13E-02	<1	0.0000		1.67E-03	<1	0.0000
38808	1.59		0.9989921	64	0.0001		3.234542	228.6	0.0002
38713	1.59		1.235688	88.9	0.0001		0.5532439	32	0.0002
38256	1.56		0.5947817	32	0.0004		1.069174	76.2	0.0006
38020.3	1.55		0.2904486	16	0.0002		0.7007045	50.8	0.0010
37784.6	1.53		0.4771377	32	0.0001		0.6840022	50.8	0.0002
37549	1.52		0.606833	32	0.0002		0.7977135	50.8	0.0003

			75 cfs				100 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
218986	12.31		0.1746348	12.7	0.00		0.1723321	12.7	0.00
218747	12.27		0.5247496	32	0.01		0.3128414	16	0.00
218509	12.22		0.5061615	32	0.28		0.5290499	32	0.64
218270	12.18		3.706733	279.4	0.27		7.773647	512	0.61
218032	12.13		0.2732814	16	0.32		0.2112613	16	0.56
217793	12.08		0.80937	50.8	1.36		1.053136	76.2	0.67
217555	12.04		0.5082768	32	1.15		0.3437995	25.4	1.24
217316	11.99		1.643904	101.6	0.81		3.001703	203.2	1.06
217078	11.95		0.1938079	12.7	1.14		0.1390006	8	0.88
216839	11.90		0.6826336	50.8	1.20		0.8009601	50.8	0.87
216601	11.86		0.5497307	32	1.48		0.7875999	50.8	0.91
215844	11.81		0.6344419	32	1.69		0.3926304	25.4	0.92
215735	11.81		0.2496397	16	2.06		0.4617058	32	0.89
215619	11.80		3.081208	228.6	2.07		2.112641	152.4	0.88
215566	11.80		15.34921	1024	2.10		10.22356	762	0.91
215514	11.79		0.1897582	12.7	2.42		0.5137858	32	0.95
215403	11.79		18.15662	1270	2.38		6.516815	457.2	0.92
215186	11.77		0.5149317	32	2.49		0.6670572	32	7.27
214042	11.71		1.257666	88.9	3.08		0.860795	64	3.01
212898	11.64		0.273318	16	3.72		0.3278014	16	3.78
211754	11.58		0.6424088	32	5.34		0.3961862	25.4	3.13
210610	11.51		0.1828933	12.7	4.56		0.1930373	12.7	6.40
210156	11.48		0.9391119	64	4.72		1.244128	88.9	6.36
209795	11.46		2.851271	203.2	4.78		1.665847	101.6	5.98
209466	11.44		0.6686652	32	4.91		1.106405	76.2	9.29
209017	11.42		8.267857	512	5.11		1.097493	76.2	7.13
208322	11.38		0.2747043	16	6.46		0.374295	25.4	7.29
207658	11.34		0.2515263	16	6.20		0.392143	25.4	8.10
207178	11.31		0.3127695	16	6.18		0.2440924	16	8.42
206448	11.27		3.981411	279.4	6.36		2.464801	177.8	115.51
205961	11.24		1.867995	128	6.32		87.57037	2048	113.83
204568	11.16		2.006402	128	7.51		335.5586	2048	235.25
203873	11.12		0.7589355	50.8	10.42		1.187317	88.9	190.99
203176	11.08		1.519977	101.6	10.89		0.6565069	32	202.77
202579	11.05		0.6661199	32	11.63		0.6640177	32	193.21
201784	11.00		0.9643571	64	12.08		1.163848	76.2	198.69
200392	10.92		1.376591	101.6	13.95		1.23835	88.9	192.55
199000	10.84		0.9418619	64	16.19		1.261333	88.9	200.49
197608	10.76		1.331959	88.9	17.09		1.091153	76.2	190.54
197473	10.75		0.7312799	50.8	17.27		0.81372	50.8	191.30
197355	10.74		1.949401	128	17.59		1.762574	128	193.59
197140	10.73		0.7509209	50.8	17.77		1.723261	128	190.50
196735	10.71		0.9556891	64	18.91		0.6618282	32	196.19
196475	10.69		0.6322294	32	19.74		0.5921217	32	198.08
196330	10.69		0.8511559	64	22.47		0.4200451	25.4	209.80

			75 cfs				100 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
195520	10.64		1.277802	88.9	23.47		5.123318	381	267.09
194983	10.61		0.9357252	64	28.42		1.043517	76.2	287.24
193901	10.55		1.540794	101.6	34.05		1.096673	76.2	264.57
192282	10.45		1.301864	88.9	54.31		3.076349	228.6	323.89
190663	10.36		1.672332	101.6	84.68		0.8453049	64	214.91
189043	10.27		0.9765223	64	70.67		0.7882582	50.8	255.27
187424	10.17		1.084562	76.2	90.15		1.089347	76.2	334.64
185805	10.08		0.8827655	64	111.53		1.258246	88.9	340.80
184186	9.98		1.315767	88.9	152.75		1.078524	76.2	476.01
183518	9.95		1.310645	88.9	163.45		2.534043	177.8	510.86
182567	9.89		1.23884	88.9	194.29		0.882423	64	507.16
180947	9.80		1.00976	76.2	218.89		2.001364	128	524.64
179328	9.70		0.6986063	50.8	244.01		0.6680667	32	514.48
177709	9.61		0.8517367	64	248.73		0.8632843	64	515.15
176090	9.52		0.9985253	64	254.16		1.329665	88.9	541.94
174470	9.42		1.287612	88.9	259.27		1.474151	101.6	528.98
172851	9.33		0.9120514	64	253.67		0.6945783	50.8	524.84
171937	9.28		0.6147456	32	242.55		0.9028335	64	565.07
171232	9.24		0.7116797	50.8	234.50		0.7040073	50.8	590.90
170379	9.19		0.8286046	50.8	234.78		3.571507	256	656.39
169613	9.14		1.040383	76.2	159.25		0.5851883	32	622.08
168754	9.09		0.768533	50.8	167.09		1.865057	128	619.60
167993	9.05		0.7126787	50.8	259.51		0.8511369	64	605.82
166374	8.96		1.366762	101.6	422.43		1.661869	101.6	595.15
164755	8.86		0.8058201	50.8	423.02		1.087659	76.2	573.30
163136	8.77		1.547719	101.6	380.34		1.781139	128	783.57
161517	8.68		0.6479421	32	328.79		1.07903	76.2	791.86
159920	8.58		1.077848	76.2	253.50		0.7458143	50.8	600.52
158324	8.49		1.660636	101.6	263.04		2.289641	152.4	853.85
156728	8.40		0.541489	32	236.72		0.5553463	32	1087.51
155132	8.31		1.130743	76.2	234.33		0.7982456	50.8	1044.45
153536	8.22		0.453866	32	310.90		0.9605896	64	281.60
151940	8.12		2.07465	152.4	309.83		0.4606324	32	331.62
150344	8.03		0.6162764	32	306.38		1.038109	76.2	406.68
148748	7.94		2.496265	177.8	313.88		3.67585	256	409.37
147151	7.85		0.715569	50.8	317.06		0.4601521	32	445.09
145555	7.75		1.351	101.6	341.80		2.270812	152.4	474.23
143959	7.66		1.031197	76.2	545.19		1.078258	76.2	517.38
142363	7.57		0.9393755	64	584.17		1.207822	88.9	569.70
140767	7.48		0.9065825	64	605.72		1.003285	64	622.31
139171	7.39		1.571132	101.6	642.96		1.090106	76.2	660.80
138392	7.34		0.7860283	50.8	633.83		0.7345954	50.8	749.96
137575	7.29		1.096664	76.2	496.10		1.017791	76.2	887.19
135979	7.20		0.790624	50.8	577.49		0.745974	50.8	966.43
134458	7.11		1.71E-01	12.7	497.63		7.24E-01	50.8	438.56

		75 cfs			100 cfs		
Transect ID	**River Mile**	**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**	**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
132937	7.03	1.945461	128	293.95	0.6869091	50.8	275.35
132269	6.99	1.193354	88.9	264.81	0.6885127	50.8	307.92
131416	6.94	1.066684	76.2	263.24	0.9627741	64	418.47
130679	6.89	0.4367495	32	204.18	0.8308867	50.8	452.59
129895	6.85	8.67E-02	4	186.01	5.03E-01	32	411.68
129348	6.82	1.684482	101.6	146.80	1.085486	76.2	367.72
128687	6.78	2.156598	152.4	184.97	3.34029	228.6	450.65
128374	6.76	3.352829	228.6	183.03	3.370738	228.6	544.60
127620	6.72	1.235826	88.9	271.65	1.385527	101.6	746.02
126992	6.68	2.029655	152.4	186.95	2.075783	152.4	1149.12
125611	6.60	1.726001	128	185.40	1.764868	128	805.42
124229	6.52	0.8719088	64	179.92	1.076708	76.2	1017.83
122848	6.44	0.7947612	50.8	180.75	1.29198	88.9	1020.54
121467	6.36	0.6237888	32	179.42	0.8565411	64	929.70
121186	6.35	0.4322046	32	178.77	0.9762293	64	934.25
121040	6.34	5.058888	381	179.63	2.087137	152.4	891.66
120651	6.32	0.8448307	64	184.39	1.177032	88.9	955.01
119866	6.27	1.270813	88.9	193.59	1.590223	101.6	899.07
119081	6.23	1.077085	76.2	202.92	1.000026	64	944.29
117511	6.14	1.411703	101.6	208.99	2.133392	152.4	878.80
115942	6.05	0.7118174	50.8	181.13	0.9442156	64	742.71
114372	5.95	1.467152	101.6	197.17	0.7132614	50.8	725.75
112803	5.86	1.008958	76.2	117.07	0.935184	64	653.31
111233	5.77	0.8579484	64	130.85	0.8160059	50.8	632.68
109663	5.68	2.487753	177.8	129.72	1.405245	101.6	636.79
108094	5.59	0.7668227	50.8	128.79	0.9969391	64	592.63
106524	5.50	1.22529	88.9	120.72	0.9504474	64	537.00
104955	5.41	0.754075	50.8	123.27	0.7034743	50.8	526.86
104923	5.41	2.070348	152.4	121.61	3.788268	279.4	535.23
104809	5.40	6.178127	457.2	122.56	1.672975	101.6	534.08
104297	5.37	0.976256	64	122.27	1.68481	101.6	498.56
103785	5.34	1.098872	76.2	120.66	1.669053	101.6	499.61
103502	5.33	1.08859	76.2	122.94	1.57003	101.6	500.20
103292	5.32	0.7323003	50.8	121.57	1.049539	76.2	485.59
102044	5.24	1.55733	101.6	122.77	1.438406	101.6	492.88
100797	5.17	0.7478011	50.8	123.75	1.164117	76.2	468.40
99550	5.10	1.341203	101.6	119.38	1.25799	88.9	482.09
99353.5	5.09	1.416692	101.6	121.27	1.41613	101.6	460.88
99157	5.08	3.27791	228.6	119.36	7.151724	512	455.33
98748.1	5.05	1.323264	88.9	117.79	1.101115	76.2	452.83
98339.2	5.03	1.337197	88.9	598.75	2.692388	203.2	833.62
97521.5	4.98	1.354113	101.6	111.47	0.9369432	64	422.61
96703.8	4.93	2.174093	152.4	118.46	1.0336	76.2	419.80
95886.1	4.89	1.207909	88.9	116.25	0.6348122	32	395.82
95068.4	4.84	1.72057	128	122.33	1.050419	76.2	385.50

			75 cfs				100 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
94250.7	4.79		0.7098048	50.8	154.77		1.008625	76.2	339.48
93433	4.75		1.50E-01	8	166.92		5.30E-01	32	347.79
93043	4.72		3.35E-02	2	153.31		6.07E-01	32	327.13
92615.2	4.70		2.53E-02	<1	165.09		6.57E-01	32	327.82
92380	4.68		2.783686	203.2	1211.07		3.183124	228.6	2115.81
91797.5	4.65		2.853485	203.2	175.06		0.2127243	16	320.09
90979.8	4.60		0.2026156	12.7	197.55		0.9274129	64	322.40
90162.1	4.56		0.5166042	32	196.79		1.929015	128	394.85
89344.4	4.51		1.019974	76.2	171.93		1.817193	128	325.56
88526.7	4.46		1.059853	76.2	211.68		0.8537544	64	338.78
87709	4.42		0.5650523	32	221.35		0.9207541	64	340.43
86929	4.37		0.3310861	16	234.04		0.554414	32	364.22
86149	4.33		0.5273976	32	263.18		0.4999597	32	354.54
85909	4.31		0.4856614	32	263.04		0.5510376	32	357.90
85369	4.28		0.6145316	32	272.13		0.6118758	32	358.40
84974	4.26		0.6847008	50.8	278.94		0.6456181	32	365.01
84589	4.24		0.5447598	32	278.90		0.6372097	32	358.04
84251	4.22		0.5370888	32	277.68		2.142689	152.4	364.16
83809	4.19		0.140056	8	284.52		2.041642	152.4	364.69
83512	4.17		2.037805	152.4	21937.44		0.9239532	64	26863.60
83272	4.16		2.203349	152.4	14748.12		1.634448	101.6	18745.25
83029	4.15		2.059597	152.4	2758.51		0.390263	25.4	6404.10
82905	4.14		2.082646	152.4	288.60		0.3145742	16	1421.51
82673	4.12		0.6076392	32	286.38		0.3003728	16	376.54
82478	4.11		2.421036	177.8	6738.20		0.2874872	16	7642.58
82249	4.10		1.751873	128	11772.54		0.3065993	16	13148.66
82032	4.09		1.939222	128	16565.48		0.2703066	16	16369.72
81824	4.08		1.803906	128	3986.14		0.2874115	16	4117.81
81604	4.06		2.242959	152.4	26851.16		2.095265	152.4	1507.14
81448	4.05		1.841514	128	13008.94		2.48469	177.8	11287.84
81177	4.04		2.613979	177.8	6441.57		2.078939	152.4	9017.08
80958	4.03		2.18858	152.4	16216.42		2.136343	152.4	947.77
80688	4.01		0.5129631	32	12777.38		1.347656	101.6	9389.02
80481.5	4.00		1.823612	128	7886.94		1.232764	88.9	9083.45
80234	3.98		0.7152575	50.8	25160.40		0.3115572	16	37454.66
79970	3.97		0.7493192	50.8	12922.06		3.32E-01	16	18277.04
79786	3.96		0.5705476	32	291.70		2.20204	152.4	373.91
79432	3.94		0.7736174	50.8	289.90		0.2416583	16	371.24
79123	3.92		0.9443491	64	297.30		0.5506777	32	371.48
78720	3.90		0.8887357	64	306.76		1.069958	76.2	372.70
78460	3.88		1.021278	76.2	307.96		0.9059321	64	372.82
78131	3.86		1.194171	88.9	300.69		1.037731	76.2	373.57
77797	3.84		0.768894	50.8	269.51		0.3574686	25.4	363.38
77517	3.83		1.123229	76.2	297.38		0.5337828	32	370.30
77134	3.81		0.6477925	32	299.57		1.005806	76.2	376.74

			75 cfs				100 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
76710	3.78		0.2960524	16	302.08		0.5796058	32	363.10
76349.5	3.76		0.824499	50.8	297.30		0.7347729	50.8	384.81
76088	3.74		0.8106014	50.8	299.62		0.5483983	32	389.69
75765	3.73		1.546545	101.6	299.69		1.662852	101.6	393.03
75565	3.71		2.055187	152.4	298.61		2.236074	152.4	392.88
74780.6	3.67		0.8939858	64	299.32		0.8031828	50.8	391.49
73996.1	3.62		0.8629645	64	293.14		1.310295	88.9	382.14
73211.7	3.58		0.4083707	25.4	285.49		0.4121374	25.4	364.47
72427.2	3.53		1.275211	88.9	289.53		1.444769	101.6	369.34
71642.8	3.49		0.4429532	32	279.71		0.4550311	32	338.58
70858.3	3.44		1.471561	101.6	282.04		1.434432	101.6	339.09
70073.9	3.40		0.6910424	50.8	191.10		1.068143	76.2	274.37
69289.4	3.35		0.8260389	50.8	167.71		0.6286674	32	282.99
68505	3.31		0.5833008	32	171.08		1.314785	88.9	299.27
67706.6	3.26		0.4800565	32	178.82		0.333051	16	300.49
66908.3	3.21		1.368405	101.6	225.46		1.847576	128	526.39
66110	3.17		0.5220196	32	204.74		0.5017065	32	314.09
65311.6	3.12		0.469431	32	205.13		1.295063	88.9	314.39
64513.3	3.08		0.4306667	32	133.74		0.6980097	50.8	286.83
63715	3.03		0.252599	16	147.80		0.6608045	32	265.72
62916.6	2.98		0.237056	16	116.30		0.5492288	32	234.02
62118.3	2.94		0.4185449	25.4	140.55		0.8238724	50.8	255.47
61320	2.89		1.196288	88.9	108.18		0.4075657	25.4	237.96
60788	2.86		0.8181596	50.8	122.58		0.4262404	32	251.57
60218	2.83		3.206053	228.6	323.69		0.5991055	32	1919.41
59540	2.79		0.5776415	32	129.58		0.5485935	32	251.09
58905	2.75		0.9315036	64	135.69		0.8793952	64	249.09
57503.5	2.67		0.6943109	50.8	134.33		0.5146145	32	252.83
56102	2.59		0.5908687	32	142.98		0.8356422	50.8	240.12
54700.5	2.51		0.4245813	32	160.12		0.4888995	32	241.93
53299	2.43		0.7903031	50.8	169.26		1.240734	88.9	253.50
53196	2.42		1.135474	76.2	175.01		1.225502	88.9	257.77
52861	2.40		0.9055381	64	175.64		1.27837	88.9	262.81
51702	2.34		0.5156161	32	197.80		0.5385435	32	254.67
50536.3	2.27		0.7531868	50.8	185.45		0.5598393	32	255.68
49370.6	2.20		0.4162352	25.4	177.77		0.3241594	16	284.66
48205	2.14		0.2827611	16	185.25		0.5156995	32	285.08
48111	2.13		0.4204491	25.4	191.80		0.4598989	32	288.99
47945	2.12		0.7939159	50.8	173.31		0.6777886	50.8	293.88
47622	2.10		0.7222313	50.8	162.62		1.134583	76.2	274.02
47388.6	2.09		0.568588	32	134.07		1.090161	76.2	287.35
47155.3	2.07		0.6234649	32	129.49		0.7861666	50.8	266.43
46922	2.06		0.4969567	32	58.41		0.4803086	32	255.38
46467.5	2.03		1.610018	101.6	29.24		0.2641314	16	55.22
44990	1.95		0.659053	32	13.43		31.99692	2048	19.64

			75 cfs				100 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
44251.2	1.91		1.62753	101.6	17.26		3.670164	256	23.55
43512.5	1.86		0.8404801	50.8	13.95		0.3349961	25.4	18.34
42035	1.78		1.47E+00	101.6	1.14		1.42E+01	1024	1.77
40557.5	1.69		2.477719	177.8	0.03		12.59866	762	0.04
39080	1.61		0.7557338	50.8	0.17		4.50E-02	2	0.48
38808	1.59		5.193697	381	0.21		2.011854	152.4	0.25
38713	1.59		0.9215243	64	0.28		0.8827436	64	0.43
38256	1.56		0.5619333	32	0.69		0.6771088	50.8	0.48
38020.3	1.55		0.6391644	32	0.29		0.3706881	25.4	0.46
37784.6	1.53		0.6543053	32	0.29		0.5792588	32	0.99
37549	1.52		0.7890403	50.8	0.51		0.7625364	50.8	1.55

			125 cfs				200 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
218986	12.31		0.1713385	12.7	0.00		0.3257777	16	0.00
218747	12.27		0.2851861	16	0.00		0.3497871	25.4	0.14
218509	12.22		0.5392997	32	1.00		0.8165689	50.8	1.68
218270	12.18		7.417036	512	1.02		1.543406	101.6	1.85
218032	12.13		0.2108259	12.7	0.83		0.4090375	25.4	2.14
217793	12.08		0.9465877	64	0.62		0.8596181	64	2.01
217555	12.04		0.3892387	25.4	0.59		0.7409834	50.8	2.03
217316	11.99		1.944541	128	2.06		1.351198	101.6	2.62
217078	11.95		0.1829448	12.7	1.03		0.3120127	16	4.93
216839	11.90		0.7402672	50.8	12.88		1.200549	88.9	5.16
216601	11.86		0.5171252	32	4.17		0.7437175	50.8	5.45
215844	11.81		0.6230021	32	4.03		0.7178881	50.8	5.55
215735	11.81		0.3679445	25.4	2.42		0.4435164	32	5.61
215619	11.80		2.032193	152.4	2.40		2.08477	152.4	5.68
215566	11.80		20.39209	1524	2.39		10.86786	762	5.57
215514	11.79		0.3954995	25.4	2.33		0.7765964	50.8	6.13
215403	11.79		7.140625	512	2.39		5.632326	406.4	6.19
215186	11.77		0.6588192	32	5.85		1.050941	76.2	10.32
214042	11.71		0.856134	64	7.22		1.065957	76.2	8.50
212898	11.64		0.3526011	25.4	5.14		0.5331125	32	9.07
211754	11.58		0.3165578	16	4.70		0.4695866	32	10.50
210610	11.51		0.2030294	12.7	5.19		0.2872024	16	8.92
210156	11.48		1.50202	101.6	5.27		0.9125503	64	8.17
209795	11.46		1.595815	101.6	5.18		5.423218	406.4	8.52
209466	11.44		1.537949	101.6	7.08		0.8259337	50.8	8.24
209017	11.42		0.6147353	32	6.34		4.069362	304.8	8.46
208322	11.38		0.3773555	25.4	6.59		0.4828724	32	13.40
207658	11.34		0.4960087	32	5.63		0.4256515	32	11.67
207178	11.31		0.2727548	16	5.60		0.1609088	8	11.71
206448	11.27		2.432067	177.8	22.66		5.545775	406.4	9.79
205961	11.24		82.32664	2048	22.67		13.67422	1024	9.84
204568	11.16		351.3814	2048	281.64		43.37748	2048	121.52
203873	11.12		1.818425	128	358.78		1.173535	88.9	176.36
203176	11.08		0.5903634	32	366.56		1.241344	88.9	182.39
202579	11.05		0.7406722	50.8	382.59		1.032005	76.2	185.01
201784	11.00		1.485378	101.6	401.69		1.454884	101.6	198.79
200392	10.92		1.156101	76.2	420.06		1.462677	101.6	238.73
199000	10.84		1.264467	88.9	446.78		1.438874	101.6	231.41
197608	10.76		1.678776	101.6	470.53		1.824906	128	236.54
197473	10.75		0.9604568	64	476.62		0.927056	64	234.06
197355	10.74		1.257676	88.9	479.51		1.853832	128	239.85
197140	10.73		2.702933	203.2	479.47		1.683775	101.6	245.50
196735	10.71		0.5286108	32	487.55		1.195678	88.9	248.92
196475	10.69		0.5483379	32	490.70		1.262972	88.9	251.76
196330	10.69		0.5313269	32	497.32		0.7236254	50.8	283.42

			125 cfs				200 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
195520	10.64		5.384892	406.4	505.31		2.25311	152.4	302.36
194983	10.61		1.01608	76.2	502.93		1.574506	101.6	330.43
193901	10.55		1.239265	88.9	495.33		1.812966	128	311.99
192282	10.45		2.889415	203.2	501.96		2.275444	152.4	348.72
190663	10.36		0.9302224	64	531.30		1.373689	101.6	470.92
189043	10.27		0.8475312	64	517.18		1.063511	76.2	454.77
187424	10.17		1.325033	88.9	477.44		1.281572	88.9	614.36
185805	10.08		1.30839	88.9	488.97		1.579319	101.6	659.05
184186	9.98		1.15677	76.2	570.26		1.375381	101.6	645.03
183518	9.95		2.621061	177.8	576.12		2.179442	152.4	688.68
182567	9.89		1.132632	76.2	583.93		1.74105	128	752.00
180947	9.80		1.842391	128	626.45		1.314313	88.9	811.96
179328	9.70		0.8720356	64	627.55		1.408086	101.6	804.19
177709	9.61		0.7269899	50.8	629.60		0.9766099	64	833.73
176090	9.52		1.970588	128	634.25		2.104704	152.4	812.64
174470	9.42		1.160071	76.2	644.50		1.190772	88.9	834.73
172851	9.33		0.8925704	64	625.34		1.436958	101.6	813.08
171937	9.28		0.9194689	64	628.84		0.9426885	64	823.78
171232	9.24		0.8542151	64	633.07		1.115433	76.2	847.66
170379	9.19		3.64929	256	656.77		1.321043	88.9	885.48
169613	9.14		0.6171129	32	969.56		0.9266096	64	1115.17
168754	9.09		2.665588	177.8	985.67		1.328352	88.9	1713.07
167993	9.05		0.8134233	50.8	776.20		1.57788	101.6	950.65
166374	8.96		2.377353	177.8	829.77		1.001935	64	1342.99
164755	8.86		0.9815889	64	824.57		1.382344	101.6	1375.14
163136	8.77		2.732389	203.2	852.23		1.401616	101.6	1434.98
161517	8.68		0.896362	64	883.34		1.051673	76.2	1609.64
159920	8.58		1.076695	76.2	993.52		1.909962	128	1808.08
158324	8.49		1.562081	101.6	1023.47		0.9488426	64	1940.70
156728	8.40		0.8441545	64	1499.87		1.333428	88.9	2220.16
155132	8.31		0.6537484	32	1452.23		1.079198	76.2	2123.68
153536	8.22		2.213855	152.4	532.59		0.8303563	50.8	1021.60
151940	8.12		0.5177308	32	598.89		1.23135	88.9	1147.44
150344	8.03		0.6846675	50.8	245.27		1.280134	88.9	790.11
148748	7.94		4.781868	355.6	334.07		2.758134	203.2	984.00
147151	7.85		0.4970704	32	432.58		0.7047259	50.8	916.42
145555	7.75		3.41904	256	467.70		1.342867	101.6	961.55
143959	7.66		1.077806	76.2	693.65		1.776662	128	1082.20
142363	7.57		1.591046	101.6	731.49		1.360215	101.6	1118.92
140767	7.48		1.366808	101.6	773.71		1.416686	101.6	1136.61
139171	7.39		1.173208	88.9	764.96		1.273184	88.9	1201.59
138392	7.34		0.7685829	50.8	761.75		1.33487	88.9	1187.88
137575	7.29		0.7972689	50.8	800.40		1.262065	88.9	1106.38
135979	7.20		0.941714	64	594.12		0.63756	32	910.99
134458	7.11		7.91E-01	50.8	380.44		1.13E+00	76.2	578.66

			125 cfs				200 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
132937	7.03		0.6627581	32	318.94		1.037545	76.2	526.57
132269	6.99		1.111817	76.2	416.19		1.389426	101.6	615.51
131416	6.94		0.7891774	50.8	388.27		1.616947	101.6	622.25
130679	6.89		1.058166	76.2	646.35		0.6631402	32	664.47
129895	6.85		5.30E-01	32	1052.82		3.51E-01	25.4	688.29
129348	6.82		1.176003	88.9	1022.92		1.524828	101.6	633.01
128687	6.78		3.481427	256	1350.23		3.904453	279.4	3280.62
128374	6.76		3.448993	256	1106.47		3.799302	279.4	727.02
127620	6.72		1.291409	88.9	1192.09		2.136055	152.4	718.71
126992	6.68		3.101597	228.6	1121.72		1.956442	128	762.97
125611	6.60		1.712601	128	1318.83		2.036268	152.4	789.60
124229	6.52		1.669683	101.6	1126.64		2.288113	152.4	974.55
122848	6.44		0.9070451	64	1113.82		1.540756	101.6	1120.45
121467	6.36		1.140915	76.2	1442.74		1.134158	76.2	1262.85
121186	6.35		1.23566	88.9	1015.38		1.744529	128	1205.58
121040	6.34		2.245901	152.4	1047.23		2.192449	152.4	1258.78
120651	6.32		1.200371	88.9	1080.89		1.095618	76.2	1264.35
119866	6.27		1.039491	76.2	1054.57		2.415852	177.8	1245.71
119081	6.23		1.377547	101.6	1106.29		1.765391	128	1253.48
117511	6.14		2.173861	152.4	1035.24		1.697358	128	1305.07
115942	6.05		0.9698591	64	1043.72		1.811736	128	1230.57
114372	5.95		0.9061232	64	1054.24		0.7690303	50.8	1369.80
112803	5.86		0.8251015	50.8	1045.29		1.63657	101.6	1286.07
111233	5.77		1.038468	76.2	1022.82		1.218526	88.9	1311.51
109663	5.68		1.499187	101.6	1065.20		1.608	101.6	1414.11
108094	5.59		0.9814296	64	1025.03		1.719748	128	1318.81
106524	5.50		1.084135	76.2	972.91		1.134854	76.2	1372.89
104955	5.41		0.814047	50.8	878.99		0.8211816	50.8	1287.17
104923	5.41		3.595487	256	872.06		3.67157	256	1302.67
104809	5.40		1.909839	128	907.11		1.792417	128	1361.75
104297	5.37		1.558368	101.6	926.13		2.993942	203.2	1376.10
103785	5.34		1.917525	128	920.25		1.343506	101.6	1353.31
103502	5.33		1.724577	128	915.26		1.772224	128	1332.13
103292	5.32		1.060845	76.2	913.67		1.238307	88.9	1307.53
102044	5.24		2.007596	128	927.96		2.171882	152.4	1402.23
100797	5.17		1.133381	76.2	939.47		1.119207	76.2	1362.55
99550	5.10		1.284329	88.9	954.60		2.356748	177.8	1440.98
99353.5	5.09		1.39049	101.6	952.15		1.186814	88.9	1380.62
99157	5.08		6.202394	457.2	955.90		5.632001	406.4	1438.72
98748.1	5.05		1.41682	101.6	959.94		1.673412	101.6	1455.44
98339.2	5.03		2.752627	203.2	918.67		3.004995	203.2	2070.61
97521.5	4.98		1.219465	88.9	1005.29		1.522077	101.6	1468.01
96703.8	4.93		0.9482607	64	1271.16		1.625653	101.6	1462.24
95886.1	4.89		0.9648601	64	1062.56		1.981155	128	1416.27
95068.4	4.84		0.7997529	50.8	932.69		0.9867855	64	1468.81

Transect ID	River Mile		125 cfs Shear Stress (lb/sq ft)	125 cfs Grain Size Mobile (mm)	125 cfs Mass Capacity (tons/day)		200 cfs Shear Stress (lb/sq ft)	200 cfs Grain Size Mobile (mm)	200 cfs Mass Capacity (tons/day)
94250.7	4.79		0.9379705	64	939.96		0.9145225	64	1540.14
93433	4.75		7.85E-01	50.8	891.56		6.83E-01	50.8	1540.74
93043	4.72		7.62E-01	50.8	867.00		6.41E-01	32	1486.88
92615.2	4.70		6.88E-01	50.8	883.71		4.37E-01	32	1490.52
92380	4.68		3.389518	256	2678.44		3.663182	256	2212.33
91797.5	4.65		0.3114171	16	828.06		3.480835	256	1397.54
90979.8	4.60		0.8652807	64	752.30		0.7460025	50.8	1164.71
90162.1	4.56		1.445707	101.6	832.08		1.084063	76.2	1025.16
89344.4	4.51		1.485076	101.6	538.84		1.02224	76.2	923.74
88526.7	4.46		0.7052277	50.8	488.27		0.6613	32	850.22
87709	4.42		1.150165	76.2	498.81		0.8790752	64	772.26
86929	4.37		0.7865738	50.8	474.32		0.4951355	32	695.69
86149	4.33		0.6617969	32	478.77		0.7159284	50.8	638.70
85909	4.31		0.6364505	32	483.41		0.6299005	32	610.18
85369	4.28		0.7504859	50.8	472.09		0.7436534	50.8	539.99
84974	4.26		0.8346896	50.8	485.04		0.6926478	50.8	547.26
84589	4.24		0.7421421	50.8	474.09		0.7250347	50.8	571.37
84251	4.22		2.223068	152.4	485.28		2.566524	177.8	551.02
83809	4.19		2.155375	152.4	477.85		2.500919	177.8	495.72
83512	4.17		1.222733	88.9	32409.91		2.283555	152.4	51549.64
83272	4.16		1.599236	101.6	26163.96		1.59942	101.6	32401.00
83029	4.15		0.4177947	25.4	8366.56		0.3295228	16	15021.76
82905	4.14		0.4752842	32	2574.19		0.352369	25.4	4237.31
82673	4.12		0.3822557	25.4	818.45		0.3578399	25.4	1459.03
82478	4.11		0.3634384	25.4	8274.88		0.3705322	25.4	749.65
82249	4.10		0.346561	25.4	11779.73		0.3208067	16	19081.98
82032	4.09		0.3683177	25.4	12868.18		0.2685163	16	15855.59
81824	4.08		0.3393934	25.4	4735.99		9.85E-02	4	8214.84
81604	4.06		2.188764	152.4	1490.95		2.425917	177.8	25586.18
81448	4.05		2.554999	177.8	11243.39		2.774935	203.2	21426.31
81177	4.04		2.158118	152.4	10513.61		2.365485	177.8	13978.90
80958	4.03		2.169489	152.4	1168.42		2.325591	152.4	1722.56
80688	4.01		1.329765	88.9	7194.49		1.348621	101.6	13171.43
80481.5	4.00		1.264952	88.9	13254.79		1.341997	101.6	26855.57
80234	3.98		0.3702141	25.4	33172.05		0.1900987	12.7	44752.84
79970	3.97		4.22E-01	32	18960.39		0.3019338	16	16346.23
79786	3.96		2.177389	152.4	492.89		0.8234001	50.8	566.60
79432	3.94		0.3075642	16	493.70		0.591844	32	564.94
79123	3.92		0.5223626	32	497.73		0.9435865	64	632.46
78720	3.90		1.281999	88.9	497.31		1.174819	88.9	555.68
78460	3.88		0.8032746	50.8	505.20		1.231004	88.9	576.51
78131	3.86		1.720785	128	501.23		1.037298	76.2	600.69
77797	3.84		0.3491331	25.4	499.37		0.9204755	64	582.88
77517	3.83		0.4895878	32	510.24		1.165756	76.2	599.61
77134	3.81		0.7708518	50.8	517.48		1.277907	88.9	600.45

			125 cfs				200 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
76710	3.78		0.6553216	32	516.73		0.7675806	50.8	558.19
76349.5	3.76		0.8837734	64	517.47		0.788843	50.8	668.51
76088	3.74		0.5929734	32	521.28		0.8804284	64	1006.53
75765	3.73		1.751124	128	519.88		2.000213	128	788.97
75565	3.71		2.364854	177.8	520.17		2.632243	177.8	655.98
74780.6	3.67		0.9352617	64	522.32		1.288475	88.9	603.73
73996.1	3.62		1.356793	101.6	521.23		1.748147	128	601.44
73211.7	3.58		0.4756905	32	524.13		0.642556	32	576.49
72427.2	3.53		1.479198	101.6	526.96		1.600613	101.6	584.57
71642.8	3.49		0.5367564	32	540.79		0.6389608	32	630.75
70858.3	3.44		1.378816	101.6	542.12		1.714847	128	632.00
70073.9	3.40		1.355282	101.6	482.06		1.667394	101.6	665.84
69289.4	3.35		0.6731972	50.8	478.36		0.8744764	64	707.92
68505	3.31		1.435676	101.6	492.08		1.697025	128	758.71
67706.6	3.26		0.3896665	25.4	503.05		0.5437144	32	764.60
66908.3	3.21		1.807059	128	665.16		1.766911	128	959.36
66110	3.17		0.6946802	50.8	509.13		0.8124665	50.8	775.49
65311.6	3.12		1.367293	101.6	497.30		1.563806	101.6	770.68
64513.3	3.08		0.6548538	32	412.98		0.9535412	64	682.71
63715	3.03		0.9075671	64	362.13		0.9911423	64	651.36
62916.6	2.98		0.502503	32	340.68		0.6490991	32	699.51
62118.3	2.94		1.261374	88.9	365.92		1.491661	101.6	718.96
61320	2.89		0.3885889	25.4	339.84		0.4127103	25.4	697.68
60788	2.86		0.5154445	32	346.15		1.292284	88.9	724.67
60218	2.83		0.6505362	32	608.15		0.9825564	64	1386.24
59540	2.79		0.5504699	32	358.84		0.6167015	32	721.32
58905	2.75		0.8092996	50.8	360.54		1.618833	101.6	737.04
57503.5	2.67		0.4989954	32	371.30		0.996645	64	748.08
56102	2.59		0.8694639	64	365.78		0.8830153	64	814.91
54700.5	2.51		0.5580669	32	372.54		0.7649524	50.8	801.30
53299	2.43		1.379671	101.6	358.77		0.8668422	64	863.06
53196	2.42		1.171727	88.9	365.20		1.173123	88.9	859.39
52861	2.40		1.607642	101.6	355.92		1.479246	101.6	940.55
51702	2.34		0.440905	32	400.48		0.9015597	64	799.75
50536.3	2.27		0.8336129	50.8	332.64		0.7286352	50.8	994.65
49370.6	2.20		0.3376738	25.4	353.46		0.5682218	32	715.62
48205	2.14		0.3031071	16	328.06		0.4773345	32	995.16
48111	2.13		0.4334366	32	330.99		0.5810195	32	1062.19
47945	2.12		0.9416459	64	333.37		0.6640338	32	895.57
47622	2.10		1.230786	88.9	347.92		1.073424	76.2	746.70
47388.6	2.09		0.8048658	50.8	343.29		1.074947	76.2	741.66
47155.3	2.07		0.6433681	32	342.27		1.087125	76.2	677.93
46922	2.06		0.5675399	32	306.52		0.9389885	64	652.99
46467.5	2.03		3.511901	256	174.35		0.5187163	32	552.45
44990	1.95		0.1725903	12.7	27.22		2.985773	203.2	53.33

			125 cfs				200 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
44251.2	1.91		0.6910833	50.8	32.03		0.7437218	50.8	48.43
43512.5	1.86		4.675287	330.2	22.98		4.114441	304.8	48.86
42035	1.78		5.16E-02	2	2.58		5.43E-02	4	6.85
40557.5	1.69		9.954771	635	0.05		0.8353031	50.8	0.14
39080	1.61		5.76E-02	4	0.41		9.55E-02	4	2.01
38808	1.59		2.297765	152.4	0.66		3.579875	256	6.02
38713	1.59		0.8659009	64	0.84		0.8559157	64	4.62
38256	1.56		0.5426591	32	0.59		0.867663	64	3.73
38020.3	1.55		1.169302	76.2	1.16		0.7670091	50.8	4.04
37784.6	1.53		0.4951507	32	1.48		0.8831041	64	4.64
37549	1.52		0.7306302	50.8	1.98		1.038425	76.2	4.62

			300 cfs				400 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
218986	12.31		0.8611102	64	0.95		1.281504	88.9	9.54
218747	12.27		0.3357887	25.4	3.56		0.499884	32	11.58
218509	12.22		1.822599	128	11.60		1.849086	128	12.35
218270	12.18		1.012391	76.2	15.01		1.06319	76.2	12.73
218032	12.13		0.7500576	50.8	22.60		0.8950174	64	30.50
217793	12.08		0.8585922	64	15.97		0.9279923	64	25.68
217555	12.04		1.106115	76.2	19.90		1.34409	101.6	35.29
217316	11.99		1.302983	88.9	14.39		1.344286	101.6	27.90
217078	11.95		0.5211577	32	19.54		0.7548452	50.8	21.90
216839	11.90		1.272482	88.9	22.47		0.9622938	64	22.36
216601	11.86		1.309582	88.9	25.90		2.254917	152.4	39.82
215844	11.81		0.9009332	64	27.70		1.034868	76.2	29.04
215735	11.81		0.5964758	32	30.55		0.7355897	50.8	27.16
215619	11.80		3.529199	256	30.25		3.378765	256	27.17
215566	11.80		3.364668	228.6	30.46		4.773275	355.6	27.06
215514	11.79		1.502132	101.6	37.67		1.467941	101.6	26.25
215403	11.79		1.720977	128	35.25		1.775353	128	26.15
215186	11.77		1.656909	101.6	39.04		1.923221	128	28.09
214042	11.71		2.501607	177.8	51.01		2.264425	152.4	73.32
212898	11.64		0.8497722	64	63.50		1.079994	76.2	75.62
211754	11.58		0.803525	50.8	64.16		1.095629	76.2	110.09
210610	11.51		0.4054449	25.4	46.71		0.4901738	32	90.39
210156	11.48		1.524062	101.6	51.11		1.91754	128	88.95
209795	11.46		3.523745	256	50.19		3.227477	228.6	88.43
209466	11.44		1.546058	101.6	75.88		2.261097	152.4	89.96
209017	11.42		4.083072	304.8	74.24		2.996648	203.2	93.99
208322	11.38		0.843908	64	61.47		0.9503812	64	134.10
207658	11.34		0.1913138	12.7	20.52		0.1690878	12.7	148.52
207178	11.31		8.61E-02	4	6.39		8.92E-02	4	151.80
206448	11.27		16.77557	1270	27.31		30.10741	2048	83.59
205961	11.24		6.777295	512	26.73		5.591946	406.4	83.77
204568	11.16		14.83947	1024	47.68		10.23598	762	216.63
203873	11.12		1.114856	76.2	52.08		1.162557	76.2	296.24
203176	11.08		1.631948	101.6	54.70		1.720368	128	321.80
202579	11.05		1.382247	101.6	57.86		1.6883	128	308.05
201784	11.00		1.410084	101.6	81.85		1.488838	101.6	338.10
200392	10.92		1.983132	128	84.13		2.272805	152.4	357.92
199000	10.84		1.328084	88.9	114.42		1.46066	101.6	365.86
197608	10.76		2.74142	203.2	117.24		2.661804	177.8	620.71
197473	10.75		1.079647	76.2	118.25		1.232609	88.9	625.97
197355	10.74		2.316826	152.4	119.18		2.548624	177.8	616.44
197140	10.73		1.757347	128	120.37		2.178741	152.4	608.11
196735	10.71		1.582913	101.6	135.55		1.901662	128	621.28
196475	10.69		1.81743	128	127.67		1.783395	128	552.68
196330	10.69		0.9510785	64	146.55		1.282329	88.9	529.21

Transect ID	River Mile		300 cfs Shear Stress (lb/sq ft)	300 cfs Grain Size Mobile (mm)	300 cfs Mass Capacity (tons/day)		400 cfs Shear Stress (lb/sq ft)	400 cfs Grain Size Mobile (mm)	400 cfs Mass Capacity (tons/day)
195520	10.64		2.131732	152.4	161.76		1.545996	101.6	527.61
194983	10.61		1.832649	128	162.09		2.506055	177.8	526.27
193901	10.55		2.242157	152.4	167.83		1.962236	128	544.76
192282	10.45		2.329044	152.4	170.79		3.237383	228.6	546.90
190663	10.36		1.77359	128	207.75		1.75781	128	691.71
189043	10.27		1.237748	88.9	228.20		1.767844	128	639.79
187424	10.17		1.557955	101.6	336.93		1.508733	101.6	816.51
185805	10.08		1.77341	128	469.70		2.29383	152.4	863.72
184186	9.98		1.737953	128	453.04		1.899493	128	843.14
183518	9.95		2.706469	203.2	468.97		2.701869	203.2	868.14
182567	9.89		2.097004	152.4	516.52		2.715873	203.2	1054.66
180947	9.80		1.65979	101.6	525.65		1.919021	128	1135.98
179328	9.70		1.627518	101.6	675.42		1.71136	128	1408.09
177709	9.61		1.35175	101.6	775.42		1.531178	101.6	1896.02
176090	9.52		1.908401	128	846.52		2.444105	177.8	2012.07
174470	9.42		1.832154	128	840.95		2.176847	152.4	1924.28
172851	9.33		1.702495	128	927.82		1.792575	128	1607.95
171937	9.28		1.420138	101.6	980.93		1.622393	101.6	1649.70
171232	9.24		1.349	101.6	1044.99		1.425578	101.6	1638.88
170379	9.19		2.575078	177.8	1205.70		4.284676	304.8	1630.96
169613	9.14		1.863471	128	1250.59		1.773653	128	1607.44
168754	9.09		1.464354	101.6	1112.64		2.084896	152.4	1605.64
167993	9.05		1.566318	101.6	488.98		1.56307	101.6	1517.33
166374	8.96		1.382498	101.6	1613.30		3.436951	256	1294.05
164755	8.86		1.258615	88.9	2052.54		1.990499	128	1293.64
163136	8.77		1.791891	128	982.99		2.727094	203.2	5424.26
161517	8.68		2.229508	152.4	1228.24		1.925989	128	2101.51
159920	8.58		1.146457	76.2	2655.74		1.384717	101.6	3088.23
158324	8.49		1.748409	128	1580.90		2.145823	152.4	3201.60
156728	8.40		1.501817	101.6	2081.07		1.317755	88.9	3165.64
155132	8.31		1.046458	76.2	2645.46		1.295722	88.9	3328.29
153536	8.22		1.163304	76.2	1698.21		1.304667	88.9	2976.77
151940	8.12		1.138047	76.2	793.27		1.242551	88.9	2799.59
150344	8.03		1.537499	101.6	457.29		1.568256	101.6	2578.88
148748	7.94		3.14403	228.6	982.50		3.739503	279.4	2769.29
147151	7.85		1.015911	76.2	1208.53		1.450835	101.6	2751.22
145555	7.75		1.836809	128	2803.05		1.83809	128	2747.30
143959	7.66		2.198999	152.4	1537.76		2.50034	177.8	2971.81
142363	7.57		1.545457	101.6	1212.81		1.780034	128	2882.07
140767	7.48		1.730391	128	2123.70		2.203617	152.4	2754.83
139171	7.39		1.32004	88.9	1978.52		1.68676	128	2823.81
138392	7.34		1.473985	101.6	1784.95		2.308439	152.4	2800.35
137575	7.29		1.221322	88.9	1243.62		1.659486	101.6	2653.36
135979	7.20		1.126966	76.2	805.10		0.8573149	64	1918.85
134458	7.11		1.00E+00	64	537.64		1.490182	101.6	1825.19

			300 cfs				400 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
132937	7.03		0.9050456	64	651.03		0.928189	64	2111.79
132269	6.99		1.380434	101.6	692.30		1.724605	128	2070.98
131416	6.94		1.309766	88.9	739.45		1.61739	101.6	2133.86
130679	6.89		0.5949275	32	651.59		1.039329	76.2	2129.34
129895	6.85		8.87E-01	64	432.29		1.047408	76.2	2007.55
129348	6.82		2.389461	177.8	600.50		1.982552	128	1672.87
128687	6.78		4.413515	330.2	4763.07		4.855392	355.6	6702.31
128374	6.76		4.240303	304.8	643.67		4.679491	330.2	1817.32
127620	6.72		2.993255	203.2	646.75		2.597348	177.8	2003.07
126992	6.68		2.354943	177.8	684.18		3.088319	228.6	1881.05
125611	6.60		2.666799	177.8	1250.69		2.881539	203.2	1866.86
124229	6.52		2.655034	177.8	1039.38		3.154784	228.6	2150.29
122848	6.44		1.88941	128	1322.55		2.171598	152.4	1988.55
121467	6.36		1.321209	88.9	1385.79		1.484209	101.6	2219.68
121186	6.35		1.954045	128	1493.54		2.25578	152.4	2281.65
121040	6.34		2.974266	203.2	1493.40		3.799701	279.4	2335.25
120651	6.32		1.531247	101.6	1477.93		1.859843	128	2298.31
119866	6.27		2.610035	177.8	1644.16		2.706479	203.2	2391.31
119081	6.23		1.859306	128	1613.85		1.565649	101.6	2256.98
117511	6.14		2.178672	152.4	1744.37		2.461631	177.8	2351.47
115942	6.05		2.090175	152.4	1696.30		2.044176	152.4	2511.67
114372	5.95		1.00823	76.2	1629.43		1.316836	88.9	2585.02
112803	5.86		1.707964	128	1727.93		1.625254	101.6	2439.67
111233	5.77		1.487381	101.6	1725.82		1.741913	128	2478.99
109663	5.68		1.892676	128	1721.73		2.266959	152.4	2629.58
108094	5.59		1.994644	128	1826.44		2.146096	152.4	2581.18
106524	5.50		1.175719	88.9	1652.47		1.271281	88.9	2547.99
104955	5.41		1.079664	76.2	1672.73		1.291021	88.9	2606.74
104923	5.41		4.464207	330.2	1679.89		6.580799	457.2	2642.88
104809	5.40		2.346565	177.8	1732.00		3.360557	228.6	2638.19
104297	5.37		2.712651	203.2	1690.18		1.888646	128	2630.19
103785	5.34		1.660087	101.6	1611.58		2.576346	177.8	2572.16
103502	5.33		2.071823	152.4	1497.20		1.813876	128	2633.46
103292	5.32		1.426521	101.6	1554.58		1.753417	128	2674.48
102044	5.24		2.883625	203.2	1624.46		2.894752	203.2	2610.89
100797	5.17		1.461799	101.6	1597.20		1.802359	128	2713.20
99550	5.10		2.381127	177.8	1617.58		2.415608	177.8	2672.38
99353.5	5.09		1.433686	101.6	1588.32		1.667433	101.6	2684.04
99157	5.08		5.36061	406.4	1620.31		5.432653	406.4	5358.68
98748.1	5.05		2.011395	152.4	1615.84		2.280628	152.4	2697.85
98339.2	5.03		3.368347	228.6	1551.77		3.711228	279.4	3200.85
97521.5	4.98		2.088442	152.4	1420.64		2.836161	203.2	3592.59
96703.8	4.93		2.082906	152.4	1408.65		2.168582	152.4	2690.80
95886.1	4.89		2.027282	152.4	1427.48		1.32545	88.9	2821.56
95068.4	4.84		1.30101	88.9	1467.10		1.505968	101.6	2858.92

			300 cfs				400 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
94250.7	4.79		1.141498	76.2	1128.00		1.692838	128	2448.56
93433	4.75		8.42E-01	50.8	881.27		0.9984977	64	2312.46
93043	4.72		6.83E-01	50.8	794.44		9.36E-01	64	2169.16
92615.2	4.70		2.87E-01	16	812.61		4.75E-01	32	2028.32
92380	4.68		4.159477	304.8	844.66		4.584047	330.2	4360.05
91797.5	4.65		4.878458	355.6	874.52		1.163994	76.2	2206.67
90979.8	4.60		0.7780746	50.8	849.47		1.349157	101.6	2224.26
90162.1	4.56		0.8034401	50.8	835.25		1.549961	101.6	2200.15
89344.4	4.51		1.195927	88.9	763.76		1.768707	128	2155.53
88526.7	4.46		0.8574348	64	711.30		0.9966762	64	2119.05
87709	4.42		0.9418543	64	637.38		1.09326	76.2	1836.73
86929	4.37		0.5839953	32	576.86		0.6955051	50.8	1646.51
86149	4.33		1.087441	76.2	498.73		1.160096	76.2	1479.40
85909	4.31		0.6673667	32	478.21		0.7287372	50.8	1267.15
85369	4.28		1.051333	76.2	415.17		1.147367	76.2	980.58
84974	4.26		0.7889455	50.8	351.24		0.8945377	64	884.61
84589	4.24		0.7301021	50.8	385.09		0.7751624	50.8	756.93
84251	4.22		2.744469	203.2	457.58		2.94343	203.2	866.51
83809	4.19		2.9296	203.2	3801.24		3.319757	228.6	701.20
83512	4.17		3.856316	279.4	4086.91		4.555493	330.2	68820.27
83272	4.16		1.662841	101.6	4151.85		1.742384	128	40364.38
83029	4.15		0.3362955	25.4	4287.18		0.4017878	25.4	7143.13
82905	4.14		0.3432607	25.4	4351.69		0.4393005	32	45175.86
82673	4.12		0.4623655	32	767.46		0.5857484	32	3616.45
82478	4.11		0.4007851	25.4	3179.10		0.5039821	32	19263.14
82249	4.10		0.3934226	25.4	3828.67		0.4926217	32	68747.77
82032	4.09		0.4419453	32	3139.06		0.5050148	32	2787.37
81824	4.08		0.2967698	16	1078.37		0.3385288	25.4	16014.64
81604	4.06		3.109558	228.6	2401.81		2.25655	152.4	4488.73
81448	4.05		3.042612	228.6	2328.27		3.245055	228.6	31209.51
81177	4.04		3.003836	203.2	2087.52		3.014389	228.6	17477.34
80958	4.03		2.527597	177.8	2300.71		2.68193	203.2	3091.57
80688	4.01		1.415885	101.6	2786.94		1.488803	101.6	3315.00
80481.5	4.00		1.446476	101.6	500.32		1.539538	101.6	38920.12
80234	3.98		0.3127857	16	521.25		0.3892183	25.4	60573.11
79970	3.97		0.3680183	25.4	521.30		0.5247701	32	5321.06
79786	3.96		0.9178454	64	524.70		1.830639	128	16747.20
79432	3.94		0.6594335	32	539.82		0.8305883	50.8	895.15
79123	3.92		1.213083	88.9	551.68		1.482121	101.6	902.65
78720	3.90		1.341462	101.6	554.63		1.138777	76.2	898.94
78460	3.88		1.460014	101.6	575.99		2.444393	177.8	864.38
78131	3.86		1.311594	88.9	592.56		1.388462	101.6	895.50
77797	3.84		1.36046	101.6	576.86		1.628194	101.6	849.25
77517	3.83		1.476907	101.6	576.00		1.410061	101.6	913.56
77134	3.81		1.533311	101.6	560.76		1.587166	101.6	980.97

			300 cfs				400 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
76710	3.78		0.9260337	64	574.35		1.247541	88.9	1036.15
76349.5	3.76		0.7874714	50.8	573.38		0.8062708	50.8	1052.74
76088	3.74		0.8732182	64	568.91		0.8057894	50.8	1053.74
75765	3.73		2.26675	152.4	549.90		2.494298	177.8	1057.92
75565	3.71		2.963858	203.2	576.88		3.265629	228.6	1066.24
74780.6	3.67		1.597116	101.6	2190.92		1.955014	128	1059.31
73996.1	3.62		2.034453	152.4	1085.66		2.085037	152.4	968.85
73211.7	3.58		0.8066841	50.8	1491.27		0.9389673	64	1134.93
72427.2	3.53		1.760087	128	1701.48		1.907829	128	1134.56
71642.8	3.49		0.7760652	50.8	1873.46		0.8593519	64	1194.58
70858.3	3.44		1.929068	128	1788.68		2.097898	152.4	1194.45
70073.9	3.40		1.741975	128	1794.61		1.827792	128	1354.84
69289.4	3.35		1.189568	88.9	1857.91		1.476096	101.6	1467.30
68505	3.31		1.830194	128	2096.22		1.971649	128	1653.77
67706.6	3.26		0.7286078	50.8	2158.15		0.9230353	64	1655.05
66908.3	3.21		1.837659	128	2261.08		1.843004	128	1438.17
66110	3.17		0.9647214	64	1974.03		1.101889	76.2	1374.53
65311.6	3.12		1.759365	128	2008.33		1.92667	128	1552.43
64513.3	3.08		1.407109	101.6	1912.88		1.579776	101.6	1600.68
63715	3.03		0.9481444	64	1921.43		1.135912	76.2	1636.62
62916.6	2.98		1.017998	76.2	1970.16		1.095856	76.2	1690.41
62118.3	2.94		1.178198	88.9	1948.98		1.474332	101.6	1688.13
61320	2.89		0.8409415	50.8	1989.62		1.009991	76.2	1687.78
60788	2.86		1.469352	101.6	3317.02		1.622099	101.6	1934.63
60218	2.83		1.00236	64	1986.23		1.134003	76.2	4284.17
59540	2.79		0.7641674	50.8	1964.92		1.071246	76.2	1709.39
58905	2.75		1.621909	101.6	1580.27		1.703299	128	1798.98
57503.5	2.67		1.1969	88.9	1317.33		1.358766	101.6	1766.10
56102	2.59		0.9925777	64	1534.87		1.219555	88.9	1798.89
54700.5	2.51		0.9530933	64	1579.26		1.007553	76.2	1879.28
53299	2.43		0.9581897	64	1652.70		1.077357	76.2	1901.87
53196	2.42		1.342826	101.6	1638.70		1.454806	101.6	1855.50
52861	2.40		1.739122	128	1643.26		2.037493	152.4	2033.47
51702	2.34		1.05359	76.2	1703.49		1.211686	88.9	1915.96
50536.3	2.27		0.8721453	64	1650.70		0.8209581	50.8	2116.40
49370.6	2.20		0.6868207	50.8	982.59		0.936709	64	1827.36
48205	2.14		0.4940403	32	801.03		0.4156782	25.4	1848.14
48111	2.13		0.6130358	32	761.25		0.5632997	32	1196.43
47945	2.12		0.6055382	32	573.11		0.6864961	50.8	1338.10
47622	2.10		1.113318	76.2	553.36		1.073613	76.2	1639.99
47388.6	2.09		1.298918	88.9	600.10		1.331735	88.9	1612.88
47155.3	2.07		1.485916	101.6	577.56		1.188515	88.9	1629.43
46922	2.06		1.248112	88.9	397.67		0.8114057	50.8	1529.51
46467.5	2.03		0.4089321	25.4	476.02		5.467338	406.4	1095.89
44990	1.95		5.511228	406.4	36.22		0.2351122	16	124.50

Transect ID	River Mile		300 cfs Shear Stress (lb/sq ft)	300 cfs Grain Size Mobile (mm)	300 cfs Mass Capacity (tons/day)		400 cfs Shear Stress (lb/sq ft)	400 cfs Grain Size Mobile (mm)	400 cfs Mass Capacity (tons/day)
44251.2	1.91		1.170857	76.2	38.96		0.969632	64	104.17
43512.5	1.86		1.635833	101.6	38.56		2.86213	203.2	116.84
42035	1.78		1.29E-01	8	3.05		0.2604846	16	31.62
40557.5	1.69		1.729848	128	0.08		2.874623	203.2	0.75
39080	1.61		0.1397293	8	0.00		0.1855782	12.7	33.13
38808	1.59		5.112674	381	2.83		4.811239	355.6	160.13
38713	1.59		0.8867549	64	2.77		0.9108543	64	66.80
38256	1.56		0.9392601	64	2.47		1.068687	76.2	46.61
38020.3	1.55		1.004929	76.2	2.65		1.022392	76.2	48.48
37784.6	1.53		1.045941	76.2	2.96		1.089155	76.2	57.70
37549	1.52		1.21192	88.9	2.47		1.295873	88.9	55.52

			500 cfs				750 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
218986	12.31		1.654783	101.6	1.68		2.384357	177.8	138.36
218747	12.27		0.6502846	32	1.03		1.122303	76.2	48.25
218509	12.22		1.744277	128	21.73		1.58042	101.6	29.13
218270	12.18		1.242253	88.9	38.80		1.266461	88.9	99.42
218032	12.13		0.9118233	64	35.16		1.314458	88.9	43.22
217793	12.08		1.032823	76.2	28.41		0.8317649	50.8	72.58
217555	12.04		1.443555	101.6	27.36		2.063887	152.4	96.78
217316	11.99		1.48592	101.6	25.13		1.329732	88.9	105.79
217078	11.95		0.790481	50.8	30.23		0.8349093	50.8	164.22
216839	11.90		0.9979378	64	33.27		1.055168	76.2	198.64
216601	11.86		2.574286	177.8	41.40		2.647963	177.8	190.67
215844	11.81		1.135762	76.2	38.99		1.281539	88.9	262.00
215735	11.81		0.8200437	50.8	37.60		1.186014	88.9	299.37
215619	11.80		3.963467	279.4	38.27		4.062536	304.8	256.82
215566	11.80		3.134226	228.6	37.79		5.496074	406.4	800.01
215514	11.79		1.84558	128	38.37		1.526541	101.6	357.54
215403	11.79		1.918397	128	38.78		2.123345	152.4	319.91
215186	11.77		2.075702	152.4	41.08		2.52255	177.8	297.14
214042	11.71		2.304038	152.4	52.69		1.618146	101.6	467.72
212898	11.64		1.301221	88.9	58.63		1.555133	101.6	481.56
211754	11.58		1.160756	76.2	69.28		1.824217	128	580.88
210610	11.51		0.6363725	32	62.71		0.8231239	50.8	668.99
210156	11.48		1.97946	128	63.45		2.313613	152.4	668.09
209795	11.46		4.341096	304.8	64.78		4.890358	355.6	620.35
209466	11.44		2.513156	177.8	82.74		1.698929	128	616.78
209017	11.42		2.360532	177.8	92.74		6.615762	457.2	649.60
208322	11.38		1.180645	88.9	107.16		5.118702	381	725.37
207658	11.34		0.2412256	16	86.51		0.253642	16	781.58
207178	11.31		0.103937	4	134.07		0.6794897	50.8	1089.98
206448	11.27		44.13351	2048	446.62		394.621	2048	650.48
205961	11.24		5.295208	381	443.67		1.545641	101.6	651.43
204568	11.16		9.369866	635	459.86		2.095832	152.4	534.53
203873	11.12		1.781479	128	462.78		1.608303	101.6	488.82
203176	11.08		2.240148	152.4	468.87		2.252728	152.4	598.09
202579	11.05		1.259485	88.9	468.80		1.79073	128	522.59
201784	11.00		1.987898	128	526.10		1.843101	128	561.13
200392	10.92		2.081053	152.4	524.31		2.190496	152.4	612.09
199000	10.84		1.536188	101.6	463.15		2.542124	177.8	898.61
197608	10.76		3.802341	279.4	460.17		3.462717	256	1125.78
197473	10.75		1.39065	101.6	456.62		1.525724	101.6	1167.10
197355	10.74		2.808156	203.2	457.53		3.052827	228.6	1224.71
197140	10.73		2.366934	177.8	460.27		2.319197	152.4	1343.25
196735	10.71		1.65886	101.6	457.79		2.121353	152.4	1400.72
196475	10.69		1.467653	101.6	457.29		1.813473	128	1328.97
196330	10.69		1.317129	88.9	459.46		1.60311	101.6	1518.19

			500 cfs				750 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
195520	10.64		2.638234	177.8	507.98		1.706215	128	1532.11
194983	10.61		2.377022	177.8	562.41		6.506328	457.2	1867.78
193901	10.55		2.669689	177.8	599.63		1.704589	128	1685.58
192282	10.45		2.761047	203.2	718.02		2.917534	203.2	2059.34
190663	10.36		2.219445	152.4	699.31		2.344403	177.8	2363.14
189043	10.27		1.608165	101.6	757.58		2.357367	177.8	2749.38
187424	10.17		2.072331	152.4	565.85		1.82191	128	3453.03
185805	10.08		2.413354	177.8	647.35		4.05204	304.8	3251.67
184186	9.98		2.243726	152.4	740.82		2.633635	177.8	2942.59
183518	9.95		2.483425	177.8	742.95		2.911173	203.2	3276.83
182567	9.89		3.010536	203.2	846.17		1.713528	128	3356.33
180947	9.80		2.504963	177.8	751.25		2.901715	203.2	3125.47
179328	9.70		1.956989	128	878.99		1.834801	128	2369.87
177709	9.61		1.479458	101.6	982.14		1.921779	128	2411.14
176090	9.52		2.961043	203.2	960.10		2.103597	152.4	2678.28
174470	9.42		2.17847	152.4	1270.46		2.252623	152.4	3236.31
172851	9.33		1.941444	128	1642.57		1.676208	101.6	4062.49
171937	9.28		1.76291	128	1650.90		1.550556	101.6	4224.43
171232	9.24		1.756326	128	1621.22		1.993627	128	5271.40
170379	9.19		4.41837	330.2	1709.84		2.216231	152.4	5150.61
169613	9.14		2.007684	128	1855.82		2.261178	152.4	4535.45
168754	9.09		2.530606	177.8	2174.06		2.061183	152.4	4582.02
167993	9.05		1.530186	101.6	2458.15		1.579271	101.6	3587.94
166374	8.96		4.478681	330.2	1308.41		1.620555	101.6	2755.02
164755	8.86		1.816364	128	3656.48		2.190727	152.4	2812.50
163136	8.77		4.215033	304.8	4194.29		1.911204	128	9866.89
161517	8.68		1.952549	128	2102.02		2.354003	177.8	7713.01
159920	8.58		1.68088	101.6	4107.05		1.728082	128	3277.45
158324	8.49		3.525223	256	4002.71		2.418113	177.8	3241.63
156728	8.40		1.317268	88.9	2094.26		2.159514	152.4	3298.33
155132	8.31		1.515123	101.6	2315.50		1.710102	128	3284.42
153536	8.22		2.846232	203.2	2061.72		1.940863	128	4730.38
151940	8.12		1.237685	88.9	2109.89		2.244641	152.4	5923.17
150344	8.03		1.152417	76.2	2211.23		1.6618	101.6	2268.50
148748	7.94		4.628449	330.2	2292.13		2.602969	177.8	2739.36
147151	7.85		1.629164	101.6	2535.74		1.740132	128	2765.61
145555	7.75		2.215703	152.4	3301.84		1.787301	128	2762.41
143959	7.66		2.522536	177.8	3361.45		2.389538	177.8	3095.53
142363	7.57		2.39852	177.8	3617.36		1.930068	128	3198.32
140767	7.48		2.167456	152.4	3841.08		2.656551	177.8	3757.70
139171	7.39		2.153553	152.4	3521.15		2.389436	177.8	4014.39
138392	7.34		2.152588	152.4	2844.55		3.201264	228.6	3577.35
137575	7.29		1.361664	101.6	2127.46		2.539173	177.8	4032.91
135979	7.20		1.287534	88.9	1426.57		1.299467	88.9	5310.15
134458	7.11		1.552567	101.6	1760.00		0.8990464	64	6516.10

			500 cfs				750 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
132937	7.03		1.341257	101.6	1816.24		3.66467	256	6651.71
132269	6.99		2.249439	152.4	1823.94		2.284707	152.4	6923.11
131416	6.94		1.304771	88.9	1813.90		2.474641	177.8	6788.11
130679	6.89		1.308185	88.9	1517.76		1.390369	101.6	5488.71
129895	6.85		1.119124	76.2	1385.36		1.750122	128	4381.51
129348	6.82		1.862525	128	1478.82		5.139132	381	2820.54
128687	6.78		5.194344	381	7039.08		9.465609	635	14301.89
128374	6.76		5.02356	381	5610.55		3.889105	279.4	3492.56
127620	6.72		2.485556	177.8	3190.97		5.632177	406.4	5650.85
126992	6.68		3.761693	279.4	2280.42		4.786119	355.6	7464.96
125611	6.60		3.27766	228.6	2147.96		4.745963	355.6	6468.83
124229	6.52		2.909421	203.2	2217.71		3.827728	279.4	3895.57
122848	6.44		2.511627	177.8	1686.82		2.90629	203.2	3583.29
121467	6.36		1.654186	101.6	1743.13		1.150321	76.2	3873.28
121186	6.35		3.009513	203.2	1471.06		0.95449	64	3902.38
121040	6.34		3.881933	279.4	1506.89		1.653907	101.6	3919.75
120651	6.32		1.995868	128	1309.45		1.549247	101.6	3469.46
119866	6.27		2.696481	203.2	1564.38		2.19012	152.4	3551.29
119081	6.23		2.79151	203.2	1640.88		2.144824	152.4	4050.74
117511	6.14		2.574516	177.8	1690.77		2.590336	177.8	4090.04
115942	6.05		2.129165	152.4	1688.49		1.556341	101.6	4311.02
114372	5.95		1.539749	101.6	1937.09		2.944442	203.2	4409.51
112803	5.86		1.750102	128	2003.72		1.764072	128	5075.86
111233	5.77		1.837461	128	1970.80		1.861118	128	5724.19
109663	5.68		2.961683	203.2	2013.66		3.110832	228.6	5432.08
108094	5.59		1.836567	128	2048.73		5.155188	381	4857.36
106524	5.50		1.453796	101.6	1693.14		0.5604206	32	5144.75
104955	5.41		1.753145	128	1844.87		0.1753679	12.7	5059.15
104923	5.41		7.294381	512	1852.19		3.939125	279.4	5025.68
104809	5.40		2.902685	203.2	1852.27		4.324048	304.8	5155.52
104297	5.37		2.239861	152.4	1820.68		7.744063	512	5186.75
103785	5.34		2.284834	152.4	1824.93		1.631192	101.6	5102.51
103502	5.33		2.909794	203.2	1901.94		2.382902	177.8	5278.48
103292	5.32		1.901011	128	1829.64		1.894887	128	5002.19
102044	5.24		2.329616	152.4	1858.91		3.621152	256	3600.25
100797	5.17		2.128031	152.4	1930.89		2.21191	152.4	3521.24
99550	5.10		2.327851	152.4	1884.61		1.391552	101.6	2161.29
99353.5	5.09		2.31565	152.4	1846.70		4.428108	330.2	1801.73
99157	5.08		5.710672	431.8	9845.07		5.414316	406.4	3470.60
98748.1	5.05		3.273788	228.6	1928.47		2.993889	203.2	2647.88
98339.2	5.03		3.509244	256	1963.29		3.429723	256	6875.19
97521.5	4.98		3.422194	256	1990.00		7.36978	512	8510.18
96703.8	4.93		2.214207	152.4	2059.86		3.723227	279.4	6632.72
95886.1	4.89		1.952361	128	1905.17		2.171901	152.4	2200.62
95068.4	4.84		1.814447	128	1875.97		1.64687	101.6	2211.46

			500 cfs				750 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
94250.7	4.79		1.20077	88.9	1655.40		1.43203	101.6	2288.93
93433	4.75		1.061877	76.2	1591.00		1.010783	76.2	2411.07
93043	4.72		1.120426	76.2	1612.77		0.3606018	25.4	2403.24
92615.2	4.70		1.06E+00	76.2	1562.49		8.29E-02	4	2382.36
92380	4.68		4.969573	355.6	1650.04		5.394728	406.4	3874.12
91797.5	4.65		0.990381	64	1678.35		3.800736	279.4	2485.63
90979.8	4.60		1.170982	76.2	1664.23		0.7644448	50.8	2601.71
90162.1	4.56		1.436056	101.6	1605.87		1.337024	88.9	2787.48
89344.4	4.51		1.906909	128	1564.08		1.821093	128	2726.75
88526.7	4.46		1.244949	88.9	1472.08		0.894775	64	2844.80
87709	4.42		1.189055	88.9	1241.11		1.169326	76.2	2622.77
86929	4.37		0.9444165	64	1059.38		0.9294738	64	2565.69
86149	4.33		1.86643	128	930.27		1.551476	101.6	2540.57
85909	4.31		1.017093	76.2	788.73		0.7723432	50.8	2214.00
85369	4.28		1.589286	101.6	752.11		0.8064489	50.8	2054.07
84974	4.26		1.415132	101.6	685.58		0.6789551	50.8	1835.04
84589	4.24		1.299806	88.9	698.73		0.3847919	25.4	1704.40
84251	4.22		2.973221	203.2	848.21		0.498943	32	1854.47
83809	4.19		3.686361	279.4	6091.47		0.1380875	8	1589.78
83512	4.17		5.219407	381	6243.20		3.698578	279.4	82668.69
83272	4.16		1.821281	128	6284.24		4.360676	330.2	47870.99
83029	4.15		0.6009664	32	6451.68		6.115229	457.2	52702.88
82905	4.14		0.5727039	32	6433.92		4.101243	304.8	56094.70
82673	4.12		0.5545307	32	1324.86		1.361899	101.6	16033.84
82478	4.11		0.5042588	32	3858.73		10.36388	762	4858.19
82249	4.10		0.5055392	32	5628.79		4.631196	330.2	86447.27
82032	4.09		0.5217711	32	4665.90		5.767643	431.8	10946.85
81824	4.08		0.4606412	32	816.60		2.611638	177.8	16110.34
81604	4.06		2.121519	152.4	3605.04		8.131038	512	6985.21
81448	4.05		3.41572	256	3667.75		17.41781	1270	8342.37
81177	4.04		3.025581	228.6	3300.79		15.21742	1024	29094.77
80958	4.03		2.879844	203.2	3302.93		10.14728	762	5689.98
80688	4.01		1.547118	101.6	4202.62		8.34247	512	6166.77
80481.5	4.00		1.623865	101.6	1953.42		5.707367	431.8	6609.73
80234	3.98		0.5559104	32	928.38		1.008494	76.2	57318.81
79970	3.97		0.6771271	50.8	896.70		0.699832	50.8	10849.86
79786	3.96		3.065188	228.6	903.06		1.027306	76.2	40525.34
79432	3.94		1.034078	76.2	897.53		1.244	88.9	2121.27
79123	3.92		1.451112	101.6	907.29		2.97772	203.2	2141.45
78720	3.90		1.245565	88.9	915.43		1.715518	128	2047.05
78460	3.88		2.608744	177.8	910.85		3.257202	228.6	6735.72
78131	3.86		2.208299	152.4	911.61		2.103472	152.4	2154.66
77797	3.84		1.490304	101.6	915.29		2.021691	152.4	2199.27
77517	3.83		1.235439	88.9	909.62		1.342075	101.6	2244.63
77134	3.81		1.269061	88.9	910.75		1.182419	88.9	2259.55

			500 cfs				750 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
76710	3.78		1.30747	88.9	901.61		1.213483	88.9	2176.65
76349.5	3.76		1.080153	76.2	881.76		1.246331	88.9	2256.91
76088	3.74		0.8446903	64	844.60		1.263429	88.9	2059.68
75765	3.73		2.701942	203.2	798.16		2.831074	203.2	2215.29
75565	3.71		3.502971	256	850.39		3.87886	279.4	2264.91
74780.6	3.67		2.092919	152.4	5195.03		2.074352	152.4	2270.64
73996.1	3.62		2.148835	152.4	11087.34		2.004662	128	2420.47
73211.7	3.58		1.052159	76.2	2669.08		1.206613	88.9	2381.12
72427.2	3.53		2.060849	152.4	9871.68		2.446524	177.8	2412.60
71642.8	3.49		0.9623381	64	1978.23		1.280859	88.9	2094.76
70858.3	3.44		2.24249	152.4	9083.95		2.940538	203.2	2316.26
70073.9	3.40		2.217033	152.4	1898.33		2.907763	203.2	10540.36
69289.4	3.35		1.60819	101.6	2494.89		2.309875	152.4	2340.44
68505	3.31		2.100378	152.4	3315.34		2.596436	177.8	2399.24
67706.6	3.26		1.168601	76.2	4417.80		2.022897	152.4	2397.32
66908.3	3.21		1.859414	128	4625.81		2.444106	177.8	8463.55
66110	3.17		1.245106	88.9	3593.21		1.759576	128	2556.33
65311.6	3.12		2.074884	152.4	3682.77		2.741749	203.2	2560.86
64513.3	3.08		1.514516	101.6	3573.94		1.69536	128	2870.35
63715	3.03		1.457633	101.6	3653.77		0.721293	50.8	3238.75
62916.6	2.98		1.015007	76.2	3578.74		2.524762	177.8	3462.23
62118.3	2.94		2.241414	152.4	3659.13		1.474692	101.6	3464.96
61320	2.89		0.9560144	64	3566.34		0.3980523	25.4	3271.63
60788	2.86		1.757328	128	3597.09		0.4033642	25.4	3548.33
60218	2.83		1.378906	101.6	3500.32		1.148407	76.2	11278.48
59540	2.79		1.123114	76.2	2973.02		0.8461154	64	3573.54
58905	2.75		1.35834	101.6	2020.86		1.243373	88.9	4106.54
57503.5	2.67		1.206677	88.9	2309.48		1.279073	88.9	4402.28
56102	2.59		1.463665	101.6	2415.27		1.1122	76.2	5003.32
54700.5	2.51		1.172087	88.9	2522.95		1.317851	88.9	4452.72
53299	2.43		1.198252	88.9	2567.49		1.340148	101.6	5529.21
53196	2.42		1.603653	101.6	2637.75		1.824615	128	4642.34
52861	2.40		2.067177	152.4	2434.94		1.834029	128	4744.43
51702	2.34		1.065539	76.2	2662.18		1.280005	88.9	4697.02
50536.3	2.27		1.125804	76.2	2338.00		1.18121	88.9	4523.07
49370.6	2.20		0.8728561	64	1440.85		0.9690254	64	4458.93
48205	2.14		0.8726646	64	1265.31		0.4569032	32	3787.05
48111	2.13		0.8274634	50.8	1445.78		0.6926584	50.8	4070.74
47945	2.12		0.9132519	64	1294.07		0.891891	64	3854.00
47622	2.10		1.553406	101.6	1243.27		2.388173	177.8	3581.12
47388.6	2.09		1.575148	101.6	1190.36		2.547256	177.8	3435.29
47155.3	2.07		1.415712	101.6	1169.04		2.44785	177.8	3818.04
46922	2.06		1.248221	88.9	1052.84		2.319522	152.4	3813.32
46467.5	2.03		1.407809	101.6	167.80		2.188125	152.4	1753.14
44990	1.95		1.096724	76.2	333.97		2.517392	177.8	1270.01

			500 cfs				750 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
44251.2	1.91		0.7929583	50.8	33.09		3.235823	228.6	639.77
43512.5	1.86		5.175282	381	123.27		2.168047	152.4	503.09
42035	1.78		0.5228541	32	22.62		1.148409	76.2	160.18
40557.5	1.69		4.793223	355.6	0.84		3.407751	256	7.69
39080	1.61		0.2273728	16	128.55		15.45299	1024	228.85
38808	1.59		4.698664	355.6	37.94		2.369992	177.8	448.22
38713	1.59		0.96323	64	23.26		1.19136	88.9	837.43
38256	1.56		0.8891584	64	50.99		0.917215	64	652.74
38020.3	1.55		1.454164	101.6	24.05		1.789062	128	925.98
37784.6	1.53		1.089156	76.2	34.53		0.9363953	64	832.13
37549	1.52		1.347981	101.6	40.00		1.474387	101.6	881.68

			1000 cfs				1500 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
218986	12.31		3.006137	203.2	0.00		4.103085	304.8	1.44
218747	12.27		1.622395	101.6	0.00		2.954324	203.2	4.05
218509	12.22		1.500176	101.6	22.46		1.416071	101.6	18.14
218270	12.18		1.425941	101.6	24.02		1.758133	128	37.56
218032	12.13		1.579785	101.6	45.17		2.266742	152.4	26.15
217793	12.08		0.8425617	50.8	46.01		0.9538648	64	70.16
217555	12.04		2.588771	177.8	47.94		3.910373	279.4	89.65
217316	11.99		1.272243	88.9	63.45		1.156922	76.2	87.33
217078	11.95		0.9242347	64	67.02		1.010205	76.2	79.50
216839	11.90		1.183766	88.9	75.19		1.687132	128	77.71
216601	11.86		2.8357	203.2	78.77		2.850457	203.2	82.00
215844	11.81		1.553276	101.6	80.47		2.215463	152.4	110.01
215735	11.81		1.507188	101.6	81.51		2.29379	152.4	125.90
215619	11.80		3.911858	279.4	81.82		4.379971	330.2	124.96
215566	11.80		3.933253	279.4	84.38		3.623545	256	124.72
215514	11.79		2.34448	177.8	82.42		3.752415	279.4	137.91
215403	11.79		2.726738	203.2	93.24		2.574902	177.8	142.03
215186	11.77		2.590814	177.8	99.52		3.679328	256	204.48
214042	11.71		1.670972	101.6	155.41		1.573344	101.6	243.99
212898	11.64		1.990132	128	182.38		2.883539	203.2	264.45
211754	11.58		1.835367	128	258.24		2.753536	203.2	276.13
210610	11.51		1.187024	88.9	325.03		1.747658	128	296.89
210156	11.48		2.85352	203.2	315.29		2.867471	203.2	302.38
209795	11.46		4.563914	330.2	309.33		5.816642	431.8	302.56
209466	11.44		1.881572	128	272.10		2.22028	152.4	336.71
209017	11.42		6.730867	457.2	247.95		4.748973	355.6	321.18
208322	11.38		4.596753	330.2	197.40		2.244912	152.4	302.08
207658	11.34		1.040212	76.2	119.50		0.4189031	25.4	285.54
207178	11.31		0.6471372	32	46.50		0.3326457	16	172.40
206448	11.27		458.6458	2048	245.32		292.399	2048	552.01
205961	11.24		1.887579	128	205.11		5.888778	431.8	455.53
204568	11.16		1.589355	101.6	404.72		5.258767	381	580.57
203873	11.12		1.470453	101.6	460.05		2.262556	152.4	619.33
203176	11.08		7.277498	512	512.28		7.169053	512	635.70
202579	11.05		1.702356	128	689.84		2.760336	203.2	651.72
201784	11.00		2.744211	203.2	1077.07		2.394844	177.8	700.04
200392	10.92		1.689751	128	887.08		4.691321	355.6	725.64
199000	10.84		2.102226	152.4	758.76		1.80871	128	782.35
197608	10.76		3.991776	279.4	771.85		3.704605	279.4	983.49
197473	10.75		1.576101	101.6	772.60		1.504087	101.6	995.80
197355	10.74		3.085798	228.6	807.78		3.296952	228.6	1015.61
197140	10.73		3.190372	228.6	835.93		9.349623	635	991.40
196735	10.71		2.065248	152.4	823.20		2.595935	177.8	980.76
196475	10.69		2.00096	128	835.79		2.363346	177.8	983.81
196330	10.69		2.261344	152.4	848.93		2.154299	152.4	1010.20

		1000 cfs			1500 cfs		
Transect ID	**River Mile**	**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**	**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
195520	10.64	3.445303	256	847.72	2.593952	177.8	1019.69
194983	10.61	7.640659	512	1070.95	6.886204	512	17266.55
193901	10.55	1.293261	88.9	866.83	1.594511	101.6	1307.13
192282	10.45	5.411737	406.4	1235.99	8.426299	635	1343.78
190663	10.36	2.153489	152.4	1117.35	2.775736	203.2	2158.17
189043	10.27	4.136727	304.8	1371.02	3.418468	256	2891.55
187424	10.17	1.702832	128	1890.11	2.256758	152.4	3453.10
185805	10.08	3.536171	256	2310.58	3.588616	256	3840.57
184186	9.98	2.245351	152.4	2836.77	2.790158	203.2	3968.99
183518	9.95	5.822546	431.8	2884.93	3.368426	228.6	3930.83
182567	9.89	1.790172	128	3047.20	1.801112	128	4124.22
180947	9.80	2.992316	203.2	3093.35	3.623402	256	4395.98
179328	9.70	2.003918	128	3147.78	2.518535	177.8	4641.20
177709	9.61	2.162142	152.4	3198.07	2.142677	152.4	4692.18
176090	9.52	2.126529	152.4	6069.14	2.478337	177.8	5596.62
174470	9.42	2.028328	152.4	3842.28	2.504405	177.8	16674.91
172851	9.33	2.086722	152.4	3277.75	2.470753	177.8	4821.50
171937	9.28	1.799456	128	3346.54	2.830345	203.2	4793.81
171232	9.24	2.236316	152.4	3295.47	2.479314	177.8	4697.41
170379	9.19	2.648783	177.8	3184.73	2.836155	203.2	4596.92
169613	9.14	2.366731	177.8	11706.05	3.026492	228.6	4333.92
168754	9.09	2.520095	177.8	3098.49	3.592378	256	4119.83
167993	9.05	1.957717	128	2877.29	2.32669	152.4	3742.17
166374	8.96	1.935269	128	2464.80	2.011782	152.4	3323.10
164755	8.86	1.997838	128	1961.52	2.957125	203.2	2803.26
163136	8.77	1.906287	128	14193.34	1.988071	128	20126.80
161517	8.68	3.210887	228.6	6945.99	2.78314	203.2	21231.71
159920	8.58	1.754988	128	18310.05	2.265968	152.4	12980.00
158324	8.49	2.432916	177.8	3726.92	3.505248	256	18598.28
156728	8.40	2.687812	203.2	5648.83	2.037489	152.4	4389.52
155132	8.31	1.794352	128	6265.20	1.799333	128	15260.68
153536	8.22	2.627567	177.8	4516.66	2.515987	177.8	3059.03
151940	8.12	1.885528	128	2754.53	2.048007	152.4	4029.53
150344	8.03	2.209264	152.4	2710.38	2.459694	177.8	10227.16
148748	7.94	2.557057	177.8	8033.02	2.83031	203.2	23568.57
147151	7.85	2.080298	152.4	8337.77	2.405291	177.8	10750.10
145555	7.75	1.733183	128	2984.33	2.244301	152.4	18106.06
143959	7.66	2.973068	203.2	4395.05	3.020448	228.6	9476.74
142363	7.57	2.21522	152.4	4742.06	3.003346	203.2	9197.97
140767	7.48	2.625058	177.8	5222.04	2.972606	203.2	9383.26
139171	7.39	2.666518	177.8	6558.68	2.707183	203.2	9039.80
138392	7.34	3.233534	228.6	7420.81	3.64179	256	9238.84
137575	7.29	2.575466	177.8	7739.49	2.434908	177.8	8866.72
135979	7.20	1.36465	101.6	7662.03	2.207453	152.4	7410.92
134458	7.11	1.283014	88.9	7881.42	1.905242	128	5039.75

Transect ID	River Mile		1000 cfs Shear Stress (lb/sq ft)	1000 cfs Grain Size Mobile (mm)	1000 cfs Mass Capacity (tons/day)		1500 cfs Shear Stress (lb/sq ft)	1500 cfs Grain Size Mobile (mm)	1500 cfs Mass Capacity (tons/day)
132937	7.03		3.94556	279.4	7559.68		4.83729	355.6	4371.68
132269	6.99		2.427086	177.8	7628.65		4.639462	330.2	3847.59
131416	6.94		2.266119	152.4	6804.95		2.885887	203.2	2743.23
130679	6.89		2.198956	152.4	6902.62		2.533529	177.8	3329.54
129895	6.85		1.461789	101.6	6913.44		1.560357	101.6	3215.99
129348	6.82		4.69598	355.6	7078.56		2.220927	152.4	2009.55
128687	6.78		8.246041	512	14342.24		3.681798	279.4	1162.15
128374	6.76		3.600763	256	16256.87		2.882182	203.2	22787.02
127620	6.72		6.617353	457.2	15397.62		9.044336	635	24289.69
126992	6.68		5.427337	406.4	14514.17		7.54098	512	22255.40
125611	6.60		6.368464	457.2	7788.29		8.196337	512	1815.91
124229	6.52		4.70868	355.6	3923.17		3.855275	279.4	1994.46
122848	6.44		2.832254	203.2	3173.06		3.006686	203.2	2009.32
121467	6.36		1.290031	88.9	2716.07		0.8313687	50.8	2134.67
121186	6.35		1.827492	128	2882.93		0.5057929	32	2212.63
121040	6.34		1.453821	101.6	2752.07		1.544851	101.6	2169.67
120651	6.32		1.605131	101.6	2621.26		2.034384	152.4	2105.97
119866	6.27		2.254111	152.4	3043.41		2.64612	177.8	2356.22
119081	6.23		2.441832	177.8	3202.06		2.940148	203.2	2397.37
117511	6.14		2.578129	177.8	3165.51		2.495046	177.8	2414.33
115942	6.05		2.329988	152.4	3297.25		2.893002	203.2	2551.66
114372	5.95		2.842787	203.2	3377.74		4.138763	304.8	2507.76
112803	5.86		2.181957	152.4	3474.02		1.759503	128	2659.76
111233	5.77		1.954327	128	3541.79		2.209246	152.4	2710.97
109663	5.68		2.798494	203.2	3895.92		2.64107	177.8	2850.31
108094	5.59		5.521587	406.4	4105.57		4.277257	304.8	3216.94
106524	5.50		0.5717096	32	4684.27		0.7157095	50.8	3394.95
104955	5.41		0.1678774	12.7	3918.23		0.1874153	12.7	2719.95
104923	5.41		3.648404	256	4080.55		5.416065	406.4	3030.02
104809	5.40		4.059739	304.8	3643.07		5.221492	381	2656.62
104297	5.37		6.23237	457.2	2607.99		4.461108	330.2	2074.44
103785	5.34		2.113322	152.4	1880.05		3.267665	228.6	1022.01
103502	5.33		2.266218	152.4	2164.47		1.87296	128	9619.12
103292	5.32		1.905567	128	1853.48		2.18925	152.4	1200.71
102044	5.24		2.508602	177.8	1886.68		2.824586	203.2	1202.75
100797	5.17		2.326177	152.4	1894.68		2.798939	203.2	1075.80
99550	5.10		1.377239	101.6	1401.95		2.068163	152.4	846.95
99353.5	5.09		5.924017	431.8	1227.00		4.748688	355.6	745.35
99157	5.08		5.499779	406.4	20796.38		5.067342	381	29298.71
98748.1	5.05		3.258716	228.6	1528.16		4.355803	330.2	3125.51
98339.2	5.03		3.885418	279.4	8128.33		7.603113	512	11295.56
97521.5	4.98		8.994657	635	1536.27		8.749527	635	6764.93
96703.8	4.93		4.130237	304.8	1544.89		5.171662	381	7048.55
95886.1	4.89		2.585919	177.8	1620.04		5.179147	381	1079.49
95068.4	4.84		1.569682	101.6	1654.41		1.417938	101.6	1125.35

			1000 cfs				1500 cfs		
Transect ID	**River Mile**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**		**Shear Stress (lb/sq ft)**	**Grain Size Mobile (mm)**	**Mass Capacity (tons/day)**
94250.7	4.79		1.763103	128	1814.24		1.529916	101.6	1157.31
93433	4.75		1.239792	88.9	1600.30		0.7431846	50.8	1142.58
93043	4.72		0.9841406	64	1761.25		0.7272414	50.8	1138.09
92615.2	4.70		0.51593	32	1659.72		0.4321792	32	1113.07
92380	4.68		6.251526	457.2	1623.86		8.438193	635	1142.36
91797.5	4.65		3.606839	256	1604.55		3.524164	256	1063.81
90979.8	4.60		0.9102821	64	1796.03		3.134757	228.6	1300.98
90162.1	4.56		1.642022	101.6	1947.32		1.482251	101.6	1431.97
89344.4	4.51		1.913526	128	2054.46		1.857296	128	1506.57
88526.7	4.46		1.622156	101.6	2065.62		1.512561	101.6	1765.50
87709	4.42		0.9430621	64	2037.99		1.464499	101.6	2075.80
86929	4.37		0.7809442	50.8	2040.73		0.8694566	64	2291.89
86149	4.33		1.278408	88.9	1975.69		0.9272509	64	2395.82
85909	4.31		0.9504946	64	1784.57		0.8423184	50.8	2571.84
85369	4.28		0.7638456	50.8	1803.38		0.8198068	50.8	2563.21
84974	4.26		0.6996371	50.8	1571.48		0.5548273	32	2605.56
84589	4.24		0.4027655	25.4	1654.97		0.4033604	25.4	2705.60
84251	4.22		0.4956748	32	1830.22		0.5225375	32	2761.93
83809	4.19		0.155518	8	6474.84		0.1665407	8	8060.86
83512	4.17		4.009272	279.4	11494.43		4.632809	330.2	16661.47
83272	4.16		3.77532	279.4	11032.46		3.598191	256	15551.04
83029	4.15		7.186451	512	11331.96		5.565717	406.4	15710.82
82905	4.14		4.446154	330.2	11267.64		7.240798	512	15774.49
82673	4.12		1.674409	101.6	2334.99		2.840401	203.2	3727.03
82478	4.11		13.10882	762	7826.46		14.70925	1024	11836.81
82249	4.10		5.532798	406.4	9827.59		7.844399	512	14057.88
82032	4.09		6.993632	512	8467.50		10.22223	762	12823.46
81824	4.08		2.791931	203.2	1670.85		3.751643	279.4	2626.06
81604	4.06		10.02062	635	8383.19		15.18873	1024	14446.32
81448	4.05		22.2319	1524	8677.88		29.96971	2048	14974.43
81177	4.04		20.11168	1524	7583.70		34.23908	2048	13874.46
80958	4.03		13.01811	762	8003.54		20.99003	1524	13751.36
80688	4.01		10.58004	762	8121.15		16.80332	1270	13767.22
80481.5	4.00		6.975859	512	7906.21		10.53778	762	12481.12
80234	3.98		1.522937	101.6	1977.87		3.020896	228.6	2872.55
79970	3.97		1.087775	76.2	1967.39		2.540861	177.8	2829.89
79786	3.96		1.419102	101.6	9015.20		1.726471	128	6735.80
79432	3.94		2.004708	128	2403.80		2.409184	177.8	7373.87
79123	3.92		2.844547	203.2	2003.45		3.780015	279.4	2861.28
78720	3.90		1.477549	101.6	1969.97		1.315873	88.9	2851.10
78460	3.88		3.748979	279.4	7726.21		4.994291	355.6	47790.85
78131	3.86		2.235224	152.4	1974.85		2.579198	177.8	2894.86
77797	3.84		2.839446	203.2	2010.21		3.319316	228.6	2860.50
77517	3.83		1.738629	128	2027.08		1.925288	128	2862.00
77134	3.81		1.111433	76.2	1969.81		1.059996	76.2	2938.76

			1000 cfs				1500 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
76710	3.78		1.177007	88.9	2080.50		1.177433	88.9	2850.99
76349.5	3.76		1.230851	88.9	1934.66		1.127507	76.2	2787.08
76088	3.74		1.415519	101.6	1886.00		1.329213	88.9	2931.18
75765	3.73		3.1507	228.6	1796.57		3.888713	279.4	2793.28
75565	3.71		4.305037	304.8	1929.96		4.867202	355.6	2883.51
74780.6	3.67		2.156409	152.4	9756.34		2.421563	177.8	12939.08
73996.1	3.62		1.961339	128	17364.02		2.160279	152.4	22276.97
73211.7	3.58		1.386314	101.6	5928.08		1.762182	128	7407.23
72427.2	3.53		2.65727	177.8	15994.57		3.170432	228.6	21659.52
71642.8	3.49		1.41106	101.6	3978.89		1.568194	101.6	2857.33
70858.3	3.44		3.025578	228.6	15999.44		3.359037	228.6	22467.38
70073.9	3.40		3.315475	228.6	13025.84		2.641194	177.8	13492.32
69289.4	3.35		2.864985	203.2	10260.34		3.201147	228.6	17929.73
68505	3.31		3.072851	228.6	12944.35		3.649426	256	18759.84
67706.6	3.26		2.704937	203.2	2910.26		3.382503	256	5865.90
66908.3	3.21		2.442317	177.8	10213.63		2.097077	152.4	13369.37
66110	3.17		2.073065	152.4	3160.23		2.909744	203.2	5511.89
65311.6	3.12		3.182665	228.6	8848.06		5.106196	381	13355.24
64513.3	3.08		1.818069	128	12976.89		2.148938	152.4	18308.82
63715	3.03		0.6929642	50.8	5656.79		0.8294985	50.8	6747.95
62916.6	2.98		2.93159	203.2	6493.51		3.96993	279.4	10894.81
62118.3	2.94		1.594626	101.6	4836.41		1.898383	128	12902.85
61320	2.89		0.4305607	32	3012.92		0.550716	32	2934.13
60788	2.86		0.3772852	25.4	7094.88		0.4548666	32	13425.72
60218	2.83		1.25711	88.9	6859.07		1.591823	101.6	2929.46
59540	2.79		0.857782	64	10488.93		1.263618	88.9	14375.40
58905	2.75		1.431543	101.6	5064.81		2.708876	203.2	8322.71
57503.5	2.67		1.94337	128	3256.89		2.229282	152.4	11369.77
56102	2.59		1.229689	88.9	4435.64		1.703962	128	10545.43
54700.5	2.51		1.307032	88.9	4509.42		1.939639	128	4156.06
53299	2.43		1.135584	76.2	5249.17		0.8687605	64	4879.14
53196	2.42		1.717655	128	4821.60		2.763604	203.2	4761.08
52861	2.40		1.781619	128	5106.88		2.541559	177.8	4970.83
51702	2.34		1.258833	88.9	4882.42		0.973639	64	5266.25
50536.3	2.27		1.313841	88.9	4259.55		1.105728	76.2	4332.71
49370.6	2.20		1.109615	76.2	1569.69		0.7941865	50.8	2108.76
48205	2.14		0.3585916	25.4	629.27		0.4410673	32	748.39
48111	2.13		0.6885853	50.8	733.42		0.7621853	50.8	1278.43
47945	2.12		1.070145	76.2	1232.23		1.25469	88.9	1383.30
47622	2.10		1.985957	128	1242.75		1.695918	128	1397.63
47388.6	2.09		2.157752	152.4	1247.89		2.030995	152.4	1402.95
47155.3	2.07		2.163734	152.4	1250.08		2.267442	152.4	1404.66
46922	2.06		2.004235	128	1151.78		2.2961	152.4	1390.95
46467.5	2.03		1.890996	128	725.06		3.060274	228.6	1170.50
44990	1.95		2.313396	152.4	890.34		2.218637	152.4	1057.97

			1000 cfs				1500 cfs		
Transect ID	River Mile		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)		Shear Stress (lb/sq ft)	Grain Size Mobile (mm)	Mass Capacity (tons/day)
44251.2	1.91		4.565202	330.2	185.55		3.694141	279.4	591.23
43512.5	1.86		2.218924	152.4	685.68		6.809453	512	706.30
42035	1.78		1.8257	128	133.33		0.9837479	64	1339.23
40557.5	1.69		3.131625	228.6	10.73		9.003928	635	3.88
39080	1.61		21.99027	1524	3339.23		37.62601	2048	23292.43
38808	1.59		2.391797	177.8	146.07		4.121188	304.8	204.22
38713	1.59		1.260788	88.9	137.83		1.098205	76.2	291.01
38256	1.56		1.43016	101.6	57.48		1.496514	101.6	160.68
38020.3	1.55		1.780402	128	65.72		2.490766	177.8	186.56
37784.6	1.53		1.218936	88.9	83.60		1.283239	88.9	147.81
37549	1.52		1.746394	128	72.51		1.934529	128	119.38

Appendix 2. Comment/Response Matrix

Geomorphology and Sediment Transport
Comment-Response Table

Comment #	Agency/Interested Party	Draft Geomorphology and Sediment Transport Section (Page) *"Text"*	Comment	Response
General				
1	U.S. Fish and Wildlife Service		The models for the Geomorphology and Sediment Study will be used to help predict how sediment, the channel, and salmon habitat may change in the river system depending on sediment sources and potential flow regimes. However, additional information on sediment is requested, as described below.	See response to comment 3 below.
Section 4.5 Sediment Transport Model Development				
2	U.S. Fish and Wildlife Service	Section 4.5.1.1. Hydraulic Model Development (Pages 21-22)	Manning's n and hydraulic conditions are extrapolated to 1,500 cubic feet per second (cfs) based on model inputs of 122 cfs. The hydraulic model predicts trends of deposition and erosion within reaches typified by gravel and cobble substrates with flows up to 150 cfs. While the model can predict which reaches saw aggradation or degradation, it's likely that these reaches would not all be aggrading or degrading under reference conditions. This indicates the test flows were not high enough for a sediment transport capacity sufficient to maintain sediment continuity. For transect ADFG6 Down at River Mile (RM) 3.3, the model predicts deposition which is validated by field observations (page 39). However, the photograph in Figure 5.3-10 has bar formation at the site indicative of degraded conditions which means there was insufficient stream power to route sediment.	Thank you for your comments. HEC-RAS hydraulic models are routinely used to extrapolate to peak flows much higher than measured conditions. As discussed in the report, the test flow releases resulted in bedload transport and substrate changes at all monitoring transects in the Eklutna River; the monitoring transect data were used to calibrate the HEC-RAS sediment transport model. Note that at ADFG6Down (RM 3.3, Figure 5.3-10) the photographs show deposition and subsequent incision into a debris flow event that occured during the test flow event as mass wasting of the old reservoir deposits (RM 4) occured. As described in the report, mass wasting and debris flows are not modeled by the HEC-RAS model which calculates sediment transport via water. The bar in the photo shows a different process that is anticipated to occur under most future flows.

Geomorphology and Sediment Transport
Comment-Response Table

Comment #	Agency/Interested Party	Draft Geomorphology and Sediment Transport Section (Page) *"Text"*	Comment	Response
Section 6.3 Sediment Transport Modeling of Example Flow Scenarios				
3	U.S. Fish and Wildlife Service	Figures 6.3-2 and 6.3-3 (Pages 113 and 114).	Sediment transport is typically described in terms of competency and capacity. Competency is described as the largest grain size particle entrained at a given flow within a given channel. Capacity describes the total volume of sediment that channel can move at a given flow, which is particularly relevant to a river like Eklutna with large and irregular sediment inputs. Competency is discussed in the report, but more information on sediment capacity is necessary. Please elaborate on sediment capacity, and display data shown in Figures 6.3-2 and 6.3-3 in a table format with capacity and supply information like in the template, Table 1 (see USFWS comment letter).	The model results shown in Figures 6.3-2 and 6.3-3 are intended to provide a first cut at transport competency to help with initial selection of peak flow levels. The report has been revised to include a table with representative sediment transport competency and capacity at flows shown in Figures 6.3-2 and 6.3-3. Note that these data are taken as a "snapshot in time" from model runs. The HEC-RAS sediment transport model itteratively changes cross section shape through time under the flow regime entered as a model input. Therefore, comptetency and capacity change through time as the channel evolves. Sediment supply (bedload and suspended load) and particle size (D50, D84, D100, armor layer particle size) change with each time step, so these data are not included in the table. The model is being run for a 35-year time frame with various flow regimes as part of continuing analysis of alternatives; these model runs will be available in the future as part of the alternatives analysis to look at changes in the channel shape and substrate through time. Modeled changes to sediment supply, transport, and particle size data through the 35-year time series can be found within the model results as part of the alternatives anlaysis process.