# Susitna-Watana Hydroelectric Project
# (FERC No. 14241)

## 2012 Upper Susitna River Fish Distribution and Habitat Study

## Habitat Report

Prepared for

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# LIST OF ACRONYMS AND SCIENTIFIC LABELS

| Abbreviation | Definition |
|---|---|
| AEA | Alaska Energy Authority |
| ADF&G | Alaska Department of Fish and Game |
| ADNR | Alaska Department of Natural Resources |
| AG | above ground |
| ATWG | Aquatic Technical Workgroup |
| cfs | cubic feet per second |
| FERC | Federal Energy Regulatory Commission |
| GIS | Geographic Information System |
| GPS | global positioning system |
| HD | high definition |
| ILP | Integrated Licensing Process |
| km | kilometer |
| LWD | large woody debris |
| m | meter |
| mph | miles per hour |
| NEPA | National Environmental Policy Act |
| Project | Susitna-Watana Hydroelectric Project |
| QC | quality control |
| RM | Susitna River historic river mile |
| RSP | Revised Study Plan |
| TWG | Technical Workgroup |
| UCB | undercut bank |
| USFS | U.S. Department of Agriculture, Forest Service |
| USGS | U.S. Geological Survey |

# SUMMARY

The 2012 Upper River Habitat study has two major components: a fish barrier assessment and habitat mapping study. The Fish Passage Barriers Assessment identified the locations of potential fish passage barriers in tributary streams upstream of Devils Canyon. Information regarding fish passage barriers, and specifically barriers to adult salmon migration, is important to define the extent of potential Project effects to fish and aquatic habitat. These data will also inform the planning and design of other Upper Susitna River studies related to fish distribution, particularly juvenile and adult salmon surveys. The study area included all tributary streams beginning at river mile (RM) 150 upstream to and including the Oshetna River at RM 233.5. Named tributaries in the study area include Cheechako Creek, Chinook Creek, Devil Creek, Fog Creek, Tsusena Creek, Deadman Creek, Watana Creek, Kosina Creek, Goose Creek and the Oshetna River.

Aerial surveys were completed in the Upper Susitna River basin from June 18 through June 22, 2012. The typical flight path started at the tributary confluence with the mainstem Susitna River and proceeded upstream to the 3,000-ft elevation contour, the highest elevation at which salmon have been observed in prior investigations. The survey was terminated at the first determined barrier or when the 3,000-ft elevation contour was reached. Physical features were defined as barriers to adult Chinook salmon passage if the vertical height was greater than 10 ft.

Surveys were flown on a total of 79 tributary drainages to the Upper Susitna River, with 41 drainages above and 38 drainages below the proposed dam site (RM 184). Approximately 815 tributary stream miles were evaluated. A total of 43 potential fish passage barriers were identified within 29 of the 79 drainages surveyed. Of these 43 barriers, 35 definitive fish passage barriers were identified within 24 tributaries.

The mainstem Susitna River between RM 150 and RM 227 is moderately confined, lying within an incised valley or canyon for most of its length. Where a limited floodplain exists, smaller tributaries generally have a short reach of relatively low-gradient streambed. This abruptly changes to a steep gradient when the tributary stream reaches the valley or canyon walls. All barriers were located in these high-gradient sections. Some streams had multiple barriers, but the first barrier was usually within 0.5 mile of the Susitna River confluence. In general, results indicated that the larger the tributary, the further upstream the first barrier was located. Above the proposed dam site, three tributaries contained definitive fish passage barriers within the inundation zone (i.e., below an elevation of 2,050 ft) of the proposed Project. Barriers on two of these tributaries (RM 194.9 Creek and RM 200.7 Creek) were located slightly below the maximum elevation of the inundation zone. Therefore, under certain Project conditions, access to previously inaccessible aquatic habitat would be available. The barrier on Deadman Creek is within the inundation zone but below the operational zone of the proposed Project and therefore, would be inundated permanently; providing year round access to approximately 44 miles of previously inaccessible aquatic habitat.

The Habitat Mapping Study was initiated in 2012 to contribute to existing aquatic meso-habitat information within the mainstem Susitna River and selected tributaries in the Upper Susitna River watershed above Devils Canyon (approximately RM 150-152) upstream to and including the Oshetna River (RM 233.5). Information regarding aquatic habitat, and specifically, habitat within the inundation zone, will provide data relevant to establishing an environmental baseline to evaluate potential Project-related effects to fish and fish habitat.

In order to characterize aquatic habitat at an informative level of resolution and over a broad geographic area, a multi-faceted mapping approach was developed that included a combination of aerial and ground-based aquatic mesohabitat mapping methodologies. Aerial habitat mapping was meant to complement ground-based meso-habitat surveys. However, challenges with accessing high gradient streams by foot resulted in aerial mapping being the primary method used in 2012. Excellent conditions (i.e. weather, low flow levels, clear water, and open canopy of stream corridors) resulted in quality aerial video footage of all primary tributaries in the Upper Susitna River, the Upper Susitna River mainstem, and the Middle Susitna River mainstem (RM 98.0-184) between September 7 and September 12. Ground-based habitat characterization occurred on three tributaries (Jay Creek, Watana Creek, and Kosina Creek) and was employed to verify the aerial videography methods and to further characterize potential anadromous salmon and resident fish habitat. The primary data collected was meso-habitat type and length. In addition and where feasible, stream gradient, channel type, substrate, large woody debris, riparian vegetation and presence of undercut banks were also recorded during ground-based surveys.

Jay Creek, Kosina Creek, and Watana Creek were partitioned into seven, eight, and eight geomorphic reaches, respectively, to facilitate study objectives. Based on GIS analysis, stream lengths below 3,000 ft elevation (i.e., the highest elevation at which salmon have been observed) are 21.7 km for Jay Creek, 29.3 km for Kosina Creek, and 33.9 km for Watana Creek. Approximately 2.05 km (9.4%) of Jay Creek, 6.4 km (21.8%) of Kosina Creek, and 2.3 km (6.8%) of Watana Creek were ground surveyed. Post-field collection review of the video footage determined that imagery collected via this methodology can be reliably used for characterizing meso-habitat frequency and distribution in the Upper and Middle Susitna River mainstem and its tributaries in combination with foot surveys for ground truthing.

Differences in meso-habitat type composition between main channel and side channels in all three creeks surveyed appeared to be driven by the different hydrologic regimes that would be expected. Riffle and run were the dominant meso-habitat types in main channels. Habitat characteristics in mainstem channel meso-habitats generally included greater bankfull and wetted widths, greater average maximum depths, larger substrates, and less large woody debris (LWD) than side channels. Although main channel riffle and run meso-habitat types appeared to compose most of the total length of stream reaches surveyed, side channels, when present, appeared to have a greater diversity of meso-habitat types. Side channels generally included more LWD, cover, and overhanging vegetation, and a greater range of substrate, including smaller materials, than main channels. Non-forest shrub alder and willow were the dominant riparian vegetation types in most main channel habitats.

In evaluating the study results as it relates to fisheries resources, information suggests that main channel and side channel habitats in the surveyed tributaries function to support different life history stages of fish species present within the Susitna River Basin. Main channel habitats, which are primarily composed of riffle and run meso-habitat types are better suited to support sub-adult and adult fish. The presence of higher velocities in this channel type may create less suitable conditions for smaller fish, particularly at high flows. Higher overall complexity within side channel habitats, as observed in this study, likely supports a greater variety of life history stages for fish species including juvenile fish. The greater availability of LWD and cover increases productivity and the available food base and creates refugia that may reduce bioenergetic expenditure (due to lower velocities) and reduce predation of juvenile fish.

Although main channel and side channel habitats may tend to support specific life history stages, the availability of both habitats in tributary systems is critical to supporting the overall health of fishery resources in the Susitna River Basin.

# 1. INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the proposed Susitna-Watana Hydroelectric Project, FERC No. 14241 (Project) using the Integrated Licensing Process (ILP). The Project would be located on the Susitna River, an approximately 300-mile-long river in Southcentral Alaska. The Project's dam site would be located at historic river mile[1] (RM) 184.

The 2012 Upper Susitna River Fish Distribution and Habitat Study was implemented to collect information on fish distribution and abundance and to characterize aquatic habitat in the Upper Susitna River watershed. The Upper Susitna River is defined as the river reach above the proposed dam site (RM 184).

The 2012 Upper Susitna River Fish Distribution and Habitat Study Plan (AEA 2012) identified three goals:

1) Characterize aquatic habitat in the Susitna River and its tributaries/lakes above Devils Canyon upstream to and including the Oshetna River.
2) Determine the distribution and relative abundance of adult Chinook salmon in the Susitna River and its tributaries above Devils Canyon upstream to and including the Oshetna River.
3) Determine the distribution and relative abundance of juvenile Chinook salmon and other fish species present in the Susitna River and its tributaries and lakes above Devils Canyon upstream to and including the Oshetna River up to 3,000-foot elevation.

To address the objectives of the study, AEA initiated four component studies in 2012 including the Fish Passage Barriers Assessment, the Aquatic Habitat Mapping Study, the Adult Salmon Spawning Ground Surveys, and the Distribution of Juvenile Chinook and Other Species in the Upper Sustina River Study (Fish Distribution Study). This report includes the result of the Fish Passage Barriers Assessment and the Aquatic Habitat Mapping Study.

This information will inform the 2013–2014 licensing study program, Exhibit E of the License Application, and FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

# 2. FISH PASSAGE BARRIERS ASSESSMENT

The Fish Passage Barriers Assessment (Barriers Assessment) was initiated in 2012 to contribute to the description of existing fish habitat within the Susitna River by identifying the locations of potential fish passage barriers in tributaries upstream of Devils Canyon. Information regarding fish passage barriers, and specifically barriers to adult salmon migration, is important to define the extent of potential Project effects to fish and aquatic habitat and will inform the planning and

[1] River mile (RM) designations used in this document pertaining to the main Susitna River are based on the historic river mile system established in the 1980s. A new, Project river mile system based on modern channel mapping will be adopted in future reporting. River miles were interpolated to the nearest tenth to facilitate spatial referencing of tributary confluences with the Susitna River and other features.

design of other Upper Susitna River studies related to fish distribution, particularly juvenile and adult salmon surveys.

## 2.1. Study Objectives

The primary objective of the Barriers Assessment was to identify the locations of potential barriers to upstream fish migrations, specifically Chinook salmon, given that a barrier to this species would also present a barrier to all other species present in Susitna River tributaries above Devils Canyon. Information collected from the Barriers Assessment will contribute to Goal 1 and is identified in the 2012 Upper Susitna River Fish Distribution and Habitat Study Plan (AEA 2012) as Objective 1.4.

## 2.2. Study Area

The study area for the Barriers Assessment included all tributary streams beginning at RM 150 (just downstream of Devils Canyon) upstream to and including the Oshetna River at RM 233.5 (Figures 1 and 2). Named tributaries in the study area include Cheechako Creek, Chinook Creek, Devil Creek, Fog Creek, Tsusena Creek, Deadman Creek, Watana creek, Kosina Creek, Goose Creek and the Oshetna River. The upper extent of tributaries in the study area was the 3,000-ft elevation contour.

## 2.3. Methods

Prior to conducting field surveys, a literature review of available information related to stream channel geomorphology in the Upper Susitna River was completed. The information consisted of data collected during the 1980s (ADF&G 1981a) and recent fish distribution studies completed by the Alaska Department of Fish and Game (ADF&G) (Buckwalter 2011a). The literature review identified the locations of large waterfalls on Devil Creek, Deadman Creek, and Tsusena Creek. In addition, a desktop analysis was conducted using U.S. Geological Survey (USGS) 100-foot contour topographic data and mapped streams to identify the initial pool of tributary streams greater than 1 mile in length for assessment by aerial survey.

Aerial surveys of all tributaries identified from the literature review and desktop analysis were conducted by helicopter. The typical flight path started at the tributary confluence with the mainstem Susitna River and proceeded upstream to the 3,000-foot elevation contour[2], the highest elevation at which salmon have been observed in prior investigations (Buckwalter 2011b). The survey was terminated at the first determined barrier or when the 3,000-foot elevation contour was reached. Occasionally surveys were terminated below the 3,000-foot elevation if observers, using best professional judgment, determined that the habitat appeared unsuitable to support Chinook salmon spawning. Factors used for this determination included low stream flow that lacked sufficient water depth for adult salmon or steep and sustained gradients (greater than 20 percent). If a barrier was observed within the proposed reservoir inundation zone, the survey was continued upstream to the 3,000-foot elevation contour. During field surveys, physical features of potential fish passage barriers were evaluated based on the Alaska Forest Resources and Practices Regulations (ADNR 2007) and the methods outlined by Powers and Orsborn (1985),

[2] Buckwalter (2011b) captured juvenile Chinook salmon in a tributary of Fog Creek at an elevation slightly below 3,000 feet.

and were considered a definitive barrier to adult Chinook salmon passage if a feature's vertical height was greater than 10 feet. Global positioning system (GPS) coordinates and photographs of all potential barriers were obtained and physical features were described.

Observers used the vertical height of adjacent spruce trees or other forest vegetation to provide a relative scale for water fall heights when making visual estimations from the helicopter. Water falls were termed "potential fish passage barriers" if helicopter observations could not unequivocally determine a vertical height greater than 10 feet. Ground surveys were conducted to measure physical features of potential barriers. These were performed at the time of the surveys when the estimated falls height was close to 10 feet and a helicopter landing zone was available within a reasonable approach distance. A Laser Tech Tru Pulse 200 laser rangefinder was used to calculate the height (vertical distance from the falls crest to the plunge pool standing wave), the horizontal distance (falls crest to plunge pool standing wave), and slope of these barriers. From a fixed position, sightings were made at two positions on the falls: one at the crest of the falls and the second at the plunge pool at the base of the falls. From these sightings the vertical and horizontal distances were calculated. Because moving water does not provide a good reflective surface for the laser, sightings were made on adjacent hard features, such as boulders or cliff faces.

During the surveys, potential fish passage barriers were classified based on physical characteristics described by Powers and Orsborn (1985) and Buckwalter et al. (2010), explained below.

The following three physical categories were used to describe the overall permanence of the barrier.

1) Fixed Permanent – feature is permanent (e.g., waterfall) and passage does not vary seasonally; therefore, it is not dependent on natural variations in flow.
2) Fixed Seasonal – feature is permanent (e.g., waterfall), but passage for species may vary seasonally, depending on flow conditions.
3) Temporary – feature is not permanent (e.g., beaver dam), but passage varies depending primarily on flow conditions.

The following nine classes were used to identify the specific type of barrier.

1) Single Falls – stream flows through a single falls, offering only one path for fish passage.
2) Multiple Falls – stream divides through two or more channels, creating multiple falls in parallel and offering the fish several passage routes of varying difficulty.
3) Simple Chute – stream flows through a chute of unvarying cross-section and constant slope steepness with supercritical flow at all stages.
4) Complex Chute – stream flows through chutes of varying cross-sections with several changes in bed slope with whitewater at all stages.
5) Boulder Cascades – stream flows through boulders that constrict flow, creating large head losses from upstream to downstream with intermediate resting areas in very turbulent pools.
6) Turbulent Cascades – stream flows through turbulent cascades where large instream roughness elements or jutting rocks churn flow into surges, boils, eddies, and vortices offering fish no resting areas.
7) Compound – stream flows through compound combinations of single falls and/or chutes.

8) Beaver Dam – passage of some fish species may be hindered or blocked by the presence of beaver dams or lodges.
9) Debris Jam –passage of some fish species may be hindered or blocked by the presence of debris jams.

## 2.4. Quality Control

Quality control (QC) measures during survey events included employing two experienced observers on each survey. Level 1 QC was performed on the field data forms at the end of each day. Level 2 QC consisted on a line-by-line verification of electronic data with data on field forms. In the Anchorage office, a QC III review was performed on the Geographic Information System (GIS) database by a senior professional before submitting the database to AEA. QC IV (database verification) and V (database verification by senior-level professionals) is ongoing.

## 2.5. Deviations from Study Plan

Changes to field methods from the 2012 Upper Susitna River Fish Distribution and Habitat Study Plan (AEA 2012) included the following:

- The study plan stated that observers would use an 11-foot vertical height as a conservative height for constituting a passage barrier to Chinook salmon. In practice, 10 feet was a more familiar height for observers to visually estimate from the helicopter and was adopted in the field. This is still considered a conservative figure given the migratory distance from tidewater a salmon would have traveled prior to reaching any of the barriers assessed within the study area.
- The study plan stated that GPS locations, photos, drawings, and dimensions would be recorded for all potential barriers that could not unequivocally be identified as a barrier. Three potential barriers could not unequivocally be determined to have a height greater than 10 feet from the helicopter and were measured from the ground. Additional potential barriers were identified as having vertical heights less than 10 feet, but have other features such as multiple chutes or cascades that in aggregate could constitute a passage barrier. These features were not surveyed from the ground due to the lack of suitable helicopter landing zones or inaccessibility of the terrain in which they were located.

## 2.6. Results

Fish passage barrier surveys were completed in the Upper Susitna River basin from June 18 through June 22, 2012. Low-level aerial surveys were flown on a total of 79 tributary drainages to the Upper Susitna River between RM 150.1 and 233.5 (Appendix A). Within the study area, 41 and 38 tributary drainages were surveyed above and below the proposed dam site (RM 184), respectively. Approximately 815 tributary stream miles were evaluated (Figures 1 and 2). Because the majority of tributaries surveyed do not have names, a naming convention was adopted using the Susitna River RM to the nearest one-tenth mile at the point that the tributary enters the Susitna River. For example, Devil Creek is designated "RM 161.5" because its confluence with the Susitna River is at RM 161.5. Where second-order tributaries were surveyed, they were designated as "L" for river left or "R" for river right (downstream view) and numbered sequentially from downstream to upstream.

A total of 43 potential fish passage barriers were identified from the helicopter within 29 of the 79 drainages surveyed (more than one barrier was identified on some tributaries) (Table 1). Of these 43 barriers, a total of 35 definitive fish passage barriers were identified within 24 tributaries, the majority of which have falls with a vertical height greater than 10 feet and that could be visually estimated from the helicopter. Three falls could not unequivocally be determined to have vertical distances greater than 10 feet from the helicopter. These were surveyed from the ground with a rangefinder to determine vertical and horizontal distances from the falls crest to the plunge pool. All three were confirmed as barriers to fish passage (PB170.0-B, PB179.1-A, and PB194.9-A) with measured distances of 15 feet, 15.7 feet, and 12.5 feet, respectively. PB170.0-B is a multiple falls with the lower fall height of 10.8 feet and an upper fall height of 4.2 feet. The plunge pool at the base of the lower falls is sloping and lacks sufficient depth for a launch zone, leading observers to conclude that the lower falls alone constitute the barrier. An additional eight features, within seven tributaries, were identified as potential fish passage barriers having falls heights visually estimated to be less than 10 feet but with other apparent elements of passage barriers such as multiple chutes and/or cascades that warrant further investigation; however, their locations in canyons precluded landing the helicopter for ground surveys. Appendix A summarizes the attributes of the 43 barriers and Appendix B contains photographs and detailed descriptions of each barrier.

A majority (31 of 43, or 72 percent) of the fish passage barriers are located in tributaries upstream of Devils Canyon to the proposed dam site (RM 184.0). As expected, barriers are more common in the vicinity of Devils Canyon due to its steep walls. All of the 11 tributaries surveyed in Devils Canyon have adult salmon passage barriers. Chinook Creek (RM 157.0) is the only tributary lacking a barrier along its mainstem course, but does contain a barrier on a second order tributary.

Above the proposed dam site, 4 of the 41 tributary streams surveyed were found to have definitive barriers to the passage of adult salmon (Appendix A): Deadman Creek, RM 194.9 Creek, RM 200.7 Creek, and RM 226.8 Creek.

The falls crest of barrier PB186.6-A on Deadman Creek lies below the likely operational range of the proposed reservoir, potentially resulting in fish passage between the reservoir and Deadman Creek throughout the year. Deadman Creek has approximately 44 miles of mainstem habitat between the existing fish passage barrier and the headwater lakes that would become accessible to migratory fish. This upper reach was surveyed as well as the secondary tributary draining the lakes near Tsusena Butte. No additional barriers were observed.

Barrier PB194.9-A on an unnamed stream (RM 194.9 Creek) is located slightly below the proposed maximum pool elevation of 2,050 feet, based on the mapped location of the barrier waypoint. Because the barrier is located close to the proposed maximum pool elevation, it would likely be exposed during seasonal drawdowns of the reservoir. When the reservoir was at maximum pool, fish would be able to pass over the barrier and access approximately 4 miles of stream habitat and several small lakes close to the Fog Lakes system.

The unnamed tributary at RM 200.7 (RM 200.7 Creek) has a series of five falls, each of which is a passage barrier to adult salmon. The uppermost barrier (PB 200.7 E) lies slightly below the maximum pool elevation based on the location of the barrier waypoint. When the proposed reservoir was at a maximum pool elevation of 2,050 feet, fish would be able to pass over the barrier to access approximately 8 miles of habitat upstream. At the time of the survey, the proposed maximum pool elevation was 2,000 feet and PB200.7E was believed to be above the maximum pool. Nonetheless, approximately 4 miles of the reach above PB200.7E was surveyed and no additional barriers were identified.

The passage barrier on the unnamed creek at RM 226.8 (PB226.8A) was determined to be above the proposed maximum pool elevation.

Three potential barriers were identified above the proposed dam site in the inundation zone on unnamed creeks located at RM 186.9, RM 201.8, and RM 213.0. One potential barrier is on RM186.9 Creek, a relatively small tributary (approximately 2 miles in length) that offers very limited, if any, habitat for adult salmon spawning. Two potential barriers were identified on RM 201.8 Creek, both lying below the proposed maximum pool elevation. This tributary was surveyed to above the 3,000-foot elevation contour and no additional barriers were identified. The unnamed creek at RM 213.0 is relatively short (approximately 3 miles), and although no definitive barriers to adult salmon passage were identified above PB213.0A, little if any adult salmon spawning habitat exists due to steep gradients and the limited water depths.

## 2.7. Discussion and Conclusion

The mainstem Susitna River between RM 150 and RM 227 is moderately confined, lying within an incised valley or canyon for most of its length. Where a limited floodplain exists, smaller tributaries generally have a short reach of relatively low-gradient streambed. This abruptly changes to a steep gradient when the tributary stream reaches the valley or canyon walls. These high-gradient sections are where 100 percent of the barriers were identified during the study. While some streams had multiple barriers, the first fish passage barrier was within 0.5 mile of the Susitna River confluence for a majority of the tributaries.

Larger named tributaries such as Kosina Creek, Watana Creek, and Fog Creek were observed to have their own incised valleys or canyons intersecting the main Susitna valley, resulting in less steep gradients than smaller streams. Four of the 11 named major tributaries (Cheechako, Devil, Tsusena, and Deadman creeks) have mainstem passage barriers, all of which were previously known and confirmed during the assessment. In general, the results of the study indicated that the larger the tributary, the farther upstream the barrier was located if one existed. Tsusena Creek falls, located 3.8 miles upstream from the mainstem Susitna River confluence, is the upstream-most barrier that was identified within the study area.

Above the proposed dam site, three Susitna River tributaries contain definitive fish passage barriers within the inundation zone (i.e., below an elevation of 2,050 feet) of the proposed Project. The barriers on two of these tributaries (RM 194.9 Creek and RM 200.7 Creek) are located below the maximum elevation of the inundation zone. Therefore, under certain Project conditions, access to previously inaccessible aquatic habitat (a total of 12 miles) would be available. The definitive barrier on Deadman Creek is below the operational zone of the proposed Project, and therefore would be inundated permanently, providing year-round access to approximately 44 miles of previously inaccessible aquatic habitat. Cascade and boulder riffle habitat types predominate above the falls for approximately 3 miles before gradients permit run/glide habitat of any significance.

# 3. AQUATIC HABITAT MAPPING STUDY

The Aquatic Habitat Mapping Study was initiated in 2012 to begin characterizing aquatic habitat within the mainstem Susitna River and selected tributaries above Devils Canyon (approximately RM 154) upstream to and including the Oshetna River (RM 233.5). Information regarding aquatic habitat, and specifically, habitat within the inundation zone, will provide data relevant to establishing an environmental baseline to evaluate potential Project-related effects to fish and their habitat.

## 3.1. Study Objectives

Specific Aquatic Habitat Mapping Study objectives included the following:

- Develop and implement a habitat mapping approach to characterize Susitna River tributaries above Devils Canyon upstream to and including the Oshetna River.
- Characterize the type and amount of aquatic habitat within the reservoir inundation zone below an elevation of 2,200 feet.
- Collect aerial video imagery of the mainstem and Upper River tributaries to determine the feasibility of using aerial video to complement ground-based habitat surveys.

## 3.2. Study Area

The study area for the Aquatic Habitat Mapping Study primarily included the mainstem Upper Susitna River (Upper River) and its tributary streams above Devils Canyon upstream to and including the Oshetna River (approximately RM 154 through RM 233.5) (Figure 3). In study tributaries, the study area extended from the confluence with the mainstem Susitna River upstream to an elevation of 3,000 feet. Within the reach of the mainstem Susitna River that represents the proposed reservoir inundation zone (RM 184.3 to RM 230.9), the study area extended to an elevation of 2,200 feet.

The study area for the aerial video component of the Aquatic Habitat Mapping Study extended beyond the Upper River to include the mainstem Middle Susitna River (Middle River; RM 98.0 to RM 184) and a short section in the mainstem Lower Susitna River (Lower River) from approximately (RM 65 to RM 81).

## 3.3. Methods

### 3.3.1. Aquatic Habitat Characterization and Mapping

Previous aquatic habitat work performed by ADF&G in the 1980s (ADF&G 1981b, 1983) and more recently by ADF&G (Buckwalter 2011a) in the Upper River basin have yielded limited habitat information. As such, uncertainties with a respect to the quality and quantity of habitat information to support fishery resources remain a central issue. Factors contributing to the lack of available information include a general lack of need (prior to licensing), access challenges, and the relatively large geographic area.

In order to characterize aquatic habitat at an informative level of resolution and over a broad geographic area in support of the Aquatic Habitat Mapping Study, the Aquatic Technical Workgroup (ATWG), in coordination with AEA and licensing participants, developed a multi-faceted mapping approach that included a combination of aerial and ground-based aquatic mesohabitat mapping methodologies.

### *Aerial Habitat Mapping (Video)*

Use of aerial video is a valuable tool for conducting aquatic habitat mapping studies in the Upper River watershed due to the watershed's large geographic area, rugged terrain, and remoteness. The video footage will be used to type stream habitat to the mesohabitat level in study area tributaries that have open canopies and are clearly visible from the air (i.e., have elevational accessibility required to collect imagery of sufficient resolution). The aerial habitat mapping approach is meant to complement the ground-based mesohabitat approach. Collecting a comprehensive mesohabitat dataset for the study area would be extremely difficult, if not impossible, via the implementation of only one of the above methods.

When shot with a professional high definition (HD) camera from a helicopter at slow speeds (15 to 40 miles per hour [mph], depending on stream size), low altitude (75–300 feet), under good lighting conditions, good water clarity, and a fairly open canopy, the video provides an up-close and panoramic view of all of a stream's features. Under these conditions, an experienced observer can effectively discern mesohabitat types (e.g., riffles, runs, pools, etc.) and classify channel character, dominant substrate, woody debris, and riparian vegetation. Use of aerial video for habitat mapping can be enhanced with on-screen integration using a GPS. Figures 19 and 20 provide example screen captures from aerial video footage taken in an Upper River tributary and the mainstem Middle River.

For the Aquatic Habitat Mapping Study, aerial video was shot from the right rear location of a Robinson 44 helicopter with its right rear door removed. An HD Cannon XF 100 video camera was fitted with a shoulder and pistol mount brace for maximum camera stability and a polarizing lens to improve visibility below the water surface. The videographer was an experienced fisheries biologist with 25 years of experience mapping aquatic habitat using the aerial video methodology. A narrator/navigator sat in the left front seat of the helicopter next to the pilot. From these positions, the pilot and the videographer had the same view of the stream and from the front seat the narrator/navigator had a full view of the stream as well as an overall view of the landscape. Optimum helicopter attitude, speed, and height above ground for best video results were continually communicated to the pilot by the videographer over the ship's intercom system. All conversations on the helicopter intercom system between the survey crew were recorded onto the video.

Tributaries were generally flown at a speed of 12 to 18 mph and at a height of 75–150 feet above ground (AG). Speed and height of the helicopter varied, depending on factors such as the width of the stream corridor, the height and narrowness of the canyon, and the height of trees in the riparian zone. At split channels where the overall stream width was wider than the field of view at the preferred survey elevation, one split channel was flown first and the pilot circled back to fly the remaining channel.

Mainstem Susitna River sections were flown at a speed of 30 to 40 mph and at a height of 250 to 300 feet AG. Higher AG surveys in the mainstem Susitna River were conducted in order to capture single channel sections with one pass.

All surveys were conducted in an upstream direction (with the exception of Kosina Creek, due to excessive water surface glare). Upper River tributaries were videotaped from their confluence with the mainstem to a stream elevation of approximately 3,000 feet. Only Devil Creek was videotaped a shorter distance. Devil Creek was flown only to the impassable barrier at approximately RM 2.2, which would not be inundated by the Watana Dam pool.

Videotaping of the mainstem Susitna River and tributaries was scheduled in early September to coincide with late summer base-flow conditions, high water clarity, leaf drop, and the possibility of a sustained high pressure, clear weather window.

### *Ground-Based Habitat Survey*

Ground-based habitat surveys were employed in order to (1) identify and characterize the length of potential anadromous salmon and resident fluvial/adfluvial fish habitat in target streams below an elevation of 3,000 feet; and (2) to characterize stream habitat in the proposed reservoir inundation zone (RM 184.3 to RM 230.9) below an elevation of 2,200 feet.

#### Geomorphic Reach Determination

Each stream where ground-based habitat surveys were conducted was first divided into geomorphic reaches based on changes in channel confinement, stream gradient, dominant substrate size, or the distribution of flow (presence of tributaries or distributaries). Once the stream was divided into geomorphic reaches, a subsection of each reach could be ground-truthed using the habitat characterization methods described below to determine the frequency of distribution of habitat units within each reach, thus precluding the need to ground-truth the entire reach.

#### Habitat Surveys

Habitat surveys for subsections of each geomorphic reach were conducted by a two-person field team starting at the downstream end of a reach and walking in an upstream direction. A GPS point was collected at the downstream location or starting point for a reach. Habitat units were mapped to the mesohabitat level (i.e., run, pool, riffle; Table 2), in accordance with the channel typing and aquatic habitat classification system developed by the Fish and Aquatics TWG. Each time a new mesohabitat unit was characterized during reach surveys, a GPS data point was recorded in order to designate the upstream end of the existing mesohabitat unit and starting point of the new mesohabitat unit (i.e., there may be multiple mesohabitat units within a reach). Ground-based surveys also collected macrohabitat data in each mesohabitat unit including channel and stream bank characteristics, large woody debris, cover/riparian vegetation, and the presence of seeps.

##### *Channel Characteristics*

Mesohabitat unit length (m) was measured in the field with a laser rangefinder or visually estimated when necessary. For mesohabitat units with lengths requiring more than one measurement, various landmarks were identified and distances to and from these landmarks were measured and summed at the top of the unit. In order for a mesohabitat unit to be classified as a distinct unit, it needed to be at least one channel width long, otherwise it was combined with an adjacent mesohabitat unit, regardless of its mesohabitat characterization.

Channel type was recorded as either mainstem or side channel, which also included off-channel habitats such as percolation channels and beaver complexes. Channel location in the stream was recorded for each mesohabitat unit. In the simplest scenario, if the unit was located in the mainstem then the location was center of the stream or if the unit was located in a side channel then the direction of the side channel facing downstream was recorded, either left or right. Side channels were surveyed to the same mesohabitat level as the adjacent mainstem, with the same habitat parameters collected.

Maximum depth (measured in scour pools and backwater pools) and pool crest depth (measured in scour pools only) were measured in meters (m). Average maximum depth (m) was recorded in each non-pool mesohabitat unit by taking the average of at least five measurements. All depth measurements were measured using a calibrated trekking pole.

Wetted width represents the lateral distance from the watered edge from one bank to the opposite stream bank. Wetted width (m) was measured at a representative point along the mesohabitat unit that was neither the narrowest nor the widest point across the stream. Bankfull width (m) represents the lateral extent of the water surface elevation perpendicular to the channel at bankfull depth (average vertical distance between channel bed and estimated water surface elevation required to completely fill the channel to a point above which water would enter the floodplain or intersect a terrace or hill slope). Both wetted and bankfull widths were measured with a laser rangefinder or with a calibrated trekking pole. In some instances, wetted and bankfull widths were visually estimated, if the laser rangefinder was not working and if the stream could be safely waded.

Stream gradient (in degrees) was measured with a laser rangefinder or with a clinometer (in percent) in each mesohabitat unit. All gradient measurements were converted to percent, if needed, at the end of the field day.

Substrate types were estimated by visual identification based on the U.S. Department of Agriculture, Forest Service (USFS; 2001) classification (See Table 3). For each mesohabitat unit, each substrate category was estimated to the nearest 10 percent.

#### *Stream Bank Characteristics*

The amount of undercut bank (UCB) on each side of the stream was estimated to the nearest percent (total amount of qualifying UCB/total length of mesohabitat unit) for each mesohabitat unit. A bank was considered undercut if the undercut was greater than or equal to 0.3 meters (12 inches) incised into the bank and greater than 1.0 meters (39 inches) long. All undercut banks contained within the channel up to bankfull height were measured even if they were above the surface of the water at the time of the survey (USFS 2001).

The percentage of bank side erosion on each bank was estimated based on bank sloughing. In order for a portion of a stream bank to be evaluated for erosion, it had to be greater than 1.0 meter in length. Percentage was determined the same way as UCB.

### Large Wood, Cover, and Riparian Vegetation

The amount of large woody debris (LWD) observed was counted for each mesohabitat unit. To be classified as LWD, a piece of wood must have been at least 0.1 meter (4 inches) in diameter and at least 1.0 meter (39 inches) in length with at least 1.0 m of the wood below the water's surface at bankfull flow (USFS 2001).

The dominant riparian vegetation class was recorded for each mesohabitat unit based on the USFS (2001) classification (Table 4).

All stream cover types (see Table 5) were lumped together and collected as a whole because this study was not aimed at identifying cover for any one species or any specific life stage of an individual species. The percentage total cover was estimated by determining how much cover for all species and all life stages of fish was present in each mesohabitat unit. Percent cover in the unit was estimated (rounded to the nearest 5 percent) once the survey crew reached the top of the mesohabitat unit.

### 3.3.2. Data Analysis

The goal for the aerial video analysis in 2012 was to determine the feasibility of using this method for detailed habitat mapping purposes in future studies. All video footage was reviewed for clarity and definition of mesohabitat types and whether the different mesohabitat types could be reliably discerned from each other. Mesohabitats will be typed using aerial video in 2013 according to methods described in the Revised Study Plan (RSP) Section 9.9, Characterization and Mapping of Aquatic Habitats in the Susitna River with Potential to be Affected by the Susitna-Watana Project.

For all ground-based surveys, all mesohabitat characterization data, including GPS information, were uploaded to a GIS database and plotted. In addition to each reach being measured on the ground, total reach lengths were measured in kilometers (km) using GIS. Lines connecting each mesohabitat unit were then digitized as a GIS shapefile representing the distribution of mesohabitat units in surveyed creeks. All data were visually QC checked to identify and address any anomalous spatial data. Anomalous data points were visually moved to the stream centerline.

The relative frequency of each mesohabitat unit type based on length was calculated. The frequency of each mesohabitat type was also calculated. Total weighted average wetted width and bankfull width were calculated by taking the total average wetted width and the total average bankfull width for each mesohabitat unit and weighting them by the total length for each mesohabitat unit.

### 3.3.3. Data Review and Quality Control

At the end of each day of collecting aerial video, files were reviewed for completeness, named according to Project guidelines, and cataloged. Duplicate video files were also made and backed up to two portable hard drives. The two hard drives were kept in different locations until all data were transferred to HDR's Anchorage server. Video files were post-processed to MPEG 4 video format with an on-screen information panel inserted that displays continuous river mile, GPS coordinate, and video time stamp. The video files will be further integrated with the Project GIS database. Upon completion of video post-processing, the video files will be made available to the public through AEA.

During ground-based surveys, data collected for each mesohabitat unit were reviewed upon completion of the habitat characterization. This review ensured that all habitat parameters were collected and that recorded values were reasonable. Notes were made to document instances when data could not be collected. All data were recorded and stored in a Juniper Archer hand-held computer with an internal GPS. The GPS provided a latitude and longitude position for each point collected. Field forms were taken into the field each day in the event of an Archer malfunction in addition to a backup Archer. The data were downloaded nightly to the field office laptop in a specific folder for each day. All data were backed up on each Archer hand-held computer and the field laptop after completion of a QC I review to verify the accuracy of the data (before leaving the field and nightly). If the data were entered directly into the Archer hand-held computer, no QC II was conducted on the data because QC II involved checking the original datasheets against the database. In the Anchorage office, a QC III review was performed on the GIS database by a senior professional before submitting the database to AEA. QC IV (database verification) and V (database verification by senior-level professional before analysis for reports) reviews will occur outside of HDR.

## 3.4. Deviations from Study Plan

Throughout the field season, there were several deviations from the 2012 Upper Susitna River Fish Distribution and Habitat Study Plan. These deviations were attributable to a variety of factors including weather, logistics, and field conditions that often precluded proposed methods. Furthermore, several habitat parameters were added prior to the field effort (i.e., bank side erosion, total percent cover, channel type, and channel location). Deviations are described in detail below.

### 3.4.1. Video-Based Deviations

There were no deviations in field videography methods from the 2012 Upper Susitna River Fish Distribution and Habitat Study Plan (AEA 2012).

### 3.4.2. Ground-Based Deviations

Changes to the 2012 ground-based habitat activities included the following:

- Parallel mesohabitats were not recorded during ground-based habitat surveys on Jay, Watana, and Kosina creeks due to the presence of deep water and high velocities, which created unsafe wading conditions.
- In order to provide more detail, a relative percentage of each substrate category (Table 3) rounded to the nearest 10 percent was recorded instead of just dominant and subdominant substrate composition in each mesohabitat as identified in the Study Plan.
- UCB was recorded as a relative percentage across the whole mesohabitat unit for each bank instead of being measured to the nearest meter.
- Additional habitat parameters were collected for each mesohabitat unit that included stream gradient, wetted width, bankside erosion, stream cover, and dominant riparian vegetation classifications.
- Mainstream, side-channel, off-chanel designations were recorded for each mesohabitat unit to differentiate between mainstem and side channel mesohabitat units. Each mesohabitat unit was also assigned a location within the channel.
- Ground based mapping was intended to cover approximately 20 percent of the area covered by video for the three targeted streams: Watana Creek, Jay Creek, and Kosina

Creek. Ground sampling this amount of the video coverage was not accomplished due to inaccessibility in steep canyon reaches, the lack of suitable helicopter landing zones, and inclement weather. Groundmapping amounted to 8% of Watana Creek, 15% for Kosina creek and 14% for Jay Creek.

- Video coverage of three target tributaries— Watana Creek, Jay Creek, and Kosina Creek—was expanded to include a total of 12 major tributaries in the study area. Addition aerial videos were also taken of the Middle River and Upper River main channel reaches. This additional coverage was added to aid in the development of sampling approaches for the RSP. The time-based method for mesohabitat frequencies was applied to the expanded set of tributaries and line mapping was performed for main channel areas as described in the RSP. These analyses were conducted in December 2012 and January 2013 and are reported in Appendix E of the Fish Distribution Implemention Plan filed with FERC on January 31, 2013.
- The time-based frequency method was not applied to mapping woody debris or riparian vegetation from aerial videos.

## 3.5. Results

### 3.5.1. Aerial Habitat Mapping

Aerial video was collected over a period of 6 days from September 7 to September 12, 2012 during optimal conditions and preceded a major flooding of the Susitna River in mid-September. Although the study area for the 2012 Aquatic Habitat Mapping Study as identified in the Study Plan was the Susitna River above Devils Canyon, the aerial video surveys were expanded to the Middle River (RM 98.0–184) and Lower River (RM 65–81) segments.

Conditions for aerial videotaping of Upper River tributaries and the mainstem of the Upper and Middle River were excellent. Both tributary and mainstem flows were at late summer seasonal lows. Tributary flows were clear with visibility of bottom substrate to depths of 2–4 feet. Mainstem flows were in the range of 10,000 to 12,000 cubic feet per second (cfs) with visibility of approximately 1 foot. Lighting was generally excellent. However, the low angle and southern position of the sun created some difficulties with glare when flying in a southerly direction. This problem was overcome by flying two tributaries—Kosina Creek and a tributary of Fog Creek—in a downstream direction. Swirling winds were also a problem on a few tributaries. Two and three passes of river sections were frequently necessary in the Middle River where split main channels, side channels, and side sloughs are common. Table 88 is a list of tributaries and mainstem sections videotaped in 2012.

Review of video of Upper River tributaries and the mainstem Upper and Middle River segments demostrated that the video footage has sufficient quality for mesohabitat typing of the aerial video coverage area. Mesohabitat types are most discernible using video in the Upper River tributaries where individual mesohabitat types are more clearly defined. In the mainstem Upper River and Middle River, low gradients make mesohabitat types less distinct from one another, and therefore are less definable, whether observed from the ground or from the air. For example, from the air and because of poor water clarity in the mainstem, it is sometimes difficult to distinguish between a run and a riffle or a pool and a glide. The purpose of ground-truthing the aerial video mapping, as described in the RSP, is to confirm or modify the aerial video mapping based on evidence on the ground.

In addition to conducting aerial video surveys of Upper River tributaries and the mainstem of the Upper and Middle River, test video was collected of the Lower River between RM 65 and RM 81 to determine the practical and technical application of aerial video for habitat characterization in this 1-mile-wide and highly braided reach of the river (Figure 21). A 16-mile section of the river was selected extending from RM 65 to RM 81 for the feasibility assessment. The test section was flown at three different heights AG. The number of parallel flight paths necessary to cover the river width at the three different elevations was as follows: one path at 2,650 feet AG; two paths at 1,700 feet AG; and four paths at 400 feet AG.

The test showed that a height of 400 feet or lower with three to five flight paths would be necessary to visually differentiate mesohabitat types in the Lower Susitna River segment. Further, several parallel paths would be extremely difficult to track even with the use of GPS and would be very difficult to follow during review of the video. In summary, review of the test section concluded that aerial videotaping would not be a practical method for habitat mapping the Lower River reach.

In summary, review of the test section concluded that aerial videotaping is not a practical method for habitat mapping the Lower River reach. Development of mapping methods for this section of river should wait until results of the 2012 interim studies are reviewed and analyzed by the Technical Workgroups (TWGs); in particular the hydrologic study. At that time, the habitat characterization objectives for the Lower River will be more clearly defined and a complementary methodology can be developed.

### 3.5.2. Ground-Based Habitat Mapping

#### *Jay Creek*

Jay Creek was broken into seven unique geomorphic reaches (Figure 4). Based on GIS analysis, the length of Jay Creek below the 3,000-foot elevation is 21.7 km. Approximately 2.05 km (9.4 percent) was ground-surveyed by two field crews on September 17, 2012. Results of the ground-based habitat surveys for each geomorphic reach are provided below.

Geomorphic Reach 1

Jay Creek Geomorphic Reach 1 is approximately 1.4 km long (Figure 5). The lower 543 m (39 percent) of the reach was ground-truthed. The majority of the segment mapped was in the mainstem (443 m) with the rest being side channel mesohabitat (100 m). In this reach, the main channels were comprised of six riffle and nine run mesohabitat units with a similar relative frequency of riffles (54.9 percent) and runs (45.1 percent; Table 6). Overall, side channels had a greater diversity of mesohabitat types, with one cascade, three riffles, three runs, one scour pool, one backwater pool, and one slough (Table 9).

Bank erosion on the left bank was greater the right bank in the side channels than in the mainstem and similar on the right bank (Table 6 and Table 9). As expected, the mainstem had greater total average bankfull and wetted widths than the side channels. There was minimal difference between stream gradient and average maximum depth between mainstem and side channel mesohabitats (Table 6 and Table 9).

The frequency of LWD was greater in side channels than in mainstem mesohabitats (Table 6 and Table 9). There was no clear pattern in the amount of UCB observed in Jay Creek Geomorphic Reach 1. The mainstem had a much greater amount of UCB on the right bank, while the side channels had a much greater amount of UCB on the left bank (Table 6 and Table 9).

Side channel mesohabitats in this reach had approximately twice the average cover as mainstem mesohabitats (Table 6 and Table 9). Both channel types were primarily composed of nonforest shrub willow dominant riparian vegetation (Table 7 and Table 10). Substrate was not estimated for this reach (Table 8 and Table 11).

### Geomorphic Reach 2

Jay Creek Geomorphic Reach 2 is approximately 1.3 km long (Figure 6). Due to helicopter inaccessibility, activities to ground-truth the reach began in the middle of the reach and worked toward the upstream end. The ground-truthed portion of Reach 2 was approximately 0.78 km long (~60 percent) and was divided into nine mesohabitat units (comprised of four riffles and five runs) in the mainstem. No side channels were present in the sampled reach. The riffles comprised 16.2 percent (126 m) by length of the mapped mesohabitats, while the runs comprised 83.8 percent (650 m) by length of the mapped mesohabitat units (Table 12).

The total average weighted wetted width was the same between riffles and runs, while the total average weighted bankfull width was greater in runs than in riffles (Table 12). Average stream gradient and the total weighted average maximum depth were similar between riffles and runs.

Very little UCB was observed in this reach. On average, the riffles had much less erosion on the left bank than on the right bank; however, for runs, the bankside erosion was relatively the same. Also, right bank erosion in the riffles was relatively similar to the amount of erosion within runs (Table 12).

On average, runs had much more LWD than riffles. Percent cover was not recorded in this reach (Table 12). Riparian vegetation type in this reach included nonforest shrub willow dominant, nonforest shrub alder dominant, and broadleaf forest-closed canopy (Table 13). As expected, riffle and run mesohabitats in this reach were dominated by larger-size substrate with approximately 60–70 percent being comprised of boulder and cobble. Gravel was also present (26–30 percent) and small amounts of sand/silt (Table 14).

### Geomorphic Reaches 3 - 5

Jay Creek Geomorphic Reach 3 is approximately 1.5 km long; Reach 4 is approximately 1.4 km long; and Reach 5 is approximately 1.0 km long. Due to helicopter inaccessibility and inclement weather, Geomorphic Reaches 3–5 were not sampled.

### Geomorphic Reach 6

Jay Creek Geomorphic Reach 6 is approximately 6.3 km long (Figure 7). The middle 0.67 km (~11 percent) of the reach was ground-truthed. There were five mesohabitat units in the mainstem, one riffle, three runs, and one scour pool and five mesohabitat units in the side channel, one riffle, two runs, one scour pool, and one backwater pool (Table 15 and Table 18). More length of stream was mapped in the mainstem than in the side channels (589 m in the mainstem and 98 m in the side channels). There was a greater diversity of mesohabitat types present in the side channels than in the mainstem. Runs accounted for the greatest habitat length in both the mainstem (93.2 percent) and side channels (65.3 percent; Table 15 and Table 18).

Total weighted average wetted width and bankfull width were much greater in the mainstem channel than in side channels. In general, the mainstem mesohabitats were much deeper than side channel mesohabitats. Average weighted stream gradient was similar in both side channels and mainstem mesohabitats in this reach (Table 15 and Table 18).

There were greater amounts of bankside erosion and LWD in the mainstem mesohabitat types; however, there were almost equal amounts of UCB.

Percent cover was not recorded in this reach (Table 15 and Table 18). For both channel types, riparian vegetation was primarily composed of willow although mainstem channel habitats included closed and open conifer forest canopy types (Table 16 and 19). Regardless of channel type, riffle and run mesohabitats in this reach were primarily composed of boulder, cobble, and gravel. In pool mesohabitats, a more diverse and even distribution of substrate types was available. Cobble and gravel were the dominant substrates in these mesohabitats and higher concentrations of sand/silt and organic material were also available (Table 17 and 20).

#### Geomorphic Reach 7

Jay Creek Geomorphic Reach 7 is approximately 8.8 km long, from the end point of Geomorphic Reach 6 to the 3,000-foot elevation mark. This reach was not sampled due to helicopter inaccessibility and inclement weather.

### *Kosina Creek*

Kosina Creek was divided into eight unique geomorphic reaches (Figure 8), based on the methods described above. Once better imagery for the Upper River basin is available, some of these reaches may be combined. Based on GIS measurements, Kosina Creek is approximately 29.3 km in length below the 3,000-foot elevation. Of the total river length below 3,000 feet, approximately 6.4 km (22 percent) were ground-truthed. Kosina Creek was ground-surveyed by two field crews on September 11, 12, and 14, 2012, from late morning through early evening. Detailed information for each reach that was ground-truthed is provided below.

#### Geomorphic Reach 1

Kosina Creek Geomorphic Reach 1 is approximately 2.7 km long (Figure 9). The lower 1.7 km (~63%) of the reach was ground-truthed. There were 11 mainstem mesohabitat units, comprised of six riffles and five runs (Table 21). There were a total of 22 side channel mesohabitat units and one off-channel mesohabitat unit. While there was almost two times as much length of riffle versus run mesohabitat, the frequency of each mesohabitat was similar. Almost the same amount of side channel mesohabitat was mapped as mainstem mesohabitat, although a greater diversity of mesohabitat types (six types) was present in the side channels (Table 21 and Table 24).

The average stream gradient for all mesohabitat units was 2.0 percent (Table 21 and Table 24). The average maximum depths in the mainstem were much deeper than in the side channels (Table 21 and Table 24).

No bankside erosion was observed in either the mainstem or side channel mesohabitats. Minimal LWD was observed in the side channels, and none was observed in the mainstem. No UCBs were observed in the mainstem with minimal amounts observed in side channels.

Total cover was not recorded for any of the mesohabitat units in this reach (Table 21 and Table 24). The majority of the riparian vegetation in the mainstem and the side channel mesohabitat units was nonforest shrub (alder and willow; Table 22 and Table 25). Regardless of channel type, riffle and run mesohabitats in this reach were primarily composed of boulders and cobbles with smaller amounts of very large or small substrate types (Table 23 and 26).

#### Geomorphic Reach 2

Kosina Creek Geomorphic Reach 2 is approximately 1.0 km long (Figure 10), and approximately 0.6 km (~60 percent) of the reach was ground-truthed. There were six mainstem mesohabitat units (one scour pool, two riffles, and three runs) totaling approximately 545 m. There was one side channel mesohabitat unit (riffle/pocketwater), which was 55 m long (Table 27 and Table 30).

Average stream gradient was 2.0 percent for all mesohabitat units. Mainstem mesohabitat depths were much greater than side channel values (Table 27 and Table 30).

There was no bankside erosion or UCB in the reach. On average, each mainstem mesohabitat unit contained one piece of LWD.

Total cover was not recorded for any of the mesohabitat units in this reach (Table 27 and Table 30). All the riparian vegetation in the mainstem and side channel mesohabitat units was nonforest shrub. Willow was the dominant riparian vegetation in the mainstem and alders were dominant in the side channels (Table 28 and Table 31). Boulder was the dominant substrate type for mesohabitats in this reach (Table 29 and 32).

#### Geomorphic Reach 3

Kosina Creek Geomorphic Reach 3 is approximately 7.2 km long (Figure 10). Approximately 0.5 km (approximately 7 percent) of the reach was ground-truthed. Three mesohabitat units were mapped in the mainstem of Reach 3 (two riffles and one run; Table 33). In side channels, eight mesohabitat units were ground-truthed (two riffles, one riffle/pocketwater, three runs, and two runs/pocketwater; Table 36).

There was no bankside erosion in any of the mesohabitat units. There was an average of two pieces of LWD per mesohabitat unit in both the mainstem and the side channels. There was no UCB in the mainstem and a small amount on both banks of the side channels.

Total cover was not recorded in this reach (Table 33 and Table 36). In the mainstem, almost equal amounts of riparian vegetation was broadleaf forest open and nonforest shrub willow, while in the side channel, most of the riparian vegetation was nonforest shrub willow (Table 34 and Table 37). Boulder was the dominant substrate type for mesohabitats in this reach (Table 35 and Table 38).

## Geomorphic Reach 4

Kosina Creek Geomorphic Reach 4 is approximately 1.4 km long (Figure 11), and approximately 0.9 km (~64 percent) of the reach was ground-truthed. Eight mainstem mesohabitat units were mapped in the mainstem channel consisting of one cascade, two riffles, three riffles/pocketwater, one run, and one run/pocketwater. There were no side channels in this reach, but there was one off-channel mesohabitat (percolation channel; Table 42). Most of the mainstem was composed of riffle habitat (Table 39).

Excluding the cascade, the average stream gradient in the mainstem and the side channel was 2.0 percent. Once the cascade was factored in, the average mainstem stream gradient increased to 3.0 percent (Table 39).

More bankside erosion and UCB were present in the mainstem than in the percolation channel. No LWD was observed in the reach.

Total cover was greater in the mainstem than in the percolation channel (Table 42). All the riparian vegetation was nonforest shrub willow in the mainstem and in the off-channel mesohabitats (Table 40 and Table 43). In general, mainstem mesohabitat types contained an even distribution of boulder, cobble, and gravel substrate types (Table 41), while the percolation channel was dominated by gravel and sand/silt substrates (Table 44).

## Geomorphic Reach 5

Kosina Creek Geomorphic Reach 5 is approximately 0.5 km long (Figure 10). Approximately 0.5 km (100 percent) of the reach was ground-truthed. Mainstem mesohabitat units consisted of one riffle, one riffle/pocketwater, and two runs. There was also one side channel run.

Average stream gradient was the same between all mesohabitat units in the reach (Table 45 and Table 48).

More bankside erosion was observed in mainstem versus side channel mesohabitats. No LWD or UCB was recorded in either the mainstem or the side channel.

The side channel had a greater percentage of total cover (Table 45 and Table 48). The mainstem mesohabitat units had riparian vegetation that consisted of nonforest shrub willow and the side channel had riparian vegetation that consisted of nonforest shrub alder (Table 46 and Table 49). In mesohabitat types of this reach, all substrate types, with the exception of organic material, were present (Table 47 and Table 50).

## Geomorphic Reach 6

Kosina Creek Geomorphic Reach 6 is approximately 0.4 km long (Figure 12). In this reach, the entire reach channel was ground-truthed. Mainstem channel mesohabitat units consisted of one riffle and two runs. There were no side channel or off-channel mesohabitat units in this reach (Table 51).

Stream gradient was the same for all mesohabitat units in the reach (Table 51). Average maximum depth was not recorded due to safety concerns.

Runs had a greater amount of streambank erosion than riffles. No LWD or UCB was present in any of the mesohabitat units. Total cover for the riffle was 20 percent.

Total cover for the two runs was 30 and 50 percent (Table 51). Riparian vegetation in the reach was primarily composed of nonforest shrub willow (Table 52). Mesohabitat types in this reach (riffle and run) were primarily composed of boulder, cobble, and gravel, although sand/silt was also present in small amounts (Table 53).

#### Geomorphic Reach 7

Kosina Creek Geomorphic Reach 7 is approximately 2.0 km long (Figure 12). Approximately 0.8 km (~40%) of the reach was ground-truthed. Mainstem mesohabitat units consisted of one riffle and two runs. Side channel and off-channel mesohabitat types consisted of one percolation channel, one scour pool, seven runs, and one slough (Table 54 and Table 57).

The average stream gradient for the mainstem and the side channels was the same. The laser rangefinder malfunctioned and lengths, widths, and stream gradients could not be recorded for many of the mesohabitat units in this reach (Table 54 and Table 57).

The side channels had a greater amount of bankside erosion. No LWD was observed in either the mainstem or the side channels. The amount of UCB was slightly more in mainstem mesohabitats (Table 54 and Table 57).

Total coverage was greater in side channel versus mainstem mesohabitat types (Table 54 and Table 57). Due to a faulty laser rangefinder the actual lengths of the mesohabitat units were not recorded, but in both the mainstem and the side channel mesohabitats, nonforest shrub willow was the dominant riparian vegetation type (Table 55 and Table 58). As expected, riffle and run mesohabitats in the mainstem channel were dominated by larger, more hydraulically stable substrate types (i.e., boulder and cobble) while side channel substrates were primarily composed of gravel, sand/silt, and organic material (Table 56 and Table 59).

#### Geomorphic Reach 8

Kosina Creek Geomorphic Reach 8 is approximately 14.1 km long below the 3,000-foot elevation mark (Figure 13). Approximately 1.0 km (~7 percent) of the reach was ground-truthed. Mainstem mesohabitat units consisted of one riffle and two runs (Table 60. The side channel mesohabitat units consisted of one riffle and two runs.

Average depth was about twice as deep in the mainstem as in the side channels. In this reach, there was no bankside erosion (Table 60 and Table 63).

LWD was not observed in any of the mesohabitat units. There was more UCB in the mainstem than in side channel habitat. Total cover was not recorded in this reach (Table 60 and Table 63).

The riparian vegetation in both the mainstem and side channel mesohabitats was dominated by nonforest shrub willows (Table 61 and Table 64). Riffle and run mesohabitats of both channel types were bedrock- and/or boulder-dominated (Table 62 and Table 65).

### *Watana Creek*

Watana Creek was divided into eight distinct geomorphic reaches (Figure 14) based on the methods described above. Once better imagery for the Upper River basin is available, some of these reaches may be collapsed into each other. Watana Creek is approximately 33.9 km long below the elevation of 3,000 feet, and 2.262 km (~7 percent) were ground-truthed. It was ground-surveyed by two field crews on September 13, 2012, from late morning through early evening. Detailed information for each reach that was ground-truthed is provided below.

### Geomorphic Reach 1

Watana Creek Geomorphic Reach 1 is approximately 1.0 km long (Figure 15). Approximately 0.9 km (~90 percent) of the reach was ground-truthed. Mainstem mesohabitat units were composed of five riffles and five runs (Table 66). No side channels were surveyed in this reach. Even though the total number of mapped habitats was equal between riffles and runs, the riffles had a greater length of habitat.

The average wetted and bankfull widths were much greater in the riffles. The average maximum depth was greater in the runs than riffles (Table 66).

Overall, there was a greater amount of UCB, LWD, and bankside erosion in the riffles than in the runs.

Total cover was not recorded for this reach (Table 66). Riparian vegetation in the majority of the mesohabitat units consisted of nonforest willow (Table 67). Mesohabitats in this reach were primarily cobble substrate (Table 68).

### Geomorphic Reach 2

Watana Creek Geomorphic Reach 2 is approximately 0.8 km long. Reach 2 was not ground-truthed due to inclement weather (i.e., rain, fog, low visibility), which resulted in navigation and access challenges.

### Geomorphic Reach 3

Watana Creek Geomorphic Reach 3 is approximately 8.2 km long (Figure 16). Approximately 0.062 km (~1 percent) of the reach was ground-truthed. It consisted of one mainstem mesohabitat unit (run) and one off-channel mesohabitat unit (percolation channel). The mainstem run was approximately two times as long as the percolation channel (Table 69 and Table 72).

Both mesohabitat units had nonforest shrub willow as their dominant riparian vegetation type (Table 70 and Table 73). The run mesohabitat was comprised of equal concentrations of cobble and gravel (40 percent) and sand/silt (20 percent) while the percolation channel had smaller substrate types, primarily gravel and sand/silt (Table 71 and Table 74).

### Geomorphic Reach 4

Watana Creek Geomorphic Reach 4 is approximately 3.4 km long (Figure 17). Approximately 0.6 km (~18 percent) of the reach was ground-truthed. Mainstem mesohabitat types consisted of three riffles and two runs. There were also side channel and off-channel mesohabitat units consisting of one beaver complex, one backwater pool, three scour pools, three riffles, one riffle/pocketwater, one run, one run/pocketwater, and one slough (Table 78. Over twice as much habitat was mapped in the mainstem; however, the diversity of mesohabitat units was much greater in the side channels (Table 75 and Table 78).

While the average stream gradient was the same between the mainstem and the side channels, the average wetted and bankfull widths were much greater in the mainstem (Table 75 and Table 78).

Percent cover was greater in the mainstem, but bankside erosion, UCB, and LWD were very similar between the mainstem and the side channels (Table 75 and Table 78). Side channels also had a greater variety of riparian vegetation types (Table 76 and Table 79). Mainstem channel habitat was primarily comprised of cobble and gravel substrate (Table 77). Substrate types in side channel habitats were more diverse and included smaller material (sand/silt and organic material; Table 80).

Geomorphic Reach 5

Watana Creek Geomorphic Reach 5 is approximately 0.3 km long. This reach was not ground-truthed due to poor weather conditions, resulting in helicopter inaccessibility.

Geomorphic Reach 6

Watana Creek Geomorphic Reach 6 is approximately 9.9 km long (Figure 18). Approximately 0.7 km (~7 percent) of the reach was ground-truthed, which consisted of three riffles and two runs in the mainstem channel (Table 81). Side and off-channel mesohabitat units were also surveyed. They consisted of two percolation channels and two riffles (Table 84).

While the average stream gradient was the same between the mainstem and the side channels, the average wetted and bankfull widths were much greater in the mainstem (Table 81 and 84).

Percent cover was greater in the side channel. Very little bankside erosion and UCB were observed in either channel types. LWD was highest in run mesohabitats (Table 81 and 84). Willow was the exclusive riparian vegetation type throughout the sampled reach (Table 82 and Table 85). Mainstem channel habitat was primarily comprised of cobble and gravel with some boulder substrate (Table 83) while side channel habitats were more diverse and trended toward smaller material (sand/silt and organic material; Table 86).

Geomorphic Reach 7 and 8

Watana Creek Geomorphic Reach 7 is approximately 6.4 km long and Reach 8 is approximately 3.9 km long below the 3,000-foot elevation mark. These reaches were not ground-truthed due to poor weather conditions, resulting in helicopter inaccessibility.

## 3.6. Discussion and Conclusion

### 3.6.1. Aerial Habitat Mapping

Excellent conditions (i.e., weather, low flow levels, clear water, and open canopy of stream corridors) resulted in excellent video footage of all the primary tributaries in the Upper River, the Upper River mainstem, and the Middle River mainstem. Post-field collection review of the video footage determined that imagery collected via this methodology can be reliably used for characterizing mesohabitat frequency and distribution in the Upper and Middle River mainstem and its tributaries in combination with ground-based surveys. Use of the aerial video methodology for this purpose will be undertaken in 2013 according to methods described in RSP

Section 9.9, Characterization and Mapping of Aquatic Habitats in the Susitna River with Potential to be Affected by the Susitna-Watana Project.

Test results in the Lower River mainstem demonstrated that the use of aerial video for mesohabitat mapping in this reach was not feasible because of the multi-channel complexity and mile-wide width of the river corridor.

### 3.6.2. Ground-Based Habitat Mapping

In 2012, the emphasis on ground-based mesohabitat mapping was to begin to characterize habitat that has the potential to be altered by the Project. Given that there has never been a habitat survey in the region, nothing was known about the types of mesohabitat units present and their relative proportion in each stream. This information will support the establishment of an environmental baseline to evaluate potential Project-related effects to fish and their habitat.

***Jay, Kosina, and Watana Creeks***

Overall, the mesohabitat type composition between main channel and side channels in all three creeks surveyed appeared to be driven by the different hydrologic regimes that would be expected within the two channel types. The dominance of riffle and run mesohabitat types in the main channels of all surveyed tributaries is likely attributable to the prevalence of higher flows and velocities, which create a greater potential for hydraulic disturbance. Habitat characteristics in the mainstem channel mesohabitats were generally comprised of greater bankfull and wetted widths, greater average maximum depths, larger substrates, and less LWD. Although main channel riffle and run mesohabitat types appeared to make up a significant portion of the total length of stream reach surveyed, side channels, when present, appeared to boast a greater diversity of mesohabitat types. This greater diversity of mesohabitat types in side channels likely results in an increase in overall habitat complexity. In side channels, the frequency of LWD, cover, greater range of substrate including smaller materials, and overhanging vegetation was more prevalent. The increased retention of elements that support habitat complexity is likely due to a more stable hydrologic regime relative to main channel habitat.

In evaluating the results of the Aquatic Habitat Mapping Study as it relates to fisheries resources, the study results indicate that in general, main channel and side channel habitats in the surveyed tributaries function to support different life history stages of fish species present within the Susitna River basin. Mains channel habitats, which are primarily composed of riffle and run mesohabitats types, are better suited to support subadult and adult fish. The presence of higher velocities in this channel type may create less suitable conditions for smaller fish, particularly at high flows (McMahon and Hartman 1989). As such, main channel habitats may function as migratory corridors and provide greater amounts of spawning habitat for certain species of fish. Higher overall complexity within side channel habitats likely supports a greater variety of life history stages for fish species in the basin. The greater availability of LWD and cover increases productivity and the available food base for rearing. LWD creates refugia that may reduce bioenergetic expenditure (due to lower velocities) and reduce predation of juvenile fish. Similar to main channels, riffle habitat in side channels may support spawning adult fish. Although main channel and side channel habitats may tend to support specific life history stages, the availability of both types of channel-type habitats in tributary systems is critical to supporting the overall health of fishery resources in the Susitna River basin.

### *Lessons Learned*

Due to the large geographic scope, remoteness of the study area, and prevalence of non-wadeable streams, challenges in gathering data were experienced by the field crews. While most of these difficulties arose out of safety concerns (e.g., stream wadeability, etc.), some were based on logistical issues such as equipment malfunction and helicopter inaccessibility to specific areas that required sampling. In order to support more efficient implementation of the 2013 study program, all documented challenges were identified and communicated to the authors of the RSP. Appropriate changes were made in the RSP to address these challenges prior to the implementation of future studies.

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# 5. TABLES

Table 1. Fish passage barrier descriptions. The Barrier ID reflects the Susitna historic river mile where the tributary enters the river and the letters denote multiple barriers within the same tributary.

| Barrier ID | Location (tributary RM) | Category | Barrier/Potential Barrier Present | Class | Description |
|---|---|---|---|---|---|
| PB150.1-A | 0.1 | Permanent | Barrier | Compound | Permanent anadromous barrier with falls > 10 ft. Cascades and chutes upstream and downstream |
| PB150.2-A | 0.2 | Permanent | Barrier | Complex Chute | Permanent anadromous barrier due to low flow, high gradient and complex chutes |
| PB151.0-A | 0.1 | Permanent | Barrier | Complex Chute | Permanent anadromous barrier due to low flow, high gradient and complex chutes |
| PB152.0-A | 0.5 | Permanent | Barrier | Compound | Permanent anadromous barrier with falls > 10 ft, low flow, high gradient, cascades, and complex chutes |
| PB152.4-A | 2.1 | Permanent | Potential | Compound | Potential seasonal barrier due to high gradient boulder cascades falls 3-4 ft, chutes, and high velocity turbulence |
| PB152.4-B | 2.1 | Permanent | Barrier | Multiple Falls | Permanent anadromous barriers (2) with falls > 10 ft and shallow plunge pool |
| PB152.4-C | 2.1 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with waterfall much >10 ft |
| PB153.4-A | 0.3 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 30 ft |
| PB154.5-A | 0.1 | Permanent | Barrier | Multiple Falls | Permanent anadromous barrier with high velocity falls > 10 ft |
| PB154.6-A | 0.1 | Permanent | Barrier | Complex Chute | Permanent anadromous barrier with high velocity bedrock chutes |
| PB155.3-A | 0.1 | Permanent | Barrier | Compound | Permanent anadromous barrier with falls > 10 ft |
| PB155.3-B | 0.1 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls 12-15 ft |
| PB155.3-C | 0.1 | Permanent | Potential | Boulder Cascade | Continuous boulder/cascade complex with limited resting areas |

| Barrier ID | Location (tributary RM) | Category | Barrier/Potential Barrier Present | Class | Description |
|---|---|---|---|---|---|
| PB157.0-A | 1.3 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 10 ft |
| PB158.8-A | 0.1 | Permanent | Barrier | Compound | Permanent anadromous barrier with falls > 30 ft |
| PB161.5-A | 1.4 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls estimated at 80- 100 ft |
| PB161.5-B | 1.4 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls estimated at 40 ft |
| PB161.5-C | 1.4 | Permanent | Potential | Compound | Chutes and falls with continuous whitewater |
| PB165.0-A | 0.1 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 10 ft |
| PB165.2-A | 0.2 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 10- 12 ft |
| PB165.6-A | 1.3 | Permanent | Potential | Compound | Potential barrier due to steep gradient boulder cascades and falls to 6 ft with limited resting places and plunge pools |
| PB168.7-A | 0.4 | Permanent | Barrier | Boulder Cascade<br>Complex Chute | Permanent anadromous barrier with multiple boulder cascades and complex chutes |
| PB171.0-A | 1.4 | Permanent | Barrier | Complex Chute | Permanent anadromous barriers due to low flow, high gradient and complex chutes |
| PB171.0-B | 1.4 | Permanent | Barrier | Complex Chute | Permanent anadromous barriers due to low flow, high gradient and complex chutes |
| PB171.0-C | 1.4 | Permanent | Barrier | Complex Chute | Permanent anadromous barriers due to low flow, high gradient and complex chutes |
| PB171.0-D | 1.4 | Permanent | Barrier | Complex Chute | Permanent anadromous barriers due to low flow, high gradient and complex chutes |
| PB171.3-A | 0.1 | Permanent | Barrier | Complex Chute | Potential barrier due to complex bedrock chutes |
| PB173.0-A | 0.2 | Permanent | Barrier | Multiple Falls | Permanent anadromous barrier with multiple falls > 6 ft and limited resting places or plunge pools |
| PB179.1-A | 2.8 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 15 ft |
| PB181.2-A | 1.8 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 30 ft |
| PB181.8-A | 3.8 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 60 ft |

| Barrier ID | Location (tributary RM) | Category | Barrier/Potential Barrier Present | Class | Description |
|---|---|---|---|---|---|
| PB186.6-A | 0.6 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 50 ft |
| PB186.9-A | 0.4 | Permanent | Potential | Complex Chute | Potential barrier due to low flow, high gradient cascades, and bedrock chutes |
| PB194.9-A | 1.3 | Permanent | Barrier | Multiple Falls<br>Boulder Cascade | Steep gradient boulder cascades and falls with limited resting places and plunge pools. Measured vertical distance 15 ft. |
| PB200.7-A | 0.2 | Permanent | Barrier | Single Falls | Permanent anadromous barriers with single falls estimated at 10 -12 ft |
| PB200.7-B | 0.2 | Permanent | Barrier | Single Falls | Permanent anadromous barriers with single falls estimated at 40-50 ft |
| PB200.7-C | 0.2 | Permanent | Barrier | Single Falls | Permanent anadromous barriers with single falls estimated at 15-20 ft |
| PB200.7-D | 0.2 | Permanent | Barrier | Single Falls | Permanent anadromous barriers with single falls estimated at 11-12 ft |
| PB200.7-E | 0.2 | Permanent | Barrier | Single Falls | Permanent anadromous barriers with single falls estimated at 20ft |
| PB201.8-A | 0.4 | Permanent | Potential | Compound | Potential barriers due to steep gradient boulder cascades and falls to 6 ft with limited resting places and plunge pools. |
| PB201.8-B | 0.6 | Permanent | Potential | Compound | Potential barriers due to steep gradient boulder cascades and falls to 6 ft with limited resting places and plunge pools |
| PB213.0-A | 0.6 | Permanent | Potential | Compound | Potential barrier due to steep gradient boulder cascades and falls to 6 ft with limited resting places and plunge pools |
| PB226.8-A | 0.7 | Permanent | Barrier | Single Falls | Permanent anadromous barrier with falls > 15ft |

Table 2. Susitna River Mainstem and Mesohabitat Type Descriptions[1]

| Classification Level | Type | Description |
|---|---|---|
| Mainstem Habitat Type | Main Channel | Channels of the river that convey streamflow throughout the year. Can include single or multiple channels. In the Susitna River, they are visually recognizable during summer months by turbid, glacial water and high velocities. In general, they convey more than 10 percent (approximate) of the total flow passing a given location. [2,3] |
| | Side Channel | Channels that contain streamflows during open water periods but may be dewatered in a portion of the channel or entirely at low flows.[1] These channels carry mainstem water so also may be characterized by turbid, glacial water. Velocities often appear lower than in mainstem sites. In general, they convey less than 10 percent (approximate) of the total flow passing a given location. [1] Side channel habitat may exist in well-defined channels or in areas possessing numerous islands and submerged gravel bars. |
| | Tributary Mouth | Clear water areas that exist where tributaries flow into Susitna River mainstem or side channel habitats.[1] The flow of this habitat type often manifests as a clear water plume extending out into the turbid receiving water of the mainstem Susitna River. Tributary mouth habitat also extends upstream into the tributary to the upper extent of any backwater influence that might exist. The surface area of tributary mouth habitat is affected both by tributary discharge and mainstem stage. [3] |
| | Tributary | Those reaches of tributary streams upstream of the tributary mouth habitats. Tributary habitat may contain distinct mainstem channel types, off-channel waterbodies, and mesohabitat types. |
| | Off-Channel | Aquatic habitats located beyond a river's active channel, yet still within the river's active valley. Off-channel habitats lack an upstream surface water connection to the main channel at intermediate or low flows, although downstream surface water connections may exist. Off-channel habitats convey water or contain water from small tributaries, upwelling groundwater, and/or local surface runoff. |
| Off-Channel Type | Side Slough (Low flow slough) | Overflow channels contained within the Susitna River floodplain that are separated from the mainstem at the upstream end by exposed alluvial berm.[1] These channels generally contain clear water from small tributaries, upwelling groundwater, and local surface runoff. Side sloughs have non-vegetated bars at their upstream ends that are overtopped during periods of moderate to high mainstem discharge. The water surface elevation of the mainstem Susitna River at the downstream end of a side slough generally causes a backwater effect in the lower portion of the slough. Overtopping from mainstem flows occurs multiple times for short durations June through August. [2] Except during periods of overtopping, the temperature of side sloughs is independent of the mainstem water temperature. |
| | Upland Slough (Slough) | Similar to side sloughs except they are separated from the mainstem channel or a side channel by a well vegetated berm. Upland sloughs contain clear water from small streams, upwelling, and/or local surface runoff. Upland sloughs are rarely overtopped by mainstem discharge. [2,3] |
| | Backwater | Found along channel margins and created by mainstem flow eddies around obstructions such as boulders, root wads, or in-channel wood. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble. Generally not as long as the full channel width. [4] |

| Classification Level | Type | Description |
|---|---|---|
| | Isolated Pond | A self-contained off-channel waterbody that lacks a surface water connection to the river when the main channel flow is less than bankfull. Substrate is highly variable. |
| | Relic Channel | An abandoned channel lacking active flow. [6] |
| Mesohabitat Type | Cascade | A fast water habitat with turbulent flow; many hydraulic jumps, strong chutes, and eddies and between 30-80% white water. High gradient; usually greater than 4% slope. Much of the exposed substrate composed of boulders organized into clusters, partial bars, or step-pool sequences. [4] |
| | Pocketwater | A stream section intermediate in slope to the slopes observed for cascades and riffles in the subject stream, but absent clear cross-channel steps characteristic of a cascade, and the flow patterns are more complex and not characteristic of riffles (where turbulence is visibly distributed more or less evenly across the channel). There are multiple, prominent pockets of velocity refuges distributed across and along the channel that are downstream of flow obstructions. The obstructions are mostly small boulders that are of a size scaling with mid- to high-flow depth. The unit should be at least 1 channel width long to be classified separately, otherwise lump in with most similar adjacent mesohabitat type. |
| | Riffle | A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. [4] Gradients are approximately 2 to less than 4%. |
| | Run | A fast water habitat with little surface turbulence. A run has generally uniform depth that is greater than the maximum substrate size. [4] Gradients are approximately 0 to less than 2%. |
| | Pool | A slow water habitat with a flat surface slope and low water velocity that is deeper than the average channel depth. Substrate is highly variable. [4] |
| | Beaver Complex | A complex waterbody created by beaver dams that includes one or more ponded areas, connecting channels, and outlet channel to the mainstem, side or a tributary channel. Substrate is generally fine grained sand, silt and organic debris. |
| Pool Subtypes | Scour Pool | Formed by mid-channel scour or flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock). Generally with a broad scour hole. Includes corner pools in meandering lowland or valley bottom streams. [4] |
| | Backwater Pool | Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble. Generally not as long as the full channel width. [4] |
| | Beaver Pond | Water impounded by the creation of a beaver dam. Maybe within main, side, or off-channel habitats. [4] |
| Other | Alcove | An off-channel habitat that is laterally displaced from the general bounds of the active channel and formed during extreme flow events or by beaver activity; not scoured during typical high flows. Substrate is typically sand and organic matter. Generally not as long as the full channel width. [4] |

| Classification Level | Type | Description |
|---|---|---|
| | Percolation Channel | A slough habitat type that is characterized by groundwater percolation from the floodplain through gravel bars. Its upstream surface water connection to the active river channel has been cut off due to an accumulation of sediment and debris at the head of the formerly open channel, yet main river flows continue to provide a groundwater source of flow to the percolation channel. At high or overbank flows, an upstream surface water connection to the active river channel may be present. [5] |
| | Isolated Pond | A self-contained off-channel waterbody that lacks a surface water connection to the main channel when flow is less than bankfull. Substrate is highly variable. An isolated pond may occur within the off-channel slough habitats or elsewhere in the off-channel portion of the river valley. [3] |

Notes:

1 Table agreed upon by the ATWG for mesohabitat classifications
2 Source: Trihey 1982.
3 Source: Schmidt et al. 1984.
4 Source: Adapted from Moore et al. 2006.
5 Source: Adapted from Peterson and Reid 1984.
6 Source: Adapted from Washington Department of Ecology, *Channel Migration Assessment*.

Table 3. Substrate Classification

| Substrate Type | Size Range (mm) |
|---|---|
| Organic | Organic |
| Sand/Silt | < 2.0 |
| Gravel | 2.0-63.9 |
| Small Cobble | 64.0-127.9 |
| Large Cobble | 128.0-255.9 |
| Small Boulder | 256-512 |
| Large/Med Boulder | > 512 |
| Bedrock | Bedrock |

Notes:

1 Appended from the USFS (2001) classification.

Table 4. Riparian Vegetation Classification

| Riparian Type | Code |
|---|---|
| Conifer Forest - Closed Canopy | CFC |
| Conifer Forest - Open Canopy | CFO |
| Broad leaf Forest - Closed Canopy | BFC |
| Broad leaf Forest - Open Canopy | BFO |
| Nonforest Shrub - Willow Dominant | NSW |
| Nonforest Shrub - Alder Dominant | NSA |
| Nonforest Shrub – Other | NSO |
| Nonforest Herbaceous – Estuarine | NHE |
| Nonforest Herbaceous – Bog | NHB |
| Nonforest Herbaceous – Fen | NHF |
| Nonforest Herbaceous – Other | NHO |

Notes:
1 From the USFS (2001) classifications.

Table 5. Stream Cover Types

| Cover Type | Codes |
|---|---|
| Tree Bole | TB |
| Rootwad | RW |
| Slash | SL |
| Debris Jam | DJ |
| Bedrock | BR |
| Large/Medium Boulder | LMB |
| Small Boulder | SB |
| Large Cobble | LC |
| Undercut Bank | UCB |
| Depth | De |
| Bridge/culvert | BC |
| Weir | W |
| Log Structures | HL |
| Boulder Structures | HB |
| Overhanging Vegetation | OV |
| Aquatic Vegetation | AV |
| Other Human | HU |

Notes:
1 From the USFS (2001) classification

Table 6. Jay Creek Reach 1 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Riffle | 243 | 54.9% | 6 | 40.0% | 10.0 | 12.0 | 2.0 | 0.4 | | | 18 | 2 | 1 | 3 | 13 | 18 |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Run | 200 | 45.1% | 9 | 60.0% | 8.0 | 11.0 | 3.0 | 0.7 | | | 0 | 2 | 10 | 8 | 6 | 17 |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **443** | **100.0%** | **15** | **100.0%** | **9** | **12** | **2.5** | **0.5** | **0.0** | **0.0** | 9 | 2 | 5 | 6 | 10 | 18 |

Table 7. Jay Creek Reach 1 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | 1 | NRD | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 13 | 422 | 95.3 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | 1 | 21 | 4.7 |
| **TOTAL** | **15** | **443** | **100.0** |

Table 8. Jay Creek Reach 1 - Mainstem Substrate

| Unit Type | Bedrock % | Boulder % | Cobble % | Gravel % | Sand/Silt % | Organic % |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | 32 | 50 | 18 | | |
| Riffle (pocketwater) | | | | | | |
| Run | | 28 | 46 | 23 | 3 | |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 9. Jay Creek Reach 1 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | 9 | 2.0% | 1 | 10.0% | 5.0 | 11.0 | 5.0 | 0.3 | | | 0 | 0 | 1 | 0 | 0 | 0 |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Riffle | 29 | 6.5% | 3 | 30.0% | 4.0 | 6.0 | 3.0 | 0.2 | | | 0 | 0 | 3 | 0 | 0 | 28 |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Run | 30 | 6.8% | 3 | 30.0% | 3.0 | 7.0 | 2.0 | 0.4 | | | 0 | 0 | 5 | 2 | 0 | 32 |
| Scour Pool | 17 | 3.8% | 1 | 10.0% | 5.0 | 8.0 | 0.0 | | 0.3 | 0.6 | 0 | 0 | 24 | 0 | 80 | 30 |
| Backwater Pool | 5 | 1.1% | 1 | 10.0% | 3.0 | 9.0 | 0.0 | | | 0.7 | 0 | 0 | 2 | 0 | 70 | 50 |
| Slough | 10 | 2.3% | 1 | 10.0% | 1.0 | 5.0 | 0.0 | 0.4 | | | 100 | 0 | 25 | 0 | 0 | 100 |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **100** | **100.0%** | **10** | **100.0%** | **4** | **7** | **1.7** | **0.2** | **0.1** | **0.1** | 17 | 0 | 9 | 1 | 17 | 35 |

Table 10. Jay Creek Reach 1 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | 2 | 19 | 19% |
| Nonforest Shrub - Willow Dominant | 7 | 76 | 76% |
| Nonforest Shrub - Alder Dominant | 1 | 5 | 5% |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **10** | **100** | **100%** |

Table 11. Jay Creek Reach 1 – Side Channel Substrate

| Unit Type | Bedrock % | Boulder % | Cobble % | Gravel % | Sand/Silt % | Organic % |
|---|---|---|---|---|---|---|
| Cascade | | 40 | 60 | | | |
| Riffle | | 10 | 30 | 47 | 13 | |
| Riffle (pocketwater) | | | | | | |
| Run | | 20 | 53 | 20 | 7 | |
| Run (pocketwater) | | 30 | 47 | 13 | | |
| Scour Pool | | 20 | 10 | | 70 | |
| Backwater Pool | | 40 | 10 | | 50 | |
| Slough | | | 40 | | 60 | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 12. Jay Creek - Reach 2 - Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 126 | 16.2% | 4 | 44.4% | 11.0 | 13.0 | 2.0 | 0.5 | | | 3 | 13 | 1 | 0 | 2 | NRD |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Run | 650 | 83.8% | 5 | 55.6% | 11.0 | 15.0 | 2.0 | 0.6 | | | 15 | 14 | 13 | 2 | 2 | NRD |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **776** | **100.0%** | **9** | **100.0%** | **11** | **15** | **2** | **1** | **0** | **0** | **9** | **14** | **7** | **1** | **2** | **NRD** |

Table 13. Jay Creek Reach 2 - Mainstem Riparian Vegetation

| Mainstem Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | 1 | 52 | 6.7 |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 5 | 391 | 50.4 |
| Nonforest Shrub - Alder Dominant | 3 | 333 | 42.9 |
| Nonforest Shrub – Other | | | |
| Nonforest Herbaceous – Estuarine | | | |
| Nonforest Herbaceous – Bog | | | |
| Nonforest Herbaceous – Fen | | | |
| Nonforest Herbaceous – Other | | | |
| **TOTAL** | **9** | **776** | **100** |

Table 14. Jay Creek Reach 2 – Mainstem Substrate

| Unit Type | Bedrock % | Boulder % | Cobble % | Gravel % | Sand/Silt % | Organic % |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 35 | 33 | 30 | 3 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 46 | 26 | 26 | 2 | |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 15. Jay Creek Reach 6 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 19 | 3.2% | 1 | 20.0% | 10.0 | 11.0 | 3.5 | 0.4 | | | 0 | 0 | 2 | 0 | 0 | NRD |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Run | 549 | 93.2% | 3 | 60.0% | 8.0 | 12.0 | 3.0 | 0.7 | | | 10 | 17 | 20 | 20 | 3 | NRD |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | 21 | 3.6% | 1 | 20.0% | 7.0 | 13.0 | 0.0 | | 0.5 | 1.3 | 0 | 20 | 3 | 10 | 0 | NRD |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **589** | **100.0%** | **5** | **100.0%** | **8** | **12** | **2** | **1** | **0** | **0** | 3 | 12 | 8 | 10 | 1 | - |

Table 16. Jay Creek Reach 6 – Mainstem Riparian Vegetation

| Mainstem Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | 1 | 21 | 3.6 |
| Conifer Forest - Open Canopy | 1 | 40 | 6.8 |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 3 | 528 | 89.6 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub – Other | | | |
| Nonforest Herbaceous – Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous – Other | | | |
| None | | | |
| **TOTAL** | **5** | **589** | **100.0** |

Table 17. Jay Creek Reach 6 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 20 | 40 | 40 | 0 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 20 | 43 | 33 | 3 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | 0 | 0 | 40 | 40 | 20 | 0 |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 18. Jay Creek Reach 6 - Side Channel Summary Statistics (Mapped Habitat Units)

| **Unit Type** | **Total Length (m)** | **Length Rel Frequency** | **Number of Units** | **Number of Units (frequency)** | **Average Wetted Width (m)** | **Average Bankfull Width (m)** | **Average Stream Gradient (%)** | **Average Maximum Depth (m)** | **Average Pool Crest Depth (m)** | **Average maximum pool depth (m)** | **Average Left Bank Erosion (%)** | **Average Right Bank Erosion (%)** | **Average LWD (pieces/unit)** | **Average Right Undercut Bank (%)** | **Average Left Undercut Bank (%)** | **Average Cover (%)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Riffle | 16 | 16.3% | 1 | 20% | 1.8 | 2.0 | 2.0 | .2 | | | 0 | 0 | 0 | 0 | 0 | NRD |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Run | 64 | 65.3% | 2 | 40% | 1.0 | 1.1 | 2.0 | 0.1 | | | 0 | 0 | 5 | 0 | 0 | NRD |
| Scour Pool | 6.0 | 6.1% | 1 | 20% | 2.0 | 2.2 | 2.0 | | 0.1 | 0.5 | 0 | 0 | 0 | 0 | 30 | NRD |
| Backwater Pool | 12 | 12.2% | 1 | 20% | 2.5 | 2.7 | 0 | | | 0.6 | 0 | 0 | 0 | 0 | 0 | NRD |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **98** | **100.0%** | **5** | **100.0%** | **1** | **2** | **2** | **0** | **0** | **0** | 0 | 0 | 1 | 0 | 8 | NRD |

Table 19. Jay Creek Reach 6 – Side Channel Riparian Vegetation

| Side Channel Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 5 | 98 | 100.0 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **5** | **98** | **100.0** |

Table 20. Jay Creek Reach 6 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | | 70 | 30 | 0 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 10 | 25 | 20 | 25 | 20 |
| Run (pocketwater) | | | | | | |
| Scour Pool | 0 | 0 | 20 | 20 | 30 | 30 |
| Backwater Pool | 0 | 10 | 40 | 40 | 10 | 0 |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 21. Kosina Creek Reach 1 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | 779 | 69.8% | 6 | 54.5% | 32.0 | 36.0 | 2.0 | 1.0 | | | 0 | 0 | 0 | 0 | 0 | NRD |
| Riffle | | | | | | | | | | | | | | | | |
| Run (pocketwater) | 337 | 30.2% | 5 | 45.5% | 24.0 | 30.4 | 2.0 | 1.7 | | | 0 | 0 | 0 | 0 | 0 | NRD |
| Run | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **1116** | **100.0%** | **11** | **100.0%** | **30** | **34** | **2** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **-** |

Table 22. Kosina Reach 1 – Mainstem Riparian Vegetation

| Mainstem Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | 1 | 60 | 5.4 |
| Nonforest Shrub - Willow Dominant | 5 | 462 | 41.4 |
| Nonforest Shrub - Alder Dominant | 5 | 594 | 53.2 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **11** | **1116** | **100.0** |

Table 23. Kosina Reach 1– Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 52 | 33 | 15 | 0 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 4 | 60 | 30 | 6 | 0 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 24. Kosina Creek Reach 1 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 215 | 21.6% | 5 | 21.7% | 11.4 | 13.8 | 2.0 | 0.4 | | | 0 | 0 | 1 | 0 | 4 | NRD |
| Riffle(pocketwater) | 295 | 29.6% | 5 | 21.7% | 19.6 | 22.0 | 2.0 | 0.5 | | | 0 | 0 | 1 | 0 | 0 | NRD |
| Run | 285 | 28.6% | 8 | 34.8% | 13.6 | 16.3 | 2.0 | 0.6 | | | 3 | 0 | 1 | 1 | 1 | NRD |
| Run(pocketwater) | 68 | 6.8% | 2 | 8.7% | 15.5 | 17.5 | 2.0 | 0.7 | | | 0 | 0 | 2 | 0 | 0 | NRD |
| Scour Pool | 37 | 3.7% | 2 | 8.7% | 11.5 | 16.0 | 2.0 | | 0.3 | 0.7 | 0 | 0 | 1 | 0 | 0 | NRD |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | 96 | 9.6% | 1 | 4.3% | 2.0 | 2.5 | 2.0 | 0.2 | | | 0 | 0 | 5 | 0 | 0 | NRD |
| **TOTAL** | **996** | **100.0%** | **23** | **100.0%** | **14** | **16** | **2** | **0** | **0** | **0** | **0** | **0** | **2** | **0** | **1** | **-** |

Table 25. Kosina Reach 1 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | 4 | 106 | 10.6 |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | 7 | 378 | 37 |
| Nonforest Shrub - Willow Dominant | 6 | 267 | 26.8 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | 3 | 247 | 24.7 |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **20** | **998** | **100.0** |

Table 26. Kosina Creek Reach 1 – Side Channel Substrate

| Unit Type | Bedrock % | Boulder % | Cobble % | Gravel % | Sand/Silt % | Organic % |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 36 | 40 | 24 | 0 | 0 |
| Riffle (pocketwater) | 0 | 44 | 44 | 12 | 0 | 0 |
| Run | 0 | 43 | 38 | 19 | 0 | 0 |
| Run (pocketwater) | 0 | 45 | 40 | 15 | 0 | 0 |
| Scour Pool | 0 | 45 | 30 | 20 | 5 | 0 |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | 0 | 40 | 20 | 20 | 10 | 10 |

Table 27. Kosina Creek Reach 2 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 383 | 66.3% | 2 | 33.3% | 31.0 | 32.0 | 2.0 | 1.1 | | | 0 | 0 | 1 | 0 | 0 | NRD |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | 169 | 29.2% | 3 | 50.0% | 26.0 | 29.0 | 2.0 | 1.9 | | | 0 | 0 | 1 | 0 | 0 | NRD |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | 26 | 4.5% | 1 | 16.7% | 11.0 | 16.0 | 2.0 | | NRD | 2.0 | 0 | 0 | 1 | 0 | 0 | NRD |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **578** | **100.0%** | **6** | **100.0%** | **29** | **30** | **2** | **1** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **-** |

Table 28. Kosina Creek Reach 2 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 5 | 548 | 94.8 |
| Nonforest Shrub - Alder Dominant | 1 | 30 | 5.2 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **6** | **578** | **100.0** |

Table 29. Kosina Creek Reach 2 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 60 | 30 | 10 | 0 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 3 | 57 | 33 | 7 | 0 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | 0 | 70 | 30 | 0 | 0 | 0 |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 30. Kosina Reach 2 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | | | | | | | | | | | | | | | | |
| Riffle(pocketwater) | 55 | 100.0% | 1 | 100.0% | 11.0 | 12.0 | 2.0 | 0.7 | | | 0 | 0 | 0 | 0 | 0 | NRD |
| Run | | | | | | | | | | | | | | | | |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **55** | **100.0%** | **1** | **100.0%** | **11** | **12** | **2** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **-** |

Table 31. Kosina Reach 2 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | | | |
| Nonforest Shrub - Alder Dominant | 1 | 55 | 100.0 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **1** | **55** | **100.0** |

Table 32. Kosina Reach 2 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | | | | | |
| Riffle (pocketwater) | 0 | 40 | 30 | 30 | 0 | 0 |
| Run | | | | | | |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 33. Kosina Creek Reach 3 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 464 | 85.0% | 2 | 66.7% | 35.5 | 37.5 | 2.0 | 1.5 | | | 0 | 0 | 3 | 0 | 0 | NRD |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | 82 | 15.0% | 1 | 33.3% | 19.0 | 26.0 | 2.0 | 1.5 | | | 0 | 0 | 1 | 0 | 0 | NRD |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **546** | **100.0%** | **3** | **100.0%** | **33** | **36** | **2** | **2** | **0** | **0** | **0** | **0** | **2** | **0** | **0** | **-** |

Table 34. Kosina Creek Reach 3 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | 1 | 262 | 48.0 |
| Nonforest Shrub - Willow Dominant | 2 | 284 | 52.0 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **3** | **546** | **100.0** |

Table 35. Kosina Creek Reach 3 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 60 | 30 | 10 | 0 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 60 | 30 | 10 | 0 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 36. Kosina Creek Reach 3 – Side Channel Summary Statistics (Mapped Habitat Units)

| **Unit Type** | **Total Length (m)** | **Length Rel Frequency** | **Number of Units** | **Number of Units (frequency)** | **Average Wetted Width (m)** | **Average Bankfull Width (m)** | **Average Stream Gradient (%)** | **Average Maximum Depth (m)** | **Average Pool Crest Depth (m)** | **Average maximum pool depth (m)** | **Average Left Bank Erosion (%)** | **Average Right Bank Erosion (%)** | **Average LWD (pieces/unit)** | **Average Right Undercut Bank (%)** | **Average Left Undercut Bank (%)** | **Average Cover (%)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 137 | 38.0% | 2 | 25.0% | 12.5 | 13.5 | 2.0 | 0.7 | | | 0 | 0 | 1 | 10 | 0 | NRD |
| Riffle(pocketwater) | 99 | 27.4% | 1 | 12.5% | 13.0 | 13.0 | 2.0 | 0.6 | | | 0 | 0 | 3 | 20 | 0 | NRD |
| Run | 68 | 18.8% | 3 | 37.5% | 10.0 | 12.3 | 2.0 | 0.8 | | | 0 | 0 | 1 | 3 | 23 | NRD |
| Run(pocketwater) | 57 | 15.8% | 2 | 25.0% | 9 | 12 | 2 | 0.9 | | | 0 | 0 | 3 | 0 | 30 | NRD |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **361** | 100.0% | **8** | 100.0% | **12** | **13** | **2** | **1** | **0** | **0** | **0** | **0** | **2** | **8** | **13** | **-** |

Table 37. Kosina Creek Reach 3 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | 2 | 47 | 13.0 |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 3 | 217 | 60.1 |
| Nonforest Shrub - Alder Dominant | 3 | 97 | 26.9 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **6** | **361** | **100.0** |

Table 38. Kosina Reach 3 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | 60 | 30 | 10 | | |
| Riffle (pocketwater) | | 60 | 30 | 10 | | |
| Run | | 50 | 23 | 17 | 10 | |
| Run (pocketwater) | | 50 | 35 | 15 | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 39. Kosina Creek Reach 4 – Mainstem Summary Statistics (Mapped Habitat Units)

| **Unit Type** | **Total Length (m)** | **Length Rel Frequency** | **Number of Units** | **Number of Units (frequency)** | **Average Wetted Width (m)** | **Average Bankfull Width (m)** | **Average Stream Gradient (%)** | **Average Maximum Depth (m)** | **Average Pool Crest Depth (m)** | **Average maximum pool depth (m)** | **Average Left Bank Erosion (%)** | **Average Right Bank Erosion (%)** | **Average LWD (pieces/unit)** | **Average Right Undercut Bank (%)** | **Average Left Undercut Bank (%)** | **Average Cover (%)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | 81 | 8.9% | 1 | 12.5% | 34.0 | 56.0 | 9.0 | 0.4 | | | NRD | NRD | 0 | 0.0 | 0.0 | 10 |
| Riffle | 321 | 35.2% | 2 | 25.0% | 27.0 | 34.5 | 2.0 | 0.5 | | | 8 | 5 | 0 | 0 | 3 | 23 |
| Riffle(pocketwater) | 307 | 33.7% | 3 | 37.5% | 44.7 | 60.7 | 2.0 | 0.5 | | | 1.7 | 1.7 | 0 | 0.0 | 0.0 | 28.3 |
| Run | 121 | 13.3% | 1 | 12.5% | 37.0 | 39.0 | 2.0 | NRD | | | 10 | NRD | 0 | NRD | 0 | 40 |
| Run(pocketwater) | 81 | 8.9% | 1 | 12.5% | 34.0 | 51.0 | 2.0 | NRD | | | 5 | 5 | 0 | 10 | 10 | 40 |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **911** | **100.0%** | **8** | **100.0%** | **36** | **47** | **3** | **0** | **0** | **0** | **6** | **4** | **0** | **3** | **3** | **28** |

Table 40. Kosina Creek Reach 4 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 8 | 911 | 100.0 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **8** | **911** | **100** |

Table 41. Kosina Creek Reach 4 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | 0 | 50 | 30 | 20 | 0 | 0 |
| Riffle | 0 | 35 | 30 | 30 | 5 | 0 |
| Riffle (pocketwater) | 0 | 37 | 37 | 23 | 3 | 0 |
| Run | 0 | 40 | 30 | 30 | 0 | 0 |
| Run (pocketwater) | 0 | 50 | 30 | 20 | 0 | 0 |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 42. Kosina Reach 4 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | | | | | | | | | | | | | | | | |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | | | | | | | | | | | | | | | | |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | 38 | 100.0 % | 1 | 100.0 % | 1.4 | 4.0 | 2.0 | 0.1 | | | 0 | 0 | 0 | 0 | 0 | 5 |
| **TOTAL** | **38** | **100.0 %** | **1** | **100.0 %** | **1** | **4** | **2** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **5** |

Table 43. Kosina Creek Reach 4 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 1 | 38 | 100 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **1** | **38** | **100** |

Table 44. Kosina Creek Reach 4 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | | | | | |
| Riffle (pocketwater) | | | | | | |
| Run | | | | | | |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | 0 | 10 | 20 | 40 | 30 | 0 |

Table 45. Kosina Creek Reach 5 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 169 | 33.9% | 1 | 25.0% | 33.0 | 44.0 | 2.0 | NRD | | | 10 | NRD | 0 | NRD | 0 | 40 |
| Riffle (pocketwater) | 89 | 17.9% | 1 | 25.0% | 29.0 | 37.0 | 2.0 | NRD | | | 0.0 | NRD | 0 | NRD | 0.0 | 30 |
| Run | 240 | 48.2% | 2 | 50.0% | 38.5 | 44.0 | 2.0 | NRD | | | 5 | NRD | 0 | NRD | 0 | 35 |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **498** | **100.0%** | **4** | **100.0%** | **35** | **43** | **2** | - | - | - | 5 | - | 0 | - | 0 | 35 |

Table 46. Kosina Creek Reach 5 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 4 | 498 | 100.0% |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **4** | **498** | **100** |

Table 47. Kosina Creek Reach 5 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 10 | 30 | 30 | 20 | 10 | 0 |
| Riffle (pocketwater) | 0 | 30 | 20 | 20 | 30 | 0 |
| Run | 10 | 40 | 20 | 15 | 15 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 48. Kosina Creek Reach 5 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | | | | | | | | | | | | | | | | |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | 28 | 100.0% | 1 | 100.0% | 2.0 | 4.0 | 2.0 | NRD | | | 0 | 0 | 0 | 0 | 0 | 70 |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **28** | **100.0%** | **1** | **100.0%** | **2** | **4** | **2** | | | | **0** | **0** | **0** | **0** | **0** | **70** |

Table 49. Kosina Creek Reach 5 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | | | |
| Nonforest Shrub - Alder Dominant | 1 | 28 | 100 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | | | |

Table 50. Kosina Creek Reach 5 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | | | | | |
| Riffle (pocketwater) | | | | | | |
| Run | 30 | 30 | 10 | 10 | 20 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 51. Kosina Creek Reach 6 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 192 | 28.5% | 1 | 33.3% | 55.0 | 66.0 | 2.0 | NRD | | | 0 | NRD | 0 | NRD | 0 | 20 |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | 481 | 71.5% | 2 | 66.7% | 55.0 | 69.0 | 2.0 | NRD | | | 28 | NRD | 0 | NRD | 0 | 40 |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **673** | **100.0%** | **3** | **100.0%** | **55** | **68** | **2** | **-** | **-!** | **-** | 14 | - | 0 | - | 0 | 30 |

Table 52. Kosina Creek Reach 6 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 3 | 673 | 100.0% |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **3** | **673** | **100** |

Table 53. Kosina Creek Reach 6 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 30 | 20 | 30 | 20 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 40 | 30 | 20 | 10 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 54. Kosina Creek Reach 7 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | NRD | | 1 | 12.5% | NRD | NRD | 2.0 | 0.5 | | | 0 | NRD | 0 | NRD | 5 | 0 |
| Riffle | | | | | | | | | | | | | | | | |
| Run (pocketwater) | NRD | | 7 | 87.5% | 59.5 | 82.5 | 1.0 | 0.7 | | | 0 | 2 | 0 | 0 | 20 | 10 |
| Run | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | | | **8** | **100.0%** | **-** | **-** | **2** | - | - | - | 0 | 2 | 0 | 0 | 13 | 5 |

Table 55. Kosina Creek Reach 7 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 5 | NRD | |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | 1 | NRD | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | 2 | NRD | |
| None | | | |
| **TOTAL** | **8** | **-** | **-** |

Table 56. Kosina Creek Reach 7 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 40 | 30 | 20 | 10 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 33 | 29 | 24 | 14 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 57. Kosina Reach 7 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | | | | | | | | | | | | | | | | |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | NRD | | 8 | 66.7% | 12.5 | 52.0 | 2.0 | 0.3 | | | 5 | 9 | 0 | 1 | 1 | 6 |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | NRD | | 2 | 16.7% | 3.0 | NRD | NRD | | 0.4 | 0.8 | 0 | 30 | 0 | 15 | 0 | 10 |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | NRD | | 1 | 8.3% | 1.3 | NRD | NRD | 0.3 | | | 0 | 0 | 0 | 0 | 0 | 20 |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | NRD | | 1 | 8.3% | 1.5 | NRD | NRD | 0.3 | | | 15 | 15 | 0 | 10 | 10 | 20 |
| **TOTAL** | | | **12** | **100.0%** | **18.3** | **52.0** | **2** | **0.9** | **0.4** | **0.8** | **5** | **14** | **0** | **7** | **3** | **14** |

Table 58. Kosina Reach 7 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 7 | NRD | |
| Nonforest Shrub - Alder Dominant | 1 | NRD | |
| Nonforest Shrub - Other | 1 | NRD | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | 3 | NRD | |
| None | | | |
| Conifer Forest - Closed Canopy | 12 | NRD | |

Table 59. Kosina Reach 7 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | | | | | |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 18 | 30 | 30 | 23 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | 0 | 0 | 0 | 50 | 50 | 0 |
| Backwater Pool | | | | | | |
| Slough | 0 | 0 | 10 | 10 | 70 | 10 |
| Beaver Complex | | | | | | |
| Percolation Channel | 0 | 0 | 0 | 40 | 20 | 40 |

Table 60. Kosina Creek Reach 8 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 159 | 16.2% | 1 | 14.3% | 112.0 | 113.0 | 3.5 | 0.7 | | | 0 | 0 | 0 | 20 | 10 | NRD |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | 825 | 83.8% | 6 | 85.7% | 94.7 | 96.2 | 2.0 | 1.3 | | | 0 | 0 | 0 | 20 | 13 | NRD |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **984** | **100.0%** | **7** | **100.0%** | **97** | **99** | **3** | **1** | - | - | 0 | 0 | 0 | 20 | 12 | - |

Table 61. Kosina Creek Reach 8 – Mainstem Riparian Vegetation

| **Riparian Vegetation** | **Number** | **Length (m)** | **Relative Frequency (%)** |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 7 | 984 | 100.0 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **7** | **984** | **100** |

Table 62. Kosina Creek Reach 8 – Mainstem Substrate

| **Unit Type** | **Bedrock (%)** | **Boulder (%)** | **Cobble (%)** | **Gravel (%)** | **Sand/Silt (%)** | **Organic (%)** |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 60 | 20 | 10 | 10 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 50 | 30 | 10 | 10 | 0 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 63. Kosina Creek Reach 8 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 44 | 31.7% | 1 | 25.0% | 6.0 | 7.0 | 2.0 | 0.4 | | | 0 | 0 | 0 | 10 | 0 | NRD |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | 95 | 68.3% | 3 | 75.0% | 10.7 | 11.3 | 2.0 | 0.5 | | | 0 | 0 | 0 | 3 | 10 | NRD |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **139** | **100.0%** | **4** | **100.0%** | **9** | **10** | **2** | **0** | - | - | 0 | 0 | 0 | 7 | 5 | - |

Table 64. Kosina Creek Reach 8 – Side Channel Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 4 | 139 | 100 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **4** | **139** | **100** |

Table 65. Kosina Creek Reach 8 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 50 | 30 | 10 | 10 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 43 | 20 | 13 | 23 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 66. Watana Creek Reach 1 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | 551 | 60.6% | 5 | 50.0% | 22.0 | 24.0 | 2.0 | 0.5 | | | 38 | 6 | 12 | 0 | 16 | NRD |
| Riffle | | | | | | | | | | | | | | | | |
| Run (pocketwater) | 358 | 39.4% | 5 | 50.0% | 13.0 | 18.0 | NRD | 1.0 | | | 4 | 17 | 7 | 0 | 6 | NRD |
| Run | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **909** | **100.0%** | **10** | **100.0%** | **18** | **22** | **2** | **1** | **0** | **0** | **21** | **12** | **10** | **0** | **11** | **-** |

Table 67. Watana Creek Reach 1 – Mainstem Riparian Vegetation

| Mainstem Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | 1 | 214 | 23.5 |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 7 | 466 | 51.3 |
| Nonforest Shrub - Alder Dominant | 2 | 229 | 25.2 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **10** | **909** | **100.0** |

Table 68. Watana Creek Reach 1 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 0 | 72 | 28 | 0 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 2 | 12 | 68 | 18 | 0 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 69. Watana Creek Reach 3 – Mainstem Summary Statistics (Mapped Habitat Units)

| **Unit Type** | **Total Length (m)** | **Length Rel Frequency** | **Number of Units** | **Number of Units (frequency)** | **Average Wetted Width (m)** | **Average Bankfull Width (m)** | **Average Stream Gradient (%)** | **Average Maximum Depth (m)** | **Average Pool Crest Depth (m)** | **Average maximum pool depth (m)** | **Average Left Bank Erosion (%)** | **Average Right Bank Erosion (%)** | **Average LWD (pieces/unit)** | **Average Right Undercut Bank (%)** | **Average Left Undercut Bank (%)** | **Average Cover (%)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | | | | | | | | | | | | | | | | |
| Riffle(pocketwater) | | | | | | | | | | | | | | | | |
| Run | 62 | 100 | 1 | 100 | 21 | 23 | 2.0 | 0.6 | - | - | | | | | | |
| Run(pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **62** | **100** | **1** | **100** | **21** | **23** | **2.0** | 1 | - | **-** | **0** | **0** | **0** | **0** | **0** | **-** |

Table 70. Watana Creek Reach 3 – Mainstem Riparian Vegetation

| Mainstem Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 1 | 62 | 100.0% |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **1** | **62** | **100** |

Table 71. Watana Creek Reach 3 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | | | | | |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 0 | 40 | 40 | 20 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 72. Watana Creek Reach 3 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Run | | | | | | | | | | | | | | | | |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | 36 | 100.0% | 1 | 100.0% | 1.2 | 1.4 | 2.0 | 0.1 | | | 0 | 0 | 0 | 0 | 0 | 40 |
| **TOTAL** | **36** | **100.0%** | **1** | **100.0%** | **1** | **1** | **2** | **0** | - | - | 0 | 0 | 0 | 0 | 0 | 40 |

Table 73. Watana Creek Reach 3 – Side Channel Riparian Vegetation

| Side Channel Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 1 | 36 | 100 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **1** | **36** | **100** |

Table 74. Watana Creek Reach 3 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | | | | | | |
| Riffle (pocketwater) | | | | | | |
| Run | | | | | | |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | 0 | 0 | 0 | 40 | 60 | 0 |

Table 75. Watana Creek Reach 4- Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 608 | 79.1% | 4 | 66.7% | 17.0 | 19.0 | 2.0 | 0.5 | | | 1 | 1 | 4 | 0 | 0 | 20 |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Run | 161 | 20.9% | 2 | 33.3% | 17.0 | 19.0 | 2.0 | 0.8 | | | 3 | 5 | 1 | 3 | 0 | 10 |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **769** | **100.0%** | **6** | **100.0%** | **17** | **19** | **2** | **1** | - | - | 2 | 3 | 3 | 2 | 0 | 15 |

Table 76. Watana Creek Reach 4 – Mainstem Riparian Vegetation

| Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 5 | 703 | 91.4 |
| Nonforest Shrub - Alder Dominant | 1 | 66 | 8.6 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **6** | **769** | **100** |

Table 77. Watana Creek Reach 4 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 13 | 45 | 33 | 10 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 15 | 35 | 35 | 15 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 78. Watana Creek Reach 4 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | 94 | 27.8% | 3 | 25.0% | 5.0 | 6.0 | 2.0 | 1.0 | | | 0 | 0 | 2 | 0 | 2 | 5 |
| Riffle | 49 | 14.5% | 1 | 8.3% | 4.0 | 5.0 | 2.0 | 0.2 | | | 0.0 | 0.0 | 0 | 0.0 | 0.0 | NRD |
| Run (pocketwater) | 20 | 5.9% | 1 | 8.3% | 3.0 | 5.0 | 2.0 | 0.3 | | | 20 | 0 | 1 | 0 | 20 | NRD |
| Run | 30 | 8.9% | 1 | 8.3% | 5.0 | 5.0 | 2.0 | 0.3 | | | 0 | 0 | 3 | 0 | 0 | NRD |
| Scour Pool | 52 | 15.4% | 3 | 25.0% | 5.0 | 6.0 | 2.0 | | 0.2 | 0.6 | 16 | 0 | 5 | 0 | 0 | NRD |
| Backwater Pool | 36 | 10.7% | 1 | 8.3% | 6.0 | 9.0 | 2.0 | | | 0.7 | 0 | 20 | 2 | 0 | 0 | NRD |
| Slough | 10 | 3.0% | 1 | 8.3% | 2.0 | 2.0 | 2.0 | 0.2 | | | 0.0 | 0 | 7 | 0 | 10 | NRD |
| Beaver Complex | 47 | 13.9% | 1 | 8.3% | 14.0 | 16.0 | 2.0 | | | 0.7 | 0 | 5 | 10 | 0 | 0 | NRD |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **338** | **100.0%** | **12** | **100.0%** | **6** | **7** | **2** | **0** | **0** | **0** | **5** | **3** | **4** | **0** | **4** | **5** |

Table 79. Watana Creek Reach 4 – Side Channel Riparian Vegetation

| Side Channel Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | 1 | 20 | 5.9 |
| Conifer Forest - Open Canopy | 1 | 47 | 13.9 |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | 1 | 11 | 3.3 |
| Nonforest Shrub - Willow Dominant | 4 | 131 | 38.8 |
| Nonforest Shrub - Alder Dominant | 5 | 129 | 38.2 |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **12** | **338** | **100.0** |

Table 80. Watana Creek Reach 4 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 3 | 37 | 47 | 13 | 0 |
| Riffle (pocketwater) | 0 | 20 | 70 | 10 | 0 | 0 |
| Run | 0 | 0 | 10 | 80 | 10 | 0 |
| Run (pocketwater) | 0 | 40 | 50 | 10 | 0 | 0 |
| Scour Pool | 0 | 13 | 40 | 30 | 17 | 0 |
| Backwater Pool | 0 | 0 | 40 | 30 | 30 | 0 |
| Slough | 0 | 0 | 0 | 0 | 50 | 50 |
| Beaver Complex | 0 | 0 | 0 | 0 | 50 | 50 |
| Percolation Channel | | | | | | |

Table 81. Watana Creek Reach 6 – Mainstem Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | | | | | | | | | | | | | | | | |
| Riffle | 460 | 62.8% | 3 | 60.0% | 8.7 | 12.0 | 2.0 | 0.3 | | | 0 | 0 | 2 | 0 | 0 | 5 |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Run | 273 | 37.2% | 2 | 40.0% | 11.0 | 16.0 | 2.0 | 0.5 | | | 3 | 0 | 7 | 0 | 0 | 0 |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | | | | | | | | | | | | | | | | |
| **TOTAL** | **733** | **100.0%** | **5** | **100.0%** | **10** | **13** | **2** | **0** | **-** | **-** | **1** | **0** | **4** | **0** | **0** | **3** |

Table 82. Watana Creek Reach 6 – Mainstem Riparian Vegetation

| Mainstem Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 5 | 733 | 100.0 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **TOTAL** | **5** | **733** | **100** |

Table 83. Watana Creek Reach 6 – Mainstem Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 13 | 37 | 47 | 3 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | 0 | 15 | 40 | 45 | 0 | 0 |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | | | | | | |

Table 84. Watana Creek Reach 6 – Side Channel Summary Statistics (Mapped Habitat Units)

| Unit Type | Total Length (m) | Length Rel Frequency | Number of Units | Number of Units (frequency) | Average Wetted Width (m) | Average Bankfull Width (m) | Average Stream Gradient (%) | Average Maximum Depth (m) | Average Pool Crest Depth (m) | Average maximum pool depth (m) | Average Left Bank Erosion (%) | Average Right Bank Erosion (%) | Average LWD (pieces/unit) | Average Right Undercut Bank (%) | Average Left Undercut Bank (%) | Average Cover (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cascade | 82 | 40.7 | 2 | 50 | 1.4 | 6.0 | 2.0 | 0.1 | | | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 20 |
| Riffle | | | | | | | | | | | | | | | | |
| Riffle (pocketwater) | | | | | | | | | | | | | | | | |
| Run | | | | | | | | | | | | | | | | |
| Run (pocketwater) | | | | | | | | | | | | | | | | |
| Scour Pool | | | | | | | | | | | | | | | | |
| Backwater Pool | | | | | | | | | | | | | | | | |
| Slough | | | | | | | | | | | | | | | | |
| Beaver Complex | | | | | | | | | | | | | | | | |
| Percolation Channel | 128 | 59.3% | 2 | 50.0% | 1.3 | 2.8 | 2.0 | 0.3 | | | 0 | 0 | 3 | 0 | 0 | 75 |
| **TOTAL** | **216** | 100.0% | **4** | 100.0% | **1** | **4** | **2** | **0** | - | - | **0** | **0** | **1** | **0** | **0** | **48** |

Table 85. Watana Creek Reach 6 – Side Channel Riparian Vegetation

| Side Channel Riparian Vegetation | Number | Length (m) | Relative Frequency (%) |
|---|---|---|---|
| Conifer Forest - Closed Canopy | | | |
| Conifer Forest - Open Canopy | | | |
| Broad leaf Forest - Closed Canopy | | | |
| Broad leaf Forest - Open Canopy | | | |
| Nonforest Shrub - Willow Dominant | 4 | 88 | 100 |
| Nonforest Shrub - Alder Dominant | | | |
| Nonforest Shrub - Other | | | |
| Nonforest Herbaceous - Estuarine | | | |
| Nonforest Herbaceous - Bog | | | |
| Nonforest Herbaceous - Fen | | | |
| Nonforest Herbaceous - Other | | | |
| None | | | |
| **Total** | **4** | **88** | **100** |

Table 86. Watana Creek Reach 6 – Side Channel Substrate

| Unit Type | Bedrock (%) | Boulder (%) | Cobble (%) | Gravel (%) | Sand/Silt (%) | Organic (%) |
|---|---|---|---|---|---|---|
| Cascade | | | | | | |
| Riffle | 0 | 0 | 30 | 45 | 25 | 0 |
| Riffle (pocketwater) | | | | | | |
| Run | | | | | | |
| Run (pocketwater) | | | | | | |
| Scour Pool | | | | | | |
| Backwater Pool | | | | | | |
| Slough | | | | | | |
| Beaver Complex | | | | | | |
| Percolation Channel | 0 | 5 | 20 | 30 | 30 | 15 |

Table 87. Mesohabitat Unit Descriptions for 2013

| Channel Type (# of channels) | Hydraulic Type | Mesohabitat Type | Definition |
|---|---|---|---|
| Single (1)<br><br>Split (2)<br><br>Channel Complex (3 or > channels) | Fast Water | Falls | Steep near vertical drop in water surface elevation greater than approximately 5 ft over a permanent feature, generally bedrock. |
| | | Cascade | A fast water habitat with turbulent flow; many hydraulic jumps, strong chutes, and eddies and between 30-80% white water. High gradient; usually greater than 4% slope. Much of the exposed substrate composed of boulders organized into clusters, partial bars, or step-pool sequences. [1] |
| | | Chute | An area where most of the flow is constricted to a channel much narrower than the average channel width. Laterally concentrated flow is generally created by a channel impingement or a laterally asymmetric bathymetric profile. Flow is fast and turbulent. |
| | | Rapid | Swift, turbulent flow including small chutes and some hydraulic jumps swirling around boulders. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Lower gradient and less dense concentration of boulders and white water than Cascade. Moderate gradient; usually 2.0-4.0% slope, occasionally 7.0-8.0%. [1] |
| | | Boulder Riffle | Same flow and gradient as Riffle but with numerous boulders that can create sub-unit sized pools or pocket water created by scour. |
| | | Riffle | A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross section.[1] Low gradient; usually 0.5-2.0% slope, rarely up to 6%. |
| | | Run/Glide | A habitat area with minimal surface turbulence with generally uniform depth that is greater than the maximum substrate size.[1] Velocities are on border of fast and slow water. Gradients are approximately 0 to less than 2%. Generally deeper than riffles with few major flow obstructions and low habitat complexity.[1] |
| | Slow Water | Pool | A slow water habitat with a flat surface slope and low water velocity that is deeper than the average channel depth. Substrate is highly variable. [1] |
| | | Pool subtypes | **Straight Scour Pool**: Formed by mid-channel scour. Generally with a broad scour hole and symmetrical cross section.[1] |
| | | | **Plunge Pool:** Formed by scour below a complete or nearly complete channel obstruction (logs, boulders, or bedrock). Pool must be Substrate is highly variable. Frequently, but not always, shorter than the active channel width.[1] |

| Channel Type (# of channels) | Hydraulic Type | Mesohabitat Type | Definition |
|---|---|---|---|
| | | | **Lateral Scour Pool:** Formed by flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock). Asymmetrical cross section. Includes corner pools in meandering lowland or valley bottom streams.[1] |
| | | | **Backwater Pool:** Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble. Generally not as long as the full channel width. [1] |
| | | Beaver Pond | Water impounded by the creation of a beaver dam. Maybe within main, side, or off-channel habitats. [1] |
| | | Alcove | An off-channel habitat that is laterally displaced from the general bounds of the active channel and formed during extreme flow events or by beaver activity; not scoured during typical high flows. Substrate is typically sand and organic matter. Generally not as long as the full channel width. An alcove is differentiated from a backwater being more protected and not scoured at high flows whereas a backwater is part of the active channel and is scoured at high flows [1] |
| | Off-channel | Percolation channel | A slough characterized by groundwater percolation through the floodplain that comes from mainstem stream channel. Upstream surface connection to active channel cut off due to accumulation of sediment/debris at the upstream end. Upstream surface water connection to the active channel present only during high flows. |

Table 88. Upper River tributaries and mainstem Susitna River sections aerial videotaped in 2012

| Name | Stream Section | Confluence | Date Videotaped | Time Start | Time End | Rivermile Start | Rivermile End |
|---|---|---|---|---|---|---|---|
| Oshetna River | RM 0.0 to RM 15.6 | Upper River Left Bank at RM 233.5 | 9/8/2012 | 1:40 PM | 2:24 PM | 0.0 | 15.6 |
| Black River | RM 0.0 to RM 3.4 | Oshetna River Left Bank at RM 12.7 | 9/8/2012 | 3:08 PM | 3:19 PM | 0.0 | 3.4 |
| Goose Creek | RM 0.0 to RM 7.8 | Upper River Left Bank at RM 231.0 | 9/8/2012 | 3:26 PM | 3:52 PM | 0.0 | 7.8 |
| Jay Creek | RM 0.0 to RM 10.4 | Upper River Right Bank at RM 208.6 | 9/9/2012 | 12:00 PM | 12:40 PM | 0.0 | 10.4 |
| Jay Creek Tributary | RM 0.0 to RM 1.9 | Jay Creek Right Bank at RM 8.1 | 9/9/2012 | 12:42 PM | 12:51 PM | 0.0 | 1.9 |
| Kosina Creek | RM 22.1 to RM 0.0 | Upper River Left Bank at RM 206.8 | 9/9/2012 | 4:39 PM | 5:45 PM | 22.1 | 0.0 |
| Watana Creek | RM 0.0 to RM 18.4 | Upper River Right Bank at RM 194.1 | 9/9/2012 | 1:50 PM | 2:50 PM | 0.0 | 18.4 |
| Watana Creek Tributary | RM 0.0 to RM 3.0 | Watana Creek Right Bank at RM 8.7 | 9/9/2012 | 2:55 PM | 3:05 PM | 0.0 | 3.8 |
| Deadman Creek | RM 0.0 to RM 21.0 | Upper River Right Bank at RM 186.6 | 9/10/2012 | 3:09 PM | 3:53 PM | 0.0 | 21.0 |
| Tsusena Creek | RM 0.0 to RM 4.2 | Middle River Right Bank at RM 181.8 | 9/10/2012 | 4:23 PM | 4:39 PM | 0.0 | 4.2 |
| Tributary 181.2 | RM 0.0 to RM 1.8 | Middle River Right Bank at RM 181.2 | 9/10/2012 | 4:42 PM | 4:51 PM | 0.0 | 1.8 |
| Fog Creek | RM 0.0 to RM 17.9 | Middle River Left Bank at RM 176.6 | 9/10/2012 | 11:53 AM | 1:33 PM | 0.0 | 17.9 |
| Fog Creek Tributary L1 | RM 7.3 to RM 0.0 | Fog Creek at RM 5.2 | 9/10/2012 | 2:08 PM | 2:31 PM | 7.3 | 0.0 |
| Devil Creek | RM 0.0 to RM 2.5 | Middle River Right Bank at RM 161.5 | 9/7/2012 | 12:02 PM | 12:12 PM | 0.0 | 2.5 |

| Name | Stream Section | Confluence | Date Videotaped | Time Start | Time End | Rivermile Start | Rivermile End |
|---|---|---|---|---|---|---|---|
| Chinook Creek | RM 0.0 to RM 3.1 | Middle River Left Bank RM 157.0 | 9/12/2012 | 3:31 PM | 4:49 PM | 0.0 | 7.1 |
| Cheechako Creek | RM 0.0 to RM 1.8 | Middle River Left Bank at RM 152.4 | 9/12/2012 | 5:14 PM | 5:21 PM | 0.0 | 1.8 |
| Upper River Mainstem | RM 184 to RM 233.5 | -- | 9/07-08/2012 | 12:18 PM | 3:15 PM | -- | -- |
| Middle River Mainstem | RM 98.5 to RM 184 | -- | 9/07 and 9/11/2012 | 12:00 PM | 3:30 PM | -- | -- |
| Lower River Mainstem | RM 65.0 to RM 81.0 | -- | 9/12/2012 | 11:45 AM | 2:00 PM | -- | -- |

# 6. FIGURES

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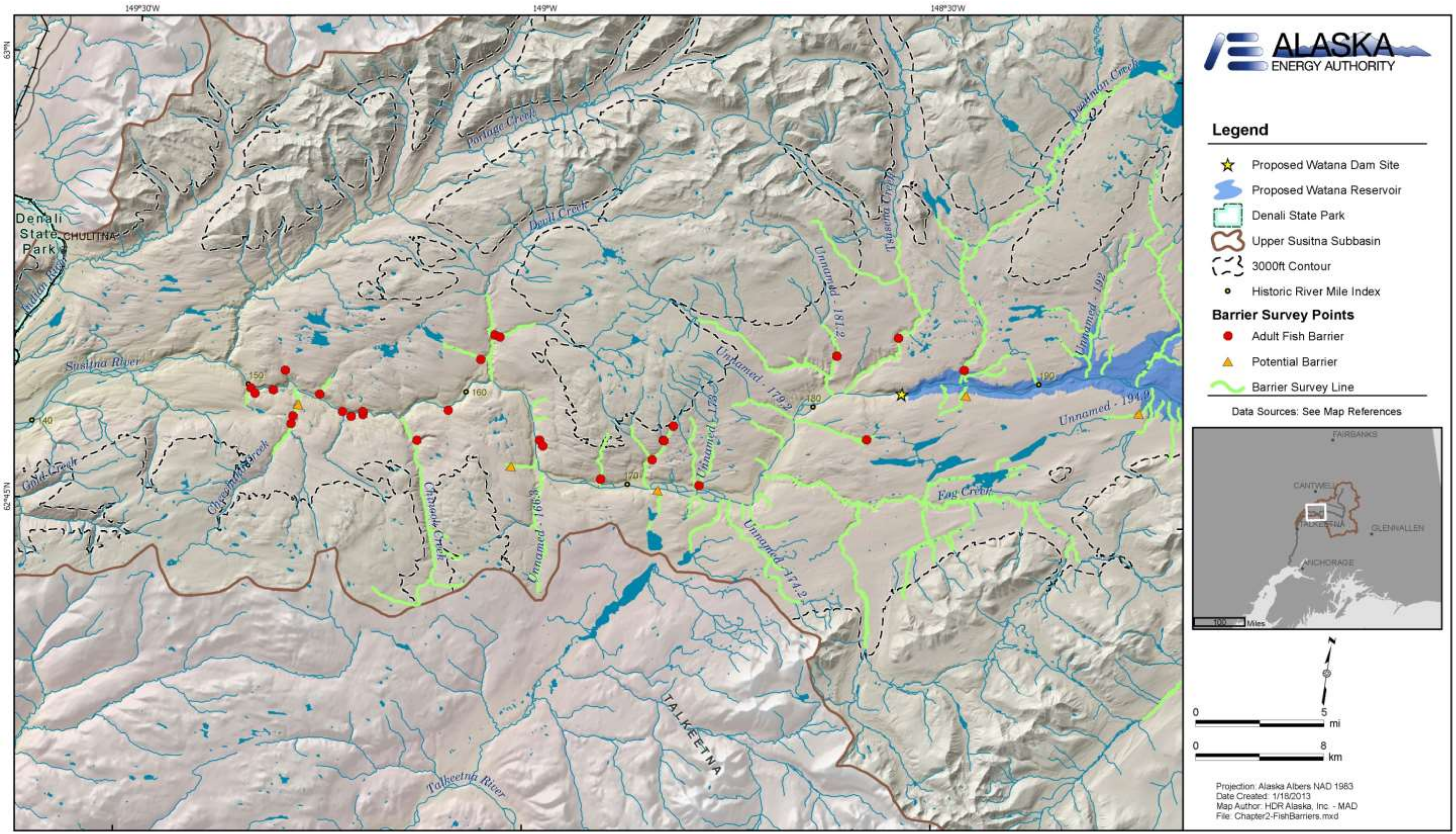


Figure 1 – Fish passage barriers survey extent and locations within the eastern half of the study area.

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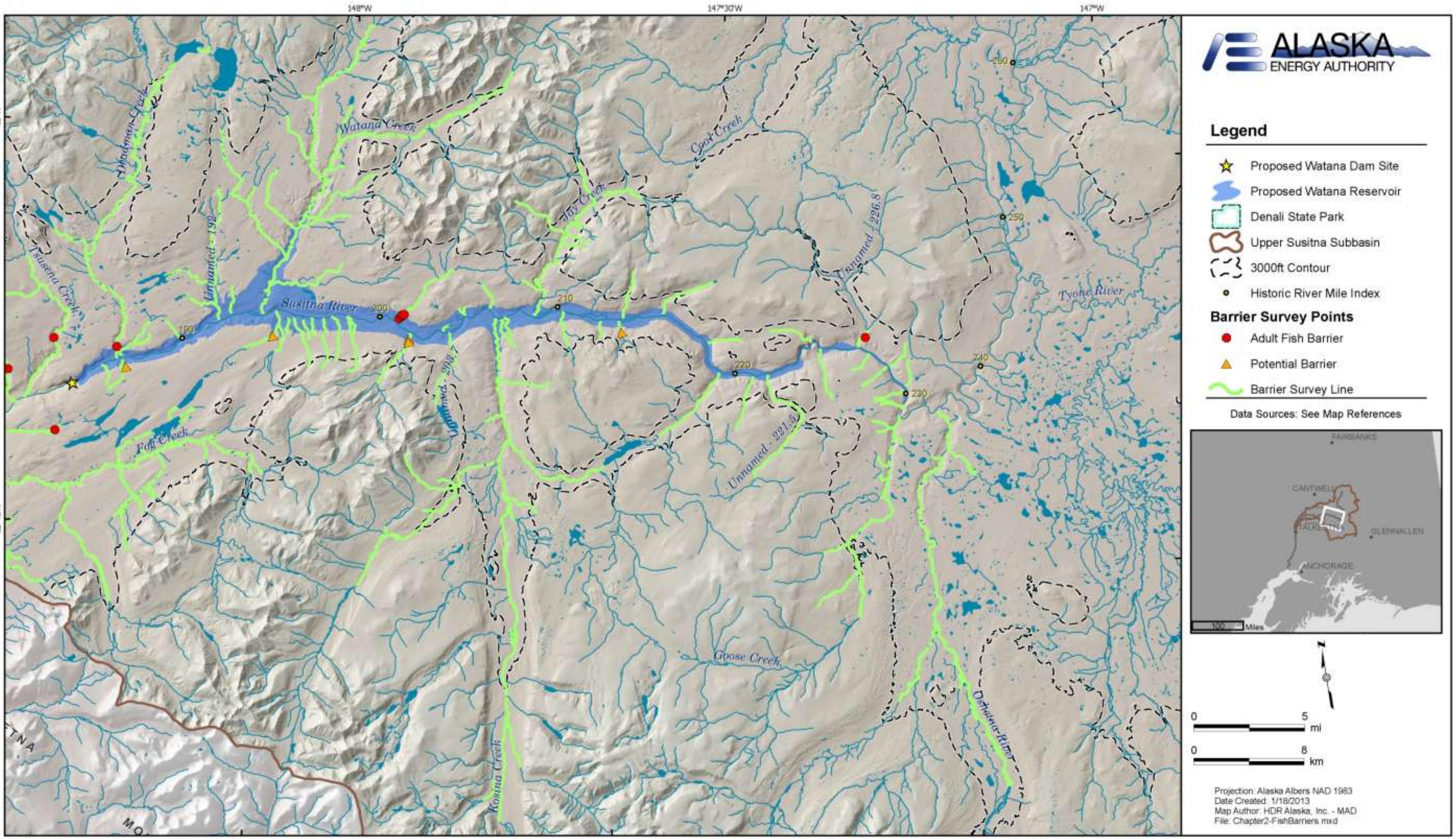


Figure 2 – Fish passage barriers survey extent and locations within the western half of the study area.

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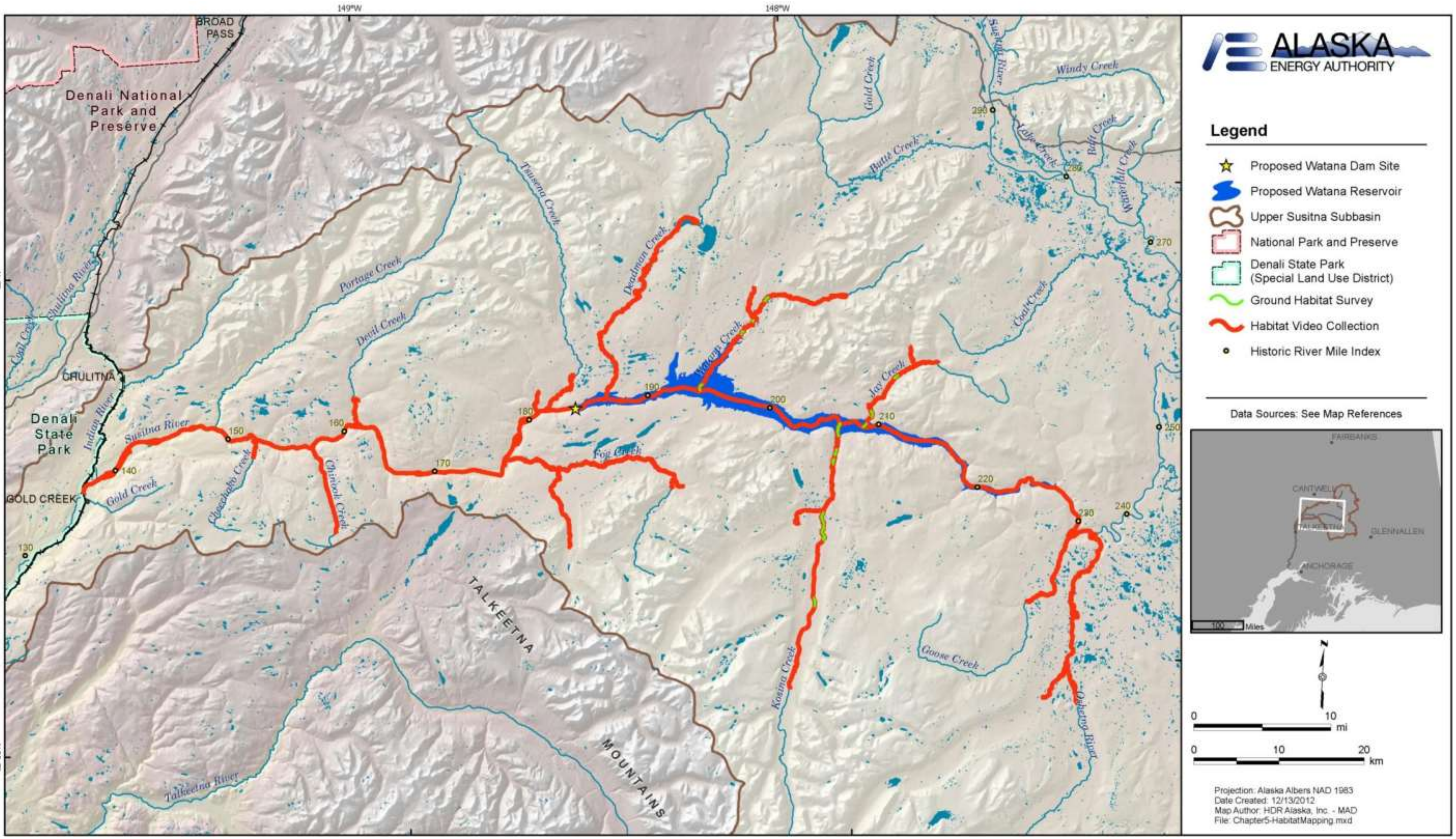


Figure 3 – Study Area map with streams where data were collected highlighted.

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Figure 4 – Jay Creek Reach Map.

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Figure 5 – Jay Creek Reach 1 Mesohabitat Survey.

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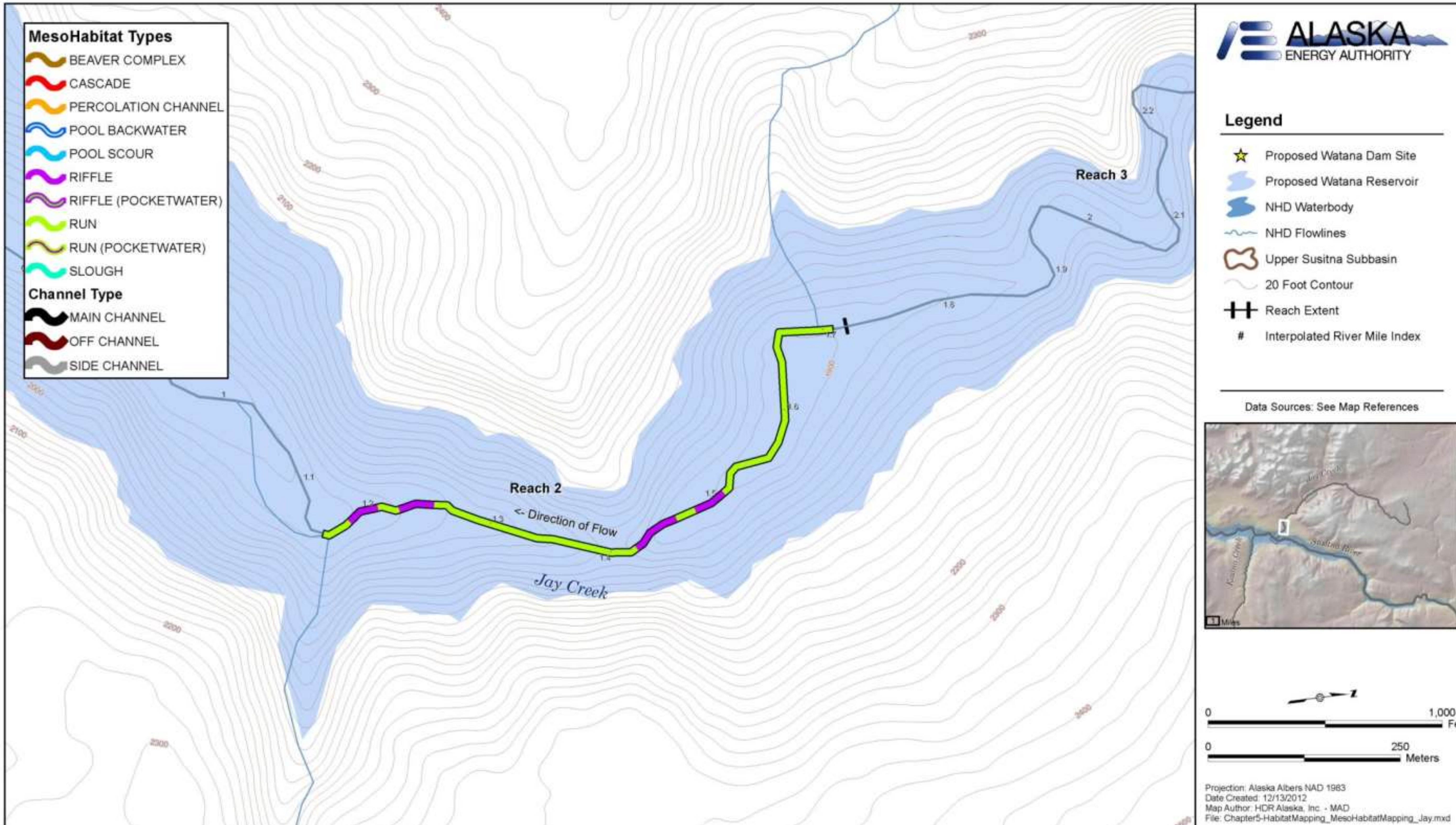


Figure 6 – Jay Creek Reach 2 Mesohabitat Survey.

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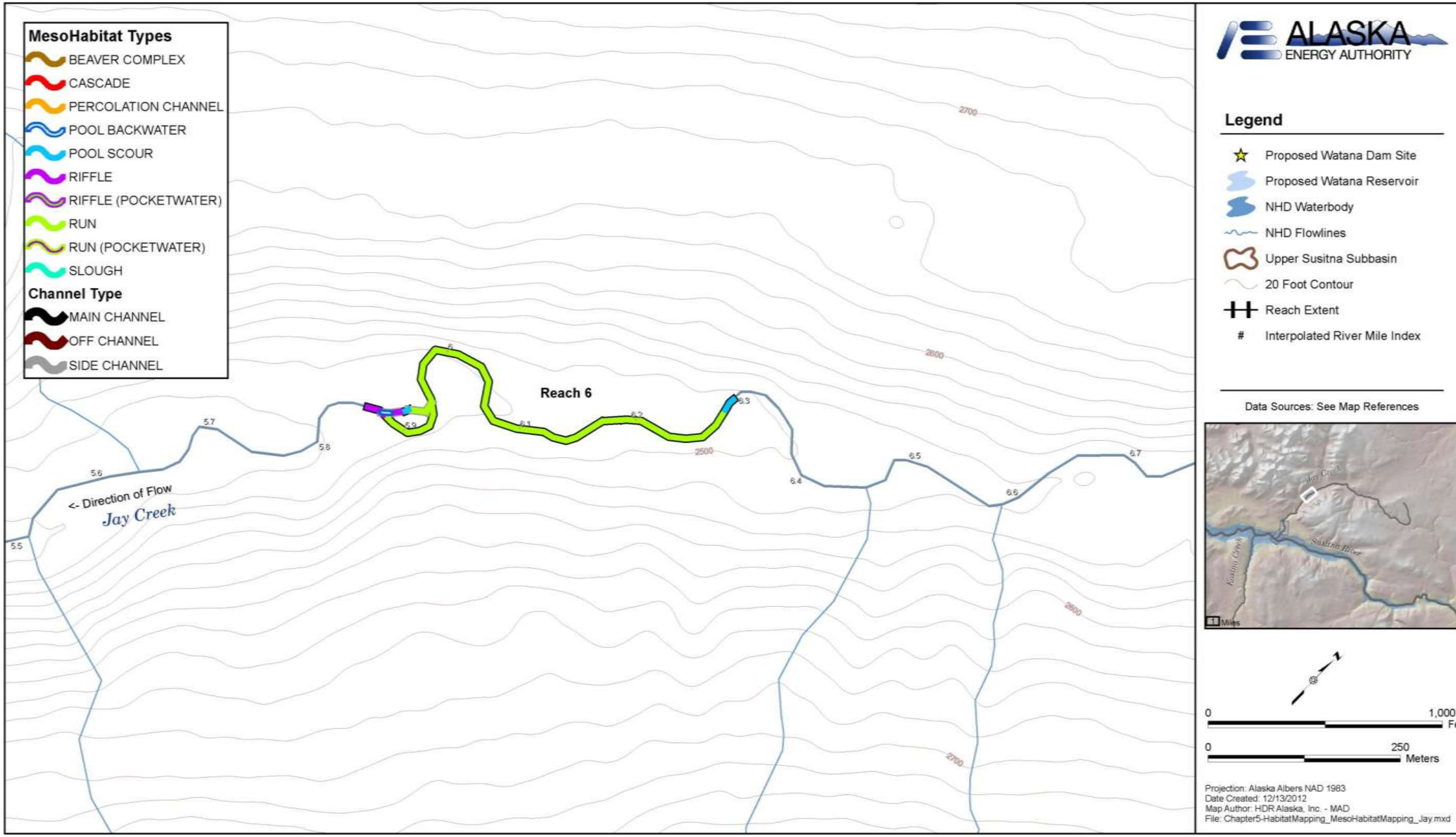


Figure 7 – Jay Creek Reach 6 Mesohabitat Survey.

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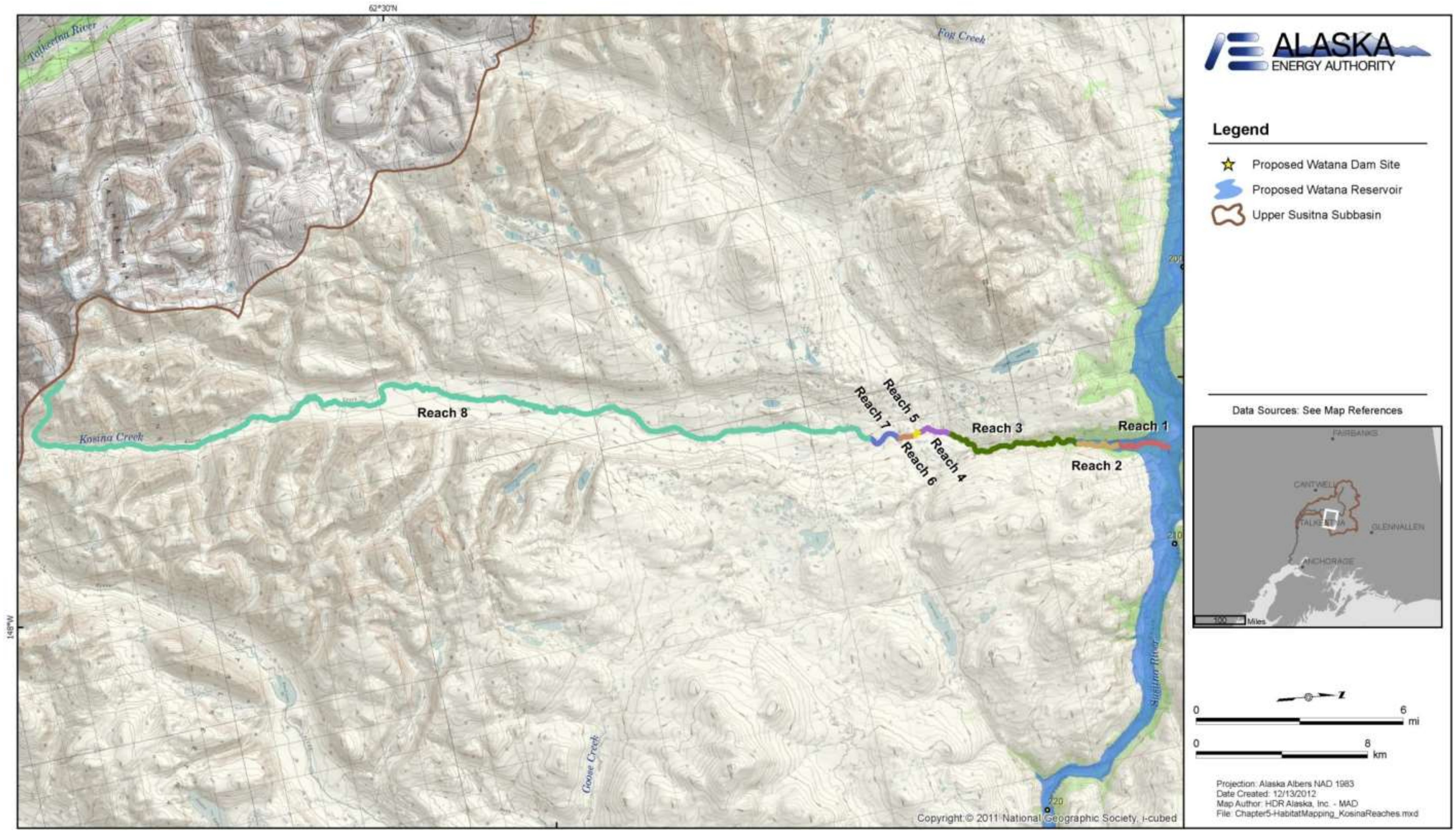


Figure 8 – Kosina Creek Reach Map.

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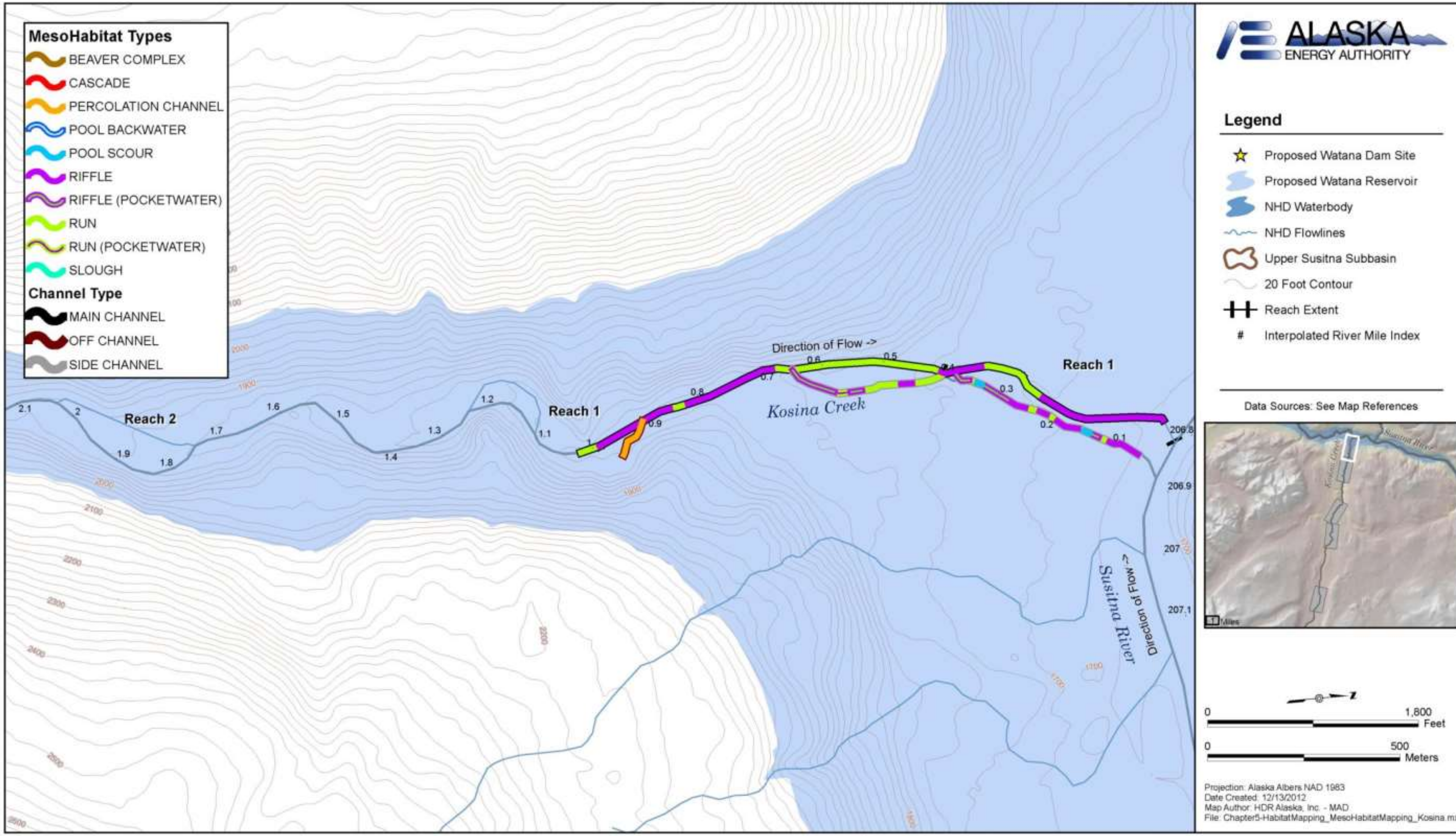


Figure 9 – Kosina Creek Reach 1 Mesohabitat Survey.

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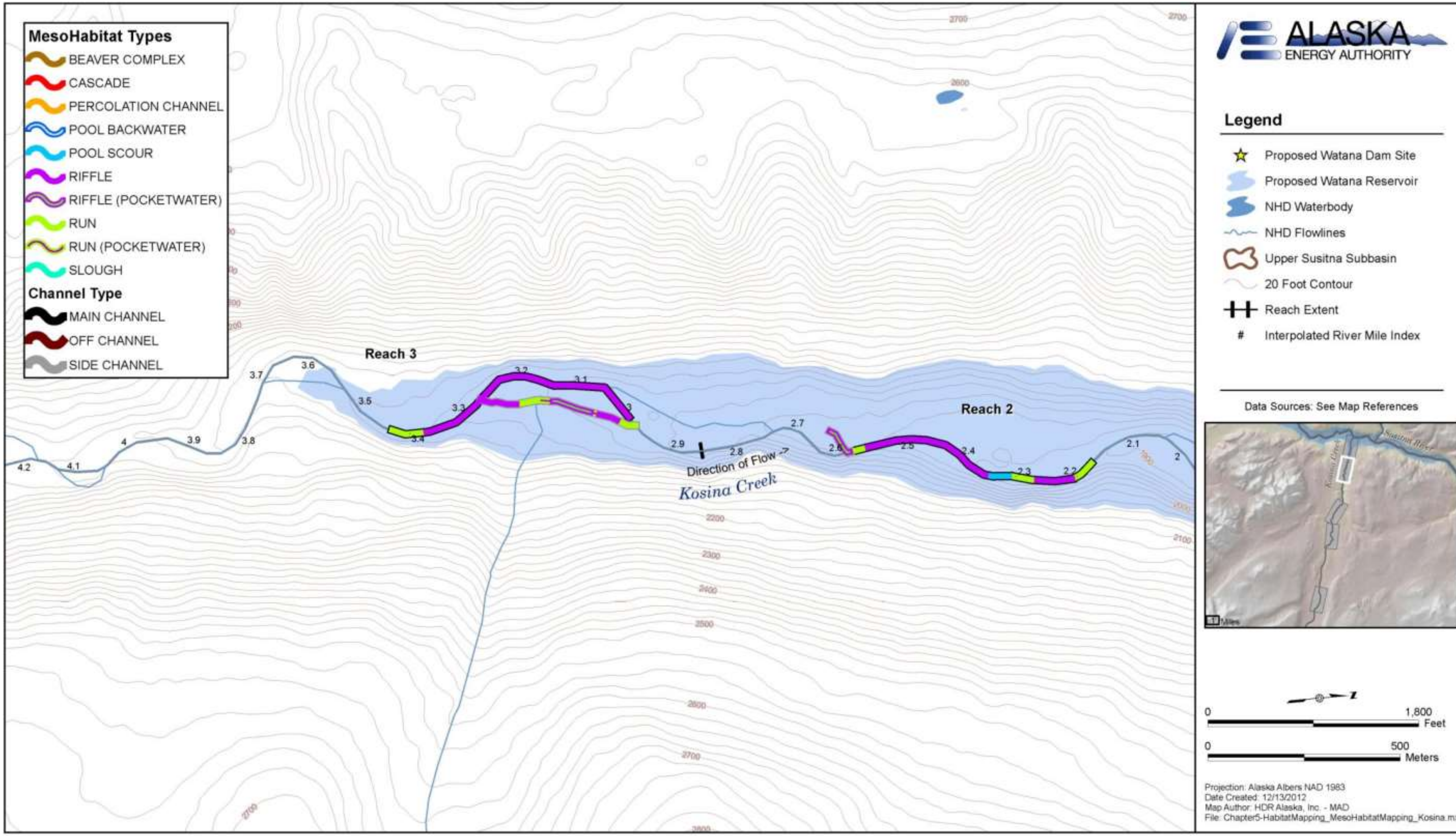


Figure 10 – Kosina Creek Reaches 2 and 3 Mesohabitat Surveys.

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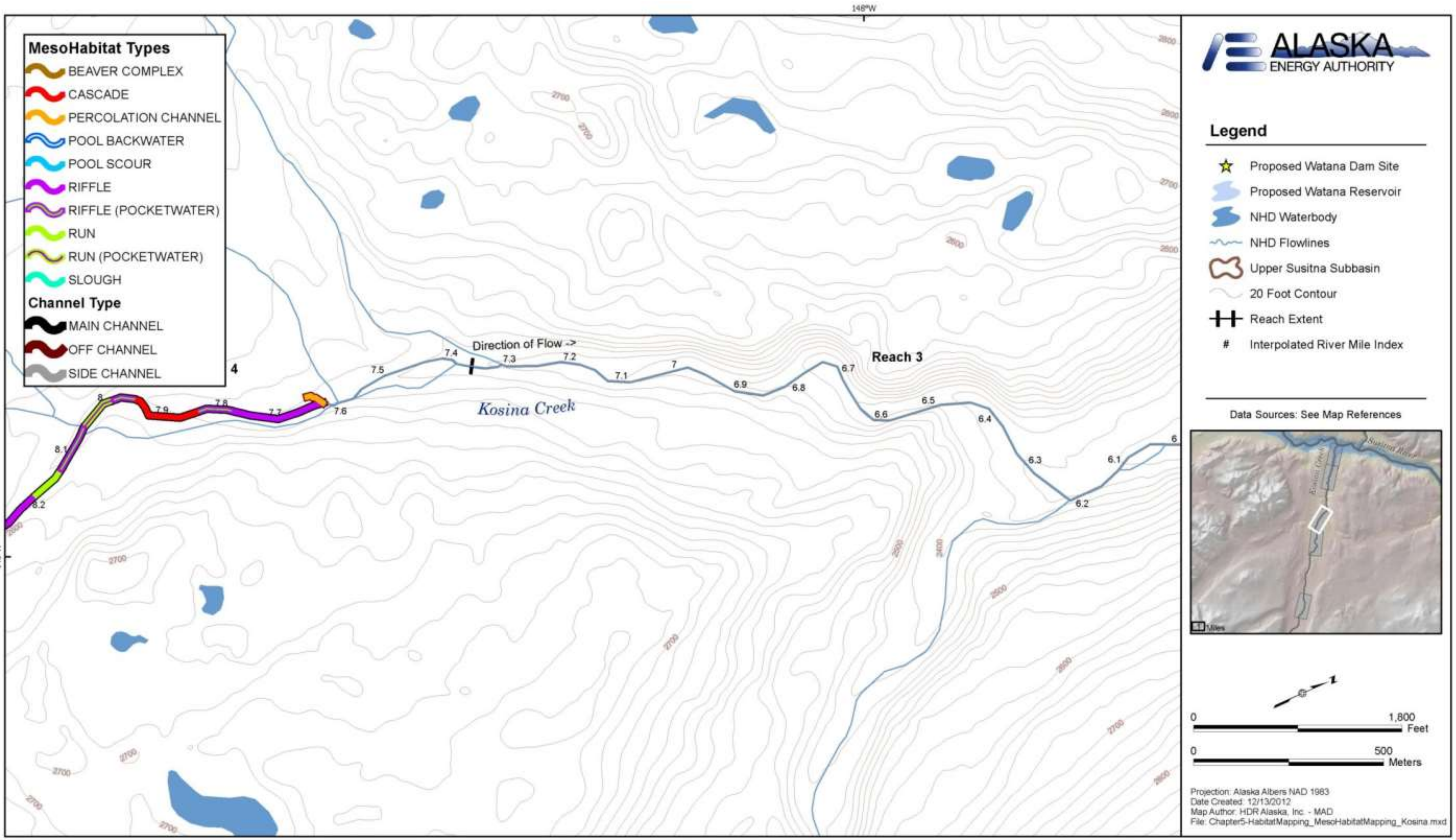


Figure 11 – Kosina Creek Reach 4 Mesohabitat Units Surveyed.

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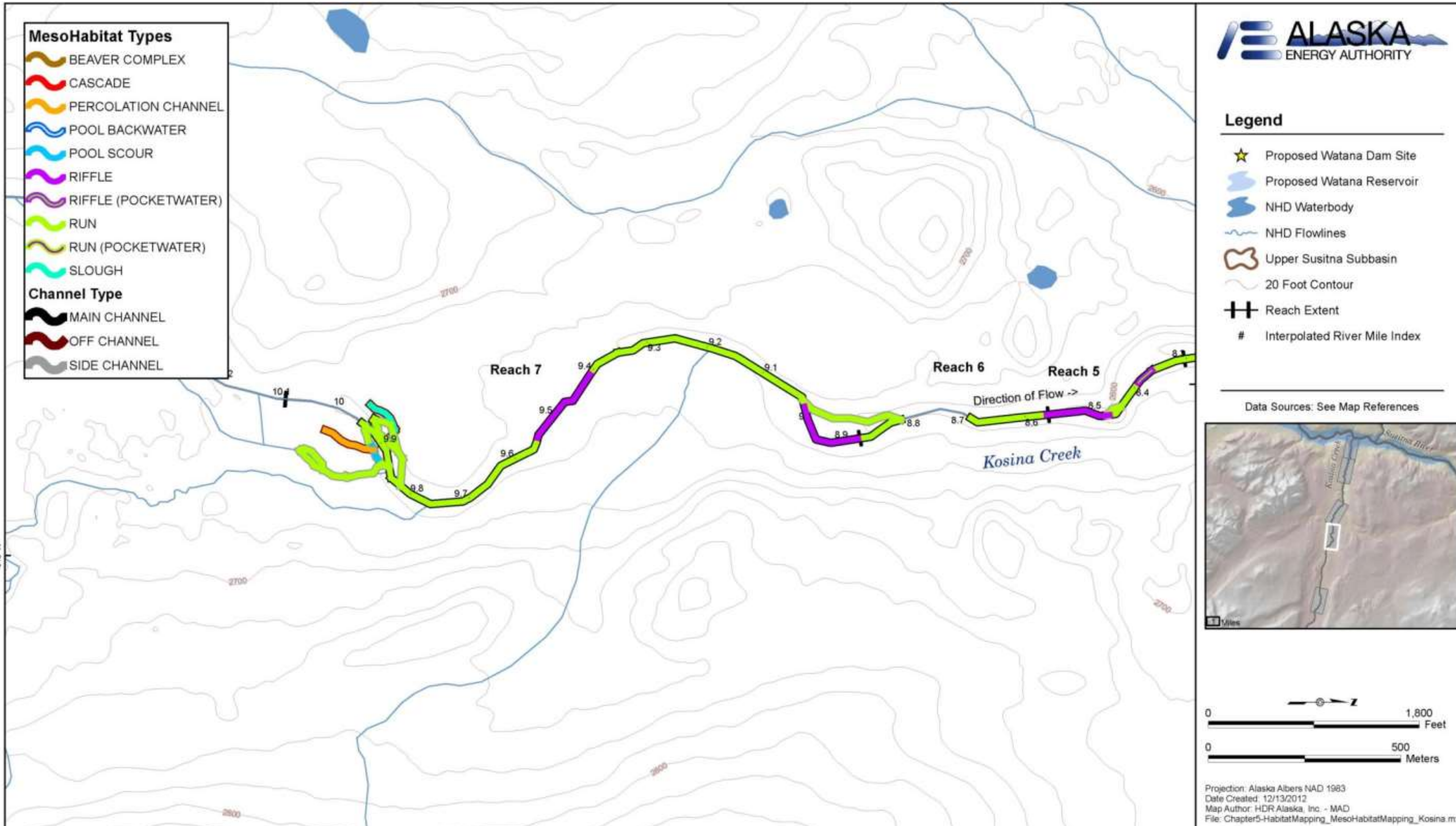


Figure 12 – Kosina Creek Reaches 5, 6, and 7 Mesohabitat Units Surveyed.

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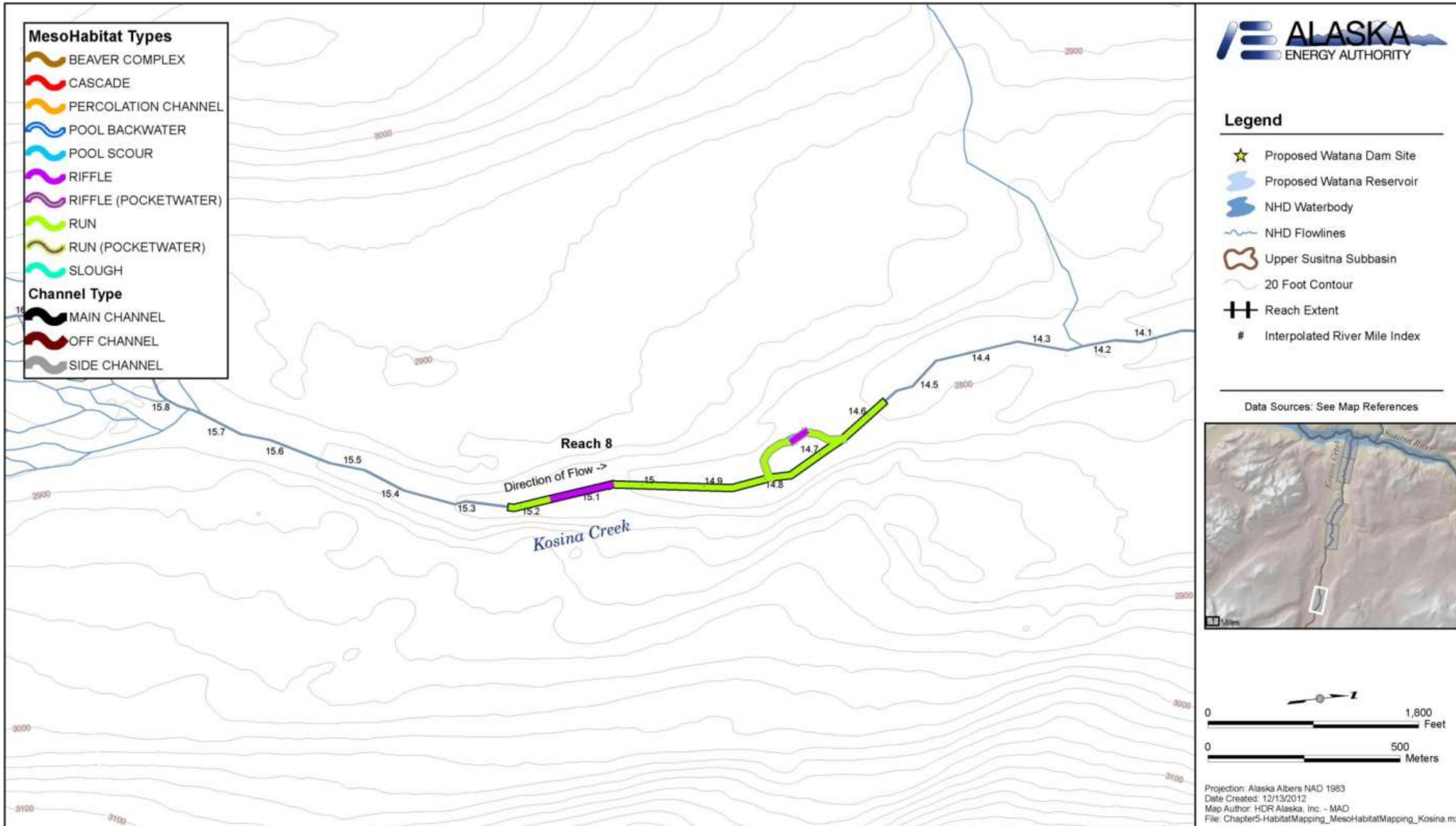


Figure 13 – Kosina Creek Reach 8 Mesohabitat Units Surveyed.

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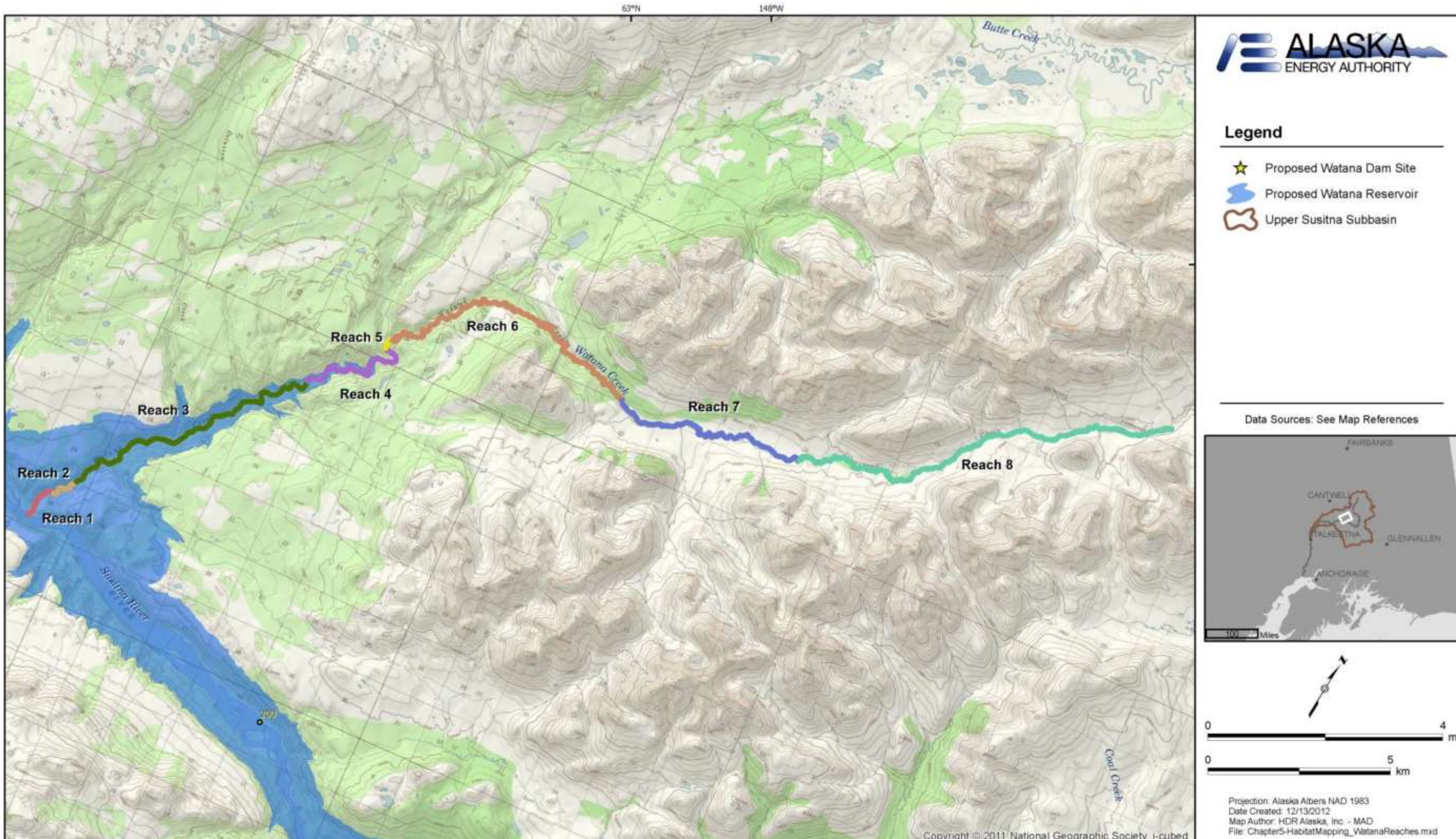


Figure 14 – Watana Creek Reaches.

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Figure 15 – Watana Creek Reach 1 Mesohabitat Units Surveyed.

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Figure 16 – Watana Creek Reaches 3 and 4 Mesohabitat Units Surveyed.

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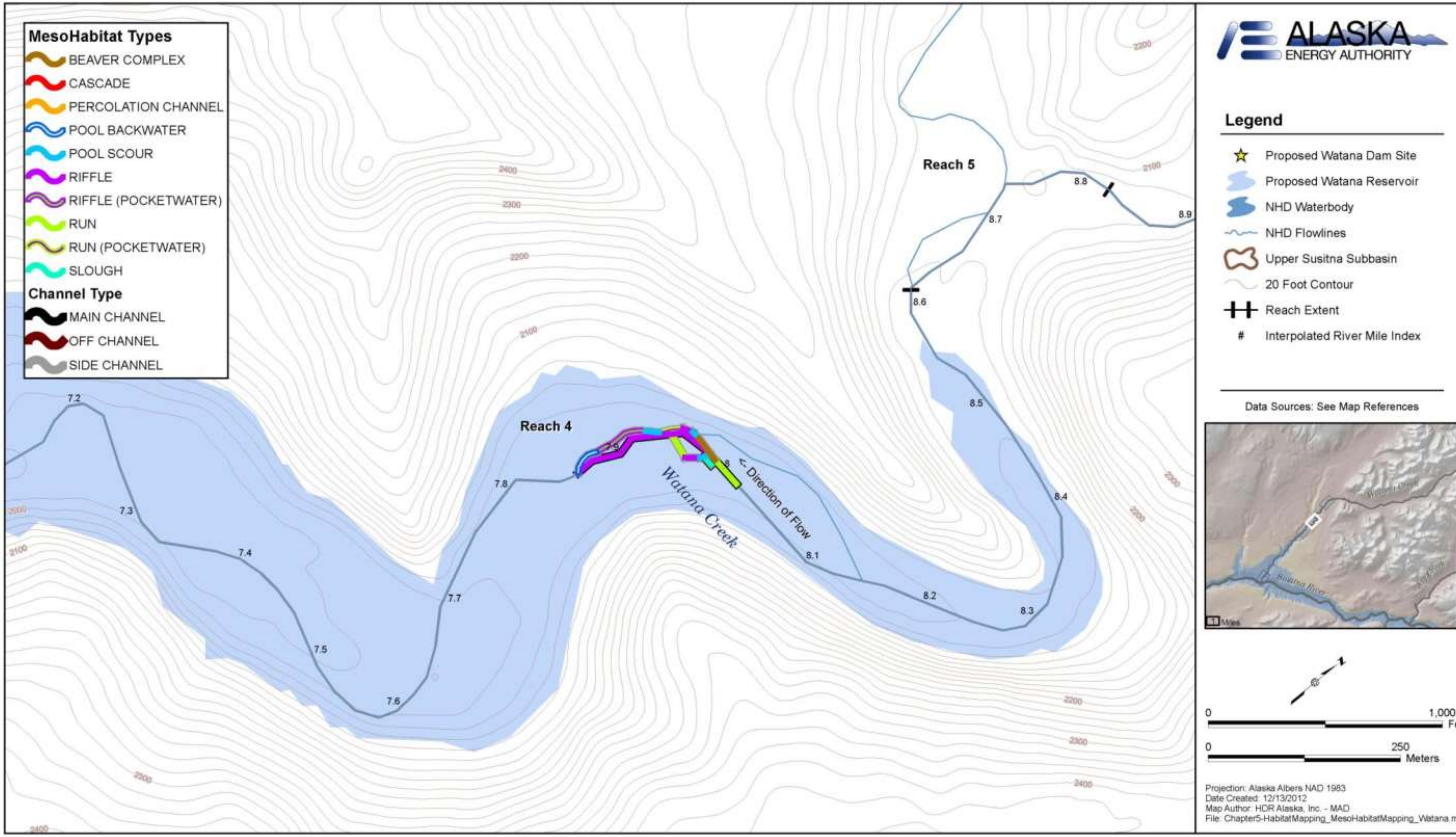


Figure 17 – Watana Creek Reach 4 Mesohabitat Units Surveyed.

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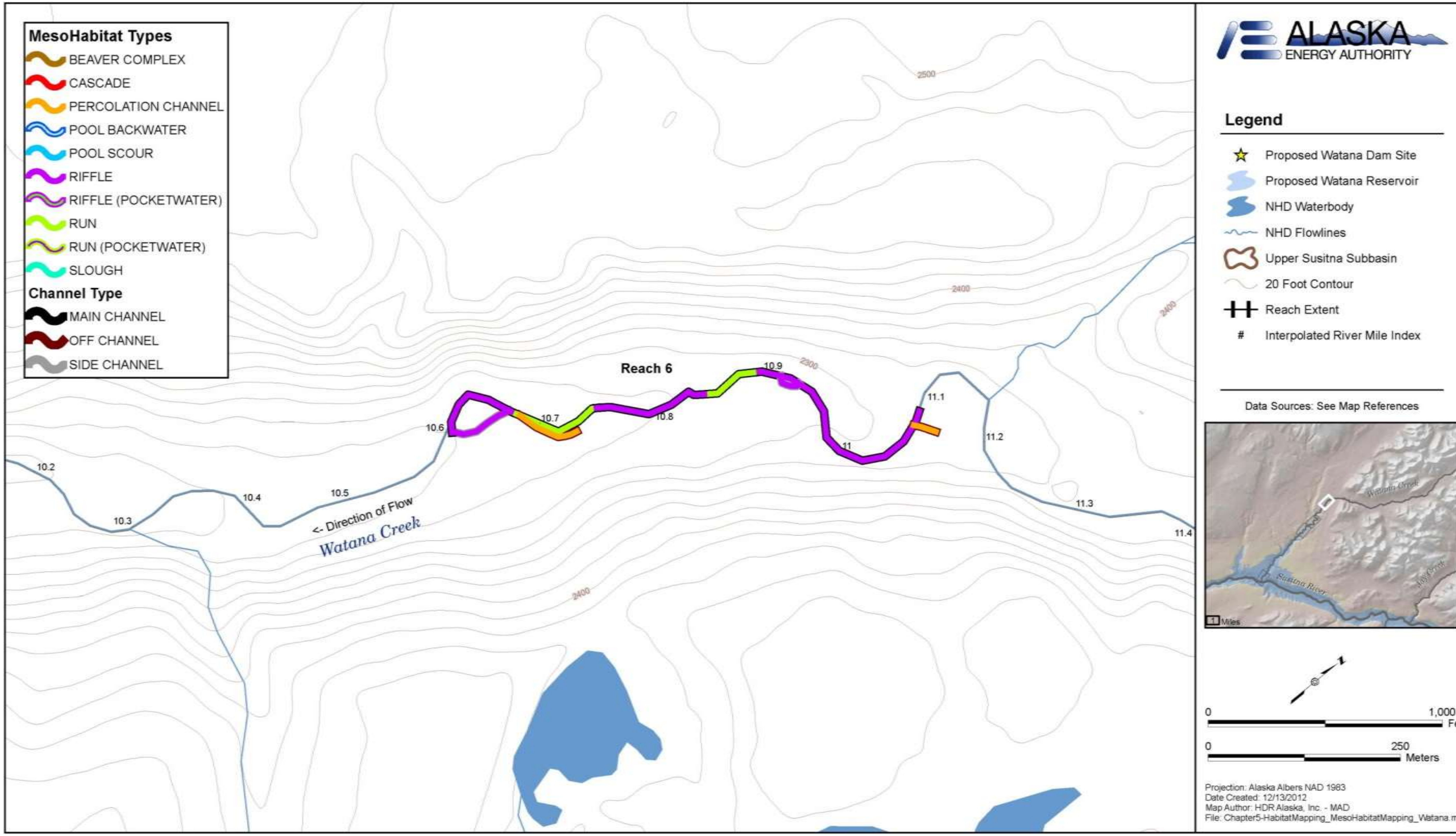


Figure 18 – Watana Creek Reach 6 Mesohabitat Units Surveyed.

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Figure 19 – Example video capture of a tributary mid-channel scour pool in a confined channel with boulder and cobble substrate and no stream wood visible.


Figure 20 – Example video capture of the Middle River in the vicinity of RM 100.5.

Figure 21 – Example video capture of the Lower River in the vicinity of RM 65.

Appendix A. Streams surveyed for fish passage barriers

| Tributary RM [1] | Tributary Name | Tributary Length (mile) [2] | Barrier(s) Present |
|---|---|---|---|
| 150.1 | Unnamed | 1.03 | Y |
| 150.2 | Unnamed | Na | Y |
| 151.0 | Unnamed | Na[b] | Y |
| 152.0 | Unnamed | Na | Y |
| 152.4 | Cheechako Creek | 10.67 | Y |
| 153.4 | Unnamed | 1.63 | Y |
| 154.5 | Unnamed | 5.35 | Y |
| 154.6 | Unnamed | Na | Y |
| 155.3 | Unnamed | Na | Y |
| 157.0 | Chinook Creek | 10.61 | Y |
| 158.8 | Unnamed | Na | Y |
| 161.5 | Devil Creek | 15.83 | Y |
| 163.5 | Unnamed | 0.91 | N |
| 164.0 | Unnamed | 0.62 | N |
| 165.0 | Unnamed | Na | Y |
| 165.2 | Unnamed | Na | Y |
| 165.6 | Unnamed | 1.57 | Y |
| 166.3 | Unnamed | 5.36 | N |
| 167.5 | Unnamed | 2.55 | N |
| 168.7 | Unnamed | Na | Y |
| 171.0 | Unnamed | 3.37 | Y |
| 171.3 | Unnamed | 2.54 | Y |
| 172.1 | Unnamed | 1.04 | N |
| 172.8 | Unnamed | 4.75 | N |
| 173.0 | Unnamed | 5.39 | Y |
| 174.0 | Unnamed | 5.45 | N |
| 174.2 | Unnamed | 8.63 | N |
| 174.5 | Unnamed | Na | N |
| 175.1 | Unnamed | 2.67 | N |
| 175.4 | Unnamed | 1.17 | N |
| 176.6 | Fog Creek | 27.81 | N |
| 176.9 | Unnamed | 0.72 | N |
| 177.9 | Unnamed | 2.89 | N |
| 179.1 | Unnamed | 3.79 | Y |
| 179.2 | Unnamed | 5.17 | N |
| 181.2 | Unnamed | 10.40 | Y |

| Tributary RM [1] | Tributary Name | Tributary Length (mile) [2] | Barrier(s) Present |
|---|---|---|---|
| 181.8 | Tsusena Creek | 30.70 | Y |
| 182.8 | Unnamed | Na | N |
| 185.8 | Unnamed | 1.19 | N |
| 186.6 | Deadman Creek | 41.91 | Y |
| 186.9 | Unnamed | 1.82 | Y |
| 189.9 | Unnamed | 3.32 | N |
| 192.0 | Unnamed | 7.08 | N |
| 192.7 | Unnamed | 1.46 | N |
| 194.0 | Unnamed | Na | N |
| 194.1 | Watana Creek | 26.91 | N |
| 194.9 | Unnamed | 5.38 | Y |
| 195.8 | Unnamed | 2.70 | N |
| 196.2 | Unnamed | 1.23 | N |
| 197.7 | Unnamed | 0.96 | N |
| 198.5 | Unnamed | 0.91 | N |
| 200.7 | Unnamed | 3.08 | Y |
| 201.8 | Unnamed | 6.15 | Y |
| 203.7 | Unnamed | 0.52 | N |
| 204.8 | Unnamed | 0.47 | N |
| 205.0 | Unnamed | 0.55 | N |
| 206.3 | Unnamed | 1.50 | N |
| 206.8 | Kosina Creek | 39.48 | N |
| 207.0 | Unnamed | 1.82 | N |
| 208.6 | Jay Creek | 19.63 | N |
| 210.2 | Unnamed | 2.07 | N |
| 211.6 | Unnamed | 1.89 | N |
| 212.0 | Unnamed | 0.92 | N |
| 213.0 | Unnamed | 2.01 | Y |
| 213.2 | Unnamed | 2.35 | N |
| 215.1 | Unnamed | 3.17 | N |
| 217.5 | Unnamed | 1.78 | N |
| 219.2 | Unnamed | 5.08 | N |
| 220.8 | Unnamed | 2.69 | N |
| 221.0 | Unnamed | Na | N |
| 221.5 | Unnamed | 9.54 | N |
| 224.3 | Unnamed | 2.21 | N |
| 225.0 | Unnamed | 2.49 | N |
| 226.8 | Unnamed | 9.23 | Y |
| 227.4 | Unnamed | 1.31 | N |

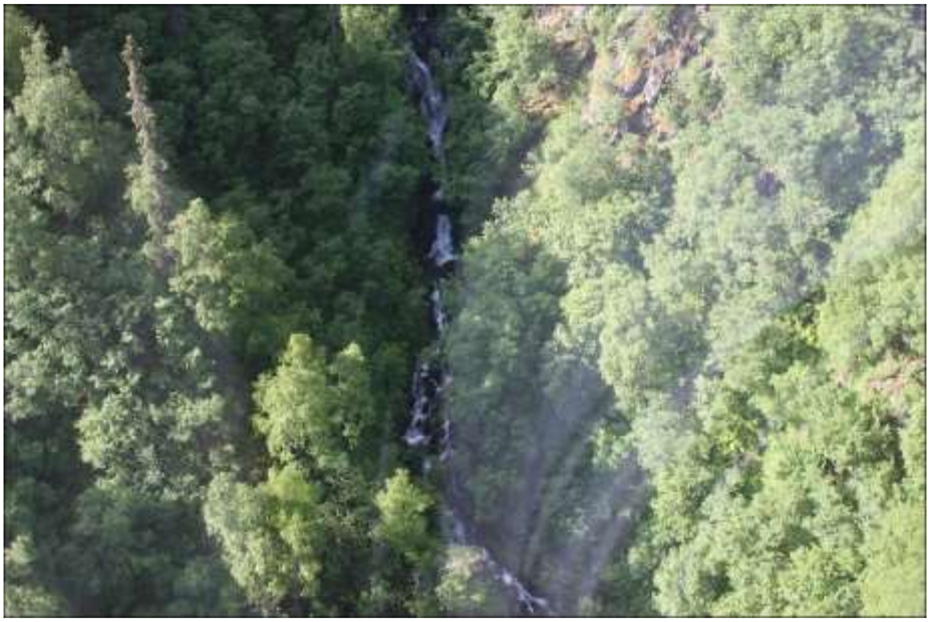
| Tributary RM [1] | Tributary Name | Tributary Length (mile) [2] | Barrier(s) Present |
|---|---|---|---|
| 228.5 | Unnamed | 1.54 | N |
| 229.8 | Unnamed | 1.52 | N |
| 231.2 | Goose Creek | 25.16 | N |
| 233.5 | Oshetna River | 55.59 | N |

Notes:

1 Tributary streams are designated by the Susitna River historic river mile (RM) at the point of confluence. RMs have been previously designated at one-mile intervals. The tenths increments were created by interpolating between RMs in the Geographic Information System (GIS). If the river had many curves between RMs, the RM listed here may not be accurate to the tenth of a mile.

2 Some streams were not mapped in the National Hydrology Dataset used in the GIS. These streams are likely less than 1 mile in length.

# Appendix B. Fish Passage Barriers – Photos



| | | | |
|---|---|---|---|
| **ID:** | PB150.1-A | **Tributary Name** | RM 150.1 -Unnamed Tributary |
| **Lat.** | 62.81589495 | **Classification** | Compound |
| **Long.** | 149.34939788 | **Vertical distance** | Estimated <10 ft |
| **Notes:** | Devils Canyon tributary on river left, Barrier just upstream from mouth, with cascades and chutes above and below. Fish habitat limited by steep gradient, large substrate and limited flows. | | |

| | | | |
|---|---|---|---|
| **ID:** | PB150.2-A | **Tributary Name** | RM 150.2 - Unnamed Tributary |
| **Lat.** | 62.81305533 | **Classification** | Complex chute |
| **Long.** | 149.34386875 | **Vertical distance** | Not Measured |

| | |
|---|---|
| **Notes:** | Devils Canyon tributary on river left. Very small stream channel. Chute observed is a likely barrier. Fish habitat limited by steep gradient, large substrate and limited flows. |

| | | | |
|---|---|---|---|
| **ID:** | PB151.0-A | **Tributary Name** | RM 151.0 - Unnamed Tributary |
| **Lat.** | 62.81536144 | **Classification** | Compound |
| **Long.** | 149.32170373 | **Vertical distance** | Not Measured |
| **Notes:** | Devils Canyon tributary on river left, steep, small stream with complex of chutes and falls. Fish habitat limited by steep gradient, large substrate and limited flows. | | |

| | | | |
|---|---|---|---|
| **ID:** | PB152.0-A | **Tributary Name** | RM 152.0 - Unnamed Tributary |
| **Lat.** | 62.82655011 | **Classification** | Compound |
| **Long.** | -149.30729105 | **Vertical distance** | 10 |

| | | | |
|---|---|---|---|
| **Notes:** | Devils Canyon tributary on river right. Small, steep right bank stream, mostly continuous cascades/ boulders with chutes forming fixed permanent falls. Very little to no fish habitat due to steep gradient, large substrate and low flows. | | |

| | | | |
|---|---|---|---|
| **ID:** | PB152.4-A | **Tributary Name** | RM 152.4 - Cheechako Creek |
| **Lat.** | 62.80752495 | **Classification** | Compound |
| **Long.** | -149.28974974 | **Vertical distance** | Estimated 3-4 ft cascades |
| **Notes:** | Devils Canyon tributary on river left., Lowest potential barrier on Cheechako Creek. Fixed feature, may be seasonally driven by velocity with limited resting zones in continuous falls/cascades. | | |

| | | | |
|---|---|---|---|
| **ID:** | PB152.4-B | **Tributary Name** | RM 152.4 - Cheechako Creek |
| **Lat.** | 62.80096393 | **Classification** | Multiple Falls |

| | | | |
|---|---|---|---|
| **Long.** | -149.29625200 | **Vertical distance** | Estimated <10 ft |
| **Notes:** | Devils Canyon tributary on river left, Falls are a fixed permanent feature. Potential plunge pool barrier and limited landing zone or resting areas at falls crest. | | |

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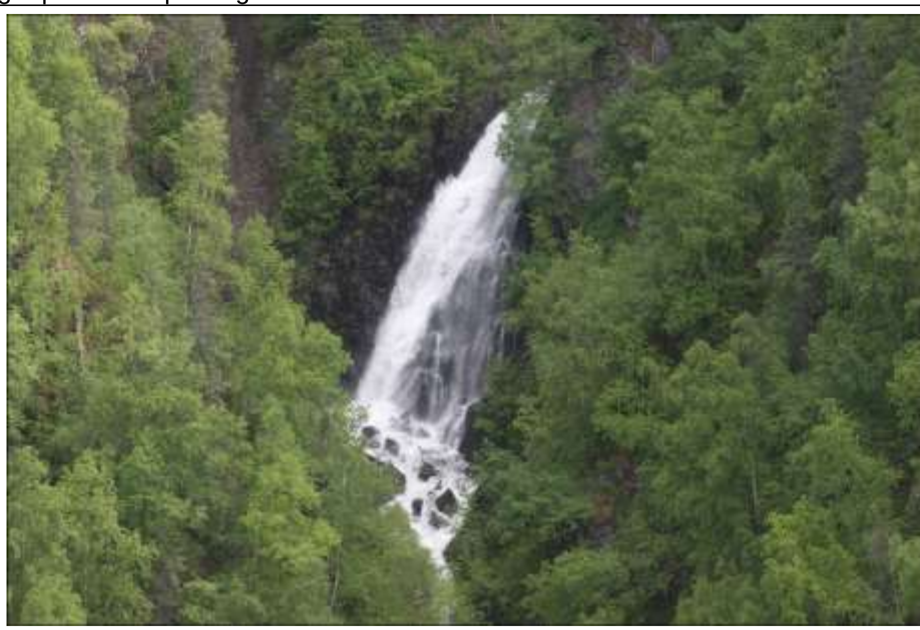
|---|---|---|---|
| **ID:** | PB152.4-C | **Tributary Name** | RM 152.4 - Cheechako Creek |
| **Lat.** | 62.79667441 | **Classification** | Single Falls |
| **Long.** | -149.29798035 | **Vertical distance** | Estimated <10 ft |
| **Notes:** | Devils Canyon tributary on river left, this barrier is located above PB152.4-A and PB152.4-B. Falls are a fixed permanent feature. Plunge pool (launch zone) probably adequate, but falls height precludes passage. | | |



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|---|---|---|---|
| **ID:** | PB153.4-A | **Tributary Name** | RM 153.4 - Unnamed Tributary |
| **Lat.** | 62.81374818 | **Classification** | Single Falls |

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|---|---|---|---|
| **Long.** | -149.26381957 | **Vertical distance** | Estimated <10 ft |
| **Notes:** | Devils Canyon tributary on river right, This large waterfall is a fixed permanent feature. | | |

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|---|---|---|---|
| **ID:** | PB154.5-A | **Tributary Name** | RM 154.5 - Unnamed Tributary |
| **Lat.** | 62.80442172 | **Classification** | Multiple Falls |
| **Long.** | -149.23537323 | **Vertical distance** | Estimated > 20 ft |
| **Notes:** | Devils Canyon tributary on river left, this shooting and  forceful falls on and incised cliff face is a permanent feature.. | | |

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|---|---|---|---|
| **ID:** | PB154.6-A | **Tributary Name** | RM 154.6 - Unnamed Tributary |
| **Lat.** | 62.80194419 | **Classification** | Complex Chute |
| **Long.** | -149.22433628 | **Vertical distance** | Estimated >10 ft |

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| **Notes:** | Devils Canyon tributary or river left, this chute is a fixed permanent feature. Flows cascade through continuous chutes over bedrock and provide no visible resting pools. |

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|---|---|---|---|
| **ID:** | PB155.3L-A | **Tributary Name** | RM 155.3L - Unnamed Tributary |
| **Lat.** | 62.80351697 | **Classification** | Compound |
| **Long.** | -149.21004421 | **Vertical distance** | Estimated 10 ft |
| **Notes:** | Devils Canyon tributary on river left, falls drop about 10 feet into a chute. Habitat also included runs and riffle through gentler gradient near flood plane. | | |

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|---|---|---|---|
| **ID:** | PB155.3L-B | **Tributary Name** | RM 155.3L - Unnamed Tributary |
| **Lat.** | 62.80296779 | **Classification** | Single Falls |
| **Long.** | -149.20975596 | **Vertical distance** | 12 |

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| **Notes:** | Devils Canyon tributary on river left, falls are a permanent fixed feature. |

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|---|---|---|---|
| **ID:** | PB155.3-C | **Tributary Name** | RM 155.3L - Unnamed Tributary |
| **Lat.** | 62.80482807 | **Classification** | Compound |
| **Long.** | -149.21028444 | **Vertical distance** | Not Measured |
| **Notes:** | Devils Canyon tributary on river right, fixed permanent barrier formed from continuous boulder cascades and falls. Few if any resting pools. | | |

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|---|---|---|---|
| **ID:** | PB157.0-A | **Tributary Name** | RM 157.0R1 - Chinook Creek right tributary |
| **Lat.** | 62.78970653 | **Classification** | Single Falls |
| **Long.** | -149.14252320 | **Vertical distance** | Estimated >10 ft |

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| **Notes:** | Devils Canyon tributary on river left, this falls is located in the first right bank tributary of Chinook Creek. Note, this prevents passage into this minor tributary of Chinook Creek, however the main stem of Chinook Creek is unobstructed. |

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| **ID:** | PB158.8-A | **Tributary Name** | RM 158.8 - Unnamed Tributary |
| **Lat.** | 62.80700158 | **Classification** | Compound |
| **Long.** | -149.10483657 | **Vertical distance** | Estimated 30 ft |
| **Notes:** | Devils Canyon tributary on river left, this small stream has continuous cascades, chutes, and falls that are fixed and permanent features. | | |

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|---|---|---|---|
| **ID:** | PB161.5-A | **Tributary Name** | RM 161.5 - Devil Creek |
| **Lat.** | 62.84993201 | **Classification** | Single Falls |

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|---|---|---|---|
| **Long.** | -149.05053257 | **Vertical distance** | Estimated 80 ft |
| **Notes:** | Middle River tributary on river right, this large and powerful waterfall is a fixed permanent feature. | | |
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| **ID:** | PB161.5-B | **Tributary Name** | RM 161.1L1 - Devil Creek |
| **Lat.** | 62.84898184 | **Classification** | Single Falls |
| **Long.** | -149.04413332 | **Vertical distance** | Estimated 40 ft |
| **Notes:** | Middle River tributary on river right, located a short distance up the first left tributary of Devil Creek this falls is a fixed permanent feature. | | |
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| **ID:** | PB161.5-C | **Tributary Name** | RM 161.5R1 - Devil Creek |

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|---|---|---|---|
| **Lat.** | 62.83612275 | **Classification** | Compound |
| **Long.** | -149.06697921 | **Vertical distance** | Not Measured |
| **Notes:** | Middle River tributary on river right, this feature is located on the first right tributary of Devil Creek. Continuous fast water through bedrock and boulder dominated high gradient chutes with 3-5’ falls. Few if any resting areas and pool launch zones. | | |

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|---|---|---|---|
| **ID:** | PB165.0-A | **Tributary Name** | RM 165.0 - Unnamed Tributary |
| **Lat.** | 62.79186479 | **Classification** | Single Falls |
| **Long.** | -148.99124284 | **Vertical distance** | Estimated 10 ft |
| **Notes:** | Middle River tributary on river right with small drainage basin and flow, permanent fixed falls on high gradient bedrock and boulder dominated slope. No plunge pool at bottom for launch. . | | |

| ID: | PB165.2-A | Tributary Name | RM 165.2 - Unnamed Tributary |
|---|---|---|---|
| Lat. | 62.78861395 | Classification | Compound |
| Long. | -148.98724426 | Vertical distance | Estimated 10 ft |
| Notes: | Middle River tributary on river right. Multiple falls with complex chutes and continuous whitewater and no resting locations. Barrier is a fixed permanent feature. | | |

| ID: | PB165.6-A | Tributary Name | RM 165.6 - Unnamed Tributary |
|---|---|---|---|
| Lat. | 62.77677745 | Classification | Single Falls |
| Long. | -149.02542533 | Vertical distance | Estimated 6 ft |
| Notes: | Middle River tributary on river left, potential barrier formed by fixed permanent falls with cascades downstream. But pool at base of falls appears to have adequate depth and area. Obstacle to fish movement but may not preclude upstream migration. | | |

| **ID:** | PB168.7-A | **Tributary Name** | RM 168.7 - Unnamed Tributary |
|---|---|---|---|
| **Lat.** | 62.77085261 | **Classification** | Compound |
| **Long.** | -148.91471154 | **Vertical distance** | Not Measured |
| **Notes:** | Middle River tributary on river right. Barrier is steep falls with cascade over bedrock on high gradient stream. | | |

| **ID:** | PB171.0-A | **Tributary Name** | RM 171.0 - Unnamed Tributary |
|---|---|---|---|
| **Lat.** | 62.80180564 | **Classification** | Single Falls |
| **Long.** | -148.82744847 | **Vertical distance** | Not Measured |
| **Notes:** | Middle River tributary on river right, This falls is located on the left most third order tributary near 3,000-foot elevation mark. | | |

| ID: | PB171.0-B | Tributary Name | RM 171.0 - Unnamed Tributary |
|---|---|---|---|
| Lat. | 62.79380126 | Classification | Single Falls |
| Long. | -148.83939503 | Vertical distance | Not Measured |
| Notes: | Middle River tributary river right, third order tributary near 3,000' elevation. Falls with cascades at tributary intersection along right bank form potential barrier. | | |

| ID: | PB171.0-C | Tributary Name | RM 171.0 - Unnamed Tributary |
|---|---|---|---|
| Lat. | 62.79336222 | Classification | Complex Falls |
| Long. | -148.83839238 | Vertical distance | Measured > 10 ft |
| Notes: | Middle River tributary on river right, This falls with boulder cascades is located on the first left main tributary.. | | |

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| **ID:** | PB171.3-A | **Tributary Name** | RM 171.3 - Unnamed Tributary |
| **Lat.** | 62.76574158 | **Classification** | Boulder Cascades |
| **Long.** | -148.84428754 | **Vertical distance** | Not Measured |
| **Notes:** | Middle River tributary on river left. This potential barrier is a very steep gradient cascade with chutes located a short distance just upstream of the confluence with the Susitna. | | |

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|---|---|---|---|
| **ID:** | PB173.0-A | **Tributary Name** | RM 173.0 - Unnamed Tributary |
| **Lat.** | 62.76887189 | **Classification** | Multiple Falls |
| **Long.** | -148.79380007 | **Vertical distance** | Estimated >10 ft |
| **Notes:** | Middle River tributary on river right, This permanent fixed feature has multiple falls through split bedrock and boulder channels. Plunge pool at bottom may have adequate depth, exit zone at crest is a chute with fast turbulent flow. | | |

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| **ID:** | PB179.1-A | **Tributary Name** | RM 179.1 - Unnamed Tributary |
| **Lat.** | 62.79672160 | **Classification** | Single Falls |
| **Long.** | -148.58887335 | **Vertical distance** | Measured 15 ft |
| **Notes:** | Middle River tributary on river left. Barrier is a single falls, which is a fixed permanent feature. | | |

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| **ID:** | PB181.2-A | **Tributary Name** | RM 181.2 - Unnamed Tributary |
| **Lat.** | 62.84338357 | **Classification** | Single Falls |
| **Long.** | -148.62792137 | **Vertical distance** | Estimate 30 ft |
| **Notes:** | Middle River tributary on river right. Single fixed permanent waterfall located on the left (north) tributary of this significant stream. The right (east) tributary is of similar size and lacks a barrier | | |

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|---|---|
| | falls.. |

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| **ID:** | PB181.8-A | **Tributary Name** | RM 181.8 - Tsusena Creek |
| **Lat.** | 62.85418021 | **Classification** | Single Falls |
| **Long.** | -148.55224796 | **Vertical distance** | Estimated 40 ft |
| **Notes:** | Middle River tributary river right. Large permanent fixed falls. | | |

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|---|---|---|---|
| **ID:** | PB186.6-A | **Tributary Name** | RM 186.6 - Deadman Creek |
| **Lat.** | 62.83697594 | **Classification** | Single Falls |
| **Long.** | -148.46997228 | **Vertical distance** | Estimated 40ft |
| **Notes:** | Upper River tributary on river right above the proposed Susitna Watana dam. Large fixed permanent falls, with fast, deep cascade and whitewater. Falls are located below the proposed maximum pool elevation. | | |

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| **ID:** | PB186.9-A | **Tributary Name** | RM 186.9 - Unnamed Tributary |
| **Lat.** | 62.82265043 | **Classification** | Complex Chute |
| **Long.** | -148.46660351 | **Vertical distance** | Not Measured |
| **Notes:** | Upper River tributary on river left upriver of the proposed Susitna Watana dam. Very shallow cascade near mouth of tributary. Stream gradient increases just upstream to continuous cascades over bedrock and boulder controlled chutes located very close to the proposed maximum pool elevation. Small drainage basin and resulting low flow provide very limited anadromous fish habitat. | | |

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| **ID:** | PB194.9-A | **Tributary Name** | RM 194.9 - Unnamed Tributary |
| **Lat.** | 62.81438545 | **Classification** | Multiple Falls |

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|---|---|---|---|
| **Long.** | -148.25308501 | **Vertical distance** | Measured 15 ft |
| **Notes:** | Upper River tributary on river left upstream of the proposed Susitna Watana dam. Multiple falls are fixed and permanent features, located slightly below the maximum pool elevation. There were no barriers observed upstream of this point. | | |

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| **ID:** | PB200.7-A | **Tributary Name** | RM 200.7 - Unnamed Tributary |
| **Lat.** | 62.80094826 | **Classification** | Single Falls |
| **Long.** | -148.07391445 | **Vertical distance** | Estimated 10 ft |
| **Notes:** | Upper River tributary on river right upstream of the proposed Susitna Watana dam. Fixed permanent single falls. The lowest of a series of falls below the maximum pool elevation. | | |

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| **ID:** | PB200.7-B | **Tributary Name** | RM 200.7 - Unnamed Tributary |
| **Lat.** | 62.80216187 | **Classification** | Single Falls |

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|---|---|---|---|
| **Long.** | -148.06896636 | **Vertical distance** | Estimated 40 ft |
| **Notes:** | Upper River tributary on river right upstream of the proposed Susitna Watana dam. Fixed permanent single falls. One of a series of falls below the maximum pool elevation. | | |

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|---|---|---|---|
| **ID:** | PB200.7-C | **Tributary Name** | RM 200.7 - Unnamed Tributary |
| **Lat.** | 62.80234527 | **Classification** | Single Falls |
| **Long.** | -148.06814351 | **Vertical distance** | Estimated >15’ |
| **Notes:** | Upper River tributary on river right upstream of the proposed Susitna Watana dam. Fixed permanent single falls. One of a series of falls below the maximum pool elevation. | | |

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| **ID:** | PB200.7-E | **Tributary Name** | RM 200.7 - Unnamed Tributary |
| **Lat.** | 62.80261927 | **Classification** | Single Falls |

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|---|---|---|---|
| **Long.** | -148.06462730 | **Vertical distance** | Estimated 20 ft |
| **Notes:** | Upper River tributary on river right upstream of the proposed Susitna Watana dam. Fixed permanent single falls. The uppermost of a series of falls below the maximum pool elevation. | | |

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|---|---|---|---|
| **ID:** | PB213.0-A | **Tributary Name** | RM 213.0 - Unnamed Tributary |
| **Lat.** | 62.74994580 | **Classification** | Single Falls |
| **Long.** | -147.77635488 | **Vertical distance** | Estimated >6 ft |
| **Notes:** | Upper River tributary on river left upstream of the proposed Susitna Watana dam. Single fixed permanent falls. Potential barrier as leaping distance may exce10 feet due to horizontal distance from falls crest to plunge pool. | | |

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| **ID:** | PB226.8-A | **Tributary Name** | RM 226.8 - Unnamed Tributary |
| **Lat.** | 62.69938029 | **Classification** | Compound |

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|---|---|---|---|
| **Long.** | -147.44758763 | **Vertical distance** | Estimated 15 ft |
| **Notes:** | Upper River tributary on river right upstream of the proposed Susitna Watana dam, Series of falls over bedrock and boulder substrate forming a fixed and permanent feature. | | |