EKLUTNA RIVER SALMON HABITAT ASSESSMENT AND COLLABORATION TO RECOMMEND RESTORATION FLOWS

2020

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ABSTRACT

Eklutna River was surveyed on foot from the Cook Inlet to Eklutna Lake within a 3-week interval in June of 2019 for salmon habitat characterization. The California Salmonid Stream Habitat Restoration Manual (*CSSHRM,* Flosi et al., 1998) was used to develop survey methods in a previous 2007 survey of the lower Eklutna River and the same methods, utilizing the 2010 updates, were applied to the entire length of Eklutna River below the lake during the 2019 survey season. Photos were taken throughout the survey and will be displayed as an interactive photo tour on the NVE website. Survey results will help scientists and officials make decisions to restore anadromous habitat functions of the Eklutna River.

1.0 INTRODUCTION

Eklutna Village is an old village located on the northeastern tip of the Knik Arm of Upper Cook Inlet in Alaska by the mouth of Eklutna River. The area was known for the two rock 'knobs' that served as geographic markers and gave the village its name, Idlughet. The name Eklutna came from the term Idlughetnu which includes the river. All necessary natural resources were found in abundance close to the village site, and it was on an important trade route between the interior and coastal regions.

Change started to take place in 1840 with the arrival of Russian Orthodox Missionaries. The railroad came through in the early 1900s, a boarding school for native children was operated close to the village site prior to World War II, and the United States Army established a facility in the same area during the mid-twentieth century. All that remains of these intrusions now are the railroad tracks and the Russian Orthodox Church. Eklutna Village endures.

Idlughet Qayeht'ana utilized their collective indigenous sovereign powers to re-organize into a Tribal Council form of government in 1961, named "Native Village of Eklutna" (NVE). NVE is a distinct, independent political community and as such is qualified to exercise powers of self-governance by reason of its original tribal sovereignty as passed down from ancestors since time immemorial. It is federally recognized as Eklutna Native Village. NVE tribal members now live in Eklutna Village, Anchorage, and elsewhere.

Eklutna people thrived on abundant runs of all 5 species of salmon until 1929 when a hydroelectric dam was built near the village that severed fish passage. A second dam at the outlet of Eklutna Lake was also originally built in 1929 and has been updated several times, with a hydro power project completed in 1955. Currently no water spills over the Eklutna Lake Dam. A 4.5-mile bypass tunnel is used to divert water from the lake to the power plant. Of the water diverted, 90% is diverted to the Knik River for hydro power while 10% is diverted for anchorage drinking and waste water, effectively blocking the remaining 14 miles of Eklutna River from its water source. The hydroelectric facility was transferred from the federal government to a consortium of three electric utilities in 1997. The agreement managing this transfer required the new owners to mitigate damage caused by the dam within 30 years of transfer. Consultation for the mitigation program must begin by 2022, with implementation of the mitigation program to begin by 2027. The electric utilities began consultation on the mitigation study plan in 2018. That same year the Conservation Fund used Army Corps of Engineers compensatory mitigation resources collected statewide to remove the abandoned lower dam. This project deconstructed the 68-foot barrier and accumulated sediment that prevented salmon reaching the lake. NVE and other agencies has argued that rehabilitation of the river will require water from the lake, but the power companies have taken no initiative to find creative technical solutions to return even a nominal amount of water to the Eklutna.

The Eklutna people were not consulted at any stage in the construction of the two hydro projects or the transfer of the federal project to the private utilities. However, NVE has been actively working since 2000 to restore the Eklutna River; removing vehicles and trash from the canyon, monitoring adult and juvenile fish, coordinating habitat assessments, performing water quality sampling, stream flow gauging, benthic macroinvertebrate bio-assessment and more. Recently, other agencies are becoming involved in collecting data on the Eklutna River, both current and historical. NVE has been collaborating with these agencies.

Consultation begun ahead of schedule in 2019 by the electric utilities with stakeholders, including the Tribe. NVE intends to influence upcoming negotiations with three power companies to return water to the upper river with both scientific data and Traditional Ecological Knowledge (TEK). NVE is committed to collaborating to restore the water to the river that bears their name, the river they built their village on, the river that supported their people for thousands of years. Because the water that is diverted from the lake is double appropriated, it will take convincing information to negotiate return of flow to the river. Without this information the Tribe is concerned that proposed mitigation measures will not include return of even nominal flow to the river and that benefits of mitigation response could be expropriated to stocked fisheries enhancement at Knik River or only the lower Eklutna River.

Historically, Eklutna people fished for salmon on the whole Eklutna River, including the shores of the lake and the upper tributaries leading to the glacier. Native Village of Eklutna maintains that rehabilitation of the river for salmon habitat will require not only water to be released into the lower river, but a passage will have to be established around the upper dam. Much of the fish habitat was in the lake and tributaries entering the lake where Kings, Silvers, and especially Sockeye were likely once abundant. Restoration of the river to include anadromous access to the lake would increase overwintering and spawning habitat. Creative technical solutions will be needed to return sufficient flows to the Eklutna and ideally access to the lake. NVE has been actively working since 2000 to restore the Eklutna River; removing vehicles and trash from the canyon, monitoring stream flow, monitoring adult and juvenile fish, coordinating habitat assessments, performing water quality sampling, benthic macroinvertebrate bioassessment and more.

The Tribe intends to work with the three power companies to accomplish return of sufficient flow for salmon.

2.0 METHODOLOGY

2.1 Habitat Assessments

Data was collected using modifications to the *California Salmonid Stream Habitat Restoration Manual (CSSHRM,* Flosi et al., 2010) 4th edition. This method was chosen for the standardization of descriptive terminology and technical methods. Modifications were made in a similar 2007 study to tailor this method to the Eklutna River and these same modifications were used again in 2019. One of the main modifications was to census all habitat units to more accurately describe the features of each habitat unit instead of the 10% sampling size proposed in the *CSSHRM* which calls for the selection of one habitat unit to be randomly selected off of each habitat unit form and all parameters measured. In addition to the *CSSHRM* methods, residual pool depth will be calculated to assess pool depth independent of flow. The photolog (Appendix II) will illustrate habitat units organized by reach.

The habitat assessment has two components: the delineation of channel types by reach and the inventory of habitat units. Data sets for both components were collected using standard field forms and standard field equipment. The channel type delineation included data on channel entrenchment, bank-full width, sinuosity, substrate composition and water slope gradient. A channel type form was filled out at the beginning of the survey and each time the channel type changed. The habitat inventory included data collection on habitat types, temperature, embeddedness, discharge, shelter, substrate composition, bank composition and canopy cover.

Channel typing was conducted following the *CSSHRM,* derived from Rosgen's Stream Type Classifications. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. Four parameters were measured to determine channel type:

- **Water slope gradient**: Gradient was calculated using USGS maps because of sinuosity and gradients generally below 2% and sinuosity within entrenched channels made measurement in the field challenging. GPS did not work in the canyon.
- **Width/depth ratio**: The ratio of the bank-full width to the mean bank-full depth.
- **Substrate composition**: The most common particle found on the bed of the stream measured at the velocity crossover. Substrate composition for each habitat unit was also assessed at areas throughout the unit.
- **Sinuosity**: The ratio between stream length and valley length. Sinuosity was estimated from aerial photos collected at the time of survey.

Habitat units are numbered sequentially and assigned a type selected from a standard list of 24 habitat types. Eklutna River habitat typing used standard basin level measurement criteria. The parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width.

The depth of embeddedness in pool tail-out areas was visually estimated by the percent of surrounded or buried in fine sediment. The values were recorded using the following ranges: 0 - 25%, 26 - 50%, 51 - 75%, and 76 - 100%.

In-stream shelter is composed of elements within a wetted stream channel that provide juvenile salmon protection from predation, reduce water velocities so fish can rest and conserve energy and allow separation of territorial units to reduce density related competition for prey. Percent of unit cover is the percentage of a unit occupied by several types of cover. Cover is classified into nine types and includes small woody debris, large woody debris, aquatic vegetation, terrestrial vegetation, bedrock ledges, bubble curtains, boulders, root mass and undercut banks. A standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) will be assigned according to the complexity of the cover. From this, an in-stream shelter rating can be calculated by multiplying the shelter value by the percent of cover. Thus, in-stream shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream. Mean shelter ratings will be calculated by reach for flat-water and pool habitat types.

Substrate composition ranged from silt/clay sized particles to boulders and bedrock elements. In all habitat units, dominant and sub-dominant substrate elements will be estimated using a list of seven size classes (silt, sand, gravel, small cobble, large cobble, boulders, and bedrock) and recorded as percentages. In addition, the dominant substrate composing the pool tail-outs were recorded for each pool.

Canopy density relates to the amount of stream shaded from the sun and was estimated from the center of every habitat unit. In addition, the area of canopy was estimated into percentages of coniferous or deciduous trees.

Banks were described based on their dominant substrate composition (bedrock, boulder, cobble/gravel, and silt/clay/sand) and based on their dominant vegetation type (grass, brush, deciduous trees, coniferous trees, or no vegetation). These factors are evaluated because they influence the ability of riverbanks to withstand flows. The dominant composition type and the dominant vegetation type for both the right and left banks at each habitat unit will be recorded in the habitat inventory form. Additionally, the percent of each bank side covered by specific vegetation (including downed trees, logs, and root wads) were estimated and recorded.

2.2 Discharge

Discharge was calculated once for each reach using a Global Water Digital flow probe to measure velocity. The United States Fish and Wildlife Service Discharge Method was followed in measuring depth and velocity for each 1-foot increment of wetted channel.

2.3 Temperature

Water and air temperature were collected at each reach's discharge station alongside flow measurements for each reach. Both a digital thermometer and an alcohol thermometer were used. The two measurements were averaged together to reduce instrument error.

2.4 Photolog

Photographs were taken at each unit the whole length of the river. Photographs were taken with an iPhone 7 and an iPhone 8. Photographs were taken at the beginning of each habitat unit and for interesting features. Long reaches are presented in multiple photographs. Not all photographs were successful.

3.0 RESULTS/DISCUSSION

The survey was completed in the field during the summer of 2019. Historically this is a dry time of year for the Eklutna Valley, but recent rain events prior to the start of data collection increased the volume of water in the Eklutna River. Extreme high daily temperatures were also a factor. Data was collected during an eleven day stretch. The river was walked as data was collected. Data was inputted off handwritten data sheets into a Microsoft Excel database. Hand drawn maps were also completed during the survey of each reach with field notes of interest.

All data for the Reaches can be found in tabular form in Appendix I: Tables, Tables 1-6.

3.1 Eklutna River, whole stretch

The survey began at the unvegetated and tidally dominated mouth approximately half mile from the confluence of the Eklutna River and Cook Inlet (low tide) and commenced at the Eklutna Lake Dam. This system is mainly a single channel system for the length of the lower river. Some braiding is present, influenced by beaver dams flooding areas and remains of historical gravel mining, rather than geomorphological features. The river is approximately 62,292.70 feet in length (11.8 miles) with only half of the river having continuous water flow (5.97 miles). The river is predominately a run ecosystem with 15% being completely dry. Sixteen percent of the river has instream shelter values, with the largest category of instream shelter provided by small woody debris and terrestrial vegetation (34.4% and 21.2% respectively). Almost three quarters of the river's banks are vegetated with deciduous trees (45%), brush (28%), and grasses (11%). Roughly 12% of the bank substrate composition is bedrock, with the remainder split three ways between boulders (29%), cobble/gravel (31%), and silt/sand/clay (27%). Water temperature averaged 8.3 degrees Celsius, with a pH of 8.3.


Knik Arm / Cook Inlet
Eklutna River
Stream Survey 2019
Survey area overview with habitat reaches identified
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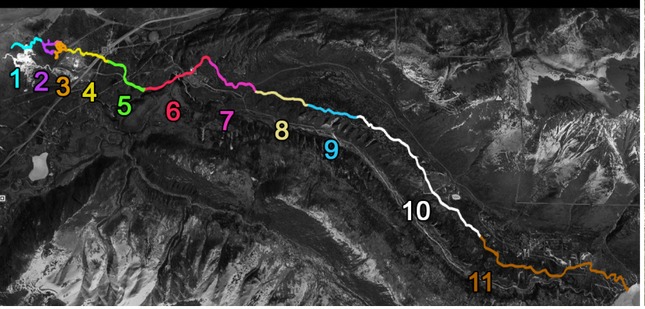
Native Village of Eklutna
Eklutna Lake

Eklutna River Stream Survey 2019

Characteristic Reach Images

Map Below: Survey area overview with habitat reaches identified



3.2 Reach 1

Reach 1 starts about half mile from the inlet at low tide. This was a decision made by the field crew due to safety of walking on the glacial silt. The start of Reach 1 was determined by a physical feature, a drainage entering the channel and vegetation on the banks. This location was also selected for the start of the survey because it was a known point, start of Unit 4, in the 2007 study.

Reach 1 is a single channel section, composed of 7 units. This reach is approximately 1,813 feet long (0.34 Miles) with a dominate habitat type as a run (87%). Running though the tidal wetlands, this reach doesn't not have and canopy and is completely in the sun. Almost 11% of the unit has in-stream shelter, composed entirely of terrestrial vegetation (100%). Bank composition remained constant of silt/clay/sand and was dominated by grass-like vegetation. The right bank was 68.3% vegetated, while the left bank was only 44.3% vegetated. Soil substrate composition was predominantly silt/clay (44%), although sand, gravel and cobble were present. Width of the channel averaged to 34.8 feet throughout the reach. Depth of water in the channel ranged from 1 inch to 24 inches, with an average of 13.4 inches. Water temperature was averaged at 8.5 degrees Celsius with a pH of 8.0. Discharge was measured at 32.46 cfs at habitat units 4 and 10.

Reach 1 has the most influence to the tides in Cook Inlet and he mouth of this reach will continually change. The gradient low throughout the reach, but does change at the end of Unit 10. This change in gradient caused a different substrate feature to be observed, and ultimately started a new reach. Nothing stands out about this reach. The banks and vegetation are typical of a river entering a tidally influenced wetland. Towards the upriver side of this reach is a traditional salmon fishing spot were fish often accumulate to osmoregulate before entering upper reaches. The banks are shallow at this spot and the gravel in the channel allow crossing by ATVs. This reach currently contains sufficient water for adult salmon to move upriver. Lateral pools are present and could be used for adult holding areas. Habitat deficiencies were not identified in this typical inter-tidal wetland reach. The only significant observation about

changes compared to 2007 is that the river mouth appears to have eroded inland. However, the Upper Cook Inlet has powerful tides that bring constant change to this area and changes may not be meaningful or representative.

3.3 Reach 2

Reach 2 is a smaller reach composed of six units. This reach contains a beaver pond complex that is actively flooding the surrounding land. Fingerling fish were observed within this unit but were not identified or measured. The river here can be classified as a single channel with bank flooding due to the beaver dams. This reach is 3,282 feet long (0.62 miles) with a dominant habitat types of Back Water Pools (BWP, 51%) and glides (32%). Substrate composition is predominantly silt/clay (67%) and sand (33%). Almost half the reach (43%) has in-stream shelter values, composed of both terrestrial vegetation and aquatic vegetation (53% and 48% respectively). Banks were 100% covered with grass-like vegetation and were of silt/clay/sand substrate. No canopy vegetation was present in the survey area although trees and brush were observed close to the bank, but outside of the survey area. Width of channels varied in this reach due to the beaver dams from 3 feet to over 200 feet. Depth was consistent to 21 inches with little variation. Water temperature was at 7.5 degrees Celsius with a pH of 8.1. Water discharge was measured at 24.3 cfs at unit 11.

Largest Beaver Dam in Reach 2. Dam approximately 4 ½ feet high.

Reach 2 does not seem to be influenced by tidal variations, due to the beaver dam that starts this reach. This reach starts in the tidal wetland area and floods back into the forest. The trees were flooded with no channel due to the water backup from beaver dams. In total there were three beaver dams in this section, two active and one defunct – all were retaining water to some degree. Aquatic and subaquatic vegetation was present in the dam pools, as were insect biota. Vegetation suggests that this

reach was not brackish. No prominent springs were observed, but past observational data suggests springs in the area, creating small ponds close to Reach 2.

Reach 2 appears to have had good pond rearing habitat for juvenile salmonids when it was assessed. Subsequent visit found the upper beaver dam ponds much lower when the river was lower and not feeding them. Increased flow could maintain all these ponds as rearing habitat year-round. Spawning has been observed in Reach 2. With sufficient flow beaver dams could enhance overwintering habitat for salmon but at current flow the beaver dams make salmon passage more challenging by dewatering otherwise passable habitat.

Aquatic Vegetation in Reach 2

3.4 Reach 3

Reach 3 was the only braided section of Eklutna River. This reach was 3,778 feet (0.72 miles) in length and comprised of 16 units. Habitat type is evenly distributed between riffles, runs, and glides (26%, 33%, and 40% respectively). The substrate composition shifted slightly in this reach to include more visible embedded gravel but was predominately silt/clay (55%). Only 10.6% of this reach has in-stream shelter, with 75% of this being terrestrial vegetation. Reach 3 also included the switch from the grass-like tidal wetlands to the forested areas of the river. The dominant bank vegetation was deciduous trees (*Alnus spp*., *Salix spp*., *Betula neoalaskana,* and *Populus spp.*). Only 50% of this reach has canopy coverage with all the canopy (100%) classified as deciduous trees. Bank composition was comprised of a silt/sand/clay substrate. Water temperature was 7.6 degrees Celsius, with a pH of 8.3. Water Discharge was measured at 19.1 cfs at Unit 13.1.

Substrate in Reach 3 was mostly embedded gravel. This section was split into two equal channels that each were braided before all coming back together. Braiding seemed unstable in this section with clear channels defined, but water depth was shallow in all the channels. Not many pools were observed in this reach, but bank vegetation and in-stream debris were observed. Not all of the reach has sufficient depths to allow more than adults to pass through.

Substrate in Reach 3 – Imbedded gravel

3.5 Reach 4

Reach 4 was mainly a single channel section 4,025 feet (0.76 miles) in length, composed of 10 units. This reach meanders under a railroad bridge, where it is confined in part by the man-made stone dyke that the rails sit on and the bridge buttresses. Habitat type in this reach was predominantly riffles (74.5%) Only 21.5% of the reach has in-stream shelter values with close to half (45.5%) composed of small woody debris. This reach included a flooded forest section that was approximately 575 feet in length with no clear channel. Width of the area changed dramatically from an average of 32.6 feet to over 200 feet in the flooded forest area. Previous gravel mining in the 1980's disrupted the river path in this area resulting in no distinct channel. Inadequate flows exacerbate the mining impact because flow has not been sufficient to carve a new channel to confine the river. Substrate composition shifted significantly in this reach to predominantly small and large cobble (35% and 25% respectively) with areas of exposed substrate. Bank composition remained consistently treed with deciduous species for the whole reach, the right bank being 83% vegetated and the left bank being 82% vegetated. Reach 4 has only 74% canopy coverage, with all canopy as deciduous trees. Water temperature was 8.7 degrees Celsius, with a pH of 8.4. Discharge was measured at 55.03 cfs at Unit 17.

Reach 4 had the highest measured flow rate. This was not expected as the channel width were not significantly different from the previous reaches. A single channel flowed under the railroad bridge and into a section of river that is known for being braided, currently called the flooded forest. In this unit, the water flowed at an increased rate, but was not measured due to the lack of safety equipment to safely accomplish this. In previous years, this unit was observed as a braided section, but due to the high water at the time of the survey, it was not discernable if braiding would still be present at lower flows. A former channel to the south no longer had water and reduced the area of this unit considerably from the 2007 survey. The river came together into a defined channelized section at the Glenn Highway bridges.

Above and Right: Flooded forest unit with no clear channel.

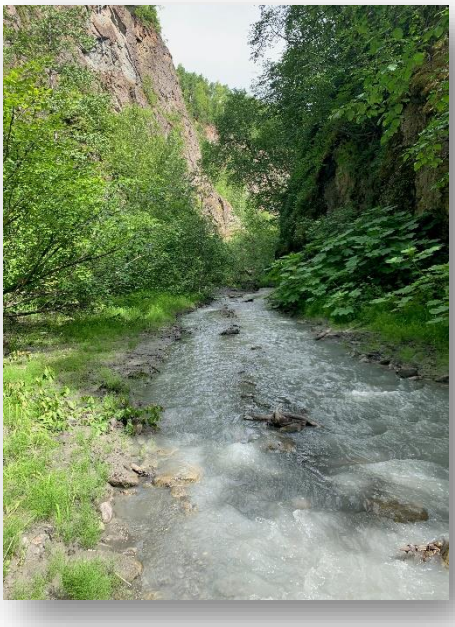
3.6 Reach 5

Reach 5 is a single channel section 3,781 feet (0.72 miles) in length, composed of 9 units. The channel flows under the Glenn Highway bridges and the Old Glenn Highway bridge in this unit. The two bridges on the Glenn Highway create channelization between their concrete supports. Bridge supports are not at the river's edge on the Old Glenn Highway bridge. Habitat type in this reach is classified as runs and riffles (51 % and 37% respectively). Only 20.6% of Reach 5 has in-stream shelter value, with 85% of that being terrestrial vegetation. The width of the river channel remained consistent with an average of 33.7 feet, while the depth varied from 4 inches to 42 inches, with an average of 18 inches. Substrate composition varied greatly in this reach, with cobbles and boulders being present in all units, and gravel/sand/silt/clay filling in the spaces in between. Exposed substrate was at 4.2%. Bank composition was predominately cobble/gravel with bedrock outcrops. The left and right banks were 94% vegetated by deciduous trees. Only 74% of the reach had canopy cover, of this 50% was deciduous trees. Water temperature was 6.8 degrees Celsius, with a pH of 8.3. Discharge was measured at 37.1 cfs at Unit 20.

The confluence of Thunderbird Creek to the right. Eklutna River continues to the middle, with a pool on the left.

The river is confined by the lower canyon in Reach 5. This reach hosted many small pools, in-stream shelter, and gravel bottom areas. Reaches 1-5 receive the majority of flow from Thunderbird Creek, the only side drainage in this section. The canyon walls provide shade most of the day, keeping the temperature down in the canyon. Most of the observed spawning and rearing occurs in this reach. Reach 5 ends at the confluence with Thunderbird Creek. Thunderbird Creek was not surveyed as part of this survey due to safety concerns.

3.7 Reach 6



Reach 6 is a single channel section 6,040 feet (1.14 miles) in length, composed of 14 units. This reach started at the Thunderbird Creek confluence and contains the old lower dam site featuring two small waterfalls that deter salmon passage at low flow. Water volume is drastically decreased in this reach compared to previous reaches, by an estimated 90%. Channel width averaged 16 feet and the average depth averaged 9.9 inches. Habitat type is classified as predominately runs (67%). Very little in-stream shelter exists (4.6%) in Reach 6, with bedrock ledges making up 50% of the in-stream shelter. Substrate composition was predominately gravel (57%) with lesser amounts of silt/clay and bedrock (both 15.7%). Bedrock and gravel comprised both left and right banks. The right bank was only 39% vegetated with small brush, while the left bank was 61% vegetated by small brush and small deciduous trees. Reach 6 has 53% canopy coverage, with 100% being of deciduous trees. Water temperature was 8.3 degrees Celsius, with a pH of 8.7. Discharge was measured at 3.8 cfs at Unit 27.

Reach 6 is just above the confluence with Thunderbird Creek and flows through the rest of the canyon. This reach housed the lower dam that was removed in 2018. Concrete blocks and debris from the dam are still visible and some remain attached to the bedrock. Some small debris from the demolition is also present. A waterfall (54 inches tall) has formed at the site of the dam. At current flow this reach is not passable for adult salmon, however substrate in this reach could offer excellent habitat under higher flow.

Substrate and water clarity in Reach 6.

Chum salmon and a few coho have been observed spawning in the lowest units of Reach 6 (ADF&G communications). Rocky obstructions prevent their passage farther upriver under low flow. Juveniles have also been observed rearing in these lower units. We believe this reach has good spawning and rearing potential with higher and flushing flows.

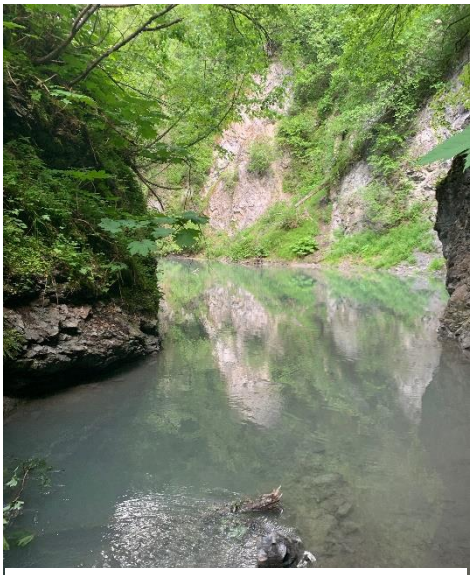
3.8 Reach 7

Reach 7 is a single channel section 4441 feet (0.84 miles) in length with 23 units. Most of the units are relatively small in length because this reach presented greater habitat complexity. This channel cuts through the canyon. The mean width of the channel is 17.3 feet and the average depth of the channel is 12 inches. Habitat type is comprised of many pools interspersed with runs (47%), cascades (06%), and riffles (16%). In-stream value (10.4%) is comprised of bedrock ledges (33%), small woody debris (25%) and large woody debris (29%). Substrate composition is predominantly silt/clay (32.8%) and gravel (20.9%). The right bank's substrate composition is predominately bedrock with 29% vegetated by brush. The left bank's substrate composition is bedrock and silt/clay/sand with 32% vegetated by brush. Reach 7 has 50% canopy coverage by deciduous trees. Water temperature is 8.9 degrees Celsius, with a pH of 8.5. Discharge was measured at 10.8 cfs at Unit 41.

An area behind the removed lower dam. Silt still towers approximately 20 feet from the surface of the water.

At the beginning of the reach, silt walls line the canyon, leftover from the dam demolition. These banks will add sediment as they are worn down. A small rockslide created a natural bottleneck. This area was dammed in the past and had pools over 5 feet deep. Currently, the area is free of debris and/or beaver dams. Colluvial slides are observed more frequently in this reach. Juvenile dolly varden have been observed recently in this reach, but salmonids have not been observed recently. We believe

that Reach 7 has good spawning and rearing habitat pending higher sustained waterflows. More flow is required for fish passage and to erode continuous deposits from the canyon wall that obstruct flow as well as dam backfill.



An existing pool in the canyon

3.9 Reach 8

Reach 8 is a single channel section 4,781 feet (0.91 miles) in length, composed of 11 units. The mean width of the channel is 9.5 feet while the mean depth is 7.5 inches. Habitat type is predominantly riffle (86%). In -stream shelter value is 21.4% with 52.5% being comprised of small woody debris. Substrate composition is predominantly boulders (43.2%) and sand (30.5%), with 17% exposed substrate. Both banks of the channel are 98 % vegetated by mainly brush. Reach 8 has 96% canopy coverages of deciduous trees (98%). Water temperatures is 7.5 degrees Celsius with a pH of 8.2 Discharge was measured at 6.8 cfs at Unit 67.

Cobble substrate with algae growth

The valley becomes wider in Reach 8. This reach has more bank vegetation and more canopy than previous reaches in the canyon. An access road is beside the river starting in this reach and will continue paralleling the river until close to the Eklutna Lake Dam, crossing the river multiple times without bridges. This road is not open for public use and is primarily only used by the utility companies. Anchorage Water and Wastewater Utilities (AWWU) pipe also parallels the river from this point to the Eklutna Lake Dam. Juvenile dolly varden have been observed in this reach. Salmonids have not been observed in this reach recently. We believe that Reach 8 has good spawning and rearing habitat pending higher sustained waterflows.

3.10 Reach 9

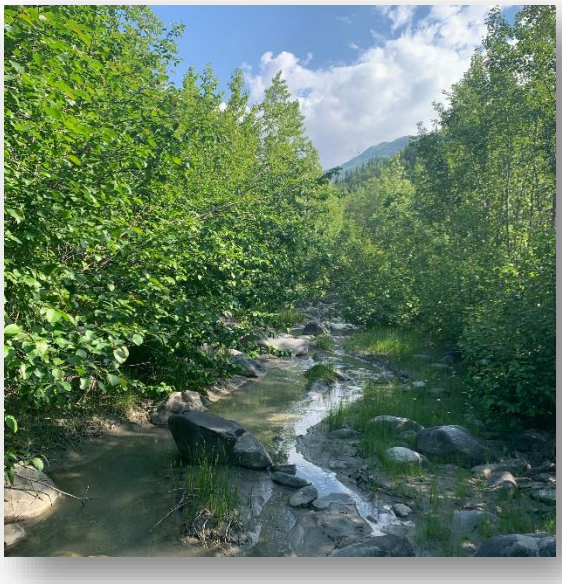
Reach 9 is a single channel section 4,308 feet (0.82 miles) in length, composed of 14 units. This reach is not continuously watered, meaning that the water level is so low in areas, that only in times of high water or a rain/snow melt event is there water in the channel. The mean width of the wetted portion of this channel is 6.35 feet and the mean depth of this channel is 6.21 inches. Habitat type is predominantly riffle (79%). In-stream shelter value is 18.93%, being comprised of large woody debris (46%) and small woody debris (29%). Substrate compositions is comprised of boulders (36%), sand (30%), and gravel (20%), with 7% exposed substrate. Bank composition is split between boulders and cobble/gravel. The right bank is 86% vegetated predominantly by deciduous trees, while the left bank is only 82.5% vegetated by deciduous trees. Reach 9 has 86% canopy coverage of deciduous trees (100%). Water temperature is 10.6 degrees Celsius and a pH reading was not taken. Discharge was measured at 2.6 cfs at Unit 74.

The valley widens in Reach 9, but the river stays channelized through the valley. Active colluvial fans enter the river on the north side and deliver more silt/clay and gravel into the system than low flow has the ability to disperse. The bank vegetation changes from short trees/shrubs to tall trees. Coniferous trees are closer to the river here, but not in high numbers.

Reach 9 needs more sustained waterflow and flushing flows to sustain salmon.

An old colluvial slide comprised of gravel and silt. Parts of this slide are still active (right).

3.11 Reach 10



Reach 10 is a single channel section 10,994 feet (2.08 miles) in length, composed of 22 units. This reach is not continuously watered, meaning that the water level is so low in areas, that only in times of high water or a rain/snow melt event is there water in the channel. In Reach 10, 5% of the reach is dry riverbed. The channel width varies greatly ranging from less than a foot to over 75 feet wide (mean 13.65 feet). The depth also varies greatly from one inch to 42 inches (mean 9.2 inches). Habitat type is classified at predominately runs (51%) and glides (30%). Substrate composition is predominantly silt/clay (38%), gravel (14.5%), and boulders (28.6%) with 30% exposed substrate. In-stream shelter value is 16.8%, being comprised of small woody debris (38%), large woody debris (45%), and boulders (15%). Bank composition is comprised of mainly boulders for both right and left banks. The right bank is 84% vegetated with predominantly deciduous trees. The left bank is 75% vegetated with predominantly deciduous trees. Reach 10 has 74% canopy coverage, composed of deciduous trees (100%). Water temperature and pH were not taken for this reach. Discharge was averaged as 3.21 cfs at Unit 88.

Substrate in Reach 10 showing gravel

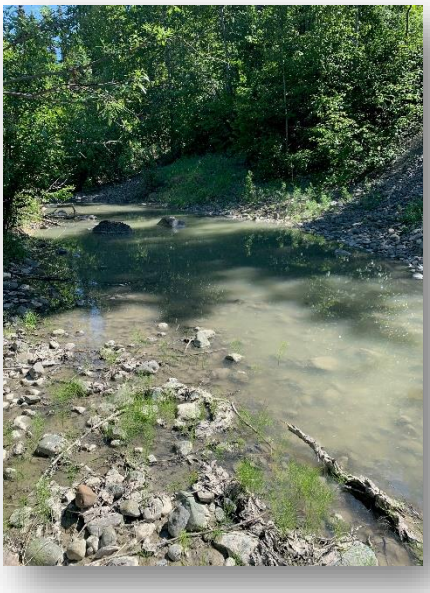
The road and the water pipe cross the channel in this reach numerous times, with no bridges. The crossings are only in inches of water and all are at areas with gravel/cobble substrate. An active beaver dam

Substrate in Reach 10

holds water back and floods some areas to the south of the river channel. Colluvial fans enter the river in multiple places along this reach.

Reach 10 needs more sustained waterflow and flushing flows to sustain salmon.

3.12 Reach 11



Reach 11 is a single channel section 14,050 feet (2.66 miles) in length, composed of 20 sections. This reach is not continuously watered, meaning that the water level is so low in areas, that only in times of high water or a rain/snow melt event is there water in the channel. In Reach 11, 62% of the reach is dry riverbed. The average with of the watered part of the channel is 17.3 feet with a mean depth of 11 inches. Habitat type of the watered area is classified as run (22%). In-stream shelter value is 17.9%, composed of predominantly small woody debris (81%). Substrate composition is comprised of silt/clay (22%), large cobble (10.5%), and boulders (51.4%), with 45% of substrate exposed. Bank composition is predominately cobble/gravel on both the right and left banks. The right bank is 66% vegetated with predominately deciduous trees while the left bank is 69% vegetated with predominantly deciduous trees. Reach 11 has 68% canopy coverage with 100% being deciduous trees. Water temperature and pH were not taken for this reach. No Discharge was calculated for this reach.

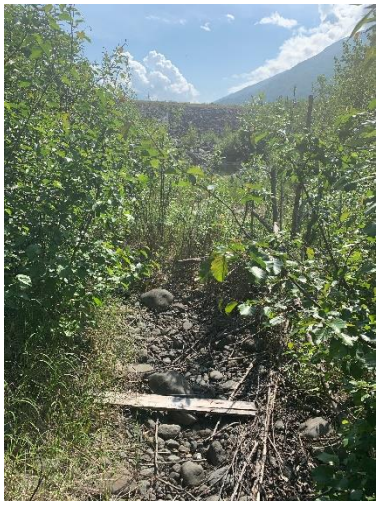
Substrate in a watered section of Reach 11

The units were lumped into a long reach due to the lack of water to observe the defining characteristics. The number of units

Stagnant ground water with algae growth

would likely increase as well. The road crosses the river again, with part of the road being the dry river channel. The first small bridge over the river is in Reach 11. There are two bridges that can support vehicle traffic that lead to a private picnic area of Chugach State Park. The road leads away from the river channel after the second bridge and up the hill to the main road. This road is still gated and only authorized access is permitted. Although the river is channelized in Reach 11, there is evidence that this was a braided section of the river. There are wetted side channels that no longer connect to the river channel in this reach. There are conifer trees along the banks in Reach 11, but only make up <1% of the bank vegetation. Below the Eklutna Lake Dam is a groundwater pool that rarely spills into the river channel.

Reach 11 needs more sustained waterflow and flushing flows to sustain salmon.



The area just below the Eklutna Lake Dam. Left: the dry channel on the outside rim of the pool. Right: the pool below the dam

4.0 Discussion for the lower Eklutna River

The Eklutna River still has good substrate for salmon habitat in the river channel downriver from the Eklutna Lake Dam. The river currently provides salmon habitat up to just above the confluence with Thunderbird Creek where there is sufficient flow for adult salmon to return and in pockets above the confluence where there is still water. Restoration work and increase in water flow would be needed to improve and connect these habitats and allow a sustainable river system to reestablish itself, including allowing spawning of salmon above the Thunderbird confluence. Juveniles of all five salmon species have been observed in the river below the Thunderbird confluence. Two fish species studies were completed in 2003 and 2010, and ongoing monitoring is being completed by the Alaska Department of Fish and Game. NVE counted adult salmon in Eklutna River below the old lower dam and Thunderbird Creek below the falls in 2002 and 2003. Salmon were observed by walking these stretches more frequently than every three weeks when adult salmon were present (NVE 2003). The mean totals found per year were: Chum 688, Coho 88, Kings 40, Pinks 32, Reds 12, Total 860. Most spawning occurred in the reach between the Glenn Highway and the confluence with Thunderbird Creek.

The Ward study in 2010 estimated over 3000 juvenile coho salmon in the lower Eklutna River. Ward did not survey other species of salmon. Alaska Department of Fish and Game have done informal observations on juvenile salmonids in the river between the Glenn Highway bridges and the lower dam site. The observations are reported in the Anadromous Stream Catalogue online (https://www.adfg.alaska.gov/sf/SARR/AWC/). More studies on the numbers of salmon returning to the river to spawn would need to be completed to track progress from the lower dam removal and the natural return of habitat due to the dam removal.

This study and other USFWS studies on the Eklutna River show that there is habitat for salmon along the entire 12 miles of lower river, pending an increase in water flow to the river. Areas of the river would benefit from manual restoration techniques. These areas are generalized currently as increased waterflow is needed to assess the area's progress and define the areas further. Flushing flows will help move sediment downstream and create more spawning areas throughout the river. Sustained higher waterflows will increase the total amount of salmon habitat from the Eklutna Lake Dam to the confluence in the Knik Arm of the Cook Inlet.

Questions that arose while surveying the river were: How much water would it take to provide sustained flow to the river channel for salmon habitat; How low is the water table in Reach 11 and how much water would be lost initially during a release due to infiltration to the water table; and how would a sustained higher flow impact the existing highway and railroad bridges. These questions were not answered during the study, but warrant further investigation.

5.0 Comparison Between the 2007 Survey and the 2019 Survey

Significant changes were observed in substrate composition between the 2006 and 2019 surveys in Units 1-6. These changes are largely influenced by dam removal. Reach 1 now has 30% more gravel and 17% more cobble. It is assumed that this substrate has migrated from the dam removal and the result is improved spawning habitat for Pink and Chum in Reach 1. Reach 2 now has 16% more silt and 11% less gravel likely indicating silt has been deposited from the dam backfill. Reach 3 now has 47% more silt and 16% more sand indicating that most of the silt from dam removal is deposited in this reach. Reach 4 now has 17% more sand and 28% less large cobble indicating sand has settled out in this portion of the river. Reach 5, below the dam has 21% less silt and 7.4% more small cobble. The greatest change observed was in Reach 6, above the dam, which had 15% less silt, 33% less sand and 42.5% more gravel.

Table 1. Percentages of substrate in Units 1-6 from both the 2006 Study and the 2019 Study

	Silt/Clay	***Sand***	***Gravel***	***Sm. Cobble***	***Lg. Cobble***	***Boulder***	***Bedrock***
Reach 1- 19'	44.3	11.4	14.3	18.6	11.4		
Reach 1- 06'	55.5		43.5	1			
Reach 2-19'	66.7	33	0.3				
Reach 2-06'	50.6	36.8	12.2	0.4			
Reach 3-19'	55.9	17.9	14.8	8.2	3.2		
Reach 3-06'	9.4	1.5	39	42.8	7.3		
Reach 4- 19'	3	17.5	10.5	35	25	9	
Reach 4-06'			5.5	32.7	53.6	8.2	
Reach 5-19'	11.1	4.8	13.4	15.8	31.7	23.2	
Reach 5-06'	32	0.3	1.5	8.4	34.3	15.6	7.9
Reach 6-19'	15.7		57.2	1.4	0.7	9.3	15.7
Reach 6-06'	31	33.5	12.5	23			

Changes in substrate are outlined below in Table 2. The changes that are significant are bolded.

Table 2: Changes in substrate per Reach from 2007-2019

Reach 1	10% less silt **30% more gravel** 10% more sand **17% more small cobble** 11% more large cobble
Reach 2	**16% more silt** 11% Less gravel
Reach3	**47% silt** **16% sand**
Reach 4	**17% sand** **28% less large cobble**
Reach 5	**21% Less silt** 7.4% More small cobble
Reach 6	**15% Less silt** **33% less sand** **42.5% more gravel**

In summary, Reach 1 is improved with increased gravel, Reach 2 and 3 have accumulated significant silt, Reach 4 has more sand while Reach 5 and 6 have much less silt and Reach 6 has much more gravel. Improvements to salmon habitat for Reach 5 and 6 are significant. However, increased flow is required for salmon to use the improved habitat.

Acknowledgements

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Author Contributions

Carrie Ann Brophil assisted in the collection of data, assimilation of data, creating a photolog, and authoring the report.

Marc Lamoreaux assisted in the collection of data, assimilation of data, assisting with the photolog, and coauthoring the report.

Chilkat Environmental assisted with the comparison data analysis and with the mapping for the final write up.

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Native Village of Eklutna

7- Lat Pool
8- Run
9- Run
6- Run
10 - Riffle
11- Glide
5- Run
4- Run
Reach 1
Reach 2
Reach 3
11.2- SCP
12.2- SCP
12- Glide
13.2- Run
13.3- Run
13.4- Riffle
13.1- Run
11.1.1- SCP
12.1- Glide
13.1.3- Run
13.1.1- Glide
12.1.4- Glide
13.1.2- Run
13.5- Riffle
11.1- BWP
12.1.6- Riffle
12.1.1- Glide
12.1.2- Glide
12.1.3- Glide
12.1.5- Run

N

Eklutna River

Stream Survey 2019

Reaches 1, 2 & 3, Units Identified

Upstream view from river mouth

Reach 1

Reach 2

Reach 3

Eklutna River

Stream Survey 2019

Reaches 4 & 5, Units Identified

15.1- Glide
15.3- HGR
15- Riffle
14- Riffle
15.2- Run
14.1- BWP
16- Riffle
17- Riffle
18- Flooded Forest
Reach 4
19- Riffle
20- Run
20.2- Run
20.1- C.Pool
21- Riffle
Reach 5
22- Pool
23- HGR
24- Run


Reach 4


Reach 5

Native Village of Eklutna

Native Village of Eklutna

23- HGR

Reach 5

24- Run

25- HGR

26- Riffle

Thunderbird Falls

27- Run

28- LSP

Reach 6

29- Glide

30- Riffle

31- LSP

32- Run

33- Riffle

N

Eklutna River

Stream Survey 2019

Reaches 5 & 6, Units Identified

38- Run
39- HGR
40- Waterfall
36- HGR
41- Riffle
41.1- BWP
37- Run
Reach 7
42- Run
35- Run
34- LSP
33- Riffle
32- Run
31- LSP
Reach 6
30- Riffle
29- Glide
28- LSP

Eklutna River

Stream Survey 2019

Reaches 6 & 7, Units Identified

N

Native Village of Eklutna

Reach 7

43- LSP
44- MCP
45- LSP
46- MCP
47- Riffle
48- MCP
49- LSP
50- Run
51- Casacade
53- Run
54- HGR
55- MCP
56- Cascade
57- Riffle
58- Riffle
59- MCP
60- MCP
61- Run
62- LSP
63- Cascade
64-Riffle
65- HGR
66- Riffle/Glide
67- Run
68- MCP
69- Riffle

Reach 8

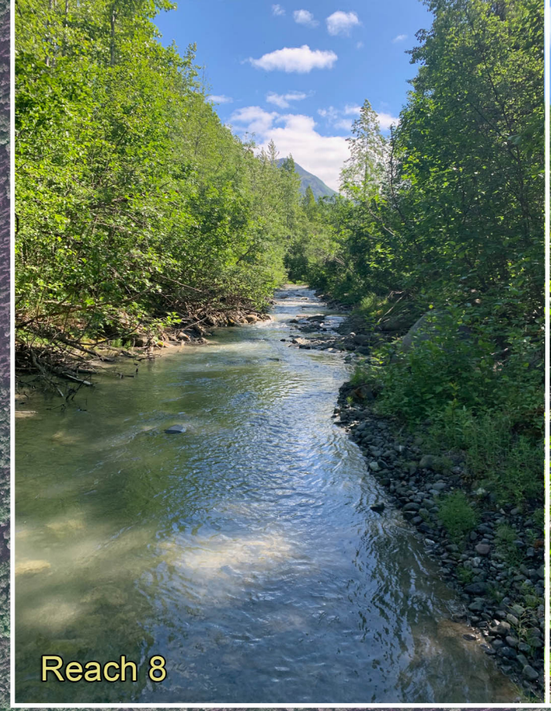
Eklutna River

Stream Survey 2019

Reaches 7 & 8, Units Identified

N

Native Village of Eklutna



69- Riffle

70- HGR

71- Glide

72- Riffle

Reach 8

73- Plunge P

74- Riffle

75- LSP

76- Riffle

77- Pocket P

Reach 9

Eklutna River

Stream Survey 2019

Reaches 8 & 9, Units Identified

N

Native Village of Eklutna

Eklutna River

Stream Survey 2019

Reaches 9 & 10, Units Identified

76- Riffle
77- Pocket P
78- Run
79- Riffle
80- Run
81- Pocket P
82- Cascade
83- Riffle
84- Cascade
85- Run
86- Cascade
88- Glide
89- Glide
90- Glide
91- Riffle
92- Riffle
93- MCP
94- Glide
95- Run
96- Pocket P
97- Run
98- HGR
99- Run
100- Glide
101- Glide

Reach 9

Reach 10

N

Native Village of Eklutna

Eklutna River

Stream Survey 2019

Reach 10, Units Identified

N

101- Glide

102- Run

103- Run

104- Run

105- Run

Reach 10

Native Village of Eklutna

Eklutna River

Stream Survey 2019

Reach 10 & 11, Units Identified

105- Run

106- Glide

Reach 10

107- Glide

108 - Dry

109 - Dry

Reach 11


Reach 10


Reach 11

Native Village of Eklutna

Eklutna River

Stream Survey 2019

Reach 11, Units Identified

109 - Dry

110 - Dry

111 - Pool

112 - Glide

113 - MCP

114 - Glide

115 - Run

116.1 - Riffle

116 - Pool

117 - Run

118 - Pool

118 -

120 - Dry

Reach 11

Native Village of Eklutna

Eklutna River

Stream Survey 2019

Reach 11, Units Identified

N

120 - Dry

121 - Dry

122 - Dry

123 - Run

124 - MCP

124.1 - Dry

125 - MCP

Reach 11

Native Village of Eklutna

Table 1. Eklutna River Reach Lengths, Widths, and % watered.

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Reach 11	Whole River
Avg. Depth (in)	13.43	21.33	12.75	20.70	18.75	9.92	11.91	7.45	6.21	9.24	11.00	12.97
Avg. Width (ft)	34.83	79.20	15.25	33.44	33.67	16.07	17.35	9.55	6.36	13.65	17.33	25.15
Approx. Length (ft)	1813.00	3282.00	3778.00	4025.00	3780.70	6040.00	4441.00	4781.00	4308.00	10994.00	14050.00	61292.70
Approx. Length (miles)	0.34	0.62	0.72	0.76	0.72	1.14	0.84	0.91	0.82	2.08	2.66	11.60847
continuous water flow	y	y	y	y	y	y	y	y	n	n	n	n
% watered	100	100	100	100	100	100	100	100	100	100	0.61	

Table 2. Percentages of Habitat Types by Reach.

Reach	1	2	3	4	5	6	7	8	9	10	11	Whole River
Length (ft)	1813.0	3282.0	3778.0	4025.0	3780.7	6040.0	4441.0	4781.0	4308.0	10994.0	14050.0	61292.7
Habitat type												
Run	0.87000		0.33298	0.01988	0.50644	0.66639	0.46724	0.03033	0.13556	0.51428	0.22819	0.33478
Glide		0.32084	0.39995	0.05714		0.04040		0.05124		0.30198	0.05246	0.11975
Riffle	0.09211		0.26707	0.73491	0.37321	0.16076	0.15740	0.85923	0.78575	0.03302	0.02135	0.25078
lateral pool	0.03751				0.01375							0.00196
BWP		0.50152		0.02484			0.01914					0.02987
SCP		0.17764										0.00951
HGR				0.02037	0.08543	0.08742	0.01801	0.04079		0.00737		0.02103
C. Pool					0.02116							0.00131
LSP						0.04305	0.09975		0.00464			0.01180
MCP							0.13758	0.00418		0.07149	0.07431	0.04015
Cascade							0.06035	0.01213	0.01161			0.00613
Waterfall						0.00199						0.00020
DPL							0.04053					0.00294
Plunge Pool								0.00209				0.00016
Pocket Pool									0.05316	0.02274		0.00781
Dry										0.04912	0.62370	0.15178
Flooded Forest				0.14286								0.00938

Table 3. In-Stream Shelter Values per Reach

Reach	1	2	3	4	5	6	7	8	9	10	11	total
in stream shelter value												
% unit covered	10.71	43.33	10.63	21.50	20.56	4.64	10.43	21.36	18.93	16.82	17.89	16.03
% undercut bank				16.00								1.58
% swd			2.14	45.50		33.33	25.00	52.50	29.17	38.33	80.77	34.36
% lwd				5.00		16.67	29.17	22.50	45.83	45.00	11.54	20.79
% root mass			22.86	0.00			4.17	15.00		1.67		3.81
% terr. Veg	100.00	52.50	75.00	33.00	85.00							21.24
% aquatic Veg		47.50										1.88
% bubble curtain					6.25							0.50
% boulders					2.50		8.33	10.00	8.33	15.00		5.45
% bedrock ledges					6.25	50.00	33.33		16.67	6.67	7.69	11.39
% total canopy	0	0	50	74.4	74.4	52.86	50	95.91	86.07	73.64	68.25	61.42
% deciduous	0	0	100	100	50	100	100	97.73	100	100	100	96.32
% coniferous	0	0	0	0	0	0	0	0	0	0	0	0.00
% rt bank vegetated	68.3	100	100	83.3	94.4	39.29	29.13	97.73	86.07	83.64	65.75	72.92
% lt bank vegetated	44.29	100	100	82.2	94.4	61.43	32.17	98.18	82.5	74.55	68.75	73.00

Table 4. Percent Substrate Composition by Reach

Reach	1	2	3	4	5	6	7	8	9	10	11	River
Substrate composition												
silt/clay	44.286	66.667	55.313	3.000	11.111	15.714	32.826	7.273	6.786	37.955	22.250	25.815
sand	11.429	33.000	17.813	16.500	4.889	0.000	10.000	30.455	30.357	4.318	8.500	13.058
gravel	14.286	0.333	14.375	10.500	13.222	57.143	20.870	0.000	20.000	14.545	6.500	17.247
sm cobble	18.571	0.000	8.125	35.000	14.778	1.429	10.652	0.909	0.000	5.909	5.800	8.004
lg cobble	11.429	0.000	3.125	25.000	28.667	0.714	8.478	18.182	0.714	4.091	10.450	9.023
boulder	0.000	0.000	0.000	9.000	23.222	9.286	13.913	43.182	35.714	28.636	51.400	23.817
bedrock	0.000	0.000	0.000	0.000	0.000	15.714	3.261	0.000	6.429	4.545	0.000	3.410
% exposed substrate	0.000	0.000	0.000	0.556	4.222	0.000	5.522	16.818	9.643	30.000	45.000	13.334

Table 5. Bank Composition for Whole River, N=151

	Substrate								Vegetation									
	1		2		3		4		5		6		7		8		9	
	Bedrock		Boulders		Cobble/Gravel		Silt/Clay/Sand		Grass		Brush		Deciduous Trees		Conifer Trees		No Vegetaion	
Right Bank	21	0.139073	43	0.284768	47	0.311258	39	0.258278	16	0.10596	46	0.304636	64	0.423841	0	0	21	0.139073
Left Bank	14	0.092715	45	0.298013	47	0.311258	43	0.284768	18	0.119205	38	0.251656	73	0.483444	0	0	20	0.13245

Table 6. Data from Reach and Flow Forms, averaged for each reach

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Reach 11
CFS	32.46	24.3	19.1	55.03	37.1	3.8	10.8	6.8	2.6	2.796	-
Flood Prone Width (ft)	54.1	400	na	na	na	28	80	49	67	35	-
Entrenchment	1.69	na	na	na	na	1.4	6.96	5.44	8.38	8.75	-
Dominate Substrate	Cobble	Silt/Clay	Gravel	n a	Cobble	Gravel	Gravel	Sand	Sand	Gravel	-
current bankfulls (in)	28	60	24	42	36	12	20	20	10	12	-
max bankfull depth (in)	14	30	12	21	18	6	10	10	5	6	-

EKLUTNA RIVER SALMON HABITAT ASSESSMENT AND COLLABORATION TO RECOMMEND RESTORATION FLOWS

PHOTO LOG

Above: The mouth of the Eklutna River looking upstream
Below: The mouth of the river looking at the inlet

Side channel at start of Unit 4 – a tidal channel with no other apparent water source.

Unit 4 – Run

Unit 5 – Run

Unit 6 – Run

Reach 1 – 0.34 miles

Unit 8 - Run

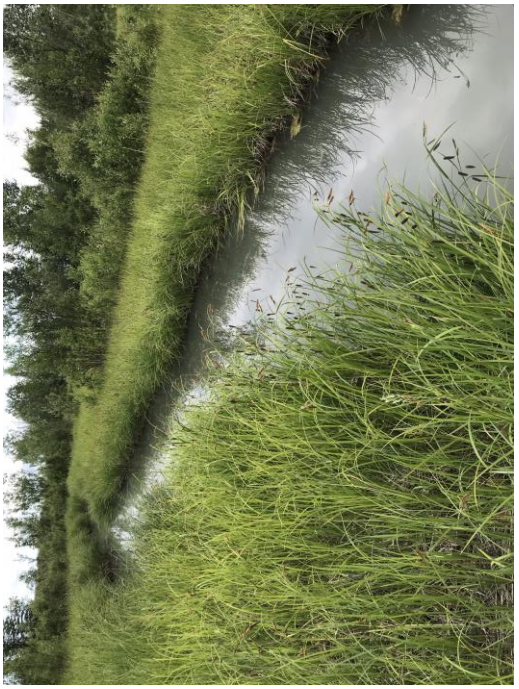
Unit 10 – Riffle

Unit 7 – lateral scour pool

Unit 9 – Run

Reach 2 – 0.62 miles

Unit 11.1 – Back Water Pool behind small beaver dam



Unit 11.2 – Secondary Channel Pool

Unit 11.0 - Glide

Unit 11.1.2 – Back water pool behind large active beaver dam

Reach 2 – 0.62 miles

Unit 12.2 – Secondary Channel Pool

Reach 3 – 0.72 miles

Unit 12.1 - Glide

Unit 12.1.2 - Glide

Unit 12 - Glide

Unit 12.1.1 - Glide

Reach 3 – 0.72 miles

Unit 12.1.5 - Run

Unit 13.3 - Run

Unit 12.1.4 - Glide

Unit 13.2 - Run

Reach 3 – 0.72 miles

Unit 12.1.6 - Riffle

Unit 13.4 - Riffle

Reach 4 – 0.76 miles

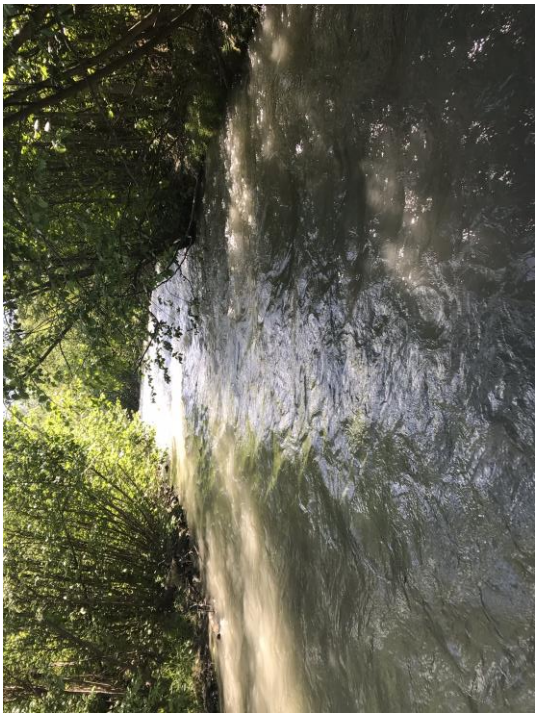
Unit 14.1 – Back Water Pool

Unit 15.1 - Glide

Unit 14.0 - Riffle

Unit 15.0 - Riffle

Reach 4 – 0.76 miles



Unit 15.3 - High Gradient Riffle

Unit 17.0 - Riffle

Unit 15.2 - Run

Unit 16.0 - Riffle

Reach 4 – 0.76 miles

Unit 19.0 - Riffle

Unit 18.0 - Flooded Forest

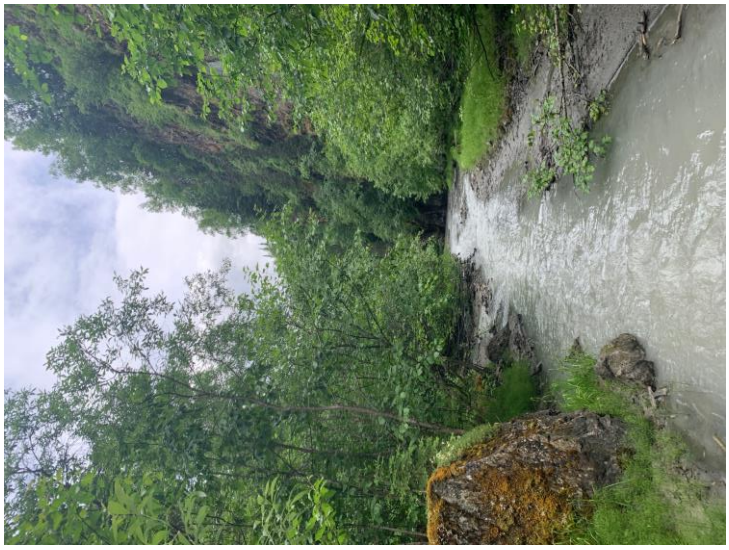
Unit 21.0 – Riffle

* Additional photos from Reach 5 are unavailable

Reach 6 – 1.14 miles

Unit 29.0 - Glide

Unit 28.0 - Lateral Scouring Pool



Unit 27.0 - Run

Reach 6 – 1.14 miles

Unit 32.0 - Run

Unit 31.0 - Lateral Scouring Pool

Unit 30.0 - Riffle

Reach 6 – 1.14 miles

Unit 35.0 - Run

Unit 34.0 - Lateral Scouring Pool

Unit 33.0 - Riffle

Reach 6 – 1.14 miles

Unit 38.0 – Run

Unit 37.0 – Run

Unit 36.0 – High Gradient Riffle

Reach 6 – 1.14 miles

Unit 40.0 – Waterfall

Unit 39.0 – High Gradient Riffle

Reach 7 – 0.84 miles

Unit 42.0 – Run

Unit 41.1 – Back Water Pool

Unit 41.0 – Riffle

Reach 7 – 0.84 miles

Unit 45.0 – Lateral Scouring Pool

Unit 44.0 – Mid Channel Pool

Unit 43.0 – Lateral Scouring Pool

Reach 7 – 0.84 miles

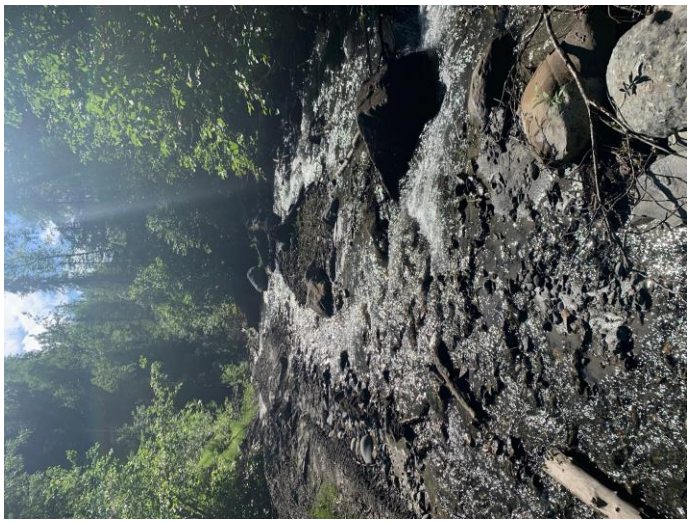
Unit 49.0 – Lateral Scouring Pool

Unit 48.0 – Mid Channel Pool

Unit 47.0 – Riffle

Reach 7 – 0.84 miles

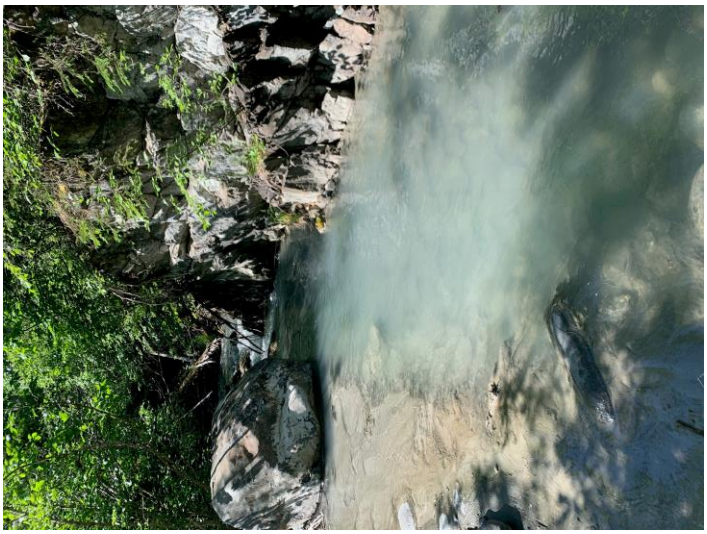
Unit 59.0 – Mid Channel Pool



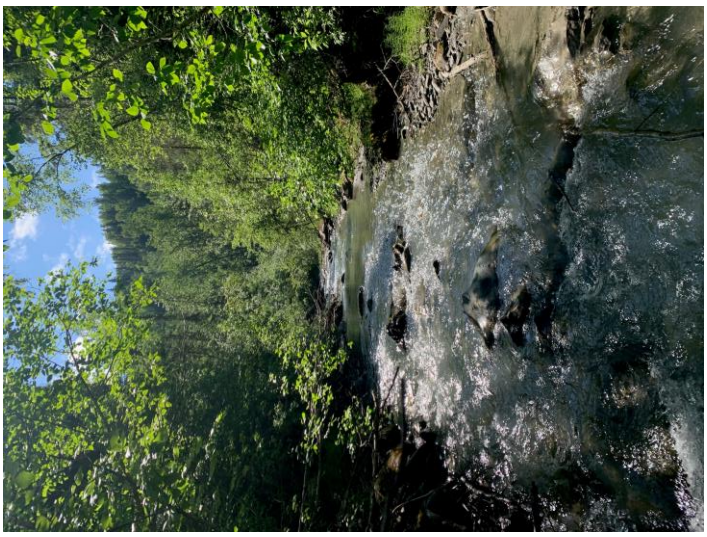
Unit 58.0 – Riffle

Unit 50.0 – Run

Reach 7 – 0.84 miles



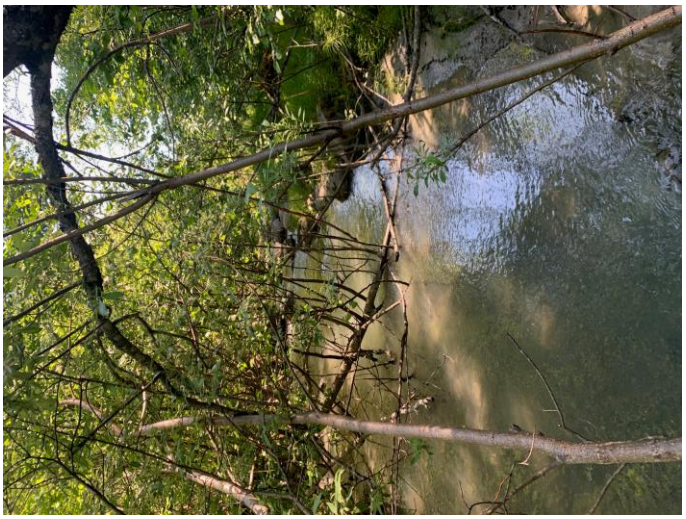
Unit 62.0 – Lateral Scouring Pool



Unit 61.0 – Run

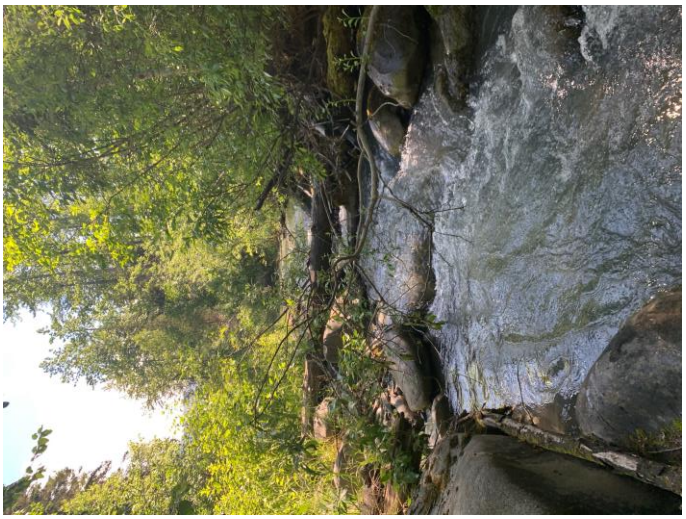
Unit 60.0 – Mid Channel Pool

Reach 8 – 0.91 miles



Unit 67.0 – Run

Unit 66.0 – Riffle/Glide

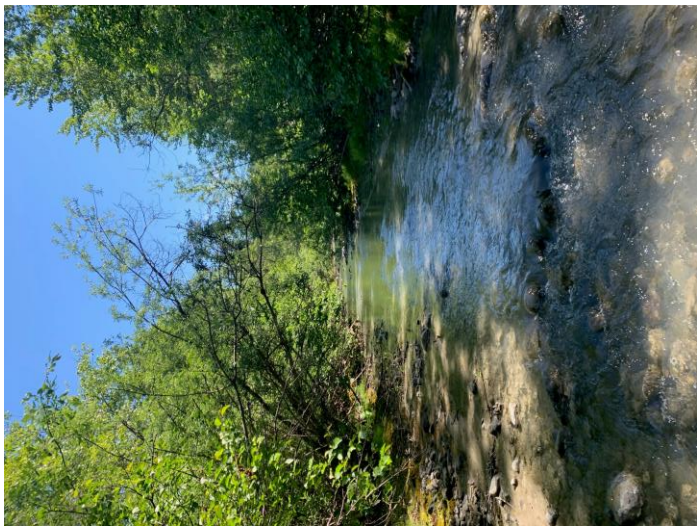


Unit 63.0 – Cascade

Reach 8 – 0.91 miles

Unit 71.0 – Glide

Unit 70.0 – High Gradient Riffle



Unit 69.0 – Riffle

Reach 8 – 0.91 miles

Unit 73.0 – Plunge Pool

Unit 72.0 – Riffle

Reach 9 – 0.82 miles

Unit 76.0 – Riffle

Unit 75.0 – Lateral Scouring Pool

Unit 74.0 – Riffle

Reach 9 – 0.82 miles

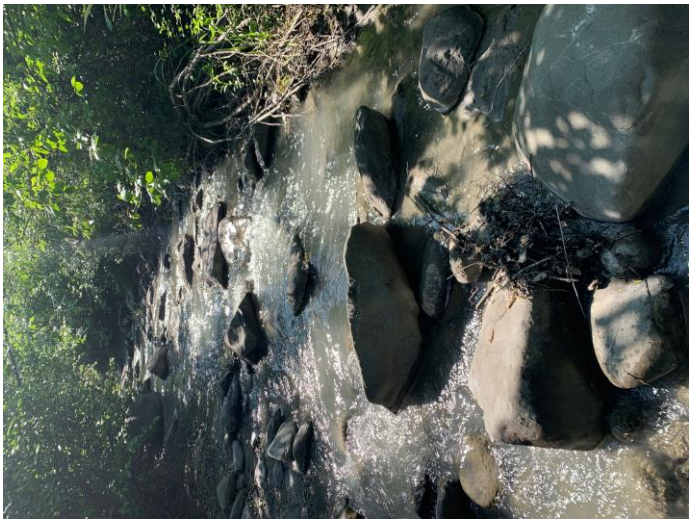
Unit 79.0 – Riffle

Unit 78.0 – Run

Unit 77.0 –Pocket Pools

Reach 9 – 0.82 miles

Unit 82.0 – Cascade



Unit 81.0 – Pocket Pools

Unit 80.0 – Run

Reach 9 – 0.82 miles

Unit 85.0 – Run

Unit 84.0 – Cascade

Unit 83.0 – Riffle

Reach 9 – 0.82 miles

Unit 87.0 – Riffle

Unit 86.0 – Cascade

Reach 10 – 2.08 miles

Unit 89.0 – Glide

Unit 88.0 – Glide

Reach 10 – 2.08 miles

Unit 92.0 – Riffle

Unit 91.0 – Riffle

Unit 90.0 – Glide

Reach 10 – 2.08 miles

Unit 94.0 – Glide

Unit 93.0 – Mid Channel Pool

Reach 10 – 2.08 miles

Unit 96.0 – Pocket Pools

Unit 95.0 – Run

Reach 10 – 2.08 miles

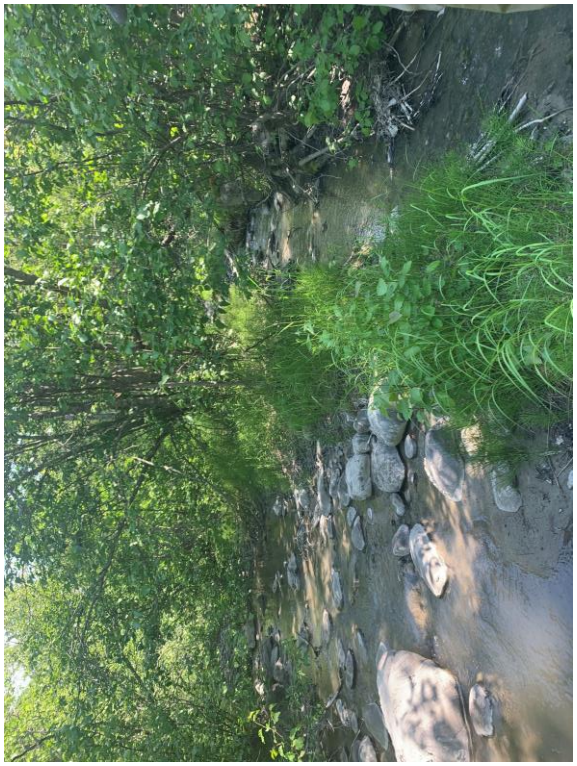
Unit 99.0 – Run

Unit 98.0 – High Gradient Riffle

Unit 97.0 – Run

Reach 10 – 2.08 miles

Unit 101.0 – Glide



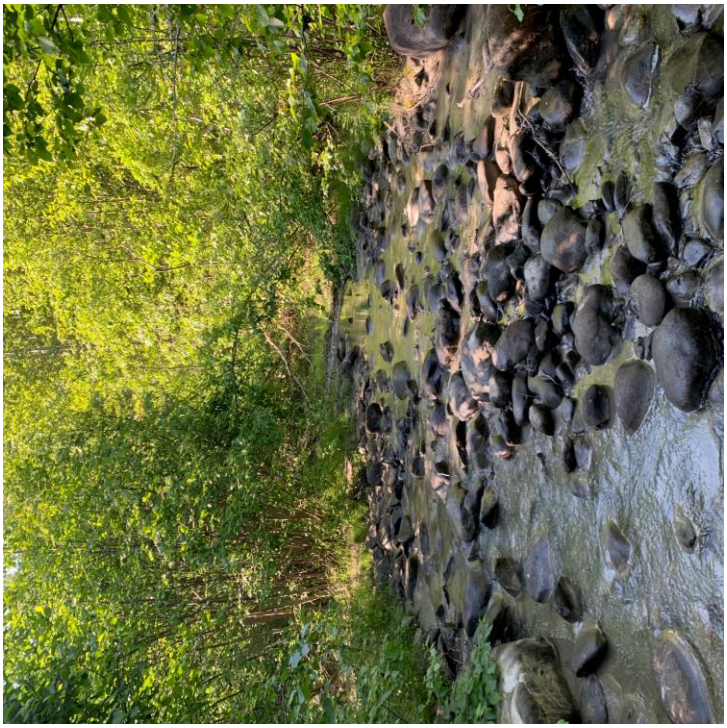
Unit 100.0 – Glide

Reach 10 – 2.08 miles

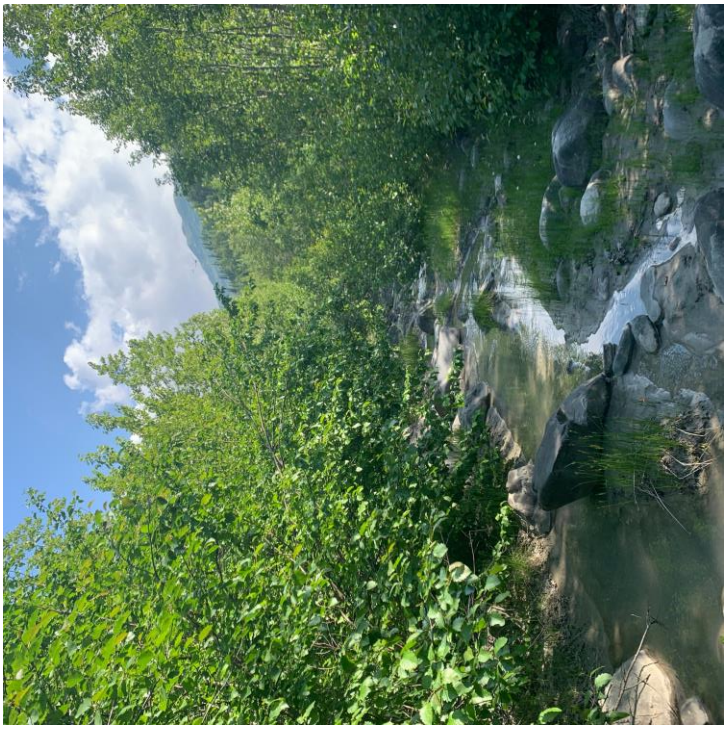
Unit 102.1 – Riffle

Unit 102.0 – Run

Reach 10 – 2.08 miles



Unit 104.0 – Run



Unit 103.0 – Run

Reach 10 – 2.08 miles

Unit 106.0 – Glide

Unit 105.0 – Run

Reach 10 – 2.08 miles

Unit 108.0 – Not Enough Water for a Decision

Unit 107.0 – Glide

Reach 11 – 2.66 miles

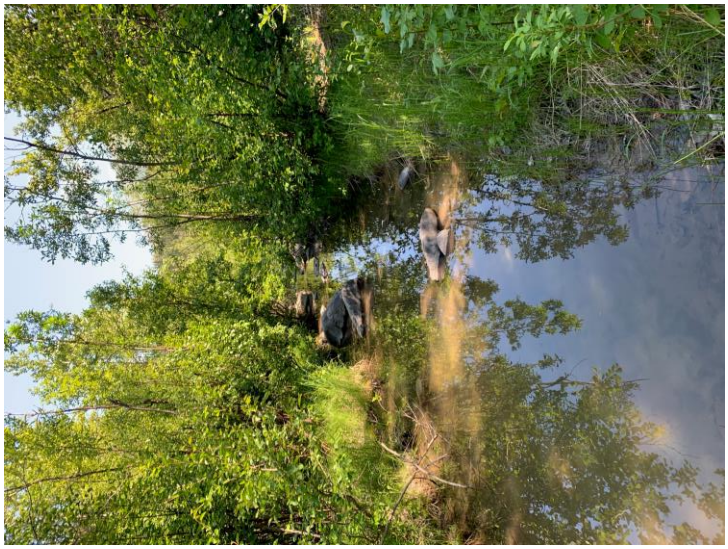
Unit 110.0 – Dry Channel

Unit 112.0 – Glide

Unit 109.0 – dry channel

Unit 111.0 – Pool

Reach 11 – 2.66 miles

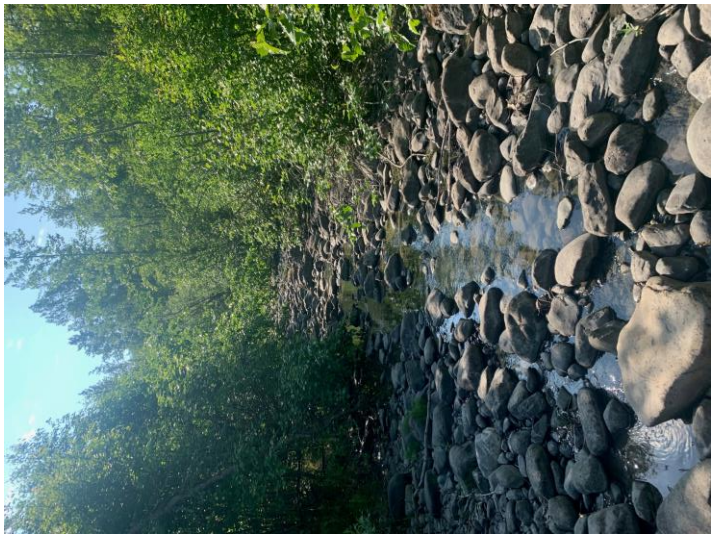


Unit 115.0 – Run

Unit 114.0 – Glide

Unit 113.0 – Mid Channel Pool

Reach 11 – 2.66 miles



Unit 117.0 – Run

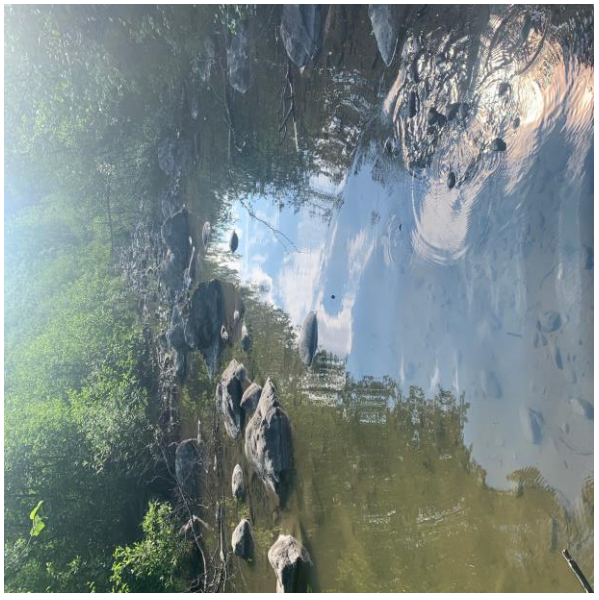
Unit 116.1 – Riffle

Unit 116.0 – Pool

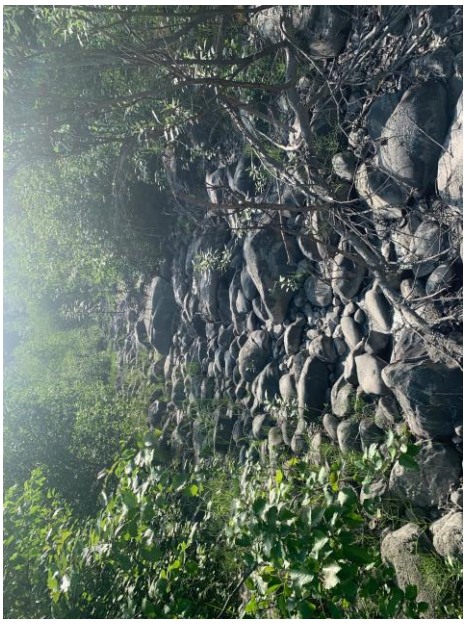
Reach 11 – 2.66 miles

Unit 119.0 – Run

Unit 120.1 – undefined water



Unit 118.0 – pool



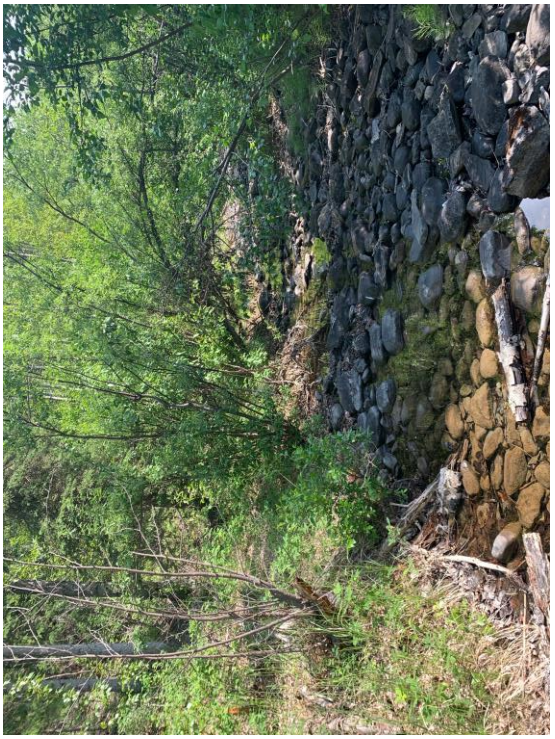
Unit 120.0 – dry channel

Reach 11 – 2.66 miles

Unit 122.0 – dry channel

Unit 124.0 – Mid Channel Pool

Unit 121.0 – dry channel



Unit 123.0 – Run

Reach 11 – 2.66 miles

Unit 125.0 – dry channel

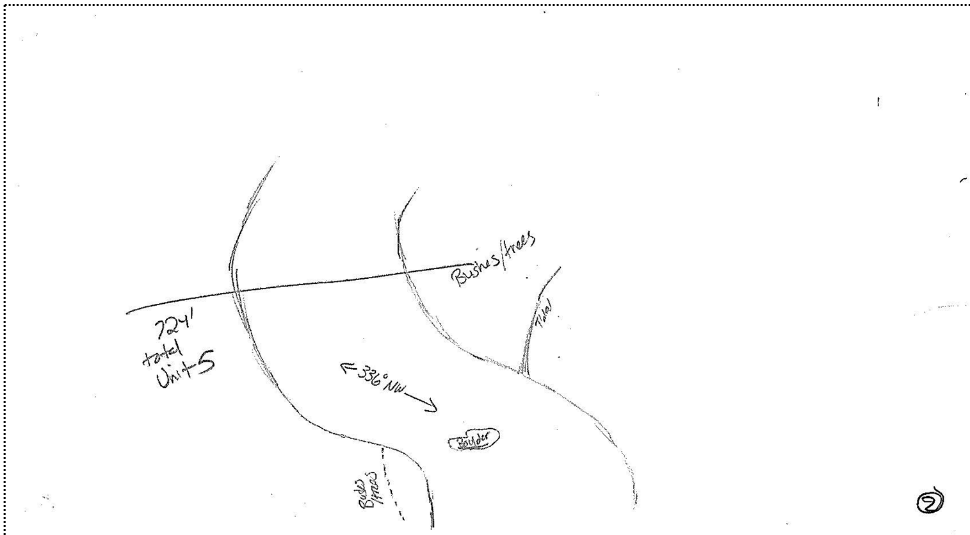
Unit 124.1 – Undefined Water

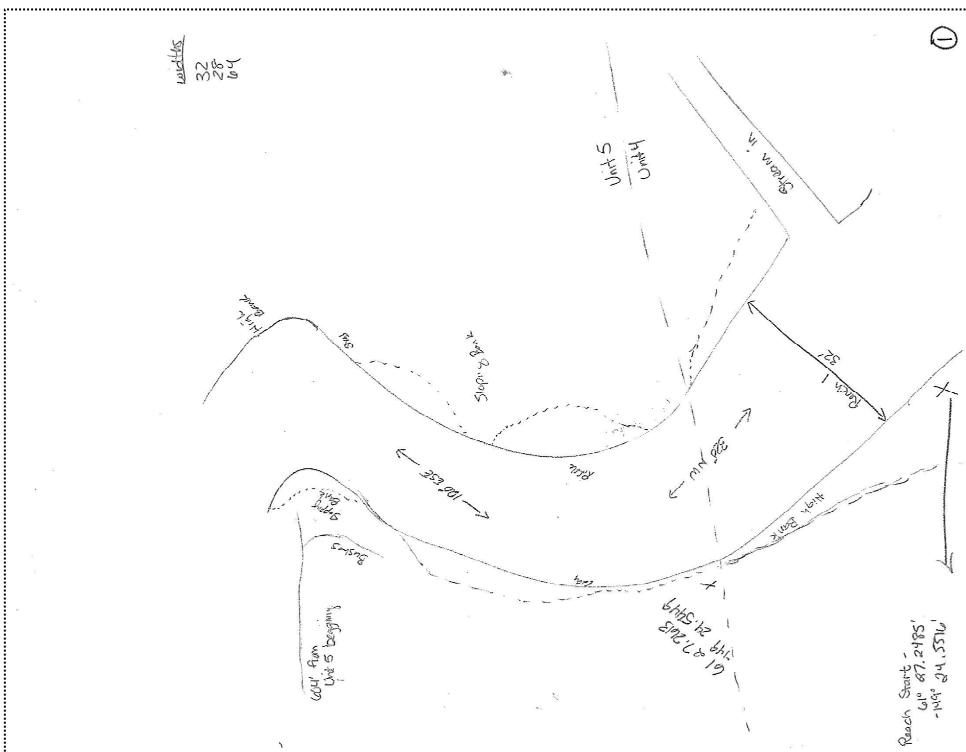
Reach 11 – 2.66 miles

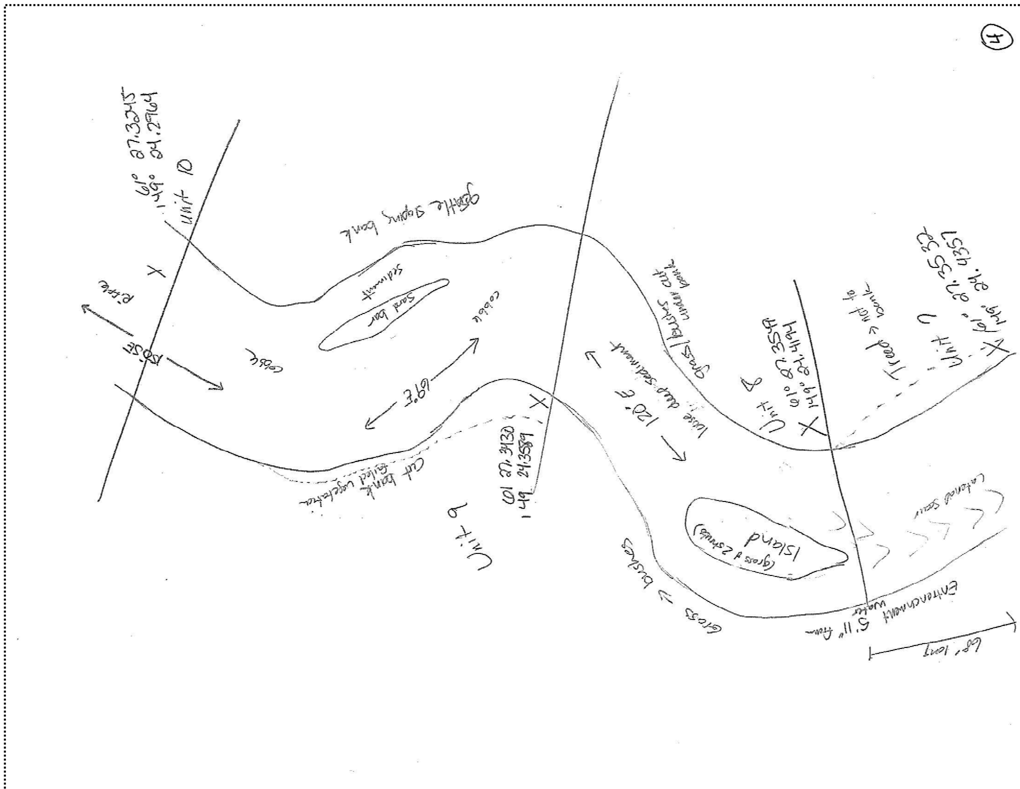
Unit 125.0– Mid Channel Pool Below Eklutna Lake Dam

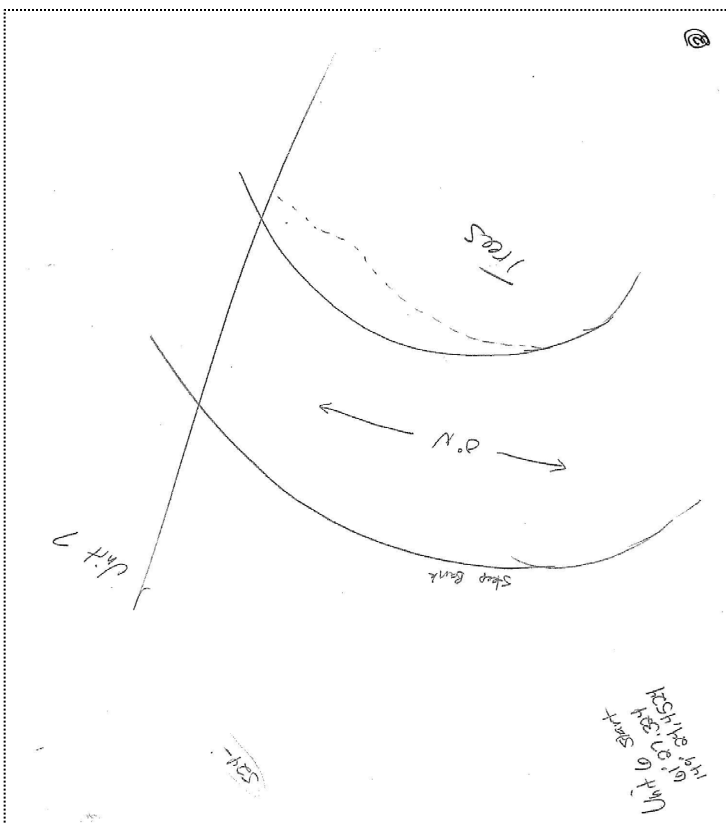
Appendix III

Field Maps/Notes



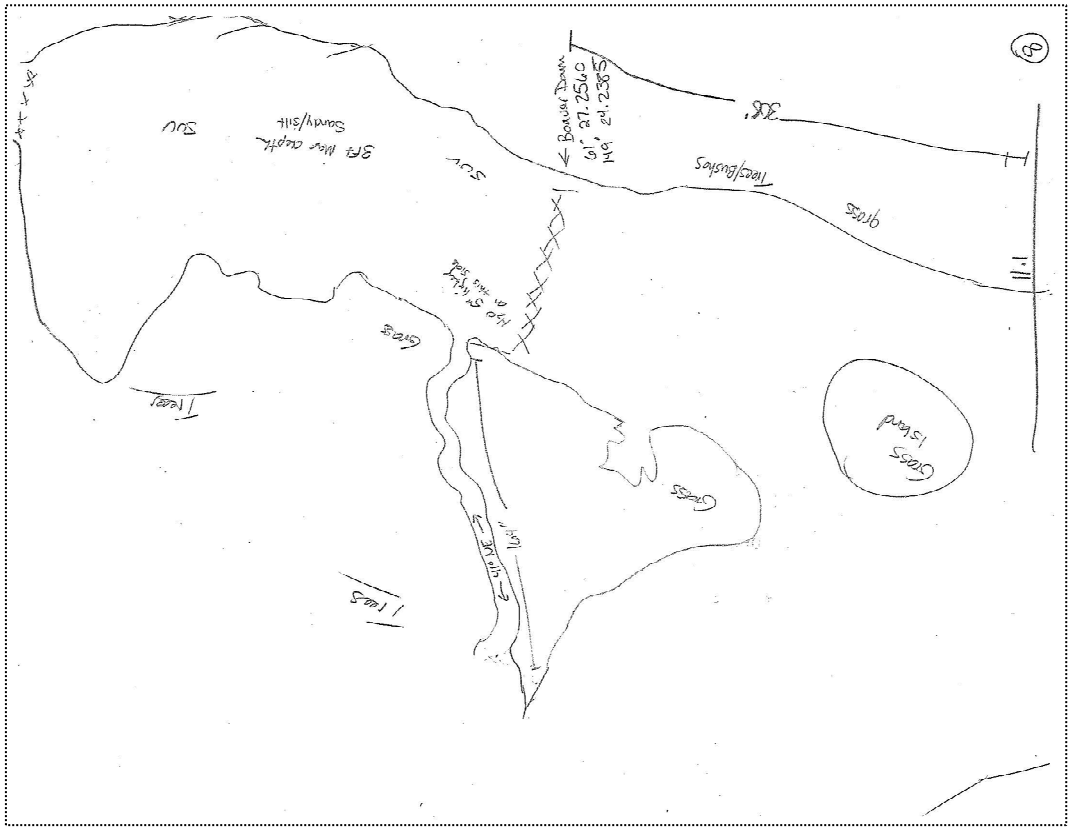


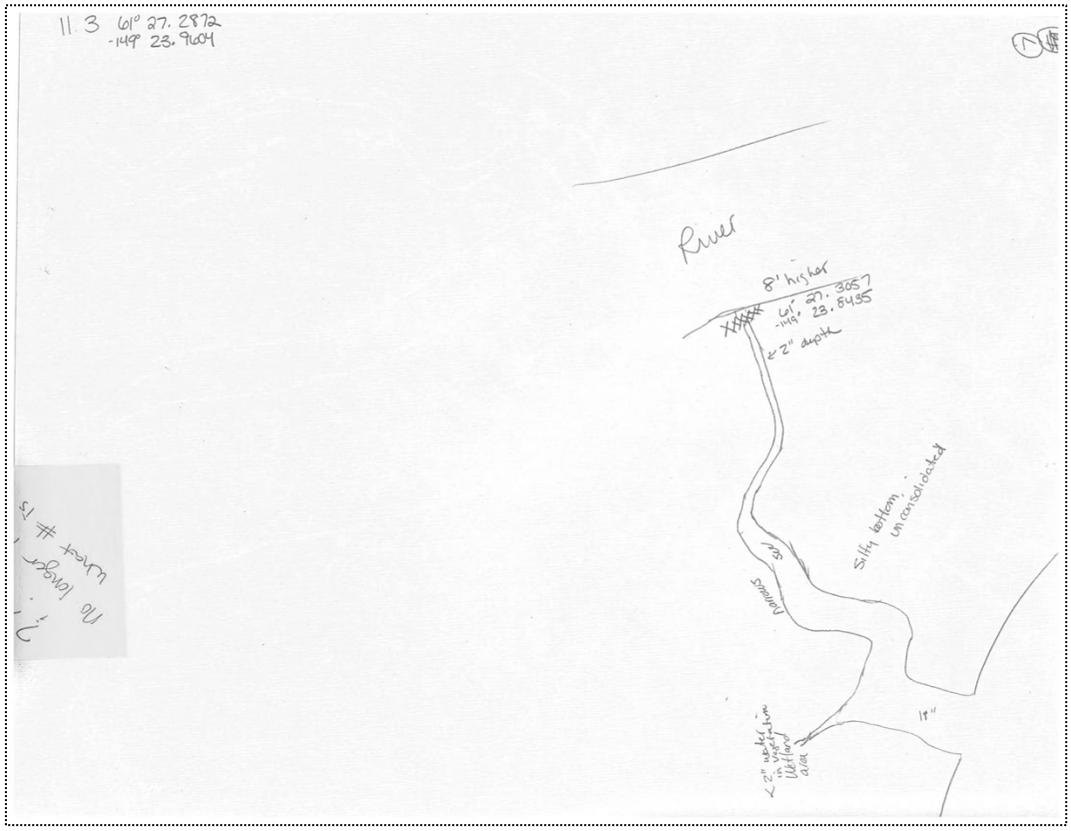

Unit 10
Unit 9
Unit 8
Unit 7
Sand bar
Island
cobble
sediment
Riffle

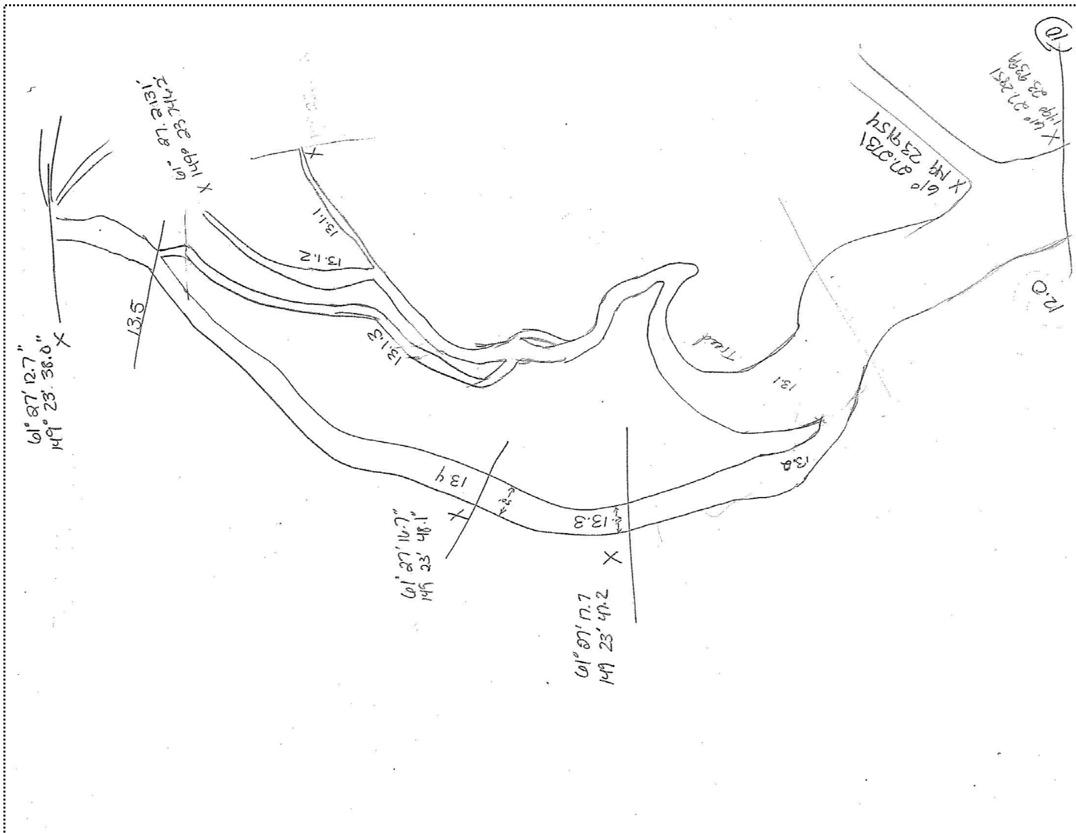

Trees
Steep Bank
Unit 7
Unit 6 start

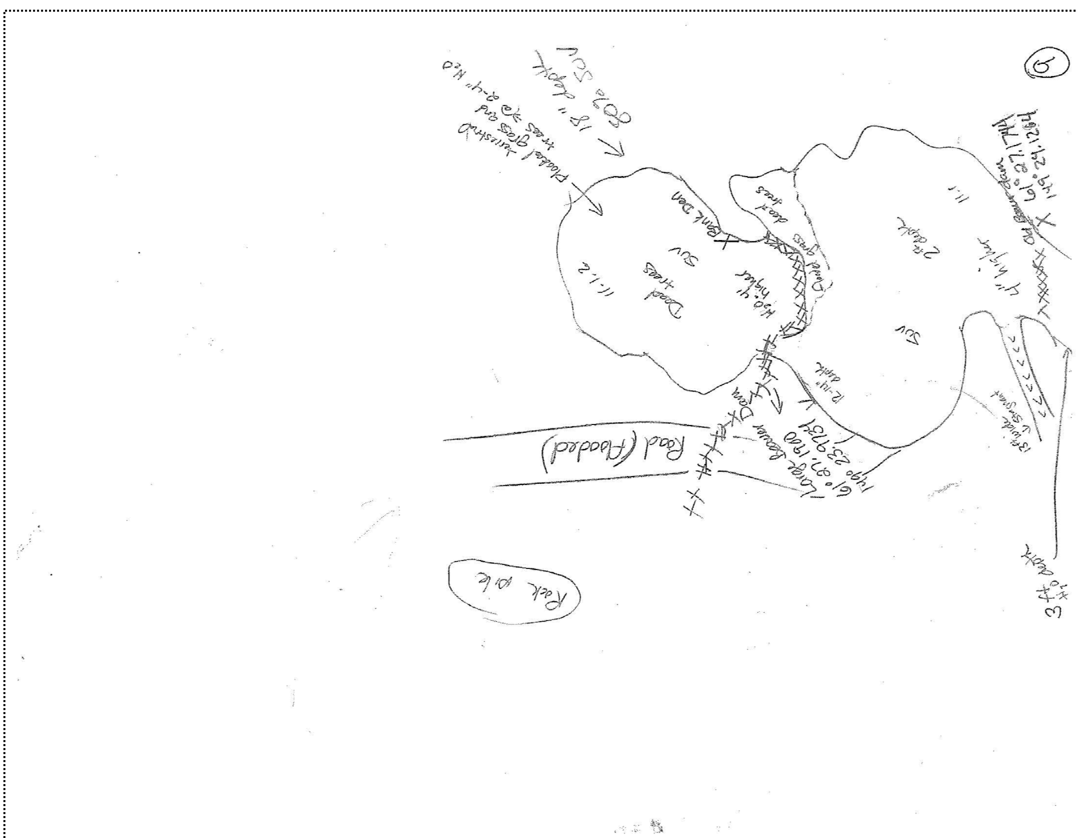
④
Unit 12 Beach
Unit 11 Beach 2
Beach Cam 2
To Jetty
Up trees
Up trees
Unit 11
11.3
Sandy bottom
Unit sandy bottom
N 41° NE
125'
78' E
Sandy bottom
X dir. 213°10'3
X 124° 24' 10"3
Tree
Lobstrock Point
Unit 11 Shore
X = 124° 24' 10"3
Up 11.2
Bldg
Shower
Glass
Glass
Bldg
Tree
Trees

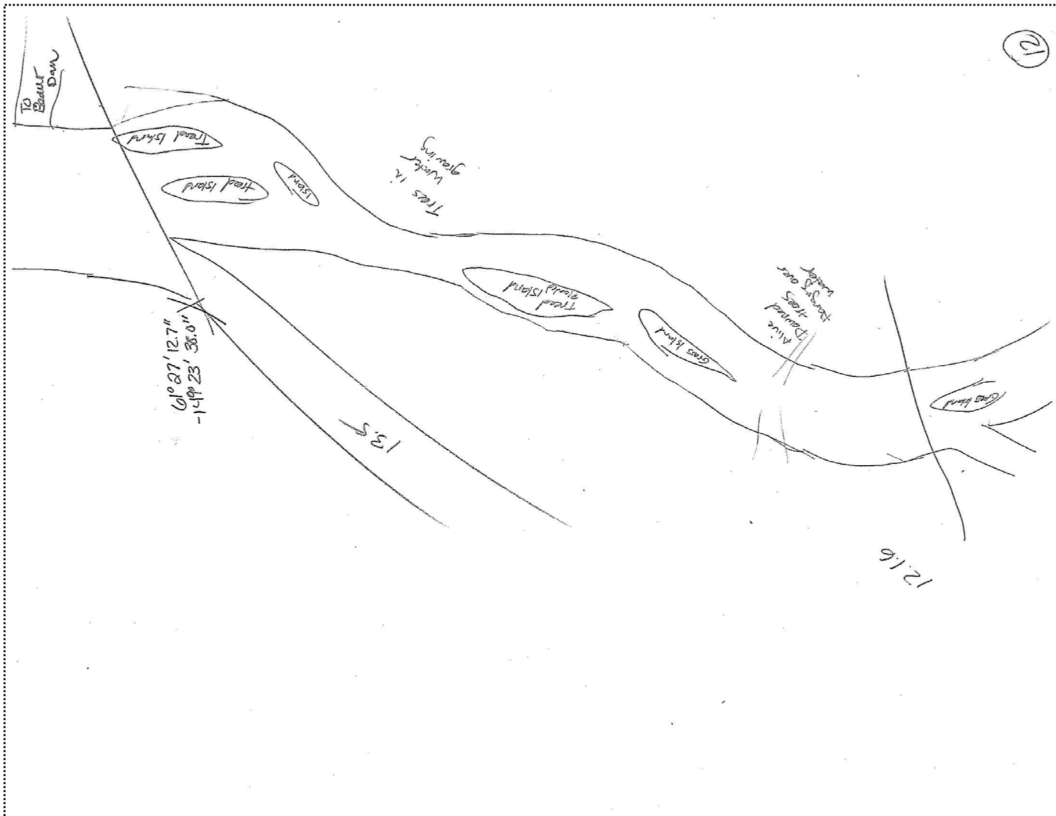
⑤
Unit 11
Bushes
Tree
Bushes
132 SE
Bldg
Trees


Boater Down
61° 27.2560
149° 23.2385
365'
11.1
trees/bushes
grass
SUV
SPA blue depth
Sandy/silt
Trees
Grass
Grass Island
Trees
Trees
~2" min depth

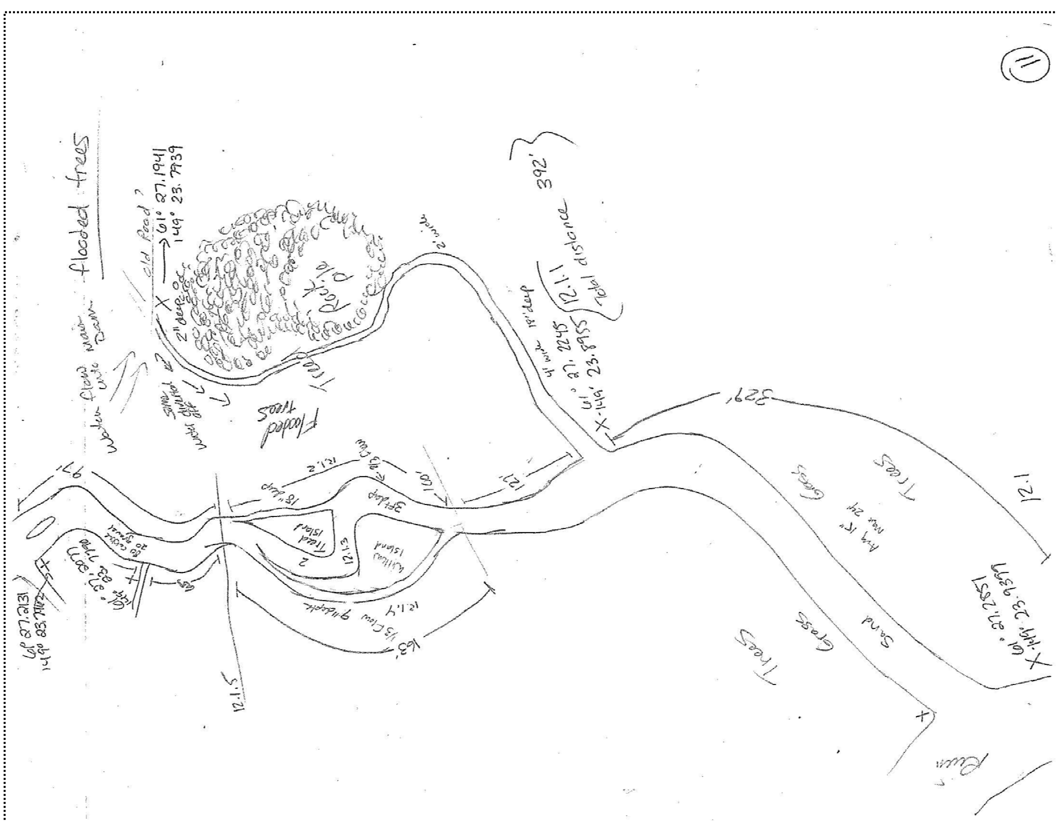

11.3 61° 27.2872
-149° 23.9604
River
8' higher
61° 27.3057
-149° 23.8435
~2" depth
Narrows
Silty bottom, some consolidated
12"
~2" water from Westward area



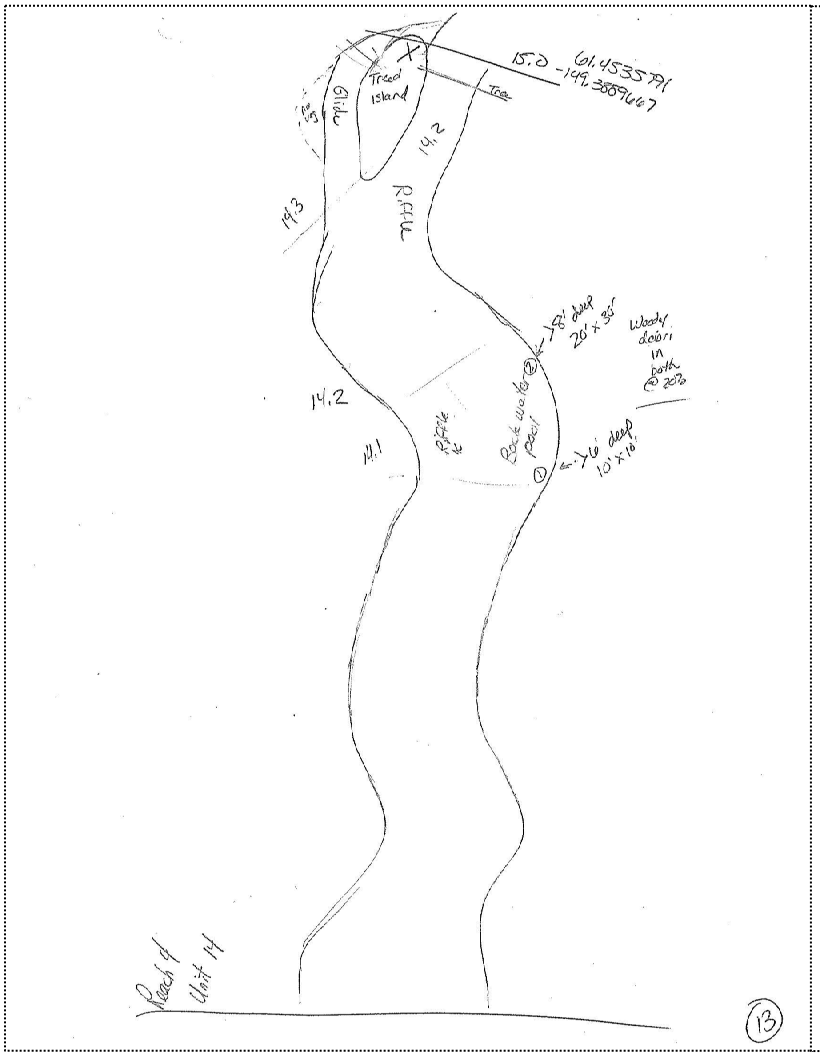


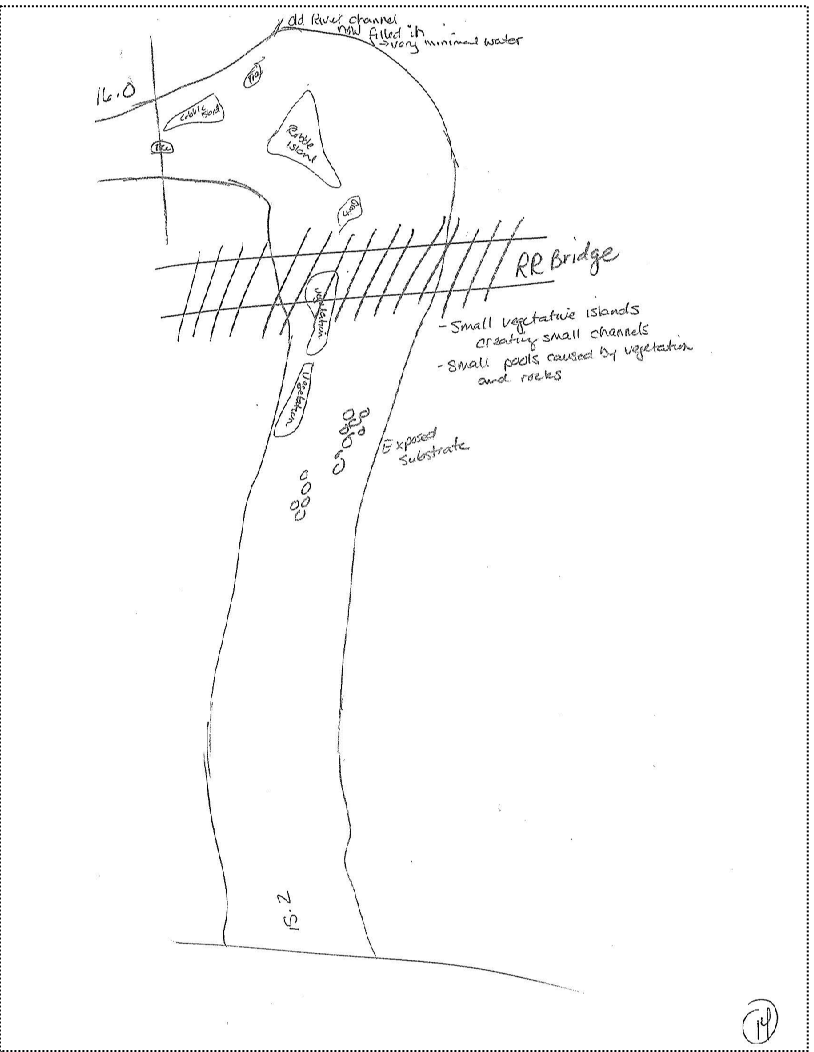


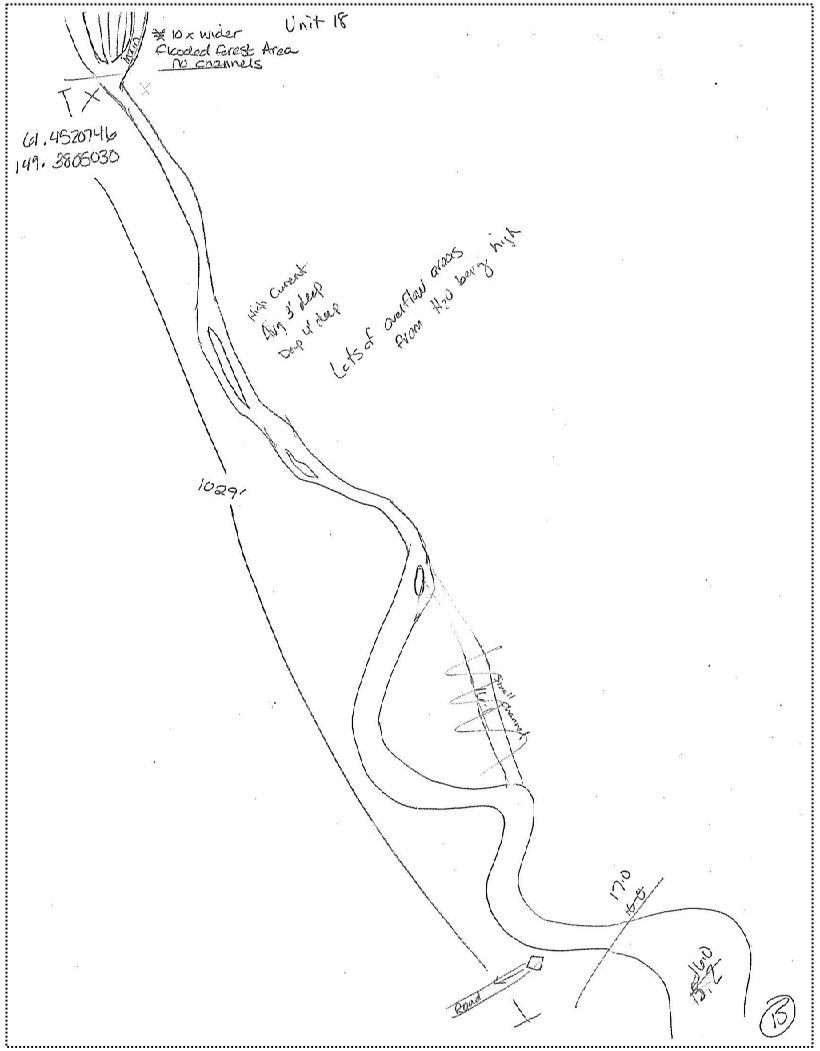
12
TO Beaver Dam
Treed Island
Treed Island
Island
Trees in Water growing
61° 27' 12.7"
-149° 23' 38.0"
13.5
Treed Island
Grass Island
Alive Downed trees over water
Grass Island
12.1.6



11
flooded trees
old Road?
61° 27.1941
149° 23.7739
Flooded trees
Rock Pile
12.1.1
total distance
392'
329'
Trees
Grass
Sand
12.1
Trees
Grass
Sand
61° 27.2821
149° 23.9371
Treed Island
Willow Island
12.1.3
12.1.2
12.1.4
12.1.5
163'
100'
127'

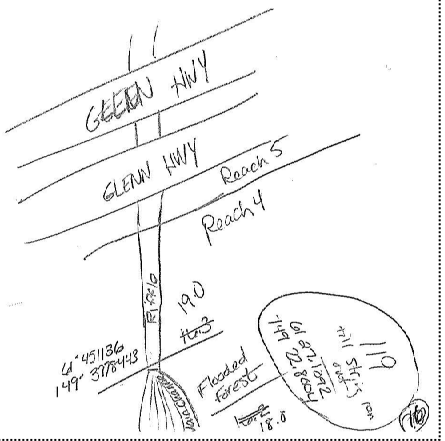

15.2
61.45535 -149.38596
Tree
Island
Glide
14.2
14.3
RIFFLE
18" deep
20' x 35'
Woody debris in bank @ 203
14.2
14.1
Riffle
Back end to pool
18" deep
10' x 10'
Beach of Unit 14
13

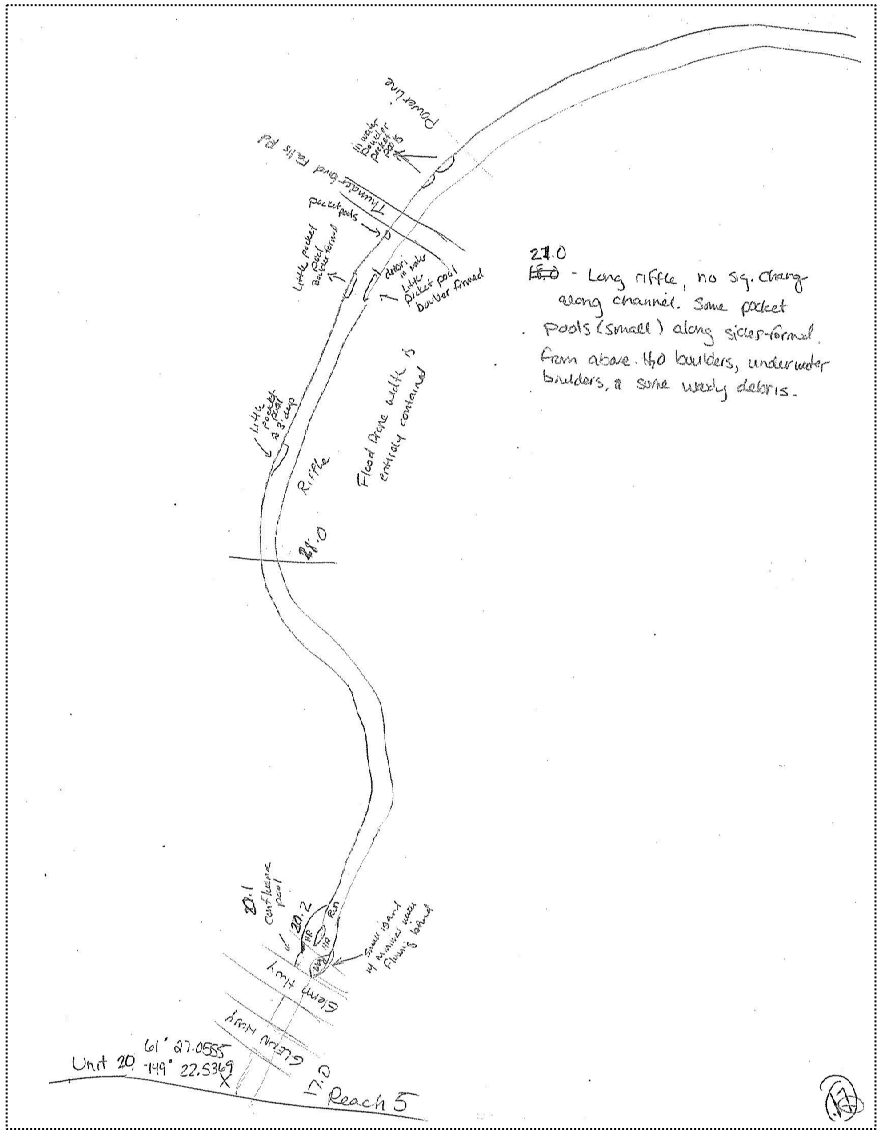

Old flood channel now filled in very minimal water
16.0
RR Bridge
- Small vegetative islands creating small channels
- Small pools caused by vegetation and rocks
Exposed substrate
15.2
14

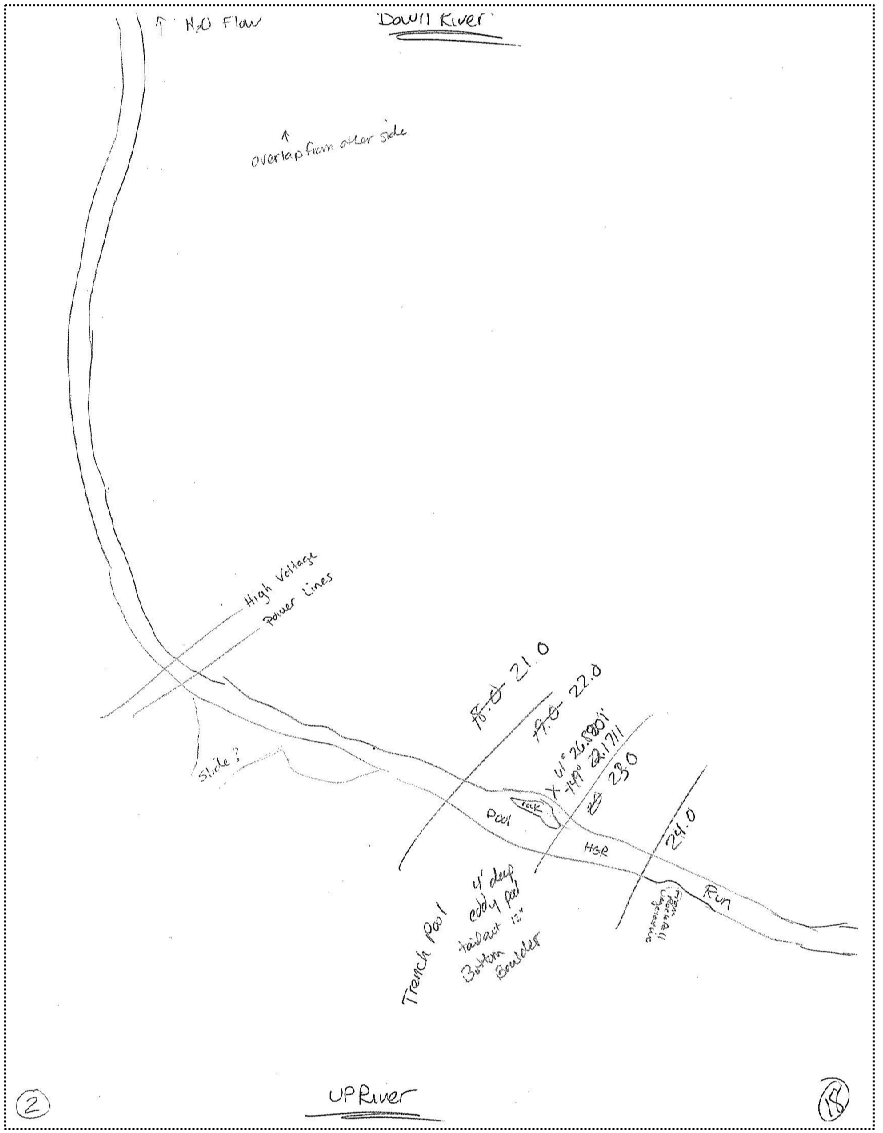


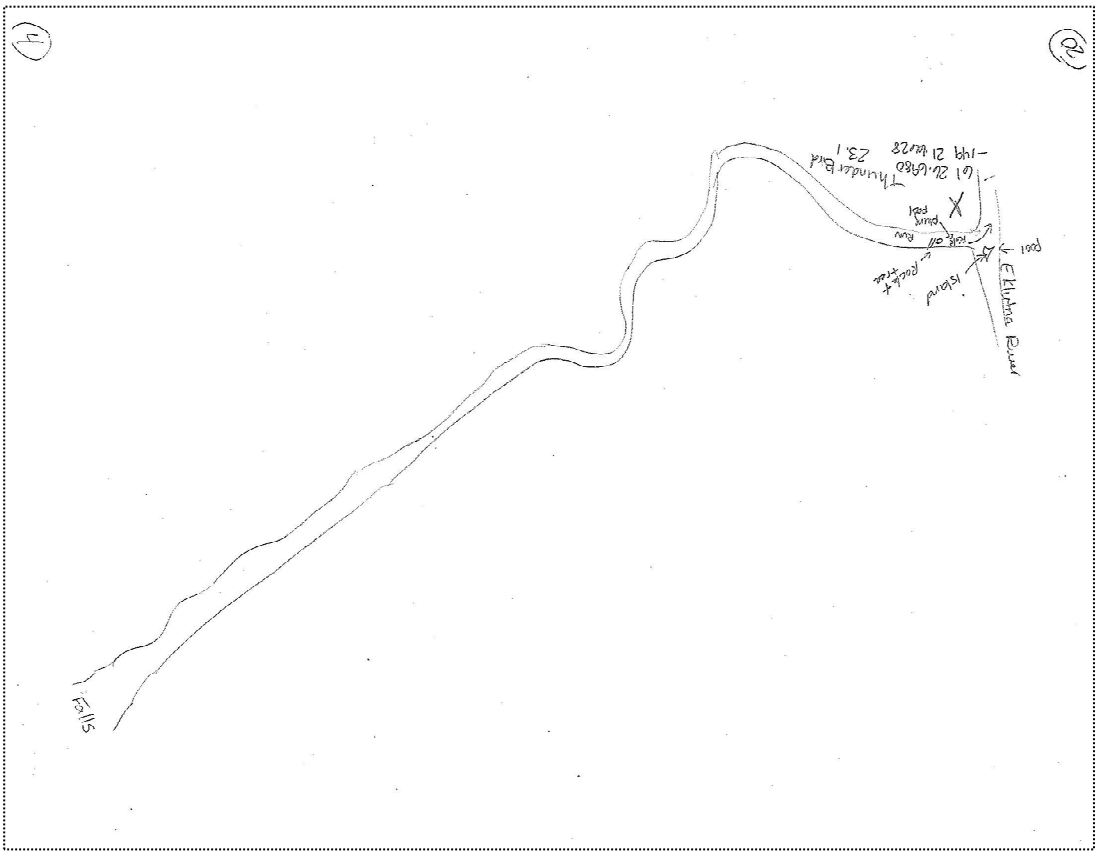
18.0 notes

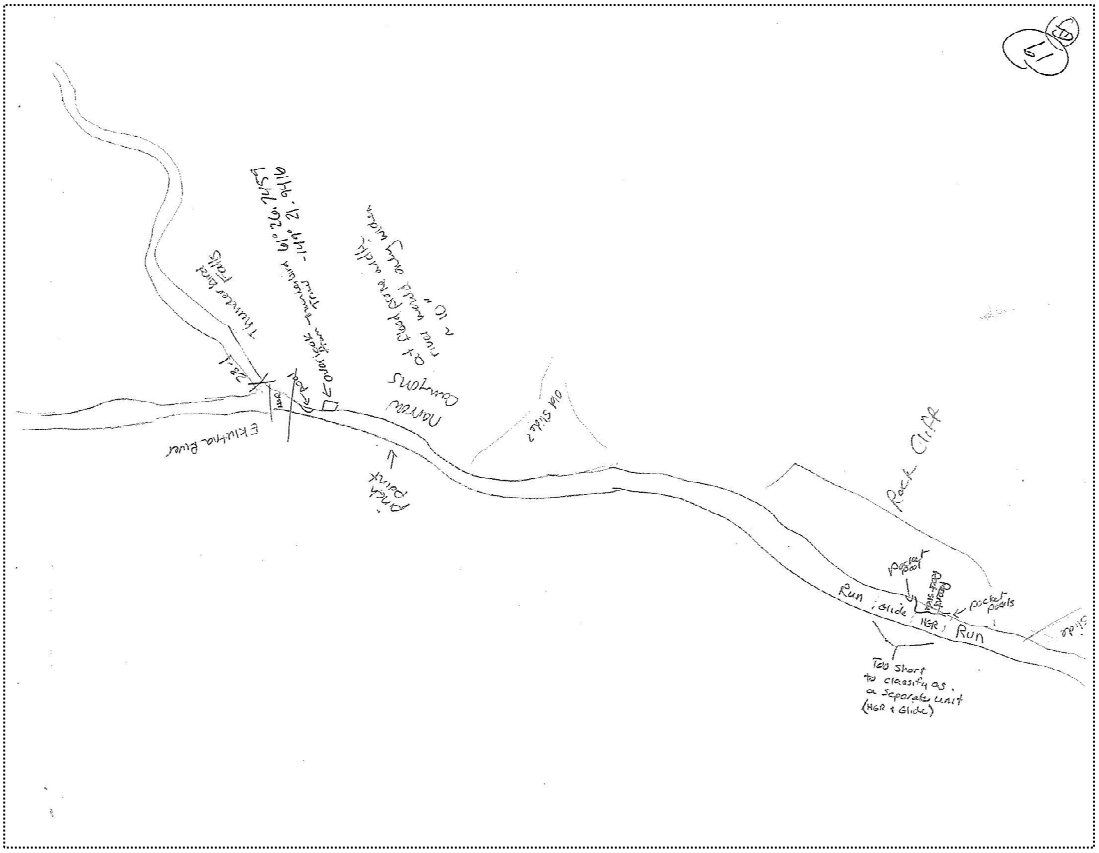
- no main channel.
- Linear distance of flooded forest is approx. 575 ft

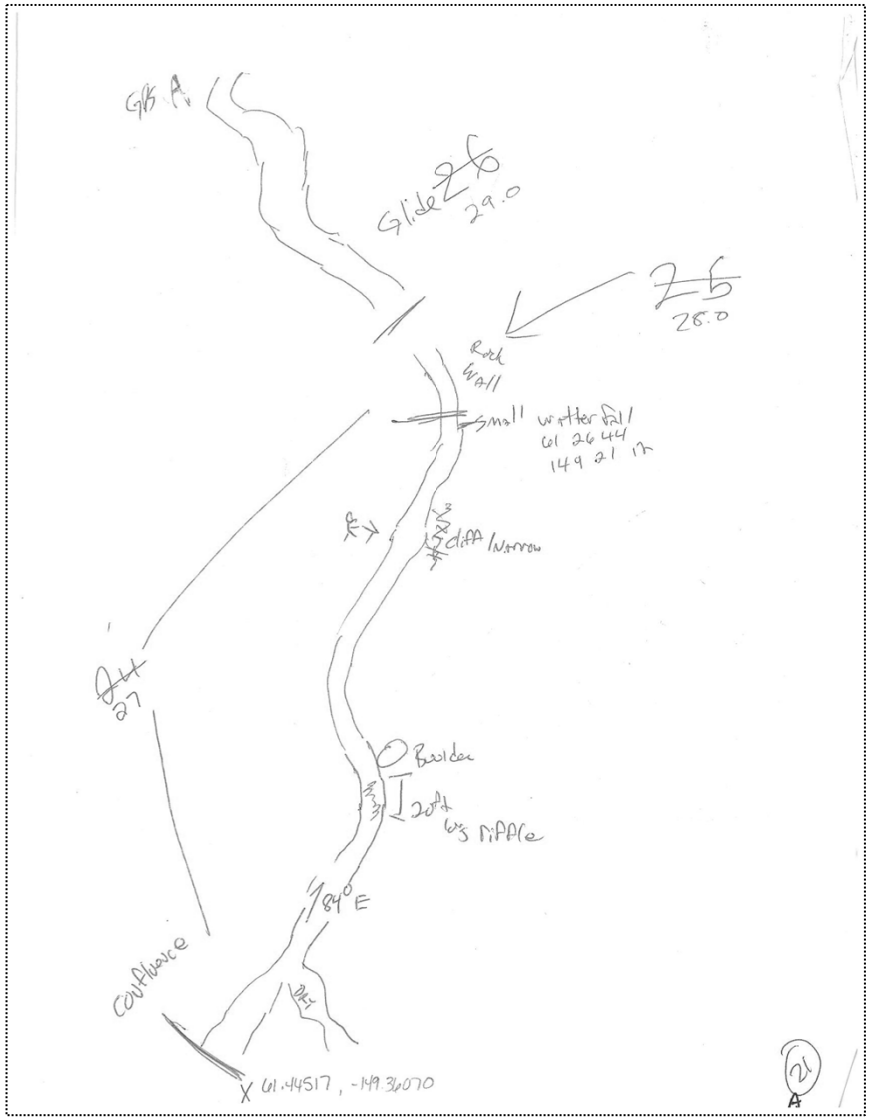


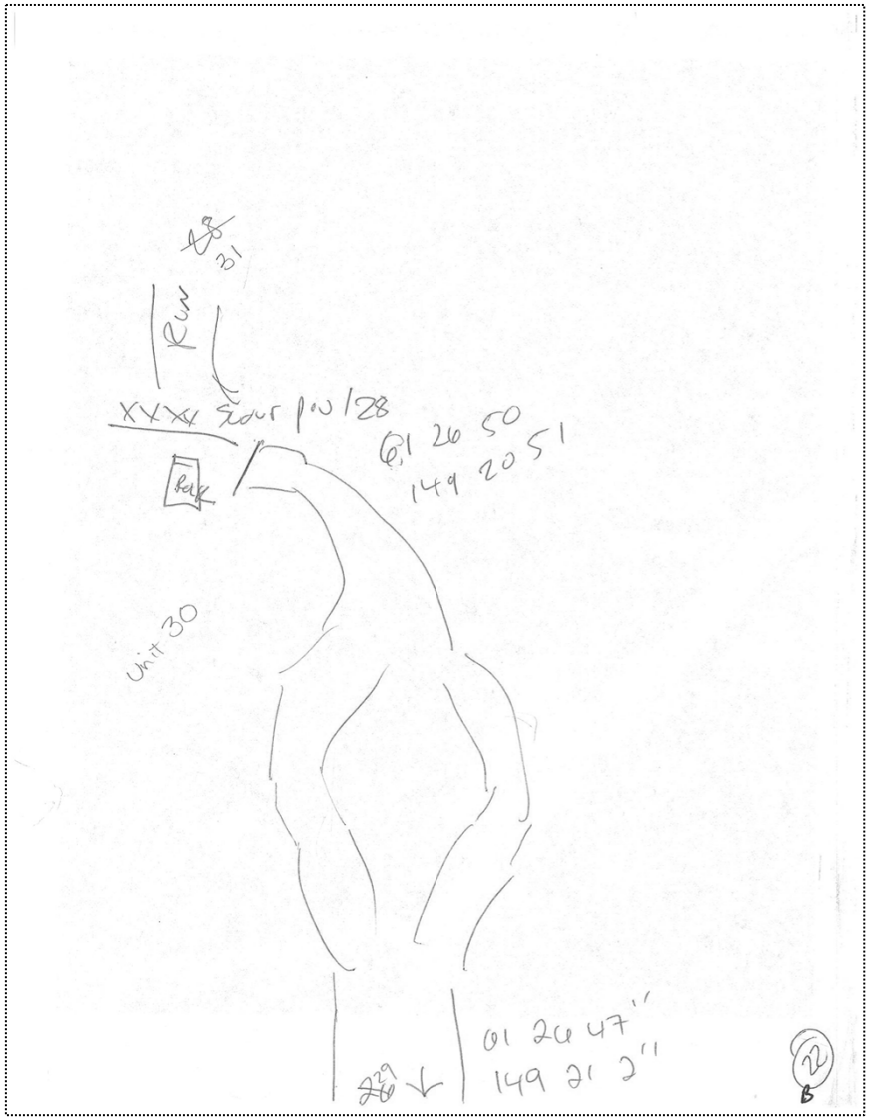

Power line
Thunder Bird Falls Rd
Pedestrian path
Light gravel path/trail
deer trails
Little pool Boulder formed
27.0
- Long riffle, no sq. change along channel. Some pocket pools (small) along sides-formed from algae. No boulders, underwater boulders, & some woody debris.
Flood prone width is entirely contained
Riffle
28.0
29.1
confluence pool
29.2
Small island w/ mature trees, Flow's behind
Bank Height
Bank Height
27.0
Reach 5
Unit 20
61° 27.0555
-149° 22.5369

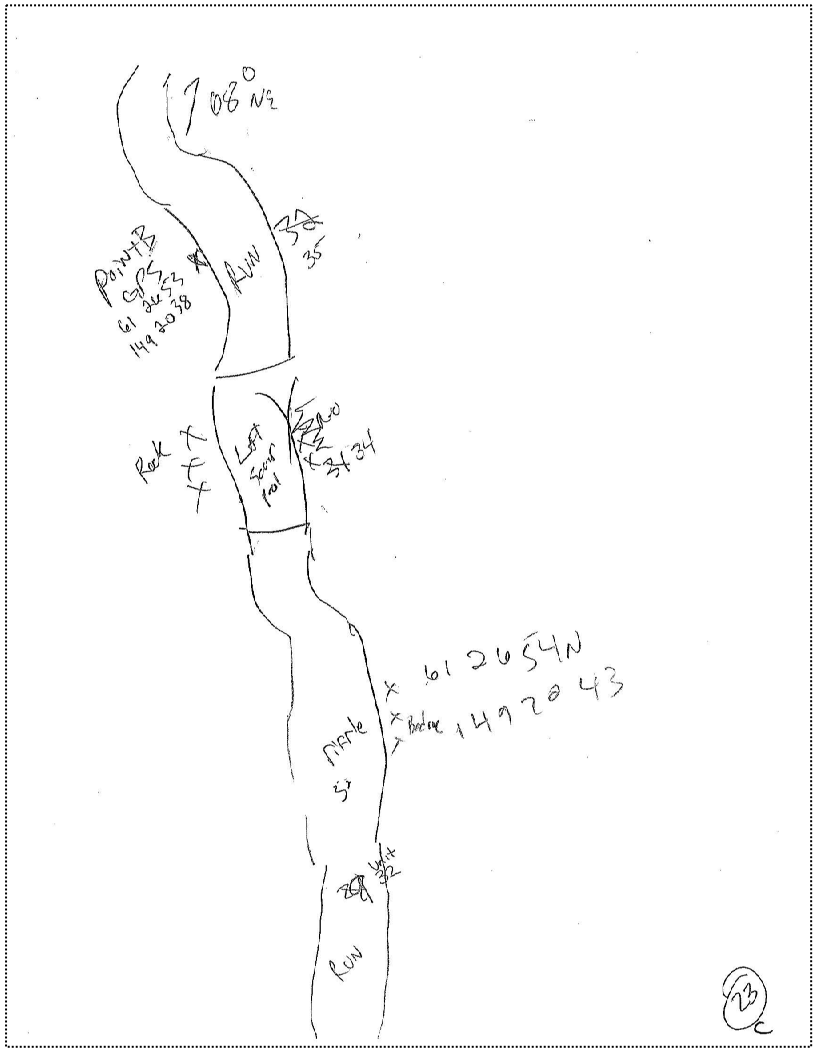

N.O Flow
Dawn River
overlap from other side
High Voltage Power Lines
slide?
28.0
22.0
61° 26.9801'
-149° 22.1711
23.0
pool
riffle
HSR
24.0
Run
Trench pool
4' deep
eddy pool
behind
Bottom
Boulder
UP River
2

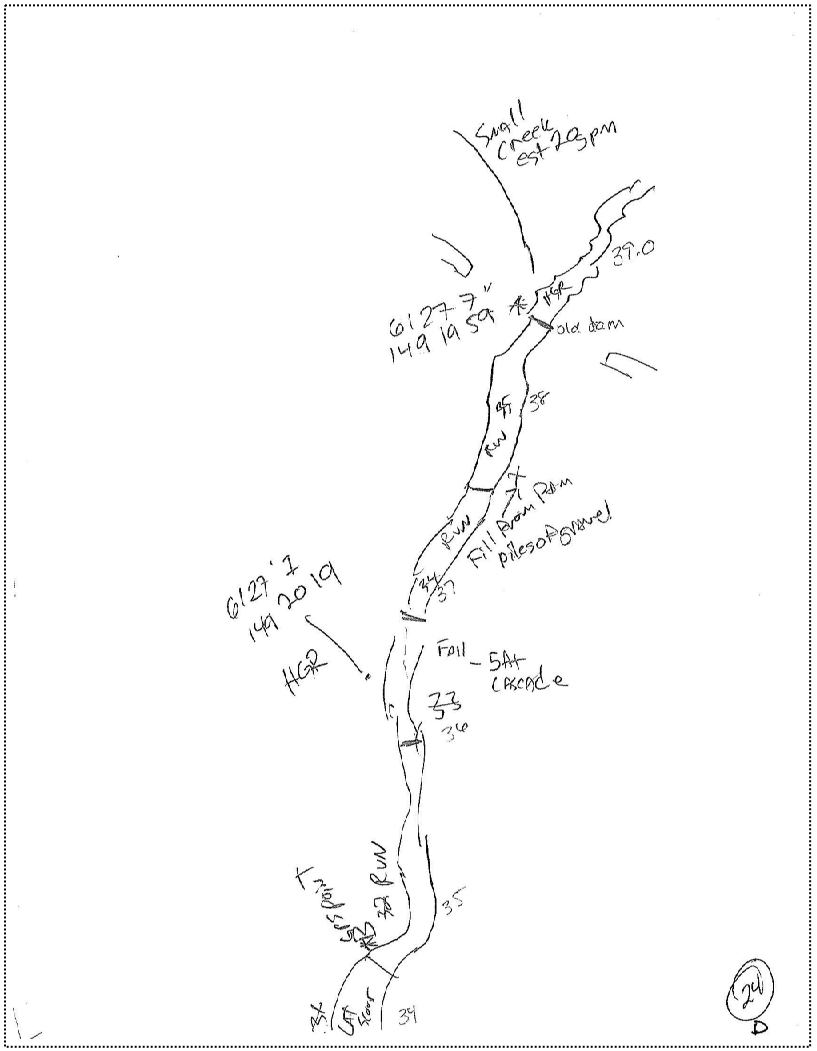

Falls
E Klutina River
Island
Rock Flow
Pool
Rock Fall
Run
Pool
X
Thunder Bird
61 26.686
-144 21 W28 23.1

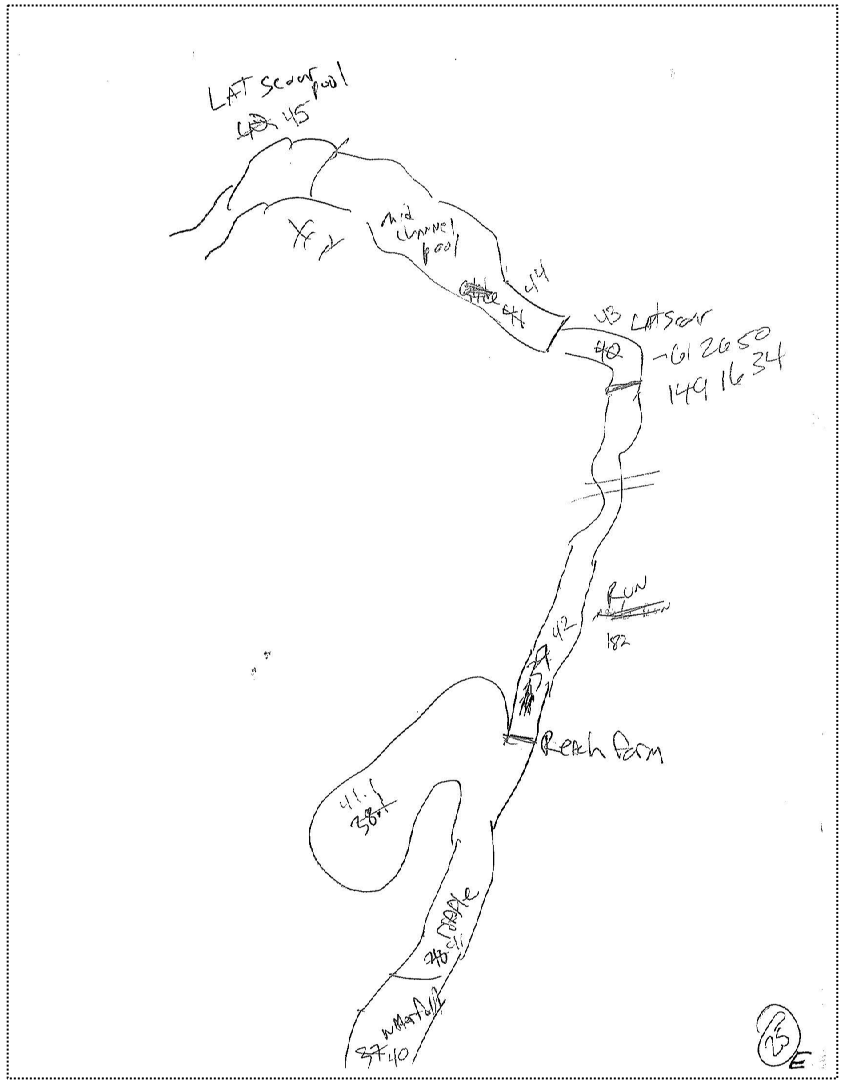

Thunder Bird Falls
Pool
Pool
Dam type structure
-144° 21.911'
61° 26.742'
Mentasta Dunes
Old Road Route visible
Rock Cliff
Oak Grade
Run ; Glide
HGR ; Run
Too short to classify as a separate unit (HGR + Glide)

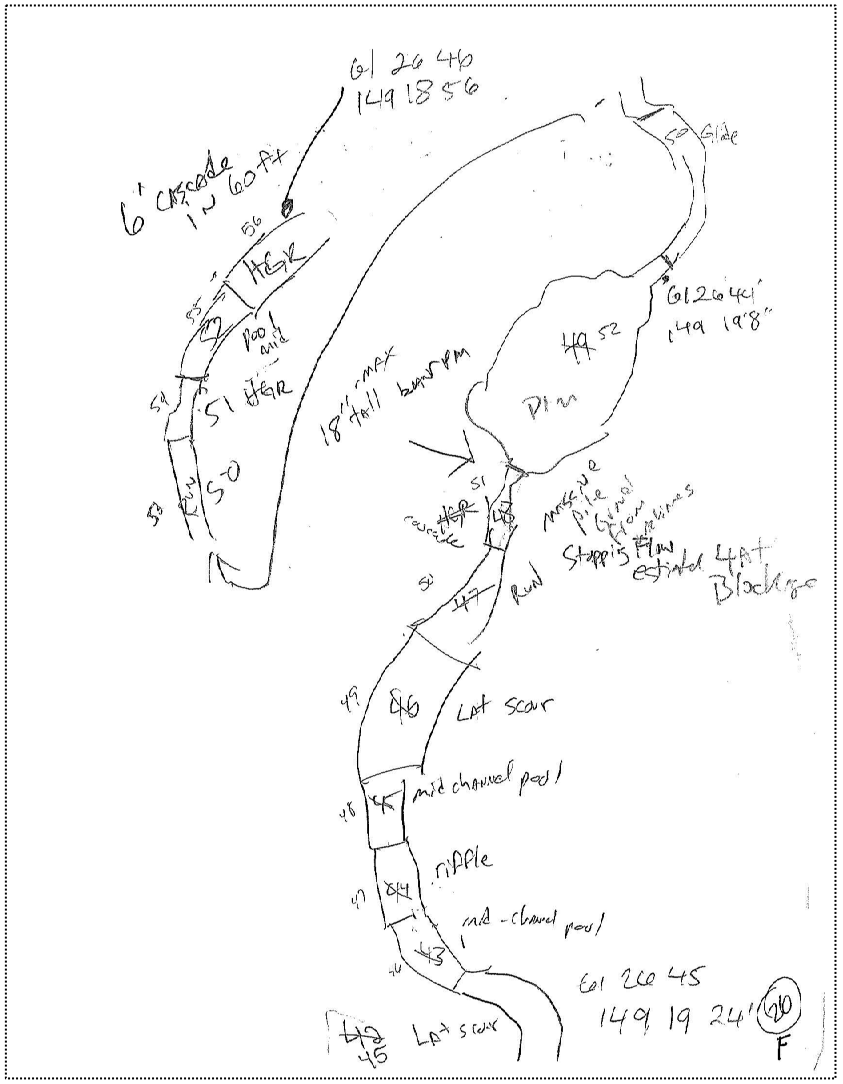

GB A
Glide 26
29.0
25
26.0
Rock wall
small waterfall
61 26 44
149 21 17
diff Narrow
27
Boulder
20ft 6's riffle
84° E
confluence
X 61.44517, -149.36070
21
A

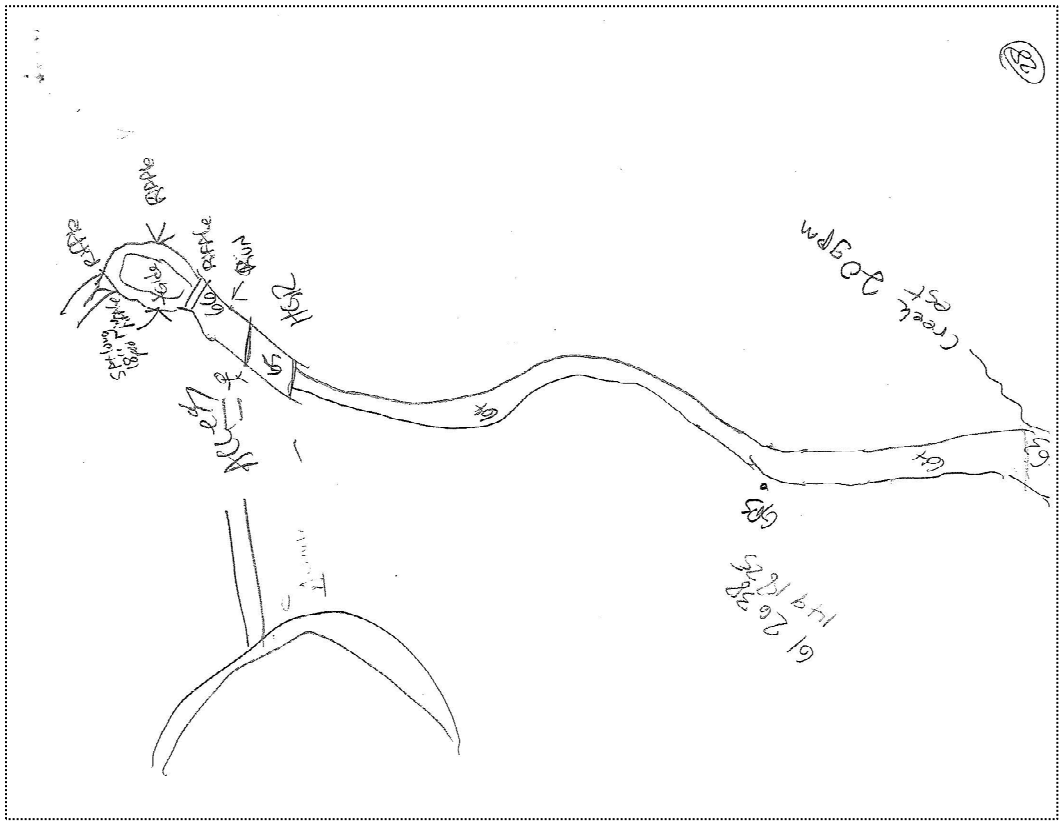

31
Run
XXXX Scour pool 28
61 26 50
149 20 51
Rock
Unit 30
29
61 26 47"
149 21 2"
22
B

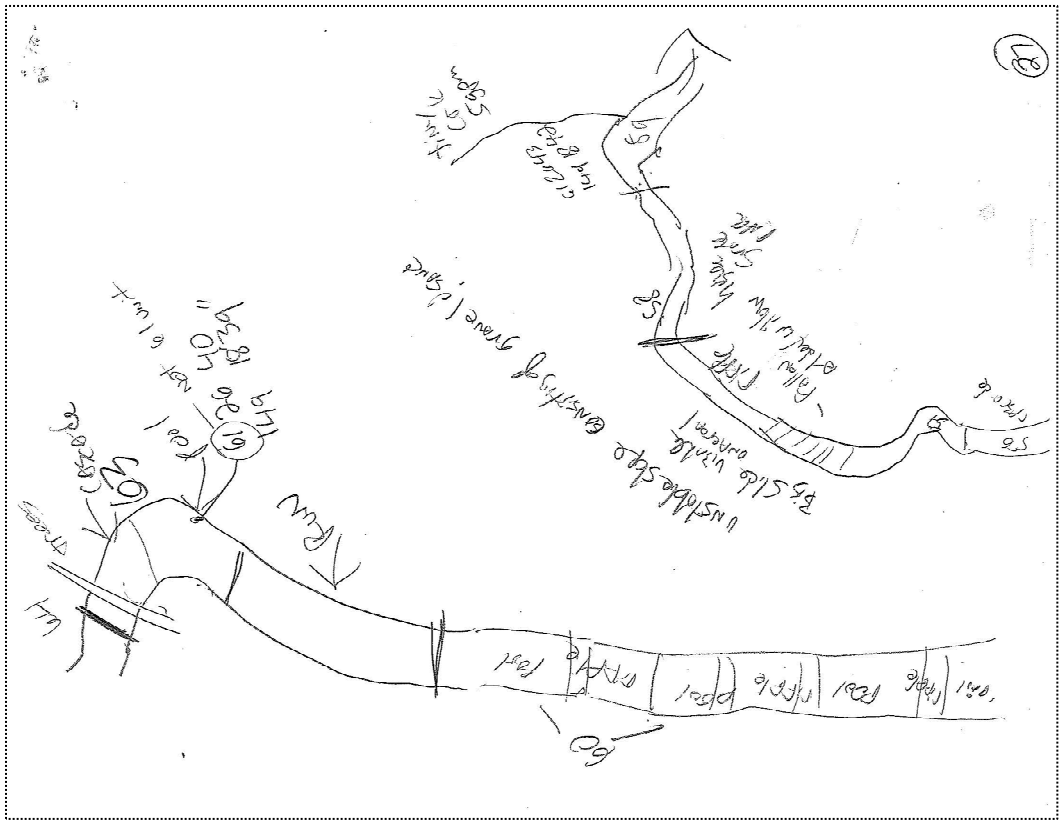

108° N
Point B
GPS
61 26 33
149 20 38
RUN
35
Rock
Left
Small
pool
34
61 26 54N
149 20 43
riffle
5'
RUN
C

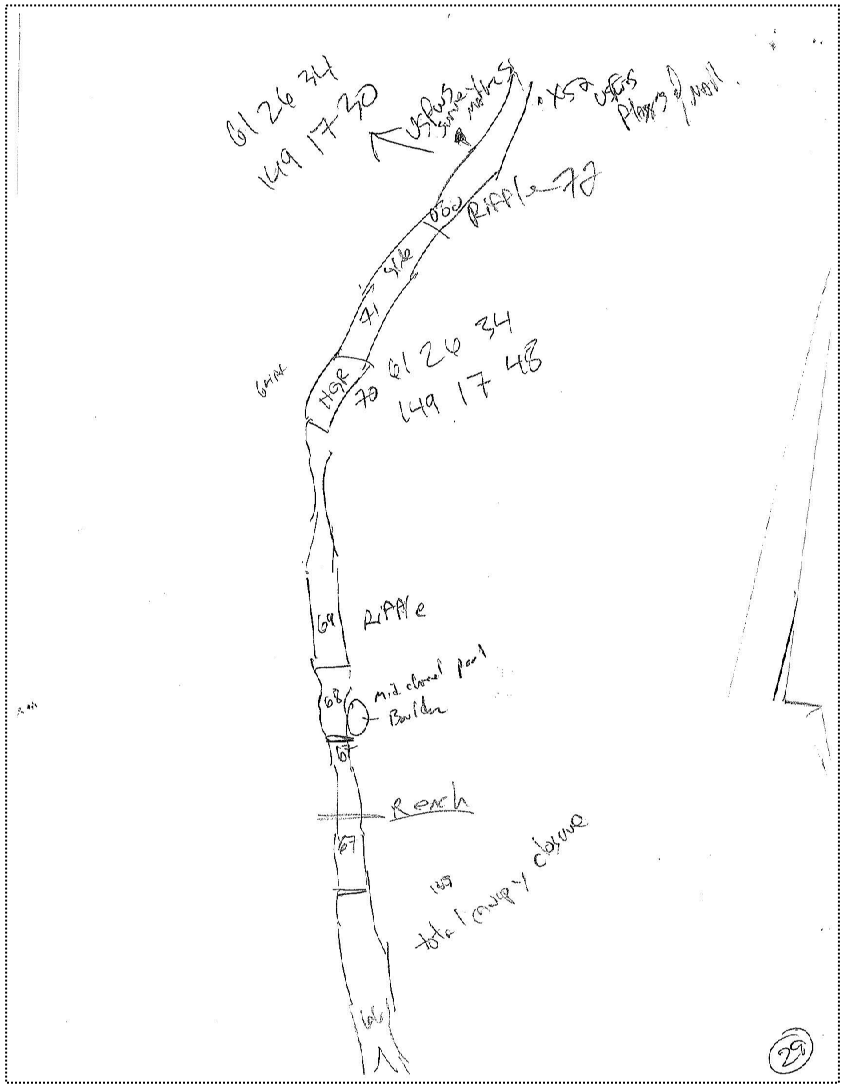

Small
Creek
est 2 gpm
39.0
61 27 7"
149 19 59
HGR
old dam
RUN
35
RUN
Fill from Ram
piles of gravel
61 27 1
149 20 19
HGR
Fall - 5ft
cascade
33
30
RUN
35
39
D

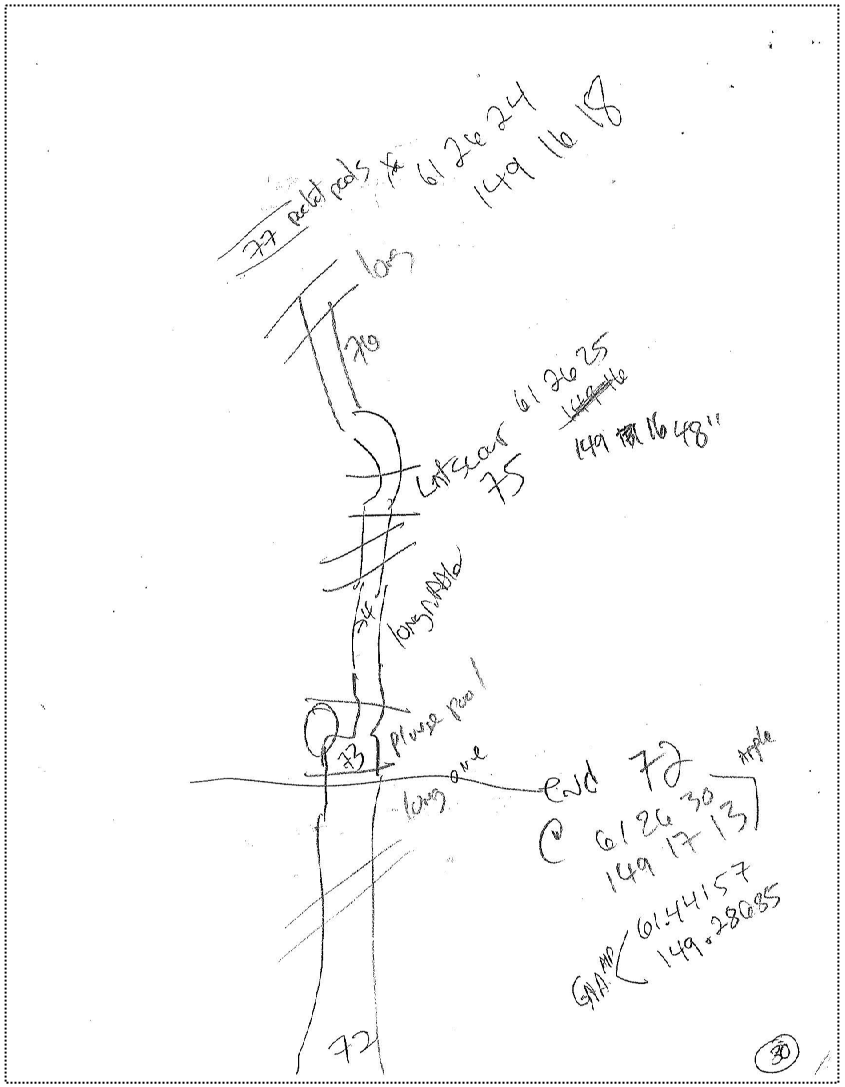

LAT scour pool
mid channel pool
US LAT scour
-61 26 50
149 16 34
RUN
Reach farm
riffle
mid channel pool
E

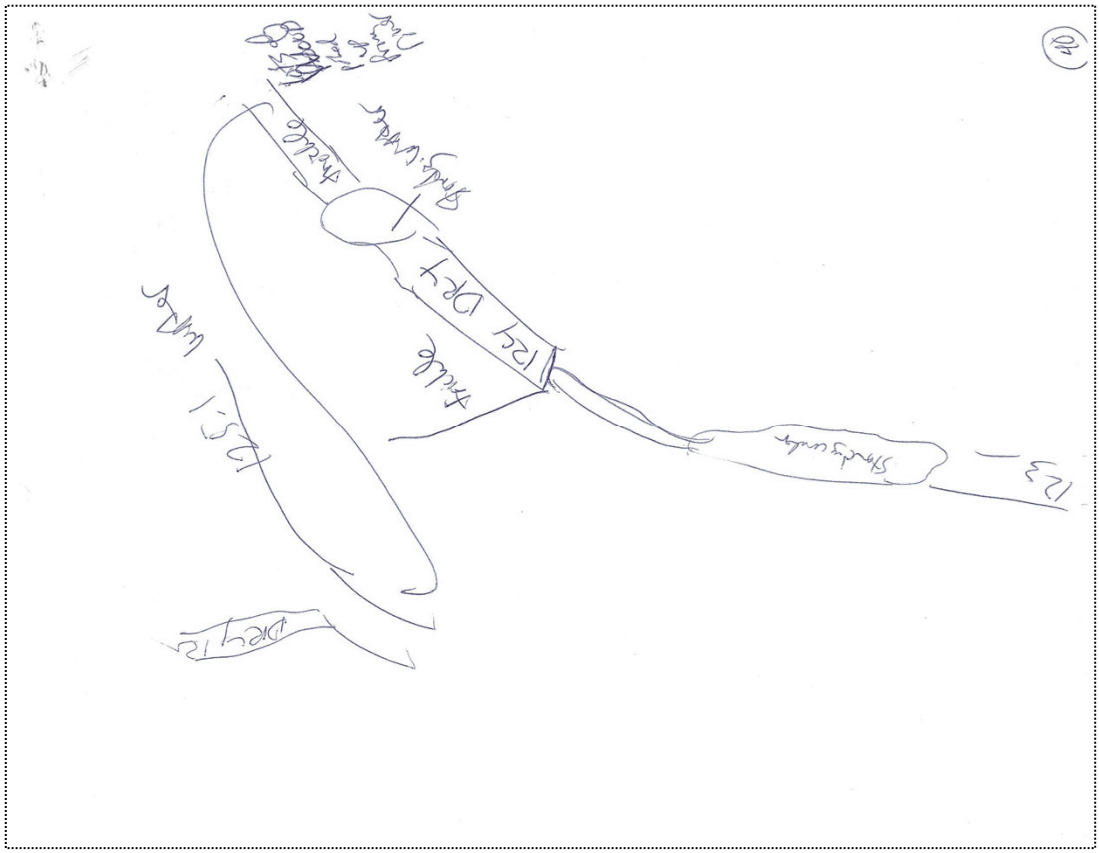

61 26 46
149 18 56
6' cascade
1:N 60 ft
HGR
pool and
51 HGR
18" max
Hall bunyrm
Run
Stoppi's Run
estimated 4ft
Blackgoo
LAT scour
mid channel pool
riffle
mid-channel pool
61 26 45
149 19 24
Lat scour
Glide
61 26 44
149 19 8"
F

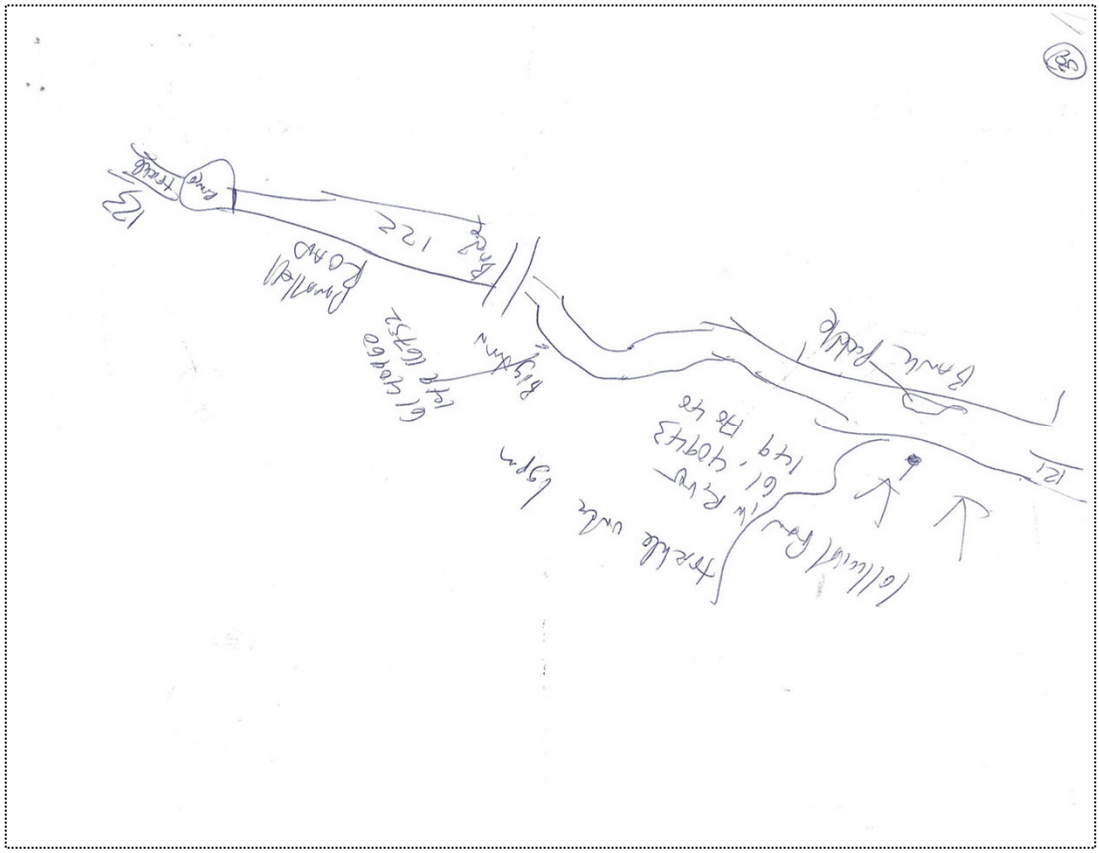





61 26 34
149 17 20
Riffle 72
61 26 34
149 17 48
RIFFLE
mid channel pool
Boulder
Reach
tot Canopy closure

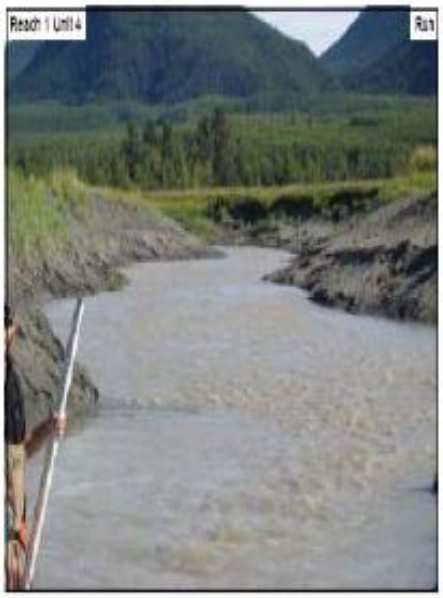

77 pocket pools
61 26 24
149 16 18
long
70
Lateral scour
75
61 26 25
149 16 48"
Plunge pool
73
long pool
end 72
61 26 30
149 17 13
61.44157
149.28085
72





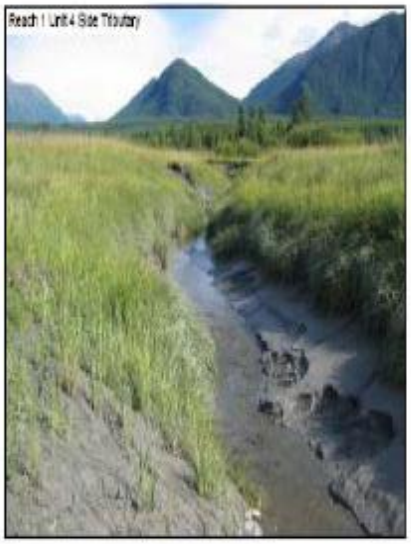
Comparison Photos

The following photos were taken at approximately the same place in 2019 as they were in 2007. Some unit numbers have changed due to environmental changes within the river channel. Not all units have comparison photos. Comparison photos were only able to be obtained below the rail road bridge.



Unit 4, 2007

Unit 4, 2019



Unit 4 side channel, 2007 Study

Unit 4 side channel, 2019 Study

Unit 5 - Run, 2007 Study

Unit 5 - Run, 2019 Study

Unit 6 - Run, 2007 Study

Unit 6 - Run, 2019 Study

Unit 8.1, 2007 Study

Unit 11, 2019 Study

Unit 7.0, 2007 Study

Unit 11.1, 2019 Study

Unit 8.2.2.1 - Glide, 2007 Study

Unit 11.1, 2019 Study

Unit 11.0, 2007 Study

Unit 16.0, 2019 Study