

*Grant Lake
Proposed Hydroelectric Project*

**2009 Water Quality
Baseline Study Plan**
Draft

Prepared for:

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Grant Lake and Falls Creek Proposed Hydroelectric Projects Water Quality Study Plan, 2009

Introduction

Kenai Hydro LLC contracted with HDR Alaska, Inc. to provide baseline data to support Federal Energy Regulatory Commission (FERC) license applications for a proposed hydroelectric project at Grant Lake near Moose Pass, Alaska (Figure 1).

This study plan outlines study plan objectives that will provide data for preparation of the Environmental Report, Exhibit E, of the FERC license application. These data will also provide information useful in the design mitigation of environmental and other impacts from development of small-scale hydroelectric energy generation at Grant Creek.

Study objectives were developed specifically to address requirements of Exhibit E of the FERC license application process. Some data requirements for Exhibit E are met by previous studies in support of an earlier licensing effort in the 1980s at Grant Lake (see previous studies below). The scope of work defined for this assignment is focused to fill data gaps and provide current information regarding fish and aquatic resources, instream flow requirements, and hydrology.

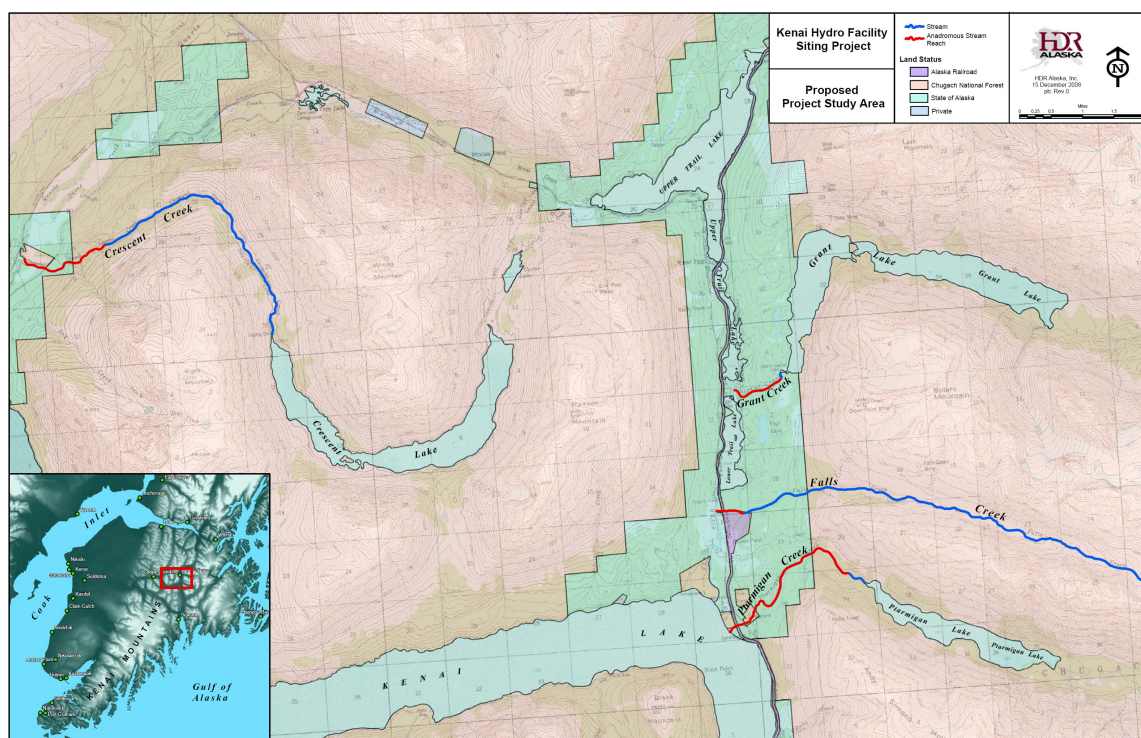


Figure 1. General location of proposed hydroelectric facilities at Grant Lake on the Kenai Peninsula, Alaska

Project History

The hydroelectric potential at Grant Lake (Figure 1) has been evaluated several times as a potential power source for the Seward/Kenai Peninsula area. In 1954, R.W. Beck and Associates (cited by APA 1984) prepared a preliminary investigation and concluded that a project was feasible. The U.S. Geological Survey (USGS) conducted geologic investigations of proposed power sites at Cooper, Grant, Ptarmigan, and Crescent Lakes in the 1950s (Plafker 1955). In 1980 CH₂M Hill (cited by APA, 1984) prepared a pre-feasibility study for a Grant Lake project and concluded that a project developed at the site would be feasible. The Grant Lake Project was referenced in the 1981 U.S. Army Corps of Engineers (USACE) National Hydroelectric Power Resources Study (USACE 1981). The most extensive study was performed by Ebasco Services, Inc. in 1984 for the Alaska Power Authority (now Alaska Energy Authority; APA 1984). Two of the alternatives evaluated by Ebasco included the diversion of adjacent Falls Creek into Grant Lake to provide additional water for power generation. This report relies on the Ebasco report for the basis of the current technical conclusions with regard to hydrology, geotechnical, and environmental considerations.

The Alaska Power Authority (APA) and Ebasco conducted detailed environmental studies of water use and quality; aquatic, botanical and wildlife resources; historical and archaeological resources; socioeconomic impacts; geological and soil resources; recreational resources; aesthetic resources; and land use (APA 1984). The primary environmental impact of Ebasco's preferred project would have been the complete dewatering and subsequent loss of all fish habitat in Grant Creek (natural outflow from Grant Lake; APA 1984). Under this alternative, Grant Creek would have been completely dewatered except for localized run-off and high flow events resulting in spill from the reservoir (APA 1984).

Ebasco (APA 1984) compiled a detailed feasibility report on the Grant Lake hydroelectric project, including environmental issues. The Arctic Environmental Data Center (AEIDC 1983) and USFWS (1961) conducted environmental baseline studies in the project area.

Project Area

The project is located near the community of Moose Pass, Alaska (pop. 206), approximately 25 miles north of Seward, Alaska (pop. 3,016), just east of the Seward Highway (State Route 9); this highway connects Anchorage (pop. 279,671) to Seward. The Alaska Railroad parallels the route of the Seward Highway, and is also adjacent to the project area. The town of Cooper Landing is located 24 miles to the northwest and is accessible via the Sterling Highway (State Route 1) which connects to the Seward Highway approximately 10 miles northwest of Moose Pass.

Grant Lake is located approximately 1.5 miles southeast from Moose Pass. It is located at an elevation of approximately 696 ft above mean sea level (MSL), with a maximum depth of nearly 300 ft and surface area of 2.6 square miles (APA 1984). Grant Lake's total drainage area is approximately 44 square miles. Tributaries include Inlet Creek at the headwaters and other glacial-fed streams in the watershed. Grant Lake consists of an upper and lower portion separated by a natural constriction and island near the midpoint.

The lake is ringed by mountains of the Kenai Mountain Range to the east, north, and south, with elevations ranging from 4,500 to 5,500 ft.

Grant Lake's only outlet, Grant Creek, runs west approximately 1 mile from the south end of Grant Lake to drain into the narrows between Upper and Lower Trail Lake. Trail River drains Lower Trail Lake, and then flows into Kenai Lake. Kenai Lake drains to the Kenai River at its west end near Cooper Landing (APA 1984). Grant Creek has a mean annual flow of 193 cubic feet per second (cfs), is 5,180 ft long, with an average gradient of 207 ft/mi; its substrate includes cobble and boulder alluvial deposits and gravel shoals (APA 1984). The stream is 25 ft wide on average. In its upper half, the stream passes through a rocky gorge with three substantial waterfalls; in its lower half, the stream becomes less turbulent as it passes over gravel shoals and diminishing boulder substrate (APA 1984).

Water Quality Study

Introduction

Previous studies by the USGS, USFS, USFWS, ADFG, and AEIDC collected water quality data in Grant Lake and Grant Creek. Water quality and temperature profiles were measured in Grant Lake in 1960, and 1981-1982 (AEIDC 1983; Figure 2). Four limnology sites were established in the Grant lake basins (upper and lower) in 1983 and water quality and zooplankton data were collected during eight sampling events during open water seasons from June 1983-September 1985 (Marcuson 1989). Water chemistry and physical data for Grant Creek were collected intermittently from 1950-1960 (Still 1976, 1980; USFWS 1961) and again in 1981-82.

Zooplankton samples were collected in Grant Lake in 1981-82 by ADF&G and USFS. Zooplankton and phytoplankton samples were collected and identified to taxa at the four limnology sites established on Grant Lake in 1983 (Marcuson 1989). Benthic macroinvertebrate and periphyton samples were collected in Grant Creek in 1983 (APA 1984).

Water quality and biotic samples will be collected to assess the baseline conditions in Grant Lake and Grant Creek. Data from previous studies on Grant Lake, Grant Creek and similar stream systems will be used to compliment data collected during this study. This information will be important in tracking potential changes in aquatic habitat quality after the project is operating. Currently water flows directly into Grant Creek from the surface of Grant Lake. After project construction water will be drawn from depth through an intake structure and bypass a portion of the stream channel, which could affect the temperature and level of nutrients in Grant Creek and thus overall productivity.

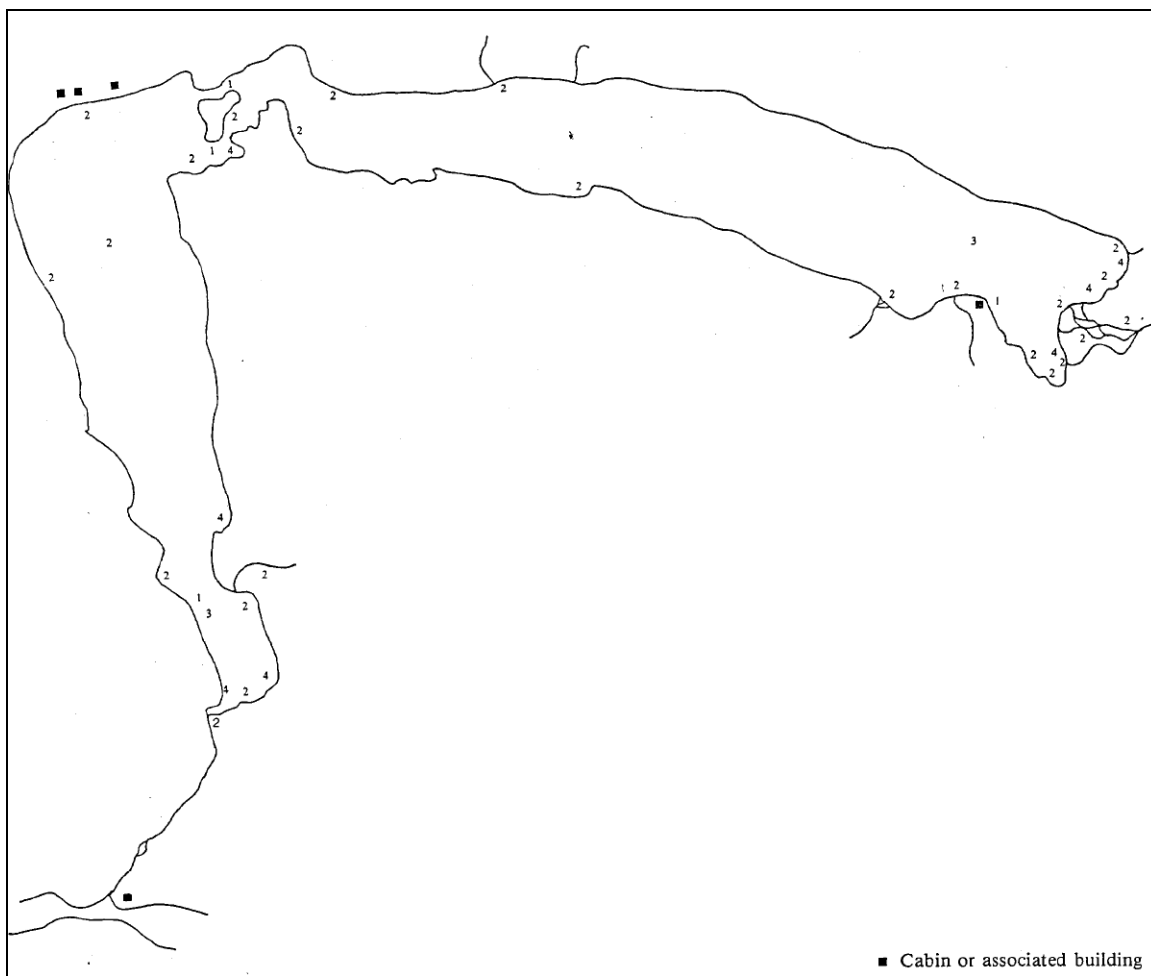


Figure 2. Sites sampled and types of samples collected at Grant Lake in 1981 – 1982 (AEIDC 1983). Numbers represent sampling sites; 1= variable mesh gill net sampling sites, 2= minnow trap sites, 3= plankton and water quality sampling sites, 4= benthos sampling sites.

Goals and Objectives

Study Goals

The water quality study has been designed to gather data on a combination of water quality parameters - including nutrients, lake plankton, stream biomass, and macroinvertebrate populations as needed for the FERC licensing process.

Study Objectives

- Collect water temperature information in a vertical transect near the proposed intake in Grant Lake.
- Collect baseline water quality information in Grant Lake near the natural outlet to the lake and near the proposed intake.
- Collect baseline water quality information in Grant Creek.
- Collect baseline water quality information in Falls Creek upstream of the potential diversion area.
- Collect baseline information on the zooplankton and phytoplankton populations in Grant Lake near the natural outlet to the lake and near the proposed intake
- Collect baseline information on the macroinvertebrate and periphyton populations in Grant Creek
- Build upon data collected in previous studies.

Study Design

Grant Lake water temperature profile

A thermistor string will be suspended and anchored in Grant Lake near the proposed intake for the project. The thermistor string will have temperature sensors at 0.2 meters, 0.5 meters, 1.5 meters, and 3 meters below the lake surface and every three meters after that to a depth of approximately 20 meters; for a total of 10 sensors. Temperature sensors and data loggers will be similar to the HOBO TidbiT or Pro v2. They will be programmed to record data every four hours. The temperature data loggers will be downloaded 2 times a year during the open water season.

Grant Lake water quality

Data on in-situ water quality parameters will be collected at two areas in Grant Lake; near the thermistor string, and in the area of the natural outlet into Grant Creek. In-situ parameters will include; temperature, conductivity, dissolved oxygen, pH, oxygen reduction potential and turbidity. Measurements will be collected at one meter increments, to a depth of up to 20 meters along the thermistor string and to a depth of up to ten meters at the natural outlet of Grant Creek. In-situ measurements will be collected using a YSI 556 multi-parameter meter.

Water samples will be collected near the thermistor string at three depths: one meter below the surface, at mid-depth (approximately 10 meters) or one meter below the thermocline when present, and one meter above the substrate. Samples will be collected at two depths near the natural outlet; one meter below the surface, and five meters below the surface. Water samples will be collected using a Niskin bottle sampler.

A list of water quality parameters appears in Table 1 below. Lead is included because it was detected above the EPA 24-hour average concentration criterion for aquatic life during the 1982 studies, but not above other EPA (EPA Drinking Water Standards and

Freshwater Aquatic Life Criteria, 1976) or State standards (EBASCO 1984). Low level mercury is included because there are mining claims in the Grant Lake watershed.

Table 1. Water Quality Parameters.

Parameter	Units
Alkalinity (CaCO ₃)	mg/L
Total dissolved solids (TDS)	mg/L
Total suspended sediment (TSS)	mg/L
Kjeldahl Nitrogen	mg/L
Nitrate/Nitrite	mg/L
Orthophosphate	mg/L
Total phosphorous	mg/L
Lead	µg/L
pH	STD
Temperature	°C
Dissolved oxygen (DO)	mg/L, %
Specific and Relative Conductivity	mS/cm, µS/cm
Oxygen Reduction Potential (ORP)	mV
Turbidity	NTU
Low level mercury	µg/L

Water quality samples and in-situ measurements will be collected three times per year during open water, May through October. Water samples will be collected at the same time that the thermistor data is downloaded during the month.

Grant Creek and Falls Creek Water Quality

In-situ water quality measurements will be collected at three locations in Grant Creek and one location in Falls Creek. The in-situ parameters measured in the creeks will be the same parameters collected in the lake. Water samples will be collected using depth and width integrated sampling techniques at the locations in which in-situ parameters are measured. A list of analytes is in Table 1, above.

Water quality samples and in-situ measurements will be collected three times per year during open water in May, July and October.

Grant Lake zooplankton and phytoplankton

Zooplankton and phytoplankton will be sampled at the water quality sampling site near the proposed intake and near the natural outlet to Grant Lake. Samples will be collected in July concurrent with water quality sampling. Samples will be collected one meter below the surface, at mid-depth (approximately 10 meters) or one meter below the thermocline if present, and one meter above the substrate. A combination of 80 µm mesh plankton nets and Niskin samplers will be used. Samples will be bottled and labeled separately and preserved. Samples will be processed according to Standard Methods for Water and Wastewater (APHA 1998).

Grant Lake macroinvertebrates

The east end of the upper lobe of Grant Lake has a natural inlet that has formed a marsh area. During the initial sampling event in May the field team will perform a reconnaissance of the marsh area to assess potential macroinvertebrate habitat. In-situ water quality parameters will be measured using a YSI meter. Macroinvertebrates will be collected using modified Alaska Stream Condition Index (ASCI) methods for a reconnaissance level characterization. This information could be used to design future studies if warranted.

Grant Creek macroinvertebrates and periphyton

Benthic macroinvertebrate and periphyton samples will be collected at two of the three water quality sampling locations in Grant Creek. Periphyton will be sampled by removing material from 10 cobbles selected from a riffle/cobble area that has not been disturbed. Periphyton will be scrubbed from a five centimeter square area on each cobble and the material rinsed onto a 45-µm glass fiber filter attached to a hand vacuum pump. Water will be extracted from the sample and 1-ml saturated magnesium carbonate (MgCO₃) solution added to the filter as a preservative. The dry filter will be wrapped in a larger filter (to absorb any additional water) and placed in a labeled zipper seal bag with silica gel desiccant. Filters will be frozen in a lightproof container for shipment to the laboratory (ADFG 1998 and pers. comm. Bill Morris, ADNR, 2007). Samples will be analyzed for chlorophyll *a*.

Macroinvertebrates will be collected using two sampling techniques: the ASCI sampling technique will be used to develop baseline descriptions of macroinvertebrates in a range of habitats within the sampling reach; and surber sampling techniques will be used to assess population densities. The ASCI methods use a D-frame kick net to proportionally sample representative habitats in a 100 meter sampling reach. Habitat information, such as riparian vegetation and stream substrate types, will also be collected. All organisms collected will be composited into one sample per site and preserved in 70% alcohol. In addition to the habitat associated ASCI samples, five samples of macroinvertebrate populations residing specifically in riffle/cobble areas will be collected using surber samplers. Each surber sample will be bottled and preserved separately. Identification will be to genus or the lowest practicable taxon.

Macroinvertebrate and periphyton samples will be collected once during the year in July. Macroinvertebrate samples will be collected at the same time as water quality samples.

Quality Control

Quality control (QC) samples for the water quality study will be collected one time per sampling event. The location of quality control samples will change each event. Since the sampling equipment used in the lake will be different from the equipment used in the creeks one QC sample will be collected from the lake and one from the creeks during each sampling event.

One of the two macroinvertebrate ASCI samples will have a second subsample sorted and identified for QC purposes. Five surber samples will be collected at each sampling location during each sampling event to provide quality assurance and quality control. One duplicate zooplankton and one duplicate phytoplankton sample will be collected in July.

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 systems will be standardized, but each study discipline described above will require some unique management and QC. Data entry and management will be done in a Microsoft Access Database, Excel spreadsheet 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.

Data Analysis

Water quality analytes and in-situ parameters will be analyzed using statistical tests to determine trends within and between sites in the creeks. Similar tests will be used to find trends from the different depths and locations within Grant Lake.

Macroinvertebrate ASCI samples will be subsampled and identified to genus. Pre-established values of tolerance to organic constituents will be assigned to organisms identified in the subsample. Entire surber samples will be identified in order to more accurately assess population densities for biomass availability. Phytoplankton in Grant Lake and periphyton in Grant Creek will be analyzed for chlorophyll *a* concentrations as indicators of productivity. Grant Lake zooplankton samples will be subsampled and identified to order. The subsample population counts will be used to estimate population densities in the water column.

Personnel and Responsibilities

Isaac Watkins: Lead Water Quality Specialist

Duties: Project management, prepare reports and study plan, budget tracking and communications with KHL and resource agencies, coordinate sampling schedule, conduct field work, QA/QC and data analysis, and reporting.

Lynn Spencer: Water Quality Specialist/ Lead Field Water Quality Program

Duties: Supervise field project, study plan design, coordinate sampling schedule, and conduct field work, QA/QC and data analysis, and reporting.

Cindy Milligan: Water Quality Specialist/ Data Analysis

Duties: Responsible for conducting data management of water quality samples; data entry, QA/QC, and statistical analysis.

Jessica Manifold: Environmental Scientist/ Lead Macroinvertebrates

Duties: Supervise macroinvertebrate, zooplankton, and periphyton field programs, Oversee data management, sorting and identification of macroinvertebrate, zooplankton, and periphyton samples.

References

- Alaska Power Authority (APA). 1984. *Grant Lake Hydroelectric Project Detailed Feasibility Analysis. Volume 2. Environmental Report*. Rep. from Ebasco Services Incorporated, Bellevue, Washington.
- Arctic Environmental Information and Data Center (AEIDC). 1983 *Summary of environmental knowledge of the proposed Grant Lake hydroelectric project area*. Final Report submitted to Ebasco Services, Inc., Redmond, Washington, University of Alaska, Anchorage, Alaska.
- CH₂M Hill. 1980. Feasibility assessment – hydropower development at Grant Lake. City of Seward, AK.
- HDR Alaska Inc. 2009. Grant Lake Proposed Hydroelectric Project Reconnaissance Report Draft. Prepared for: Kenai Hydro, LLC.
- Marcuson, P. 1989. Coho salmon fry stocking in Grant Lake, Alaska. Prepared for U.S. Forest Service Seward Ranger District, Chugach National Forest. Seward, Alaska.
- Plafker, G. 1955. Geologic investigations of proposed power sites at Cooper, Grant, Ptarmigan, and Crescent Lakes, AK. U.S. Geological Survey Bulletin 1031-A. U.S. Government Printing Office, Washington D.C.
- R. W. Beck and Associates. 1982. Kenai Peninsula power supply and transmission study supplement.
- Still, P., 1976. Index of surface water quality records to September 30, 1973, southcentral Alaska. US Geological Survey. Anchorage, Alaska. Unpublished data.
- U.S. Army Corps of Engineers (USACE). 1981. *National Hydroelectric Power Study, Regional Report. Regional Report: Volume XXIII – Alaska*. USACE North Pacific Division, Portland, Oregon and Alaska District, Anchorage, Alaska.
- U.S. Fish and Wildlife Service (USFWS). 1961. *Ptarmigan and Grant Lakes and Falls Creek, Kenai Peninsula, Alaska, progress report on the fish and wildlife resources*. Department of the Interior. Juneau, Alaska.