Grant Lake Project
(FERC No. 13211 and 13212)

Aquatic Resources

Draft Study Plan

Prepared for:
Kenai Hydro, LLC
3977 Lake Street
Homer, AK 99603

Prepared by:

HDR Alaska, Inc.
2525 C Street, Suite 305
Anchorage, AK 99503

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List of Acronyms

ADF&G	Alaska Department of Fish and Game
AEIDC	Arctic Environmental Information and Data Center (University of Alaska)
AHRS	Alaska Heritage Resources Survey
APA	Alaska Power Authority
ARWG	Aquatic Resources Work Group
AWC	Anadromous Waters Catalog
BLM	Bureau of Land Management
°C	Degrees Celsius
cfs	cubic feet per second
cm	centimeter
CPUE	catch per unit effort
°F	Degrees Fahrenheit
DNR	Alaska Department of Natural Resources
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FL	Fork Length
fps	feet per second
ft	feet
G&A	general and administrative
GPS	global positioning system
GWh	gigawatt hours
HEP	Hydroelectric Evaluation Program
IFIM	instream flow incremental methodology
in	inch
KHI	Kenai Hydro Inc.
KHL	Kenai Hydro, LLC
KPB	Kenai Peninsula Borough
kWh	kilowatt hours
LLC	Limited liability company
mg/L	milligrams per liter
mi	mile

MIF	minimum instream flow
mm	millimeter
MSL	Mean sea level
MW	Megawatt
MWh	Megawatt hours
NWI	National Wetlands Inventory
O&M	Operations & maintenance
RM	river miles
RVDs	Recreation visitor days
TL	total length
TWG	technical working group
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
YOY	Young of the year

Aquatic Resources Draft Study Plan
Grant Lake Hydroelectric Project
(FERC No. 13211/13212)

1 Introduction

Kenai Hydro, LLC (KHL) received preliminary permits from the Federal Energy Regulatory Commission (FERC) for the study of proposed hydroelectric projects at Grant Lake/Grant Creek (FERC No. 13212) and Falls Creek (FERC No. 13211) in October 2008. The preliminary permits expire on September 30, 2011. On August 6, 2009, KHL filed a Pre-Application Document (PAD), along with a Notice of Intent to file an application for an original license for a combined Grant Lake/Falls Creek Project (FERC No. 13211/13212 ["Project" or "Grant Lake Project"]) under Part I of the Federal Power Act. On September 15, 2009, FERC approved the use of the Traditional Licensing Process for development of the license application and supporting materials. KHL is planning to file a License Application for the Project in September 2011.

The Project will be located near the community of Moose Pass, Alaska in the Kenai Peninsula Borough, approximately 25 miles north of Seward, Alaska, and just east of the Seward Highway (State Route 9) (Figure 1).

This Aquatic Resources study plan is designed to address information needs identified in the PAD, during the Traditional Licensing Process public comment process, and through early scoping conducted by FERC. A study report will be produced in early 2011. The study report will present existing information relative to the scope and context of potential effects of the Project. This information will be used to analyze Project impacts and propose protection, mitigation, and enhancement measures in the draft and final License Application for the Project.

Proposed Project Description

The PAD identified a preliminary Project facilities proposal, which includes a diversion dam at the outlet to Grant Lake, and a powerhouse along Grant Creek. The PAD Project proposal also included diverting water from Falls Creek into Grant Lake to provide additional flows and power generation at the Grant Creek powerhouse. The Falls Creek diversion has been removed from the Project proposal and associated impacts will not be studied. Portions of the Falls Creek preliminary permit area will continue to be studied for access and transmission routes associated with the Grant Lake Project.

The proposed Project (Figure 1) will use approximately 48,000 acre-feet of storage in Grant Lake during operations between pool elevations of approximately 675 and 709 feet mean sea level (MSL). Storage will be obtained by raising the natural level of Grant Lake using a low diversion at the outlet and drawing down Grant Lake below its natural water level. The proposed lake level will range from approximately 9 feet above up to 25 feet below the natural lake elevation. A multi-level intake will be constructed near the diversion structure. An approximate 2800-foot-long, 10-foot diameter horseshoe tunnel will convey water from the intake to directly above the powerhouse at about elevation 650 MSL. At the outlet of the tunnel a 650-foot-long section of penstock will convey water to the powerhouse located at about elevation 518 MSL. The tailrace will be located in order to minimize impacts to fish habitat by returning flows to

Grant Creek upstream of the most productive fish habitat. An existing mining road along Falls Creek will be extended in the area between Falls Creek and Grant Creek in order to access the Project. Two potential transmission line options will be investigated; an overhead line and an underground option. The transmission line corridor for each option would generally follow the access road grade.

2 Goals and Objectives

Together with existing information, the goal of the study effort described in this plan is to provide baseline information, and where applicable, information on alternative flow regimes, which will inform an assessment of potential Project impacts on aquatic resources in the study report. The impact assessments will inform potential protection, mitigation, and enhancement measures to be presented in the draft and final License Applications.

The objectives of this study are to provide supporting information on the potential resource impacts of the proposed Project that were identified during development of the PAD, public comment, and FERC scoping for the License Application, as follows:

- Impact of Project operation on sediment transport (relative to the availability of spawning gravels) due to changes in flow in Grant Creek.
- Impact of Project operation (fluctuating lake levels in Grant Lake, changes in seasonal flow in Grant Creek, reduced flows between the dam and powerhouse on Grant Creek) on fish abundance and distribution
- Impact of Project construction and operation on biological productivity and abundance of fish food organisms in Grant Creek and Grant Lake.
- Impact of Project intake structure operation on fish populations.
- Impact of Project construction on fish habitat in Grant Creek.
- Impact of Project facilities (increased access) on fish populations due to potential increased recreational fishing.
- Impact of Project construction and operation on commercial, sport, and subsistence fisheries supported by the Kenai River watershed.

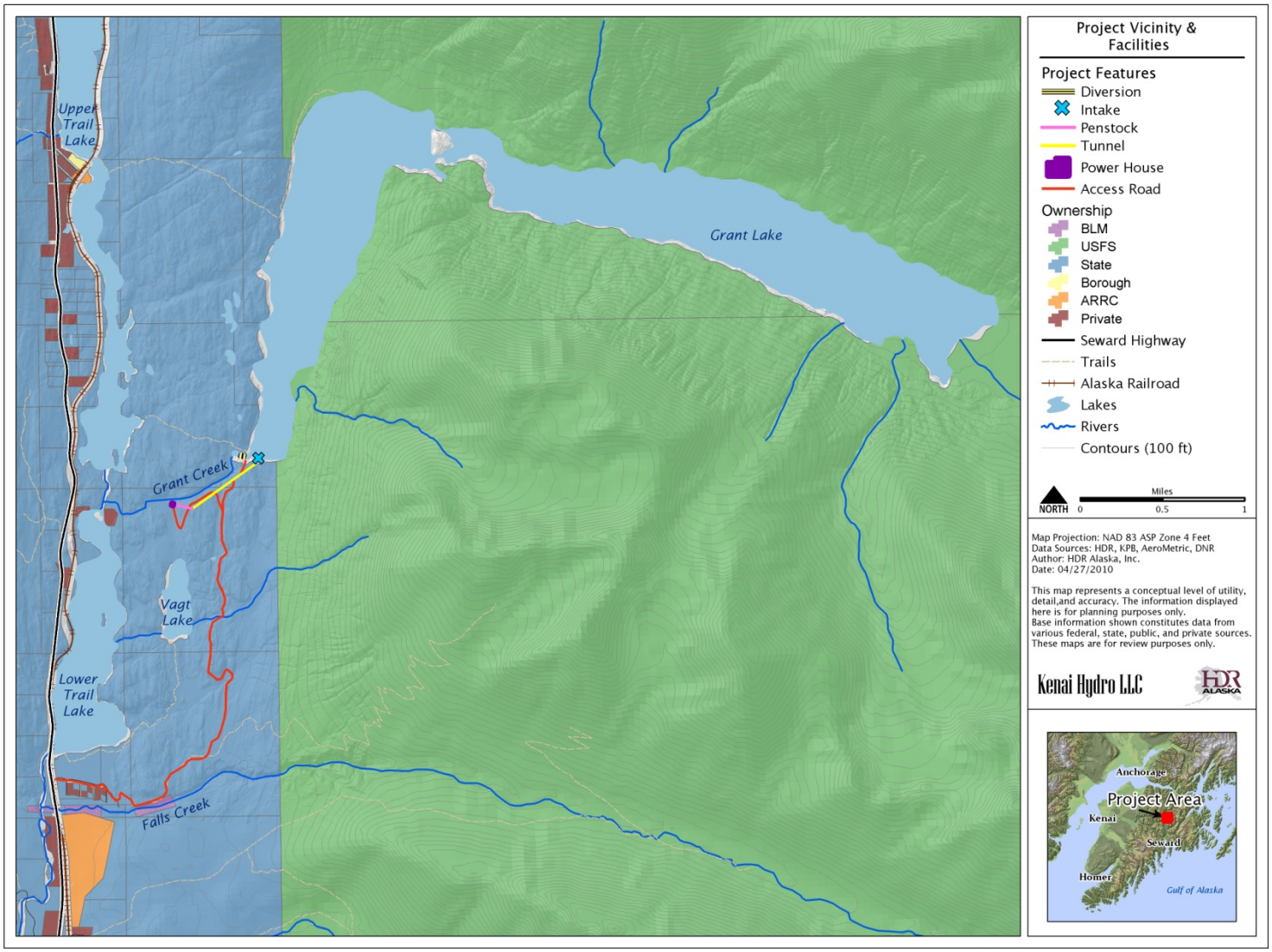

Figure 1. Project vicinity and proposed facilities.

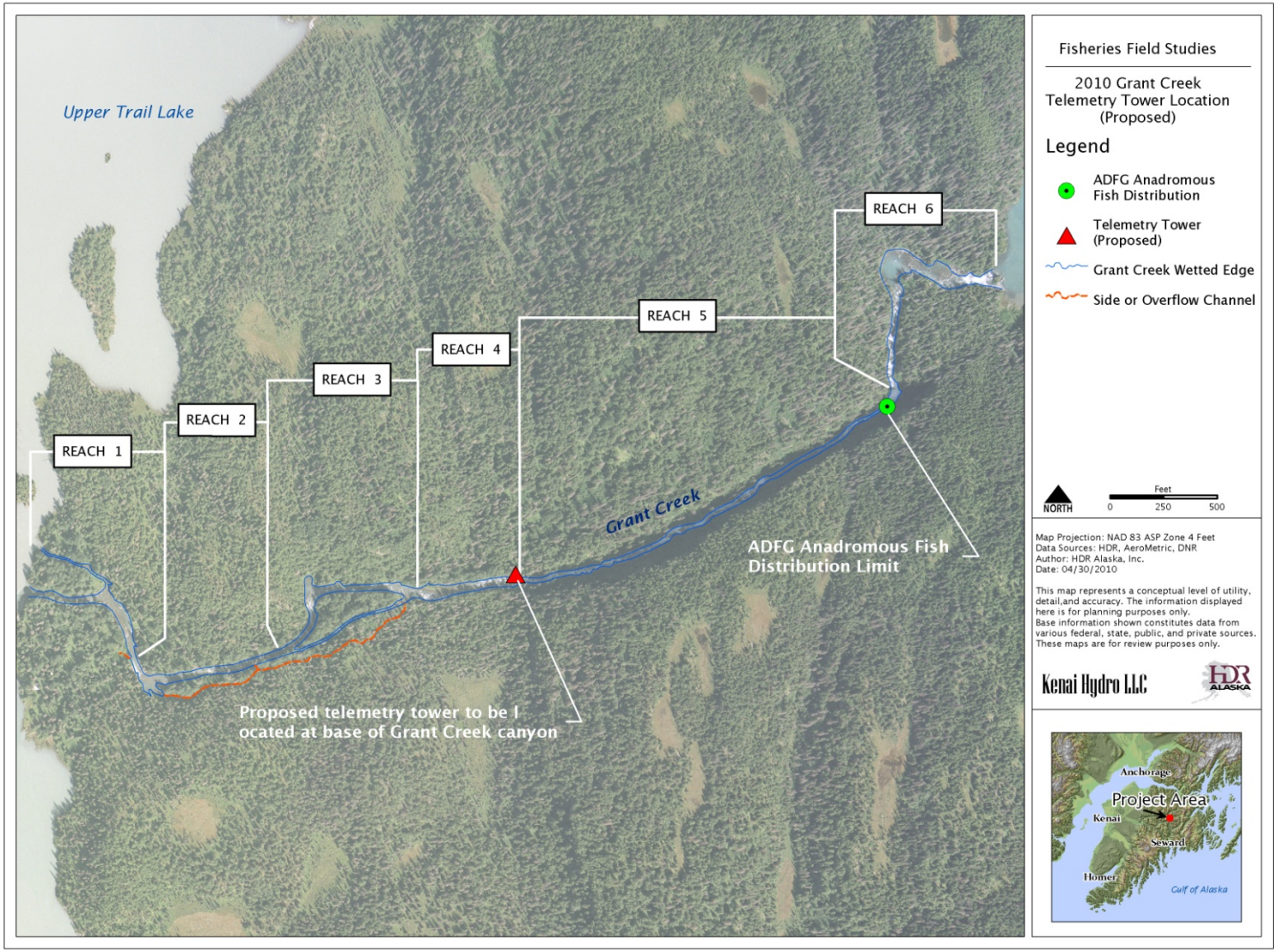

Figure 2. Study reaches designated on Grant Creek and proposed telemetry tower location.

2.1 Existing Information

Information relating to aquatic resources has been collected during previous investigations into the potential development of hydroelectric generation at Grant Creek, as well as during a pre-licensing study conducted by the current applicant in 2009.

2.1.1 Pre-2009 Studies

Previous FERC licensing efforts in the 1960s and 1980s for a proposed hydroelectric project at Grant Lake included studies of fish resources in Grant Lake and Grant Creek. Arctic Environmental Information and Data Center (AEIDC 1983) conducted fish sampling from 1981 to 1982 as part of a comprehensive environmental baseline study effort and USFWS (1961) conducted limited sampling from 1959 to 1960. An instream flow study was completed in 1987 as part of a preliminary FERC license application prepared by Kenai Hydro LLC (not related to the current Kenai Hydro, LLC; Envirosphere 1987, KHI 1987a, and KHI 1987b).

Grant Creek Fish Resources. Both anadromous and resident fish are present in Grant Creek, including salmon, trout, and other fish. Spawning Chinook (*Oncorhynchus tshawytscha*), sockeye (*Oncorhynchus nerka*), and coho salmon (*Oncorhynchus kisutch*), as well as rainbow trout (*Oncorhynchus mykiss*) and Dolly Varden (*Salvelinus malma*) are found in the lower reaches of Grant Creek (APA 1984; Johnson and Klein 2009; Figure 1). Rearing Chinook, coho and rainbow trout are also present (APA 1984, Johnson and Klein 2009). Round whitefish (*Prosopium cylindraceum*) and Arctic grayling (*Thymallus arcticus*) were caught during angling surveys, but not assumed to spawn in Grant Creek (APA 1984).

Upper Grant Creek is impassable to salmon 0.5 mi (APA 1984) to 1 mi (Johnson and Klein 2009) upstream of the mouth; fish habitat is most likely concentrated within the lower portion of stream. Habitat for juvenile fish exists mainly in stream margins, eddies, deep pools and side channels offering reduced velocities (APA 1984). Substrate material is coarse throughout the entire length of the creek due to high water velocity that tends to wash away smaller gravels (APA 1984). Isolated areas of suitable spawning gravels occur in the lower half of the stream (APA 1984).

Periodic minnow trapping on Grant Creek from July 1959 through January 1961 captured juvenile Chinook salmon, coho salmon, Dolly Varden and sculpin (extent of sampling area unknown; USFWS 1961). Minnow trapping and electrofishing in lower reaches of Grant Creek for week-long periods in October 1981 and March, May, June, and August 1982 yielded higher catches of trout, salmon and Dolly Varden in the fall and summer than in winter and spring (AEIDC 1983). Catches of Dolly Varden were generally most abundant in minnow traps, followed by juvenile Chinook, juvenile rainbow trout, and juvenile coho. Juvenile Chinook were the most commonly caught fish during electrofishing surveys (APA 1984).

APA (1984) estimated that Grant Creek supported 250 Chinook spawners and 1,650 sockeye spawners. The stream was also estimated to support 209 8-inch “trout” (including Dolly Varden and rainbow trout; APA 1984). Spawning coho were not surveyed (APA 1984), but have been recorded as being present at unknown levels in the stream by the AWC (Johnson and Klein

2009). Maximum counts from intermittent stream surveys by ADFG were 76 Chinook (1963) and 324 (1952) sockeye salmon.[1]

Grant Lake Fish Resources. Sampling during 1981-1982 found no fish in any of the tributaries of Grant Lake (AEIDC 1983). Sculpin and threespine stickleback were the only fish found to inhabit Grant Lake. A series of impassable falls[2] near Grant Lake's outlet prevents colonization of the lake by salmonids via Grant Creek (APA 1984). Density of threespine stickleback was ten times higher in the lower basin than the upper basin of Grant Lake (AEIDC 1983).

Because of the impassable falls below Grant Lake's outlet, no anadromous fish species occur in Grant Lake and its tributaries (USFWS 1961, AEIDC 1983, APA 1984), and Grant Lake is not included in the Anadromous Waters Catalog (AWC) published by ADF&G (Johnson and Daigneault 2008). Grant Lake appears to support only resident populations of sculpin–including slimy sculpin (*Cottus cognatus*) and coast range sculpin (*Cottus aleuticus*)–and threespine stickleback (*Gasterosteus aculeatus*) (AEIDC 1983, USFWS 1961, Johnson and Klein 2009). Although Sisson (1984) reported that Dolly Varden and a few rainbow trout occupied Grant Lake, subsequent investigations (USFWS 1961, AEIDC 1983, Marcuson 1989) have documented only sculpin and stickleback. From 1983-1986, coho salmon fry were stocked in Grant Lake by ADF&G, with limited success, though some enhanced returns to Grant Creek were recorded (Marcuson 1989).

Instream Flow. Environmental analyses that emphasized the relationship between stream flow and aquatic habitats (instream flow studies) were conducted on Grant Creek in the 1980s by Kenai Hydro, Inc. (KHI; unrelated to Kenai Hydro, LLC). These documents were compiled in support of a license application for hydropower development on Grant Creek. The documents include reports and written communications between KHI and state and federal agencies in 1986 and 1987 relative to a FERC license application for the proposed Grant Lake Hydroelectric Project (FERC No. 7633-002). Included were: draft and final reports of a limited but complete instream flow incremental methodology (IFIM) investigation and negotiated minimum instream flows and ramping rates (Envirosphere 1987, KHI 1987a, and KHI 1987b). A technical memorandum was drafted and shared with the Instream Flow Technical Working Group (TWG) participants in 2009 detailing the results of the previous instream flow study efforts (HDR 2009b).

2.1.2 2009 Aquatic Resources Studies

The 2009 aquatic resources study program began the process of acquiring resource information needed for FERC licensing and other regulatory requirements. Emphasis was on updating existing information, acquiring more complete information required for specific issue analysis, and providing background information needed to develop more focused studies after initiation of the formal FERC licensing process.

[1]Anadromous Waters Catalog Stream Nomination #08-153, http://www.sf.adfg.state.ak.us/SARR/FishDistrib/Nomination/FDDNomHome.cfm

[2] 2007 ADFG Stream survey referenced in Anadromous Waters Catalog Stream Nomination #08-153, http://www.sf.7adfg.state.ak.us/SARR/FishDistrib/Nomination/FDDNomHome.cfm

Fish. The 2009 fisheries study (HDR 2009a) focused on the following objectives:

1. Determine the relative abundance and distribution of juvenile fish in Grant Creek
2. Determine relative abundance and distribution of resident Dolly Varden and rainbow trout in Grant Creek
3. Estimate abundance and run timing of spawning salmon
4. Estimate abundance and run timing of spawning adult resident fish
5. Determine fish presence and distribution in Grant Lake

Consistent with studies conducted by AIEDC (1983), Grant Creek was divided into study Reaches 1 through 6; Reaches 1 through 4 were roughly 0.25 mi each in length, and Reaches 5 and 6 were established based on geomorphologic characteristics (HDR 2009a; Figure 2). Relative abundance and distribution of juvenile fish were determined by minnow trapping and calculating the catch per unit effort (CPUE) for each reach. Reaches 1 through 4 were sampled relatively evenly, with nine to 13 minnow traps per reach. Terrain was difficult to access in Reaches 5 and 6, so these reaches were sampled less frequently and with only three and five sites, respectively. A total of 50 baited minnow traps were placed throughout the creek in Reaches 1 through 6; mesh size was 0.25 inch. The creek was sampled monthly, with the exception of Reach 6, which was sampled in June and August only. Dolly Varden were found to be the most abundant species in Grant Creek and distributed throughout Grant Creek Reaches 1 through 5, although they had a greater relative abundance in Reaches 4 and 5. Coho salmon were the next most abundant species and were also distributed throughout Reaches 1 through 5. However, they appeared to have the greatest relative abundance in Reach 1. Chinook salmon were the next most abundant species. There was a noticeable decrease in their abundance in upstream reaches and they were not caught above Reach 4. Other fish present in small numbers were sockeye salmon, rainbow trout, sculpin, and threespine stickleback. Most salmon captured were young-of-the-year with few larger juveniles present (HDR 2009a).

Relative abundance of larger size resident salmonids (i.e., rainbow trout and Dolly Varden) was determined by calculation of angling CPUE (HDR 2009a). A total of 18 angling sites were established along the creek and each site was fished for 30 minutes approximately every 10 days, from early June through late September. Rainbow trout (n=68) were found to be more abundant than Dolly Varden (n=9) and were caught throughout the creek, although their relative abundance was higher in Reaches 3 through 5 than in Reaches 1 and 2. Dolly Varden were captured in Reaches 1, 2, and 3; their relative abundance was highest in Reach 1. This study was also aimed at determining the timing of spawning of adult resident fish; however, it appeared that spawning, if present, occurred before or after the 2009 study period, since little evidence of spawning fish was seen (HDR 2009a).

Abundance and run timing of spawning anadromous fish was estimated through data collected during foot surveys (HDR 2009a). Foot surveys occurred approximately every 10 days beginning in mid-June and ending in late September. Both sockeye and Chinook salmon were seen in the lower five reaches. Chinook salmon reached Grant Creek first around the beginning of August. Sockeye salmon did not arrive until the end of August. Escapement of Chinook salmon was estimated to be 231 fish, and escapement of sockeye salmon estimated at 6,293.

Fish distribution and presence in Grant Lake and its tributaries was assessed using minnow traps, electrofishing, and gill nets (HDR 2009a). Sampling occurred at nine gill netting sites, 18

electrofishing sites, and 28 minnow trapping sites. Threespine stickleback was the dominant species in the lake followed by sculpin. No other species of fish was captured (HDR 2009a).

Instream Flow. The collaboration process for a study of "instream flow" effects in Grant Creek was initiated in 2009 (HDR 2009a). The primary goal of the 2009 instream flow study program was to establish a technical working group (TWG) consisting of state and federal resource agency staff, Project staff and interested members of the local community. Once established, the TWG met three times throughout the 2009 study season to review the results of the 2009 aquatic baseline study efforts, discuss and agree upon an acceptable instream flow evaluation method, and request additional information to support the selection of an instream flow method (HDR 2009a).

As part of the instream flow study, and at the request of the TWG, a sampling event was conducted from 23 to 25 June 2009 on Grant Creek in order to characterize the types of aquatic habitats utilized by resident fish and rearing fish (HDR 2009a). Aquatic habitat was described at each sample site by recording macro-, meso-, and micro- habitat characteristics. During the June sampling event, snorkeling was the primary method used to document fish presence. Electrofishing was used primarily to confirm species identification and calibrate fish length estimates (HDR 2009a).

Collaboratively, the TWG and KHL decided to select an instream flow study methodology based on the knowledge obtained from the summer 2009 aquatic resources and hydrology studies (HDR 2009a). Data and analyses from these studies were shared with the TWG in July and September. Based on the knowledge gained of Grant Creek's fish and hydrologic resources, KHL presented a proposed instream flow approach to the TWG on 23 September (HDR 2009a).

Macroinvertebrates, Plankton, and Periphyton. Benthic macroinvertebrate and periphyton samples were collected in Grant Creek in August, 2009 (HDR 2009a). Macroinvertebrate population density and taxa diversity can be used to assess stream water and habitat health and are important factors in availability of food sources for fish. Periphyton (algae attached to large rocky substrate) is used to assess chlorophyll *a* content, an indicator of primary productivity. The sampling event was scheduled to occur during the time of year that typically displays the peak of diversity and population densities. Examining the stream sites for macroinvertebrates and periphyton during the same time period for multiple years is necessary to understand yearly variability due to fluctuations between years and weather events (HDR 2009a).

Sampling in 2009 was postponed due to a large rain event (HDR 2009a). This rain event may have scoured Grant Creek, dislodging many larger genera of macroinvertebrates and washing them out of the system. The macroinvertebrates that were found were typically smaller genera although taxa diversity was at levels expected for south central Alaska streams. Periphyton is not affected as easily by high flow.

Zooplankton and phytoplankton were collected in Grant Lake in August (HDR 2009a). Phytoplankton samples were analyzed for chlorophyll *a* concentrations similar to periphyton in the creek. Concentrations in the lake were lower than that found in the creek.

2.2 Need for additional information

Early study programs and the 2009 baseline study program conducted by KHL have provided a significant amount of background information regarding aquatic resources in the Project area. Following analysis of the 2009 study results, information gaps were identified for further study to support the FERC licensing process and accompanying permit requirements. Additional field studies will:

- Determine juvenile fish use of winter habitats.
- Better define fish use of microhabitats and overall species composition and relative abundances in Reaches 1 through 4.
- Determine the extent of rainbow trout spawning in Grant Creek
- Determine use of Reach 5 by juvenile and adult fish, with additional emphasis on spawning Chinook salmon use of Reach 5.
- Delineate aquatic habitats available in Grant Creek; identify key habitats[3] for fish and describe and distinguish the factors that may influence fish use of the key habitats over those habitat units not occupied by fish in Grant Creek.
- Provide an estimate of salmon spawning escapement in Grant Creek.
- Examine how important individual habitat units may be affected by changes in flow due to the operation of the proposed Project using instream flow assessment methods.
- Collect benthic macroinvertebrates in Grant Creek to establish baseline diversity and abundance characteristics.
- Collect periphyton samples in conjunction with macroinvertebrate samples in Grant Creek to establish baseline chlorophyll *a* availability.

3 Methods

Aquatic resources of Grant Creek will be studied in 2010-2011 through an integrated study program with three main disciplines: fish biology, instream flow, and an aquatic ecology element that includes macroinvertebrates and periphyton.

3.1 Study Area

The 2010 Aquatic Resources Study Plan and subsequent field investigations will focus on Grant Creek, located near the community of Moose Pass, Alaska, approximately 25 miles north of Seward, Alaska, and just east of the Seward Highway (State Route 9). The proposed Project location is in the Kenai Peninsula Borough. The study area is indicated on Figure 3.

[3] Key Habitats are defined as micro- or macro-habitat areas that receive disproportionate use as indicated by fish density or contain characteristics that allow special uses such as spawning or overwintering

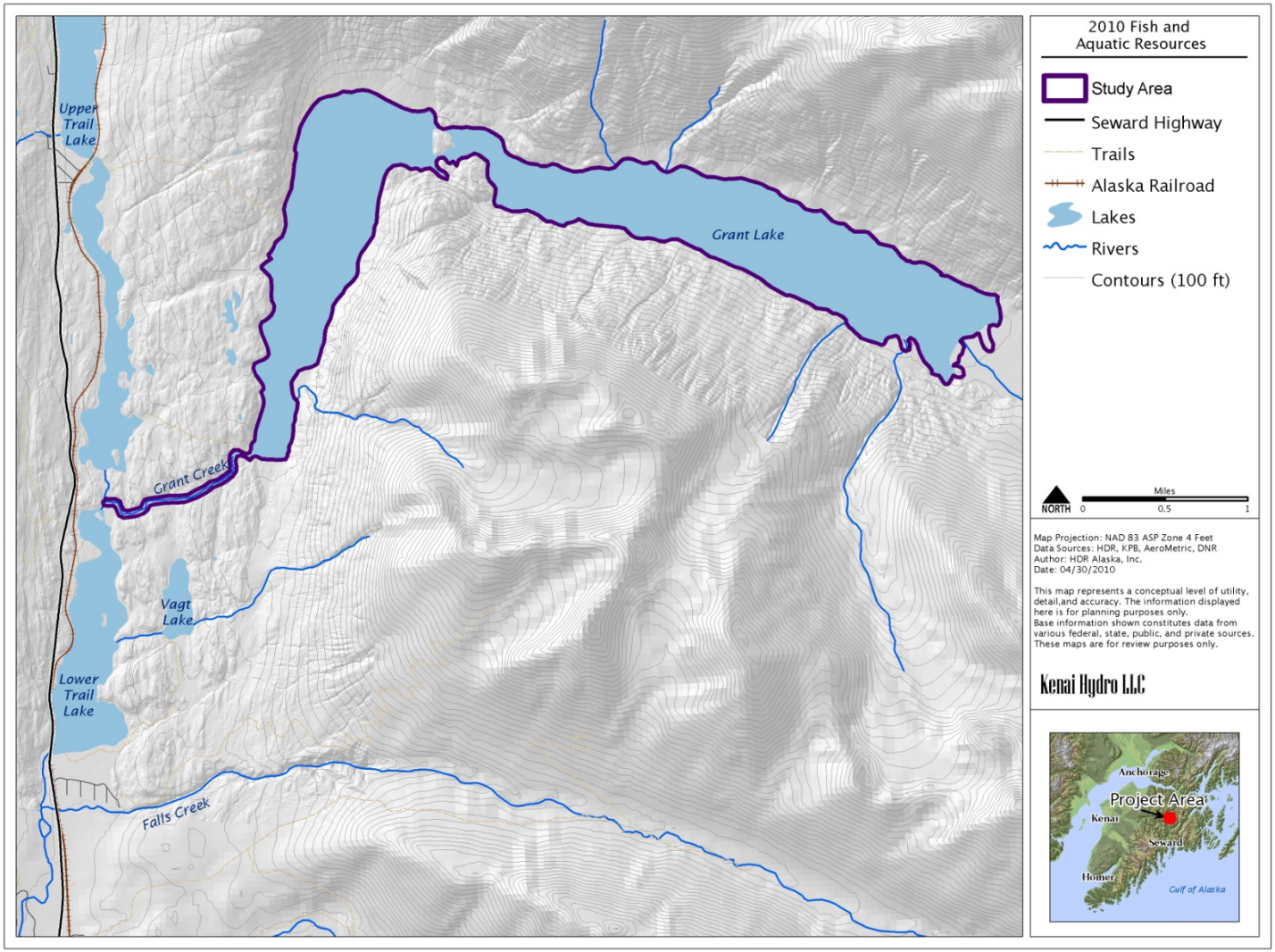

Figure 3. Aquatic Resources Study Area.

3.2 Field Study Design

Field studies in 2010 will include the following principal components:

1. Grant Creek salmon spawning distribution and abundance:
    - Foot surveys of Grant Creek to determine distribution and abundance of spawning salmon.
    - Telemetry study of Chinook salmon spawning distribution with emphasis on the canyon section of Grant Creek (Reach 5).
2. Grant Creek resident and rearing fish distribution and abundance:
    - Surveys to determine timing, distribution and abundance of spawning rainbow trout in Grant Creek.
    - Surveys to determine fish presence in suspected overwintering habitats.
    - Surveys of Grant Creek to estimate distribution and abundance of juvenile fish by habitat type with emphasis on areas not surveyed in 2009 including Reach 5.
3. Grant Creek aquatic habitat mapping and critical factors analysis:
    - Synthesis of fish use and aquatic habitat data for Grant Creek.
    - Delineation of aquatic habitats in Reaches 1 though 5 of Grant Creek.
    - Surveys to ground-truth office based habitat delineation, fill spatial data gaps, and verify fish use of aquatic habitats.
    - Identification of key habitats based on observed fish use.
    - Analysis of habitat factors that distinguish key habitats from other habitats available in Grant Creek.
4. Grant Creek Instream Flow Study, including the following components:
    - Habitat availability analysis using measurements of stream geometry, hydraulics, and other habitat parameters at selected transect sites.
    - Fish use of meso- and microhabitats.
    - Integration of flow and temperature monitoring.
    - Analysis and modeling to predict habitat response to changes in flow regime.
5. Benthic macroinvertebrates in Grant Creek:
    - Sampling using pseudo-replication Surber sampling methods to estimate population density in riffle/run habitats.
    - Macroinvertebrate identification to genus level (when possible) identification for use in calculating population metrics.
6. Periphyton in Grant Creek:
    - Collecting periphyton samples from riffle areas at two locations within Grant Creek.

- Processing and filtration to prepare samples for laboratory analysis.
- Analyzing chlorophyll *a* concentration in individual samples.

3.2.1 Grant Creek Salmon Spawning Distribution and Abundance

The purpose of this study component is to characterize spawning salmon distribution, run timing and abundance in Grant Creek. This study effort will consist of two components:

- A continuation of foot surveys conducted during 2009 to describe overall abundance and distribution of all species of spawning salmon.
- A radio telemetry study to further assess the spawning distribution of Chinook salmon.

3.2.1.1 Overall Salmon Spawning Distribution and Abundance

During the 2009 foot surveys, salmon counts were conducted approximately every 10 days from mid-June through September. Based on the run timing in 2009, foot surveys in 2010 will be conducted later in the ice-free season, from August through November (or freeze up of Trail Lake). Foot surveys will be conducted weekly through early September, and approximately every 10 days thereafter.

Foot surveys will be conducted to estimate the abundance of spawning fish in Grant Creek using methods similar to those employed in 2009. Survey crews will begin at the downstream terminus of each stream reach, visually counting fish as they walk upstream. The survey area will include all active channels including side channels and back water pool areas. Salmon that are obviously spawned out but still swimming (i.e., a live carcass) will be counted as a carcass rather than a live fish.

Data collected will include:

- A tally of all fish observed per reach, identified to species
- GPS coordinates of all redds observed
- Number of swimming carcasses observed (see above)
- Number of carcasses observed
- Turbidity of water (a metric of viewing conditions)
- Overall survey conditions

If the data are sufficiently complete, escapement for each salmon species observed will be estimated using an area-under-the-curve method that is based on a trapezoidal approximation using linear interpolation to estimate the number of fish present in the stream for the days not surveyed. This method has been in use for more than 25 years (Neilson and Geen, 1981; English et al., 1992; Bue et al. 1998). Survey life, the number of days a fish is alive in the survey area, observer efficiency, and the proportion of fish actually seen by the observers will be determined based on professional judgment.

Escapement will be estimated by dividing the area-under-the-curve by survey life and then adjusting for the proportion of fish actually observed. An estimate of the number of fish in the stream can be obtained by dividing the total number of fish days by the average number of days a fish was in the survey area (i.e., survey life). Naturally, if the observer only sees a portion of the

fish present, then the estimate will be biased low and the adjustment for observer efficiency corrects this bias.

Quantitative estimates of either survey life or observer efficiency do not exist for Grant Creek. As such, subjective estimates of both values will be made based on professional judgment by the fish biologists conducting the foot surveys and assumed to be reasonable values.

The primary tasks associated with this study are as follows:

- Mobilize/breakdown field equipment/safety training (July and November)
- Survey Grant Creek for fish (August through November)
- Enter and QA/QC data (August through November)
    - Enter all survey data
    - Conduct QA/QC procedures
- Data analysis of adult salmon escapement based on an area under the curve estimate

3.2.1.2 Chinook Salmon Spawning Distribution in Grant Creek

During the 2009 preliminary investigations, the crew was unable to access Reach 5 (Figure 2), except for the first 300 m beyond the reach-break between Reaches 4 and 5. Reach 5 was also not accessed in the 1980s by previous investigators (AIEDC 1983). High-velocity flows and cascades prevented safe wading of the stream and precipitous terrain prevented walking along the edge of the stream. As a result, the upstream extent of salmon spawning activity in Grant Creek has not been adequately characterized. Turbid water due to glacial runoff in Grant Creek also lowered observer efficiencies and added to uncertainty of escapement estimates and spawning distribution in the remainder of the stream (HDR 2009a). The purpose of a radio telemetry study of Chinook salmon in Grant Creek is to determine spawning distribution of Chinook salmon throughout the creek, including determining presence or absence and relative abundance in Reach 5.

Approximately 50 Chinook salmon will be captured near the mouth of Grant Creek using a method to be determined in the field based on observed conditions. Captured fish will be radio tagged starting in early August, with the goal of distributing the tags proportionately throughout the run, which is expected to last from mid to late August. However, this run timing estimate is based on information from previous years, and inter-annual variability in run timing may occur.

Possible capture methods include use of beach seines, dip nets, or large-mesh fyke nets. Once fish are captured, they will be anesthetized using CO_2 and a Lotek, Inc. coded gastric tag will be inserted. Tags will be lubricated with glycerin and pushed down the esophagus into the stomach using a smooth plastic rod. All radio-tagged fish will also be tagged with Floy spaghetti tags. Radio tags will be programmed to have a 60-day battery life. A radio telemetry receiver tower will be installed at the reach-break between Reaches 4 and 5 (Figure 2) in order to detect when fish enter or exit Reach 5. During the foot surveys described in Section 4.2.1.1, observers will also carry a handheld Yagi antenna and mobile receiver in order to detect tagged fish that may be present in the vicinity. A trail will be established along a safe route on the canyon rim paralleling Reach 5. Once a fish is detected, the crew will walk until the signal is perpendicular to their position (i.e., as close as possible), until signal strength is high enough to code the fish. Locations of the tagged fish will be recorded using GPS coordinates as well as marked on hand-held maps. The primary tasks associated with this study are as follows.

- Acquire field equipment (April and May)
    - Capture nets
    - Anesthesia equipment
    - Telemetry tags and receiver
    - Fixed receiving station components
- Establish trail (May and July)
    - Cut and mark trail (May)
    - Brush trail (July)
- Mobilize field equipment (July and August; October)
    - Transport field equipment to site
    - Install fixed telemetry towers
    - Breakdown and transport field equipment off site
- Capture and tag Chinook salmon (August and September)
    - Tag 50 Chinook salmon
- Track movement of tagged salmon (August through October)
    - Foot surveys
    - Download data from fixed receiving stations
- Enter and QA/QC data (August through November)
    - Enter all capture data
    - Upload tracking data to GIS-enabled database
    - Conduct QA/QC procedures
- Conduct a spatial analysis of tag location data

3.2.2 Grant Creek Resident and Rearing Fish Distribution and Abundance

The purpose of this study component is to characterize distribution and abundance of all species of resident and rearing fish, and run timing of rainbow trout in Grant Creek that may be affected by Project activities. This study effort will consist of the following components:

- Angling surveys to assess run timing and relative abundance of spawning rainbow trout.
- Investigation of juvenile fish presence in Reach 5 of Grant Creek using minnow traps and other sampling techniques.
- Minnow trap and video sampling in late winter/early spring at likely overwintering habitats to determine salmonid overwintering presence in Grant Creek.
- Snorkel sampling to determine fish use of mesohabitats in Grant Creek.

3.2.2.1 Rainbow Trout Spawning and Distribution in Grant Creek

During the 2009 aquatic resources study program, hook and line sampling to assess rainbow trout abundance and distribution in Grant Creek did not begin until early June which was likely after, or near the end of, the rainbow trout spawning time period. The spawning condition of captured fish could not be determined with confidence during the 2009 angling surveys. Rainbow trout studies in 2010 will emphasize the likely spawning period to obtain important information regarding spawning use, spawner abundance, and spawning locations within Grant Creek.

Angling surveys for rainbow trout will be timed to coincide with the probable spawning time, which occurs after breakup in late spring. Rainbow trout spawning normally begins after water

temperatures warm to about 4°C. Grant Creek water temperatures will be monitored after ice-out to determine when surveys should be initiated. Surveys will occur once per week during the probable spawning period and will continue until no additional reproductive information can be obtained, probably in mid-June. Tackle will include a variety of artificial lures and/or flies. Barbs will be filed off hooks to ease hook removal and minimize fish injury. Preserved sterilized salmon eggs may be used as bait if bait increases catch efficiency.

Angling sampling conducted in 2009 occurred at eighteen angling stations, with four angling stations in Reaches 1-4 and two stations in Reach 5. Each angling station was fished for 30 minutes or about 2 hours total sampling effort per reach in reaches 1-4 and 1 hour of effort in reach 5.

In 2010, rod and reel sampling will be conducted again, however in order to help randomize sampling locations, rod and reel sampling efforts will be stratified based on stream reach rather than the use of pre-established sampling stations. Anglers will move up and down each sample reach covering a variety locations and habitats. Special attention will be given to ensure anglers do not sample only those areas that are perceived as good fish habitat or to be holding fish. In order to ensure that 2009 and 2010 data are comparable, sampling effort will be conducted for a duration of two person hours per sample reach in reaches 1-4 and one hour in reach 5. Rod and reel sampling will be conducted in accordance with ADF&G Sport Fishing Regulations and the ADF&G Fish Resource Permit.

All fish captured will be immediately landed and netted. Fish will be marked with individually numbered Floy Tags as well as with a caudal fin clip (0.25 inch) in order to detect recaptures. Each fish will be measured, sexed (if possible), and its spawning condition described. After being captured each fish will be walked down stream and released in a slow water area away from the angling station. Limited numbers of fish that are judged to have poor survival prospects because of hooking injuries may be sacrificed and dissected to determine reproductive condition.

Data analysis will emphasize CPUE calculations. If the number of captures and recaptures is sufficiently high, then mark/recapture population estimates using either Peterson or Schnabel methods will be utilized. If population estimates are calculated, they will be accompanied by a thorough discussion of assumptions and possible errors, as well as statistical analysis as applicable.

The primary tasks associated with this study are as follows.

- Acquire and inventory field equipment (April)
- Mobilize/breakdown field equipment/safety training(May and June)
- Capture, measure, mark and assess spawning condition of rainbow trout (May through June)
- Enter and QA/QC data (May through July)
    - Enter all capture data
    - Upload tracking data to GIS-enabled database
    - Conduct QA/QC procedures
- Conduct data analysis
    - Assess the relative abundance and distribution of spawning rainbow trout based on CPUE
    - Calculate population estimates, if applicable

- Describe fish movements based on tag recaptures, if applicable

3.2.2.2 Rearing Fish use of Study Reach 5

During 2009 minnow trap sampling, crews were unable to access Reach 5, except for the first 300 m beyond the reach-break between Reaches 4 and 5 (Figure 2). Most of Reach 5 was also not accessed in the 1980s by previous investigators (AIEDC 1983). High-velocity flows and cascades prevented safe wading of the stream, and steep terrain prevented safe upland access without climbing gear. In order to assess the presence of juvenile fish in Reach 5, juvenile fish sampling will be expanded to areas not reached in 2009.

An initial reconnaissance of Reach 5 will be conducted in late winter 2010 when the creek is frozen and can be accessed on foot at the bottom of the gorge; information will be gathered regarding potential summer access points, likely fish habitat and potential sample sites.

Juvenile fish use of Reach 5 will be assessed using the same minnow trapping methods that were employed during 2009, except that special equipment will be used to access the creek in Reach 5 in a safe manner. Routine access of Reach 5 during high flow conditions will be accomplished by using roped protection. Sample site locations will be based on the ability to safely access this reach from the canyon rim, which will be influenced by following criteria:

- Safe access via rappel/belay techniques
- Proximity to safe anchor sites
- Proximity to likely fish habitats

A crew of two will set minnow traps in as many locations as possible with 3 to 4 traps each within likely fish habitats, such as plunge pools and eddies. The three sites trapped in 2009 in the lower 300m of Reach 5 will also be re-sampled, for a total of 6 to 7 sites in Reach 5. Target species will include Chinook and coho salmon, Dolly Varden, rainbow trout, and sculpin. CPUE can be defined as the catch per trap-hour.

All sampling sites will be marked by a GPS, staked, and flagged for future identification. Habitat characteristics will also be recorded. Once minnow trapping is complete, a backpack electroshocker will be used to sample the area around which the traps were placed to confirm minnow trapping results and to collect species that may not be attracted to the traps. All sites in Reach 5 will be minnow trapped in May, July, and September.

Fish captured will be identified to species, measured, and released near the point of capture. If fish are very abundant, then a random subsample will be measured and the remainder will be counted. Salmonid length measurements will be based on fork length (tip of the snout to the fork in the tail), and other fish length measurements will be based on total length (tip of snout to end of tail).

The primary tasks associated with this study are as follows.

- Acquire/and inventory field equipment and complete safety training(April and May)
  - Climbing/ascension/and belay equipment
  - Fish sampling equipment
  - Safety equipment
  - Safety training for normal crew and two alternates
- Establish trail (May and July)

    - Cut and mark trail (May)
    - Brush trail (July)
- Mobilize field equipment (July and August; October)
    - Transport field equipment to site
    - Scout for best access points
    - Set up fixed ropes and anchors
    - Select sampling sites
    - Breakdown and transport field equipment off site
- Conduct routine sampling (mid May, July, September)
- Enter and QA/QC data (August through November)
    - Enter all capture data
    - Conduct QA/QC procedures
- Conduct data analysis based on CPUE, species composition and relative abundance.

3.2.2.3 Resident and Rearing Fish Use of Winter Habitats

The results of the 2009 snorkel and minnow trapping surveys provided evidence that very few juvenile salmon observed were older than young-of-the-year fish (YOY; i.e., hatched in spring). Based on these results there is some question as to whether Grant Creek provides favorable overwinter habitat for juvenile salmon. This study component will assess juvenile salmon presence in likely overwintering habitats such as open water, springs and seeps, deep pools, and backwater areas.

Areas of unfrozen water will be sampled using both minnow traps and backpack electrofisher. In frozen areas where substantial unfrozen water is suspected under the ice, an ice auger will be used to gain access to water under the ice, if necessary. A baited minnow trap or bait container will be lowered into the water along with an underwater video camera. Under-ice conditions will be observed on a monitor. If fish are seen on the monitor, then video will be recorded for later review. Footage will then be analyzed in the office to determine species and age class of any fish attracted to the bait. This one-time sampling event will occur in late winter 2011, before breakup occurs in Grant Creek. The study will likely need to be conducted before break-up in Trail Lake to ensure safe access to Grant Creek.

The primary tasks associated with this study are as follows.

- Identify likely overwintering habitats in the office based on existing habitat mapping, knowledge of study area, and 2009 data (February)
- Identify additional likely overwintering habitats in the field based on observations, i.e., presence of open water (March).
- Sample for fish in likely overwintering habitats (February 2011)
- Enter and QA/QC data (February-March)
    - Enter data into database and Conduct QA/QC
    - Review camera footage to determine fish species and approximate age

3.2.2.4 Resident and Rearing Fish Use of Open Water Habitats

Findings from 2009 minnow trap sampling of Grant Creek indicated that Dolly Varden were the most abundant juvenile species present, but snorkel sampling detected the presence of relatively

few Dolly Varden and instead detected Chinook and coho salmon as the dominant juvenile fish species. Dolly Varden are known to be difficult to detect during daytime snorkeling so their absence in snorkeling observations is not surprising. Juvenile Chinook and coho salmon are readily attracted to baited traps but the small YOY fish may have been able to escape through the 0.25- inch mesh, or high water velocity may have prevented access. In August 2009, the numbers of Chinook and coho salmon caught in minnow traps increased as the size of the fish increased.

The disparity between the minnow trapping and snorkeling results may also have been due to the habitats sampled. The minnow trapping sites were set mostly in margins of fastwater riffles (favoring an even spatial distribution along stream Reaches 1 through 4, Figure 2) whereas the snorkeling sites were set in a variety of microhabitats.

In Study Reaches 1-4, sample sites in which catch of juvenile salmon in minnow traps was poor or sample sites in habitats that were underrepresented by sampling in 2009 (e.g., low-velocity habitats, backwaters, undercut banks) will be identified in the office and in the field in 2010. Each habitat type will be uniformly sampled using baited 0.125-inch mesh minnow traps to determine CPUE. CPUE can be defined as the catch per trap-hour. Sampling methods for this subcomponent are the same as those used in Reach 5 (Section 3.2.2.2), with the exception of the method of site determination, which will be based on habitat units. Where possible minnow trapping sites will also be electrofished or snorkeled to attempt to correct for gear bias of the minnow traps (i.e., document species that may not be captured in the minnow traps). Minnow trapping will take place at approximately 40 established sites on three occasions during the 2010 open water period, May, July, and September.

The primary tasks associated with this study are as follows.

- Acquire and inventory field equipment (April)
- Mobilize/breakdown field equipment/safety training (May and October)
- Conduct in-water sampling in May, July, and September
- Enter and QA/QC data (May through October)
    - Enter all capture data
    - Conduct QA/QC procedures
- Conduct data analysis based on CPUE, species composition and relative abundance.

3.2.3 Grant Creek Aquatic Habitat Mapping and Critical Factors Analysis

The purpose of this study is to fully delineate and map the aquatic habitats available in Grant Creek; identify key habitats for fish (i.e., rearing and resident fish; spawning salmon); and describe and distinguish the factors that may influence fish use of the key habitats over those habitat units not occupied by fish in Grant Creek.

The approach of this study involves three primary phases. During the first phase, the team will spatially synthesize existing aquatic habitat and fish use data generated during various field efforts throughout the 2009 field season. This exercise will be completed primarily to identify spatial data gaps. In the second phase, the team will then verify (i.e., ground-truth) habitat data in the field, collect additional habitat and fish use data in Reaches 1 through 5[4], and incorporate

[4] Due to physical access limitations, the field team may be unable to ground-truth aquatic habitats delineated in portions of Reach 5.

other suitable habitat and fish use data collected in 2010 (e.g., instream flow study, Section 4.2.4). Finally, the team will analyze the suite of habitats and fish use data to identify critical factors. The primary tasks associated with this approach will be to:

- Prepare an office-based aquatic habitat map (i.e., based on habitat observations assembled throughout the 2009 field season).
- Conduct field surveys to ground-truth the office-based mapping effort and fill spatial data gaps relative to aquatic habitat and fish use in Reaches 1 though 5.
- Incorporate aquatic habitat fish use data to identify key rearing, spawning, and feeding habitats for salmon and resident fish; and potential overwintering habitats (i.e., see Section 4.2.2); and
- Analyze and identify the factors that may influence fish use of the key habitats over those habitat units not occupied by fish in Grant Creek.

The office-based mapping exercise will incorporate existing habitat data overlain by fish use data into a spatial format, using ArcMap© geographic information system (GIS) software. The initial dataset will include habitat units mapped during a microhabitat fish use reconnaissance study completed in June 2009[5]. The team will also plot locations of salmon spawning activity recorded during 2009 foot surveys and high-use spawning areas identified by historical data (APA 1984). The team will use the preliminary spatial fish habitat information to catalog and identify gaps in coverage.

The team will conduct surveys to ground-truth the preliminary aquatic habitat delineation (i.e., generated through the office-based exercise) to identify where data gaps exist and to determine where to collect additional information. The team will delineate aquatic habitats at the mesohabitat scale, consistent with the approach developed for the 2009 habitat reconnaissance study. Mesohabitats identified in 2009 included: fastwater pools and fastwater riffles; margins with undercut bank, margins without undercut bank, large woody debris dams, and margin shelves associated with large wood debris; and backwater pools, sloughs, and pockets. Additional microhabitat characterizations will be added if deemed necessary.

The field team will record fish presence (or absence) within discrete mesohabitats, so that fish presence (or lack of fish presence) can be correlated with the specific habitat characteristics present (or absent) at each location sampled. A component of the instream flow study (see Section 4.2.4.2) will employ a similar sampling approach at specific locations in Reaches 1 through 4 (i.e., primarily at areas sampled in 2009). Data collection methods for the 2010 effort, described below, will be consistent with those developed for the 2009 mesohabitat reconnaissance study.

The field team will identify each fish observed to species and estimate its fork length using 20 mm size ranges, or bins. The team will rely on snorkeling as the primary method to document fish presence (or absence) within each mesohabitat sample area. Electrofishing will be used primarily to confirm species identification and calibrate fish length estimates. Electrofishing will

[5] The 2009 fish microhabitat use reconnaissance study was initiated to gain insight into the types of habitats that fish occupy in Grant Creek. The team identified discrete microhabitat types and sampled for fish presence at 16 sites in Grant Creek.

be used in lieu of snorkeling, if conditions preclude the effectiveness of snorkeling (i.e., shallow conditions).

For a prescribed number of observations the field team will record microhabitat use data for individuals or groups of fish. Microhabitat parameters will include substrate, cover, depth, and velocity. Both mean column and nose depths and velocities will be measured using a wading rod and a.Price-AA or Swoffer current meter attached to a top-setting or standard wading rod. Water temperature will also be measured.

The team will identify key fish habitats in Grant Creek, based on observed fish use. This will be accomplished by analyzing the microhabitat fish utilization data collected in support of this study, data collected in support of the instream flow study (see Section 4.2.4.2), and data collected in 2009 during the reconnaissance study (HDR 2009a). These data will be incorporated into the spatial dataset. Other fish use habitat datasets (e.g., foot surveys, telemetry surveys, electrofishing) will be also be considered when developing key habitat designations. Surface areas of habitat types will be calculated as needed using the capability of the GIS software.

The team will perform a critical habitat factors analysis to identify those factors (i.e., habitat components) which may be critical to fish in Grant Creek. The critical factors analysis will compare habitat factors found at key habitats (i.e., habitats utilized by fish) from other habitats available (i.e., not utilized by fish) in Grant Creek. The intent will be to distinguish those factors, potentially unique to key habitats and which may be critical to fish in Grant Creek, from the suite of habitat factors available in Grant Creek.

3.2.4 Grant Creek Instream Flow Study

The Grant Creek instream flow study approach was collaboratively developed based on input from the TWG. Public meetings of the TWG were held in April and September, 2009, and a conference call was held in May 2009; input and suggestions were solicited during these meetings and also through email and phone communications with the TWG and TWG members.

The instream flow study approach represents a detailed study of utilized habitat types and addresses the desire of the TWG to examine how important individual habitat units may be affected by changes in flow due to the operation of the Project. Rather than applying a typical instream flow habitat study that generalizes mesohabitat units in a study reach, this approach uses several techniques to tie physical microhabitat to flow and timing, and applies *in situ* knowledge of fish habitat use in Grant Creek as tools to determine potential effects of the Project.

For an instream flow study in Grant Creek, we propose an integrated effort that provides a cost-effective way of obtaining information that most directly answers the questions the TWG members have regarding the effects of the Project on fish habitat in Grant Creek. The approach includes:

1. A series of single transect analyses with each transect going through a known fish use area such as high use spawning or rearing areas;
2. Fish studies that help identify microhabitat factors that affect fish use within each key habitat type;

3. Monitoring temperature and flows at multiple locations on Grant Creek in conjunction with the Water Resources study program to establish baseline stream flow and temperature changes.

These three components will be analyzed to determine effects of different flow regimes on several factors that are important in the life stages of Grant Creek resident and anadromous fish.

3.2.4.1 Habitat Availability Study

The purpose of the habitat availability component of the instream flow study is to measure available habitat at proposed mesohabitat sites as a function of discharge (Table 1). Available habitat will be correlated to results of the Habitat Utilization Study described below in Section 3.2.4.2. This information will be cross-referenced with historic hydrographs, recent hydrologic data, and potential flow scenarios in Grant Creek to determine discrete time periods when the habitat unit may be available for its designated use.

Cross section geometry, substrate, cover, and hydraulic data will be measured at each transect using techniques developed for the Physical Habitat Simulation (PHABSIM) method. Application of PHABSIM techniques on Grant Creek is different from most other studies because transects are selected on important habitat units with known fish use, as opposed to a standard PHABSIM that attempts to represent all habitat units regardless of unique importance or known fish use. Collected data will enable several analyses including:

- a graphical plot of wetted perimeter and depth versus discharge, on which the range of flows at which habitat area is unavailable can be determined visually;
- changes in the availability of microhabitat (depth, velocity, substrate, and cover) across a transect or at specific cells or groups of cells along the transect as a function of discharge;
- lateral connectivity of main channel flow with side-channel, off-channel, or undercut bank habitats as a function of flow;
- egg incubation effective habitat analysis;

Transects will be oriented across the selected habitat unit to best capture the average condition of interest in that unit, such as spawning or rearing potential. Headpins, tailpins, and a temporary benchmark will be set at each transect. Survey instrument and photo points will be established and marked. Each transect site will be fixed using a handheld GPS. Habitat unit cross sectional profiles will be surveyed using standard differential survey techniques. Cross section survey points will divide the profile into 1 to 3 foot cells. Hydraulics (depth and velocity) and dominant and subdominant substrate and cover will be recorded within each cell.

Water surface elevations at each transect will be measured using a survey instrument at 3 to 4 discharges ranging from a low flow of approximately 75-100 cfs to a high flow of approximately 400 - 500 cfs. Mean column velocities will be measured within each cell at a medium-low flow of 150 - 200 cfs, or the highest possible flow within practical and safety limitations. Numerous photos from established photopoints will be taken at each of the 3-4 flow levels.

Proposed cross sections (Table 1) were located during a site visit 24 September 2009. The locations were set based on presence of physical microhabitat (i.e., undercut bank, overhead cover, bedrock outcrops, and pocket water) and observations of fish during the site visit and

during snorkeling studies. The site locations will be refined and measured during spring, summer, and early fall 2010.

Table 1. Proposed mesohabitat assessment sites.

Reach	Number of Sites	Description
1	2	distributary channel in rearing habitat
	4	main channel in rearing habitat
	1	main channel in spawning habitat
2	2	main channel in rearing habitat
	2	off-channel pool rearing habitat
	1	main channel in spawning habitat
3	1	off-channel pool rearing habitat
	2	secondary channel rearing habitat
	1	tertiary channel rearing habitat
	1	main channel spawning habitat
4	3	main channel rearing habitat
	1	main channel spawning habitat

3.2.4.2 Habitat Utilization Study

The purpose of the habitat utilization component is to learn what meso- and microhabitat factors the fish in Grant Creek occupy in order to assess whether the Project would have an effect on instream habitat. In order to maximize the knowledge of habitat selection factors for fish in Grant Creek, observations will be made at the locations of the transects as described in the previous section.

Fish spawning and rearing microhabitat values will be recorded in 2010 at programmatically-selected sites (described in Section 3.2.4.1) in Reaches 1 through 4. Measured microhabitat use parameters will vary by habitat units. During the TWG meeting on September 23, the following table was developed with input from TWG members.

Table 2. Parameters used in the habitat utilization study.

Habitat use function by life history	Habitat use parameters to measure
Salmon rearing	Depth, velocity, cover, wetted perimeter, habitat connectivity
Salmon spawning	Substrate, depth, velocity, temperature
Rainbow trout spawning	Substrate, depth, velocity
Incubation	Depth, wetted perimeter, temperature
Resident rearing and spawning	Salmon rearing will be used as a surrogate

Information relating to site-specific habitat suitability criteria (HSC) will be developed from these data and used in combination with HSC available in the existing literature and professional judgment to determine final HSC to be used in modeling. Development of final HSC will occur as a collaborative effort with the Instream Flow TWG. HSC will be combined with the transect measurements and mesohabitat characterizations in order to model changes in habitat as a function of discharge.

Habitat utilization data collection will be similar to the sampling approach developed in 2009. However, the 2010 field effort may be expanded to include multiple sampling events at varying flow regimes, as discussed below. The primary tasks associated with this approach are to:

- Identify and describe discrete mesohabitat sample areas within each sample site, based on habitat factors observed; and
- Record fish species presence (or absence) within each mesohabitat sample area

The field team established 16 sample sites in Grant Creek in June 2009. The sample sites comprise habitats expected to contain high densities of juvenile fish (i.e., backwater areas; along stream margins) as well as those not necessarily expected to contain high numbers of rearing fish (i.e., fast water near the thalweg). As a result, the team identified a number of key habitats for rearing and resident fish. The instream flow team considered the key habitats identified through the June 2009 effort and in September 2009 established cross-sections at these locations (as discussed in Section 4.2.4). In 2010, the field team will sample mesohabitats associated with the selected transects. Most transects are co-located with at least one mesohabitat unit sampled in June 2009. Additional sample sites will be established if deemed necessary.

Sites will be divided into discrete mesohabitat sample areas based on habitat characteristics observed within the stream segment sampled. In 2009, the field team identified the following mesohabitat sample areas: fast water pool, fast water riffle, margin with undercut bank, margin without undercut bank, large woody debris dam, and margin shelf associated with large wood debris, backwater pools, pockets, and sloughs; and “other” channels (i.e., distributary, secondary, tertiary). One sample site may be comprised of multiple mesohabitat categories. Additional

mesohabitat categories will be added if encountered. Mesohabitat factors taken into consideration will include:

- Location relative to the main channel (i.e., stream margin; mid-channel; backwater slough; backwater pocket);
- Depth and flow regimes (i.e., shallow fast, shallow slow, deep fast, deep slow);
- Presence of cover (i.e., no cover; velocity; instream cover); and
- Type of instream cover when present (i.e., undercut bank; woody debris; overhanging vegetation; submerged vegetation; substrate).

The field team will record fish presence (or absence) within discrete mesohabitat sample areas, so that fish presence (or lack of fish presence) can be correlated with the microhabitat characteristics present (or absent) at each location sampled.

The team will rely on snorkeling as the primary method to document fish presence (or absence) within each mesohabitat sample area. Electrofishing will be used primarily to confirm species identification and calibrate fish length estimates. Electrofishing will be used in lieu of snorkeling, if conditions preclude the effective use of snorkeling (i.e., shallow conditions). Each fish observed during snorkeling will be identified to species and its fork length will be estimated using 20 mm size intervals.

Within rearing habitats and near stream margins, the field team will record dominant and subdominant types of cover for each separate observed group of fish. Stream depth will be recorded using a wading rod at locations of observed fish use, and fish nose depth will be estimated by the snorkeler. Mean column velocities and velocity at the fish location will be recorded using a Price-AA or Swoffer current meter attached to a top-setting or standard wading rod. Water temperature will be recorded at each station, ideally mid-column and at or near the location of observed fish.

In areas of observed spawning use, high stream depth and velocity may preclude field staff from measuring all microhabitat parameters. When possible, depth and velocity will be recorded as described above. Dominant and subdominant types of substrate size will be recorded by visual estimate using categories as described in Table 3 below. When direct measurements are not possible, depth at the spawning habitat will be visually estimated, and a GPS point will be taken and the habitat area described. The field team will revisit spawning habitat areas in the fall when flows allow wading, and will record dominant and subdominant types of substrate types immediately outside the redd perimeter for each observed redd. In all cases, surface water temperature will be measured near mid-column in a well-mixed area near the location of the observed redd.

Table 3. Substrate size classes used on Grant Creek instream flow study.

Substrate Type	Size (inches)
Organics, vegetation	--
Clay, silt (fines)	<0.002
Sand (coarse)	0.002 - 0.07
Small gravel	0.07- 0.30
Medium gravel	0.30 – 1.25
Large gravel	1.25 – 2.5
Small cobble	2.5 – 5.0
Large cobble	5.0 – 10.0
Boulder	>10.0
Bedrock	--

3.2.4.3 Integration with Flow and Temperature Monitoring

Grant Creek flow and temperature studies for 2010 are described in the Water Resources Study Plan (HDR 2009c). Specifically, continuous flow and temperature monitoring stations that were set in 2009 will be continued and/or reestablished in 2010. The instream flow study relies on integration of the collected data, described in the previous sections, with the data collected per the Water Resources Study Plan. The data loggers will be downloaded at regular intervals to contribute to analysis during the 2010 field season.

3.2.4.4 Analysis Methods

Field data collected as described above will permit both empirical analysis and habitat modeling as a function of flow.

A number of different graphs can be provided and may include the “wetted perimeter versus flow” relationship, a static cross section of the channel showing substrate distribution and water surface at any flow, and/or a dynamic Excel graphic. A static example of the dynamic graphic is shown below in Figure 4. Changing the value in the “Discharge Window” will adjust the water level up or down corresponding to the stage/discharge formula imbedded in the worksheet. Wetted perimeter and average depth values in the lower right also change with the assigned discharge. Values such as percent of change in wetted perimeter can be easily added to the graphic. This type of dynamic graphic can be provided for any transect, as appropriate.

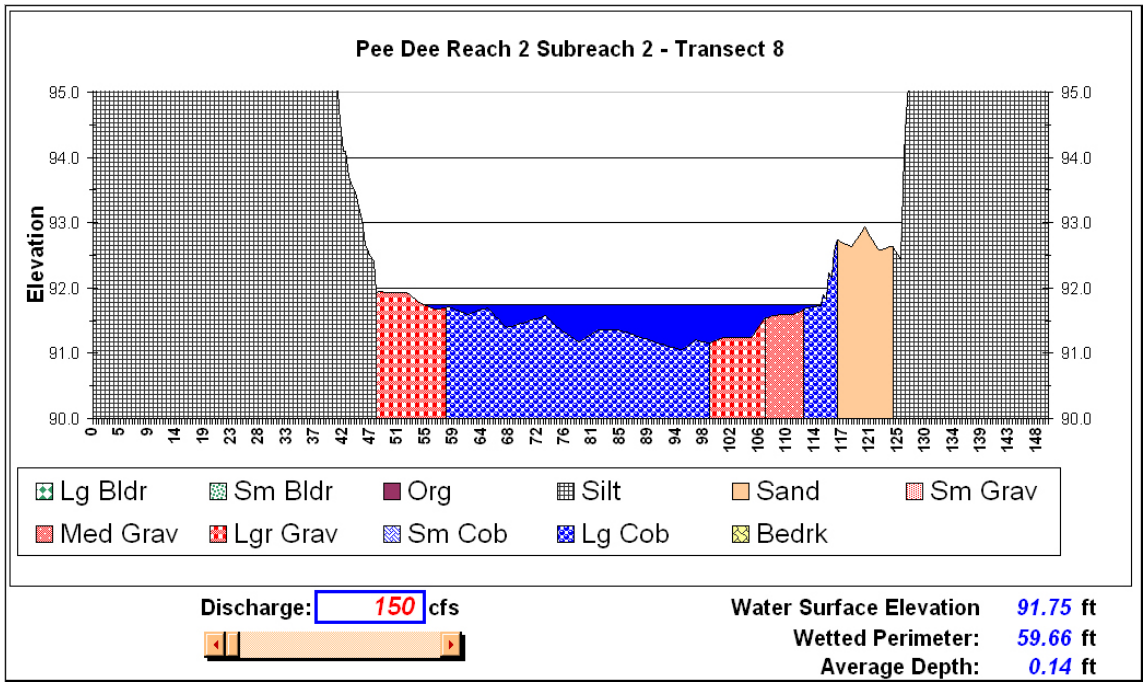

Figure 4. Example of a Channel/Flow Response cross sectional profile.

Collected data will also permit the application of the PHABSIM model and effective habitat model for evaluation of changes in suitable habitat at select transects as a function of flow (Bovee et al. 1998). Site specific habitat suitability will be developed from observations of microhabitat use by fish as described in Section 3.2.4.2 above. KHL will use a commercial version of PHABSIM known as Riverine Habitat Simulation (RHABSIM).

3.2.5 Baseline Studies of Benthic Macroinvertebrates in Grant Creek

Benthic macroinvertebrates inhabit every wetted habitat within a stream system. The various genera of aquatic macroinvertebrates feed on multiple trophic levels ranging from primary consumers to predators. They are the primary food source for many fish species, so the abundance of macroinvertebrates can directly affect fish populations. Benthic macroinvertebrates also serve a role in understanding long-term water quality trends within a stream system. Many benthic macroinvertebrate genera have been assigned “biotic index” values that rate their relative tolerance for environmental stress (e.g., organic pollution or sedimentation). Assigned biotic index values can be used to calculate an average score for a stream system. Repeated collection of macroinvertebrates in the same locations and using the same methods will contribute to overall understanding of stream conditions. Continuing to collect macroinvertebrates consistently from year to year can provide an early indication of changes in aquatic habitat quality.

Benthic macroinvertebrate samples will be collected at two stations on Grant Creek (GC 100 and GC 300) in August, 2010 using the Surber sampling method. This technique is used to accurately characterize population density and taxa richness in a single habitat within a stream system and allows comparison between seasons and/or years.

Five replicate samples will be collected at each station. Each sample is collected from within the same riffle/run area of the stream. A specialized net is placed in the riffle/run which defines a 1

ft^2 area that is then thoroughly examined for invertebrates by kicking, scrubbing and moving substrate and allowing the invertebrates to wash downstream into the net. The contents of the net will be emptied into a sample jar and preserved with 70 percent ethyl alcohol..

Macroinvertebrates will be sorted from substrate material in the laboratory, identified to genus (except for Chironomidae), and counted. Data analyses will include a variety of standard metrics including taxa abundance, taxa diversity, percent dominance, and percent EPT (Ephemeroptera, Plecoptera, Trichoptera).

3.2.6 Baseline Studies of Periphyton in Grant Creek

Periphyton are single-celled algae that typically grow on rocky substrates in streams and rivers. Periphyton will be collected to assess chlorophyll *a* concentration, representing primary productivity, in Grant Creek. Many genera of benthic macroinvertebrates and some fishes depend on periphyton as their primary food source. Chlorophyll *a* concentration also can provide an indication of stream condition.

Periphyton will be collected by isolating a space of known area on a rock and collecting the algae from the space. This material is then sent to a laboratory to be analyzed for chlorophyll *a* content. Collection procedures will be as follows:

- Periphyton samples will be collected in August 2010 at two stream locations within Grant Creek (GC 100 and GC 300).
- Ten periphyton samples will be removed from a defined area on large gravel or cobble collected from the stream substrate.
- The material scrubbed from the rocks will be rinsed and then filtered onto glass fiber filters, preserved, and then frozen.
- The filters will be sent to a laboratory to assess chlorophyll *a* content.

3.3 Quality Control

All data collection will be conducted by experienced personnel. Consistency and completeness will be assured in all field procedures. Data will be recorded on custom standard datasheets; datasheets will be checked for accuracy and completeness by someone other than the recorder. Data entry and management will use a Microsoft Access Database, Excel spreadsheets or other project-specific system for data management. HDR will provide three levels of QA/QC, which are described below.

QC Level 1 Field QC. At the end of each field day the task manager will review the data collected that day and make any needed comments or note any deficiencies that need to be addressed. This review will be noted on each data sheet.

QC Level 2 Line by Line Review. After data has been entered and prior to analysis, all data will be checked for data entry errors and completeness. Any changes to the data relative to data sheets will be documented as will completion of QC Level 2.

QC Level 3 Data Anomalies. Data outliers or inconsistencies identified, typically during analysis, will be evaluated to determine if they are erroneous, the result of sample bias or caused by natural variability. All data anomalies will be handled on a case-by-case basis for inclusion in subsequent analyses.

4 Agency Resource Management Goals

Aquatic resources including fish and their habitats are generally protected by a variety of state and federal mandates. In addition, various land management agencies, local jurisdictions, and non-governmental interest groups have specific goals related to their land management responsibilities or special interests. These goals are expressed in various statutes, plans, and directives:

- Alaska Statute 41.14.170 provides the authority for state regulations to protect the spawning, rearing, or migration of anadromous fish. Alaska Statute 41.14.840 regulates the construction of fishways and dams. State regulations relating to fish resources are generally administered by ADF&G. In addition to the state statutes, the following resource management plans and directives provide guidance and direction for protection of fish resources and aquatic habitats on lands within or adjacent to the Project area:
- Magnuson-Stevens Fishery Conservation and Management Act (PL 104-267) provides federal protection to "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." NOAA's National Marine Fishery Service (NOAA Fisheries) is responsible for designating Essential Fish Habitat (EFH). In the case of anadromous fish streams (principally salmon), NOAA Fisheries has designated the AWC prepared by ADF&G (Johnson and Klein 2009) as the definition of EFH within freshwater habitats.
- Aquatic Resources Implementation Plan for Alaska's Comprehensive Wildlife Conservation Strategy, September 2006. Prepared by Alaska Dept. of Fish and Game, Div. of Sport Fish.
- Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources. Prepared by Alaska Department of Fish and Game, Juneau, Alaska. xviii+824 pp.
- Kenai River Comprehensive Management Plan. Prepared by Alaska Department of Natural Resources, Division of Land and Division of Parks and Outdoor Recreation; in conjunction with Alaska Department of Fish and Game, Habitat and Restoration Division; Kenai Peninsula Borough.
- Kenai Peninsula Borough Comprehensive Plan. Prepared by KPB Planning Department. In 2005. Soldotna, Alaska.
- Kenai Peninsula Borough Coastal Zone Management Plan. Prepared by the Kenai Peninsula Borough Coastal Management Program and LaRoche and Associates. 2008. Kenai Peninsula Borough. Soldotna, Alaska.
- Kenai River Special Management Area (KRSMA), ADNR.
- Final Environmental Impact Statement and the Revised Land and Resource Management Plan for the Chugach National Forest, Chapter 3 Environment and Effects. Prepared by the U.S. Forest Service, 2002.

5 Project Nexus

The proposed Project may have a number of potential impacts on aquatic resources within Grant Creek and Grant Lake. The studies described above are intended to provide sufficient information regarding the nature of the existing aquatic resources such that these potential impacts can be adequately assessed. A discussion of the data will be presented in the study report, and will be used to inform the development of protection, mitigation, and enhancement measures to be proposed in the draft and final License Applications. Some of the direct and indirect Project effects that could impact aquatic resources are itemized below:

- Alteration of the streamflow and temperature regime (depending on the depth of water withdrawal in Grant Lake) in Grant Creek as the result of potential Project operation could affect spawning and rearing habitat for anadromous fish species and habitat for all life stages of resident fish species, depending on the timing and magnitude of flow alteration.
- Changes in water surface elevations in Grant Lake would likely affect aquatic biota in littoral areas, including fish, macroinvertebrates, and macrophytes; the timing and magnitude of lake level changes would dictate the level of effects (the proposed lake level changes would range from 9 feet (ft) above to 25 ft below the natural lake elevation of approximately 700 ft). Areas of shoreline wetlands could also be affected.
- Any dredging of Grant Lake in the vicinity of the proposed intake structure could result in short-term impacts on benthic macroinvertebrate populations in the area.
- Water temperatures in Grant Lake could be influenced by operation of the proposed Project, depending on the depth of water withdrawal.

6 Consistency with Generally Accepted Practices

Sampling methodology for Grant Creek and Grant Lake was designed in consultation with the public, resource agency scientists, and members of the Instream Flow TWG. Quality control of all study plans is maintained by using established methods used elsewhere to assess similar potential resource impacts and are reviewed by outside expert scientific reviewers. Methods proposed herein (use of foot surveys, minnow trapping, angling, block and removal techniques, and radio telemetry) are generally-accepted practices for assessing fish resources.

The instream flow approach, as a whole, is custom-designed for Grant Creek and its unique hydrology, geomorphology, and fish resources. However, each component of the study is a well-known and accepted technique for study application in the field. The integration of these components is accomplished through post-processing and analysis of results.

Macroinvertebrates will be collected using the sampling method described by Eaton et al. (1998). Surber sampling is a preferred method of the USGS and ADF&G. Periphyton will be collected using methods from Eaton et al. (1998).

7 Schedule for Conducting the Study

The start and end of field season, sampling events, and other notable Project licensing milestones are shown below:

- April 2010 – Apply for fish resources sampling permits, secure field equipment, telemetry tags, telemetry tower, traps etc., exploration of Reach 5, instream flow transect measurements.
- May 2010 –Begin rainbow trout angling survey, juvenile fish habitat use sampling, set up instream flow transects and measure low flow water surface elevations and discharge, map transect substrate can cover, collect instream flow habitat suitability measurements.
- June 2010 – Complete rainbow trout survey, data entry and QC for field data, habitat map GIS work, instream flow middle flow water surface elevations, discharge, and transect/meso habitat velocities.
- July 2010 – Juvenile fish habitat use sampling, instream flow habitat suitability measurements, instream flow high water surface elevation measurements, data entry and QC for field data
- August 2010 – Begin foot surveys for spawning salmon, capture and radio tag Chinook salmon, habitat use snorkel surveys, data entry and QC for field data.
- September 2010 – Continue foot surveys for spawning salmon, tracking radio tagged Chinook salmon, juvenile fish habitat use sampling, instream flow habitat suitability measurements, instream flow water surface measurements (if necessary), data entry and QC for field data.
- October 2010 – Continue foot surveys for spawning salmon, continue tracking radio tagged salmon, complete field work and demobilize field equipment, data entry and QC for field data.
- November 2010 – Continue foot surveys for spawning salmon, complete data entry and QC for field data, begin development of draft baseline study reports
- December 2010 – Complete draft study report for internal review
- January 2011- Complete draft study report
- February 2011 – Conduct winter fish sampling
- March 2011 – Complete final study report, prepare draft supplemental report for winter studies
- April 2011 – Complete final supplemental report

8 Provisions for Technical Review

KHL will provide updates and study products for review by the Aquatic Resources Work Group during the licensing process.

- May 2010: distribute draft study plan for review
- June 2010: Issue revised study plan
- May through June 2010: Start of Study Season [varies by study area]
- Mid-Summer 2010: Work Group update on field activities and update to study plan (if necessary per FERC scoping process)
- November 2010: End of Study Season

- Fall 2010: Work Group update on field activities
- January 2011: Distribute draft study report
- February 2011: Work Group meeting/conference call to discuss comments on draft study report
- May 2011: Issue Draft License Application
- September 2011: File Final License Application

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